BENCH-SCALE TESTING OF THE MULTI-GRAVITY SEPARATOR IN COMBINATION WITH MICROCEL™

FINAL REPORT VOLUME OF APPENDICES

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by

Gerald H. Luttrell, Parthasarathy Venkatraman, Dennis I. Phillips, and Roe-Hoan Yoon

Center for Coal and Minerals Processing
Virginia Polytechnic Institute and State University
146 Holden Hall
Blacksburg, Virginia 24061-0258

Prepared for:

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Pittsburgh Energy Technology Center
P.O. Box 10940
Pittsburgh, Pennsylvania 15236-0940

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APPENDIX 1

Circuit Design

APPENDIX 1-A

Circuit Design

ET Circuit Flowsheets

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
lb/hr coal	0					475	25	500							500				500	500
lb/hr water	397					1539	25	1167							1167				1564	1564
gpm slurry	0.79					3.80	0.05	3.10							3.06				3.89	3.89
gpm water	0.79					3.08	0.05	2.33							2.3				3.13	3.13
% Solids	0					23.6	50	30							30				24.2	24.2

MGS Circuit Flow Diagram		Pittsburgh Energy Technology Center	
Prepared By:	Date:	Bruceton, PA	
Drawn By:			
Checked By:			
Checked By:			
SH 2	OF 4	Dwg. No. 0002	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
lb/hr coal	0			0	0	408	22	430				430	500	20					500	500
lb/hr water	397			3333	12495	1662	25	1290				1290	4500	15705					17392	17392
gph slurry	0.79			6.7	25	3.91	0.08	3.2				3.2	9.78	31.5					32.6	32.6
gph water	0.79			6.7	25	3.33	0.05	2.6				2.6	9.0	31.4					34.8	34.8
% Solids	0			0	0	19.7	46.8	25				25	10.0	0.44					2.8	2.8

Microcel/MGS Circuit Flow Diagram		Pittsburgh Energy Technology Center	
Prepared By	Date	Bruceton, PA	
Drawn By			
Checked By			
Checked By			
Sheet 3 of 4	Dwg. No. 0003		

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
lb/hr coal	0		0	0	0	205	10	215	430	215	215	430	500	70		500			500	500
lb/hr water	397		2580	3333	12495	1548	10	1161	3870	1161	2709	1290	4500	15705		1167			19972	19972
gpm slurry	0.79		52	6.7	25	34	--	2.6	8.4	2.6	5.8	3.2	9.78	31.5		3.06			40.7	40.7
gpm water	0.79		52	6.7	25	31	--	2.3	7.8	2.3	5.5	2.6	9.0	31.4		2.3			40.0	40.0
% Solids	0		0	0	0	11.7	50	15.6	10	15.6	7.35	25	10	8.44		30			2.44	2.44

APPENDIX 1-B

Circuit Design

Detailed Equipment Specifications

DETAILED LIST OF MAJOR EQUIPMENT

QUAN. REQ'D.	EQUIPMENT DESCRIPTION	UNIT SIZE	CAPACITY	POWER	AIR	WATER
1	Microcel Column (VCCMP)	30" I.D. x 15 ft. H	500 lbs./hr. 10 GPM	— —	25 SCFM @ 25 PSI —	25–30 GPM —
1	MGS Unit (VCCMP)	5'–5" L x 2'–4" W x 3'–8" H	200 lbs./hr. 3 GPM	0.92 KW —	— —	1–3 GPM —
1	2" W.O. Cyclone (VCCMP)	4" L x 3 1/2" W x 10" H	500 lbs./hr. 10 GPM	— —	— —	— —
1	Microcel Sump	2'–6" dia. x 4'–3" H	100 Gal.	—	—	—
1	MGS Sump	2'–6" dia. x 4'–3" H	100 Gal.	—	—	—
1	Cyclone Sump	2'–6" dia. x 4'–3" H	100 Gal.	—	—	—
1	Waste Sump	5' Dia. x 5'–6" H	587 Gal.	—	—	—
1	Microcel Aeration Pump (VCCMP)	45" L x 25" W x 45" H	400 GPM	10 HP	—	1 GPM
1	MGS Feed Pump	20" L x 9 1/2" W x 9 5/16" H	0.1 – 3.5 GPM	1/4 HP	—	—
1	MGS Recycle Pump	43" L x 21" W x 38" H	30 GPM	3 HP	—	1 GPM
1	Microcel Recycle Pump	43" L x 21" W x 38" H	30 GPM	3 HP	—	1 GPM
1	Waste Sump Pump	43" L x 21" W x 38" H	50 GPM	3 HP	—	1 GPM
1	Cyclone Recycle Pump	43" L x 21" W x 38" H	30 GPM	5 HP	—	1 GPM
2	Reagent Pumps (VCCMP)	5" Dia. x 10" L	6 ML/Min.	115 VAC	—	—
2	Reagent Feed Tanks (PTI)	15" dia. x 18" H	5 Gal.	—	—	—
3	Sump Mixers – (Microcel, MGS, & Cyclone)	12" Dia. x 60" L	—	0.65 HP	—	—
1	Sump Mixer – (Waste Sump)	15" dia. x 78" L	—	2.3 HP	—	—
1	Foam Breaker Pump – (VCCMP)	18" L x 12" W x 24" H	20 GPM	2 HP, 440 V	—	—
1	MCC Panel	72" L x 22" W x 56" H	—	35 HP	—	—
1	Control Panel	36" L x 10" W x 48" H	—	115 VAC	10 SCFM – 80 PSI	—
2	Nuclear Density Guages (VCCMP)	12" L x 24" W x 12" H	—	115 VAC	—	—
1	Magnetic Flowmeter – (VCCMP/PTI)	8" dia. x 14" L	30 GPM	115 VAC	—	—
1	Miscellaneous (Instruments, Control Valves)	—	—	115 VAC	10 SCFM – 80 PSI	—

EQUIPMENT/MATERIALS LIST

EQUIPMENT

QUAN. EQUIP/SPARE	DESCRIPTION	VENDOR	ORDER NO.	ESTIMATED EQUIPMENT	ESTIMATED SPARE PARTS	ESTIMATED TOTAL
1	Microcel Column	VPI	-	0	0	0
1	MGS Unit	VPI	-	0	0	0
1	2" W.O. Cyclone	VPI	-	0	0	0
4	Sumps	McGrew	Quote	4,549	0	4,549
1	Microcel Aeration Pump	VPI	-	0	0	0
1	MGS Feed Pump	Gould	Quote	1,400	250	1,650
1	MGS Recycle Pump	Gould	Quote	3,412	350	3,762
1	Microcel Recycle Pump	Gould	Quote	3,412	350	3,762
1	Waste Sump Pump	Gould	Quote	3,412	350	3,762
1	Cyclone Recycle Pump	Gould	Quote	3,436	350	3,786
2	Reagent Pumps	VPI	-	0	0	0
0/1	Reagent Pump (Spare)	PTI	-	0	0	0
2	Reagent Feed Tanks	PTI	-	0	0	0
4	Sump Mixers	Lightnin	Quote	12,177	0	12,177
1	Foam Breaker Pump	VPI	-	0	0	0
SUBTOTAL				31,798	1,650	33,448

EQUIPMENT/MATERIALS LIST

MCC PANEL

QUAN. EQUIP/SPARE	DESCRIPTION	VENDOR	ORDER NO.	ESTIMATED EQUIPMENT	ESTIMATED SPARE PARTS	ESTIMATED TOTAL
1	Enclosure with Subpanel	McJunkin	Quote	1,360	0	1,360
1	Main Contactor w/Accessories	McJunkin	Quote	429	0	429
10	Circuit Breakers	McJunkin	Quote	1,935	0	1,935
10	Starters	McJunkin	Quote	1,695	0	1,695
24	Circuit Breakers	McJunkin	Quote	823	0	823
1 lot	Term, Blocks, Panduit, and Accessories	McJunkin	Quote	275	0	275
1	Main Circuit Breaker	McJunkin	Quote	153	0	153
3	Relays	McJunkin	Quote	65	0	65
1 lot	Shop Assembly, Wiring, Test	Cross	Quote	2,100	0	2,100
1	Control Transformer	McJunkin	Quote	150	0	150
SUBTOTAL				8,985	0	8,985

EQUIPMENT/MATERIALS LIST

CONTROL PANEL

QUAN. EQUIP/SPARE	DESCRIPTION	VENDOR	ORDER NO.	ESTIMATED EQUIPMENT	ESTIMATED SPARE PARTS	ESTIMATED TOTAL
8	Press Regulators w/ Gauges	Wilkerson	Quote	742	0	742
1	Enclosure	Hoffman	Quote	410	0	410
12	Digital Indicators	Action	Quote	3,240	0	3,240
3	Speed Pots	A-B	Quote	354	0	354
2	Controllers	Love	Quote	400	0	400
3	Signal Conditioners	Action	Quote	1,050	0	1,050
1	Power Supply	Sola	Quote	200	0	200
12	Push Buttons	Sq. D	Quote	1,440	0	1,440
100	Terminal Blocks	A-B	Quote	150	0	150
1 Lot	Tubing, Wire, Panduit	Various	Quote	230	0	230
1 Lot	Shop Assy., Wiring, Test	Cross	Quote	3,550	0	3,550
1 Lot	Misc. Spare Parts	Various	Quote	0	1,000	1,000
SUBTOTAL				11,766	1,000	12,766

EQUIPMENT/MATERIALS LIST

FIELD INSTRUMENTS

QUAN. EQUIP/SPARE	DESCRIPTION	VENDOR	ORDER NO.	ESTIMATED EQUIPMENT	ESTIMATED SPARE PARTS	ESTIMATED TOTAL
5/1	Paddle Wheel Flowmeters	Kobold	Quote	2,515	500	3,015
7/1	Pinch Valves	Red Valve	Quote	2,750	350	3,100
2	Level Probes	B & W	Quote	500	0	500
2/1	I/P Transducers	Moore	Quote	600	300	900
1	Col. Eff. Control Valve	Red Valve	Quote	600	0	600
3	Mass Flow Units	VPI	Quote	0	0	0
1	Col. Air Flow Gauge	VPI	Quote	0	0	0
2	Press. Transmitters	VPI	Quote	0	0	0
3	Ground Fault Receptacle	Hubbell	Quote	450	0	450
SUBTOTAL				7,415	1,150	8,565

APPENDIX 2

Test Data and Performance Calculations

APPENDIX 2-A

Test Data and Performance Calculations

Independent Microcel Tests
Pittsburgh No. 8 Seam Coal

Microcel/MGS Independent Testing - Pittsburgh #8

Microcel Conditions Held Constant

Collector Dosage (lbs/ton): 1
Wash Water (lpm): 40.13
Percent Solids (w/w): 11-12
Air Flow Rate (SCFM): 9.01

Microcel Variables

Test Number	Feed Size (microns)	Feed Rate (lbs/hr)	Frother Dosage (ml/min)
101	300	300	1.00
102	300	400	0.50
103	300	500	1.00
104	300	400	1.50
105	200	400	1.00
106	200	500	0.50
107	200	500	1.50
108	200	400	1.00
109	100	300	1.00
110	100	400	0.50
111	100	500	1.00
113	200	300	1.50
114	200	400	1.00
116	200	300	1.50
117	200	400	1.00

Microcel/MGS Independent Tests Results - Pittsburgh #8
Microcel - Ash

Test Number	Measured Column Feed Ash %	Adjusted Column Feed Ash %	Measured Column Product Ash %	Adjusted Column Product Ash %	Measured Column Reject Ash %	Adjusted Column Reject Ash %	Measured Column Ash Yield %	Adjusted Column Ash Yield %
101	20.67	20.67	12.84	12.84	78.25	78.25	88.03	88.03
102	18.57	18.57	7.63	7.63	63.42	63.42	80.39	80.39
103	21.25	21.25	8.97	8.97	74.65	74.65	81.30	81.30
104	21.45	21.45	11.97	11.97	80.10	80.10	86.09	86.09
105	20.30	20.30	9.14	9.14	78.77	78.77	83.97	83.97
106	19.37	19.40	6.59	6.59	45.74	45.69	67.36	67.24
107	19.57	19.57	9.31	9.31	76.06	76.06	84.63	84.63
108	19.64	19.64	9.30	9.30	78.29	78.29	85.01	85.01
109	19.82	19.82	10.16	10.16	72.89	72.89	84.60	84.60
110	20.60	20.60	10.68	10.68	75.33	75.33	84.66	84.66
111	20.66	20.65	11.04	11.04	75.50	75.52	85.08	85.10
113	20.99	20.99	18.32	18.32	77.73	77.73	95.51	95.51
114	20.62	20.70	9.58	9.57	68.75	68.59	81.34	81.14
116	18.94	18.94	11.24	11.24	76.98	76.98	88.29	88.29
117	14.19	14.23	7.03	7.02	64.47	64.36	87.53	87.43

Microcel - Total Sulfur

Test Number	Measured Column Feed T. Sulfur %	Adjusted Column Feed T. Sulfur %	Measured Column Product T. Sulfur %	Adjusted Column Product T. Sulfur %	Measured Column Reject T. Sulfur %	Adjusted Column Reject T. Sulfur %
101	3.14	3.04	2.88	2.95	3.64	3.66
102	2.31	2.51	2.78	2.54	2.44	2.40
103	3.56	3.26	3.14	3.33	2.95	2.99
104	2.96	3.05	3.11	3.03	3.21	3.20
105	2.96	2.96	2.67	2.67	4.49	4.49
106	3.37	2.93	2.61	2.79	3.09	3.21
107	2.92	2.79	2.65	2.74	2.99	3.01
108	2.79	2.82	2.80	2.78	3.04	3.04
109	2.78	2.78	2.77	2.77	2.81	2.81
110	2.85	2.78	2.83	2.89	2.18	2.19
111	2.68	2.90	2.74	2.54	5.10	4.98
113	2.68	2.76	2.74	2.66	5.10	5.09
114	3.29	3.45	3.42	3.28	4.21	4.16
116	2.83	3.00	3.16	2.97	3.24	3.21
117	2.30	2.22	2.19	2.26	1.94	1.95

Microcel - Pyritic Sulfur

Test Number	Measured Column Feed Pyritic S %	Adjusted Column Feed Pyritic S %	Measured Column Product Pyritic S %	Adjusted Column Product Pyritic S %	Measured Column Reject Pyritic S %	Adjusted Column Reject Pyritic S %
101	1.55	1.56	1.38	1.37	2.98	2.97
102	0.91	0.95	0.81	0.78	1.66	1.63
103	1.64	1.56	1.32	1.36	2.39	2.42
104	1.50	1.66	1.62	1.46	2.99	2.90
105	1.53	1.55	1.20	1.19	3.45	3.43
106	0.96	0.91	0.40	0.41	1.90	1.96
107	1.40	1.34	1.15	1.18	2.22	2.24
108	1.43	1.44	1.31	1.30	2.22	2.22
109	0.83	0.88	0.69	0.66	2.09	2.05
110	1.00	1.05	0.99	0.95	1.58	1.56
111	1.13	1.04	0.43	0.44	4.23	4.43
113	0.75	0.86	1.05	0.84	1.52	1.50
114	1.66	1.07	0.47	0.51	3.11	3.50
116	0.93	0.87	0.61	0.63	2.62	2.67
117	0.59	0.41	0.26	0.29	1.18	1.27

Microcel/MGS Independent Tests Results - Pittsburgh #8

Microcel Performance

Test Number	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Pyritic S Rejection %	Pyritic S Separation Efficiency %
101	96.72	45.32	42.04	14.58	11.29	22.69	19.41
102	91.19	66.97	58.16	18.65	9.84	33.99	25.19
103	93.98	65.68	59.66	16.95	10.93	29.12	23.10
104	96.47	51.96	48.44	14.48	10.95	24.29	20.76
105	95.73	62.19	57.92	24.25	19.99	35.53	31.26
106	77.92	77.16	55.08	35.97	13.90	69.71	47.63
107	95.42	59.74	55.16	16.89	12.31	25.48	20.90
108	95.95	59.74	55.70	16.19	12.14	23.25	19.20
109	94.79	56.63	51.43	15.70	10.50	36.55	31.34
110	95.23	56.11	51.34	11.99	7.23	23.41	18.64
111	95.40	54.51	49.91	25.47	20.87	64.00	59.40
113	98.73	16.64	15.38	7.95	6.69	6.72	5.45
114	92.53	62.49	55.02	22.86	15.39	61.32	53.86
116	96.67	47.61	44.28	12.60	9.27	36.07	32.74
117	94.78	56.87	51.65	11.00	5.77	38.16	32.94

Microcel/MGS Independent Tests Results - Pittsburgh #8

Microcel Energy Performance

Test Number	Column Feed Calorific Value Btu/lb	Column Product Calorific Value Btu/lb	Column Reject Calorific Value Btu/lb	Energy Recovery %	SO2 Emission lb/MM Btu	Ash Rejection %	Ash Separation Efficiency % (Based on energy rec.)
101	11791	13113	2072	97.90	4.50	45.32	43.21
102	12146	13992	4575	92.61	3.63	66.97	59.58
103	11693	13766	2680	95.71	4.84	65.68	61.39
104	11660	13260	1760	97.90	4.57	51.96	49.86
105	11854	13737	1984	97.32	3.89	62.19	59.51
106	12006	14168	7568	79.35	3.94	77.16	56.51
107	11977	13709	2442	96.87	4.00	59.74	56.61
108	11965	13710	2065	97.41	4.06	59.74	57.16
109	11935	13565	2977	96.16	4.08	56.63	52.79
110	11803	13477	2565	96.66	4.29	56.11	52.78
111	11795	13417	2533	96.80	3.79	54.51	51.30
113	11737	12188	2160	99.17	4.37	16.64	15.82
114	11786	13665	3703	94.07	4.80	62.49	56.56
116	12083	13383	2287	97.78	4.44	47.61	45.39
117	12878	14095	4417	95.69	3.21	56.87	52.56

APPENDIX 2-B

Test Data and Performance Calculations

Independent Microcel Tests
Illinois No. 6 Seam Coal

Microcel/MGS Independent Testing - Illinois #6

Microcel Conditions Held Constant

Feed Rate (lbs/hr): 500
Wash Water (lpm): 40.1
Percent Solids (w/w): 11-12
Grind Size (d80 (microns)) 200
Air Flow Rate (SCFM): 8.89

Microcel Collector and Frother Dosages

Test Number	Collector Dosage lbs/ton	Frother Dosage ml/min
401	2.00	2.00
402	2.00	1.00
403	3.00	3.00
404	2.00	3.00
405	1.00	3.00
406	1.00	2.00
407	3.00	1.00
408	3.00	2.00
409	1.00	1.00

Microcel/MGS Independent Tests Results - Illinois #6
Microcel - Ash

Test Number	Measured Column Feed Ash %	Adjusted Column Feed Ash %	Measured Column Product Ash %	Adjusted Column Product Ash %	Measured Column Reject Ash %	Adjusted Column Reject Ash %	Measured Column Ash Yield %	Adjusted Column Ash Yield %
401	32.85	32.85	11.89	11.89	73.51	73.51	65.99	65.99
402	39.52	39.56	9.53	9.53	74.00	73.94	53.48	53.38
403	35.85	35.81	12.44	12.44	76.53	76.60	63.47	63.58
404	34.26	34.19	12.17	12.18	75.20	75.32	64.95	65.14
405	35.90	35.90	11.65	11.65	76.25	76.24	62.46	62.46
406	32.23	32.38	12.40	12.38	76.37	76.10	69.00	68.61
407	33.61	33.61	10.52	10.52	73.30	73.30	63.22	63.22
408	34.37	34.32	10.20	10.20	78.12	78.22	64.41	64.54
409	34.53	34.47	8.73	8.73	72.86	72.98	59.77	59.94

Microcel - Total Sulfur

Test Number	Measured Column Feed T. Sulfur %	Adjusted Column Feed T. Sulfur %	Measured Column Product T. Sulfur %	Adjusted Column Product T. Sulfur %	Measured Column Reject T. Sulfur %	Adjusted Column Reject T. Sulfur %
401	4.12	4.22	3.96	3.90	4.90	4.85
402	4.77	4.36	3.88	4.02	4.58	4.75
403	4.23	4.27	4.08	4.06	4.67	4.65
404	4.17	4.60	4.42	4.11	5.81	5.52
405	4.15	3.79	3.25	3.39	4.31	4.46
406	4.13	4.29	4.24	4.12	4.74	4.67
407	3.90	4.07	4.08	3.96	4.32	4.24
408	4.07	4.30	3.70	3.58	5.76	5.60
409	3.99	4.34	3.94	3.74	5.50	5.24

Microcel - Pyritic Sulfur

Test Number	Measured Column Feed Pyritic S %	Adjusted Column Feed Pyritic S %	Measured Column Product Pyritic S %	Adjusted Column Product Pyritic S %	Measured Column Reject Pyritic S %	Adjusted Column Reject Pyritic S %
401	2.58	2.62	1.91	1.90	4.06	4.03
402	3.41	2.80	1.76	1.85	3.58	3.89
403	2.40	2.58	2.01	1.93	3.87	3.70
404	2.47	2.79	2.15	1.99	4.67	4.27
405	2.65	2.61	1.93	1.94	3.69	3.72
406	2.14	2.38	1.97	1.83	3.84	3.59
407	2.10	2.32	1.93	1.82	3.38	3.18
408	2.59	2.74	1.74	1.70	4.82	4.64
409	2.31	2.62	1.72	1.62	4.64	4.13

Microcel/MGS Independent Tests Results - Illinois #6

Microcel Performance

Test Number	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Pyritic S Rejection %	Pyritic S Separation Efficiency %
401	86.58	76.12	62.70	39.02	25.60	52.15	38.73
402	79.90	87.14	67.04	50.79	30.68	64.73	44.63
403	86.72	77.91	64.64	39.55	26.27	52.44	39.16
404	86.93	76.79	63.72	41.80	28.73	53.54	40.46
405	86.08	79.73	65.82	44.14	30.22	53.58	39.66
406	88.91	73.77	62.67	34.11	23.01	47.24	36.15
407	85.21	80.21	65.42	38.49	23.70	50.40	35.61
408	88.24	80.82	69.06	46.27	34.51	59.96	48.20
409	83.48	84.82	68.30	48.35	31.83	62.94	46.42

Microcel Energy Performance

Test Number	Column Feed Calorific Value Btu/lb	Column Product Calorific Value Btu/lb	Column Reject Calorific Value Btu/lb	Energy Recovery %	SO2 Emission lb/MM Btu	Ash Rejection %	Ash Separation Efficiency % (Based on energy rec.)
401	9382	12842	2671	90.31	6.07	76.12	66.43
402	8275	13231	2600	85.35	6.08	87.14	72.49
403	8894	12751	2161	91.15	6.37	77.91	69.06
404	9161	12794	2373	90.97	6.42	76.79	67.77
405	8879	12881	2221	90.61	5.26	79.73	70.34
406	9460	12761	2244	92.55	6.46	73.77	66.32
407	9257	13068	2706	89.25	6.06	80.21	69.46
408	9140	13121	1894	92.65	5.46	80.82	73.47
409	9115	13363	2759	87.87	5.60	84.82	72.69

APPENDIX 2-C

Test Data and Performance Calculations

Independent MGS Tests
Pittsburgh No. 8 Seam Coal

Microcel/MGS Independent Testing - Pittsburgh #8

MGS Conditions Held Constant

Shake Amplitude (mm): 15
 Shake Frequency (cps): 5
 Tilt Angle (degrees): 6

MGS Variables

Test Number	Grind Size (microns)	Drum Speed rpm	Wash Water lpm	Percent Feed Solids w/w	Feed Rate lbs/hr
201	200	280	1.02	35	110
202	200	280	1.02	35	235
203	200	241	1.48	26	169
204	200	280	0.53	25	273
205	200	240	0.53	25	159
206	200	280	0.53	25	100
207	200	280	0.95	26	200
208	200	321	1.10	15	173
209	200	280	0.91	16	261
210	300	281	0.95	35	216
211	300	280	0.98	25	260
212	300	280	1.51	26	215
213	300	280	0.91	25	110
214	300	321	0.95	25	217
215	300	281	0.45	26	215
216	300	241	1.02	25	217
217	300	280	1.02	14	239
218	200	282	0.49	35	210
219	200	280	1.51	35	216
220	200	320	0.98	25	334
221	200	240	0.98	24	347
222	200	280	0.98	26	164
223	200	240	0.98	26	137
224	200	281	1.51	25	313
225	200	281	1.48	16	200
226	200	242	0.98	15	212
227	100	284	0.98	36	197
228	100	282	0.91	25	100
229	100	280	0.98	26	321
230	100	320	0.98	26	198
231	100	280	0.49	25	204
232	100	240	0.98	25	208
233	100	280	1.48	26	200
234	100	280	0.98	15	205
235	200	320	0.95	35	208
236	200	241	0.95	35	223
237	200	320	0.98	25	128
238	200	280	0.98	26	176
239	200	321	0.53	26	186
240	200	321	1.51	25	146
241	200	280	1.59	25	103
242	200	280	0.42	15	236
243	200	280	0.91	16	119

Microcel/MGS Independent Tests Results - Pittsburgh #8

MGS - Ash

Test Number	Measured MGS Feed Ash %	Adjusted MGS Feed Ash %	Measured MGS Lights Ash %	Adjusted MGS Lights Ash %	Measured MGS Heavies Ash %	Adjusted MGS Heavies Ash %	Measured MGS Ash Yield %	Adjusted MGS Ash Yield %
201	18.40	18.42	12.52	12.52	63.86	63.84	88.55	88.50
202	19.36	19.34	12.57	12.58	57.80	57.90	84.99	85.08
203	17.49	17.58	16.13	16.06	73.80	73.76	97.64	97.37
204	20.84	20.80	19.31	14.33	54.04	54.08	95.59	83.72
205	21.41	21.45	19.63	19.60	76.10	76.08	96.85	96.72
206	23.02	22.97	15.00	15.02	73.45	73.52	86.28	86.41
207	21.29	21.24	15.76	15.79	74.51	74.57	90.59	90.73
208	18.14	18.18	13.92	13.90	65.58	65.53	91.83	91.71
209	17.71	17.77	14.13	14.10	44.80	44.75	88.33	88.03
210	19.65	19.66	12.23	12.23	49.77	49.68	80.23	80.16
211	19.92	19.96	19.15	19.11	73.80	73.79	98.59	98.45
212	20.80	20.77	13.70	13.71	59.04	59.08	84.34	84.44
213	21.23	21.20	13.79	13.80	61.81	61.85	84.51	84.60
214	19.80	19.79	12.43	12.43	41.03	41.04	74.23	74.27
215	20.94	20.92	13.93	13.94	51.80	51.82	81.49	81.57
216	20.54	20.50	18.58	18.61	74.54	74.56	96.50	96.62
217	20.06	20.06	17.44	17.44	70.40	70.40	95.05	95.05
218	20.52	20.52	12.57	12.57	48.26	48.26	77.72	77.72
219	20.23	20.21	13.00	13.00	56.13	56.15	83.24	83.29
220	20.31	20.28	12.61	12.62	46.60	46.64	77.35	77.48
221	20.68	20.67	17.63	17.64	69.14	69.15	94.08	94.12
222	21.51	21.48	14.22	14.23	56.77	56.81	82.87	82.97
223	24.72	24.12	22.97	23.48	70.14	70.21	96.29	98.63
224	19.73	19.73	14.05	14.05	56.52	56.52	86.63	86.63
225	19.14	19.13	16.07	16.09	70.74	70.75	94.38	94.44
226	20.06	20.06	19.30	19.30	72.52	72.52	98.57	98.57
227	19.69	19.70	13.50	13.50	55.22	55.21	85.16	85.14
228	20.70	20.69	14.73	14.74	69.12	69.14	89.02	89.06
229	20.89	20.88	16.71	16.72	57.92	57.93	89.86	89.91
230	20.87	20.86	14.54	14.54	51.24	51.25	82.75	82.78
231	20.24	20.28	15.40	15.42	57.05	57.01	88.38	88.31
232	20.19	20.18	17.42	17.43	75.38	75.39	95.22	95.26
233	19.62	19.61	14.64	14.64	64.25	64.26	89.96	89.98
234	19.75	19.76	16.43	16.42	66.11	66.10	93.32	93.28
235	29.22	29.15	11.31	11.31	39.65	39.73	36.80	37.23
236	20.15	20.18	15.99	15.97	72.73	72.70	92.67	92.58
237	22.30	22.25	14.08	14.10	65.96	66.03	84.16	84.31
238	21.00	20.98	15.07	15.07	65.01	65.03	88.13	88.17
239	21.01	21.01	12.46	12.46	47.61	47.61	75.68	75.68
240	21.00	21.00	14.09	14.09	63.50	63.49	86.01	86.01
241	24.47	24.52	17.77	17.75	70.92	70.87	87.39	87.26
242	20.99	21.07	17.30	17.25	65.34	65.28	92.32	92.05
243	19.75	19.79	13.47	13.45	65.16	65.11	87.85	87.73

Microcel/MGS Independent Tests Results - Pittsburgh #8
MGS - Total Sulfur

Test Number	Measured MGS Feed T. Sulfur %	Adjusted MGS Feed T. Sulfur %	Measured MGS Lights T. Sulfur %	Adjusted MGS Lights T. Sulfur %	Measured MGS Heavies T. Sulfur %	Adjusted MGS Heavies T. Sulfur %
201	2.72	2.60	1.76	1.81	8.56	8.70
202	2.83	2.90	1.75	1.73	9.71	9.59
203	2.73	2.73	2.03	2.03	28.57	28.67
204	2.74	2.86	1.80	1.76	8.71	8.52
205	2.89	2.83	2.04	2.07	25.40	25.54
206	2.98	3.18	1.81	1.75	12.73	12.25
207	2.86	2.92	1.90	1.87	13.30	13.17
208	2.82	2.66	1.85	1.91	10.89	10.99
209	2.48	2.48	1.88	1.88	6.95	6.95
210	2.96	2.88	1.79	1.81	7.06	7.16
211	2.89	2.79	2.41	2.48	22.15	22.24
212	2.96	3.00	1.93	1.92	8.91	8.86
213	3.11	3.08	2.04	2.05	8.72	8.75
214	3.09	3.00	1.83	1.85	6.21	6.31
215	3.04	3.00	1.97	1.98	7.48	7.52
216	3.05	3.09	2.37	2.35	24.42	24.34
217	3.56	3.03	2.10	2.28	16.91	17.50
218	3.04	2.96	1.82	1.84	6.76	6.85
219	2.89	2.98	1.89	1.86	8.69	8.56
220	2.76	2.91	1.88	1.83	6.87	6.66
221	2.79	2.80	2.05	2.05	14.76	14.75
222	2.69	2.77	1.81	1.78	7.66	7.56
223	3.38	3.01	2.42	2.61	31.61	32.05
224	2.98	2.91	1.85	1.87	9.57	9.66
225	2.65	2.65	1.96	1.96	14.32	14.32
226	2.87	2.87	2.43	2.43	32.87	32.88
227	2.76	2.67	1.68	1.71	8.08	8.19
228	2.85	2.77	1.76	1.79	10.66	10.78
229	2.77	2.76	1.87	1.87	10.66	10.72
230	2.78	2.77	1.76	1.76	7.62	7.63
231	2.92	2.70	1.79	1.86	8.78	9.01
232	2.90	2.86	1.95	1.97	20.80	20.89
233	2.76	2.69	1.78	1.81	10.50	10.60
234	2.82	2.77	1.93	1.95	14.08	14.16
235	4.46	4.25	1.68	1.69	5.55	5.76
236	2.95	2.92	1.95	1.96	14.85	14.90
237	2.99	3.06	1.85	1.83	9.79	9.67
238	2.96	3.00	1.91	1.89	11.39	11.31
239	3.05	3.00	1.79	1.80	6.65	6.71
240	3.05	3.03	1.87	1.88	10.07	10.10
241	3.55	3.43	2.00	2.03	12.79	12.99
242	2.99	2.89	1.98	2.02	12.81	12.96
243	2.77	2.76	1.84	1.85	9.25	9.27

Microcel/MGS Independent Tests Results - Pittsburgh #8
MGS - Pyritic Sulfur

Test Number	Measured MGS Feed Pyritic S %	Adjusted MGS Feed Pyritic S %	Measured MGS Lights Pyritic S %	Adjusted MGS Lights Pyritic S %	Measured MGS Heavies Pyritic S %	Adjusted MGS Heavies Pyritic S %
201	1.26	1.29	0.45	0.45	7.84	7.73
202	1.35	1.41	0.43	0.42	7.29	7.03
203	1.24	1.39	0.73	0.68	30.11	27.76
204	1.42	1.51	0.50	0.49	7.17	6.78
205	1.58	1.53	0.73	0.74	24.26	24.68
206	1.30	1.71	0.54	0.50	12.24	9.35
207	1.38	1.55	0.56	0.54	12.74	11.43
208	1.45	1.35	0.50	0.51	10.15	10.57
209	1.17	1.21	0.59	0.58	5.93	5.81
210	1.53	1.51	0.47	0.47	5.63	5.69
211	1.18	1.14	0.81	0.83	21.00	21.18
212	1.26	1.40	0.46	0.44	7.33	6.59
213	1.17	1.34	0.47	0.45	7.22	6.23
214	1.18	1.30	0.36	0.35	4.51	4.05
215	1.42	1.53	0.51	0.50	6.53	6.10
216	1.34	1.43	0.75	0.72	22.40	21.59
217	1.34	1.42	0.76	0.74	14.92	14.45
218	1.44	1.51	0.46	0.45	5.38	5.17
219	1.41	1.40	0.48	0.48	6.36	6.25
220	1.36	1.43	0.48	0.47	4.93	4.72
221	1.47	1.51	0.76	0.75	13.93	13.71
222	1.44	1.55	0.57	0.56	6.85	6.41
223	1.89	1.69	1.19	1.27	32.56	31.75
224	1.29	1.36	0.43	0.42	7.72	7.40
225	1.08	1.14	0.52	0.51	12.36	11.91
226	1.14	1.14	0.77	0.77	27.05	27.02
227	1.27	1.31	0.40	0.40	6.72	6.55
228	1.07	1.20	0.36	0.35	9.20	8.15
229	1.19	1.26	0.48	0.47	8.67	8.30
230	1.44	1.49	0.48	0.48	6.57	6.38
231	1.24	1.20	0.42	0.42	6.94	7.08
232	1.28	1.34	0.56	0.55	17.88	17.28
233	1.28	1.37	0.51	0.50	9.68	9.18
234	0.98	1.13	0.48	0.45	12.02	10.54
235	3.62	2.96	0.37	0.37	3.99	4.49
236	1.32	1.48	0.64	0.60	13.76	12.45
237	1.06	1.23	0.31	0.30	7.69	6.26
238	1.62	1.68	0.61	0.60	9.94	9.69
239	1.27	1.31	0.30	0.30	4.61	4.47
240	1.76	1.76	0.57	0.57	9.02	9.04
241	2.24	2.12	0.70	0.71	12.18	11.79
242	1.53	1.61	0.70	0.68	11.40	12.35
243	1.28	1.38	0.56	0.54	7.80	7.35

Microcel/MGS Independent Tests Results - Pittsburgh #8
MGS Performance

Test Number	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	T.Sulfur Rejection %	T.Sulfur Separation Efficiency %	Pyritic S Rejection %	Pyritic S Separation Efficiency %
201	94.90	39.84	34.75	38.39	33.29	69.13	64.03
202	92.21	44.66	36.87	49.24	41.46	74.66	66.87
203	99.16	11.05	10.21	27.60	26.76	52.37	51.53
204	90.56	42.32	32.88	48.48	39.04	72.83	63.39
205	99.00	11.62	10.62	29.25	28.25	53.22	52.22
206	95.33	43.50	38.83	52.45	47.78	74.73	70.06
207	97.01	32.55	29.56	41.90	38.90	68.39	65.40
208	96.51	29.88	26.39	34.15	30.66	65.35	61.86
209	91.95	30.15	22.11	33.27	25.23	57.81	49.76
210	87.57	50.13	37.71	49.62	37.20	75.05	62.62
211	99.49	5.75	5.24	12.49	11.98	28.32	27.82
212	91.96	44.26	36.23	45.96	37.92	73.46	65.43
213	92.54	44.93	37.47	43.69	36.24	71.59	64.13
214	81.09	53.35	34.44	54.20	35.29	80.00	61.09
215	88.77	45.64	34.42	46.16	34.94	73.34	62.12
216	98.92	12.29	11.21	26.52	25.44	51.35	50.27
217	98.17	17.36	15.53	28.48	26.64	50.47	48.63
218	85.50	52.39	37.89	51.68	37.18	76.84	62.34
219	90.82	46.42	37.24	48.01	38.83	71.44	62.26
220	84.93	51.78	36.71	51.27	36.20	74.53	59.46
221	97.71	19.68	17.39	31.09	28.80	53.25	50.97
222	90.63	45.03	35.67	46.68	37.32	70.02	60.66
223	99.46	3.99	3.45	14.48	13.94	25.88	25.34
224	92.76	38.31	31.07	44.33	37.09	73.25	66.00
225	97.99	20.57	18.56	30.15	28.14	57.75	55.74
226	99.51	5.16	4.67	16.54	16.05	33.42	32.93
227	91.71	41.66	33.37	45.48	37.18	74.00	65.71
228	95.74	36.55	32.29	42.45	38.19	74.02	69.77
229	94.63	28.01	22.64	39.09	33.72	66.46	61.10
230	89.39	42.30	31.69	47.40	36.80	73.33	62.73
231	93.70	32.85	26.55	39.16	32.86	69.09	62.79
232	98.54	17.73	16.26	34.39	32.92	60.90	59.44
233	95.55	32.82	28.37	39.45	35.00	67.16	62.71
234	97.16	22.49	19.65	34.34	31.50	62.85	60.01
235	46.60	85.56	32.16	85.20	31.80	95.35	41.95
236	97.46	26.74	24.20	37.86	35.32	62.47	59.93
237	93.14	46.57	39.72	49.58	42.72	79.44	72.58
238	94.76	36.67	31.43	44.45	39.22	68.51	63.28
239	83.87	55.12	38.99	54.59	38.46	82.67	66.54
240	93.54	42.29	35.83	46.63	40.17	72.14	65.68
241	95.08	36.84	31.92	48.36	43.44	70.78	65.86
242	96.50	24.64	21.14	35.66	32.16	61.12	57.62
243	94.66	40.38	35.04	41.20	35.86	65.67	60.33

Microcel/MGS Independent Tests Results - Pittsburgh #8

MGS Energy Performance

Test Number	MGS Feed Calorific Value Btu/lb	MGS Lights Calorific Value Btu/lb	MGS Heavies Calorific Value Btu/lb	Energy Recovery %	SO2 Emission lb/MM Btu	Pyritic S Rejection %	Pyritic S Separation Efficiency % (Based on energy rec.)
201	12171	13167	4505	95.75	2.75	69.13	64.87
202	12016	13157	5507	93.16	2.63	74.66	67.82
203	12313	12569	2830	99.39	3.23	52.37	51.76
204	11769	12861	6152	91.49	2.74	72.83	64.32
205	11660	11972	2439	99.31	3.46	53.22	52.53
206	11403	12745	2871	96.58	2.75	74.73	71.31
207	11695	12615	2693	97.86	2.96	68.39	66.26
208	12211	12934	4219	97.14	2.95	65.35	62.49
209	12281	12900	7727	92.47	2.91	57.81	50.27
210	11962	13216	6895	88.56	2.74	75.05	63.61
211	11911	12055	2825	99.63	4.11	28.32	27.96
212	11774	12966	5308	92.98	2.96	73.46	66.45
213	11702	12951	4840	93.63	3.17	71.59	65.22
214	11940	13182	8353	82.00	2.81	80.00	62.01
215	11749	12927	6533	89.75	3.06	73.34	63.10
216	11820	12139	2695	99.23	3.87	51.35	50.58
217	11894	12336	3397	98.59	3.70	50.47	49.05
218	11817	13158	7134	86.55	2.80	76.84	63.39
219	11869	13086	5803	91.83	2.84	71.44	63.27
220	11857	13150	7408	85.93	2.78	74.53	60.47
221	11791	12303	3608	98.20	3.33	53.25	51.45
222	11654	12878	5691	91.69	2.76	70.02	61.71
223	11209	11317	3429	99.58	4.61	25.88	25.46
224	11950	12909	5740	93.58	2.90	73.25	66.82
225	12051	12564	3338	98.46	3.12	57.75	56.21
226	11894	12022	3039	99.64	4.04	33.42	33.06
227	11955	13001	5961	92.59	2.63	74.00	66.59
228	11788	12792	3610	96.65	2.80	74.02	70.67
229	11756	12458	5502	95.28	3.00	66.46	61.74
230	11759	12826	6630	90.29	2.74	73.33	63.63
231	11857	12677	5657	94.42	2.93	69.09	63.51
232	11874	12338	2555	98.98	3.19	60.90	59.88
233	11970	12809	4434	96.29	2.83	67.16	63.45
234	11945	12509	4123	97.68	3.12	62.85	60.53
235	10360	13371	8574	48.05	2.53	95.35	43.39
236	11874	12585	3009	98.12	3.11	62.47	60.59
237	11525	12900	4135	94.37	2.84	79.44	73.81
238	11739	12736	4304	95.66	2.97	68.51	64.17
239	11734	13177	7244	84.98	2.73	82.67	67.65
240	11735	12902	4564	94.56	2.91	72.14	66.70
241	11141	12284	3318	96.20	3.31	70.78	66.98
242	11724	12368	4261	97.11	3.27	61.12	58.23
243	11940	13010	4290	95.59	2.84	65.67	61.26

APPENDIX 2-D

Test Data and Performance Calculations

Independent MGS Tests
Illinois No. 6 Seam Coal

Microcel/MGS Independent Testing - Illinois #6

MGS Conditions Held Constant

Shake Amplitude (mm): 15
 Shake Frequency (cps): 5
 Tilt Angle (degrees): 6
 Grind Size (d80 (microns)): 200

MGS Variables

Test Number	Drum Speed rpm	Wash Water lpm	Percent Feed Solids w/w	Feed Rate lbs/hr
501	280	0.76	30.71	345
502	280	0.76	24.16	199
503	281	1.63	34.63	200
504	321	1.51	25.81	212
505	280	0.00	18.95	234
506	280	0.76	17.14	306
507	281	0.80	29.60	242
508	283	1.51	24.46	272
509	280	0.00	26.32	293
510	281	0.83	33.89	141
511	283	0.68	25.56	210
512	320	0.83	17.06	207
513	241	1.55	26.40	216
514	320	0.76	28.13	141
515	320	0.80	37.77	230
516	240	0.76	24.36	267
517	280	0.00	30.11	155
518	241	0.80	37.18	225
519	320	0.76	25.38	279
520	281	0.83	18.24	136
521	280	1.59	28.63	148
522	240	0.80	29.61	153
523	241	0.83	17.22	209
524	281	1.59	17.30	214
525	322	0.00	25.72	217
526	241	0.00	26.20	227
527	281	0.00	37.75	260

Microcel/MGS Independent Tests Results - Illinois #6
MGS - Ash

Test Number	Measured MGS Feed Ash %	Adjusted MGS Feed Ash %	Measured MGS Lights Ash %	Adjusted MGS Lights Ash %	Measured MGS Heavies Ash %	Adjusted MGS Heavies Ash %	Measured MGS Ash Yield %	Adjusted MGS Ash Yield %
501	32.28	32.01	24.08	24.20	65.43	65.64	80.17	81.15
502	35.28	35.54	24.07	23.98	68.64	68.39	74.85	73.97
503	35.83	35.95	24.40	24.36	68.57	68.45	74.12	73.71
504	32.61	32.93	22.13	22.02	65.79	65.46	76.00	74.88
505	37.56	37.74	28.55	28.47	68.19	68.05	77.27	76.58
506	36.14	35.17	29.76	30.34	69.59	70.03	83.98	87.83
507	31.61	31.77	20.70	20.65	65.80	65.63	75.81	75.28
508	32.18	32.24	23.05	23.02	68.55	68.49	79.93	79.72
509	32.40	31.68	20.59	20.80	58.53	59.20	68.87	71.67
510	33.53	33.92	24.56	24.40	65.36	65.01	78.01	76.56
511	37.47	37.03	24.10	24.23	65.89	66.31	68.01	69.58
512	36.43	36.09	27.18	27.33	66.69	66.94	76.59	77.88
513	33.33	33.33	26.24	26.24	75.33	75.33	85.56	85.56
514	31.75	31.90	20.06	20.02	60.45	60.29	71.06	70.50
515	34.55	35.00	23.86	23.71	61.98	61.55	71.96	70.16
516	33.01	33.44	26.82	26.58	70.28	69.97	85.76	84.19
517	34.65	34.69	20.79	20.78	58.39	58.35	63.14	62.98
518	35.65	35.74	28.57	28.52	73.67	73.61	84.30	83.99
519	31.47	31.51	20.76	20.75	60.49	60.45	73.04	72.90
520	35.66	35.31	25.56	25.70	70.58	70.87	77.57	78.72
521	36.83	37.02	24.80	24.74	70.34	70.15	73.58	72.96
522	38.39	38.43	27.62	27.61	73.02	72.99	76.28	76.16
523	39.76	39.70	36.26	37.03	72.02	72.04	90.21	92.37
524	35.76	36.06	35.57	31.42	70.92	70.78	99.46	88.21
525	36.78	36.23	24.29	24.45	58.76	59.23	63.77	66.13
526	38.95	39.15	36.81	34.41	64.69	64.60	92.32	84.30
527	34.68	34.63	25.27	25.29	61.08	61.12	73.72	73.93

Microcel/MGS Independent Tests Results - Illinois #6
MGS - Total Sulfur

Test Number	Measured MGS Feed T. Sulfur %	Adjusted MGS Feed T. Sulfur %	Measured MGS Lights T. Sulfur %	Adjusted MGS Lights T. Sulfur %	Measured MGS Heavies T. Sulfur %	Adjusted MGS Heavies T. Sulfur %
501	3.65	3.53	2.43	2.47	7.97	8.08
502	4.02	4.08	2.42	2.40	8.94	8.86
503	4.27	4.22	2.42	2.43	9.18	9.24
504	4.01	3.92	2.43	2.46	8.19	8.29
505	4.27	4.13	2.37	2.40	9.64	9.80
506	3.87	3.60	2.49	2.59	10.70	10.95
507	4.08	4.17	2.53	2.51	9.33	9.22
508	4.00	3.99	2.56	2.56	9.60	9.61
509	4.04	4.02	2.44	2.44	8.00	8.02
510	3.68	3.76	2.30	2.28	8.69	8.59
511	4.92	4.78	2.58	2.61	9.59	9.75
512	4.27	4.08	2.45	2.50	9.45	9.65
513	4.24	4.24	2.73	2.73	13.19	13.19
514	4.19	4.16	2.53	2.54	8.03	8.06
515	4.57	4.11	2.27	2.35	7.84	8.24
516	4.21	4.20	2.66	2.66	12.35	12.37
517	4.42	4.34	2.50	2.52	7.35	7.43
518	4.38	4.34	2.54	2.55	13.67	13.73
519	3.73	3.88	2.42	2.37	8.13	7.94
520	4.39	4.18	2.46	2.51	10.11	10.35
521	4.78	4.73	2.56	2.57	10.48	10.55
522	4.91	4.99	2.74	2.72	12.37	12.25
523	4.26	3.89	2.67	2.81	16.54	16.97
524	4.19	3.66	2.49	2.65	10.81	11.22
525	3.85	3.93	2.29	2.27	7.25	7.16
526	4.34	3.86	2.49	2.62	10.09	10.50
527	4.28	4.02	2.44	2.50	8.06	8.30

Microcel/MGS Independent Tests Results - Illinois #6
MGS - Pyritic Sulfur

Test Number	Measured MGS Feed Pyritic S %	Adjusted MGS Feed Pyritic S %	Measured MGS Lights Pyritic S %	Adjusted MGS Lights Pyritic S %	Measured MGS Heavies Pyritic S %	Adjusted MGS Heavies Pyritic S %
501	1.88	1.37	0.78	0.85	3.31	3.61
502	2.35	1.85	0.85	0.90	4.14	4.55
503	2.58	1.78	0.76	0.81	4.00	4.50
504	2.12	1.61	0.72	0.76	3.75	4.14
505	2.34	1.76	0.86	0.92	4.08	4.49
506	2.12	1.53	0.97	1.08	4.46	4.78
507	2.19	1.50	0.74	0.80	3.27	3.65
508	2.13	1.72	0.90	0.96	4.39	4.74
509	1.90	1.52	0.73	0.77	3.14	3.43
510	1.95	1.56	0.74	0.78	3.76	4.10
511	2.91	1.98	0.92	0.98	3.77	4.25
512	2.61	1.73	0.89	0.97	3.98	4.43
513	2.55	1.97	1.08	1.17	6.24	6.74
514	2.09	1.49	0.64	0.68	3.05	3.43
515	2.45	1.65	0.64	0.68	3.45	3.93
516	2.32	1.85	1.01	1.08	5.53	5.95
517	2.36	1.62	0.76	0.81	2.65	3.00
518	2.43	1.88	1.00	1.08	5.60	6.07
519	1.97	1.40	0.67	0.72	2.91	3.25
520	2.62	1.73	0.80	0.87	4.39	4.92
521	2.83	1.91	0.79	0.84	4.23	4.79
522	2.78	2.11	0.92	0.98	5.18	5.73
523	2.54	2.26	1.17	1.22	14.14	14.80
524	2.61	2.27	1.13	1.19	9.79	10.36
525	2.46	2.55	0.78	0.77	6.20	6.01
526	2.98	2.59	1.16	1.21	9.41	10.02
527	2.52	2.37	0.72	0.73	6.73	7.01

Microcel/MGS Independent Tests Results - Illinois #6
MGS Performance

Test Number	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	T.Sulfur Rejection %	T.Sulfur Separation Efficiency %	Pyritic S Rejection %	Pyritic S Separation Efficiency %
501	90.48	38.65	29.12	43.22	33.69	49.65	40.12
502	87.24	50.09	37.33	56.49	43.72	64.01	51.25
503	87.05	50.05	37.10	57.55	44.61	66.46	53.51
504	87.07	49.93	36.99	53.01	40.07	64.65	51.72
505	87.98	42.23	30.21	55.50	43.48	59.97	47.95
506	94.37	24.23	18.61	36.81	31.18	38.00	32.38
507	87.55	51.07	38.62	54.69	42.24	59.85	47.40
508	90.57	43.08	33.65	48.85	39.42	55.50	46.07
509	83.08	52.95	36.03	56.50	39.58	63.70	46.77
510	87.59	44.93	32.52	53.58	41.16	61.72	49.31
511	83.73	54.47	38.20	62.01	45.73	65.56	49.29
512	88.56	41.02	29.58	52.28	40.84	56.33	44.89
513	94.66	32.64	27.30	44.91	39.57	49.19	43.84
514	82.80	55.76	38.55	56.95	39.75	67.83	50.62
515	82.35	52.47	34.82	59.88	42.23	71.08	53.43
516	92.87	33.08	25.95	46.68	39.55	50.85	43.72
517	76.39	62.28	38.66	63.43	39.82	68.51	44.90
518	93.42	32.98	26.40	50.65	44.08	51.75	45.18
519	84.35	52.00	36.35	55.47	39.82	62.51	46.86
520	90.42	42.70	33.12	52.73	43.15	60.41	50.83
521	87.18	51.24	38.43	60.36	47.54	67.91	55.10
522	89.54	45.29	34.83	58.49	48.03	64.63	54.17
523	96.46	13.84	10.30	33.27	29.74	50.13	46.60
524	94.61	23.14	17.75	36.13	30.74	53.76	48.37
525	78.35	55.37	33.72	61.80	40.15	80.03	58.38
526	90.87	25.91	16.77	42.78	33.65	60.62	51.48
527	84.50	46.01	30.50	54.02	38.52	77.23	61.72

Microcel/MGS Independent Tests Results - Illinois #6

MGS Energy Performance

Test Number	MGS Feed Calorific Value Btu/lb	MGS Lights Calorific Value Btu/lb	MGS Heavies Calorific Value Btu/lb	Energy Recovery %	SO2 Emission lb/MM Btu	Pyritic S Rejection %	Pyritic S Separation Efficiency % (Based on energy rec.)
501	9521	10810	3970	92.14	4.57	49.65	41.79
502	8938	10846	3517	89.76	4.43	64.01	53.77
503	8871	10784	3507	89.61	4.51	66.46	56.07
504	9369	11170	4000	89.28	4.40	64.65	53.93
505	8575	10105	3573	90.24	4.75	59.97	50.21
506	8999	9797	3246	95.61	5.29	38.00	33.61
507	9561	11396	3972	89.73	4.41	59.85	49.58
508	9483	11005	3500	92.52	4.65	55.50	48.02
509	9575	11371	5033	85.11	4.29	63.70	48.80
510	9206	10777	4074	89.62	4.23	61.72	51.35
511	8692	10805	3860	86.49	4.83	65.56	52.05
512	8848	10293	3756	90.61	4.86	56.33	46.94
513	9303	10473	2371	96.32	5.21	49.19	45.51
514	9539	11500	4853	84.99	4.42	67.83	52.82
515	9028	10891	4645	84.65	4.32	71.08	55.73
516	9285	10417	3256	94.46	5.11	50.85	45.31
517	9079	11375	5174	78.90	4.43	68.51	47.41
518	8905	10097	2655	95.23	5.05	51.75	46.98
519	9604	11379	4827	86.38	4.17	62.51	48.89
520	8976	10562	3107	92.64	4.75	60.41	53.05
521	8694	10721	3226	89.97	4.79	67.91	57.88
522	8461	10247	2757	92.23	5.31	64.63	56.86
523	8252	8692	2914	97.31	6.47	50.13	47.44
524	8853	9618	3122	95.84	5.51	53.76	49.60
525	8825	10769	5028	80.70	4.22	80.03	60.73
526	8343	9125	4142	92.20	5.74	60.62	52.82
527	9089	10630	4716	86.47	4.70	77.23	63.70

APPENDIX 2-E

Test Data and Performance Calculations

Combined Microcel/MGS Tests
Pittsburgh No. 8 Seam Coal

Microcel/MGS Combined Testing - Pittsburgh #8

Conditions Held Constant

Microcel

Wash Water (lpm):	40.12
Percent Solids (w/w):	14.5 - 15.5
Grind Size (d80 (microns))	200
Air Flow Rate (SCFM):	8.89
Diesel dosage (lbs/ton):	1
Frother Dosage (ml/min):	1

MGS

Percent Solids (w/w):	18 - 22
Shake Frequency (cps):	5
Shake Amplitude (mm):	15
Tilt Angle (degrees):	6

Microcel/MGS Combined Testing - Pittsburgh #8
Combined Variables

Test Number	Column Feed (lbs/hr)	Drum Speed rpm	Wash Water lpm	MGS Feed lbs/hr
301	512	282	0.51	249
302	527	283	1.02	378
303	415	241	1.51	259
304	392	242	0.98	373
305	414	280	0.49	381
306	427	282	1.06	260
307	420	322	1.50	241
308	414	242	0.98	124
309	415	320	0.98	351
310	391	280	0.49	135
311	397	280	1.51	393
312	410	280	1.55	134
313	458	280	0.95	259
314	302	280	0.98	160
315	333	241	1.00	267
316	529	281	0.98	141
317	474	241	0.98	276
318	491	320	0.98	267
319	491	282	1.55	285
320	444	242	0.49	326
321	383	280	0.95	313
322	427	320	0.51	297
323	393	320	0.97	170
324	311	281	0.51	268
325	318	281	1.55	285
326	294	280	0.95	474
327	324	320	0.98	328

Combined Microcel/MGS Tests Results - Pittsburgh #8

Ash

Test No.	Microcel						MGS						Yields					
	Measured Microcel Feed Ash %	Adjusted Microcel Feed Ash %	Measured Microcel Product Ash %	Adjusted Microcel Product Ash %	Measured Microcel Reject Ash %	Adjusted Microcel Reject Ash %	Measured MGS Feed Ash %	Adjusted MGS Feed Ash %	Measured MGS Lights Ash %	Adjusted MGS Lights Ash %	Measured MGS Heavies Ash %	Adjusted MGS Heavies Ash %	Measured Microcel Ash Yield %	Adjusted Microcel Ash Yield %	Measured MGS Ash Yield %	Adjusted MGS Ash Yield %	Measured Combined Ash Yield %	Adjusted Combined Ash Yield %
301	20.31	20.36	7.47	7.57	72.45	72.32	7.60	7.57	6.83	6.77	53.98	53.92	80.24	80.25	98.37	98.30	78.93	78.89
302	19.41	19.40	7.98	7.96	69.68	69.70	7.98	7.96	6.93	6.95	57.86	57.89	81.47	81.47	97.94	98.02	79.80	79.86
303	20.10	20.02	9.20	9.15	77.29	77.48	9.17	9.15	8.99	9.06	60.68	60.69	83.99	84.09	99.65	99.83	83.70	83.95
304	22.84	23.00	7.08	7.42	64.50	64.16	7.69	7.42	7.35	7.22	47.83	47.80	72.55	72.54	99.16	99.51	71.94	72.18
305	19.66	19.71	7.68	7.77	72.82	72.69	7.83	7.77	6.98	6.94	57.61	57.57	81.61	81.61	98.32	98.36	80.24	80.27
306	20.15	20.26	8.19	8.39	71.77	71.50	8.57	8.39	7.46	7.41	61.01	60.95	81.19	81.19	97.93	98.17	79.51	79.71
307	20.49	20.58	8.00	8.17	73.95	73.72	8.21	8.17	6.72	6.63	58.79	58.57	81.06	81.07	97.14	97.04	78.74	78.66
308	20.11	20.06	8.09	8.69	76.48	76.60	10.04	8.69	7.96	8.23	25.98	26.06	82.42	83.26	88.46	97.42	72.91	81.11
309	20.11	20.48	7.69	7.96	72.73	71.78	8.34	7.96	6.72	6.73	52.71	52.73	80.90	80.38	96.48	97.33	78.05	78.23
310	21.23	21.38	7.57	7.85	75.72	75.33	7.97	7.85	7.17	7.00	59.67	59.47	79.96	79.95	98.48	98.38	78.74	78.65
311	20.67	20.74	7.12	7.26	71.98	71.79	7.29	7.26	6.82	6.71	59.70	59.61	79.11	79.11	99.11	98.96	78.41	78.29
312	19.79	19.94	7.11	7.40	71.50	71.10	7.50	7.40	6.97	6.77	59.38	59.20	80.31	80.31	98.99	98.80	79.50	79.35
313	17.89	17.89	8.14	8.13	77.50	77.51	8.35	8.13	7.07	7.23	58.40	58.60	85.94	85.93	97.51	98.25	83.80	84.43
314	18.17	18.45	7.87	8.08	75.10	74.35	8.27	8.08	7.33	7.26	61.51	61.43	84.68	84.35	98.27	98.49	83.21	83.08
315	20.62	20.58	7.82	7.74	69.35	69.44	7.71	7.74	7.52	7.56	53.81	53.82	79.20	79.19	99.59	99.61	78.87	78.88
316	19.75	19.80	7.42	7.50	67.39	67.28	7.54	7.50	7.07	7.02	58.78	58.75	79.44	79.42	99.09	99.07	78.72	78.69
317	20.59	20.78	7.50	7.85	71.82	71.35	8.18	7.85	7.45	7.36	41.29	41.25	79.65	79.64	97.84	98.55	77.93	78.49
318	19.12	19.13	7.33	7.34	66.15	66.14	7.36	7.34	5.93	5.94	50.41	50.43	79.96	79.95	96.79	96.85	77.39	77.43
319	18.58	18.72	6.97	7.23	60.70	60.38	7.36	7.23	6.59	6.45	57.95	57.79	78.39	78.38	98.50	98.48	77.22	77.19
320	20.44	20.42	7.59	7.55	68.56	68.61	7.54	7.55	7.14	7.17	45.88	45.89	78.92	78.92	98.97	99.02	78.11	78.15
321	22.41	22.42	7.11	7.13	66.11	66.08	7.12	7.13	6.41	6.39	57.48	57.45	74.07	74.06	98.61	98.55	73.04	72.99
322	21.45	21.44	7.08	7.06	71.53	71.55	7.01	7.06	5.58	5.57	38.89	38.86	77.70	77.70	95.71	95.52	74.37	74.22
323	20.10	20.09	7.53	7.52	58.97	58.98	7.51	7.52	5.54	5.54	41.55	41.55	75.56	75.57	94.53	94.50	71.43	71.42
324	22.41	22.43	7.69	7.73	58.40	58.36	7.75	7.73	6.85	6.83	55.72	55.69	70.97	70.97	98.16	98.16	69.67	69.66
325	18.51	18.58	7.03	7.17	64.89	64.71	7.20	7.17	6.51	6.42	57.45	57.34	80.16	80.17	98.65	98.53	79.07	78.99
326	21.45	21.38	7.81	7.75	70.69	70.85	7.69	7.75	6.90	6.90	57.78	57.78	78.31	78.40	98.45	98.33	77.09	77.09
327	23.51	23.73	7.71	7.83	72.81	72.29	8.04	7.83	5.93	5.96	35.50	35.57	75.73	75.33	92.86	93.68	70.33	70.58

Combined Microcel/MGS Tests Results - Pittsburgh #8

Total Sulfur

Test Number	Microcel						MGS					
	Measured Microcel Feed T. Sulfur %	Adjusted Microcel Feed T. Sulfur %	Measured Microcel Product T. Sulfur %	Adjusted Microcel Product T. Sulfur %	Measured Microcel Reject T. Sulfur %	Adjusted Microcel Reject T. Sulfur %	Measured MGS Feed T. Sulfur %	Adjusted MGS Feed T. Sulfur %	Measured MGS Lights T. Sulfur %	Adjusted MGS Lights T. Sulfur %	Measured MGS Heavies T. Sulfur %	Adjusted MGS Heavies T. Sulfur %
301	2.58	2.46	2.36	2.42	2.60	2.62	2.43	2.42	1.85	1.87	34.60	34.71
302	2.60	2.57	2.46	2.47	3.03	3.04	2.43	2.47	1.82	1.80	35.50	35.37
303	2.52	2.54	2.51	2.54	2.54	2.54	2.45	2.54	2.62	2.47	43.00	42.92
304	2.50	2.57	2.32	2.47	2.86	2.84	2.49	2.47	2.51	2.31	35.90	35.70
305	2.50	2.45	2.36	2.40	2.68	2.69	2.38	2.40	1.84	1.83	36.50	36.43
306	2.62	2.53	2.61	2.48	2.71	2.73	2.47	2.48	1.79	1.87	34.70	35.28
307	2.67	2.57	2.66	2.54	2.68	2.70	2.55	2.54	1.70	1.78	26.70	27.33
308	2.67	2.79	2.58	2.62	3.62	3.58	2.56	2.62	2.37	2.21	19.00	18.73
309	2.54	2.59	2.53	2.56	2.74	2.73	2.71	2.56	1.88	1.92	25.70	25.88
310	2.70	2.66	2.56	2.60	2.90	2.91	2.65	2.60	1.92	1.94	42.13	42.29
311	2.90	2.65	2.54	2.60	2.78	2.83	2.63	2.60	2.08	2.15	44.60	44.96
312	2.71	2.72	2.52	2.50	3.59	3.59	2.57	2.50	1.92	1.96	46.70	47.01
313	2.67	2.71	2.62	2.68	2.91	2.90	2.63	2.68	2.07	1.98	42.50	41.85
314	2.67	2.52	2.55	2.45	2.91	2.94	2.55	2.45	1.72	1.86	38.80	39.94
315	2.59	2.59	2.44	2.44	3.15	3.15	2.44	2.44	2.29	2.29	41.70	41.69
316	2.33	2.34	2.14	2.19	2.38	2.40	2.20	2.19	1.85	1.86	37.40	37.44
317	2.31	2.40	2.09	2.23	3.07	3.04	2.18	2.23	2.08	1.84	29.90	29.18
318	2.45	2.23	2.08	2.16	2.46	2.50	2.10	2.16	1.52	1.52	22.00	21.97
319	2.52	2.50	2.43	2.46	2.63	2.64	2.47	2.46	1.87	1.87	41.00	40.99
320	2.70	2.61	2.49	2.54	2.82	2.84	2.52	2.54	2.25	2.24	33.04	33.02
321	3.03	2.91	2.45	2.44	4.18	4.24	2.44	2.44	1.88	1.92	37.13	37.38
322	3.06	2.74	2.41	2.44	3.70	3.80	2.39	2.44	1.71	1.75	17.12	17.28
323	2.40	2.48	2.39	2.41	2.70	2.68	2.46	2.41	1.69	1.67	15.30	15.21
324	2.83	2.65	2.44	2.47	3.02	3.08	2.45	2.47	1.89	1.92	31.10	31.26
325	2.51	2.50	2.40	2.45	2.72	2.72	2.52	2.45	1.88	1.89	39.92	39.99
326	2.76	2.64	2.54	2.50	3.11	3.14	2.44	2.50	1.89	1.92	36.65	36.81
327	2.71	2.70	2.48	2.53	3.23	3.23	2.55	2.53	1.71	1.70	14.93	14.87

Combined Microcel/MGS Tests Results - Pittsburgh #8

Pyritic Sulfur

Test Number	Microcel						MGS					
	Measured Microcel Feed Pyritic S %	Adjusted Microcel Feed Pyritic S %	Measured Microcel Product Pyritic S %	Adjusted Microcel Product Pyritic S %	Measured Microcel Reject Pyritic S %	Adjusted Microcel Reject Pyritic S %	Measured MGS Feed Pyritic S %	Adjusted MGS Feed Pyritic S %	Measured MGS Lights Pyritic S %	Adjusted MGS Lights Pyritic S %	Measured MGS Heavies Pyritic S %	Adjusted MGS Heavies Pyritic S %
301	1.30	1.28	1.03	1.10	1.95	1.99	1.15	1.10	0.57	0.58	31.40	31.74
302	1.34	1.35	1.07	1.16	2.18	2.18	1.13	1.16	0.58	0.54	34.18	31.65
303	1.34	1.14	1.03	1.06	1.50	1.54	0.99	1.06	1.01	0.99	39.77	39.73
304	1.19	1.21	0.89	0.93	1.96	1.94	1.03	0.93	0.84	0.86	17.09	17.12
305	1.33	1.14	0.90	0.92	2.02	2.10	0.99	0.92	0.58	0.63	17.73	18.45
306	1.30	1.34	1.27	1.19	2.03	2.01	1.12	1.19	0.58	0.57	34.89	34.34
307	1.40	1.26	1.09	1.13	1.78	1.82	1.01	1.13	0.45	0.43	26.01	24.07
308	1.21	1.42	1.06	1.16	2.93	2.72	1.13	1.16	1.07	0.81	15.89	14.43
309	1.26	1.27	1.06	1.10	1.97	1.97	1.06	1.10	0.50	0.48	24.59	23.46
310	1.37	1.34	1.00	1.15	2.10	2.11	1.13	1.15	0.61	0.55	41.05	36.91
311	1.26	1.18	0.92	0.97	1.95	1.99	1.06	0.97	0.55	0.57	37.94	38.86
312	1.07	1.23	0.83	0.94	2.62	2.43	0.96	0.94	0.59	0.51	41.28	36.36
313	0.93	1.04	0.95	0.98	1.43	1.39	0.88	0.98	0.55	0.47	35.37	29.55
314	0.96	1.14	0.94	1.03	1.82	1.72	1.13	1.03	0.57	0.51	38.45	34.35
315	1.16	1.35	1.39	1.10	2.49	2.31	1.02	1.10	1.00	0.96	38.00	37.75
316	1.15	1.15	0.88	0.99	1.77	1.77	1.02	0.99	0.69	0.64	40.28	38.56
317	1.19	1.25	0.90	1.00	2.28	2.23	0.92	1.00	0.81	0.64	29.29	26.06
318	1.15	1.10	0.90	1.00	1.50	1.52	0.90	1.00	0.49	0.44	21.40	18.25
319	1.07	1.22	0.93	1.09	1.78	1.69	2.47	1.09	0.57	0.55	37.31	36.08
320	1.49	1.40	1.17	1.20	2.12	2.16	1.11	1.20	0.97	0.91	32.28	31.57
321	1.90	1.79	1.13	1.13	3.55	3.65	1.11	1.13	0.60	0.60	37.11	37.17
322	1.91	1.64	1.05	1.12	3.28	3.46	1.05	1.12	0.42	0.41	17.08	16.25
323	1.19	1.32	1.06	1.10	2.10	2.00	1.12	1.10	0.36	0.35	14.87	13.91
324	1.40	1.37	1.07	1.07	2.07	2.09	1.04	1.07	0.53	0.53	29.94	29.70
325	1.10	1.12	0.95	0.99	1.66	1.65	1.00	0.99	0.51	0.50	34.39	33.66
326	1.39	1.37	1.03	1.08	2.39	2.40	1.06	1.08	0.57	0.55	33.06	31.99
327	1.36	1.40	0.90	1.08	2.44	2.40	1.22	1.08	0.42	0.40	12.58	11.17

Combined Microcel/MGS Tests Results - Pittsburgh #8

Ash Performance

Test Number	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery	Ash Rejection	Ash Separation Efficiency	Comb. Recovery	Ash Rejection	Ash Separation Efficiency	Comb. Recovery	Ash Rejection	Ash Separation Efficiency
	%	%	%	%	%	%	%	%	%
301	93.13	70.16	63.30	99.15	12.09	11.24	92.35	73.77	66.12
302	93.03	66.57	59.61	99.09	14.42	13.51	92.19	71.39	63.58
303	95.52	61.57	57.09	99.92	1.16	1.08	95.45	62.01	57.46
304	87.22	76.60	63.82	99.72	3.17	2.90	86.98	77.34	64.32
305	93.74	67.83	61.57	99.25	12.15	11.39	93.04	71.74	64.77
306	93.28	66.38	59.65	99.22	13.30	12.52	92.55	70.85	63.40
307	93.74	67.82	61.55	98.66	21.26	19.92	92.48	74.66	67.14
308	95.10	63.93	59.03	97.91	7.74	5.65	93.11	66.72	59.84
309	93.04	68.76	61.80	98.63	17.71	16.34	91.76	74.29	66.05
310	93.71	70.65	64.35	99.29	12.27	11.56	93.04	74.25	67.29
311	92.57	72.31	64.87	99.55	8.54	8.08	92.15	74.67	66.82
312	92.89	70.19	63.09	99.47	9.61	9.08	92.40	73.06	65.46
313	96.15	60.95	57.10	99.21	12.63	11.84	95.39	65.88	61.27
314	95.08	63.06	58.14	99.36	11.51	10.87	94.47	67.31	61.78
315	91.99	70.22	62.21	99.81	2.71	2.51	91.81	71.02	62.84
316	91.61	69.91	61.52	99.59	7.27	6.85	91.23	72.10	63.33
317	92.64	69.92	62.55	99.08	7.60	6.68	91.78	72.20	63.98
318	91.60	69.32	60.93	98.32	21.62	19.94	90.06	75.96	66.02
319	89.46	69.73	59.19	99.31	12.14	11.45	88.84	73.40	62.25
320	91.69	70.82	62.51	99.43	5.97	5.39	91.16	72.56	63.72
321	88.66	76.45	65.11	99.34	11.68	11.01	88.07	79.20	67.27
322	91.92	74.41	66.34	97.06	24.64	21.69	89.22	80.72	69.94
323	87.46	71.71	59.17	96.52	30.38	26.91	84.42	80.31	64.73
324	84.41	75.54	59.96	99.12	13.27	12.39	83.67	78.79	62.46
325	91.41	69.06	60.47	99.32	11.78	11.10	90.79	72.71	63.49
326	91.99	71.58	63.57	99.24	12.46	11.69	91.29	75.12	66.41
327	91.04	75.14	66.18	95.59	28.69	24.27	87.02	82.27	69.29

Combined Microcel/MGS Tests Results - Pittsburgh #8

Total Sulfur Performance

Test Number	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %
301	93.13	21.06	14.19	99.15	24.04	23.19	92.35	40.03	32.38
302	93.03	21.70	14.73	99.09	28.57	27.66	92.19	44.07	36.26
303	95.52	15.91	11.43	99.92	2.93	2.85	95.45	18.37	13.82
304	87.22	30.28	17.50	99.72	6.94	6.66	86.98	35.12	22.10
305	93.74	20.06	13.80	99.25	25.00	24.25	93.04	40.04	33.08
306	93.28	20.41	13.69	99.22	25.98	25.20	92.55	41.09	33.64
307	93.74	19.88	13.61	98.66	32.00	30.66	92.48	45.52	38.00
308	95.10	21.82	16.91	97.91	17.83	15.74	93.11	35.75	28.86
309	93.04	20.55	13.59	98.63	27.01	25.63	91.76	42.00	33.77
310	93.71	21.85	15.56	99.29	26.59	25.88	93.04	42.64	35.68
311	92.57	22.38	14.95	99.55	18.17	17.71	92.15	36.48	28.63
312	92.89	26.18	19.08	99.47	22.54	22.01	92.40	42.82	35.22
313	96.15	15.02	11.17	99.21	27.41	26.62	95.39	38.32	33.70
314	95.08	17.99	13.07	99.36	25.23	24.60	94.47	38.68	33.16
315	91.99	25.40	17.39	99.81	6.51	6.32	91.81	30.26	22.07
316	91.61	25.67	17.27	99.59	15.86	15.44	91.23	37.45	28.68
317	92.64	26.00	18.64	99.08	18.68	17.76	91.78	39.83	31.61
318	91.60	22.56	14.17	98.32	31.84	30.16	90.06	47.22	37.28
319	89.46	22.87	12.33	99.31	25.14	24.45	88.84	42.26	31.10
320	91.69	23.19	14.88	99.43	12.68	12.10	91.16	32.93	24.09
321	88.66	37.90	26.56	99.34	22.45	21.79	88.07	51.84	39.91
322	91.92	30.81	22.73	97.06	31.49	28.54	89.22	52.59	41.81
323	87.46	26.56	14.02	96.52	34.52	31.04	84.42	51.91	36.33
324	84.41	33.85	18.27	99.12	23.70	22.81	83.67	49.53	33.20
325	91.41	21.43	12.84	99.32	23.99	23.32	90.79	40.28	31.07
326	91.99	25.76	17.75	99.24	24.48	23.72	91.29	43.93	35.22
327	91.04	29.41	20.45	95.59	37.05	32.64	87.02	55.56	42.58

Combined Microcel/MGS Tests Results - Pittsburgh #8

Test Number	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery	Pyritic S Rejection	Pyritic S Separation Efficiency	Comb. Recovery	Pyritic S Rejection	Pyritic S Separation Efficiency	Comb. Recovery	Pyritic S Rejection	Pyritic S Separation Efficiency
	%	%	%	%	%	%	%	%	%
301	93.13	31.04	24.17	99.15	48.17	47.32	92.35	64.25	56.60
302	93.03	30.00	23.03	99.09	54.37	53.46	92.19	68.06	60.25
303	95.52	21.81	17.33	99.92	6.77	6.69	95.45	27.10	22.55
304	87.22	44.25	31.46	99.72	7.98	7.70	86.98	48.70	35.67
305	93.74	34.14	27.88	99.25	32.64	31.89	93.04	55.64	48.68
306	93.28	27.90	21.17	99.22	52.98	52.20	92.55	66.10	58.65
307	93.74	27.30	21.03	98.66	63.08	61.74	92.48	73.15	65.64
308	95.10	31.99	27.09	97.91	31.97	29.88	93.11	53.73	46.85
309	93.04	30.38	23.42	98.63	57.53	56.16	91.76	70.43	62.19
310	93.71	31.39	25.09	99.29	52.95	52.24	93.04	67.72	60.76
311	92.57	34.97	27.53	99.55	41.85	41.40	92.15	62.18	54.33
312	92.89	38.62	31.52	99.47	46.40	45.87	92.40	67.10	59.50
313	96.15	19.03	15.17	99.21	52.88	52.09	95.39	61.85	57.23
314	95.08	23.79	18.87	99.36	51.23	50.60	94.47	62.83	57.31
315	91.99	35.48	27.47	99.81	13.07	12.87	91.81	43.91	35.72
316	91.61	31.63	23.23	99.59	35.95	35.54	91.23	56.21	47.44
317	92.64	36.29	28.93	99.08	36.93	36.00	91.78	59.81	51.60
318	91.60	27.32	18.92	98.32	57.38	55.70	90.06	69.03	59.09
319	89.46	29.97	19.43	99.31	50.31	49.62	88.84	65.20	54.04
320	91.69	32.35	24.04	99.43	24.91	24.34	91.16	49.20	40.36
321	88.66	53.25	41.90	99.34	47.67	47.01	88.07	75.53	63.61
322	91.92	46.94	38.86	97.06	65.03	62.09	89.22	81.44	70.66
323	87.46	37.02	24.48	96.52	69.93	66.46	84.42	81.06	65.49
324	84.41	44.57	28.99	99.12	51.38	50.50	83.67	73.05	56.72
325	91.41	29.14	20.54	99.32	50.24	49.56	90.79	64.74	55.52
326	91.99	38.20	30.19	99.24	49.92	49.16	91.29	69.05	60.34
327	91.04	41.89	32.92	95.59	65.30	60.89	87.02	79.84	66.85

Combined Microcel/MGS Tests Results - Pittsburgh #8

Combined - Energy Performance

Combined							
Test Number	Feed Calorific Value Btu/lb	Product Calorific Value Btu/lb	Reject Calorific Value Btu/lb	Energy Recovery %	SO2 Emission lb/MM Btu	Pyritic S Rejection %	Pyritic S Separation Efficiency % (Based on Energy Rec.)
301	11844	14137	3273	94.16	2.65	64.25	58.42
302	12006	14107	3675	93.83	2.55	68.06	61.89
303	11901	13751	2228	96.99	3.59	27.10	24.09
304	11398	14061	4486	89.05	3.29	48.70	37.75
305	11953	14109	3184	94.74	2.59	55.64	50.39
306	11860	14029	3342	94.28	2.67	66.10	60.38
307	11806	14161	3125	94.35	2.51	73.16	67.51
308	11894	13891	3321	94.73	3.18	53.73	48.46
309	11823	14144	3482	93.59	2.71	70.43	64.02
310	11671	14099	2728	95.01	2.75	67.72	62.73
311	11779	14147	3241	94.03	3.04	62.18	56.21
312	11914	14137	3373	94.15	2.77	67.10	61.25
313	12260	14060	2506	96.82	2.82	61.85	58.66
314	12166	14055	2895	95.97	2.65	62.83	58.81
315	11806	14004	3598	93.56	3.27	43.91	37.47
316	11938	14095	3974	92.91	2.64	56.21	49.11
317	11773	14038	3509	93.59	2.62	59.81	53.40
318	12051	14277	4412	91.74	2.13	69.03	60.76
319	12120	14191	5111	90.38	2.64	65.20	55.58
320	11833	14070	3835	92.92	3.18	49.20	42.12
321	11496	14202	4184	90.17	2.70	75.53	65.70
322	11661	14340	3948	91.27	2.44	81.44	72.72
323	11889	14345	5753	86.17	2.33	81.06	67.23
324	11494	14127	5449	85.62	2.72	73.05	58.67
325	12144	14196	4428	92.34	2.66	64.74	57.08
326	11671	14115	3447	93.23	2.72	69.05	62.28
327	11275	14274	4080	89.35	2.38	79.84	69.19

Combined Microcel/MGS Tests Results - Pittsburgh #8

MGS Only- Energy Recovery

Test Number	Feed Calorific Value Btu/lb	Product Calorific Value Btu/lb	Reject Calorific Value Btu/lb	Energy Recovery %	SO2 Emission lb/MM Btu	Pyritic S Rejection %	Pyritic S Separation Efficiency (based on energy rec.) %
301	14002	14137	6179	99.25	2.65	48.17	47.42
302	13937	14107	5509	99.22	2.55	54.37	53.59
303	13736	13751	5036	99.94	3.59	6.77	6.70
304	14028	14061	7212	99.75	3.29	7.98	7.73
305	13969	14109	5563	99.35	2.59	32.64	31.99
306	13864	14029	4992	99.34	2.67	52.98	52.32
307	13901	14161	5394	98.85	2.51	63.08	61.92
308	13813	13891	10881	97.97	3.18	31.97	29.94
309	13937	14144	6380	98.78	2.71	57.53	56.31
310	13955	14099	5242	99.39	2.75	52.95	52.34
311	14055	14147	5219	99.61	3.04	41.85	41.46
312	14031	14137	5288	99.55	2.77	46.40	45.94
313	13908	14060	5389	99.32	2.82	52.88	52.20
314	13916	14055	4911	99.47	2.65	51.23	50.70
315	13974	14004	6196	99.83	3.27	13.07	12.89
316	14014	14095	5364	99.64	2.64	35.95	35.60
317	13955	14038	8317	99.14	2.62	36.93	36.06
318	14041	14277	6768	98.48	2.13	57.38	55.87
319	14060	14191	5526	99.40	2.64	50.31	49.71
320	14006	14070	7534	99.47	3.18	24.91	24.38
321	14077	14202	5583	99.43	2.70	47.67	47.10
322	14088	14340	8721	97.23	2.44	65.03	62.26
323	14011	14345	8267	96.76	2.33	69.93	66.69
324	13975	14127	5880	99.22	2.72	51.38	50.60
325	14070	14196	5602	99.41	2.66	50.24	49.65
326	13972	14115	5527	99.34	2.72	49.92	49.26
327	13958	14274	9276	95.80	2.38	65.30	61.11

APPENDIX 2-F

Test Data and Performance Calculations

**Combined Microcel/MGS Tests
Illinois No. 6 Seam Coal**

Microcel/MGS Combined Testing - Illinois #6

Conditions Held Constant

Microcel

Feed Rate (lbs/hr):	550.00
Wash Water (lpm):	40.1
Percent Solids (w/w):	11-12
Grind Size (d80 (microns)	200
Air Flow Rate (SCFM):	8.89
Diesel dosage (lbs/ton):	1
Frother Dosage (ml/min):	1.5 - 1.6

MGS

Shake Amplitude (mm):	15
Shake Frequency (cps):	5
Tilt Angle (degrees):	6
Grind Size (d80 (microns)	200
Percent Solids (w/w):	21 - 22

Microcel/MGS Combined Testing - Illinois #6

MGS Variables

Test Number	Drum Speed rpm	Wash Water lpm	Shake Amplitude mm	Feed Rate lbs/hr
601	283	1.51	10	269
602	283	0.95	15	269
603	280	0.47	20	257
604	239	1.06	15	342
605	239	0.95	20	276
606	280	0.95	15	268
607	240	1.51	15	273
608	280	1.51	15	161
609	323	1.10	10	306
610	239	0.45	15	259
611	322	0.91	20	282
612	322	0.98	15	148
613	280	1.59	20	241
614	282	0.95	15	300
615	280	0.45	15	148
616	321	1.06	15	343
617	282	0.45	15	357
618	282	0.93	20	378
619	240	0.96	15	163
620	282	1.51	15	353
621	283	0.53	10	287
622	241	1.06	10	219
623	322	1.55	15	238
624	281	1.10	10	160
625	320	0.53	15	305
626	280	0.98	20	135
627	281	1.10	10	377

Combined Microcel/MGS Tests Results - Illinois #6
Ash

Test No.	Microcel						MGS						Yields					
	Measured Microcel Feed Ash %	Adjusted Microcel Feed Ash %	Measured Microcel Product Ash %	Adjusted Microcel Product Ash %	Measured Microcel Reject Ash %	Adjusted Microcel Reject Ash %	Measured MGS Feed Ash %	Adjusted MGS Feed Ash %	Measured MGS Lights Ash %	Adjusted MGS Lights Ash %	Measured MGS Heavies Ash %	Adjusted MGS Heavies Ash %	Measured Microcel Ash Yield %	Adjusted Microcel Ash Yield %	Measured MGS Ash Yield %	Adjusted MGS Ash Yield %	Measured Combined Ash Yield %	Adjusted Combined Ash Yield %
601	35.12	35.00	10.26	10.22	77.89	78.10	10.00	10.22	9.00	8.87	54.40	54.25	63.24	63.49	97.80	97.03	61.85	61.61
602	32.73	32.77	9.33	9.43	77.00	76.92	9.33	9.43	8.28	8.13	54.77	54.58	65.42	65.42	97.74	97.20	63.94	63.59
603	32.30	32.97	9.06	9.74	79.92	78.53	10.73	9.74	8.27	8.26	57.81	57.79	67.20	66.23	95.03	97.01	63.87	64.25
604	37.49	38.31	10.42	11.42	74.04	72.63	13.55	11.42	9.94	10.14	63.65	63.85	57.45	56.07	93.28	97.62	53.59	54.73
605	34.82	34.71	10.84	10.72	78.38	78.58	10.62	10.72	9.63	9.64	63.14	63.15	64.50	64.65	98.15	97.98	63.30	63.34
606	34.10	34.40	9.90	10.25	77.56	76.99	10.58	10.25	8.03	7.98	56.91	56.78	64.23	63.81	94.78	95.35	60.88	60.85
607	35.20	34.78	10.36	10.65	79.00	79.75	10.13	10.65	11.05	10.14	63.41	63.12	63.81	65.08	101.76	99.04	64.93	64.45
608	30.28	30.27	10.58	10.55	77.66	77.68	10.53	10.55	9.01	8.95	65.25	65.15	70.63	70.62	97.30	97.15	68.72	68.61
609	34.87	34.91	9.03	9.92	81.77	81.70	11.23	9.92	6.33	6.31	33.25	33.16	64.48	65.19	81.80	86.55	52.74	56.42
610	32.22	32.39	10.22	10.41	79.18	78.85	10.60	10.41	9.38	9.36	63.07	63.05	68.10	67.88	97.73	98.04	66.55	66.56
611	32.39	32.68	10.21	10.49	77.74	77.18	10.98	10.49	6.62	6.67	43.21	43.45	67.16	66.73	88.08	89.61	59.15	59.80
612	34.87	34.87	10.28	10.29	77.19	77.19	10.30	10.29	5.97	5.97	38.15	38.16	63.25	63.26	86.54	86.58	54.74	54.77
613	35.41	35.95	8.57	9.29	76.39	75.37	10.24	9.29	8.04	7.98	61.87	61.78	60.42	59.65	95.91	97.57	57.96	58.20
614	34.95	34.50	9.43	8.95	77.81	78.63	8.48	8.95	7.24	7.20	54.84	54.75	62.68	63.33	97.39	96.32	61.05	61.00
615	35.86	35.60	10.93	10.55	76.98	77.43	10.28	10.55	8.00	8.04	62.59	62.72	62.26	62.54	95.82	95.41	59.66	59.67
616	33.42	33.41	9.16	9.80	77.79	77.80	10.65	9.80	7.22	7.21	35.80	35.78	64.65	65.28	88.00	90.93	56.89	59.36
617	34.46	34.68	9.81	10.03	76.93	76.53	10.28	10.03	7.19	7.19	47.94	47.94	63.27	62.93	92.42	93.03	58.48	58.55
618	30.46	30.45	9.86	9.85	77.86	77.87	9.84	9.85	8.05	8.05	58.53	58.54	69.71	69.71	96.45	96.43	67.23	67.23
619	39.68	39.06	12.06	10.93	76.69	77.66	10.08	10.93	10.04	10.01	63.80	63.78	57.26	57.85	99.93	98.29	57.22	56.86
620	30.61	31.74	8.05	8.86	77.31	74.81	10.26	8.86	6.59	6.59	56.86	56.87	67.43	65.31	92.70	95.49	62.50	62.36
621	33.83	33.81	10.59	10.84	79.05	79.08	11.15	10.84	7.47	7.48	37.86	37.91	66.05	66.34	87.89	88.96	58.05	59.01
622	34.18	35.04	7.34	8.37	73.86	72.19	9.87	8.37	8.55	8.25	62.80	62.76	59.65	58.21	97.57	99.78	58.20	58.08
623	30.25	30.20	10.16	10.29	74.21	74.31	10.51	10.29	6.85	6.88	39.20	39.31	68.63	68.90	88.69	89.49	60.87	61.66
624	35.06	35.58	9.70	10.22	77.47	76.49	10.84	10.22	6.76	6.74	54.56	54.47	62.58	61.73	91.46	92.71	57.24	57.23
625	34.07	33.89	9.29	9.45	78.58	78.91	9.66	9.45	6.31	6.33	31.50	31.55	64.24	64.81	86.70	87.63	55.69	56.80
626	34.50	34.61	8.54	8.85	73.26	73.06	8.94	8.85	8.30	8.08	63.17	62.99	59.89	59.88	98.83	98.60	59.19	59.04
627	37.69	37.68	12.03	11.40	78.33	78.35	10.94	11.40	7.57	7.60	41.88	41.99	61.30	60.75	90.18	88.95	55.28	54.03

Combined Microcel/MGS Tests Results - Illinois #6
Total Sulfur

Test No.	Microcel						MGS					
	Measured Microcel Feed T. Sulfur %	Adjusted Microcel Feed T. Sulfur %	Measured Microcel Product T. Sulfur %	Adjusted Microcel Product T. Sulfur %	Measured Microcel Reject T. Sulfur %	Adjusted Microcel Reject T. Sulfur %	Measured MGS Feed T. Sulfur %	Adjusted MGS Feed T. Sulfur %	Measured MGS Lights T. Sulfur %	Adjusted MGS Lights T. Sulfur %	Measured MGS Heavies T. Sulfur %	Adjusted MGS Heavies T. Sulfur %
601	4.00	3.91	3.99	3.77	4.11	4.15	3.90	3.77	2.99	3.22	21.55	21.91
602	4.06	3.88	3.88	3.73	4.11	4.17	3.88	3.73	2.85	3.07	26.29	26.82
603	3.65	3.49	3.20	3.30	3.81	3.87	3.20	3.30	2.57	2.49	30.00	29.66
604	4.30	4.62	4.05	4.20	5.37	5.15	4.01	4.20	3.64	3.24	45.15	43.64
605	4.11	4.01	3.84	3.92	4.12	4.16	3.84	3.92	3.18	3.11	43.80	43.52
606	3.82	3.85	3.55	3.66	4.22	4.20	3.84	3.66	2.46	2.48	27.70	27.80
607	4.00	3.67	3.66	3.68	3.55	3.64	3.48	3.68	3.36	3.31	42.04	41.97
608	3.29	3.54	3.67	3.60	3.47	3.39	3.76	3.60	2.68	2.69	34.50	34.54
609	4.47	3.89	3.93	3.81	3.87	4.02	3.63	3.81	2.61	2.69	10.85	11.05
610	3.76	3.66	3.68	3.74	3.47	3.50	3.80	3.74	2.95	2.99	41.10	41.26
611	3.74	4.05	4.05	4.06	4.16	4.03	3.80	4.07	2.86	2.61	17.80	16.66
612	4.09	4.12	4.00	3.83	4.64	4.62	3.76	3.83	2.23	2.25	14.00	14.10
613	6.00	4.04	3.89	4.11	3.64	3.93	4.06	4.11	3.08	3.21	39.70	40.25
614	4.11	3.40	3.91	3.52	3.06	3.20	3.19	3.52	2.51	2.63	26.40	26.90
615	4.03	3.97	3.93	3.94	4.01	4.03	3.81	3.94	2.51	2.47	34.90	34.51
616	3.85	4.04	3.77	3.83	4.54	4.45	4.12	3.83	2.73	2.76	14.48	14.56
617	4.00	4.06	3.81	3.80	4.52	4.49	3.81	3.80	2.42	2.41	22.40	22.36
618	3.80	3.78	3.75	3.71	3.91	3.92	3.70	3.71	2.64	2.66	32.20	32.30
619	4.39	4.62	4.35	3.87	5.82	5.65	3.74	3.87	3.07	3.16	44.50	44.82
620	3.59	3.81	3.63	3.90	3.70	3.62	4.85	3.90	2.83	2.90	25.00	25.24
621	3.28	3.63	3.70	3.73	3.59	3.45	3.97	3.73	2.53	2.48	14.00	13.81
622	3.80	3.70	3.32	3.39	4.03	4.09	3.88	3.39	3.02	3.31	38.96	39.07
623	3.73	4.18	4.04	3.95	4.92	4.68	4.07	3.95	2.67	2.61	15.59	15.35
624	3.44	3.57	3.54	3.69	3.43	3.38	3.91	3.69	2.45	2.43	19.90	19.78
625	3.40	4.07	3.48	3.47	5.87	5.17	3.66	3.47	2.43	2.31	12.10	11.68
626	3.98	3.67	3.65	3.64	3.61	3.71	3.68	3.64	2.98	3.12	39.90	40.25
627	3.99	4.11	3.80	3.94	4.41	4.35	3.80	3.94	2.59	2.44	16.80	16.04

Combined Microcel/MGS Tests Results - Illinois #6
Pyritic Sulfur

Test No.	Microcel						MGS					
	Measured Microcel Feed Pyritic S %	Adjusted Microcel Feed Pyritic S %	Measured Microcel Product Pyritic S %	Adjusted Microcel Product Pyritic S %	Measured Microcel Reject Pyritic S %	Adjusted Microcel Reject Pyritic S %	Measured MGS Feed Pyritic S %	Adjusted MGS Feed Pyritic S %	Measured MGS Lights Pyritic S %	Adjusted MGS Lights Pyritic S %	Measured MGS Heavies Pyritic S %	Adjusted MGS Heavies Pyritic S %
601	1.96	1.98	1.65	1.43	2.97	2.95	1.65	1.43	0.75	0.84	18.91	20.62
602	1.87	1.80	1.53	1.40	2.45	2.50	1.53	1.40	0.64	0.69	23.80	25.88
603	2.33	2.16	1.58	1.69	3.00	3.09	1.88	1.69	0.82	0.84	28.52	29.25
604	2.60	2.60	1.91	2.11	3.22	3.22	2.11	2.11	1.26	1.17	43.13	40.62
605	2.82	2.67	2.13	2.09	3.63	3.72	1.97	2.09	1.29	1.27	42.39	42.00
606	2.46	2.32	1.78	1.81	3.14	3.22	2.02	1.81	0.55	0.57	25.60	27.30
607	2.33	2.17	1.49	1.64	3.05	3.15	1.67	1.64	1.33	1.26	41.80	41.15
608	2.01	2.16	1.91	1.79	3.16	3.05	1.99	1.79	0.89	0.94	29.25	30.71
609	2.85	2.36	1.70	1.77	3.25	3.47	2.00	1.77	0.58	0.60	8.57	9.29
610	2.35	2.38	1.92	1.97	3.25	3.23	2.00	1.97	1.24	1.22	39.92	39.57
611	2.06	2.37	1.87	2.01	3.35	3.08	2.08	2.01	0.68	0.65	15.50	13.72
612	2.90	2.29	2.16	2.12	2.43	2.59	1.93	2.12	0.55	0.55	12.27	12.29
613	4.18	2.37	1.68	1.88	2.78	3.10	1.96	1.88	0.97	0.98	37.60	38.01
614	3.07	2.23	1.77	1.67	2.92	3.20	1.57	1.67	0.76	0.79	23.70	24.72
615	2.62	2.73	2.28	2.17	3.75	3.66	1.99	2.17	0.85	0.83	31.90	30.22
616	2.26	2.22	1.54	1.70	3.16	3.19	1.94	1.70	0.67	0.67	11.97	12.01
617	2.75	2.75	1.88	1.97	4.08	4.08	1.96	1.97	0.77	0.75	18.90	18.20
618	2.17	2.26	1.87	1.79	3.39	3.33	1.76	1.79	0.90	0.90	26.00	25.99
619	3.11	3.19	2.36	2.14	4.71	4.63	1.99	2.14	1.44	1.43	42.80	42.71
620	1.89	2.01	1.44	1.63	2.82	2.73	1.87	1.63	0.69	0.67	22.90	21.89
621	1.84	2.20	2.01	1.90	3.15	2.80	2.01	1.90	0.65	0.64	12.24	12.00
622	2.01	2.04	1.25	1.21	3.24	3.20	1.71	1.21	0.95	1.12	39.00	39.66
623	1.82	2.21	1.80	1.73	3.79	3.26	1.64	1.73	0.64	0.61	13.03	11.33
624	2.35	2.29	1.86	1.85	2.96	3.00	2.02	1.85	0.57	0.59	16.80	17.90
625	2.20	2.62	1.76	1.70	5.13	4.32	1.92	1.70	0.57	0.58	9.46	9.68
626	2.18	1.98	1.47	1.49	2.61	2.72	1.43	1.49	0.99	0.98	38.25	37.95
627	2.43	2.57	2.23	2.16	3.32	3.21	2.18	2.16	0.64	0.64	14.30	14.39

Combined Microcel/MGS Tests Results - Illinois #6
Ash Performance

Test Number	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %
601	87.70	81.46	69.16	98.48	15.79	14.28	86.37	84.39	70.76
602	88.13	81.18	69.30	98.60	16.20	14.80	86.89	84.22	71.12
603	89.18	80.43	69.62	98.60	17.73	16.33	87.94	83.90	71.84
604	80.51	83.29	63.80	99.03	13.32	12.35	79.73	85.51	65.24
605	88.40	80.03	68.44	99.17	11.89	11.06	87.67	82.41	70.07
606	87.31	80.99	68.29	97.76	25.77	23.53	85.35	85.89	71.24
607	89.16	80.07	69.23	99.60	5.71	5.31	88.80	81.21	70.01
608	90.60	75.39	65.98	98.89	17.58	16.47	89.59	79.71	69.31
609	90.21	81.48	71.69	90.02	44.94	34.97	81.21	89.80	71.01
610	89.95	78.18	68.14	99.19	11.84	11.04	89.23	80.77	69.99
611	88.72	78.58	67.30	93.44	43.02	36.46	82.90	87.80	70.70
612	87.13	81.33	68.46	90.75	49.77	40.52	79.07	90.62	69.69
613	84.49	84.58	69.07	98.97	16.19	15.17	83.62	87.08	70.70
614	88.04	83.57	71.61	98.17	22.51	20.68	86.43	87.27	73.70
615	86.87	81.46	68.34	98.09	27.29	25.38	85.21	86.52	71.73
616	88.42	80.85	69.28	93.55	33.10	26.64	82.72	87.19	69.91
617	86.68	81.80	68.48	95.97	33.31	29.28	83.19	87.86	71.05
618	90.36	77.45	67.81	98.36	21.19	19.55	88.88	82.23	71.11
619	84.55	83.81	68.36	99.30	9.98	9.29	83.96	85.43	69.39
620	87.20	81.77	68.97	97.86	28.98	26.84	85.33	87.05	72.39
621	89.36	78.73	68.09	92.31	38.62	30.93	82.49	86.94	69.43
622	82.11	86.10	68.20	99.91	1.65	1.56	82.04	86.32	68.36
623	88.55	76.52	65.08	92.89	40.17	33.06	82.25	85.95	68.21
624	86.03	82.27	68.30	96.30	38.86	35.16	82.85	89.16	72.01
625	88.78	81.93	70.70	90.65	41.30	31.95	80.47	89.39	69.86
626	83.47	84.69	68.16	99.43	9.98	9.41	83.00	86.22	69.21
627	86.36	81.62	67.98	92.77	40.70	33.47	80.12	89.10	69.22

Combined Microcel/MGS Tests Results - Illinois #6
Total Sulfur Performance

Test No.	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %
601	87.70	38.78	26.48	98.48	17.13	15.61	86.37	49.27	35.64
602	88.13	37.11	25.24	98.60	20.00	18.59	86.89	49.69	36.58
603	89.18	37.38	26.56	98.60	26.80	25.40	87.94	54.16	42.10
604	80.51	49.03	29.54	99.03	24.70	23.72	79.73	61.62	41.34
605	88.40	36.80	25.20	99.17	22.26	21.43	87.67	50.87	38.54
606	87.31	39.33	26.64	97.76	35.39	33.15	85.35	60.81	46.16
607	89.16	34.74	23.90	99.60	10.92	10.52	88.80	41.87	30.67
608	90.60	28.18	18.78	98.89	27.41	26.30	89.59	47.86	37.45
609	90.21	36.16	26.37	90.02	38.89	28.91	81.21	60.98	42.20
610	89.95	30.63	20.59	99.19	21.62	20.81	89.23	45.63	34.86
611	88.72	33.11	21.83	93.44	42.53	35.97	82.90	61.46	44.36
612	87.13	41.19	28.33	90.75	49.14	39.89	79.07	70.09	49.16
613	84.49	39.31	23.80	98.97	23.80	22.77	83.62	53.76	37.37
614	88.04	34.43	22.47	98.17	28.03	26.20	86.43	52.81	39.24
615	86.87	37.93	24.80	98.09	40.19	38.27	85.21	62.87	48.08
616	88.42	38.11	26.54	93.55	34.47	28.02	82.72	59.45	42.16
617	86.68	41.10	27.78	95.97	41.00	36.97	83.19	65.25	48.43
618	90.36	31.58	21.94	98.36	30.86	29.22	88.88	52.69	41.57
619	84.55	51.55	36.09	99.30	19.74	19.05	83.96	61.11	45.07
620	87.20	33.15	20.35	97.86	29.00	26.86	85.33	52.54	37.87
621	89.36	31.83	21.19	92.31	40.85	33.16	82.49	59.68	42.17
622	82.11	46.67	28.78	99.91	2.57	2.49	82.04	48.04	30.08
623	88.55	34.89	23.44	92.89	40.87	33.76	82.25	61.50	43.76
624	86.03	36.19	22.23	96.30	38.95	35.25	82.85	61.04	43.90
625	88.78	44.74	33.52	90.65	41.66	32.31	80.47	67.76	48.24
626	83.47	40.61	24.08	99.43	15.49	14.92	83.00	49.81	32.80
627	86.36	41.77	28.13	92.77	44.91	37.68	80.12	67.92	48.04

Combined Microcel/MGS Tests Results - Illinois #6
Pyritic Sulfur Performance

Test No.	<i>Microcel</i>			<i>MGS</i>			<i>Combined Microcel/MGS</i>		
	Comb. Recovery %	Pyritic S Rejection %	Pyritic S Separation Efficiency %	Comb. Recovery %	Pyritic S Rejection %	Pyritic S Separation Efficiency %	Comb. Recovery %	Pyritic S Rejection %	Pyritic S Separation Efficiency %
601	87.70	54.14	41.84	98.48	43.01	41.49	86.37	73.86	60.24
602	88.13	49.12	37.25	98.60	52.09	50.69	86.89	75.63	62.52
603	89.18	48.20	37.39	98.60	51.78	50.38	87.94	75.02	62.96
604	80.51	54.50	35.01	99.03	45.87	44.90	79.73	75.37	55.10
605	88.40	49.40	37.80	99.17	40.46	39.63	87.67	69.87	57.54
606	87.31	50.21	37.52	97.76	69.97	67.73	85.35	85.05	70.40
607	89.16	50.82	39.97	99.60	23.91	23.51	88.80	62.58	51.38
608	90.60	41.47	32.07	98.89	48.98	47.87	89.59	70.14	59.73
609	90.21	51.11	41.32	90.02	70.66	60.68	81.21	85.66	66.87
610	89.95	43.81	33.76	99.19	39.28	38.48	89.23	65.88	55.11
611	88.72	43.41	32.13	93.44	71.02	64.46	82.90	83.60	66.50
612	87.13	41.44	28.57	90.75	77.54	68.29	79.07	86.85	65.92
613	84.49	52.68	37.16	98.97	49.14	48.12	83.62	75.93	59.55
614	88.04	52.57	40.61	98.17	54.44	52.61	86.43	78.39	64.82
615	86.87	50.28	37.16	98.09	63.51	61.59	85.21	81.86	67.07
616	88.42	50.01	38.44	93.55	64.16	57.71	82.72	82.08	64.80
617	86.68	54.92	41.60	95.97	64.58	60.55	83.19	84.03	67.22
618	90.36	44.78	35.15	98.36	51.51	49.87	88.88	73.23	62.11
619	84.55	61.19	45.74	99.30	34.32	33.63	83.96	74.51	58.47
620	87.20	47.04	34.24	97.86	60.75	58.61	85.33	79.21	64.55
621	89.36	42.71	32.07	92.31	70.04	62.35	82.49	82.83	65.32
622	82.11	65.47	47.58	99.91	7.64	7.55	82.04	68.11	50.15
623	88.55	46.06	34.62	92.89	68.45	61.33	82.25	82.98	65.24
624	86.03	50.13	36.16	96.30	70.43	66.74	82.85	85.25	68.11
625	88.78	57.94	46.72	90.65	70.10	60.75	80.47	87.43	67.90
626	83.47	54.94	38.41	99.43	35.15	34.58	83.00	70.78	53.77
627	86.36	48.94	35.31	92.77	73.64	66.41	80.12	86.54	66.66

Combined Microcel/MGS Tests Results - Illinois #6
Combined Circuit - Energy Recovery

Test No.	Feed Calorific Value Btu	Product Calorific Value Btu	Reject Calorific Value Btu	Energy Recovery %	SO2 Emission %	Pyritic S Rejection %	Pyritic S Separation Efficiency % (based on energy rec.)
601	9028	13340	2108	91.04	4.83	73.86	64.90
602	9396	13462	2294	91.11	4.56	75.63	66.73
603	9363	13441	2032	92.24	3.71	75.02	67.26
604	8481	13131	2859	84.74	4.94	75.37	60.11
605	9075	13213	1925	92.22	4.71	69.87	62.09
606	9127	13487	2350	89.92	3.68	85.05	74.97
607	9064	13131	1690	93.37	5.04	62.58	55.95
608	9808	13327	2116	93.23	4.04	70.14	63.37
609	9042	13763	2931	85.87	3.91	85.66	71.53
610	9458	13259	1894	93.30	4.51	65.88	59.19
611	9410	13703	3025	87.07	3.81	83.60	70.68
612	9049	13819	3273	83.64	3.26	86.85	70.49
613	8871	13487	2442	88.49	4.76	75.93	64.42
614	9110	13616	2062	91.17	3.86	78.39	69.56
615	8928	13477	2197	90.08	3.67	81.86	71.93
616	9290	13614	2973	86.99	4.05	82.08	69.08
617	9080	13618	2672	87.80	3.54	84.03	71.83
618	9778	13476	2194	92.65	3.95	73.23	65.88
619	8357	13152	2039	89.47	4.81	74.51	63.99
620	9566	13717	2689	89.42	4.23	79.21	68.63
621	9224	13570	2967	86.82	3.66	82.83	69.65
622	9021	13443	2894	86.55	4.92	68.11	54.66
623	9820	13669	3631	85.82	3.82	82.98	68.80
624	8932	13692	2562	87.73	3.55	85.25	72.99
625	9211	13760	3231	84.85	3.36	87.43	72.27
626	9092	13471	2780	87.48	4.63	70.78	58.25
627	8585	13550	2749	85.28	3.60	86.54	71.83

Combined Microcel/MGS Tests Results - Illinois #6
MGS Only - Energy Recovery

Test No.	Feed Calorific Value Btu	Product Calorific Value Btu	Reject Calorific Value Btu	Energy Recovery %	SO2 Emission %	Pyritic S Rejection %	Pyritic S Separation Efficiency % (based on energy rec.)
601	13117	13340	5850	98.67	4.83	43.01	41.68
602	13248	13462	5796	98.78	4.56	52.09	50.87
603	13197	13441	5266	98.81	3.71	51.78	50.59
604	12919	13131	4266	99.21	4.94	45.87	45.08
605	13035	13213	4381	99.32	4.71	40.46	39.78
606	13113	13487	5433	98.07	3.68	69.97	68.05
607	13046	13131	4386	99.68	5.04	23.91	23.59
608	13063	13327	4051	99.12	4.04	48.98	48.10
609	13167	13763	9331	90.47	3.91	70.66	61.13
610	13086	13259	4398	99.34	4.51	39.28	38.62
611	13073	13703	7633	93.94	3.81	71.02	64.96
612	13106	13819	8506	91.29	3.26	77.54	68.83
613	13271	13487	4607	99.15	4.76	49.14	48.30
614	13327	13616	5768	98.41	3.86	54.44	52.84
615	13063	13477	4452	98.44	3.67	63.51	61.94
616	13187	13614	8899	93.88	4.05	64.16	58.04
617	13149	13618	6892	96.35	3.54	64.58	60.93
618	13179	13476	5142	98.61	3.95	51.51	50.12
619	13000	13152	4277	99.44	4.81	34.32	33.76
620	13342	13717	5418	98.17	4.23	60.75	58.92
621	13015	13570	8547	92.75	3.66	70.04	62.78
622	13423	13443	4446	99.93	4.92	7.64	7.57
623	13106	13669	8316	93.33	3.82	68.45	61.78
624	13117	13692	5814	96.77	3.55	70.43	67.20
625	13245	13760	9597	91.04	3.36	70.10	61.14
626	13344	13471	4408	99.54	4.63	35.15	34.69
627	12923	13550	7874	93.27	3.60	73.64	66.91

APPENDIX 3

Box-Behnken Statistical Analyses

APPENDIX 3-A

Box-Behnken Statistical Analyses

**Independent Microcel Tests
Pittsburgh No. 8 Seam Coal**

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Coal Seam:  Pittsburgh No. 8
Circuit:    Individual Microcel
Data File:  P-CLM-00
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FAC      FACTOR          UNITS      -1 LEVEL      +1 LEVEL
A        Size            microns    100.000      300.000
B        Feed Rate       lbs/hr     300.000      500.000
C        Frother         ml/min     0.500        1.500
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				A	B	C	Y1	Y2
Obs	Dsn	Run		Size	Feed Rate	Frother	Comb. rec	Ash rej
	ID	Ord	Blk	microns	lbs/hr	ml/min	%	%
2	2	1	1	300.0	300.0	1.000	96.72	45.32
6	6	2	1	300.0	400.0	0.500	91.19	66.97
4	4	3	1	300.0	500.0	1.000	93.98	65.68
8	8	4	1	300.0	400.0	1.500	96.47	51.96
13	0	5	1	200.0	400.0	1.000	95.73	62.19
10	10	6	1	200.0	500.0	0.500	77.92	77.16
12	12	7	1	200.0	500.0	1.500	95.42	59.74
14	0	8	1	200.0	400.0	1.000	92.53	62.49
1	1	9	1	100.0	300.0	1.000	94.79	56.63
5	5	10	1	100.0	400.0	0.500	95.23	56.11
3	3	11	1	100.0	500.0	1.000	95.40	54.51
7	7	12	1	100.0	400.0	1.500		
11	11	13	1	200.0	300.0	1.500	98.73	16.64
15	0	14	1	200.0	400.0	1.000	95.95	59.74
9	9	15	1	200.0	300.0	0.500		
16	11	16	1	200.0	300.0	1.500	96.67	47.61
17	0	17	1	200.0	400.0	1.000	94.78	56.87

				Y3	Y4	Y5	Y6	Y7
Obs	Dsn	Run		Sulfur rej	Pyritic rej	Energy rec	Efficiency	SO2 emiss.
	ID	Ord	Blk	%	%	%	%	lbs/MM Btu
2	2	1	1	14.58	22.69	97.90	43.21	4.500
6	6	2	1	18.65	33.99	92.61	59.58	3.630
4	4	3	1	16.95	29.12	95.71	61.39	4.840
8	8	4	1	14.48	24.29	97.90	49.86	4.570
13	0	5	1	24.25	35.53	97.32	59.51	3.890
10	10	6	1	35.97	69.71	79.35	56.51	3.940
12	12	7	1	16.89	25.48	96.87	56.61	4.000
14	0	8	1	22.86	61.32	94.07	56.56	4.800
1	1	9	1	15.70	36.55	96.16	52.79	4.080
5	5	10	1	11.99	23.41	96.66	52.78	4.290
3	3	11	1	25.47	64.00	96.80	51.30	3.790
7	7	12	1					
11	11	13	1	7.95	6.72	99.17	15.82	4.370
15	0	14	1	16.19	23.25	97.41	57.16	4.060
9	9	15	1					
16	11	16	1	12.60	36.07	97.78	45.39	4.440
17	0	17	1	11.00	38.16	95.69	52.56	3.210

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Coal Seam: Pittsburgh No. 8
Circuit: Individual Microcel
Response: Combustible Recovery
Data File: P-CLM-00
Comments: Analysis of Complete Data Set
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FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Size	microns	100.000	300.000
B	Feed Rate	lbs/hr	300.000	500.000
C	Frother	ml/min	0.500	1.500

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	132824.0	1	132824.0		
Linear	156.9	3	52.3	3.423	0.0562
Quadratic	101.5	6	16.9	1.270	0.4056
Cubic	57.2	1	57.2	24.19	0.0079
RESIDUAL	9.5	4	2.4		
TOTAL	133149.0	15			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	158.6	7	22.7	9.591	0.0226
Quadratic	57.2	1	57.2	24.19	0.0079
Cubic	0.0	0			
PURE ERR	9.5	4	2.4		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	11	3.91	0.4828	0.3417	347.53
Quadratic	10	5	3.65	0.7951	0.4261	
Cubic	11	4	1.54	0.9709	0.8982	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	156.9	3	52.30	3.423	0.0562
RESIDUAL	168.1	11	15.28		
Lack Of Fit	158.6	7	22.66	9.591	0.0226
Pure Error	9.5	4	2.36		
COR TOTAL	325.0	14			
ROOT MSE	3.91		R-SQUARED	0.4828	
DEP MEAN	94.10		ADJ R-SQUARED	0.3417	
C.V.	4.15%				

Predicted Residual Sum of Squares (PRESS) = 347.5

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	93.90	1	1.02	92.23	
A	-0.66	1	1.50	-0.4384	0.6695
B	-2.11	1	1.44	-1.472	0.1690
C	3.64	1	1.56	2.338	0.0393

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Comb. rec} = & 93.90 \\ & - 0.66 * A \\ & - 2.11 * B \\ & + 3.64 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Comb. rec} = & 96.39 \\ & - 6.574\text{E-}03 * \text{Size} \\ & - 2.114\text{E-}02 * \text{Feed Rate} \\ & + 7.2794 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	94.79	96.67	-1.88	0.361	-0.602	0.051	-0.584	9
2	96.72	95.36	1.36	0.348	0.432	0.025	0.415	1
3	95.40	92.45	2.95	0.373	0.954	0.135	0.950	11
4	93.98	91.13	2.85	0.318	0.883	0.091	0.873	3
5	95.23	90.92	4.31	0.366	1.385	0.277	1.453	10
6	91.19	89.60	1.59	0.418	0.531	0.051	0.513	2
8	96.47	96.88	-0.41	0.296	-0.126	0.002	-0.120	4
10	77.92	88.15	-10.23	0.296	-3.118	1.021	-8.719	6
11	98.73	99.66	-0.93	0.268	-0.277	0.007	-0.265	13
12	95.42	95.43	-0.01	0.418	-0.003	0.000	-0.002	7
13	95.73	93.90	1.83	0.068	0.484	0.004	0.467	5
14	92.53	93.90	-1.37	0.068	-0.363	0.002	-0.349	8
15	95.95	93.90	2.05	0.068	0.543	0.005	0.524	14
16	96.67	99.66	-2.99	0.268	-0.893	0.073	-0.884	16
17	94.78	93.90	0.88	0.068	0.233	0.001	0.222	17


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Coal Seam: Pittsburgh No. 8
Circuit: Individual Microcel
Response: Combustible Recovery
Data File: P-CLM-00
Comments: Analysis with Outliers Removed
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Size            microns       100.000       300.000
B      Feed Rate       lbs/hr       300.000       500.000
C      Frother         ml/min       0.500         1.500
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	127033.02	1	127033.02		
Linear	24.93	3	8.31	4.253	0.0353
Quadratic	10.09	6	1.68	0.7117	0.6626
Cubic	0.00	0			
RESIDUAL	9.45	4	2.36		
TOTAL	127077.50	14			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	10.09	6	1.68	0.7117	0.6626
Quadratic	0.00	0			
Cubic	0.00	0			
PURE ERR	9.45	4	2.36		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	10	1.398	0.5606	0.4288	41.255
Quadratic	10	4	1.537	0.7875	0.3093	
Cubic	10	4	1.537	0.7875	0.3093	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	24.93	3	8.311	4.253	0.0353
RESIDUAL	19.54	10	1.954		
Lack Of Fit	10.09	6	1.682	0.7117	0.6626
Pure Error	9.45	4	2.363		
COR TOTAL	44.48	13			
ROOT MSE	1.398		R-SQUARED	0.5606	
DEP MEAN	95.256		ADJ R-SQUARED	0.4288	
C.V.	1.47%				

Predicted Residual Sum of Squares (PRESS) = 41.26

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	94.987	1	0.385	246.9	
A	-0.547	1	0.536	-1.019	0.3321
B	-0.763	1	0.536	-1.423	0.1851
C	1.780	1	0.596	2.986	0.0137

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Comb. rec} = & 94.987 \\ & - 0.547 * A \\ & - 0.763 * B \\ & + 1.780 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Comb. rec} = & 95.573 \\ & - 5.467\text{E-}03 * \text{Size} \\ & - 7.633\text{E-}03 * \text{Feed Rate} \\ & + 3.5600 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	94.790	96.297	-1.507	0.361	-1.349	0.257	-1.415	9
2	96.720	95.203	1.517	0.348	1.344	0.242	1.409	1
3	95.400	94.770	0.630	0.409	0.586	0.059	0.566	11
4	93.980	93.677	0.303	0.361	0.272	0.010	0.259	3
5	95.230	93.753	1.477	0.420	1.387	0.348	1.464	10
6	91.190	92.660	-1.470	0.481	-1.459	0.492	-1.560	2
8	96.470	96.220	0.250	0.299	0.214	0.005	0.203	4
11	98.730	97.530	1.200	0.299	1.025	0.112	1.028	13
12	95.420	96.003	-0.583	0.420	-0.548	0.054	-0.528	7
13	95.730	94.987	0.743	0.076	0.553	0.006	0.533	5
14	92.530	94.987	-2.457	0.076	-1.828	0.068	-2.125	8
15	95.950	94.987	0.963	0.076	0.717	0.011	0.698	14
16	96.670	97.530	-0.860	0.299	-0.735	0.057	-0.717	16
17	94.780	94.987	-0.207	0.076	-0.154	0.000	-0.146	17

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Coal Seam: Pittsburgh No. 8
Circuit: Individual Microcel
Response: Energy Recovery
Data File: P-CLM-00
Comments: Analysis of Complete Data Set
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FAC      FACTOR          UNITS      -1 LEVEL      +1 LEVEL
A        Size           microns    100.000      300.000
B        Feed Rate      lbs/hr    300.000      500.000
C        Frother        ml/min    0.500        1.500
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	136593.7	1	136593.7		
Linear	140.5	3	46.8	2.974	0.0784
Quadratic	109.5	6	18.2	1.432	0.3554
Cubic	55.3	1	55.3	26.14	0.0069
RESIDUAL	8.5	4	2.1		
TOTAL	136907.4	15			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	164.8	7	23.5	11.13	0.0173
Quadratic	55.3	1	55.3	26.14	0.0069
Cubic	0.0	0			
PURE ERR	8.5	4	2.1		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	11	3.97	0.4479	0.2973	356.65
Quadratic	10	5	3.57	0.7969	0.4312	
Cubic	11	4	1.45	0.9730	0.9056	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	140.5	3	46.83	2.974	0.0784
RESIDUAL	173.2	11	15.75		
Lack Of Fit	164.8	7	23.54	11.13	0.0173
Pure Error	8.5	4	2.11		
COR TOTAL	313.7	14			
ROOT MSE	3.97		R-SQUARED	0.4479	
DEP MEAN	95.43		ADJ R-SQUARED	0.2973	
C.V.	4.16%				

Predicted Residual Sum of Squares (PRESS) = 356.6

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	95.23	1	1.03	92.14	
A	-0.61	1	1.52	-0.3995	0.6972
B	-1.90	1	1.46	-1.306	0.2181
C	3.52	1	1.58	2.230	0.0475

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & 95.23 \\ & - 0.61 * A \\ & - 1.90 * B \\ & + 3.52 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & 97.02 \\ & - 6.080\text{E-}03 * \text{Size} \\ & - 1.904\text{E-}02 * \text{Feed Rate} \\ & + 7.0479 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	96.16	97.74	-1.58	0.361	-0.499	0.035	-0.482	9
2	97.90	96.53	1.37	0.348	0.428	0.025	0.412	1
3	96.80	93.94	2.86	0.373	0.911	0.123	0.904	11
4	95.71	92.72	2.99	0.318	0.912	0.097	0.905	3
5	96.66	92.32	4.34	0.366	1.375	0.273	1.440	10
6	92.61	91.10	1.51	0.418	0.499	0.045	0.481	2
8	97.90	98.15	-0.25	0.296	-0.075	0.001	-0.071	4
10	79.35	89.80	-10.45	0.296	-3.139	1.035	-9.279	6
11	99.17	100.66	-1.49	0.268	-0.439	0.018	-0.422	13
12	96.87	96.85	0.02	0.418	0.006	0.000	0.006	7
13	97.32	95.23	2.09	0.068	0.545	0.005	0.527	5
14	94.07	95.23	-1.16	0.068	-0.303	0.002	-0.290	8
15	97.41	95.23	2.18	0.068	0.568	0.006	0.550	14
16	97.78	100.66	-2.88	0.268	-0.849	0.066	-0.837	16
17	95.69	95.23	0.46	0.068	0.119	0.000	0.114	17

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Coal Seam: Pittsburgh No. 8
Circuit: Individual Microcel
Response: Energy Recovery
Data File: P-CLM-00
Comments: Analysis with Outliers Removed
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Size           microns       100.000       300.000
B      Feed Rate      lbs/hr       300.000       500.000
C      Frother        ml/min       0.500         1.500
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	130574.23	1	130574.23		
Linear	18.77	3	6.26	3.471	0.0587
Quadratic	9.57	6	1.59	0.7541	0.6400
Cubic	0.00	0			
RESIDUAL	8.46	4	2.11		
TOTAL	130611.02	14			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	9.57	6	1.59	0.7541	0.6400
Quadratic	0.00	0			
Cubic	0.00	0			
PURE ERR	8.46	4	2.11		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	10	1.343	0.5101	0.3632	38.264
Quadratic	10	4	1.454	0.7701	0.2530	
Cubic	10	4	1.454	0.7701	0.2530	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	18.77	3	6.257	3.471	0.0587
RESIDUAL	18.02	10	1.802		
Lack Of Fit	9.57	6	1.595	0.7541	0.6400
Pure Error	8.46	4	2.114		
COR TOTAL	36.79	13			
ROOT MSE	1.343		R-SQUARED	0.5101	
DEP MEAN	96.575		ADJ R-SQUARED	0.3632	
C.V.	1.39%				

Predicted Residual Sum of Squares (PRESS) = 38.26

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	96.341	1	0.370	260.7	
A	-0.495	1	0.515	-0.9608	0.3593
B	-0.524	1	0.515	-1.017	0.3333
C	1.623	1	0.572	2.835	0.0177

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & 96.341 \\ & - 0.495 * A \\ & - 0.524 * B \\ & + 1.623 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & 96.179 \\ & - 4.949\text{E-}03 * \text{Size} \\ & - 5.237\text{E-}03 * \text{Feed Rate} \\ & + 3.2464 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	96.160	97.360	-1.200	0.361	-1.118	0.177	-1.134	9
2	97.900	96.370	1.530	0.348	1.412	0.267	1.497	1
3	96.800	96.312	0.488	0.409	0.473	0.039	0.453	11
4	95.710	95.322	0.388	0.361	0.361	0.018	0.345	3
5	96.660	95.213	1.447	0.420	1.415	0.363	1.501	10
6	92.610	94.223	-1.613	0.481	-1.667	0.643	-1.861	2
8	97.900	97.469	0.431	0.299	0.383	0.016	0.366	4
11	99.170	98.488	0.682	0.299	0.607	0.039	0.586	13
12	96.870	97.441	-0.571	0.420	-0.558	0.056	-0.538	7
13	97.320	96.341	0.979	0.076	0.758	0.012	0.741	5
14	94.070	96.341	-2.271	0.076	-1.760	0.063	-2.009	8
15	97.410	96.341	1.069	0.076	0.828	0.014	0.814	14
16	97.780	98.488	-0.708	0.299	-0.630	0.042	-0.610	16
17	95.690	96.341	-0.651	0.076	-0.504	0.005	-0.485	17

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Coal Seam:  Pittsburgh No. 8
Circuit:    Individual Microcel
Response:   Ash Rejection
Data File:  P-CLM-00
Comments:   Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Size            microns       100.000       300.000
B      Feed Rate       lbs/hr       300.000       500.000
C      Frother         ml/min       0.500         1.500
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	46997.4	1	46997.4		
Linear	1580.6	3	526.9	6.146	0.0104
Quadratic	258.6	6	43.1	0.3150	0.9040
Cubic	184.3	1	184.3	1.474	0.2915
RESIDUAL	500.0	4	125.0		
TOTAL	49521.0	15			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	442.9	7	63.3	0.5062	0.7971
Quadratic	184.3	1	184.3	1.474	0.2915
Cubic	0.0	0			
PURE ERR	500.0	4	125.0		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	11	9.26	0.6264	0.5244	1890.88
Quadratic	10	5	11.70	0.7288	0.2408	
Cubic	11	4	11.18	0.8019	0.3065	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1580.6	3	526.88	6.146	0.0104
RESIDUAL	942.9	11	85.72		
Lack Of Fit	442.9	7	63.27	0.5062	0.7971
Pure Error	500.0	4	125.00		
COR TOTAL	2523.6	14			
ROOT MSE	9.26		R-SQUARED	0.6264	
DEP MEAN	55.97		ADJ R-SQUARED	0.5244	
C.V.	16.54%				

Predicted Residual Sum of Squares (PRESS) = 1890.9

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	56.44	1	2.41	23.41	
A	2.21	1	3.55	0.6236	0.5456
B	9.04	1	3.40	2.660	0.0222
C	-9.27	1	3.69	-2.513	0.0288

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 56.44 \\ & + 2.21 * A \\ & + 9.04 * B \\ & - 9.27 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & 34.37 \\ & + 2.214\text{E-}02 * \text{Size} \\ & + 9.045\text{E-}02 * \text{Feed Rate} \\ & - 18.531 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	56.63	45.19	11.44	0.361	1.546	0.337	1.666	9
2	45.32	49.61	-4.29	0.348	-0.575	0.044	-0.556	1
3	54.51	63.28	-8.77	0.373	-1.195	0.212	-1.222	11
4	65.68	67.70	-2.02	0.318	-0.265	0.008	-0.253	3
5	56.11	63.50	-7.39	0.366	-1.002	0.145	-1.002	10
6	66.97	67.92	-0.95	0.418	-0.135	0.003	-0.129	2
8	51.96	49.39	2.57	0.296	0.330	0.011	0.317	4
10	77.16	74.76	2.40	0.296	0.310	0.010	0.296	6
11	16.64	38.13	-21.49	0.268	-2.714	0.675	-4.502	13
12	59.74	56.22	3.52	0.418	0.498	0.044	0.480	7
13	62.19	56.44	5.75	0.068	0.643	0.008	0.625	5
14	62.49	56.44	6.05	0.068	0.676	0.008	0.659	8
15	59.74	56.44	3.30	0.068	0.369	0.002	0.354	14
16	47.61	38.13	9.48	0.268	1.196	0.131	1.223	16
17	56.87	56.44	0.43	0.068	0.048	0.000	0.045	17


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Coal Seam: Pittsburgh No. 8
Circuit: Individual Microcel
Response: Ash Rejection
Data File: P-CLM-00
Comments: Analysis with Outliers Removed
=====

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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Size           microns       100.000       300.000
B      Feed Rate      lbs/hr       300.000       500.000
C      Frother        ml/min       0.500         1.500
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	48378.3	1	48378.3		
Linear	554.3	3	184.8	5.931	0.0136
Quadratic	246.5	6	41.1	2.528	0.1942
Cubic	44.6	1	44.6	6.538	0.0834
RESIDUAL	20.4	3	6.8		
TOTAL	49244.1	14			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	291.1	7	41.6	6.102	0.0827
Quadratic	44.6	1	44.6	6.538	0.0834
Cubic	0.0	0			
PURE ERR	20.4	3	6.8		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	10	5.58	0.6402	0.5323	733.32
Quadratic	10	4	4.03	0.9249	0.7560	
Cubic	11	3	2.61	0.9764	0.8977	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	554.3	3	184.77	5.931	0.0136
RESIDUAL	311.5	10	31.15		
Lack Of Fit	291.1	7	41.58	6.102	0.0827
Pure Error	20.4	3	6.81		
COR TOTAL	865.8	13			
ROOT MSE	5.58		R-SQUARED	0.6402	
DEP MEAN	58.78		ADJ R-SQUARED	0.5323	
C.V.	9.49%				

Predicted Residual Sum of Squares (PRESS) = 733.3

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	58.24	1	1.51	38.64	
A	1.50	1	2.15	0.6978	0.5012
B	6.18	1	2.15	2.878	0.0164
C	-6.04	1	2.33	-2.588	0.0271

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 58.24 \\ & + 1.50 * A \\ & + 6.18 * B \\ & - 6.04 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & 42.61 \\ & + 1.498\text{E-}02 * \text{Size} \\ & + 6.179\text{E-}02 * \text{Feed Rate} \\ & - 12.083 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	56.63	50.56	6.07	0.406	1.412	0.341	1.497	9
2	45.32	53.55	-8.23	0.373	-1.863	0.516	-2.188	1
3	54.51	62.92	-8.41	0.373	-1.902	0.538	-2.259	11
4	65.68	65.91	-0.23	0.323	-0.051	0.000	-0.048	3
5	56.11	62.78	-6.67	0.367	-1.502	0.326	-1.619	10
6	66.97	65.78	1.19	0.425	0.282	0.015	0.269	2
8	51.96	53.69	-1.73	0.325	-0.378	0.017	-0.361	4
10	77.16	70.46	6.70	0.325	1.462	0.257	1.564	6
12	59.74	58.37	1.37	0.425	0.323	0.019	0.308	7
13	62.19	58.24	3.95	0.073	0.736	0.011	0.718	5
14	62.49	58.24	4.25	0.073	0.792	0.012	0.776	8
15	59.74	58.24	1.50	0.073	0.280	0.002	0.267	14
16	47.61	46.02	1.59	0.367	0.359	0.019	0.343	16
17	56.87	58.24	-1.37	0.073	-0.254	0.001	-0.242	17

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Coal Seam:  Pittsburgh No. 8
Circuit:    Individual Microcel
Response:   Sulfur Rejection
Data File:  P-CLM-00
Comments:   Analysis of Complete Data Set
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FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Size	microns	100.000	300.000
B	Feed Rate	lbs/hr	300.000	500.000
C	Frother	ml/min	0.500	1.500

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	4700.4	1	4700.4		
Linear	318.8	3	106.3	3.142	0.0690
Quadratic	115.6	6	19.3	0.3758	0.8673
Cubic	131.9	1	131.9	4.240	0.1086
RESIDUAL	124.4	4	31.1		
TOTAL	5391.2	15			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	247.5	7	35.4	1.137	0.4782
Quadratic	131.9	1	131.9	4.240	0.1086
Cubic	0.0	0			
PURE ERR	124.4	4	31.1		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	11	5.82	0.4615	0.3146	712.16
Quadratic	10	5	7.16	0.6289	-0.0391	
Cubic	11	4	5.58	0.8198	0.3694	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	318.8	3	106.26	3.142	0.0690
RESIDUAL	372.0	11	33.82		
Lack Of Fit	247.5	7	35.36	1.137	0.4782
Pure Error	124.4	4	31.11		
COR TOTAL	690.8	14			
ROOT MSE	5.82		R-SQUARED	0.4615	
DEP MEAN	17.70		ADJ R-SQUARED	0.3146	
C.V.	32.85%				

Predicted Residual Sum of Squares (PRESS) = 712.2

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	17.95	1	1.51	11.85	
A	-0.46	1	2.23	-0.2054	0.8410
B	4.75	1	2.14	2.222	0.0482
C	-3.24	1	2.32	-1.400	0.1891

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sulfur rej} = & 17.95 \\ & - 0.46 * A \\ & + 4.75 * B \\ & - 3.24 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sulfur rej} = & 6.36 \\ & - 4.582\text{E-}03 * \text{Size} \\ & + 4.746\text{E-}02 * \text{Feed Rate} \\ & - 6.4824 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	15.70	13.66	2.04	0.361	0.438	0.027	0.422	9
2	14.58	12.74	1.84	0.348	0.391	0.020	0.375	1
3	25.47	23.15	2.32	0.373	0.503	0.038	0.485	11
4	16.95	22.24	-5.29	0.318	-1.101	0.141	-1.112	3
5	11.99	21.65	-9.66	0.366	-2.086	0.627	-2.557	10
6	18.65	20.73	-2.08	0.418	-0.469	0.039	-0.452	2
8	14.48	14.25	0.23	0.296	0.047	0.000	0.045	4
10	35.97	25.94	10.03	0.296	2.056	0.444	2.499	6
11	7.95	9.96	-2.01	0.268	-0.404	0.015	-0.388	13
12	16.89	19.45	-2.56	0.418	-0.578	0.060	-0.559	7
13	24.25	17.95	6.30	0.068	1.122	0.023	1.137	5
14	22.86	17.95	4.91	0.068	0.875	0.014	0.865	8
15	16.19	17.95	-1.76	0.068	-0.313	0.002	-0.300	14
16	12.60	9.96	2.64	0.268	0.530	0.026	0.512	16
17	11.00	17.95	-6.95	0.068	-1.238	0.028	-1.272	17

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Coal Seam:  Pittsburgh No. 8
Circuit:    Individual Microcel
Response:   Pyritic Sulfur Rejection
Data File:  P-CLM-00
Comments:   Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Size           microns       100.000       300.000
B      Feed Rate      lbs/hr       300.000       500.000
C      Frother        ml/min       0.500         1.500
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	18747.2	1	18747.2		
Linear	1555.7	3	518.6	2.145	0.1524
Quadratic	887.9	6	148.0	0.4177	0.8410
Cubic	583.0	1	583.0	1.962	0.2339
RESIDUAL	1188.4	4	297.1		
TOTAL	22962.3	15			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	1470.9	7	210.1	0.7073	0.6773
Quadratic	583.0	1	583.0	1.962	0.2339
Cubic	0.0	0			
PURE ERR	1188.4	4	297.1		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	11	15.55	0.3691	0.1970	5182.17
Quadratic	10	5	18.82	0.5797	-0.1767	
Cubic	11	4	17.24	0.7181	0.0132	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1555.7	3	518.58	2.145	0.1524
RESIDUAL	2659.3	11	241.76		
Lack Of Fit	1470.9	7	210.13	0.7073	0.6773
Pure Error	1188.4	4	297.11		
COR TOTAL	4215.1	14			
ROOT MSE	15.55		R-SQUARED	0.3691	
DEP MEAN	35.35		ADJ R-SQUARED	0.1970	
C.V.	43.98%				

Predicted Residual Sum of Squares (PRESS) = 5182.2

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	36.21	1	4.05	8.941	
A	-6.21	1	5.96	-1.041	0.3201
B	9.13	1	5.71	1.599	0.1381
C	-6.61	1	6.19	-1.068	0.3084

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Pyritic rej} = & 36.21 \\ & - 6.21 * A \\ & + 9.13 * B \\ & - 6.61 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Pyritic rej} = & 25.32 \\ & - 6.209\text{E-}02 * \text{Size} \\ & + 9.132\text{E-}02 * \text{Feed Rate} \\ & - 13.224 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	36.55	33.28	3.27	0.361	0.263	0.010	0.251	9
2	22.69	20.87	1.82	0.348	0.145	0.003	0.139	1
3	64.00	51.55	12.45	0.373	1.011	0.152	1.012	11
4	29.12	39.13	-10.01	0.318	-0.779	0.071	-0.765	3
5	23.41	49.03	-25.62	0.366	-2.069	0.617	-2.524	10
6	33.99	36.61	-2.62	0.418	-0.221	0.009	-0.211	2
8	24.29	23.39	0.90	0.296	0.069	0.001	0.066	4
10	69.71	51.95	17.76	0.296	1.361	0.194	1.423	6
11	6.72	20.46	-13.74	0.268	-1.033	0.098	-1.037	13
12	25.48	38.73	-13.25	0.418	-1.117	0.224	-1.131	7
13	35.53	36.21	-0.68	0.068	-0.045	0.000	-0.043	5
14	61.32	36.21	25.11	0.068	1.673	0.051	1.847	8
15	23.25	36.21	-12.96	0.068	-0.863	0.014	-0.852	14
16	36.07	20.46	15.61	0.268	1.173	0.126	1.196	16
17	38.16	36.21	1.95	0.068	0.130	0.000	0.124	17

```

=====
Coal Seam:  Pittsburgh No. 8
Circuit:      Individual Microcel
Response:     Separation Efficiency
Data File:    P-CLM-00
Comments:     Analysis of Complete Data Set
=====

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=====
FAC    FACTOR          UNITS      -1 LEVEL    +1 LEVEL
A      Size            microns    100.000     300.000
B      Feed Rate       lbs/hr     300.000     500.000
C      Frother         ml/min     0.500       1.500
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	39632.5	1	39632.5		
Linear	801.0	3	267.0	3.188	0.0667
Quadratic	421.4	6	70.2	0.7026	0.6633
Cubic	37.6	1	37.6	0.3256	0.5988
RESIDUAL	462.2	4	115.6		
TOTAL	41354.7	15			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	459.0	7	65.6	0.5675	0.7593
Quadratic	37.6	1	37.6	0.3256	0.5988
Cubic	0.0	0			
PURE ERR	462.2	4	115.6		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	11	9.15	0.4651	0.3192	1751.55
Quadratic	10	5	10.00	0.7098	0.1874	
Cubic	11	4	10.75	0.7316	0.0607	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	801.0	3	267.00	3.188	0.0667
RESIDUAL	921.2	11	83.75		
Lack Of Fit	459.0	7	65.58	0.5675	0.7593
Pure Error	462.2	4	115.55		
COR TOTAL	1722.2	14			
ROOT MSE	9.15		R-SQUARED	0.4651	
DEP MEAN	51.40		ADJ R-SQUARED	0.3192	
C.V.	17.80%				

Predicted Residual Sum of Squares (PRESS) = 1751.6

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	51.68	1	2.38	21.68	
A	1.60	1	3.51	0.4572	0.6564
B	7.14	1	3.36	2.124	0.0572
C	-5.74	1	3.64	-1.576	0.1434

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Efficiency} = & 51.68 \\ & + 1.60 * A \\ & + 7.14 * B \\ & - 5.74 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Efficiency} = & 31.39 \\ & + 1.605\text{E-}02 * \text{Size} \\ & + 7.140\text{E-}02 * \text{Feed Rate} \\ & - 11.484 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	52.79	42.93	9.86	0.361	1.347	0.256	1.405	9
2	43.21	46.14	-2.93	0.348	-0.397	0.021	-0.381	1
3	51.30	57.21	-5.91	0.373	-0.816	0.099	-0.802	11
4	61.39	60.42	0.97	0.318	0.128	0.002	0.122	3
5	52.78	55.81	-3.03	0.366	-0.416	0.025	-0.400	10
6	59.58	59.02	0.56	0.418	0.080	0.001	0.076	2
8	49.86	47.54	2.32	0.296	0.302	0.010	0.289	4
10	56.51	64.56	-8.05	0.296	-1.048	0.115	-1.053	6
11	15.82	38.80	-22.98	0.268	-2.935	0.790	-6.010	13
12	56.61	53.08	3.53	0.418	0.506	0.046	0.488	7
13	59.51	51.68	7.83	0.068	0.886	0.014	0.877	5
14	56.56	51.68	4.88	0.068	0.553	0.006	0.534	8
15	57.16	51.68	5.48	0.068	0.620	0.007	0.602	14
16	45.39	38.80	6.59	0.268	0.842	0.065	0.830	16
17	52.56	51.68	0.88	0.068	0.100	0.000	0.095	17


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Coal Seam: Pittsburgh No. 8
Circuit: Individual Microcel
Response: Separation Efficiency
Data File: P-CLM-00
Comments: Analysis with Outliers Removed
=====

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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Size            microns       100.000       300.000
B      Feed Rate       lbs/hr       300.000       500.000
C      Frother         ml/min       0.500         1.500
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	40738.7	1	40738.7		
Linear	166.0	3	55.3	2.770	0.0969
Quadratic	174.7	6	29.1	4.652	0.0793
Cubic	0.0	1	0.0	3.20E-03	0.9585
RESIDUAL	25.0	3	8.3		
TOTAL	41104.5	14			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	174.7	7	25.0	2.994	0.1985
Quadratic	0.0	1	0.0	3.20E-03	0.9585
Cubic	0.0	0			
PURE ERR	25.0	3	8.3		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	10	4.47	0.4538	0.2900	428.72
Quadratic	10	4	2.50	0.9315	0.7775	
Cubic	11	3	2.89	0.9316	0.7036	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	166.0	3	55.33	2.770	0.0969
RESIDUAL	199.8	10	19.98		
Lack Of Fit	174.7	7	24.96	2.994	0.1985
Pure Error	25.0	3	8.34		
COR TOTAL	365.7	13			
ROOT MSE	4.47		R-SQUARED	0.4538	
DEP MEAN	53.94		ADJ R-SQUARED	0.2900	
C.V.	8.29%				

Predicted Residual Sum of Squares (PRESS) = 428.7

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	53.59	1	1.21	44.41	
A	0.84	1	1.72	0.4881	0.6360
B	4.08	1	1.72	2.371	0.0392
C	-2.30	1	1.87	-1.228	0.2477

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Efficiency} = & 53.59 \\ & + 0.84 * A \\ & + 4.08 * B \\ & - 2.30 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Efficiency} = & 40.20 \\ & + 8.390\text{E-}03 * \text{Size} \\ & + 4.076\text{E-}02 * \text{Feed Rate} \\ & - 4.5910 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	52.79	48.68	4.11	0.406	1.194	0.244	1.223	9
2	43.21	50.36	-7.15	0.373	-2.019	0.606	-2.489	1
3	51.30	56.83	-5.53	0.373	-1.562	0.363	-1.705	11
4	61.39	58.51	2.88	0.323	0.784	0.073	0.768	3
5	52.78	55.05	-2.27	0.367	-0.638	0.059	-0.618	10
6	59.58	56.73	2.85	0.425	0.842	0.131	0.829	2
8	49.86	52.14	-2.28	0.325	-0.620	0.046	-0.600	4
10	56.51	59.96	-3.45	0.325	-0.941	0.107	-0.935	6
12	56.61	55.37	1.24	0.425	0.365	0.025	0.349	7
13	59.51	53.59	5.92	0.073	1.375	0.037	1.449	5
14	56.56	53.59	2.97	0.073	0.690	0.009	0.670	8
15	57.16	53.59	3.57	0.073	0.829	0.014	0.815	14
16	45.39	47.22	-1.83	0.367	-0.515	0.038	-0.495	16
17	52.56	53.59	-1.03	0.073	-0.240	0.001	-0.228	17

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=====
Coal Seam:  Pittsburgh No. 8
Circuit:    Individual Microcel
Response:   1b SO2/MM Btu
Data File:  P-CLM-00
Comments:   Analysis of Complete Data Set
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=====
FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Size           microns        100.000       300.000
B    Feed Rate      lbs/hr         300.000       500.000
C    Frother        ml/min         0.500         1.500
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	259.667	1	259.667		
Linear	0.454	3	0.151	0.7159	0.5628
Quadratic	0.881	6	0.147	0.5081	0.7831
Cubic	0.162	1	0.162	0.5067	0.5159
RESIDUAL	1.282	4	0.320		
TOTAL	262.446	15			

Lack of Fit Tests

MODEL	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
Linear	1.043	7	0.149	0.4649	0.8228
Quadratic	0.162	1	0.162	0.5067	0.5159
Cubic	0.000	0			
PURE ERR	1.282	4	0.320		

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	4	11	0.460	0.1634	-0.0648	3.959
Quadratic	10	5	0.537	0.4803	-0.4553	
Cubic	11	4	0.566	0.5387	-0.6146	

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	0.454	3	0.151	0.7159	0.5628
RESIDUAL	2.325	11	0.211		
Lack Of Fit	1.043	7	0.149	0.4649	0.8228
Pure Error	1.282	4	0.320		
COR TOTAL	2.779	14			
ROOT MSE	0.460		R-SQUARED	0.1634	
DEP MEAN	4.161		ADJ R-SQUARED	-0.0648	
C.V.	11.05%				

Predicted Residual Sum of Squares (PRESS) = 3.959

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	4.140	1	0.120	34.58	
A	0.155	1	0.176	0.8776	0.3989
B	-0.063	1	0.169	-0.3746	0.7151
C	0.157	1	0.183	0.8576	0.4094

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{SO}_2 \text{ emiss.} &= \\ &4.140 \\ &+ 0.155 * A \\ &- 0.063 * B \\ &+ 0.157 * C \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{SO}_2 \text{ emiss.} &= \\ &3.769 \\ &+ 1.547\text{E-}03 * \text{Size} \\ &- 6.325\text{E-}04 * \text{Feed Rate} \\ &+ 0.31396 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	4.080	4.048	0.032	0.361	0.086	0.001	0.082	9
2	4.500	4.358	0.142	0.348	0.383	0.020	0.368	1
3	3.790	3.922	-0.132	0.373	-0.362	0.019	-0.347	11
4	4.840	4.231	0.609	0.318	1.603	0.299	1.746	3
5	4.290	3.828	0.462	0.366	1.262	0.230	1.301	10
6	3.630	4.138	-0.508	0.418	-1.447	0.375	-1.533	2
8	4.570	4.452	0.118	0.296	0.307	0.010	0.294	4
10	3.940	3.920	0.020	0.296	0.053	0.000	0.050	6
11	4.370	4.360	0.010	0.268	0.025	0.000	0.024	13
12	4.000	4.234	-0.234	0.418	-0.666	0.080	-0.648	7
13	3.890	4.140	-0.250	0.068	-0.563	0.006	-0.545	5
14	4.800	4.140	0.660	0.068	1.487	0.040	1.586	8
15	4.060	4.140	-0.080	0.068	-0.180	0.001	-0.172	14
16	4.440	4.360	0.080	0.268	0.203	0.004	0.194	16
17	3.210	4.140	-0.930	0.068	-2.095	0.080	-2.577	17

APPENDIX 3-B

Box-Behnken Statistical Analyses

**Independent Microcel Tests
Illinois No. 6 Seam Coal**

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=====
Coal Seam:  Illinois No. 6
Circuit:    Individual Microcel
Data File:  I-CLM-00
=====
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				A	B	Y1	Y2	Y3
Obs	Dsn ID	Run Ord	Blk	Collector lb/ton	Frother ml/min	Comb. rec %	Ash rej %	Sulfur rej %
5	5	1	1	2.000	2.000	86.58	76.12	39.02
2	2	2	1	2.000	1.000	79.90	87.14	50.79
9	9	3	1	3.000	3.000	86.72	77.91	39.55
8	8	4	1	2.000	3.000	86.93	76.79	41.80
7	7	5	1	1.000	3.000	86.08	79.73	44.14
4	4	6	1	1.000	2.000	88.91	73.77	34.11
3	3	7	1	3.000	1.000	85.21	80.21	38.49
6	6	8	1	3.000	2.000	88.24	80.82	46.27
1	1	9	1	1.000	1.000	83.48	84.82	48.35

				Y4	Y5	Y6	Y7
Obs	Dsn ID	Run Ord	Blk	Pyr rej %	Energy rec %	Efficiency %	SO2 emiss lbs/MMBtu
5	5	1	1	52.15	90.31	66.43	6.07
2	2	2	1	64.73	85.35	72.49	6.08
9	9	3	1	52.44	91.15	69.06	6.37
8	8	4	1	53.54	90.97	67.77	6.42
7	7	5	1	53.58	90.61	70.34	5.26
4	4	6	1	47.24	92.55	66.32	6.46
3	3	7	1	50.40	89.25	69.46	6.06
6	6	8	1	59.96	92.65	73.47	5.46
1	1	9	1	62.94	87.87	72.69	5.60

```

=====
Coal Seam:  Illinois No. 6
Circuit:    Individual Microcel
Response:   Combustible Recovery
Data File:  I-CLM-00
Comments:   Analysis of Complete Data Set
=====

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=====
FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Collector       lb/ton        1.000         3.000
B    Frother         ml/min        1.000         3.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	66229.02	1	66229.02		
Linear	21.16	2	10.58	1.679	0.2635
Quadratic	28.41	3	9.47	3.023	0.1939
Cubic	9.40	2	4.70	7518	0.0082
RESIDUAL	0.00	1	0.00		
TOTAL	66288.00	9			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	3	6	2.510	0.3589	0.1452	77.502
Quadratic	6	3	1.770	0.8406	0.5751	114.569
Cubic	8	1	0.025	1.0000	0.9999	0.114

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	21.16	2	10.582	1.679	0.2635
RESIDUAL	37.81	6	6.301		
COR TOTAL	58.97	8			
ROOT MSE	2.510		R-SQUARED	0.3589	
DEP MEAN	85.783		ADJ R-SQUARED	0.1452	
C.V.	2.93%				

Predicted Residual Sum of Squares (PRESS) = 77.50

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	85.783	1	0.837	102.5	
A	0.283	1	1.025	0.2765	0.7915
B	1.857	1	1.025	1.812	0.1200

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Comb. rec} = & 85.783 \\ & + 0.283 * A \\ & + 1.857 * B \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Comb. rec} = & 81.503 \\ & + 0.28333 * \text{Collector} \\ & + 1.8567 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	83.480	83.643	-0.163	0.444	-0.087	0.002	-0.080	9
2	79.900	83.927	-4.027	0.278	-1.888	0.457	-2.703	2
3	85.210	84.210	1.000	0.444	0.534	0.076	0.500	7
4	88.910	85.500	3.410	0.278	1.598	0.328	1.926	6
5	86.580	85.783	0.797	0.111	0.337	0.005	0.310	1
6	88.240	86.067	2.173	0.278	1.019	0.133	1.023	8
7	86.080	87.357	-1.277	0.444	-0.682	0.124	-0.649	5
8	86.930	87.640	-0.710	0.278	-0.333	0.014	-0.307	4
9	86.720	87.923	-1.203	0.444	-0.643	0.110	-0.608	3

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	49.58	5	9.915	3.165	0.1859
RESIDUAL	9.40	3	3.133		
COR TOTAL	58.97	8			
ROOT MSE	1.770		R-SQUARED	0.8406	
DEP MEAN	85.783		ADJ R-SQUARED	0.5751	
C.V.	2.06%				

Predicted Residual Sum of Squares (PRESS) = 114.57

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	86.597	1	1.319	65.64	
A	0.283	1	0.723	0.3921	0.7212
B	1.857	1	0.723	2.570	0.0825
A2	1.970	1	1.252	1.574	0.2135
B2	-3.190	1	1.252	-2.549	0.0840
AB	-0.272	1	0.885	-0.3079	0.7783

Final Equation in Terms of Coded Factors:

```

Comb. rec =
            86.597
            +      0.283 * A
            +      1.857 * B
            +      1.970 * A2
            -      3.190 * B2
            -      0.272 * AB

```

Final Equation in Terms of Actual Factors:

```

Comb. rec =
            76.347
            -      7.0517 * Collector
            +      15.162 * Frother
            +      1.9700 * Collector^2
            -      3.1900 * Frother ^2
            -      0.27250 * Collector * Frother

```

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	83.480	82.964	0.516	0.806	0.661	0.302	0.584	9
2	79.900	81.550	-1.650	0.556	-1.398	0.407	-1.935	2
3	85.210	84.076	1.134	0.806	1.453	1.458	2.181	7
4	88.910	88.283	0.627	0.556	0.531	0.059	0.456	6
5	86.580	86.597	-0.017	0.556	-0.014	0.000	-0.012	1
6	88.240	88.850	-0.610	0.556	-0.517	0.056	-0.442	8
7	86.080	87.223	-1.143	0.806	-1.464	1.480	-2.236	5
8	86.930	85.263	1.667	0.556	1.412	0.416	1.993	4
9	86.720	87.244	-0.524	0.806	-0.672	0.311	-0.595	3

```

=====
Coal Seam:  Illinois No. 6
Circuit:    Individual Microcel
Response:   Energy Recovery
Data File:  I-CLM-00
Comments:   Analysis of Complete Data Set
=====

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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Collector       lb/ton        1.000         3.000
B      Frother         ml/min        1.000         3.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	73027.86	1	73027.86		
Linear	18.22	2	9.11	2.214	0.1905
Quadratic	20.58	3	6.86	5.004	0.1094
Cubic	3.88	2	1.94	8.184	0.2400
RESIDUAL	0.24	1	0.24		
TOTAL	73070.78	9			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	3	6	2.029	0.4246	0.2328	49.939
Quadratic	6	3	1.171	0.9042	0.7444	49.022
Cubic	8	1	0.487	0.9945	0.9559	43.165

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	18.22	2	9.112	2.214	0.1905
RESIDUAL	24.70	6	4.116		
COR TOTAL	42.92	8			
ROOT MSE	2.029		R-SQUARED	0.4246	
DEP MEAN	90.079		ADJ R-SQUARED	0.2328	
C.V.	2.25%				

Predicted Residual Sum of Squares (PRESS) = 49.94

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	90.079	1	0.676	133.2	
A	0.337	1	0.828	0.4065	0.6985
B	1.710	1	0.828	2.065	0.0845

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & \\ & 90.079 \\ & + 0.337 * A \\ & + 1.710 * B \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & \\ & 85.986 \\ & + 0.33667 * \text{Collector} \\ & + 1.7100 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	87.870	88.032	-0.162	0.444	-0.107	0.003	-0.098	9
2	85.350	88.369	-3.019	0.278	-1.751	0.393	-2.286	2
3	89.250	88.706	0.544	0.444	0.360	0.035	0.332	7
4	92.550	89.742	2.808	0.278	1.628	0.340	1.990	6
5	90.310	90.079	0.231	0.111	0.121	0.001	0.110	1
6	92.650	90.416	2.234	0.278	1.296	0.215	1.394	8
7	90.610	91.452	-0.842	0.444	-0.557	0.083	-0.522	5
8	90.970	91.789	-0.819	0.278	-0.475	0.029	-0.442	4
9	91.150	92.126	-0.976	0.444	-0.645	0.111	-0.610	3

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	38.81	5	7.762	5.661	0.0922
RESIDUAL	4.11	3	1.371		
COR TOTAL	42.92	8			
ROOT MSE	1.171		R-SQUARED	0.9042	
DEP MEAN	90.079		ADJ R-SQUARED	0.7444	
C.V.	1.30%				

Predicted Residual Sum of Squares (PRESS) = 49.02

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	90.634	1	0.873	103.8	
A	0.337	1	0.478	0.7043	0.5320
B	1.710	1	0.478	3.577	0.0374
A2	1.803	1	0.828	2.178	0.1176
B2	-2.637	1	0.828	-3.184	0.0499
AB	-0.210	1	0.585	-0.3587	0.7436

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & 90.634 \\ & + 0.337 * A \\ & + 1.710 * B \\ & + 1.803 * A^2 \\ & - 2.637 * B^2 \\ & - 0.210 * AB \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & 82.368 \\ & - 6.4567 * \text{Collector} \\ & + 12.677 * \text{Frother} \\ & + 1.8033 * \text{Collector}^2 \\ & - 2.6367 * \text{Frother}^2 \\ & - 0.21000 * \text{Collector} * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	87.870	87.544	0.326	0.806	0.631	0.274	0.553	9
2	85.350	86.288	-0.938	0.556	-1.201	0.301	-1.362	2
3	89.250	88.638	0.612	0.806	1.186	0.971	1.328	7
4	92.550	92.101	0.449	0.556	0.575	0.069	0.498	6
5	90.310	90.634	-0.324	0.556	-0.416	0.036	-0.350	1
6	92.650	92.774	-0.124	0.556	-0.159	0.005	-0.131	8
7	90.610	91.384	-0.774	0.806	-1.500	1.553	-2.449	5
8	90.970	89.708	1.262	0.556	1.617	0.545	3.683	4
9	91.150	91.638	-0.488	0.806	-0.945	0.616	-0.920	3

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Coal Seam:  Illinois No. 6
Circuit:    Individual Microcel
Response:   Ash Rejection
Data File:  I-CLM-00
Comments:   Analysis of Complete Data Set
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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Collector      lb/ton        1.000         3.000
B      Frother        ml/min        1.000         3.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	57170.4	1	57170.4		
Linear	52.5	2	26.3	1.746	0.2525
Quadratic	37.6	3	12.5	0.7151	0.6053
Cubic	49.9	2	24.9	9.180	0.2273
RESIDUAL	2.7	1	2.7		
TOTAL	57313.1	9			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	3	6	3.88	0.3679	0.1572	194.13
Quadratic	6	3	4.19	0.6315	0.0172	628.39
Cubic	8	1	1.65	0.9810	0.8477	495.17

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	52.5	2	26.26	1.746	0.2525
RESIDUAL	90.2	6	15.04		
COR TOTAL	142.7	8			
ROOT MSE	3.88		R-SQUARED	0.3679	
DEP MEAN	79.70		ADJ R-SQUARED	0.1572	
C.V.	4.87%				

Predicted Residual Sum of Squares (PRESS) = 194.1

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	79.70	1	1.29	61.66	
A	0.10	1	1.58	6.53E-02	0.9501
B	-2.96	1	1.58	-1.868	0.1110

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 79.70 \\ & + 0.10 * A \\ & - 2.96 * B \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & 85.41 \\ & + 0.10333 * \text{Collector} \\ & - 2.9567 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	84.82	82.55	2.27	0.444	0.784	0.164	0.755	9
2	87.14	82.66	4.48	0.278	1.360	0.237	1.493	2
3	80.21	82.76	-2.55	0.444	-0.883	0.208	-0.864	7
4	73.77	79.60	-5.83	0.278	-1.768	0.401	-2.333	6
5	76.12	79.70	-3.58	0.111	-0.980	0.040	-0.976	1
6	80.82	79.80	1.02	0.278	0.308	0.012	0.284	8
7	79.73	76.64	3.09	0.444	1.069	0.305	1.084	5
8	76.79	76.74	0.05	0.278	0.014	0.000	0.013	4
9	77.91	76.85	1.06	0.444	0.368	0.036	0.339	3

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	90.1	5	18.03	1.028	0.5251
RESIDUAL	52.6	3	17.53		
COR TOTAL	142.7	8			
ROOT MSE	4.19		R-SQUARED	0.6315	
DEP MEAN	79.70		ADJ R-SQUARED	0.0172	
C.V.	5.25%				

Predicted Residual Sum of Squares (PRESS) = 628.4

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	77.22	1	3.12	24.74	
A	0.10	1	1.71	6.04E-02	0.9556
B	-2.96	1	1.71	-1.730	0.1822
A2	-0.47	1	2.96	-0.1599	0.8831
B2	4.20	1	2.96	1.417	0.2514
AB	0.70	1	2.09	0.3331	0.7610

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 77.22 \\ & + 0.10 * A \\ & - 2.96 * B \\ & - 0.47 * A^2 \\ & + 4.20 * B^2 \\ & + 0.70 * AB \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & 100.61 \\ & + 0.60167 * \text{Collector} \\ & - 21.138 * \text{Frother} \\ & - 0.47333 * \text{Collector}^2 \\ & + 4.1967 * \text{Frother}^2 \\ & + 0.69750 * \text{Collector} * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	84.82	84.49	0.33	0.806	0.177	0.022	0.145	9
2	87.14	84.37	2.77	0.556	0.991	0.205	0.987	2
3	80.21	83.30	-3.09	0.806	-1.676	1.940	-5.424	7
4	73.77	76.64	-2.87	0.556	-1.029	0.221	-1.044	6
5	76.12	77.22	-1.10	0.556	-0.394	0.032	-0.330	1
6	80.82	76.85	3.97	0.556	1.423	0.422	2.036	8
7	79.73	77.18	2.55	0.806	1.378	1.312	1.859	5
8	76.79	78.46	-1.67	0.556	-0.598	0.074	-0.520	4
9	77.91	78.79	-0.88	0.806	-0.475	0.156	-0.403	3

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Coal Seam:  Illinois No. 6
Circuit:    Individual Microcel
Response:   Ash Rejection
Data File:  I-CLM-00
Comments:   Analysis with Outliers Removed
=====

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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Collector       lb/ton        1.000        3.000
B      Frother         ml/min        1.000        3.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	50737.1	1	50737.1		
Linear	63.9	2	32.0	2.036	0.2255
Quadratic	75.2	3	25.1	14.96	0.0633
Cubic	3.3	2	1.7		
RESIDUAL	0.0	0			
TOTAL	50879.5	8			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	3	5	3.96	0.4489	0.2284	202.79
Quadratic	6	2	1.29	0.9765	0.9177	66.91
Cubic	8	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	139.1	5	27.82	16.62	0.0577
RESIDUAL	3.3	2	1.67		
COR TOTAL	142.4	7			
ROOT MSE	1.29		R-SQUARED	0.9765	
DEP MEAN	79.64		ADJ R-SQUARED	0.9177	
C.V.	1.62%				

Predicted Residual Sum of Squares (PRESS) = 66.9

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	75.45	1	1.02	74.11	
A	2.76	1	0.72	3.828	0.0620
B	-5.61	1	0.72	-7.792	0.0161
A2	2.18	1	1.04	2.101	0.1705
B2	6.85	1	1.04	6.602	0.0222
AB	-3.28	1	0.98	-3.355	0.0785

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 75.45 \\ & + 2.76 * A \\ & - 5.61 * B \\ & + 2.18 * A^2 \\ & + 6.85 * B^2 \\ & - 3.28 * AB \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & 104.15 \\ & + 0.60167 * \text{Collector} \\ & - 26.444 * \text{Frother} \\ & + 2.1793 * \text{Collector}^2 \\ & + 6.8493 * \text{Frother}^2 \\ & - 3.2814 * \text{Collector} * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	84.82	84.05	0.77	0.810	1.362	1.314	3.570	9
2	87.14	87.91	-0.77	0.810	-1.362	1.314	-3.570	2
4	73.77	74.87	-1.10	0.619	-1.382	0.517	-4.611	6
5	76.12	75.45	0.67	0.619	0.838	0.190	0.736	1
6	80.82	80.39	0.43	0.810	0.769	0.419	0.648	8
7	79.73	79.40	0.33	0.905	0.838	1.113	0.736	5
8	76.79	76.69	0.10	0.619	0.125	0.004	0.088	4
9	77.91	78.34	-0.43	0.810	-0.769	0.419	-0.648	3

```

=====
Coal Seam:  Illinois No. 6
Circuit:    Individual Microcel
Response:   Sulfur Rejection
Data File:  I-CLM-00
Comments:   Analysis of Complete Data Set
=====

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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Collector      lb/ton        1.000        3.000
B      Frother        ml/min        1.000        3.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	16258.0	1	16258.0		
Linear	25.4	2	12.7	0.3774	0.7008
Quadratic	48.2	3	16.1	0.3132	0.8171
Cubic	143.6	2	71.8	6.917	0.2596
RESIDUAL	10.4	1	10.4		
TOTAL	16485.6	9			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	3	6	5.80	0.1118	-0.1843	452.31
Quadratic	6	3	7.16	0.3236	-0.8037	1827.72
Cubic	8	1	3.22	0.9544	0.6352	1891.60

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	25.4	2	12.72	0.3774	0.7008
RESIDUAL	202.2	6	33.70		
COR TOTAL	227.6	8			
ROOT MSE	5.80		R-SQUARED	0.1118	
DEP MEAN	42.50		ADJ R-SQUARED	-0.1843	
C.V.	13.66%				

Predicted Residual Sum of Squares (PRESS) = 452.3

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	42.50	1	1.93	21.97	
A	-0.38	1	2.37	-0.1610	0.8773
B	-2.02	1	2.37	-0.8538	0.4260

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sulfur rej} = & \\ & 42.50 \\ & - 0.38 * A \\ & - 2.02 * B \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sulfur rej} = & \\ & 47.31 \\ & - 0.38167 * \text{Collector} \\ & - 2.0233 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	48.35	44.91	3.44	0.444	0.796	0.169	0.768	9
2	50.79	44.53	6.26	0.278	1.270	0.207	1.356	2
3	38.49	44.14	-5.65	0.444	-1.307	0.455	-1.410	7
4	34.11	42.88	-8.77	0.278	-1.779	0.406	-2.361	6
5	39.02	42.50	-3.48	0.111	-0.636	0.017	-0.601	1
6	46.27	42.12	4.15	0.278	0.841	0.091	0.818	8
7	44.14	40.86	3.28	0.444	0.758	0.153	0.728	5
8	41.80	40.48	1.32	0.278	0.268	0.009	0.246	4
9	39.55	40.10	-0.55	0.444	-0.126	0.004	-0.116	3

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	73.7	5	14.73	0.2870	0.8937
RESIDUAL	154.0	3	51.32		
COR TOTAL	227.6	8			
ROOT MSE	7.16		R-SQUARED	0.3236	
DEP MEAN	42.50		ADJ R-SQUARED	-0.8037	
C.V.	16.86%				

Predicted Residual Sum of Squares (PRESS) = 1827.7

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	41.17	1	5.34	7.710	
A	-0.38	1	2.92	-0.1305	0.9044
B	-2.02	1	2.92	-0.6918	0.5388
A2	-2.05	1	5.07	-0.4050	0.7126
B2	4.05	1	5.07	0.8002	0.4821
AB	1.32	1	3.58	0.3678	0.7374

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sulfur rej} = & 41.17 \\ & - 0.38 * A \\ & - 2.02 * B \\ & - 2.05 * A^2 \\ & + 4.05 * B^2 \\ & + 1.32 * AB \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sulfur rej} = & 59.25 \\ & + 5.1900 * \text{Collector} \\ & - 20.872 * \text{Frother} \\ & - 2.0517 * \text{Collector}^2 \\ & + 4.0533 * \text{Frother}^2 \\ & + 1.3175 * \text{Collector} * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	48.35	46.89	1.46	0.806	0.462	0.147	0.391	9
2	50.79	47.24	3.55	0.556	0.742	0.115	0.671	2
3	38.49	43.49	-5.00	0.806	-1.584	1.732	-3.196	7
4	34.11	39.50	-5.39	0.556	-1.128	0.265	-1.214	6
5	39.02	41.17	-2.15	0.556	-0.450	0.042	-0.380	1
6	46.27	38.73	7.54	0.556	1.578	0.519	3.123	8
7	44.14	40.21	3.93	0.806	1.244	1.068	1.460	5
8	41.80	43.20	-1.40	0.556	-0.293	0.018	-0.242	4
9	39.55	42.08	-2.53	0.806	-0.802	0.444	-0.738	3

```

=====
Coal Seam: Illinois No. 6
Circuit: Individual Microcel
Response: Pyritic Sulfur Rejection
Data File: I-CLM-00
Comments: Analysis of Complete Data Set
=====

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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Collector       lb/ton        1.000         3.000
B      Frother         ml/min        1.000         3.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	27443.2	1	27443.2		
Linear	57.3	2	28.6	0.7640	0.5063
Quadratic	63.7	3	21.2	0.3956	0.7668
Cubic	146.4	2	73.2	4.991	0.3018
RESIDUAL	14.7	1	14.7		
TOTAL	27725.3	9			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	3	6	6.12	0.2030	-0.0627	533.20
Quadratic	6	3	7.33	0.4289	-0.5230	1894.31
Cubic	8	1	3.83	0.9480	0.5840	2673.41

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	57.3	2	28.63	0.7640	0.5063
RESIDUAL	224.8	6	37.47		
COR TOTAL	282.1	8			
ROOT MSE	6.12		R-SQUARED	0.2030	
DEP MEAN	55.22		ADJ R-SQUARED	-0.0627	
C.V.	11.09%				

Predicted Residual Sum of Squares (PRESS) = 533.2

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	55.22	1	2.04	27.06	
A	-0.16	1	2.50	-6.40E-02	0.9510
B	-3.08	1	2.50	-1.234	0.2632

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Pyr rej} = & \\ & 55.22 \\ & - 0.16 * A \\ & - 3.08 * B \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Pyr rej} = & \\ & 61.71 \\ & - 0.16000 * \text{Collector} \\ & - 3.0850 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	62.94	58.46	4.48	0.444	0.981	0.257	0.977	9
2	64.73	58.30	6.42	0.278	1.235	0.196	1.306	2
3	50.40	58.15	-7.74	0.444	-1.697	0.768	-2.149	7
4	47.24	55.38	-8.14	0.278	-1.565	0.314	-1.857	6
5	52.15	55.22	-3.07	0.111	-0.532	0.012	-0.497	1
6	59.96	55.06	4.90	0.278	0.942	0.114	0.931	8
7	53.58	52.30	1.29	0.444	0.282	0.021	0.259	5
8	53.54	52.13	1.41	0.278	0.270	0.009	0.248	4
9	52.44	51.97	0.47	0.444	0.102	0.003	0.093	3

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	121.0	5	24.20	0.4506	0.7960
RESIDUAL	161.1	3	53.70		
COR TOTAL	282.1	8			
ROOT MSE	7.33		R-SQUARED	0.4289	
DEP MEAN	55.22		ADJ R-SQUARED	-0.5230	
C.V.	13.27%				

Predicted Residual Sum of Squares (PRESS) = 1894.3

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	54.70	1	5.46	10.02	
A	-0.16	1	2.99	-5.35E-02	0.9607
B	-3.08	1	2.99	-1.031	0.3783
A2	-2.38	1	5.18	-0.4593	0.6772
B2	3.15	1	5.18	0.6089	0.5856
AB	2.85	1	3.66	0.7778	0.4934

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Pyr rej} = & 54.70 \\ & - 0.16 * A \\ & - 3.08 * B \\ & - 2.38 * A^2 \\ & + 3.15 * B^2 \\ & + 2.85 * AB \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Pyr rej} = & 75.69 \\ & + 3.6600 * \text{Collector} \\ & - 21.405 * \text{Frother} \\ & - 2.3800 * \text{Collector}^2 \\ & + 3.1550 * \text{Frother}^2 \\ & + 2.8500 * \text{Collector} * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	62.94	61.57	1.37	0.806	0.423	0.124	0.356	9
2	64.73	60.94	3.79	0.556	0.775	0.125	0.708	2
3	50.40	55.55	-5.15	0.806	-1.595	1.756	-3.338	7
4	47.24	52.48	-5.24	0.556	-1.073	0.240	-1.117	6
5	52.15	54.70	-2.55	0.556	-0.523	0.057	-0.448	1
6	59.96	52.16	7.80	0.556	1.596	0.531	3.353	8
7	53.58	49.70	3.88	0.806	1.200	0.994	1.358	5
8	53.54	54.77	-1.23	0.556	-0.252	0.013	-0.208	4
9	52.44	55.08	-2.64	0.806	-0.818	0.462	-0.758	3

```

=====
Coal Seam:  Illinois No. 6
Circuit:    Individual Microcel
Response:   Separation Efficiency
Data File:  I-CLM-00
Comments:   Analysis of Complete Data Set
=====

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=====
FAC      FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A        Collector      lb/ton        1.000         3.000
B        Frother        ml/min        1.000         3.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	43824.63	1	43824.63		
Linear	10.46	2	5.23	0.6659	0.5481
Quadratic	9.35	3	3.12	0.2474	0.8593
Cubic	33.21	2	16.61	3.632	0.3479
RESIDUAL	4.57	1	4.57		
TOTAL	43882.23	9			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	3	6	2.803	0.1816	-0.0912	100.898
Quadratic	6	3	3.549	0.3439	-0.7495	438.941
Cubic	8	1	2.138	0.9206	0.3649	833.333

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	10.46	2	5.231	0.6659	0.5481
RESIDUAL	47.14	6	7.856		
COR TOTAL	57.60	8			
ROOT MSE	2.803		R-SQUARED	0.1816	
DEP MEAN	69.781		ADJ R-SQUARED	-0.0912	
C.V.	4.02%				

Predicted Residual Sum of Square's (PRESS) = 100.90

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	69.781	1	0.934	74.69	
A	0.440	1	1.144	0.3845	0.7138
B	-1.245	1	1.144	-1.088	0.3183

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Efficiency} = & \\ & 69.781 \\ & + 0.440 * A \\ & - 1.245 * B \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Efficiency} = & \\ & 71.391 \\ & + 0.44000 * \text{Collector} \\ & - 1.2450 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	72.690	70.586	2.104	0.444	1.007	0.270	1.009	9
2	72.490	71.026	1.464	0.278	0.615	0.048	0.580	2
3	69.460	71.466	-2.006	0.444	-0.960	0.246	-0.953	7
4	66.320	69.341	-3.021	0.278	-1.268	0.206	-1.353	6
5	66.430	69.781	-3.351	0.111	-1.268	0.067	-1.353	1
6	73.470	70.221	3.249	0.278	1.364	0.239	1.499	8
7	70.340	68.096	2.244	0.444	1.074	0.308	1.091	5
8	67.770	68.536	-0.766	0.278	-0.322	0.013	-0.296	4
9	69.060	68.976	0.084	0.444	0.040	0.000	0.037	3

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	19.81	5	3.962	0.3146	0.8774
RESIDUAL	37.79	3	12.596		
COR TOTAL	57.60	8			
ROOT MSE	3.549		R-SQUARED	0.3439	
DEP MEAN	69.781		ADJ R-SQUARED	-0.7495	
C.V.	5.09%				

Predicted Residual Sum of Squares (PRESS) = 438.94

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	67.856	1	2.645	25.65	
A	0.440	1	1.449	0.3037	0.7812
B	-1.245	1	1.449	-0.8593	0.4534
A2	1.327	1	2.510	0.5286	0.6337
B2	1.562	1	2.510	0.6223	0.5778
AB	0.488	1	1.775	0.2747	0.8014

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Efficiency} = & 67.856 \\ & + 0.440 * A \\ & - 1.245 * B \\ & + 1.327 * A^2 \\ & + 1.562 * B^2 \\ & + 0.488 * AB \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Efficiency} = & 82.969 \\ & - 5.8417 * \text{Collector} \\ & - 8.4667 * \text{Frother} \\ & + 1.3267 * \text{Collector}^2 \\ & + 1.5617 * \text{Frother}^2 \\ & + 0.48750 * \text{Collector} * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	72.690	72.036	0.654	0.806	0.418	0.120	0.351	9
2	72.490	70.662	1.828	0.556	0.773	0.124	0.705	2
3	69.460	71.941	-2.481	0.806	-1.586	1.736	-3.217	7
4	66.320	68.742	-2.422	0.556	-1.024	0.218	-1.036	6
5	66.430	67.856	-1.426	0.556	-0.603	0.076	-0.525	1
6	73.470	69.622	3.848	0.556	1.626	0.551	3.859	8
7	70.340	68.571	1.769	0.806	1.130	0.882	1.218	5
8	67.770	68.172	-0.402	0.556	-0.170	0.006	-0.139	4
9	69.060	70.426	-1.366	0.806	-0.873	0.526	-0.825	3

```

=====
Coal Seam:  Illinois No. 6
Circuit:    Individual Microcel
Response:   1b SO2/MM Btu
Data File:  I-CLM-00
Comments:   Analysis of Complete Data Set
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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Collector       lb/ton        1.000         3.000
B      Frother         ml/min        1.000         3.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	321.365	1	321.365		
Linear	0.070	2	0.035	0.1438	0.8689
Quadratic	0.315	3	0.105	0.2738	0.8422
Cubic	1.104	2	0.552	12.32	0.1975
RESIDUAL	0.045	1	0.045		
TOTAL	322.899	9			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	3	6	0.494	0.0458	-0.2723	3.550
Quadratic	6	3	0.619	0.2509	-0.9977	13.794
Cubic	8	1	0.212	0.9708	0.7663	8.165

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	0.070	2	0.035	0.1438	0.8689
RESIDUAL	1.463	6	0.244		
COR TOTAL	1.534	8			
ROOT MSE	0.494		R-SQUARED	0.0458	
DEP MEAN	5.976		ADJ R-SQUARED	-0.2723	
C.V.	8.26%				

Predicted Residual Sum of Squares (PRESS) = 3.550

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	5.976	1	0.165	36.30	
A	0.095	1	0.202	0.4712	0.6542
B	0.052	1	0.202	0.2563	0.8063

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{SO2 emiss} = & \\ & 5.976 \\ & + 0.095 * A \\ & + 0.052 * B \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{SO2 emiss} = & \\ & 5.682 \\ & + 9.500\text{E-}02 * \text{Collector} \\ & + 5.167\text{E-}02 * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	5.600	5.829	-0.229	0.444	-0.622	0.103	-0.587	9
2	6.080	5.924	0.156	0.278	0.372	0.018	0.344	2
3	6.060	6.019	0.041	0.444	0.112	0.003	0.102	7
4	6.460	5.881	0.579	0.278	1.381	0.244	1.526	6
5	6.070	5.976	0.094	0.111	0.203	0.002	0.186	1
6	5.460	6.071	-0.611	0.278	-1.455	0.271	-1.651	8
7	5.260	5.932	-0.672	0.444	-1.826	0.889	-2.501	5
8	6.420	6.027	0.393	0.278	0.936	0.112	0.924	4
9	6.370	6.122	0.248	0.444	0.673	0.121	0.639	3

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	0.385	5	0.077	0.2009	0.9419
RESIDUAL	1.149	3	0.383		
COR TOTAL	1.534	8			
ROOT MSE	0.619		R-SQUARED	0.2509	
DEP MEAN	5.976		ADJ R-SQUARED	-0.9977	
C.V.	10.36%				

Predicted Residual Sum of Squares (PRESS) = 13.794

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	6.211	1	0.461	13.47	
A	0.095	1	0.253	0.3760	0.7319
B	0.052	1	0.253	0.2045	0.8510
A2	-0.322	1	0.438	-0.7351	0.5155
B2	-0.032	1	0.438	-7.24E-02	0.9469
AB	0.163	1	0.309	0.5252	0.6358

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{SO2 emiss} = & 6.211 \\ & + 0.095 * A \\ & + 0.052 * B \\ & - 0.322 * A^2 \\ & - 0.032 * B^2 \\ & + 0.163 * AB \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{SO2 emiss} = & 5.154 \\ & + 1.0567 * \text{Collector} \\ & - 0.14667 * \text{Frother} \\ & - 0.32167 * \text{Collector}^2 \\ & - 3.167\text{E-}02 * \text{Frother}^2 \\ & + 0.16250 * \text{Collector} * \text{Frother} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	5.600	5.874	-0.274	0.806	-1.003	0.694	-1.004	9
2	6.080	6.128	-0.048	0.556	-0.116	0.003	-0.095	2
3	6.060	5.739	0.321	0.806	1.178	0.958	1.311	7
4	6.460	5.794	0.666	0.556	1.613	0.542	3.619	6
5	6.070	6.211	-0.141	0.556	-0.342	0.024	-0.285	1
6	5.460	5.984	-0.524	0.556	-1.271	0.337	-1.528	8
7	5.260	5.652	-0.392	0.806	-1.436	1.424	-2.098	5
8	6.420	6.231	0.189	0.556	0.458	0.044	0.388	4
9	6.370	6.167	0.203	0.806	0.744	0.382	0.673	3

APPENDIX 3-C

Box-Behnken Statistical Analyses

**Independent MGS Tests
Pittsburgh No. 8 Seam Coal**

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=====
Coal Seam:  Pittsburgh No. 8
Circuit:    Individual MGS
Data File:  P-MGS-00
=====
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FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Grind Size	microns	100.000	300.000
B	Feed Rate	lbs/hr	100.000	300.000
C	Drum Speed	rpm	240.000	320.000
D	Wash Water	lpm	0.500	1.500
E	% Solids	w/w	15.000	35.000

				A	B	C	D	E
Obs	Dsn	Run		Grind Size	Feed Rate	Drum Speed	Wash Water	% Solids
	ID	Ord	Blk	microns	lbs/hr	rpm	lpm	w/w
11	11	1	1	200.0	110.0	280.0	1.020	35.00
12	12	2	1	200.0	235.0	280.0	1.020	35.00
7	7	3	1	200.0	169.0	241.0	1.480	26.00
38	38	4	1	200.0	273.0	280.0	0.530	25.00
5	5	5	1	200.0	159.0	240.0	0.530	25.00
37	37	6	1	200.0	100.0	280.0	0.530	25.00
43	0	7	1	200.0	200.0	280.0	0.950	26.00
30	30	8	1	200.0	173.0	321.0	1.100	15.00
10	10	9	1	200.0	261.0	280.0	0.910	16.00
36	36	10	1	300.0	216.0	281.0	0.950	35.00
4	4	11	1	300.0	260.0	280.0	0.980	25.00
28	28	12	1	300.0	215.0	280.0	1.510	26.00
2	2	13	1	300.0	110.0	280.0	0.910	25.00
16	16	14	1	300.0	217.0	321.0	0.950	25.00
26	26	15	1	300.0	215.0	281.0	0.450	26.00
14	14	16	1	300.0	217.0	241.0	1.020	25.00
34	34	17	1	300.0	239.0	280.0	1.020	14.00
19	19	18	1	200.0	210.0	282.0	0.490	35.00
20	20	19	1	200.0	216.0	280.0	1.510	35.00
24	24	20	1	200.0	334.0	320.0	0.980	25.00
22	22	21	1	200.0	347.0	240.0	0.980	24.00
42	0	22	1	200.0	164.0	280.0	0.980	26.00
21	21	23	1	200.0	137.0	240.0	0.980	26.00
40	40	24	1	200.0	313.0	281.0	1.510	25.00
18	18	25	1	200.0	200.0	281.0	1.480	16.00
29	29	26	1	200.0	212.0	242.0	0.980	15.00
35	35	27	1	100.0	197.0	284.0	0.980	36.00
1	1	28	1	100.0	100.0	282.0	0.910	25.00
3	3	29	1	100.0	321.0	280.0	0.980	26.00
15	15	30	1	100.0	198.0	320.0	0.980	26.00
25	25	31	1	100.0	204.0	280.0	0.490	25.00
13	13	32	1	100.0	208.0	240.0	0.980	25.00
27	27	33	1	100.0	200.0	280.0	1.480	26.00
33	33	34	1	100.0	205.0	280.0	0.980	15.00
32	32	35	1	200.0	208.0	320.0	0.950	35.00
31	31	36	1	200.0	223.0	241.0	0.950	35.00
23	23	37	1	200.0	128.0	320.0	0.980	25.00
41	0	38	1	200.0	176.0	280.0	0.980	26.00
6	6	39	1	200.0	186.0	321.0	0.530	26.00
8	8	40	1	200.0	146.0	321.0	1.510	25.00
39	39	41	1	200.0	103.0	280.0	1.590	25.00
17	17	42	1	200.0	236.0	280.0	0.420	15.00
9	9	43	1	200.0	119.0	280.0	0.910	16.00

				Y1	Y2	Y3	Y4	Y5
Obs	Dsn ID	Run Ord	Blk	Comb. rec %	Ash rej %	Sul rej %	Pyr rej %	Energy rec %
11	11	1	1	94.9	39.84	38.39	69.13	95.8
12	12	2	1	92.2	44.66	49.24	74.66	93.2
7	7	3	1	99.2	11.05	27.60	52.37	99.4
38	38	4	1	90.6	42.32	48.48	72.83	91.5
5	5	5	1	99.0	11.62	29.25	53.22	99.3
37	37	6	1	95.3	43.50	52.45	74.73	96.6
43	0	7	1	97.0	32.55	41.90	68.39	97.9
30	30	8	1	96.5	29.88	34.15	65.35	97.1
10	10	9	1	92.0	30.15	33.27	57.81	92.5
36	36	10	1	87.6	50.13	49.62	75.05	88.6
4	4	11	1	99.5	5.75	12.49	28.32	99.6
28	28	12	1	92.0	44.26	45.96	73.46	93.0
2	2	13	1	92.5	44.93	43.69	71.59	93.6
16	16	14	1	81.1	53.35	54.20	80.00	82.0
26	26	15	1	88.8	45.64	46.16	73.34	89.8
14	14	16	1	98.9	12.29	26.52	51.35	99.2
34	34	17	1	98.2	17.36	28.48	50.47	98.6
19	19	18	1	85.5	52.39	51.68	76.84	86.5
20	20	19	1	90.8	46.42	48.01	71.44	91.8
24	24	20	1	84.9	51.78	51.27	74.53	85.9
22	22	21	1	97.7	19.68	31.09	53.25	98.2
42	0	22	1	90.6	45.03	46.68	70.02	91.7
21	21	23	1	99.5	3.99	14.48	25.88	99.6
40	40	24	1	92.8	38.31	44.33	73.25	93.6
18	18	25	1	98.0	20.57	30.15	57.75	98.5
29	29	26	1	99.5	5.16	16.54	33.42	99.6
35	35	27	1	91.7	41.66	45.48	74.00	92.6
1	1	28	1	95.7	36.55	42.45	74.02	96.7
3	3	29	1	94.6	28.01	39.09	66.46	95.3
15	15	30	1	89.4	42.30	47.40	73.33	90.3
25	25	31	1	93.7	32.85	39.16	69.09	94.4
13	13	32	1	98.5	17.73	34.39	60.90	99.0
27	27	33	1	95.5	32.82	39.45	67.16	96.3
33	33	34	1	97.2	22.49	34.34	62.85	97.7
32	32	35	1	46.6	85.56	85.20	95.35	48.0
31	31	36	1	97.5	26.74	37.86	62.47	98.1
23	23	37	1	93.1	46.57	49.58	79.44	94.4
41	0	38	1	94.8	36.67	44.45	68.51	95.7
6	6	39	1	83.9	55.12	54.59	82.67	85.0
8	8	40	1	93.5	42.29	46.63	72.14	94.6
39	39	41	1	95.1	36.84	48.36	70.78	96.2
17	17	42	1	96.5	24.64	35.66	61.12	97.1
9	9	43	1	94.7	40.38	41.20	65.67	95.6

				Y6	Y7
Obs	Dsn ID	Run Ord	Blk	Efficiency %	SO2 emiss lbs/MM Btu
---	---	---	---	-----	-----
11	11	1	1	64.03	2.750
12	12	2	1	66.87	2.630
7	7	3	1	51.53	3.230
38	38	4	1	63.39	2.740
5	5	5	1	52.22	3.460
37	37	6	1	70.06	2.750
43	0	7	1	65.40	2.960
30	30	8	1	61.86	2.950
10	10	9	1	49.76	2.910
36	36	10	1	62.62	2.740
4	4	11	1	27.82	4.110
28	28	12	1	65.43	2.960
2	2	13	1	64.13	3.170
16	16	14	1	61.09	2.810
26	26	15	1	62.12	3.060
14	14	16	1	50.27	3.870
34	34	17	1	48.63	3.700
19	19	18	1	62.34	2.800
20	20	19	1	62.26	2.840
24	24	20	1	59.46	2.780
22	22	21	1	50.97	3.330
42	0	22	1	60.66	2.760
21	21	23	1	25.34	4.610
40	40	24	1	66.00	2.900
18	18	25	1	55.74	3.120
29	29	26	1	32.93	4.040
35	35	27	1	65.71	2.630
1	1	28	1	69.67	2.800
3	3	29	1	61.10	3.000
15	15	30	1	62.73	2.740
25	25	31	1	62.79	2.930
13	13	32	1	59.44	3.190
27	27	33	1	62.71	2.830
33	33	34	1	60.01	3.120
32	32	35	1	41.95	2.530
31	31	36	1	59.93	3.110
23	23	37	1	72.58	2.840
41	0	38	1	63.28	2.970
6	6	39	1	66.54	2.730
8	8	40	1	65.68	2.910
39	39	41	1	65.86	3.310
17	17	42	1	57.62	3.270
9	9	43	1	60.33	2.840

```

=====
Coal Seam:  Pittsburgh No. 8
Circuit:    Individual MGS
Response:   Combustible Recovery
Data File:  P-MGS-00
Comments:   Analysis of Complete Data Set
=====

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=====
FAC    FACTOR                UNITS          -1 LEVEL      +1 LEVEL
A      Grind Size            microns       100.000       300.000
B      Feed Rate             lbs/hr        100.000       300.000
C      Drum Speed            rpm           240.000       320.000
D      Wash Water            lpm           0.500         1.500
E      % Solids              w/w           15.000        35.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	369583.8	1	369583.8		
Linear	1490.0	5	298.0	7.151	0.0001
Quadratic	778.4	15	51.9	1.496	0.1904
Cubic	763.4	22	34.7		
RESIDUAL	0.0	0			
TOTAL	372615.5	43			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	37	6.46	0.4915	0.4227	2081.06
Quadratic	21	22	5.89	0.7482	0.5193	2973.28
Cubic	43	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1490.0	5	297.99	7.151	0.0001
RESIDUAL	1541.8	37	41.67		
COR TOTAL	3031.8	42			
ROOT MSE	6.46		R-SQUARED	0.4915	
DEP MEAN	92.71		ADJ R-SQUARED	0.4227	
C.V.	6.96%				

Predicted Residual Sum of Squares (PRESS) = 2081.1

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	93.05	1	0.99	94.24	
A	-1.18	1	1.62	-0.7319	0.4688
B	-1.82	1	1.64	-1.112	0.2733
C	-7.61	1	1.62	-4.703	0.0001
D	1.82	1	1.58	1.151	0.2571
E	-5.40	1	1.62	-3.334	0.0020

Final Equation in Terms of Coded Factors:

```

Comb. rec =
              93.05
-             1.18 * A
-             1.82 * B
-             7.61 * C
+             1.82 * D
-             5.40 * E

```

Final Equation in Terms of Actual Factors:

```

Comb. rec =
              162.18
-             1.182E-02 * Grind Size
-             1.824E-02 * Feed Rate
-             0.19023 * Drum Speed
+             3.6379 * Wash Water
-             0.53968 * % Solids

```

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	95.74	95.34	0.40	0.149	0.067	0.000	0.066	28
2	92.54	93.18	-0.64	0.146	-0.107	0.000	-0.105	13
3	94.63	91.41	3.22	0.184	0.552	0.011	0.547	29
4	99.50	90.70	8.80	0.105	1.442	0.041	1.464	11
5	99.00	99.69	-0.69	0.152	-0.117	0.000	-0.115	5
6	83.87	83.25	0.62	0.139	0.103	0.000	0.102	39
7	99.16	102.24	-3.08	0.153	-0.518	0.008	-0.513	3
8	93.54	88.09	5.45	0.168	0.926	0.029	0.924	40
9	94.66	99.05	-4.39	0.126	-0.728	0.013	-0.723	43
10	91.95	96.46	-4.51	0.099	-0.736	0.010	-0.732	9
11	94.90	89.36	5.54	0.133	0.921	0.022	0.919	1
12	92.21	87.08	5.13	0.091	0.833	0.012	0.830	2
13	98.54	101.62	-3.08	0.151	-0.517	0.008	-0.512	32
14	98.92	99.05	-0.13	0.147	-0.021	0.000	-0.021	16

15	89.39	86.04	3.35	0.147	0.561	0.009	0.556	30
16	81.09	83.57	-2.48	0.153	-0.418	0.005	-0.413	14
17	96.50	95.68	0.82	0.169	0.140	0.001	0.138	42
18	97.99	99.46	-1.47	0.138	-0.245	0.002	-0.242	25
19	85.50	85.23	0.27	0.144	0.045	0.000	0.044	18
20	90.82	89.21	1.61	0.149	0.270	0.002	0.267	19
21	99.46	101.19	-1.73	0.119	-0.286	0.002	-0.282	23
22	97.71	98.44	-0.73	0.215	-0.128	0.001	-0.126	21
23	93.14	86.68	6.46	0.115	1.064	0.024	1.066	37
24	84.93	82.92	2.01	0.207	0.350	0.005	0.346	20
25	93.70	92.30	1.40	0.144	0.235	0.002	0.232	31
26	88.77	88.86	-0.09	0.156	-0.015	0.000	-0.015	15
27	95.55	95.43	0.12	0.145	0.019	0.000	0.019	33
28	91.96	92.91	-0.95	0.153	-0.159	0.001	-0.157	12
29	99.51	105.38	-5.87	0.146	-0.984	0.028	-0.984	26
30	96.51	91.50	5.01	0.164	0.849	0.023	0.846	8
31	97.46	94.47	2.99	0.148	0.502	0.007	0.497	36
32	46.60	79.71	-33.11	0.144	-5.544	0.861	-13.287	35
33	97.16	99.46	-2.30	0.155	-0.388	0.005	-0.383	34
34	98.17	97.16	1.01	0.170	0.172	0.001	0.169	17
35	91.71	87.51	4.20	0.156	0.708	0.015	0.703	27
36	87.57	85.80	1.77	0.149	0.297	0.003	0.293	10
37	95.33	93.16	2.17	0.142	0.363	0.004	0.359	6
38	90.56	90.00	0.56	0.104	0.091	0.000	0.090	4
39	95.08	96.96	-1.88	0.171	-0.320	0.004	-0.316	41
40	92.76	92.65	0.11	0.173	0.019	0.000	0.019	24
41	94.76	92.87	1.89	0.028	0.297	0.000	0.293	38
42	90.63	93.09	-2.46	0.033	-0.387	0.001	-0.383	22
43	97.01	92.32	4.69	0.024	0.735	0.002	0.730	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2268.4	20	113.42	3.269	0.0042
RESIDUAL	763.4	22	34.70		
COR TOTAL	3031.8	42			
ROOT MSE	5.89		R-SQUARED	0.7482	
DEP MEAN	92.71		ADJ R-SQUARED	0.5193	
C.V.	6.35%				

Predicted Residual Sum of Squares (PRESS) = 2973.3

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	95.39	1	3.04	31.33	
A	-1.32	1	1.52	-0.8691	0.3942
B	-1.26	1	1.64	-0.7719	0.4484
C	-7.02	1	1.50	-4.685	0.0001
D	1.39	1	1.47	0.9455	0.3547
E	-4.80	1	1.51	-3.190	0.0042
A2	0.39	1	2.21	0.1782	0.8602
B2	-0.01	1	2.19	-3.93E-03	0.9969
C2	-3.14	1	2.18	-1.440	0.1640
D2	-0.74	1	2.11	-0.3490	0.7304
E2	-3.05	1	2.36	-1.294	0.2090
AB	0.95	1	3.13	0.3033	0.7645
AC	-2.33	1	2.96	-0.7865	0.4400
AD	-0.07	1	2.87	-2.29E-02	0.9819
AE	-1.48	1	2.87	-0.5155	0.6113
BC	-1.62	1	2.54	-0.6379	0.5301
BD	0.09	1	2.78	3.31E-02	0.9739
BE	-3.57	1	4.19	-0.8524	0.4032
CD	2.14	1	3.06	0.7007	0.4908
CE	-12.07	1	3.04	-3.967	0.0007
DE	1.05	1	2.90	0.3633	0.7198

Final Equation in Terms of Coded Factors:

Comb. rec =

```

95.39
- 1.32 * A
- 1.26 * B
- 7.02 * C
+ 1.39 * D
- 4.80 * E
+ 0.39 * A2
- 0.01 * B2
- 3.14 * C2
- 0.74 * D2
- 3.05 * E2
+ 0.95 * AB
- 2.33 * AC
- 0.07 * AD
- 1.48 * AE
- 1.62 * BC
+ 0.09 * BD
- 3.57 * BE
+ 2.14 * CD
- 12.07 * CE
+ 1.05 * DE

```

Final Equation in Terms of Actual Factors:

Comb. rec =

$$\begin{aligned}
 & -268.33 \\
 & + 0.15343 * \text{Grind Size} \\
 & + 0.16963 * \text{Feed Rate} \\
 & + 1.7701 * \text{Drum Speed} \\
 & - 26.694 * \text{Wash Water} \\
 & + 10.296 * \% \text{ Solids} \\
 & + 3.933\text{E-}05 * \text{Grind Size}^2 \\
 & - 8.617\text{E-}07 * \text{Feed Rate}^2 \\
 & - 1.966\text{E-}03 * \text{Drum Speed}^2 \\
 & - 2.9500 * \text{Wash Water}^2 \\
 & - 3.053\text{E-}02 * \% \text{ Solids}^2 \\
 & + 9.490\text{E-}05 * \text{Grind Size} * \text{Feed Rate} \\
 & - 5.820\text{E-}04 * \text{Grind Size} * \text{Drum Speed} \\
 & - 1.318\text{E-}03 * \text{Grind Size} * \text{Wash Water} \\
 & - 1.482\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 4.053\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 1.839\text{E-}03 * \text{Feed Rate} * \text{Wash Water} \\
 & - 3.571\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & + 0.10713 * \text{Drum Speed} * \text{Wash Water} \\
 & - 3.018\text{E-}02 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.21065 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	95.74	98.86	-3.12	0.612	-0.850	0.054	-0.844	28
2	92.54	94.50	-1.96	0.559	-0.501	0.015	-0.492	13
3	94.63	93.55	1.08	0.582	0.283	0.005	0.277	29
4	99.50	94.22	5.28	0.284	1.059	0.021	1.062	11
5	99.00	99.21	-0.21	0.551	-0.054	0.000	-0.052	5
6	83.87	79.50	4.37	0.504	1.053	0.054	1.055	39
7	99.16	98.64	0.52	0.526	0.128	0.001	0.125	3
8	93.54	89.31	4.23	0.585	1.115	0.084	1.121	40
9	94.66	95.57	-0.91	0.568	-0.235	0.003	-0.230	43
10	91.95	98.32	-6.37	0.295	-1.287	0.033	-1.308	9
11	94.90	91.97	2.93	0.649	0.838	0.062	0.832	1
12	92.21	85.94	6.27	0.243	1.223	0.023	1.237	2
13	98.54	98.63	-0.09	0.522	-0.021	0.000	-0.021	32
14	98.92	100.77	-1.85	0.501	-0.446	0.009	-0.437	16
15	89.39	87.64	1.75	0.507	0.424	0.009	0.416	30
16	81.09	80.89	0.20	0.515	0.048	0.000	0.047	14
17	96.50	96.56	-0.06	0.608	-0.015	0.000	-0.015	42
18	97.99	97.13	0.86	0.450	0.197	0.002	0.193	25
19	85.50	82.71	2.79	0.503	0.672	0.022	0.663	18
20	90.82	88.50	2.32	0.504	0.559	0.015	0.551	19
21	99.46	99.98	-0.52	0.289	-0.106	0.000	-0.103	23
22	97.71	99.57	-1.86	0.773	-0.662	0.071	-0.653	21
23	93.14	87.17	5.97	0.287	1.201	0.028	1.214	37
24	84.93	81.21	3.72	0.762	1.297	0.257	1.319	20
25	93.70	94.76	-1.06	0.492	-0.253	0.003	-0.248	31
26	88.77	90.90	-2.13	0.535	-0.531	0.015	-0.523	15
27	95.55	97.56	-2.01	0.506	-0.484	0.011	-0.476	33
28	91.96	94.41	-2.45	0.524	-0.603	0.019	-0.594	12
29	99.51	90.03	9.48	0.501	2.277	0.248	2.545	26
30	96.51	99.32	-2.81	0.549	-0.710	0.029	-0.701	8
31	97.46	102.37	-4.91	0.495	-1.172	0.064	-1.183	36
32	46.60	64.32	-17.72	0.483	-4.186	0.780	-9.061	35
33	97.16	97.42	-0.26	0.538	-0.066	0.000	-0.064	34
34	98.17	99.10	-0.93	0.581	-0.244	0.004	-0.239	17
35	91.71	88.00	3.71	0.510	0.899	0.040	0.895	27

36	87.57	83.72	3.85	0.490	0.916	0.038	0.913	10
37	95.33	94.78	0.55	0.425	0.123	0.001	0.120	6
38	90.56	92.45	-1.89	0.318	-0.388	0.003	-0.381	4
39	95.08	97.11	-2.03	0.578	-0.531	0.018	-0.522	41
40	92.76	94.54	-1.78	0.578	-0.465	0.014	-0.456	24
41	94.76	95.21	-0.45	0.237	-0.088	0.000	-0.086	38
42	90.63	95.41	-4.78	0.220	-0.918	0.011	-0.915	22
43	97.01	94.73	2.28	0.260	0.451	0.003	0.442	7

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Coal Seam:  Pittsburgh No. 8
Circuit:      Individual MGS
Response:     Combustible Recovery
Data File:    P-MGS-00
Comments:     Analysis with Outliers Removed
=====

```

FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Grind Size	microns	100.000	300.000
B	Feed Rate	lbs/hr	100.000	300.000
C	Drum Speed	rpm	240.000	320.000
D	Wash Water	lpm	0.500	1.500
E	% Solids	w/w	15.000	35.000

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	369588.9	1	369588.9		
Linear	594.0	5	118.8	16.38	0.0001
Quadratic	105.7	15	7.0	0.9515	0.5301
Cubic	155.5	21	7.4		
RESIDUAL	0.0	0			
TOTAL	370444.0	42			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	36	2.69	0.6946	0.6522	346.35
Quadratic	21	21	2.72	0.8182	0.6450	491.04
Cubic	42	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	594.0	5	118.79	16.38	0.0001
RESIDUAL	261.2	36	7.25		
COR TOTAL	855.1	41			
ROOT MSE	2.69		R-SQUARED	0.6946	
DEP MEAN	93.81		ADJ R-SQUARED	0.6522	
C.V.	2.87%				

Predicted Residual Sum of Squares (PRESS) = 346.3

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	93.83	1	0.42	225.5	
A	-1.14	1	0.67	-1.697	0.0983
B	-1.45	1	0.68	-2.122	0.0408
C	-5.22	1	0.70	-7.480	0.0001
D	1.60	1	0.66	2.427	0.0204
E	-3.06	1	0.70	-4.377	0.0001

Final Equation in Terms of Coded Factors:

Comb. rec =
 93.83
 - 1.14 * A
 - 1.45 * B
 - 5.22 * C
 + 1.60 * D
 - 3.06 * E

Final Equation in Terms of Actual Factors:

Comb. rec =
 140.04
 - 1.143E-02 * Grind Size
 - 1.454E-02 * Feed Rate
 - 0.13062 * Drum Speed
 + 3.2011 * Wash Water
 - 0.30554 * % Solids

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	95.74	95.88	-0.14	0.150	-0.057	0.000	-0.056	28
2	92.54	93.71	-1.17	0.146	-0.470	0.006	-0.465	13
3	94.63	92.85	1.78	0.186	0.733	0.020	0.728	29
4	99.50	91.75	7.75	0.106	3.042	0.183	3.480	11
5	99.00	98.15	0.85	0.154	0.343	0.004	0.339	5
6	83.87	86.87	-3.00	0.150	-1.208	0.043	-1.216	39
7	99.16	100.61	-1.45	0.155	-0.585	0.010	-0.580	3
8	93.54	90.90	2.64	0.174	1.080	0.041	1.083	40
9	94.66	97.47	-2.81	0.128	-1.118	0.031	-1.122	43
10	91.95	95.41	-3.46	0.100	-1.353	0.034	-1.370	9
11	94.90	92.15	2.75	0.139	1.100	0.033	1.103	1
12	92.21	90.33	1.88	0.100	0.734	0.010	0.730	2
13	98.54	100.02	-1.48	0.153	-0.597	0.011	-0.592	32
14	98.92	97.60	1.32	0.149	0.531	0.008	0.525	16

15	89.39	89.41	-0.02	0.156	-0.009	0.000	-0.009	30
16	81.09	86.93	-5.84	0.162	-2.367	0.180	-2.540	14
17	96.50	94.51	1.99	0.170	0.812	0.023	0.808	42
18	97.99	97.99	0.00	0.140	0.000	0.000	0.000	25
19	85.50	88.74	-3.24	0.154	-1.307	0.052	-1.320	18
20	90.82	92.18	-1.36	0.156	-0.549	0.009	-0.543	19
21	99.46	99.60	-0.14	0.121	-0.057	0.000	-0.056	23
22	97.71	97.16	0.55	0.216	0.229	0.002	0.226	21
23	93.14	89.59	3.55	0.121	1.406	0.045	1.426	37
24	84.93	86.60	-1.67	0.217	-0.700	0.023	-0.695	20
25	93.70	93.29	0.41	0.145	0.166	0.001	0.164	31
26	88.77	90.28	-1.51	0.157	-0.609	0.012	-0.603	15
27	95.55	96.21	-0.66	0.145	-0.264	0.002	-0.261	33
28	91.96	93.80	-1.84	0.154	-0.742	0.017	-0.737	12
29	99.51	101.61	-2.10	0.157	-0.851	0.023	-0.848	26
30	96.51	92.25	4.26	0.164	1.732	0.098	1.783	8
31	97.46	95.38	2.08	0.148	0.838	0.020	0.834	36
33	97.16	97.90	-0.74	0.157	-0.297	0.003	-0.294	34
34	98.17	95.55	2.62	0.172	1.070	0.040	1.072	17
35	91.71	91.07	0.64	0.165	0.259	0.002	0.256	27
36	87.57	89.11	-1.54	0.157	-0.623	0.012	-0.618	10
37	95.33	93.78	1.55	0.142	0.620	0.011	0.615	6
38	90.56	91.27	-0.71	0.106	-0.278	0.002	-0.274	4
39	95.08	97.13	-2.05	0.171	-0.837	0.024	-0.833	41
40	92.76	93.69	-0.93	0.173	-0.381	0.005	-0.376	24
41	94.76	93.81	0.95	0.028	0.357	0.001	0.352	38
42	90.63	93.99	-3.36	0.033	-1.268	0.009	-1.279	22
43	97.01	93.37	3.64	0.025	1.369	0.008	1.387	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	699.6	20	34.98	4.725	0.0004
RESIDUAL	155.5	21	7.40		
COR TOTAL	855.1	41			
ROOT MSE	2.72		R-SQUARED	0.8182	
DEP MEAN	93.81		ADJ R-SQUARED	0.6450	
C.V.	2.90%				

Predicted Residual Sum of Squares (PRESS) = 491.0

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	94.90	1	1.41	67.43	
A	-1.14	1	0.70	-1.622	0.1197
B	-1.24	1	0.76	-1.643	0.1154
C	-5.24	1	0.72	-7.282	0.0001
D	1.45	1	0.68	2.143	0.0439
E	-3.05	1	0.72	-4.230	0.0004
A2	-0.35	1	1.02	-0.3389	0.7381
B2	-0.26	1	1.01	-0.2560	0.8004
C2	-0.82	1	1.04	-0.7846	0.4414
D2	-1.12	1	0.98	-1.142	0.2663
E2	-0.73	1	1.12	-0.6498	0.5229
AB	0.69	1	1.45	0.4739	0.6404
AC	-2.09	1	1.37	-1.529	0.1412
AD	0.15	1	1.33	0.1131	0.9110
AE	-1.21	1	1.33	-0.9085	0.3739
BC	-1.39	1	1.17	-1.182	0.2503
BD	0.14	1	1.28	0.1110	0.9127
BE	-1.46	1	1.95	-0.7513	0.4608
CD	2.23	1	1.41	1.582	0.1286
CE	-3.37	1	1.70	-1.982	0.0607
DE	0.79	1	1.34	0.5912	0.5607

Final Equation in Terms of Coded Factors:

Comb. rec =

```

          94.90
-          1.14 * A
-          1.24 * B
-          5.24 * C
+          1.45 * D
-          3.05 * E
-          0.35 * A2
-          0.26 * B2
-          0.82 * C2
-          1.12 * D2
-          0.73 * E2
+          0.69 * AB
-          2.09 * AC
+          0.15 * AD
-          1.21 * AE
-          1.39 * BC
+          0.14 * BD
-          1.46 * BE
+          2.23 * CD
-          3.37 * CE
+          0.79 * DE

```

Final Equation in Terms of Actual Factors:

Comb. rec =

$$\begin{aligned}
 & 7.62 \\
 & + 0.16230 * \text{Grind Size} \\
 & + 0.11520 * \text{Feed Rate} \\
 & + 0.42812 * \text{Drum Speed} \\
 & - 24.585 * \text{Wash Water} \\
 & + 2.7962 * \% \text{ Solids} \\
 & - 3.466\text{E-}05 * \text{Grind Size}^2 \\
 & - 2.593\text{E-}05 * \text{Feed Rate}^2 \\
 & - 5.106\text{E-}04 * \text{Drum Speed}^2 \\
 & - 4.4632 * \text{Wash Water}^2 \\
 & - 7.274\text{E-}03 * \% \text{ Solids}^2 \\
 & + 6.850\text{E-}05 * \text{Grind Size} * \text{Feed Rate} \\
 & - 5.227\text{E-}04 * \text{Grind Size} * \text{Drum Speed} \\
 & + 3.003\text{E-}03 * \text{Grind Size} * \text{Wash Water} \\
 & - 1.206\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 3.471\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 2.846\text{E-}03 * \text{Feed Rate} * \text{Wash Water} \\
 & - 1.464\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & + 0.11173 * \text{Drum Speed} * \text{Wash Water} \\
 & - 8.436\text{E-}03 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.15836 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	95.74	97.00	-1.26	0.618	-0.748	0.043	-0.740	28
2	92.54	93.40	-0.86	0.561	-0.479	0.014	-0.470	13
3	94.63	92.54	2.09	0.584	1.190	0.095	1.202	29
4	99.50	92.92	6.58	0.287	2.865	0.157	3.583	11
5	99.00	99.02	-0.02	0.551	-0.010	0.000	-0.009	5
6	83.87	83.84	0.03	0.535	0.015	0.000	0.015	39
7	99.16	97.53	1.63	0.528	0.869	0.040	0.864	3
8	93.54	92.61	0.93	0.603	0.542	0.021	0.533	40
9	94.66	96.67	-2.01	0.570	-1.130	0.081	-1.137	43
10	91.95	96.82	-4.87	0.298	-2.137	0.093	-2.357	9
11	94.90	93.42	1.48	0.652	0.920	0.076	0.917	1
12	92.21	90.23	1.98	0.273	0.855	0.013	0.849	2
13	98.54	98.01	0.53	0.523	0.284	0.004	0.278	32
14	98.92	99.89	-0.97	0.502	-0.503	0.012	-0.494	16
15	89.39	91.12	-1.73	0.527	-0.923	0.045	-0.920	30
16	81.09	84.30	-3.21	0.534	-1.727	0.162	-1.819	14
17	96.50	94.94	1.56	0.612	0.919	0.063	0.915	42
18	97.99	96.73	1.26	0.450	0.623	0.015	0.614	25
19	85.50	86.83	-1.33	0.531	-0.712	0.027	-0.703	18
20	90.82	91.83	-1.01	0.523	-0.535	0.015	-0.526	19
21	99.46	99.27	0.19	0.290	0.084	0.000	0.082	23
22	97.71	99.17	-1.46	0.773	-1.128	0.207	-1.136	21
23	93.14	90.46	2.68	0.305	1.183	0.029	1.194	37
24	84.93	84.70	0.23	0.782	0.184	0.006	0.180	20
25	93.70	93.11	0.59	0.496	0.303	0.004	0.296	31
26	88.77	89.39	-0.62	0.539	-0.335	0.006	-0.327	15
27	95.55	95.79	-0.24	0.511	-0.126	0.001	-0.123	33
28	91.96	93.44	-1.48	0.525	-0.792	0.033	-0.784	12
29	99.51	98.49	1.02	0.618	0.606	0.028	0.597	26
30	96.51	95.30	1.21	0.576	0.684	0.030	0.675	8
31	97.46	98.39	-0.93	0.521	-0.494	0.013	-0.485	36
33	97.16	96.76	0.40	0.539	0.217	0.003	0.212	34
34	98.17	97.62	0.55	0.584	0.314	0.007	0.307	17
35	91.71	92.09	-0.38	0.538	-0.207	0.002	-0.202	27
36	87.57	87.56	0.01	0.515	0.003	0.000	0.003	10

37	95.33	93.66	1.67	0.427	0.809	0.023	0.803	6
38	90.56	91.40	-0.84	0.319	-0.376	0.003	-0.368	4
39	95.08	95.85	-0.77	0.580	-0.438	0.013	-0.430	41
40	92.76	93.53	-0.77	0.580	-0.438	0.013	-0.429	24
41	94.76	94.84	-0.08	0.237	-0.034	0.000	-0.033	38
42	90.63	94.99	-4.36	0.221	-1.814	0.044	-1.928	22
43	97.01	94.42	2.59	0.261	1.107	0.021	1.113	7

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Coal Seam:  Pittsburgh No. 8
Circuit:    Individual MGS
Response:   Energy Recovery
Data File:  P-MGS-00
Comments:   Analysis of Complete Data Set
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FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Grind Size      microns        100.000       300.000
B    Feed Rate       lbs/hr         100.000       300.000
C    Drum Speed      rpm            240.000       320.000
D    Wash Water      lpm            0.500         1.500
E    % Solids        w/w            15.000        35.000
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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	375785.9	1	375785.9		
Linear	1374.3	5	274.9	6.700	0.0002
Quadratic	776.2	15	51.7	1.535	0.1757
Cubic	741.6	22	33.7		
RESIDUAL	0.0	0			
TOTAL	378677.9	43			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	37	6.40	0.4752	0.4043	2049.09
Quadratic	21	22	5.81	0.7436	0.5105	2916.24
Cubic	43	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1374.3	5	274.86	6.700	0.0002
RESIDUAL	1517.8	37	41.02		
COR TOTAL	2892.0	42			
ROOT MSE	6.40		R-SQUARED	0.4752	
DEP MEAN	93.48		ADJ R-SQUARED	0.4043	
C.V.	6.85%				

Predicted Residual Sum of Squares (PRESS) = 2049.1

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	93.81	1	0.98	95.76	
A	-1.17	1	1.60	-0.7286	0.4708
B	-1.93	1	1.63	-1.185	0.2435
C	-7.27	1	1.61	-4.529	0.0001
D	1.78	1	1.57	1.134	0.2642
E	-5.17	1	1.61	-3.222	0.0027

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & 93.81 \\ & - 1.17 * A \\ & - 1.93 * B \\ & - 7.27 * C \\ & + 1.78 * D \\ & - 5.17 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & 160.27 \\ & - 1.168\text{E-}02 * \text{Grind Size} \\ & - 1.929\text{E-}02 * \text{Feed Rate} \\ & - 0.18175 * \text{Drum Speed} \\ & + 3.5557 * \text{Wash Water} \\ & - 0.51747 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	96.65	96.22	0.43	0.149	0.072	0.000	0.071	28
2	93.63	94.06	-0.43	0.146	-0.072	0.000	-0.071	13
3	95.28	92.05	3.23	0.184	0.557	0.012	0.552	29
4	99.63	91.41	8.22	0.105	1.356	0.036	1.372	11
5	99.31	100.20	-0.89	0.152	-0.151	0.001	-0.149	5
6	84.98	84.44	0.54	0.139	0.091	0.000	0.090	39
7	99.39	102.68	-3.29	0.153	-0.559	0.009	-0.554	3
8	94.56	89.21	5.35	0.168	0.915	0.028	0.913	40
9	95.59	99.71	-4.12	0.126	-0.688	0.011	-0.683	43
10	92.47	96.97	-4.50	0.099	-0.740	0.010	-0.736	9
11	95.75	90.44	5.31	0.133	0.890	0.020	0.887	1
12	93.16	88.03	5.13	0.091	0.840	0.012	0.837	2
13	98.98	102.02	-3.04	0.151	-0.515	0.008	-0.510	32
14	99.23	99.47	-0.24	0.147	-0.041	0.000	-0.041	16

15	90.29	87.16	3.13	0.147	0.530	0.008	0.524	30
16	82.00	84.68	-2.68	0.153	-0.455	0.006	-0.450	14
17	97.11	96.23	0.88	0.169	0.151	0.001	0.149	42
18	98.46	99.99	-1.53	0.138	-0.258	0.002	-0.254	25
19	86.55	86.27	0.28	0.144	0.048	0.000	0.047	18
20	91.83	90.14	1.69	0.149	0.286	0.002	0.282	19
21	99.58	101.71	-2.13	0.119	-0.354	0.003	-0.349	23
22	98.20	98.69	-0.49	0.215	-0.086	0.000	-0.085	21
23	94.37	87.86	6.51	0.115	1.081	0.025	1.083	37
24	85.93	83.88	2.05	0.207	0.359	0.006	0.354	20
25	94.42	93.09	1.33	0.144	0.225	0.001	0.222	31
26	89.75	89.70	0.05	0.156	0.009	0.000	0.009	15
27	96.29	96.17	0.12	0.145	0.021	0.000	0.021	33
28	92.98	93.65	-0.67	0.153	-0.113	0.000	-0.112	12
29	99.64	105.59	-5.95	0.146	-1.005	0.029	-1.005	26
30	97.14	92.41	4.73	0.164	0.808	0.021	0.804	8
31	98.12	95.10	3.02	0.148	0.510	0.008	0.505	36
32	48.05	81.03	-32.98	0.144	-5.566	0.868	-13.608	35
33	97.68	99.98	-2.30	0.155	-0.391	0.005	-0.387	34
34	98.59	97.65	0.94	0.170	0.161	0.001	0.158	17
35	92.59	88.54	4.05	0.156	0.687	0.015	0.682	27
36	88.56	86.80	1.76	0.149	0.298	0.003	0.294	10
37	96.58	94.07	2.51	0.142	0.423	0.005	0.419	6
38	91.49	90.73	0.76	0.104	0.125	0.000	0.124	4
39	96.20	97.78	-1.58	0.171	-0.271	0.003	-0.267	41
40	93.58	93.26	0.32	0.173	0.055	0.000	0.054	24
41	95.66	93.68	1.98	0.028	0.313	0.000	0.309	38
42	91.69	93.92	-2.23	0.033	-0.353	0.001	-0.349	22
43	97.86	93.11	4.75	0.024	0.750	0.002	0.745	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2150.5	20	107.52	3.190	0.0049
RESIDUAL	741.6	22	33.71		
COR TOTAL	2892.0	42			
ROOT MSE	5.81		R-SQUARED	0.7436	
DEP MEAN	93.48		ADJ R-SQUARED	0.5105	
C.V.	6.21%				

Predicted Residual Sum of Squares (PRESS) = 2916.2

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	96.18	1	3.00	32.05	
A	-1.28	1	1.49	-0.8590	0.3996
B	-1.39	1	1.61	-0.8633	0.3973
C	-6.67	1	1.48	-4.521	0.0002
D	1.33	1	1.44	0.9223	0.3664
E	-4.59	1	1.48	-3.091	0.0053
A2	0.33	1	2.18	0.1510	0.8813
B2	0.10	1	2.16	4.49E-02	0.9646
C2	-3.29	1	2.15	-1.529	0.1404
D2	-0.67	1	2.08	-0.3222	0.7503
E2	-3.07	1	2.32	-1.321	0.2002
AB	0.86	1	3.08	0.2792	0.7827
AC	-2.27	1	2.92	-0.7786	0.4445
AD	-0.05	1	2.83	-1.65E-02	0.9870
AE	-1.46	1	2.83	-0.5149	0.6118
BC	-1.75	1	2.50	-0.6969	0.4932
BD	0.12	1	2.74	4.22E-02	0.9668
BE	-3.34	1	4.13	-0.8089	0.4272
CD	2.11	1	3.01	0.6989	0.4919
CE	-11.94	1	3.00	-3.982	0.0006
DE	1.11	1	2.86	0.3869	0.7025

Final Equation in Terms of Coded Factors:

Energy rec =

$$\begin{aligned}
 &96.18 \\
 &- 1.28 * A \\
 &- 1.39 * B \\
 &- 6.67 * C \\
 &+ 1.33 * D \\
 &- 4.59 * E \\
 &+ 0.33 * A^2 \\
 &+ 0.10 * B^2 \\
 &- 3.29 * C^2 \\
 &- 0.67 * D^2 \\
 &- 3.07 * E^2 \\
 &+ 0.86 * AB \\
 &- 2.27 * AC \\
 &- 0.05 * AD \\
 &- 1.46 * AE \\
 &- 1.75 * BC \\
 &+ 0.12 * BD \\
 &- 3.34 * BE \\
 &+ 2.11 * CD \\
 &- 11.94 * CE \\
 &+ 1.11 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Energy rec =

$$\begin{aligned}
 & -274.99 \\
 & + 0.15321 * \text{Grind Size} \\
 & + 0.16835 * \text{Feed Rate} \\
 & + 1.8276 * \text{Drum Speed} \\
 & - 27.256 * \text{Wash Water} \\
 & + 10.176 * \% \text{ Solids} \\
 & + 3.286\text{E-}05 * \text{Grind Size}^2 \\
 & + 9.693\text{E-}06 * \text{Feed Rate}^2 \\
 & - 2.058\text{E-}03 * \text{Drum Speed}^2 \\
 & - 2.6843 * \text{Wash Water}^2 \\
 & - 3.070\text{E-}02 * \% \text{ Solids}^2 \\
 & + 8.610\text{E-}05 * \text{Grind Size} * \text{Feed Rate} \\
 & - 5.679\text{E-}04 * \text{Grind Size} * \text{Drum Speed} \\
 & - 9.333\text{E-}04 * \text{Grind Size} * \text{Wash Water} \\
 & - 1.458\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 4.364\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 2.307\text{E-}03 * \text{Feed Rate} * \text{Wash Water} \\
 & - 3.340\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & + 0.10531 * \text{Drum Speed} * \text{Wash Water} \\
 & - 2.986\text{E-}02 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.22109 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	96.65	99.73	-3.08	0.612	-0.852	0.055	-0.847	28
2	93.63	95.55	-1.92	0.559	-0.497	0.015	-0.489	13
3	95.28	94.39	0.89	0.582	0.236	0.004	0.231	29
4	99.63	94.89	4.74	0.284	0.966	0.018	0.964	11
5	99.31	99.61	-0.30	0.551	-0.077	0.000	-0.076	5
6	84.98	80.70	4.28	0.504	1.047	0.053	1.050	39
7	99.39	99.01	0.38	0.526	0.095	0.000	0.093	3
8	94.56	90.43	4.13	0.585	1.106	0.082	1.112	40
9	95.59	96.51	-0.92	0.568	-0.241	0.004	-0.236	43
10	92.47	98.75	-6.28	0.295	-1.287	0.033	-1.308	9
11	95.75	92.95	2.80	0.649	0.813	0.058	0.806	1
12	93.16	86.98	6.18	0.243	1.224	0.023	1.238	2
13	98.98	98.89	0.09	0.522	0.023	0.000	0.022	32
14	99.23	100.99	-1.76	0.501	-0.429	0.009	-0.420	16
15	90.29	88.50	1.79	0.507	0.439	0.009	0.431	30
16	82.00	81.85	0.15	0.515	0.036	0.000	0.036	14
17	97.11	97.19	-0.08	0.608	-0.023	0.000	-0.023	42
18	98.46	97.68	0.78	0.450	0.182	0.001	0.178	25
19	86.55	83.80	2.75	0.503	0.672	0.022	0.663	18
20	91.83	89.58	2.25	0.504	0.551	0.015	0.542	19
21	99.58	100.32	-0.74	0.289	-0.151	0.000	-0.148	23
22	98.20	100.04	-1.84	0.773	-0.666	0.072	-0.657	21
23	94.37	88.39	5.98	0.287	1.220	0.029	1.234	37
24	85.93	82.04	3.89	0.762	1.375	0.289	1.405	20
25	94.42	95.59	-1.17	0.492	-0.283	0.004	-0.277	31
26	89.75	91.78	-2.03	0.535	-0.512	0.014	-0.503	15
27	96.29	98.26	-1.97	0.506	-0.483	0.011	-0.474	33
28	92.98	95.21	-2.23	0.524	-0.556	0.016	-0.547	12
29	99.64	90.22	9.42	0.501	2.296	0.252	2.573	26
30	97.14	100.05	-2.91	0.549	-0.746	0.032	-0.738	8
31	98.12	102.81	-4.69	0.495	-1.136	0.060	-1.144	36
32	48.05	65.63	-17.58	0.483	-4.213	0.791	-9.369	35
33	97.68	97.89	-0.21	0.538	-0.053	0.000	-0.052	34
34	98.59	99.40	-0.81	0.581	-0.216	0.003	-0.211	17
35	92.59	88.92	3.67	0.510	0.903	0.041	0.899	27

36	88.56	84.71	3.85	0.490	0.929	0.039	0.926	10
37	96.58	95.93	0.65	0.425	0.147	0.001	0.144	6
38	91.49	93.29	-1.80	0.318	-0.376	0.003	-0.368	4
39	96.20	98.13	-1.93	0.578	-0.511	0.017	-0.502	41
40	93.58	95.36	-1.78	0.578	-0.472	0.015	-0.463	24
41	95.66	96.05	-0.39	0.237	-0.078	0.000	-0.076	38
42	91.69	96.27	-4.58	0.220	-0.893	0.011	-0.889	22
43	97.86	95.54	2.32	0.260	0.465	0.004	0.456	7

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	531.6	5	106.33	15.49	0.0001
RESIDUAL	247.0	36	6.86		
COR TOTAL	778.7	41			
ROOT MSE	2.62		R-SQUARED	0.6827	
DEP MEAN	94.57		ADJ R-SQUARED	0.6387	
C.V.	2.77%				

Predicted Residual Sum of Squares (PRESS) = 328.2

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	94.59	1	0.40	233.7	
A	-1.13	1	0.66	-1.723	0.0935
B	-1.56	1	0.67	-2.341	0.0249
C	-4.89	1	0.68	-7.204	0.0001
D	1.56	1	0.64	2.432	0.0201
E	-2.84	1	0.68	-4.187	0.0002

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & 94.59 \\ & - 1.13 * A \\ & - 1.56 * B \\ & - 4.89 * C \\ & + 1.56 * D \\ & - 2.84 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & 138.22 \\ & - 1.129\text{E-}02 * \text{Grind Size} \\ & - 1.560\text{E-}02 * \text{Feed Rate} \\ & - 0.12236 * \text{Drum Speed} \\ & + 3.1206 * \text{Wash Water} \\ & - 0.28424 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	96.65	96.76	-0.11	0.150	-0.044	0.000	-0.044	28
2	93.63	94.59	-0.96	0.146	-0.396	0.004	-0.391	13
3	95.28	93.49	1.79	0.186	0.757	0.022	0.753	29
4	99.63	92.47	7.16	0.106	2.892	0.166	3.255	11
5	99.31	98.66	0.65	0.154	0.269	0.002	0.266	5
6	84.98	88.04	-3.06	0.150	-1.269	0.047	-1.280	39
7	99.39	101.06	-1.67	0.155	-0.695	0.015	-0.690	3
8	94.56	92.01	2.55	0.174	1.070	0.040	1.073	40
9	95.59	98.13	-2.54	0.128	-1.040	0.027	-1.042	43
10	92.47	95.92	-3.45	0.100	-1.388	0.036	-1.407	9
11	95.75	93.22	2.53	0.139	1.042	0.029	1.043	1
12	93.16	91.27	1.89	0.100	0.761	0.011	0.756	2
13	98.98	100.43	-1.45	0.153	-0.602	0.011	-0.596	32
14	99.23	98.03	1.20	0.149	0.495	0.007	0.489	16

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Coal Seam:  Pittsburgh No. 8
Circuit:    Individual MGS
Response:   Energy Recovery
Data File:  P-MGS-00
Comments:   Analysis with Outliers Removed
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FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Grind Size	microns	100.000	300.000
B	Feed Rate	lbs/hr	100.000	300.000
C	Drum Speed	rpm	240.000	320.000
D	Wash Water	lpm	0.500	1.500
E	% Solids	w/w	15.000	35.000

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	375590.4	1	375590.4		
Linear	531.6	5	106.3	15.49	0.0001
Quadratic	103.9	15	6.9	1.016	0.4762
Cubic	143.2	21	6.8		
RESIDUAL	0.0	0			
TOTAL	376369.1	42			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	36	2.62	0.6827	0.6387	328.17
Quadratic	21	21	2.61	0.8162	0.6411	458.03
Cubic	42	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

15	90.29	90.51	-0.22	0.156	-0.093	0.000	-0.092	30
16	82.00	88.03	-6.03	0.162	-2.513	0.203	-2.728	14
17	97.11	95.07	2.04	0.170	0.857	0.025	0.854	42
18	98.46	98.53	-0.07	0.140	-0.028	0.000	-0.028	25
19	86.55	89.76	-3.21	0.154	-1.332	0.054	-1.347	18
20	91.83	93.09	-1.26	0.156	-0.525	0.008	-0.520	19
21	99.58	100.12	-0.54	0.121	-0.222	0.001	-0.219	23
22	98.20	97.42	0.78	0.216	0.337	0.005	0.333	21
23	94.37	90.76	3.61	0.121	1.470	0.050	1.495	37
24	85.93	87.55	-1.62	0.217	-0.698	0.023	-0.693	20
25	94.42	94.07	0.35	0.145	0.145	0.001	0.143	31
26	89.75	91.11	-1.36	0.157	-0.565	0.010	-0.559	15
27	96.29	96.94	-0.65	0.145	-0.267	0.002	-0.264	33
28	92.98	94.54	-1.56	0.154	-0.647	0.013	-0.641	12
29	99.64	101.84	-2.20	0.157	-0.914	0.026	-0.911	26
30	97.14	93.15	3.99	0.164	1.665	0.091	1.708	8
31	98.12	96.01	2.11	0.148	0.873	0.022	0.870	36
33	97.68	98.43	-0.75	0.157	-0.310	0.003	-0.306	34
34	98.59	96.05	2.54	0.172	1.067	0.039	1.069	17
35	92.59	92.09	0.50	0.165	0.208	0.001	0.205	27
36	88.56	90.09	-1.53	0.157	-0.638	0.013	-0.633	10
37	96.58	94.69	1.89	0.142	0.780	0.017	0.776	6
38	91.49	91.99	-0.50	0.106	-0.201	0.001	-0.199	4
39	96.20	97.95	-1.75	0.171	-0.733	0.019	-0.728	41
40	93.58	94.30	-0.72	0.173	-0.303	0.003	-0.299	24
41	95.66	94.62	1.04	0.028	0.402	0.001	0.397	38
42	91.69	94.81	-3.12	0.033	-1.211	0.008	-1.219	22
43	97.86	94.15	3.71	0.025	1.433	0.009	1.455	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	635.5	20	31.78	4.661	0.0005
RESIDUAL	143.2	21	6.82		
COR TOTAL	778.7	41			
ROOT MSE	2.61		R-SQUARED	0.8162	
DEP MEAN	94.57		ADJ R-SQUARED	0.6411	
C.V.	2.76%				

Predicted Residual Sum of Squares (PRESS) = 458.0

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	95.69	1	1.35	70.86	
A	-1.10	1	0.67	-1.642	0.1154
B	-1.37	1	0.73	-1.890	0.0726
C	-4.91	1	0.69	-7.113	0.0001
D	1.40	1	0.65	2.151	0.0433
E	-2.85	1	0.69	-4.115	0.0005
A2	-0.41	1	0.98	-0.4132	0.6836
B2	-0.15	1	0.97	-0.1562	0.8774
C2	-0.98	1	1.00	-0.9838	0.3364
D2	-1.05	1	0.94	-1.116	0.2770
E2	-0.76	1	1.07	-0.7103	0.4853
AB	0.60	1	1.39	0.4320	0.6701
AC	-2.04	1	1.31	-1.552	0.1357
AD	0.17	1	1.27	0.1316	0.8965
AE	-1.19	1	1.27	-0.9303	0.3628
BC	-1.51	1	1.13	-1.344	0.1932
BD	0.17	1	1.23	0.1344	0.8944
BE	-1.25	1	1.87	-0.6682	0.5113
CD	2.20	1	1.36	1.622	0.1198
CE	-3.32	1	1.63	-2.030	0.0552
DE	0.85	1	1.29	0.6583	0.5175

Final Equation in Terms of Coded Factors:

Energy rec =

95.69
 - 1.10 * A
 - 1.37 * B
 - 4.91 * C
 + 1.40 * D
 - 2.85 * E
 - 0.41 * A2
 - 0.15 * B2
 - 0.98 * C2
 - 1.05 * D2
 - 0.76 * E2
 + 0.60 * AB
 - 2.04 * AC
 + 0.17 * AD
 - 1.19 * AE
 - 1.51 * BC
 + 0.17 * BD
 - 1.25 * BE
 + 2.20 * CD
 - 3.32 * CE
 + 0.85 * DE

Final Equation in Terms of Actual Factors:

Energy rec =

$$\begin{aligned}
 & -1.21 \\
 & + 0.16201 * \text{Grind Size} \\
 & + 0.11435 * \text{Feed Rate} \\
 & + 0.49618 * \text{Drum Speed} \\
 & - 25.163 * \text{Wash Water} \\
 & + 2.7352 * \% \text{ Solids} \\
 & - 4.056\text{E-}05 * \text{Grind Size}^2 \\
 & - 1.518\text{E-}05 * \text{Feed Rate}^2 \\
 & - 6.143\text{E-}04 * \text{Drum Speed}^2 \\
 & - 4.1856 * \text{Wash Water}^2 \\
 & - 7.630\text{E-}03 * \% \text{ Solids}^2 \\
 & + 5.992\text{E-}05 * \text{Grind Size} * \text{Feed Rate} \\
 & - 5.090\text{E-}04 * \text{Grind Size} * \text{Drum Speed} \\
 & + 3.353\text{E-}03 * \text{Grind Size} * \text{Wash Water} \\
 & - 1.185\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 3.787\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 3.307\text{E-}03 * \text{Feed Rate} * \text{Wash Water} \\
 & - 1.250\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & + 0.10988 * \text{Drum Speed} * \text{Wash Water} \\
 & - 8.289\text{E-}03 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.16921 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	96.65	97.89	-1.24	0.618	-0.766	0.045	-0.759	28
2	93.63	94.46	-0.83	0.561	-0.480	0.014	-0.471	13
3	95.28	93.39	1.89	0.584	1.122	0.084	1.129	29
4	99.63	93.59	6.04	0.287	2.739	0.144	3.334	11
5	99.31	99.42	-0.11	0.551	-0.062	0.000	-0.061	5
6	84.98	85.00	-0.02	0.535	-0.012	0.000	-0.012	39
7	99.39	97.91	1.48	0.528	0.824	0.036	0.818	3
8	94.56	93.70	0.86	0.603	0.522	0.020	0.513	40
9	95.59	97.61	-2.02	0.570	-1.180	0.088	-1.191	43
10	92.47	97.26	-4.79	0.298	-2.191	0.097	-2.434	9
11	95.75	94.39	1.36	0.652	0.882	0.070	0.878	1
12	93.16	91.23	1.93	0.273	0.868	0.013	0.862	2
13	98.98	98.27	0.71	0.523	0.392	0.008	0.384	32
14	99.23	100.11	-0.88	0.502	-0.475	0.011	-0.466	16
15	90.29	91.95	-1.66	0.527	-0.927	0.046	-0.924	30
16	82.00	85.23	-3.23	0.534	-1.813	0.179	-1.927	14
17	97.11	95.59	1.52	0.612	0.932	0.065	0.929	42
18	98.46	97.28	1.18	0.450	0.608	0.014	0.598	25
19	86.55	87.88	-1.33	0.531	-0.746	0.030	-0.738	18
20	91.83	92.88	-1.05	0.523	-0.581	0.018	-0.571	19
21	99.58	99.61	-0.03	0.290	-0.013	0.000	-0.013	23
22	98.20	99.65	-1.45	0.773	-1.165	0.221	-1.176	21
23	94.37	91.65	2.72	0.305	1.247	0.032	1.265	37
24	85.93	85.50	0.43	0.782	0.351	0.021	0.344	20
25	94.42	93.96	0.46	0.496	0.250	0.003	0.245	31
26	89.75	90.27	-0.52	0.539	-0.294	0.005	-0.288	15
27	96.29	96.51	-0.22	0.511	-0.119	0.001	-0.116	33
28	92.98	94.25	-1.27	0.525	-0.705	0.026	-0.696	12
29	99.64	98.61	1.03	0.618	0.636	0.031	0.627	26
30	97.14	96.06	1.08	0.576	0.635	0.026	0.626	8
31	98.12	98.86	-0.74	0.521	-0.411	0.009	-0.403	36
33	97.68	97.23	0.45	0.539	0.252	0.004	0.247	34
34	98.59	97.93	0.66	0.584	0.391	0.010	0.383	17
35	92.59	92.98	-0.39	0.538	-0.218	0.003	-0.213	27
36	88.56	88.53	0.03	0.515	0.017	0.000	0.017	10

37	96.58	94.82	1.76	0.427	0.889	0.028	0.884	6
38	91.49	92.25	-0.76	0.319	-0.355	0.003	-0.347	4
39	96.20	96.88	-0.68	0.580	-0.400	0.011	-0.392	41
40	93.58	94.36	-0.78	0.580	-0.461	0.014	-0.452	24
41	95.66	95.68	-0.02	0.237	-0.011	0.000	-0.011	38
42	91.69	95.85	-4.16	0.221	-1.807	0.044	-1.918	22
43	97.86	95.24	2.62	0.261	1.169	0.023	1.180	7

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Coal Seam:  Pittsburgh No. 8
Circuit:      Individual MGS
Response:     Ash Rejection
Data File:    P-MGS-00
Comments:     Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Grind Size      microns       100.000       300.000
B      Feed Rate       lbs/hr        100.000       300.000
C      Drum Speed      rpm           240.000       320.000
D      Wash Water      lpm           0.500         1.500
E      % Solids         w/w           15.000        35.000
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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	51757.1	1	51757.1		
Linear	8163.0	5	1632.6	20.90	0.0001
Quadratic	1137.7	15	75.8	0.9523	0.5285
Cubic	1752.2	22	79.6		
RESIDUAL	0.0	0			
TOTAL	62810.1	43			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	37	8.8	0.7385	0.7032	3814.7
Quadratic	21	22	8.9	0.8415	0.6974	5622.0
Cubic	43	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	8163.0	5	1632.6	20.90	0.0001
RESIDUAL	2890.0	37	78.1		
COR TOTAL	11053.0	42			
ROOT MSE	8.8		R-SQUARED	0.7385	
DEP MEAN	34.7		ADJ R-SQUARED	0.7032	
C.V.	25.47%				

Predicted Residual Sum of Squares (PRESS) = 3814.7

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	34.0	1	1.4	25.17	
A	1.5	1	2.2	0.6904	0.4943
B	-0.8	1	2.2	-0.3575	0.7228
C	18.5	1	2.2	8.374	0.0001
D	-2.8	1	2.2	-1.305	0.2000
E	12.3	1	2.2	5.552	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 34.0 \\ & + 1.5 * A \\ & - 0.8 * B \\ & + 18.5 * C \\ & - 2.8 * D \\ & + 12.3 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & -122.4 \\ & + 1.527\text{E-}02 * \text{Grind Size} \\ & - 8.027\text{E-}03 * \text{Feed Rate} \\ & + 0.46375 * \text{Drum Speed} \\ & - 5.6465 * \text{Wash Water} \\ & + 1.2306 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	36.5	34.7	1.8	0.149	0.223	0.001	0.220	28
2	44.9	36.8	8.2	0.146	0.998	0.028	0.998	13
3	28.0	32.9	-4.9	0.184	-0.608	0.014	-0.603	29
4	5.8	35.2	-29.4	0.105	-3.520	0.243	-4.258	11
5	11.6	18.5	-6.8	0.152	-0.840	0.021	-0.836	5
6	55.1	57.0	-1.9	0.139	-0.233	0.001	-0.230	39
7	11.1	14.7	-3.7	0.153	-0.449	0.006	-0.444	3
8	42.3	50.6	-8.3	0.168	-1.029	0.036	-1.030	40
9	40.4	24.1	16.3	0.126	1.970	0.093	2.054	43
10	30.1	23.0	7.2	0.099	0.857	0.013	0.854	9
11	39.8	46.9	-7.1	0.133	-0.862	0.019	-0.859	1
12	44.7	45.9	-1.3	0.091	-0.151	0.000	-0.149	2
13	17.7	14.0	3.7	0.151	0.459	0.006	0.454	32
14	12.3	17.2	-4.9	0.147	-0.603	0.010	-0.598	16

15	42.3	52.4	-10.1	0.147	-1.238	0.044	-1.247	30
16	53.4	54.7	-1.4	0.153	-0.167	0.001	-0.165	14
17	24.6	24.7	-0.1	0.169	-0.008	0.000	-0.007	42
18	20.6	20.7	-0.1	0.138	-0.016	0.000	-0.015	25
19	52.4	50.1	2.3	0.144	0.286	0.002	0.282	18
20	46.4	43.3	3.1	0.149	0.380	0.004	0.376	19
21	4.0	17.3	-13.3	0.119	-1.607	0.058	-1.644	23
22	19.7	13.2	6.5	0.215	0.831	0.031	0.827	21
23	46.6	53.3	-6.7	0.115	-0.805	0.014	-0.801	37
24	51.8	51.6	0.2	0.207	0.022	0.000	0.022	20
25	32.9	35.3	-2.5	0.144	-0.305	0.003	-0.301	31
26	45.6	40.2	5.4	0.156	0.667	0.014	0.661	15
27	32.8	31.0	1.8	0.145	0.221	0.001	0.218	33
28	44.3	33.8	10.5	0.153	1.289	0.050	1.301	12
29	5.2	4.1	1.1	0.146	0.129	0.000	0.127	26
30	29.9	40.4	-10.5	0.164	-1.299	0.055	-1.312	8
31	26.7	28.3	-1.6	0.148	-0.196	0.001	-0.193	36
32	85.6	65.1	20.5	0.144	2.503	0.175	2.708	35
33	22.5	20.3	2.2	0.155	0.274	0.002	0.271	34
34	17.4	21.6	-4.2	0.170	-0.525	0.009	-0.519	17
35	41.7	48.0	-6.4	0.156	-0.784	0.019	-0.779	27
36	50.1	48.5	1.7	0.149	0.203	0.001	0.201	10
37	43.5	37.5	6.0	0.142	0.735	0.015	0.731	6
38	42.3	36.1	6.2	0.104	0.745	0.011	0.740	4
39	36.8	31.5	5.4	0.171	0.668	0.015	0.663	41
40	38.3	30.7	7.6	0.173	0.947	0.031	0.946	24
41	36.7	35.6	1.1	0.028	0.128	0.000	0.126	38
42	45.0	35.7	9.4	0.033	1.079	0.007	1.081	22
43	32.5	35.5	-3.0	0.024	-0.342	0.000	-0.338	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	9300.7	20	465.0	5.839	0.0001
RESIDUAL	1752.2	22	79.6		
COR TOTAL	11053.0	42			
ROOT MSE	8.9		R-SQUARED	0.8415	
DEP MEAN	34.7		ADJ R-SQUARED	0.6974	
C.V.	25.72%				

Predicted Residual Sum of Squares (PRESS) = 5622.0

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	32.9	1	4.6	7.124	
A	2.1	1	2.3	0.8986	0.3786
B	-1.9	1	2.5	-0.7697	0.4497
C	18.3	1	2.3	8.071	0.0001
D	-2.8	1	2.2	-1.248	0.2251
E	11.7	1	2.3	5.114	0.0001
A2	-1.9	1	3.3	-0.5691	0.5750
B2	3.0	1	3.3	0.9027	0.3765
C2	-3.2	1	3.3	-0.9584	0.3483
D2	2.6	1	3.2	0.8174	0.4225
E2	2.9	1	3.6	0.8235	0.4190
AB	-3.3	1	4.7	-0.7027	0.4896
AC	4.8	1	4.5	1.069	0.2965
AD	0.3	1	4.4	6.33E-02	0.9501
AE	2.9	1	4.4	0.6568	0.5181
BC	-2.2	1	3.9	-0.5707	0.5740
BD	2.0	1	4.2	0.4672	0.6449
BE	9.1	1	6.3	1.436	0.1652
CD	-3.7	1	4.6	-0.7907	0.4376
CE	10.0	1	4.6	2.177	0.0405
DE	0.7	1	4.4	0.1520	0.8806

Final Equation in Terms of Coded Factors:

Ash rej =

$$\begin{aligned}
 &32.9 \\
 &+ 2.1 * A \\
 &- 1.9 * B \\
 &+ 18.3 * C \\
 &- 2.8 * D \\
 &+ 11.7 * E \\
 &- 1.9 * A^2 \\
 &+ 3.0 * B^2 \\
 &- 3.2 * C^2 \\
 &+ 2.6 * D^2 \\
 &+ 2.9 * E^2 \\
 &- 3.3 * AB \\
 &+ 4.8 * AC \\
 &+ 0.3 * AD \\
 &+ 2.9 * AE \\
 &- 2.2 * BC \\
 &+ 2.0 * BD \\
 &+ 9.1 * BE \\
 &- 3.7 * CD \\
 &+ 10.0 * CE \\
 &+ 0.7 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Ash rej =

$$\begin{aligned}
 & -21.8 \\
 & - 0.24931 * \text{Grind Size} \\
 & - 0.18563 * \text{Feed Rate} \\
 & + 0.99366 * \text{Drum Speed} \\
 & + 12.501 * \text{Wash Water} \\
 & - 9.8597 * \% \text{ Solids} \\
 & - 1.903\text{E-}04 * \text{Grind Size}^2 \\
 & + 2.998\text{E-}04 * \text{Feed Rate}^2 \\
 & - 1.982\text{E-}03 * \text{Drum Speed}^2 \\
 & + 10.468 * \text{Wash Water}^2 \\
 & + 2.943\text{E-}02 * \% \text{ Solids}^2 \\
 & - 3.331\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 1.199\text{E-}03 * \text{Grind Size} * \text{Drum Speed} \\
 & + 5.510\text{E-}03 * \text{Grind Size} * \text{Wash Water} \\
 & + 2.860\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 5.493\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 3.930\text{E-}02 * \text{Feed Rate} * \text{Wash Water} \\
 & + 9.110\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 0.18314 * \text{Drum Speed} * \text{Wash Water} \\
 & + 2.510\text{E-}02 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.13353 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	36.5	32.3	4.3	0.612	0.771	0.045	0.763	28
2	44.9	41.0	3.9	0.559	0.661	0.026	0.652	13
3	28.0	37.0	-9.0	0.582	-1.566	0.163	-1.623	29
4	5.8	31.0	-25.3	0.284	-3.346	0.212	-4.664	11
5	11.6	14.0	-2.4	0.551	-0.397	0.009	-0.389	5
6	55.1	59.7	-4.6	0.504	-0.725	0.025	-0.717	39
7	11.1	14.8	-3.7	0.526	-0.610	0.020	-0.601	3
8	42.3	46.4	-4.1	0.585	-0.715	0.034	-0.707	40
9	40.4	35.9	4.5	0.568	0.768	0.037	0.760	43
10	30.1	20.2	10.0	0.295	1.331	0.035	1.357	9
11	39.8	43.3	-3.4	0.649	-0.647	0.037	-0.638	1
12	44.7	50.3	-5.6	0.243	-0.726	0.008	-0.718	2
13	17.7	12.5	5.2	0.522	0.850	0.038	0.845	32
14	12.3	7.1	5.2	0.501	0.824	0.032	0.818	16
15	42.3	41.4	0.9	0.507	0.140	0.001	0.137	30
16	53.4	52.8	0.5	0.515	0.088	0.000	0.086	14
17	24.6	27.3	-2.6	0.608	-0.467	0.016	-0.459	42
18	20.6	24.1	-3.5	0.450	-0.528	0.011	-0.519	25
19	52.4	54.5	-2.1	0.503	-0.330	0.005	-0.323	18
20	46.4	49.6	-3.2	0.504	-0.505	0.012	-0.496	19
21	4.0	12.0	-8.0	0.289	-1.066	0.022	-1.070	23
22	19.7	16.7	3.0	0.773	0.710	0.082	0.702	21
23	46.6	52.8	-6.3	0.287	-0.830	0.013	-0.824	37
24	51.8	48.0	3.7	0.762	0.860	0.113	0.855	20
25	32.9	34.7	-1.9	0.492	-0.291	0.004	-0.285	31
26	45.6	40.1	5.5	0.535	0.906	0.045	0.903	15
27	32.8	29.4	3.5	0.506	0.553	0.015	0.544	33
28	44.3	34.5	9.8	0.524	1.591	0.133	1.652	12
29	5.2	12.4	-7.2	0.501	-1.145	0.063	-1.153	26
30	29.9	31.6	-1.8	0.549	-0.295	0.005	-0.289	8
31	26.7	18.9	7.8	0.495	1.229	0.071	1.244	36
32	85.6	73.6	11.9	0.483	1.857	0.154	1.975	35
33	22.5	22.8	-0.3	0.538	-0.052	0.000	-0.050	34
34	17.4	15.0	2.3	0.581	0.406	0.011	0.398	17
35	41.7	44.3	-2.7	0.510	-0.429	0.009	-0.421	27

36	50.1	52.2	-2.1	0.490	-0.322	0.005	-0.316	10
37	43.5	44.5	-1.0	0.425	-0.152	0.001	-0.149	6
38	42.3	36.6	5.7	0.318	0.772	0.013	0.764	4
39	36.8	35.7	1.2	0.578	0.204	0.003	0.200	41
40	38.3	37.0	1.3	0.578	0.227	0.003	0.222	24
41	36.7	34.6	2.1	0.237	0.266	0.001	0.260	38
42	45.0	34.9	10.1	0.220	1.280	0.022	1.300	22
43	32.5	34.4	-1.8	0.260	-0.235	0.001	-0.229	7

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Coal Seam: Pittsburgh No. 8
Circuit: Individual MGS
Response: Ash Rejection
Data File: P-MGS-00
Comments: Analysis with Outliers Removed
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FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Grind Size	microns	100.000	300.000
B	Feed Rate	lbs/hr	100.000	300.000
C	Drum Speed	rpm	240.000	320.000
D	Wash Water	lpm	0.500	1.500
E	% Solids	w/w	15.000	35.000

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	52581.8	1	52581.8		
Linear	8273.3	5	1654.7	30.99	0.0001
Quadratic	1061.2	15	70.7	1.726	0.1225
Cubic	860.8	21	41.0		
RESIDUAL	0.0	0			
TOTAL	62777.0	42			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	36	7.3	0.8115	0.7853	2603.5
Quadratic	21	21	6.4	0.9156	0.8352	3023.8
Cubic	42	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	8273.3	5	1654.7	30.99	0.0001
RESIDUAL	1922.0	36	53.4		
COR TOTAL	10195.3	41			
ROOT MSE	7.3		R-SQUARED	0.8115	
DEP MEAN	35.4		ADJ R-SQUARED	0.7853	
C.V.	20.65%				

Predicted Residual Sum of Squares (PRESS) = 2603.5

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	34.8	1	1.1	30.73	
A	3.5	1	1.9	1.876	0.0688
B	0.4	1	1.9	0.1946	0.8468
C	18.6	1	1.8	10.15	0.0001
D	-2.8	1	1.8	-1.578	0.1232
E	12.3	1	1.8	6.724	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 34.8 \\ & + 3.5 * A \\ & + 0.4 * B \\ & + 18.6 * C \\ & - 2.8 * D \\ & + 12.3 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & -128.4 \\ & + 3.542\text{E-}02 * \text{Grind Size} \\ & + 3.653\text{E-}03 * \text{Feed Rate} \\ & + 0.46483 * \text{Drum Speed} \\ & - 5.6471 * \text{Wash Water} \\ & + 1.2322 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	36.5	32.3	4.3	0.156	0.633	0.012	0.628	28
2	44.9	38.5	6.4	0.149	0.955	0.027	0.954	13
3	28.0	33.0	-5.0	0.184	-0.758	0.022	-0.754	29
5	11.6	18.7	-7.1	0.152	-1.049	0.033	-1.051	5
6	55.1	57.7	-2.5	0.140	-0.375	0.004	-0.371	39
7	11.1	15.0	-4.0	0.153	-0.595	0.011	-0.589	3
8	42.3	50.7	-8.5	0.168	-1.269	0.054	-1.280	40
9	40.4	23.9	16.5	0.126	2.414	0.140	2.600	43
10	30.1	24.4	5.7	0.101	0.829	0.013	0.825	9
11	39.8	46.6	-6.8	0.133	-1.001	0.026	-1.001	1
12	44.7	47.1	-2.4	0.093	-0.351	0.002	-0.347	2
13	17.7	12.8	5.0	0.152	0.736	0.016	0.732	32
14	12.3	20.1	-7.8	0.156	-1.168	0.042	-1.174	16
15	42.3	51.2	-8.9	0.148	-1.314	0.050	-1.327	30

16	53.4	57.7	-4.4	0.162	-0.652	0.014	-0.647	14
17	24.6	25.9	-1.2	0.171	-0.182	0.001	-0.180	42
18	20.6	21.4	-0.9	0.139	-0.127	0.000	-0.126	25
19	52.4	50.9	1.5	0.145	0.215	0.001	0.212	18
20	46.4	44.3	2.2	0.150	0.319	0.003	0.315	19
21	4.0	17.3	-13.3	0.119	-1.939	0.085	-2.021	23
22	19.7	15.6	4.1	0.221	0.634	0.019	0.628	21
23	46.6	53.2	-6.6	0.115	-0.966	0.020	-0.965	37
24	51.8	54.0	-2.2	0.213	-0.337	0.005	-0.333	20
25	32.9	34.1	-1.3	0.146	-0.188	0.001	-0.186	31
26	45.6	43.2	2.5	0.165	0.370	0.004	0.366	15
27	32.8	29.7	3.1	0.146	0.455	0.006	0.450	33
28	44.3	36.7	7.5	0.162	1.128	0.041	1.132	12
29	5.2	4.9	0.2	0.147	0.033	0.000	0.032	26
30	29.9	40.8	-11.0	0.164	-1.641	0.088	-1.682	8
31	26.7	29.3	-2.6	0.149	-0.384	0.004	-0.379	36
32	85.6	66.0	19.6	0.145	2.895	0.236	3.260	35
33	22.5	19.0	3.5	0.156	0.515	0.008	0.509	34
34	17.4	24.8	-7.4	0.180	-1.123	0.046	-1.127	17
35	41.7	46.7	-5.1	0.157	-0.758	0.018	-0.753	27
36	50.1	51.4	-1.3	0.158	-0.195	0.001	-0.192	10
37	43.5	37.1	6.4	0.142	0.952	0.025	0.950	6
38	42.3	37.7	4.6	0.107	0.671	0.009	0.665	4
39	36.8	31.1	5.8	0.171	0.866	0.026	0.863	41
40	38.3	32.8	5.5	0.177	0.836	0.025	0.833	24
41	36.7	36.0	0.6	0.028	0.089	0.000	0.088	38
42	45.0	36.0	9.0	0.033	1.259	0.009	1.270	22
43	32.5	36.3	-3.7	0.024	-0.517	0.001	-0.512	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	9334.5	20	466.7	11.39	0.0001
RESIDUAL	860.8	21	41.0		
COR TOTAL	10195.3	41			
ROOT MSE	6.4		R-SQUARED	0.9156	
DEP MEAN	35.4		ADJ R-SQUARED	0.8352	
C.V.	18.09%				

Predicted Residual Sum of Squares (PRESS) = 3023.8

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	36.5	1	3.4	10.74	
A	3.8	1	1.7	2.263	0.0344
B	-0.1	1	1.8	-4.68E-02	0.9631
C	18.4	1	1.6	11.29	0.0001
D	-2.8	1	1.6	-1.734	0.0976
E	11.8	1	1.6	7.195	0.0001
A2	-1.5	1	2.4	-0.6082	0.5496
B2	2.4	1	2.4	0.9901	0.3334
C2	-5.7	1	2.4	-2.339	0.0293
D2	0.3	1	2.4	0.1223	0.9038
E2	0.2	1	2.6	7.81E-02	0.9385
AB	2.1	1	3.6	0.5950	0.5582
AC	4.9	1	3.2	1.517	0.1442
AD	0.1	1	3.1	2.49E-02	0.9804
AE	2.7	1	3.1	0.8501	0.4048
BC	-2.3	1	2.8	-0.8303	0.4157
BD	0.8	1	3.0	0.2711	0.7889
BE	10.5	1	4.6	2.305	0.0315
CD	-3.0	1	3.3	-0.8942	0.3814
CE	10.0	1	3.3	3.024	0.0065
DE	1.0	1	3.2	0.3169	0.7544

Final Equation in Terms of Coded Factors:

Ash rej =

$$\begin{aligned}
 &36.5 \\
 &+ 3.8 * A \\
 &- 0.1 * B \\
 &+ 18.4 * C \\
 &- 2.8 * D \\
 &+ 11.8 * E \\
 &- 1.5 * A^2 \\
 &+ 2.4 * B^2 \\
 &- 5.7 * C^2 \\
 &+ 0.3 * D^2 \\
 &+ 0.2 * E^2 \\
 &+ 2.1 * AB \\
 &+ 4.9 * AC \\
 &+ 0.1 * AD \\
 &+ 2.7 * AE \\
 &- 2.3 * BC \\
 &+ 0.8 * BD \\
 &+ 10.5 * BE \\
 &- 3.0 * CD \\
 &+ 10.0 * CE \\
 &+ 1.0 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Ash rej =

$$\begin{aligned}
 & -143.9 \\
 & - 0.35567 * \text{Grind Size} \\
 & - 0.25693 * \text{Feed Rate} \\
 & + 1.8468 * \text{Drum Speed} \\
 & + 25.230 * \text{Wash Water} \\
 & - 8.7614 * \% \text{ Solids} \\
 & - 1.460\text{E-}04 * \text{Grind Size}^2 \\
 & + 2.363\text{E-}04 * \text{Feed Rate}^2 \\
 & - 3.559\text{E-}03 * \text{Drum Speed}^2 \\
 & + 1.1499 * \text{Wash Water}^2 \\
 & + 2.054\text{E-}03 * \% \text{ Solids}^2 \\
 & + 2.140\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 1.220\text{E-}03 * \text{Grind Size} * \text{Drum Speed} \\
 & + 1.555\text{E-}03 * \text{Grind Size} * \text{Wash Water} \\
 & + 2.656\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 5.733\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 1.641\text{E-}02 * \text{Feed Rate} * \text{Wash Water} \\
 & + 1.052\text{E-}02 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 0.14872 * \text{Drum Speed} * \text{Wash Water} \\
 & + 2.501\text{E-}02 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.19975 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	36.5	37.3	-0.7	0.640	-0.190	0.003	-0.186	28
2	44.9	39.6	5.4	0.561	1.266	0.098	1.286	13
3	28.0	34.2	-6.2	0.591	-1.523	0.160	-1.576	29
5	11.6	12.3	-0.7	0.554	-0.158	0.001	-0.154	5
6	55.1	57.5	-2.4	0.509	-0.539	0.014	-0.529	39
7	11.1	12.9	-1.8	0.530	-0.413	0.009	-0.404	3
8	42.3	45.3	-3.0	0.587	-0.728	0.036	-0.719	40
9	40.4	36.1	4.2	0.568	1.006	0.063	1.006	43
10	30.1	21.7	8.4	0.297	1.573	0.050	1.634	9
11	39.8	40.9	-1.1	0.655	-0.285	0.007	-0.279	1
12	44.7	52.4	-7.7	0.247	-1.387	0.030	-1.421	2
13	17.7	12.0	5.7	0.522	1.286	0.086	1.307	32
14	12.3	11.6	0.7	0.524	0.158	0.001	0.154	16
15	42.3	41.2	1.1	0.507	0.236	0.003	0.231	30
16	53.4	57.3	-4.0	0.537	-0.908	0.046	-0.904	14
17	24.6	25.8	-1.2	0.610	-0.299	0.007	-0.292	42
18	20.6	23.0	-2.4	0.451	-0.510	0.010	-0.500	25
19	52.4	53.1	-0.7	0.505	-0.160	0.001	-0.156	18
20	46.4	48.8	-2.4	0.505	-0.539	0.014	-0.530	19
21	4.0	11.5	-7.5	0.289	-1.392	0.037	-1.426	23
22	19.7	19.0	0.7	0.779	0.222	0.008	0.217	21
23	46.6	52.4	-5.8	0.287	-1.075	0.022	-1.079	37
24	51.8	50.4	1.3	0.769	0.438	0.030	0.430	20
25	32.9	34.3	-1.4	0.492	-0.317	0.005	-0.311	31
26	45.6	44.6	1.1	0.557	0.253	0.004	0.247	15
27	32.8	29.8	3.0	0.506	0.678	0.022	0.669	33
28	44.3	38.6	5.6	0.543	1.303	0.096	1.327	12
29	5.2	10.9	-5.7	0.503	-1.272	0.078	-1.292	26
30	29.9	29.8	0.1	0.553	0.015	0.000	0.015	8
31	26.7	18.3	8.4	0.496	1.855	0.161	1.980	36
32	85.6	72.3	13.3	0.485	2.885	0.374	3.625	35
33	22.5	21.8	0.7	0.539	0.152	0.001	0.148	34
34	17.4	19.8	-2.4	0.606	-0.597	0.026	-0.587	17
35	41.7	43.7	-2.0	0.511	-0.457	0.010	-0.448	27
36	50.1	56.6	-6.4	0.512	-1.437	0.103	-1.477	10

37	43.5	42.6	0.9	0.429	0.191	0.001	0.187	6
38	42.3	40.0	2.3	0.330	0.445	0.005	0.436	4
39	36.8	35.0	1.8	0.578	0.439	0.013	0.431	41
40	38.3	38.2	0.1	0.580	0.034	0.000	0.033	24
41	36.7	37.7	-1.0	0.248	-0.186	0.001	-0.182	38
42	45.0	37.8	7.3	0.229	1.293	0.024	1.315	22
43	32.5	38.0	-5.4	0.275	-0.991	0.018	-0.991	7

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Coal Seam: Pittsburgh No. 8
Circuit: Individual MGS
Response: Sulfur Rejection
Data File: P-MGS-00
Comments: Analysis of Complete Data Set
=====

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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Grind Size      microns       100.000       300.000
B      Feed Rate       lbs/hr        100.000       300.000
C      Drum Speed      rpm           240.000       320.000
D      Wash Water      lpm           0.500         1.500
E      % Solids         w/w           15.000        35.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	72149.4	1	72149.4		
Linear	4117.9	5	823.6	12.73	0.0001
Quadratic	788.2	15	52.5	0.7201	0.7407
Cubic	1605.3	22	73.0		
RESIDUAL	0.0	0			
TOTAL	78660.8	43			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	37	8.04	0.6324	0.5827	3172.94
Quadratic	21	22	8.54	0.7535	0.5293	5207.23
Cubic	43	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4117.9	5	823.57	12.73	0.0001
RESIDUAL	2393.5	37	64.69		
COR TOTAL	6511.4	42			
ROOT MSE	8.04		R-SQUARED	0.6324	
DEP MEAN	40.96		ADJ R-SQUARED	0.5827	
C.V.	19.64%				

Predicted Residual Sum of Squares (PRESS) = 3172.9

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	40.47	1	1.23	32.90	
A	-0.68	1	2.01	-0.3382	0.7371
B	-0.46	1	2.04	-0.2227	0.8250
C	12.72	1	2.02	6.310	0.0001
D	-1.98	1	1.97	-1.006	0.3211
E	9.40	1	2.02	4.662	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sul rej} = & 40.47 \\ & - 0.68 * A \\ & - 0.46 * B \\ & + 12.72 * C \\ & - 1.98 * D \\ & + 9.40 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sul rej} = & -65.86 \\ & - 6.805\text{E-}03 * \text{Grind Size} \\ & - 4.551\text{E-}03 * \text{Feed Rate} \\ & + 0.31803 * \text{Drum Speed} \\ & - 3.9607 * \text{Wash Water} \\ & + 0.94035 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	42.45	42.60	-0.15	0.149	-0.020	0.000	-0.020	28
2	43.69	40.55	3.14	0.146	0.422	0.005	0.417	13
3	39.09	41.62	-2.53	0.184	-0.348	0.005	-0.344	29
4	12.49	39.59	-27.10	0.105	-3.563	0.249	-4.336	11
5	29.25	29.80	-0.55	0.152	-0.074	0.000	-0.073	5
6	54.59	56.37	-1.78	0.139	-0.239	0.002	-0.236	39
7	27.60	27.25	0.35	0.153	0.048	0.000	0.047	3
8	46.63	51.73	-5.10	0.168	-0.696	0.016	-0.691	40
9	41.20	32.73	8.47	0.126	1.126	0.031	1.131	43
10	33.27	32.08	1.19	0.099	0.155	0.000	0.153	9
11	38.39	50.20	-11.81	0.133	-1.577	0.063	-1.611	1
12	49.24	49.63	-0.39	0.091	-0.051	0.000	-0.051	2
13	34.39	28.47	5.92	0.151	0.798	0.019	0.794	32
14	26.52	27.23	-0.71	0.147	-0.095	0.000	-0.094	16

15	47.40	54.90	-7.50	0.147	-1.009	0.029	-1.010	30
16	54.20	52.95	1.25	0.153	0.169	0.001	0.167	14
17	35.66	33.20	2.46	0.169	0.336	0.004	0.332	42
18	30.15	30.42	-0.27	0.138	-0.037	0.000	-0.036	25
19	51.68	52.48	-0.80	0.144	-0.108	0.000	-0.106	18
20	48.01	47.78	0.23	0.149	0.031	0.000	0.031	19
21	14.48	29.05	-14.57	0.119	-1.931	0.084	-2.008	23
22	31.09	26.22	4.87	0.215	0.684	0.021	0.679	21
23	49.58	53.60	-4.02	0.115	-0.531	0.006	-0.526	37
24	51.27	52.66	-1.39	0.207	-0.194	0.002	-0.191	20
25	39.16	43.15	-3.99	0.144	-0.536	0.008	-0.531	31
26	46.16	43.16	3.00	0.156	0.406	0.005	0.402	15
27	39.45	40.19	-0.74	0.145	-0.099	0.000	-0.098	33
28	45.96	38.64	7.32	0.153	0.989	0.029	0.988	12
29	16.54	19.01	-2.47	0.146	-0.332	0.003	-0.328	26
30	34.15	43.83	-9.68	0.164	-1.316	0.056	-1.330	8
31	37.86	37.56	0.30	0.148	0.040	0.000	0.039	36
32	85.20	62.76	22.44	0.144	3.016	0.255	3.426	35
33	34.34	31.80	2.54	0.155	0.343	0.004	0.339	34
34	28.48	29.19	-0.71	0.170	-0.097	0.000	-0.095	17
35	45.48	52.86	-7.38	0.156	-0.998	0.031	-0.998	27
36	49.62	49.64	-0.02	0.149	-0.002	0.000	-0.002	10
37	52.45	42.79	9.66	0.142	1.297	0.046	1.309	6
38	48.48	42.00	6.48	0.104	0.852	0.014	0.848	4
39	48.36	38.57	9.79	0.171	1.337	0.061	1.351	41
40	44.33	38.25	6.08	0.173	0.831	0.024	0.827	24
41	44.45	41.60	2.85	0.028	0.360	0.001	0.355	38
42	46.68	41.65	5.03	0.033	0.636	0.002	0.630	22
43	41.90	41.61	0.29	0.024	0.037	0.000	0.036	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4906.1	20	245.30	3.362	0.0035
RESIDUAL	1605.3	22	72.97		
COR TOTAL	6511.4	42			
ROOT MSE	8.54		R-SQUARED	0.7535	
DEP MEAN	40.96		ADJ R-SQUARED	0.5293	
C.V.	20.85%				

Predicted Residual Sum of Squares (PRESS) = 5207.2

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	39.03	1	4.41	8.841	
A	-0.20	1	2.20	-9.29E-02	0.9268
B	-1.15	1	2.37	-0.4857	0.6319
C	12.43	1	2.17	5.725	0.0001
D	-2.08	1	2.13	-0.9781	0.3387
E	8.91	1	2.18	4.082	0.0005
A2	-1.68	1	3.20	-0.5253	0.6046
B2	1.80	1	3.18	0.5655	0.5774
C2	-0.83	1	3.17	-0.2623	0.7955
D2	3.37	1	3.06	1.098	0.2840
E2	1.40	1	3.42	0.4092	0.6864
AB	-3.00	1	4.54	-0.6623	0.5147
AC	4.25	1	4.29	0.9908	0.3326
AD	0.60	1	4.17	0.1437	0.8870
AE	1.57	1	4.17	0.3768	0.7099
BC	-2.15	1	3.69	-0.5840	0.5652
BD	1.00	1	4.03	0.2488	0.8059
BE	8.75	1	6.07	1.440	0.1638
CD	-2.34	1	4.43	-0.5279	0.6029
CE	8.95	1	4.41	2.028	0.0548
DE	0.98	1	4.20	0.2327	0.8181

Final Equation in Terms of Coded Factors:

Sul rej =

```

39.03
- 0.20 * A
- 1.15 * B
+ 12.43 * C
- 2.08 * D
+ 8.91 * E
- 1.68 * A2
+ 1.80 * B2
- 0.83 * C2
+ 3.37 * D2
+ 1.40 * E2
- 3.00 * AB
+ 4.25 * AC
+ 0.60 * AD
+ 1.57 * AE
- 2.15 * BC
+ 1.00 * BD
+ 8.75 * BE
- 2.34 * CD
+ 8.95 * CE
+ 0.98 * DE

```

Final Equation in Terms of Actual Factors:

Sul rej =

$$\begin{aligned}
 & 122.71 \\
 & - 0.22364 * \text{Grind Size} \\
 & - 0.11146 * \text{Feed Rate} \\
 & + 5.417\text{E-}02 * \text{Drum Speed} \\
 & - 9.6056 * \text{Wash Water} \\
 & - 8.3336 * \% \text{ Solids} \\
 & - 1.681\text{E-}04 * \text{Grind Size}^2 \\
 & + 1.798\text{E-}04 * \text{Feed Rate}^2 \\
 & - 5.193\text{E-}04 * \text{Drum Speed}^2 \\
 & + 13.462 * \text{Wash Water}^2 \\
 & + 1.400\text{E-}02 * \% \text{ Solids}^2 \\
 & - 3.005\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 1.063\text{E-}03 * \text{Grind Size} * \text{Drum Speed} \\
 & + 1.198\text{E-}02 * \text{Grind Size} * \text{Wash Water} \\
 & + 1.571\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 5.380\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 2.003\text{E-}02 * \text{Feed Rate} * \text{Wash Water} \\
 & + 8.749\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 0.11703 * \text{Drum Speed} * \text{Wash Water} \\
 & + 2.238\text{E-}02 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.19569 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	42.45	38.81	3.64	0.612	0.685	0.035	0.676	28
2	43.69	42.88	0.81	0.559	0.143	0.001	0.139	13
3	39.09	44.29	-5.20	0.582	-0.943	0.059	-0.940	29
4	12.49	35.34	-22.85	0.284	-3.162	0.189	-4.182	11
5	29.25	28.77	0.48	0.551	0.083	0.000	0.081	5
6	54.59	60.33	-5.74	0.504	-0.954	0.044	-0.952	39
7	27.60	28.85	-1.25	0.526	-0.213	0.002	-0.209	3
8	46.63	51.62	-4.99	0.585	-0.907	0.055	-0.903	40
9	41.20	41.42	-0.22	0.568	-0.040	0.000	-0.039	43
10	33.27	27.84	5.43	0.295	0.757	0.011	0.750	9
11	38.39	43.89	-5.50	0.649	-1.086	0.104	-1.091	1
12	49.24	52.20	-2.96	0.243	-0.398	0.002	-0.390	2
13	34.39	28.89	5.50	0.522	0.931	0.045	0.928	32
14	26.52	19.83	6.69	0.501	1.108	0.059	1.114	16
15	47.40	46.74	0.66	0.507	0.111	0.001	0.108	30
16	54.20	52.75	1.45	0.515	0.244	0.003	0.239	14
17	35.66	35.84	-0.18	0.608	-0.034	0.000	-0.033	42
18	30.15	32.46	-2.31	0.450	-0.364	0.005	-0.357	25
19	51.68	55.82	-4.14	0.503	-0.687	0.023	-0.679	18
20	48.01	53.15	-5.14	0.504	-0.854	0.035	-0.849	19
21	14.48	25.33	-10.85	0.289	-1.506	0.044	-1.553	23
22	31.09	29.79	1.30	0.773	0.318	0.016	0.312	21
23	49.58	54.15	-4.57	0.287	-0.634	0.008	-0.625	37
24	51.27	49.56	1.71	0.762	0.411	0.026	0.403	20
25	39.16	43.82	-4.66	0.492	-0.766	0.027	-0.758	31
26	46.16	43.68	2.48	0.535	0.426	0.010	0.418	15
27	39.45	38.93	0.52	0.506	0.087	0.000	0.085	33
28	45.96	40.00	5.96	0.524	1.011	0.054	1.012	12
29	16.54	26.58	-10.04	0.501	-1.663	0.132	-1.738	26
30	34.15	36.60	-2.45	0.549	-0.428	0.011	-0.420	8
31	37.86	29.92	7.94	0.495	1.308	0.080	1.331	36
32	85.20	70.71	14.49	0.483	2.360	0.248	2.668	35
33	34.34	31.42	2.92	0.538	0.503	0.014	0.494	34
34	28.48	22.13	6.35	0.581	1.149	0.087	1.158	17
35	45.48	48.86	-3.38	0.510	-0.566	0.016	-0.557	27

36	49.62	50.51	-0.89	0.490	-0.146	0.001	-0.143	10
37	52.45	47.85	4.60	0.425	0.710	0.018	0.702	6
38	48.48	43.39	5.09	0.318	0.722	0.012	0.713	4
39	48.36	42.93	5.43	0.578	0.979	0.062	0.978	41
40	44.33	42.75	1.58	0.578	0.285	0.005	0.279	24
41	44.45	40.20	4.25	0.237	0.570	0.005	0.561	38
42	46.68	40.37	6.31	0.220	0.837	0.009	0.831	22
43	41.90	40.17	1.73	0.260	0.236	0.001	0.231	7

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Coal Seam:  Pittsburgh No. 8
Circuit:    Individual MGS
Response:   Sulfur Rejection
Data File:  P-MGS-00
Comments:   Analysis with Outliers Removed
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FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Grind Size      microns      100.000      300.000
B    Feed Rate       lbs/hr       100.000      300.000
C    Drum Speed      rpm          240.000      320.000
D    Wash Water      lpm          0.500        1.500
E    % Solids        w/w          15.000       35.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	72823.4	1	72823.4		
Linear	4109.0	5	821.8	18.82	0.0001
Quadratic	696.4	15	46.4	1.113	0.4020
Cubic	876.0	21	41.7		
RESIDUAL	0.0	0			
TOTAL	78504.8	42			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	36	6.61	0.7232	0.6848	2143.04
Quadratic	21	21	6.46	0.8458	0.6990	3260.56
Cubic	42	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4109.0	5	821.81	18.82	0.0001
RESIDUAL	1572.4	36	43.68		
COR TOTAL	5681.4	41			
ROOT MSE	6.61		R-SQUARED	0.7232	
DEP MEAN	41.64		ADJ R-SQUARED	0.6848	
C.V.	15.87%				

Predicted Residual Sum of Squares (PRESS) = 2143.0

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	41.16	1	1.02	40.22	
A	1.18	1	1.71	0.6883	0.4957
B	0.62	1	1.70	0.3657	0.7168
C	12.76	1	1.66	7.704	0.0001
D	-1.98	1	1.62	-1.224	0.2289
E	9.42	1	1.66	5.682	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sul rej} = & 41.16 \\ & + 1.18 * A \\ & + 0.62 * B \\ & + 12.76 * C \\ & - 1.98 * D \\ & + 9.42 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sul rej} = & -71.34 \\ & + 1.176\text{E-}02 * \text{Grind Size} \\ & + 6.207\text{E-}03 * \text{Feed Rate} \\ & + 0.31902 * \text{Drum Speed} \\ & - 3.9612 * \text{Wash Water} \\ & + 0.94173 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	42.45	40.36	2.09	0.156	0.345	0.004	0.341	28
2	43.69	42.13	1.56	0.149	0.256	0.002	0.252	13
3	39.09	41.75	-2.66	0.184	-0.446	0.007	-0.441	29
5	29.25	30.00	-0.75	0.152	-0.124	0.000	-0.122	5
6	54.59	56.95	-2.36	0.140	-0.386	0.004	-0.381	39
7	27.60	27.56	0.04	0.153	0.006	0.000	0.006	3
8	46.63	51.88	-5.25	0.168	-0.871	0.025	-0.868	40
9	41.20	32.54	8.66	0.126	1.402	0.047	1.422	43
10	33.27	33.42	-0.15	0.101	-0.023	0.000	-0.023	9
11	38.39	49.94	-11.55	0.133	-1.876	0.090	-1.948	1
12	49.24	50.71	-1.47	0.093	-0.234	0.001	-0.231	2
13	34.39	27.35	7.04	0.152	1.157	0.040	1.162	32
14	26.52	29.92	-3.40	0.156	-0.560	0.010	-0.554	16
15	47.40	53.75	-6.35	0.148	-1.041	0.031	-1.043	30

16	54.20	55.72	-1.52	0.162	-0.251	0.002	-0.247	14
17	35.66	34.26	1.40	0.171	0.232	0.002	0.229	42
18	30.15	31.10	-0.95	0.139	-0.155	0.001	-0.153	25
19	51.68	53.30	-1.62	0.145	-0.264	0.002	-0.261	18
20	48.01	48.65	-0.64	0.150	-0.106	0.000	-0.104	19
21	14.48	29.03	-14.55	0.119	-2.345	0.124	-2.512	23
22	31.09	28.45	2.64	0.221	0.453	0.010	0.448	21
23	49.58	53.55	-3.97	0.115	-0.639	0.009	-0.633	37
24	51.27	54.83	-3.56	0.213	-0.607	0.017	-0.602	20
25	39.16	42.03	-2.87	0.146	-0.469	0.006	-0.464	31
26	46.16	45.87	0.29	0.165	0.049	0.000	0.048	15
27	39.45	39.02	0.43	0.146	0.070	0.000	0.069	33
28	45.96	41.35	4.61	0.162	0.762	0.019	0.758	12
29	16.54	19.77	-3.23	0.147	-0.529	0.008	-0.524	26
30	34.15	44.26	-10.11	0.164	-1.672	0.091	-1.717	8
31	37.86	38.47	-0.61	0.149	-0.101	0.000	-0.099	36
32	85.20	63.58	21.62	0.145	3.537	0.353	4.317	35
33	34.34	30.67	3.67	0.156	0.604	0.011	0.598	34
34	28.48	32.14	-3.66	0.180	-0.611	0.014	-0.606	17
35	45.48	51.68	-6.20	0.157	-1.022	0.032	-1.022	27
36	49.62	52.37	-2.75	0.158	-0.453	0.006	-0.448	10
37	52.45	42.40	10.05	0.142	1.642	0.074	1.683	6
38	48.48	43.47	5.01	0.107	0.802	0.013	0.798	4
39	48.36	38.22	10.14	0.171	1.686	0.098	1.732	41
40	44.33	40.16	4.17	0.177	0.696	0.017	0.691	24
41	44.45	42.03	2.42	0.028	0.371	0.001	0.367	38
42	46.68	41.96	4.72	0.033	0.727	0.003	0.722	22
43	41.90	42.30	-0.40	0.024	-0.061	0.000	-0.060	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4805.4	20	240.27	5.760	0.0001
RESIDUAL	876.0	21	41.71		
COR TOTAL	5681.4	41			
ROOT MSE	6.46		R-SQUARED	0.8458	
DEP MEAN	41.64		ADJ R-SQUARED	0.6990	
C.V.	15.51%				

Predicted Residual Sum of Squares (PRESS) = 3260.6

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	42.33	1	3.43	12.34	
A	1.39	1	1.70	0.8142	0.4247
B	0.50	1	1.84	0.2702	0.7897
C	12.49	1	1.64	7.608	0.0001
D	-2.07	1	1.61	-1.288	0.2116
E	9.01	1	1.65	5.459	0.0001
A2	-1.28	1	2.42	-0.5287	0.6026
B2	1.22	1	2.41	0.5081	0.6167
C2	-3.11	1	2.46	-1.267	0.2189
D2	1.26	1	2.37	0.5308	0.6011
E2	-1.08	1	2.65	-0.4058	0.6890
AB	1.94	1	3.63	0.5357	0.5978
AC	4.33	1	3.25	1.334	0.1965
AD	0.42	1	3.15	0.1333	0.8952
AE	1.39	1	3.15	0.4398	0.6646
BC	-2.24	1	2.79	-0.8035	0.4307
BD	-0.03	1	3.05	-1.10E-02	0.9913
BE	10.02	1	4.60	2.177	0.0410
CD	-1.72	1	3.36	-0.5120	0.6140
CE	8.92	1	3.34	2.673	0.0142
DE	1.28	1	3.18	0.4020	0.6918

Final Equation in Terms of Coded Factors:

Sul rej =

$$\begin{aligned}
 &42.33 \\
 &+ 1.39 * A \\
 &+ 0.50 * B \\
 &+ 12.49 * C \\
 &- 2.07 * D \\
 &+ 9.01 * E \\
 &- 1.28 * A^2 \\
 &+ 1.22 * B^2 \\
 &- 3.11 * C^2 \\
 &+ 1.26 * D^2 \\
 &- 1.08 * E^2 \\
 &+ 1.94 * AB \\
 &+ 4.33 * AC \\
 &+ 0.42 * AD \\
 &+ 1.39 * AE \\
 &- 2.24 * BC \\
 &- 0.03 * BD \\
 &+ 10.02 * BE \\
 &- 1.72 * CD \\
 &+ 8.92 * CE \\
 &+ 1.28 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Sul rej =

$$\begin{aligned}
 & 12.29 \\
 & - 0.31984 * \text{Grind Size} \\
 & - 0.17595 * \text{Feed Rate} \\
 & + 0.82585 * \text{Drum Speed} \\
 & + 1.9079 * \text{Wash Water} \\
 & - 7.3402 * \% \text{ Solids} \\
 & - 1.281\text{E-}04 * \text{Grind Size}^2 \\
 & + 1.223\text{E-}04 * \text{Feed Rate}^2 \\
 & - 1.946\text{E-}03 * \text{Drum Speed}^2 \\
 & + 5.0341 * \text{Wash Water}^2 \\
 & - 1.077\text{E-}02 * \% \text{ Solids}^2 \\
 & + 1.944\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 1.082\text{E-}03 * \text{Grind Size} * \text{Drum Speed} \\
 & + 8.403\text{E-}03 * \text{Grind Size} * \text{Wash Water} \\
 & + 1.386\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 5.598\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & - 6.726\text{E-}04 * \text{Feed Rate} * \text{Wash Water} \\
 & + 1.002\text{E-}02 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 8.590\text{E-}02 * \text{Drum Speed} * \text{Wash Water} \\
 & + 2.230\text{E-}02 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.25558 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	42.45	43.34	-0.89	0.640	-0.230	0.004	-0.225	28
2	43.69	41.56	2.13	0.561	0.497	0.015	0.488	13
3	39.09	41.76	-2.67	0.591	-0.648	0.029	-0.638	29
5	29.25	27.24	2.01	0.554	0.466	0.013	0.457	5
6	54.59	58.39	-3.80	0.509	-0.840	0.035	-0.834	39
7	27.60	27.10	0.50	0.530	0.112	0.001	0.110	3
8	46.63	50.61	-3.98	0.587	-0.959	0.062	-0.957	40
9	41.20	41.67	-0.47	0.568	-0.110	0.001	-0.108	43
10	33.27	29.23	4.04	0.297	0.747	0.011	0.739	9
11	38.39	41.76	-3.37	0.655	-0.889	0.071	-0.884	1
12	49.24	54.07	-4.83	0.247	-0.861	0.012	-0.856	2
13	34.39	28.49	5.90	0.522	1.322	0.091	1.347	32
14	26.52	23.90	2.62	0.524	0.587	0.018	0.578	16
15	47.40	46.57	0.83	0.507	0.182	0.002	0.178	30
16	54.20	56.82	-2.62	0.537	-0.597	0.020	-0.587	14
17	35.66	34.56	1.10	0.610	0.272	0.006	0.266	42
18	30.15	31.48	-1.33	0.451	-0.279	0.003	-0.273	25
19	51.68	54.59	-2.91	0.505	-0.640	0.020	-0.631	18
20	48.01	52.47	-4.46	0.505	-0.983	0.047	-0.982	19
21	14.48	24.87	-10.39	0.289	-1.907	0.070	-2.047	23
22	31.09	31.92	-0.83	0.779	-0.274	0.013	-0.267	21
23	49.58	53.75	-4.17	0.287	-0.765	0.011	-0.757	37
24	51.27	51.73	-0.46	0.769	-0.147	0.003	-0.143	20
25	39.16	43.46	-4.30	0.492	-0.933	0.040	-0.930	31
26	46.16	47.69	-1.53	0.557	-0.357	0.008	-0.349	15
27	39.45	39.31	0.14	0.506	0.032	0.000	0.031	33
28	45.96	43.76	2.20	0.543	0.504	0.014	0.495	12
29	16.54	25.24	-8.70	0.503	-1.911	0.176	-2.051	26
30	34.15	34.94	-0.79	0.553	-0.184	0.002	-0.180	8
31	37.86	29.34	8.52	0.496	1.857	0.161	1.983	36
32	85.20	69.50	15.70	0.485	3.389	0.516	4.914	35
33	34.34	30.54	3.80	0.539	0.866	0.042	0.861	34
34	28.48	26.42	2.06	0.606	0.509	0.019	0.500	17
35	45.48	48.29	-2.81	0.511	-0.621	0.019	-0.612	27
36	49.62	54.47	-4.85	0.512	-1.075	0.058	-1.079	10

37	52.45	46.08	6.37	0.429	1.304	0.061	1.328	6
38	48.48	46.43	2.05	0.330	0.389	0.004	0.381	4
39	48.36	42.35	6.01	0.578	1.434	0.134	1.473	41
40	44.33	43.82	0.51	0.580	0.123	0.001	0.120	24
41	44.45	43.01	1.44	0.248	0.257	0.001	0.251	38
42	46.68	42.92	3.76	0.229	0.663	0.006	0.654	22
43	41.90	43.43	-1.53	0.275	-0.278	0.001	-0.272	7

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Coal Seam:  Pittsburgh No. 8
Circuit:    Individual MGS
Response:   Sulfur Rejection
Data File:  P-MGS-00
Comments:   Analysis with Outliers Removed
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FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Grind Size      microns      100.000      300.000
B    Feed Rate       lbs/hr       100.000      300.000
C    Drum Speed      rpm          240.000      320.000
D    Wash Water      lpm          0.500        1.500
E    % Solids        w/w          15.000       35.000
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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	67508.1	1	67508.1		
Linear	2711.6	5	542.3	18.50	0.0001
Quadratic	629.2	15	41.9	2.114	0.0593
Cubic	396.8	20	19.8		
RESIDUAL	0.0	0			
TOTAL	71245.7	41			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	35	5.41	0.7255	0.6863	1395.19
Quadratic	21	20	4.45	0.8938	0.7877	1612.19
Cubic	41	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2711.6	5	542.32	18.50	0.0001
RESIDUAL	1026.0	35	29.32		
COR TOTAL	3737.6	40			
ROOT MSE	5.41		R-SQUARED	0.7255	
DEP MEAN	40.58		ADJ R-SQUARED	0.6863	
C.V.	13.34%				

Predicted Residual Sum of Squares (PRESS) = 1395.2

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	40.63	1	0.85	47.95	
A	1.10	1	1.40	0.7882	0.4359
B	0.35	1	1.39	0.2522	0.8023
C	11.20	1	1.40	7.977	0.0001
D	-1.84	1	1.33	-1.386	0.1745
E	7.89	1	1.40	5.620	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sul rej} = & 40.63 \\ & + 1.10 * A \\ & + 0.35 * B \\ & + 11.20 * C \\ & - 1.84 * D \\ & + 7.89 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sul rej} = & -56.74 \\ & + 1.103\text{E-}02 * \text{Grind Size} \\ & + 3.512\text{E-}03 * \text{Feed Rate} \\ & + 0.28004 * \text{Drum Speed} \\ & - 3.6757 * \text{Wash Water} \\ & + 0.78869 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	42.45	40.06	2.39	0.156	0.480	0.007	0.475	28
2	43.69	41.74	1.95	0.149	0.390	0.004	0.385	13
3	39.09	40.81	-1.72	0.186	-0.352	0.005	-0.347	29
5	29.25	31.01	-1.76	0.154	-0.353	0.004	-0.348	5
6	54.59	54.57	0.02	0.150	0.003	0.000	0.003	39
7	27.60	28.62	-1.02	0.155	-0.205	0.001	-0.202	3
8	46.63	50.04	-3.41	0.174	-0.693	0.017	-0.688	40
9	41.20	33.57	7.63	0.128	1.509	0.056	1.538	43
10	33.27	34.07	-0.80	0.102	-0.156	0.000	-0.154	9
11	38.39	48.12	-9.73	0.139	-1.937	0.101	-2.021	1
12	49.24	48.56	0.68	0.101	0.132	0.000	0.130	2
13	34.39	28.42	5.97	0.154	1.198	0.044	1.206	32
14	26.52	30.79	-4.27	0.157	-0.860	0.023	-0.856	16
15	47.40	51.58	-4.18	0.157	-0.841	0.022	-0.837	30

16	54.20	53.45	0.75	0.171	0.151	0.001	0.149	14
17	35.66	35.00	0.66	0.172	0.135	0.001	0.133	42
18	30.15	32.04	-1.89	0.141	-0.377	0.004	-0.372	25
19	51.68	50.98	0.70	0.155	0.140	0.001	0.138	18
20	48.01	46.69	1.32	0.157	0.265	0.002	0.261	19
21	14.48	30.06	-15.58	0.121	-3.070	0.216	-3.540	23
22	31.09	29.22	1.87	0.222	0.391	0.007	0.386	21
23	49.58	51.65	-2.07	0.121	-0.407	0.004	-0.402	37
24	51.27	52.37	-1.10	0.224	-0.231	0.003	-0.228	20
25	39.16	41.41	-2.25	0.147	-0.450	0.006	-0.445	31
26	46.16	44.87	1.29	0.166	0.261	0.002	0.257	15
27	39.45	38.55	0.90	0.147	0.181	0.001	0.178	33
28	45.96	40.70	5.26	0.163	1.063	0.037	1.065	12
29	16.54	22.21	-5.67	0.158	-1.142	0.041	-1.147	26
30	34.15	43.76	-9.61	0.164	-1.941	0.123	-2.025	8
31	37.86	37.86	0.00	0.149	0.001	0.000	0.001	36
33	34.34	31.73	2.61	0.159	0.526	0.009	0.521	34
34	28.48	33.12	-4.64	0.182	-0.947	0.033	-0.945	17
35	45.48	49.38	-3.90	0.167	-0.789	0.021	-0.785	27
36	49.62	50.14	-0.52	0.167	-0.104	0.000	-0.103	10
37	52.45	42.00	10.45	0.142	2.083	0.120	2.194	6
38	48.48	42.61	5.87	0.108	1.148	0.027	1.154	4
39	48.36	38.12	10.24	0.171	2.078	0.149	2.188	41
40	44.33	39.43	4.90	0.178	0.999	0.036	0.999	24
41	44.45	41.40	3.05	0.029	0.571	0.002	0.565	38
42	46.68	41.36	5.32	0.033	0.999	0.006	0.999	22
43	41.90	41.60	0.30	0.025	0.057	0.000	0.056	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	3340.8	20	167.04	8.419	0.0001
RESIDUAL	396.8	20	19.84		
COR TOTAL	3737.6	40			
ROOT MSE	4.45		R-SQUARED	0.8938	
DEP MEAN	40.58		ADJ R-SQUARED	0.7877	
C.V.	10.98%				

Predicted Residual Sum of Squares (PRESS) = 1612.2

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	42.94	1	2.37	18.13	
A	1.31	1	1.18	1.112	0.2792
B	0.56	1	1.27	0.4427	0.6627
C	10.91	1	1.18	9.269	0.0001
D	-2.13	1	1.11	-1.920	0.0692
E	7.46	1	1.18	6.315	0.0001
A2	-0.60	1	1.68	-0.3591	0.7233
B2	1.42	1	1.66	0.8532	0.4036
C2	-5.30	1	1.75	-3.026	0.0067
D2	1.49	1	1.64	0.9096	0.3739
E2	-3.27	1	1.88	-1.737	0.0978
AB	2.43	1	2.50	0.9702	0.3435
AC	4.12	1	2.24	1.841	0.0805
AD	0.22	1	2.17	0.1007	0.9208
AE	1.13	1	2.17	0.5206	0.6084
BC	-2.45	1	1.92	-1.275	0.2170
BD	-0.13	1	2.11	-6.22E-02	0.9510
BE	8.21	1	3.20	2.569	0.0183
CD	-1.77	1	2.31	-0.7640	0.4538
CE	1.18	1	2.79	0.4233	0.6766
DE	1.53	1	2.19	0.6956	0.4947

Final Equation in Terms of Coded Factors:

Sul rej =

$$\begin{aligned}
 &42.94 \\
 &+ 1.31 * A \\
 &+ 0.56 * B \\
 &+ 10.91 * C \\
 &- 2.13 * D \\
 &+ 7.46 * E \\
 &- 0.60 * A^2 \\
 &+ 1.42 * B^2 \\
 &- 5.30 * C^2 \\
 &+ 1.49 * D^2 \\
 &- 3.27 * E^2 \\
 &+ 2.43 * AB \\
 &+ 4.12 * AC \\
 &+ 0.22 * AD \\
 &+ 1.13 * AE \\
 &- 2.45 * BC \\
 &- 0.13 * BD \\
 &+ 8.21 * BE \\
 &- 1.77 * CD \\
 &+ 1.18 * CE \\
 &+ 1.53 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Sul rej =

$$\begin{aligned}
 & -238.79 \\
 & - 0.33262 * \text{Grind Size} \\
 & - 0.13080 * \text{Feed Rate} \\
 & + 2.0588 * \text{Drum Speed} \\
 & + 0.61612 * \text{Wash Water} \\
 & - 0.61835 * \% \text{ Solids} \\
 & - 6.020\text{E-}05 * \text{Grind Size}^2 \\
 & + 1.417\text{E-}04 * \text{Feed Rate}^2 \\
 & - 3.312\text{E-}03 * \text{Drum Speed}^2 \\
 & + 5.9519 * \text{Wash Water}^2 \\
 & - 3.271\text{E-}02 * \% \text{ Solids}^2 \\
 & + 2.430\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 1.030\text{E-}03 * \text{Grind Size} * \text{Drum Speed} \\
 & + 4.378\text{E-}03 * \text{Grind Size} * \text{Wash Water} \\
 & + 1.132\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 6.126\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & - 2.621\text{E-}03 * \text{Feed Rate} * \text{Wash Water} \\
 & + 8.211\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 8.841\text{E-}02 * \text{Drum Speed} * \text{Wash Water} \\
 & + 2.951\text{E-}03 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.30514 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	42.45	45.23	-2.78	0.648	-1.050	0.097	-1.053	28
2	43.69	42.47	1.22	0.563	0.413	0.010	0.405	13
3	39.09	42.53	-3.44	0.592	-1.211	0.102	-1.226	29
5	29.25	27.33	1.92	0.554	0.644	0.025	0.634	5
6	54.59	54.43	0.16	0.542	0.051	0.000	0.050	39
7	27.60	28.00	-0.40	0.532	-0.130	0.001	-0.127	3
8	46.63	47.62	-0.99	0.605	-0.355	0.009	-0.347	40
9	41.20	40.70	0.50	0.570	0.172	0.002	0.168	43
10	33.27	30.63	2.64	0.302	0.709	0.010	0.700	9
11	38.39	40.37	-1.98	0.659	-0.760	0.053	-0.751	1
12	49.24	50.35	-1.11	0.276	-0.293	0.002	-0.286	2
13	34.39	29.02	5.37	0.523	1.745	0.159	1.847	32
14	26.52	24.90	1.62	0.526	0.528	0.015	0.518	16
15	47.40	43.47	3.93	0.527	1.284	0.088	1.306	30
16	54.20	54.00	0.20	0.554	0.068	0.000	0.066	14
17	35.66	35.93	-0.27	0.614	-0.099	0.001	-0.096	42
18	30.15	31.79	-1.64	0.452	-0.496	0.010	-0.487	25
19	51.68	50.87	0.81	0.534	0.268	0.004	0.261	18
20	48.01	49.48	-1.47	0.524	-0.479	0.012	-0.469	19
21	14.48	25.48	-11.00	0.290	-2.930	0.167	-3.780	23
22	31.09	32.38	-1.29	0.780	-0.617	0.064	-0.607	21
23	49.58	50.80	-1.22	0.305	-0.329	0.002	-0.321	37
24	51.27	48.73	2.54	0.788	1.237	0.270	1.255	20
25	39.16	44.91	-5.75	0.496	-1.818	0.155	-1.939	31
26	46.16	49.25	-3.09	0.562	-1.047	0.067	-1.050	15
27	39.45	40.90	-1.45	0.511	-0.464	0.011	-0.455	33
28	45.96	44.81	1.15	0.546	0.382	0.008	0.374	12
29	16.54	17.64	-1.10	0.623	-0.404	0.013	-0.395	26
30	34.15	38.43	-4.28	0.578	-1.482	0.143	-1.530	8
31	37.86	32.85	5.01	0.521	1.626	0.137	1.701	36
33	34.34	31.09	3.25	0.540	1.076	0.065	1.081	34
34	28.48	27.95	0.53	0.611	0.190	0.003	0.185	17
35	45.48	44.62	0.86	0.539	0.285	0.005	0.278	27
36	49.62	51.25	-1.63	0.533	-0.535	0.016	-0.525	10
37	52.45	46.99	5.46	0.431	1.625	0.095	1.700	6

38	48.48	47.51	0.97	0.333	0.267	0.002	0.260	4
39	48.36	43.44	4.92	0.581	1.706	0.192	1.799	41
40	44.33	44.76	-0.43	0.581	-0.151	0.002	-0.147	24
41	44.45	43.48	0.97	0.248	0.250	0.001	0.244	38
42	46.68	43.42	3.26	0.230	0.834	0.010	0.828	22
43	41.90	43.87	-1.97	0.275	-0.518	0.005	-0.509	7

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Coal Seam:  Pittsburgh No. 8
Circuit:    Individual MGS
Response:   Pyritic Sulfur Rejection
Data File:  P-MGS-00
Comments:   Analysis of Complete Data Set
=====

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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Grind Size      microns      100.000      300.000
B      Feed Rate       lbs/hr       100.000      300.000
C      Drum Speed      rpm         240.000      320.000
D      Wash Water      lpm          0.500        1.500
E      % Solids        w/w         15.000       35.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	186834.4	1	186834.4		
Linear	4796.6	5	959.3	11.95	0.0001
Quadratic	842.2	15	56.1	0.5805	0.8594
Cubic	2127.7	22	96.7		
RESIDUAL	0.0	0			
TOTAL	194600.9	43			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	37	8.96	0.6176	0.5659	3890.44
Quadratic	21	22	9.83	0.7260	0.4770	6346.12
Cubic	43	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4796.6	5	959.32	11.95	0.0001
RESIDUAL	2969.9	37	80.27		
COR TOTAL	7766.5	42			
ROOT MSE	8.96		R-SQUARED	0.6176	
DEP MEAN	65.92		ADJ R-SQUARED	0.5659	
C.V.	13.59%				

Predicted Residual Sum of Squares (PRESS) = 3890.4

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	65.43	1	1.37	47.75	
A	-2.51	1	2.24	-1.120	0.2698
B	-1.10	1	2.28	-0.4846	0.6308
C	14.28	1	2.25	6.359	0.0001
D	-1.86	1	2.19	-0.8476	0.4021
E	8.94	1	2.25	3.978	0.0003

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Pyr rej} = & 65.43 \\ & - 2.51 * A \\ & - 1.10 * B \\ & + 14.28 * C \\ & - 1.86 * D \\ & + 8.94 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Pyr rej} = & -45.92 \\ & - 2.511\text{E-}02 * \text{Grind Size} \\ & - 1.103\text{E-}02 * \text{Feed Rate} \\ & + 0.35697 * \text{Drum Speed} \\ & - 3.7183 * \text{Wash Water} \\ & + 0.89385 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	74.02	70.09	3.93	0.149	0.475	0.007	0.470	28
2	71.59	64.25	7.34	0.146	0.887	0.022	0.884	13
3	66.46	67.58	-1.12	0.184	-0.138	0.001	-0.136	29
4	28.32	62.33	-34.01	0.105	-4.014	0.316	-5.269	11
5	53.22	53.35	-0.13	0.152	-0.016	0.000	-0.016	5
6	82.67	82.86	-0.19	0.139	-0.023	0.000	-0.023	39
7	52.37	50.96	1.41	0.153	0.171	0.001	0.169	3
8	72.14	78.77	-6.63	0.168	-0.811	0.022	-0.807	40
9	65.67	58.61	7.06	0.126	0.842	0.017	0.839	43
10	57.81	57.05	0.76	0.099	0.090	0.000	0.088	9
11	69.13	75.29	-6.16	0.133	-0.738	0.014	-0.733	1
12	74.66	73.91	0.75	0.091	0.088	0.000	0.087	2
13	60.90	53.65	7.25	0.151	0.878	0.023	0.875	32
14	51.35	48.74	2.61	0.147	0.316	0.003	0.312	16

15	73.33	83.21	-9.88	0.147	-1.194	0.041	-1.201	30
16	80.00	77.55	2.45	0.153	0.297	0.003	0.293	14
17	61.12	58.25	2.87	0.169	0.351	0.004	0.347	42
18	57.75	55.96	1.79	0.138	0.215	0.001	0.213	25
19	76.84	76.87	-0.03	0.144	-0.004	0.000	-0.004	18
20	71.44	72.30	-0.86	0.149	-0.104	0.000	-0.102	19
21	25.88	52.82	-26.94	0.119	-3.203	0.231	-3.717	23
22	53.25	48.71	4.54	0.215	0.572	0.015	0.566	21
23	79.44	80.58	-1.14	0.115	-0.135	0.000	-0.133	37
24	74.53	78.31	-3.78	0.207	-0.473	0.010	-0.468	20
25	69.09	69.79	-0.70	0.144	-0.085	0.000	-0.084	31
26	73.34	66.05	7.29	0.156	0.886	0.024	0.883	15
27	67.16	67.05	0.11	0.145	0.013	0.000	0.013	33
28	73.46	61.75	11.71	0.153	1.420	0.061	1.440	12
29	33.42	42.87	-9.45	0.146	-1.142	0.037	-1.146	26
30	65.35	71.05	-5.70	0.164	-0.696	0.016	-0.691	8
31	62.47	60.38	2.09	0.148	0.253	0.002	0.249	36
32	95.35	88.75	6.60	0.144	0.797	0.018	0.793	35
33	62.85	59.02	3.83	0.155	0.465	0.007	0.460	34
34	50.47	52.58	-2.11	0.170	-0.259	0.002	-0.256	17
35	74.00	79.31	-5.31	0.156	-0.645	0.013	-0.640	27
36	75.05	72.22	2.83	0.149	0.342	0.003	0.338	10
37	74.73	68.28	6.45	0.142	0.777	0.017	0.773	6
38	72.83	66.37	6.46	0.104	0.761	0.011	0.757	4
39	70.78	64.31	6.47	0.171	0.794	0.022	0.790	41
40	73.25	62.65	10.60	0.173	1.301	0.059	1.314	24
41	68.51	66.66	1.85	0.028	0.209	0.000	0.206	38
42	70.02	66.80	3.22	0.033	0.366	0.001	0.361	22
43	68.39	66.51	1.88	0.024	0.212	0.000	0.210	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	5638.8	20	281.94	2.915	0.0084
RESIDUAL	2127.7	22	96.71		
COR TOTAL	7766.5	42			
ROOT MSE	9.83		R-SQUARED	0.7260	
DEP MEAN	65.92		ADJ R-SQUARED	0.4770	
C.V.	14.92%				

Predicted Residual Sum of Squares (PRESS) = 6346.1

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	62.74	1	5.08	12.34	
A	-2.10	1	2.53	-0.8306	0.4151
B	-1.84	1	2.73	-0.6719	0.5086
C	14.40	1	2.50	5.761	0.0001
D	-2.06	1	2.45	-0.8416	0.4091
E	8.68	1	2.51	3.454	0.0023
A2	0.93	1	3.69	0.2512	0.8040
B2	1.99	1	3.66	0.5429	0.5927
C2	-2.28	1	3.65	-0.6245	0.5387
D2	5.17	1	3.53	1.467	0.1566
E2	1.49	1	3.94	0.3775	0.7094
AB	-4.44	1	5.22	-0.8507	0.4041
AC	4.62	1	4.94	0.9347	0.3601
AD	1.16	1	4.80	0.2409	0.8118
AE	2.82	1	4.80	0.5881	0.5624
BC	-4.91	1	4.24	-1.158	0.2592
BD	3.09	1	4.63	0.6675	0.5114
BE	5.25	1	6.99	0.7513	0.4604
CD	-3.67	1	5.10	-0.7198	0.4792
CE	1.58	1	5.08	0.3110	0.7587
DE	0.06	1	4.84	1.22E-02	0.9904

Final Equation in Terms of Coded Factors:

Pyr rej =

$$\begin{aligned}
 &62.74 \\
 &- 2.10 * A \\
 &- 1.84 * B \\
 &+ 14.40 * C \\
 &- 2.06 * D \\
 &+ 8.68 * E \\
 &+ 0.93 * A^2 \\
 &+ 1.99 * B^2 \\
 &- 2.28 * C^2 \\
 &+ 5.17 * D^2 \\
 &+ 1.49 * E^2 \\
 &- 4.44 * AB \\
 &+ 4.62 * AC \\
 &+ 1.16 * AD \\
 &+ 2.82 * AE \\
 &- 4.91 * BC \\
 &+ 3.09 * BD \\
 &+ 5.25 * BE \\
 &- 3.67 * CD \\
 &+ 1.58 * CE \\
 &+ 0.06 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Pyr rej =

$$\begin{aligned}
 & -105.75 \\
 & - 0.38619 * \text{Grind Size} \\
 & + 0.14180 * \text{Feed Rate} \\
 & + 1.2568 * \text{Drum Speed} \\
 & - 11.365 * \text{Wash Water} \\
 & - 2.6085 * \% \text{ Solids} \\
 & + 9.258\text{E-}05 * \text{Grind Size}^2 \\
 & + 1.987\text{E-}04 * \text{Feed Rate}^2 \\
 & - 1.423\text{E-}03 * \text{Drum Speed}^2 \\
 & + 20.697 * \text{Wash Water}^2 \\
 & + 1.487\text{E-}02 * \% \text{ Solids}^2 \\
 & - 4.443\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 1.155\text{E-}03 * \text{Grind Size} * \text{Drum Speed} \\
 & + 2.312\text{E-}02 * \text{Grind Size} * \text{Wash Water} \\
 & + 2.822\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 1.229\text{E-}03 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 6.186\text{E-}02 * \text{Feed Rate} * \text{Wash Water} \\
 & + 5.254\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 0.18371 * \text{Drum Speed} * \text{Wash Water} \\
 & + 3.951\text{E-}03 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 1.179\text{E-}02 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	74.02	67.21	6.81	0.612	1.112	0.093	1.118	28
2	71.59	69.65	1.94	0.559	0.297	0.005	0.291	13
3	66.46	73.05	-6.59	0.582	-1.037	0.071	-1.039	29
4	28.32	58.48	-30.16	0.284	-3.625	0.248	-5.579	11
5	53.22	49.37	3.85	0.551	0.584	0.020	0.575	5
6	82.67	87.53	-4.86	0.504	-0.701	0.024	-0.693	39
7	52.37	51.68	0.69	0.526	0.101	0.001	0.099	3
8	72.14	77.13	-4.99	0.585	-0.788	0.042	-0.781	40
9	65.67	63.75	1.92	0.568	0.298	0.006	0.291	43
10	57.81	53.07	4.74	0.295	0.574	0.007	0.565	9
11	69.13	71.25	-2.12	0.649	-0.364	0.012	-0.357	1
12	74.66	74.31	0.35	0.243	0.041	0.000	0.040	2
13	60.90	54.30	6.60	0.522	0.971	0.049	0.970	32
14	51.35	40.79	10.56	0.501	1.520	0.111	1.570	16
15	73.33	74.35	-1.02	0.507	-0.148	0.001	-0.144	30
16	80.00	77.26	2.74	0.515	0.399	0.008	0.392	14
17	61.12	61.37	-0.25	0.608	-0.041	0.000	-0.040	42
18	57.75	59.10	-1.35	0.450	-0.186	0.001	-0.181	25
19	76.84	81.33	-4.49	0.503	-0.647	0.020	-0.639	18
20	71.44	77.35	-5.91	0.504	-0.853	0.035	-0.848	19
21	25.88	45.32	-19.44	0.289	-2.344	0.106	-2.644	23
22	53.25	53.17	0.08	0.773	0.017	0.000	0.017	21
23	79.44	81.08	-1.64	0.287	-0.197	0.001	-0.193	37
24	74.53	69.45	5.08	0.762	1.059	0.171	1.062	20
25	69.09	74.41	-5.32	0.492	-0.758	0.027	-0.751	31
26	73.34	69.20	4.14	0.535	0.617	0.021	0.608	15
27	67.16	68.05	-0.89	0.506	-0.129	0.001	-0.126	33
28	73.46	66.85	6.61	0.524	0.975	0.050	0.973	12
29	33.42	40.98	-7.56	0.501	-1.088	0.057	-1.093	26
30	65.35	68.57	-3.22	0.549	-0.488	0.014	-0.480	8
31	62.47	56.97	5.50	0.495	0.787	0.029	0.780	36
32	95.35	87.09	8.26	0.483	1.168	0.061	1.178	35
33	62.85	61.40	1.45	0.538	0.217	0.003	0.213	34
34	50.47	46.32	4.15	0.581	0.651	0.028	0.642	17
35	74.00	75.05	-1.05	0.510	-0.153	0.001	-0.149	27

36	75.05	75.02	0.03	0.490	0.004	0.000	0.004	10
37	74.73	75.97	-1.24	0.425	-0.167	0.001	-0.163	6
38	72.83	66.84	5.99	0.318	0.737	0.012	0.730	4
39	70.78	67.62	3.16	0.578	0.495	0.016	0.486	41
40	73.25	70.17	3.08	0.578	0.482	0.015	0.473	24
41	68.51	64.17	4.34	0.237	0.506	0.004	0.497	38
42	70.02	64.48	5.54	0.220	0.638	0.005	0.629	22
43	68.39	63.88	4.51	0.260	0.534	0.005	0.525	7

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Coal Seam: Pittsburgh No. 8
Circuit: Individual MGS
Response: Pyritic Sulfur Rejection
Data File: P-MGS-00
Comments: Analysis with Outliers Removed
=====

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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Grind Size      microns      100.000      300.000
B      Feed Rate       lbs/hr       100.000      300.000
C      Drum Speed      rpm          240.000      320.000
D      Wash Water      lpm          0.500        1.500
E      % Solids         w/w          15.000      35.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	187479.5	1	187479.5		
Linear	4642.5	5	928.5	19.93	0.0001
Quadratic	819.7	15	54.6	1.339	0.2635
Cubic	857.1	21	40.8		
RESIDUAL	0.0	0			
TOTAL	193798.9	42			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	36	6.82	0.7346	0.6978	2270.40
Quadratic	21	21	6.39	0.8644	0.7352	3036.26
Cubic	42	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4642.5	5	928.49	19.93	0.0001
RESIDUAL	1676.9	36	46.58		
COR TOTAL	6319.3	41			
ROOT MSE	6.82		R-SQUARED	0.7346	
DEP MEAN	66.81		ADJ R-SQUARED	0.6978	
C.V.	10.22%				

Predicted Residual Sum of Squares (PRESS) = 2270.4

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	66.30	1	1.06	62.74	
A	-0.18	1	1.76	-0.1032	0.9184
B	0.25	1	1.75	0.1408	0.8888
C	14.33	1	1.71	8.376	0.0001
D	-1.86	1	1.67	-1.113	0.2731
E	8.96	1	1.71	5.232	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Pyr rej} = & 66.30 \\ & - 0.18 * A \\ & + 0.25 * B \\ & + 14.33 * C \\ & - 1.86 * D \\ & + 8.96 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Pyr rej} = & -52.81 \\ & - 1.820\text{E-}03 * \text{Grind Size} \\ & + 2.467\text{E-}03 * \text{Feed Rate} \\ & + 0.35822 * \text{Drum Speed} \\ & - 3.7189 * \text{Wash Water} \\ & + 0.89559 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	74.02	67.28	6.74	0.156	1.074	0.035	1.077	28
2	71.59	66.23	5.36	0.149	0.852	0.021	0.849	13
3	66.46	67.75	-1.29	0.184	-0.209	0.002	-0.206	29
5	53.22	53.61	-0.39	0.152	-0.063	0.000	-0.062	5
6	82.67	83.59	-0.92	0.140	-0.146	0.001	-0.144	39
7	52.37	51.36	1.01	0.153	0.161	0.001	0.159	3
8	72.14	78.95	-6.81	0.168	-1.094	0.040	-1.097	40
9	65.67	58.37	7.30	0.126	1.144	0.032	1.149	43
10	57.81	58.72	-0.91	0.101	-0.141	0.000	-0.139	9
11	69.13	74.95	-5.82	0.133	-0.916	0.021	-0.914	1
12	74.66	75.26	-0.60	0.093	-0.093	0.000	-0.091	2
13	60.90	52.24	8.66	0.152	1.378	0.057	1.396	32
14	51.35	52.11	-0.76	0.156	-0.121	0.000	-0.120	16
15	73.33	81.77	-8.44	0.148	-1.340	0.052	-1.356	30

16	80.00	81.03	-1.03	0.162	-0.165	0.001	-0.162	14
17	61.12	59.59	1.53	0.171	0.247	0.002	0.244	42
18	57.75	56.81	0.94	0.139	0.149	0.001	0.147	25
19	76.84	77.89	-1.05	0.145	-0.166	0.001	-0.164	18
20	71.44	73.39	-1.95	0.150	-0.310	0.003	-0.307	19
21	25.88	52.78	-26.90	0.119	-4.199	0.397	-5.797	23
22	53.25	51.51	1.74	0.221	0.289	0.004	0.285	21
23	79.44	80.52	-1.08	0.115	-0.168	0.001	-0.166	37
24	74.53	81.03	-6.50	0.213	-1.073	0.052	-1.075	20
25	69.09	68.38	0.71	0.146	0.112	0.000	0.110	31
26	73.34	69.45	3.89	0.165	0.624	0.013	0.618	15
27	67.16	65.59	1.57	0.146	0.249	0.002	0.246	33
28	73.46	65.15	8.31	0.162	1.330	0.057	1.345	12
29	33.42	43.83	-10.41	0.147	-1.652	0.078	-1.694	26
30	65.35	71.59	-6.24	0.164	-1.000	0.033	-1.000	8
31	62.47	61.52	0.95	0.149	0.150	0.001	0.148	36
32	95.35	89.79	5.56	0.145	0.882	0.022	0.879	35
33	62.85	57.61	5.24	0.156	0.836	0.022	0.833	34
34	50.47	56.28	-5.81	0.180	-0.941	0.032	-0.939	17
35	74.00	77.83	-3.83	0.157	-0.611	0.012	-0.606	27
36	75.05	75.65	-0.60	0.158	-0.096	0.000	-0.095	10
37	74.73	67.80	6.93	0.142	1.097	0.033	1.100	6
38	72.83	68.22	4.61	0.107	0.714	0.010	0.709	4
39	70.78	63.86	6.92	0.171	1.114	0.043	1.117	41
40	73.25	65.04	8.21	0.177	1.327	0.063	1.341	24
41	68.51	67.21	1.30	0.028	0.194	0.000	0.191	38
42	70.02	67.18	2.84	0.033	0.424	0.001	0.419	22
43	68.39	67.38	1.01	0.024	0.150	0.000	0.148	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	5462.2	20	273.11	6.691	0.0001
RESIDUAL	857.1	21	40.81		
COR TOTAL	6319.3	41			
ROOT MSE	6.39		R-SQUARED	0.8644	
DEP MEAN	66.81		ADJ R-SQUARED	0.7352	
C.V.	9.56%				

Predicted Residual Sum of Squares (PRESS) = 3036.3

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	67.09	1	3.39	19.77	
A	-0.00	1	1.69	-1.07E-04	0.9999
B	0.34	1	1.82	0.1876	0.8530
C	14.48	1	1.62	8.916	0.0001
D	-2.05	1	1.59	-1.289	0.2116
E	8.81	1	1.63	5.396	0.0001
A2	1.45	1	2.40	0.6072	0.5502
B2	1.23	1	2.38	0.5159	0.6113
C2	-5.29	1	2.43	-2.177	0.0410
D2	2.39	1	2.35	1.020	0.3191
E2	-1.78	1	2.62	-0.6789	0.5046
AB	2.09	1	3.59	0.5818	0.5669
AC	4.72	1	3.21	1.470	0.1564
AD	0.92	1	3.12	0.2951	0.7708
AE	2.58	1	3.12	0.8271	0.4175
BC	-5.03	1	2.76	-1.824	0.0823
BD	1.73	1	3.02	0.5718	0.5735
BE	6.93	1	4.55	1.522	0.1428
CD	-2.85	1	3.32	-0.8593	0.3999
CE	1.54	1	3.30	0.4659	0.6461
DE	0.45	1	3.14	0.1444	0.8865

Final Equation in Terms of Coded Factors:

Pyr rej =

$$\begin{aligned}
 &67.09 \\
 &- 0.00 * A \\
 &+ 0.34 * B \\
 &+ 14.48 * C \\
 &- 2.05 * D \\
 &+ 8.81 * E \\
 &+ 1.45 * A^2 \\
 &+ 1.23 * B^2 \\
 &- 5.29 * C^2 \\
 &+ 2.39 * D^2 \\
 &- 1.78 * E^2 \\
 &+ 2.09 * AB \\
 &+ 4.72 * AC \\
 &+ 0.92 * AD \\
 &+ 2.58 * AE \\
 &- 5.03 * BC \\
 &+ 1.73 * BD \\
 &+ 6.93 * BE \\
 &- 2.85 * CD \\
 &+ 1.54 * CE \\
 &+ 0.45 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Pyr rej =

$$\begin{aligned}
 & -251.50 \\
 & - 0.51317 * \text{Grind Size} \\
 & + 5.668\text{E-}02 * \text{Feed Rate} \\
 & + 2.2753 * \text{Drum Speed} \\
 & + 3.8310 * \text{Wash Water} \\
 & - 1.2974 * \% \text{ Solids} \\
 & + 1.455\text{E-}04 * \text{Grind Size}^2 \\
 & + 1.228\text{E-}04 * \text{Feed Rate}^2 \\
 & - 3.306\text{E-}03 * \text{Drum Speed}^2 \\
 & + 9.5731 * \text{Wash Water}^2 \\
 & - 1.782\text{E-}02 * \% \text{ Solids}^2 \\
 & + 2.088\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 1.180\text{E-}03 * \text{Grind Size} * \text{Drum Speed} \\
 & + 1.839\text{E-}02 * \text{Grind Size} * \text{Wash Water} \\
 & + 2.578\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 1.257\text{E-}03 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 3.454\text{E-}02 * \text{Feed Rate} * \text{Wash Water} \\
 & + 6.932\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 0.14262 * \text{Drum Speed} * \text{Wash Water} \\
 & + 3.845\text{E-}03 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 9.084\text{E-}02 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	74.02	73.20	0.82	0.640	0.215	0.004	0.210	28
2	71.59	67.91	3.68	0.561	0.869	0.046	0.863	13
3	66.46	69.71	-3.25	0.591	-0.796	0.044	-0.789	29
5	53.22	47.35	5.87	0.554	1.377	0.112	1.408	5
6	82.67	84.97	-2.30	0.509	-0.514	0.013	-0.505	39
7	52.37	49.37	3.00	0.530	0.685	0.025	0.676	3
8	72.14	75.80	-3.66	0.587	-0.891	0.054	-0.887	40
9	65.67	64.07	1.60	0.568	0.381	0.009	0.373	43
10	57.81	54.91	2.90	0.297	0.542	0.006	0.533	9
11	69.13	68.45	0.68	0.655	0.182	0.003	0.178	1
12	74.66	76.78	-2.12	0.247	-0.382	0.002	-0.375	2
13	60.90	53.77	7.13	0.522	1.615	0.136	1.685	32
14	51.35	46.16	5.19	0.524	1.177	0.073	1.189	16
15	73.33	74.13	-0.80	0.507	-0.179	0.002	-0.175	30
16	80.00	82.64	-2.64	0.537	-0.607	0.020	-0.598	14
17	61.12	59.68	1.44	0.610	0.360	0.010	0.352	42
18	57.75	57.82	-0.07	0.451	-0.015	0.000	-0.014	25
19	76.84	79.71	-2.87	0.505	-0.638	0.020	-0.629	18
20	71.44	76.46	-5.02	0.505	-1.117	0.061	-1.124	19
21	25.88	44.71	-18.83	0.289	-3.495	0.236	-5.275	23
22	53.25	55.97	-2.72	0.779	-0.908	0.139	-0.904	21
23	79.44	80.54	-1.10	0.287	-0.205	0.001	-0.200	37
24	74.53	72.31	2.22	0.769	0.722	0.083	0.713	20
25	69.09	73.92	-4.83	0.492	-1.062	0.052	-1.065	31
26	73.34	74.50	-1.16	0.557	-0.274	0.004	-0.268	15
27	67.16	68.55	-1.39	0.506	-0.310	0.005	-0.303	33
28	73.46	71.81	1.65	0.543	0.382	0.008	0.374	12
29	33.42	39.21	-5.79	0.503	-1.286	0.080	-1.308	26
30	65.35	66.38	-1.03	0.553	-0.242	0.003	-0.237	8
31	62.47	56.20	6.27	0.496	1.381	0.089	1.414	36
32	95.35	85.49	9.86	0.485	2.151	0.208	2.377	35
33	62.85	60.24	2.61	0.539	0.603	0.020	0.593	34
34	50.47	51.99	-1.52	0.606	-0.378	0.010	-0.370	17
35	74.00	74.29	-0.29	0.511	-0.066	0.000	-0.064	27
36	75.05	80.25	-5.20	0.512	-1.164	0.068	-1.175	10

37	74.73	73.64	1.09	0.429	0.226	0.002	0.220	6
38	72.83	70.85	1.98	0.330	0.379	0.003	0.371	4
39	70.78	66.85	3.93	0.578	0.946	0.058	0.944	41
40	73.25	71.58	1.67	0.580	0.403	0.011	0.395	24
41	68.51	67.88	0.63	0.248	0.114	0.000	0.112	38
42	70.02	67.85	2.17	0.229	0.387	0.002	0.379	22
43	68.39	68.18	0.21	0.275	0.039	0.000	0.038	7

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Coal Seam:  Pittsburgh No. 8
Circuit:      Individual MGS
Response:     Pyritic Sulfur Rejection
Data File:    P-MGS-00
Comments:     Analysis with Outliers Removed
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FAC    FACTOR                UNITS          -1 LEVEL      +1 LEVEL
A      Grind Size            microns       100.000       300.000
B      Feed Rate             lbs/hr        100.000       300.000
C      Drum Speed            rpm           240.000       320.000
D      Wash Water            lpm           0.500         1.500
E      % Solids              w/w           15.000        35.000
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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	188526.0	1	188526.0		
Linear	3747.7	5	749.5	30.67	0.0001
Quadratic	496.9	15	33.1	1.848	0.0993
Cubic	358.5	20	17.9		
RESIDUAL	0.0	0			
TOTAL	193129.1	41			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	35	4.94	0.8142	0.7876	1205.73
Quadratic	21	20	4.23	0.9221	0.8443	1607.71
Cubic	41	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	3747.7	5	749.53	30.67	0.0001
RESIDUAL	855.4	35	24.44		
COR TOTAL	4603.1	40			
ROOT MSE	4.94		R-SQUARED	0.8142	
DEP MEAN	67.81		ADJ R-SQUARED	0.7876	
C.V.	7.29%				

Predicted Residual Sum of Squares (PRESS) = 1205.7

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	67.04	1	0.78	86.37	
A	-0.14	1	1.28	-0.1096	0.9133
B	-1.12	1	1.29	-0.8707	0.3898
C	12.32	1	1.29	9.574	0.0001
D	-1.89	1	1.21	-1.559	0.1281
E	9.07	1	1.24	7.314	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Pyr rej} = & 67.04 \\ & - 0.14 * A \\ & - 1.12 * B \\ & + 12.32 * C \\ & - 1.89 * D \\ & + 9.07 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Pyr rej} = & -35.56 \\ & - 1.401\text{E-}03 * \text{Grind Size} \\ & - 1.125\text{E-}02 * \text{Feed Rate} \\ & + 0.30797 * \text{Drum Speed} \\ & - 3.7729 * \text{Wash Water} \\ & + 0.90697 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	74.02	69.26	4.76	0.160	1.050	0.035	1.051	28
2	71.59	68.26	3.33	0.154	0.733	0.016	0.728	13
3	66.46	66.81	-0.35	0.185	-0.077	0.000	-0.076	29
5	53.22	56.96	-3.74	0.165	-0.828	0.023	-0.824	5
6	82.67	82.51	0.16	0.141	0.035	0.000	0.035	39
7	52.37	54.48	-2.11	0.165	-0.466	0.007	-0.461	3
8	72.14	78.35	-6.21	0.168	-1.378	0.064	-1.397	40
9	65.67	60.13	5.54	0.130	1.201	0.036	1.209	43
10	57.81	58.53	-0.72	0.101	-0.155	0.000	-0.152	9
11	69.13	77.05	-7.92	0.138	-1.726	0.080	-1.778	1
12	74.66	75.64	-0.98	0.093	-0.209	0.001	-0.206	2
13	60.90	54.85	6.05	0.160	1.335	0.057	1.351	32
14	51.35	54.63	-3.28	0.164	-0.725	0.017	-0.720	16
15	73.33	80.51	-7.18	0.150	-1.575	0.073	-1.611	30

16	80.00	79.53	0.47	0.165	0.104	0.000	0.103	14
17	61.12	59.76	1.36	0.171	0.303	0.003	0.299	42
18	57.75	57.38	0.37	0.139	0.081	0.000	0.080	25
19	76.84	78.54	-1.70	0.145	-0.372	0.004	-0.368	18
20	71.44	74.01	-2.57	0.150	-0.564	0.009	-0.558	19
22	53.25	52.24	1.01	0.221	0.231	0.003	0.228	21
23	79.44	80.25	-0.81	0.115	-0.174	0.001	-0.171	37
24	74.53	77.93	-3.40	0.224	-0.781	0.029	-0.777	20
25	69.09	69.06	0.03	0.147	0.006	0.000	0.006	31
26	73.34	70.03	3.31	0.165	0.734	0.018	0.729	15
27	67.16	66.28	0.88	0.147	0.193	0.001	0.190	33
28	73.46	65.72	7.74	0.162	1.711	0.095	1.762	12
29	33.42	46.21	-12.79	0.154	-2.813	0.240	-3.152	26
30	65.35	70.53	-5.18	0.165	-1.146	0.043	-1.152	8
31	62.47	64.03	-1.56	0.156	-0.344	0.004	-0.340	36
32	95.35	88.53	6.82	0.147	1.493	0.064	1.521	35
33	62.85	58.13	4.72	0.157	1.039	0.033	1.040	34
34	50.47	56.41	-5.94	0.180	-1.328	0.065	-1.343	17
35	74.00	78.50	-4.50	0.158	-0.992	0.031	-0.992	27
36	75.05	76.29	-1.24	0.158	-0.274	0.002	-0.270	10
37	74.73	69.94	4.79	0.147	1.049	0.032	1.050	6
38	72.83	68.00	4.83	0.107	1.035	0.021	1.036	4
39	70.78	65.91	4.87	0.176	1.086	0.042	1.089	41
40	73.25	64.16	9.09	0.178	2.029	0.148	2.128	24
41	68.51	68.30	0.21	0.029	0.044	0.000	0.043	38
42	70.02	68.43	1.59	0.035	0.327	0.001	0.323	22
43	68.39	68.14	0.25	0.025	0.051	0.000	0.051	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4244.6	20	212.23	11.84	0.0001
RESIDUAL	358.5	20	17.92		
COR TOTAL	4603.1	40			
ROOT MSE	4.23		R-SQUARED	0.9221	
DEP MEAN	67.81		ADJ R-SQUARED	0.8443	
C.V.	6.24%				

Predicted Residual Sum of Squares (PRESS) = 1607.7

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	68.38	1	2.26	30.24	
A	-0.00	1	1.12	-2.34E-03	0.9982
B	-0.87	1	1.23	-0.7093	0.4863
C	12.63	1	1.13	11.16	0.0001
D	-1.98	1	1.05	-1.880	0.0748
E	8.89	1	1.08	8.214	0.0001
A2	0.48	1	1.60	0.2993	0.7678
B2	1.29	1	1.58	0.8184	0.4228
C2	-3.89	1	1.63	-2.384	0.0271
D2	1.25	1	1.57	0.7998	0.4332
E2	-2.65	1	1.75	-1.520	0.1443
AB	1.84	1	2.38	0.7746	0.4476
AC	4.44	1	2.13	2.087	0.0499
AD	0.88	1	2.07	0.4253	0.6752
AE	2.50	1	2.07	1.210	0.2402
BC	-1.53	1	1.94	-0.7880	0.4400
BD	1.46	1	2.00	0.7272	0.4755
BE	6.02	1	3.02	1.992	0.0602
CD	-2.56	1	2.20	-1.164	0.2581
CE	0.90	1	2.19	0.4106	0.6857
DE	0.48	1	2.08	0.2293	0.8209

Final Equation in Terms of Coded Factors:

Pyr rej =

$$\begin{aligned}
 &68.38 \\
 &- 0.00 * A \\
 &- 0.87 * B \\
 &+ 12.63 * C \\
 &- 1.98 * D \\
 &+ 8.89 * E \\
 &+ 0.48 * A^2 \\
 &+ 1.29 * B^2 \\
 &- 3.89 * C^2 \\
 &+ 1.25 * D^2 \\
 &- 2.65 * E^2 \\
 &+ 1.84 * AB \\
 &+ 4.44 * AC \\
 &+ 0.88 * AD \\
 &+ 2.50 * AE \\
 &- 1.53 * BC \\
 &+ 1.46 * BD \\
 &+ 6.02 * BE \\
 &- 2.56 * CD \\
 &+ 0.90 * CE \\
 &+ 0.48 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Pyr rej =

$$\begin{aligned}
 & -149.35 \\
 & - 0.44697 * \text{Grind Size} \\
 & - 0.16964 * \text{Feed Rate} \\
 & + 1.6038 * \text{Drum Speed} \\
 & + 10.134 * \text{Wash Water} \\
 & - 0.21296 * \% \text{ Solids} \\
 & + 4.784\text{E-}05 * \text{Grind Size}^2 \\
 & + 1.292\text{E-}04 * \text{Feed Rate}^2 \\
 & - 2.432\text{E-}03 * \text{Drum Speed}^2 \\
 & + 5.0199 * \text{Wash Water}^2 \\
 & - 2.655\text{E-}02 * \% \text{ Solids}^2 \\
 & + 1.843\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 1.110\text{E-}03 * \text{Grind Size} * \text{Drum Speed} \\
 & + 1.757\text{E-}02 * \text{Grind Size} * \text{Wash Water} \\
 & + 2.501\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 3.828\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 2.912\text{E-}02 * \text{Feed Rate} * \text{Wash Water} \\
 & + 6.019\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 0.12807 * \text{Drum Speed} * \text{Wash Water} \\
 & + 2.249\text{E-}03 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 9.558\text{E-}02 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	74.02	74.18	-0.16	0.642	-0.064	0.000	-0.062	28
2	71.59	69.50	2.09	0.566	0.749	0.035	0.741	13
3	66.46	68.85	-2.39	0.593	-0.886	0.054	-0.881	29
5	53.22	52.93	0.29	0.617	0.111	0.001	0.108	5
6	82.67	84.06	-1.39	0.511	-0.469	0.011	-0.460	39
7	52.37	54.15	-1.78	0.576	-0.646	0.027	-0.637	3
8	72.14	74.74	-2.60	0.589	-0.957	0.062	-0.955	40
9	65.67	64.86	0.81	0.570	0.293	0.005	0.286	43
10	57.81	55.19	2.62	0.298	0.738	0.011	0.730	9
11	69.13	70.92	-1.79	0.667	-0.731	0.051	-0.722	1
12	74.66	76.54	-1.88	0.248	-0.511	0.004	-0.502	2
13	60.90	56.70	4.20	0.540	1.460	0.119	1.506	32
14	51.35	49.04	2.31	0.540	0.806	0.036	0.798	16
15	73.33	74.15	-0.82	0.507	-0.277	0.004	-0.270	30
16	80.00	82.56	-2.56	0.537	-0.890	0.044	-0.885	14
17	61.12	58.46	2.66	0.613	1.012	0.077	1.012	42
18	57.75	57.30	0.45	0.452	0.142	0.001	0.139	25
19	76.84	78.62	-1.78	0.508	-0.600	0.018	-0.590	18
20	71.44	75.48	-4.04	0.507	-1.360	0.091	-1.391	19
22	53.25	53.81	-0.56	0.789	-0.287	0.015	-0.280	21
23	79.44	79.74	-0.30	0.288	-0.085	0.000	-0.083	37
24	74.53	76.33	-1.80	0.801	-0.952	0.174	-0.950	20
25	69.09	72.92	-3.83	0.494	-1.271	0.075	-1.292	31
26	73.34	73.16	0.18	0.561	0.063	0.000	0.062	15
27	67.16	67.93	-0.77	0.507	-0.260	0.003	-0.253	33
28	73.46	70.69	2.77	0.546	0.972	0.054	0.971	12
29	33.42	41.54	-8.12	0.514	-2.752	0.381	-3.404	26
30	65.35	66.11	-0.76	0.553	-0.267	0.004	-0.261	8
31	62.47	59.20	3.27	0.514	1.107	0.062	1.114	36
32	95.35	84.96	10.39	0.486	3.423	0.527	5.185	35
33	62.85	59.52	3.33	0.540	1.161	0.075	1.172	34
34	50.47	51.07	-0.60	0.608	-0.226	0.004	-0.220	17
35	74.00	73.55	0.45	0.512	0.152	0.001	0.148	27
36	75.05	79.24	-4.19	0.514	-1.420	0.101	-1.459	10
37	74.73	74.88	-0.15	0.432	-0.047	0.000	-0.046	6

38	72.83	70.40	2.43	0.331	0.700	0.012	0.691	4
39	70.78	68.18	2.60	0.582	0.949	0.060	0.946	41
40	73.25	70.22	3.03	0.583	1.110	0.082	1.117	24
41	68.51	69.47	-0.96	0.253	-0.264	0.001	-0.257	38
42	70.02	69.61	0.41	0.235	0.112	0.000	0.109	22
43	68.39	69.45	-1.06	0.278	-0.294	0.002	-0.287	7

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Coal Seam: Pittsburgh No. 8
Circuit: Individual MGS
Response: Separation Efficiency
Data File: P-MGS-00
Comments: Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Grind Size      microns      100.000      300.000
B      Feed Rate       lbs/hr       100.000      300.000
C      Drum Speed      rpm          240.000      320.000
D      Wash Water      lpm          0.500        1.500
E      % Solids         w/w          15.000       35.000
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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	147784.5	1	147784.5		
Linear	1337.1	5	267.4	3.104	0.0194
Quadratic	1503.4	15	100.2	1.309	0.2757
Cubic	1683.9	22	76.5		
RESIDUAL	0.0	0			
TOTAL	152309.0	43			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	37	9.28	0.2955	0.2003	4207.66
Quadratic	21	22	8.75	0.6278	0.2895	5630.05
Cubic	43	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1337.1	5	267.42	3.104	0.0194
RESIDUAL	3187.3	37	86.14		
COR TOTAL	4524.4	42			
ROOT MSE	9.28		R-SQUARED	0.2955	
DEP MEAN	58.62		ADJ R-SQUARED	0.2003	
C.V.	15.83%				

Predicted Residual Sum of Squares (PRESS) = 4207.7

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	58.48	1	1.42	41.19	
A	-3.69	1	2.32	-1.588	0.1207
B	-2.92	1	2.36	-1.239	0.2233
C	6.67	1	2.33	2.867	0.0068
D	-0.04	1	2.27	-1.76E-02	0.9860
E	3.54	1	2.33	1.522	0.1365

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Efficiency} = & 58.48 \\ & - 3.69 * A \\ & - 2.92 * B \\ & + 6.67 * C \\ & - 0.04 * D \\ & + 3.54 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Efficiency} = & 16.23 \\ & - 3.689\text{E-}02 * \text{Grind Size} \\ & - 2.921\text{E-}02 * \text{Feed Rate} \\ & + 0.16674 * \text{Drum Speed} \\ & - 8.005\text{E-}02 * \text{Wash Water} \\ & + 0.35431 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	69.67	65.43	4.24	0.149	0.496	0.007	0.491	28
2	64.13	57.42	6.71	0.146	0.782	0.017	0.778	13
3	61.10	58.99	2.11	0.184	0.252	0.002	0.249	29
4	27.82	53.04	-25.22	0.105	-2.872	0.162	-3.214	11
5	52.22	53.04	-0.82	0.152	-0.096	0.000	-0.095	5
6	66.54	66.11	0.43	0.139	0.050	0.000	0.049	39
7	51.53	53.19	-1.66	0.153	-0.195	0.001	-0.192	3
8	65.68	66.85	-1.17	0.168	-0.138	0.001	-0.136	40
9	60.33	57.66	2.67	0.126	0.308	0.002	0.304	43
10	49.76	53.51	-3.75	0.099	-0.426	0.003	-0.421	9
11	64.03	64.65	-0.62	0.133	-0.071	0.000	-0.070	1
12	66.87	60.99	5.88	0.091	0.664	0.007	0.659	2
13	59.44	55.26	4.18	0.151	0.488	0.007	0.483	32
14	50.27	47.79	2.48	0.147	0.290	0.002	0.286	16

15	62.73	69.25	-6.52	0.147	-0.760	0.017	-0.756	30
16	61.09	61.13	-0.04	0.153	-0.005	0.000	-0.005	14
17	57.62	53.93	3.69	0.169	0.437	0.006	0.432	42
18	55.74	55.42	0.32	0.138	0.038	0.000	0.037	25
19	62.34	62.10	0.24	0.144	0.028	0.000	0.027	18
20	62.26	61.51	0.75	0.149	0.088	0.000	0.086	19
21	25.34	54.00	-28.66	0.119	-3.290	0.244	-3.859	23
22	50.97	47.16	3.81	0.215	0.463	0.010	0.458	21
23	72.58	67.25	5.33	0.115	0.610	0.008	0.605	37
24	59.46	61.23	-1.77	0.207	-0.214	0.002	-0.212	20
25	62.79	62.09	0.70	0.144	0.082	0.000	0.081	31
26	62.12	54.91	7.21	0.156	0.845	0.022	0.842	15
27	62.71	62.48	0.23	0.145	0.027	0.000	0.026	33
28	65.43	54.66	10.77	0.153	1.261	0.048	1.271	12
29	32.93	48.25	-15.32	0.146	-1.786	0.091	-1.843	26
30	61.86	62.55	-0.69	0.164	-0.081	0.000	-0.080	8
31	59.93	54.85	5.08	0.148	0.593	0.010	0.588	36
32	41.95	68.46	-26.51	0.144	-3.087	0.267	-3.534	35
33	60.01	58.48	1.53	0.155	0.180	0.001	0.177	34
34	48.63	49.75	-1.12	0.170	-0.132	0.001	-0.131	17
35	65.71	66.82	-1.11	0.156	-0.130	0.001	-0.128	27
36	62.62	58.03	4.59	0.149	0.536	0.008	0.530	10
37	70.06	61.43	8.63	0.142	1.003	0.028	1.003	6
38	63.39	56.38	7.01	0.104	0.798	0.012	0.794	4
39	65.86	61.26	4.60	0.171	0.544	0.010	0.539	41
40	66.00	55.30	10.70	0.173	1.267	0.056	1.278	24
41	63.28	59.53	3.75	0.028	0.409	0.001	0.405	38
42	60.66	59.88	0.78	0.033	0.085	0.000	0.084	22
43	65.40	58.83	6.57	0.024	0.716	0.002	0.711	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2840.5	20	142.02	1.855	0.0806
RESIDUAL	1683.9	22	76.54		
COR TOTAL	4524.4	42			
ROOT MSE	8.75		R-SQUARED	0.6278	
DEP MEAN	58.62		ADJ R-SQUARED	0.2895	
C.V.	14.92%				

Predicted Residual Sum of Squares (PRESS) = 5630.0

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	58.14	1	4.52	12.86	
A	-3.41	1	2.25	-1.516	0.1437
B	-3.09	1	2.43	-1.272	0.2167
C	7.39	1	2.22	3.321	0.0031
D	-0.67	1	2.18	-0.3092	0.7601
E	3.88	1	2.24	1.735	0.0968
A2	1.31	1	3.28	0.4003	0.6928
B2	1.97	1	3.26	0.6038	0.5521
C2	-5.42	1	3.24	-1.671	0.1089
D2	4.44	1	3.14	1.414	0.1715
E2	-1.57	1	3.50	-0.4483	0.6583
AB	-3.52	1	4.65	-0.7583	0.4563
AC	2.29	1	4.40	0.5205	0.6079
AD	1.09	1	4.27	0.2552	0.8010
AE	1.34	1	4.27	0.3141	0.7564
BC	-6.54	1	3.77	-1.732	0.0972
BD	3.18	1	4.12	0.7719	0.4484
BE	1.68	1	6.22	0.2700	0.7897
CD	-1.53	1	4.54	-0.3369	0.7394
CE	-10.49	1	4.52	-2.321	0.0299
DE	1.11	1	4.31	0.2583	0.7986

Final Equation in Terms of Coded Factors:

Efficiency =

```

58.14
-      3.41 * A
-      3.09 * B
+      7.39 * C
-      0.67 * D
+      3.88 * E
+      1.31 * A2
+      1.97 * B2
-      5.42 * C2
+      4.44 * D2
-      1.57 * E2
-      3.52 * AB
+      2.29 * AC
+      1.09 * AD
+      1.34 * AE
-      6.54 * BC
+      3.18 * BD
+      1.68 * BE
-      1.53 * CD
-     10.49 * CE
+      1.11 * DE

```

Final Equation in Terms of Actual Factors:

Efficiency =

$$\begin{aligned}
 & -474.38 \\
 & - 0.23160 * \text{Grind Size} \\
 & + 0.31296 * \text{Feed Rate} \\
 & + 3.0268 * \text{Drum Speed} \\
 & - 38.066 * \text{Wash Water} \\
 & + 7.6903 * \% \text{ Solids} \\
 & + 1.312\text{E-}04 * \text{Grind Size}^2 \\
 & + 1.966\text{E-}04 * \text{Feed Rate}^2 \\
 & - 3.388\text{E-}03 * \text{Drum Speed}^2 \\
 & + 17.746 * \text{Wash Water}^2 \\
 & - 1.571\text{E-}02 * \% \text{ Solids}^2 \\
 & - 3.524\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 5.720\text{E-}04 * \text{Grind Size} * \text{Drum Speed} \\
 & + 2.178\text{E-}02 * \text{Grind Size} * \text{Wash Water} \\
 & + 1.341\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 1.635\text{E-}03 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 6.365\text{E-}02 * \text{Feed Rate} * \text{Wash Water} \\
 & + 1.680\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 7.650\text{E-}02 * \text{Drum Speed} * \text{Wash Water} \\
 & - 2.623\text{E-}02 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.22245 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	69.67	66.01	3.66	0.612	0.671	0.034	0.663	28
2	64.13	64.17	-0.04	0.559	-0.006	0.000	-0.006	13
3	61.10	66.62	-5.52	0.582	-0.977	0.063	-0.976	29
4	27.82	52.69	-24.87	0.284	-3.360	0.213	-4.704	11
5	52.22	48.59	3.63	0.551	0.620	0.022	0.611	5
6	66.54	67.04	-0.50	0.504	-0.081	0.000	-0.079	39
7	51.53	50.33	1.20	0.526	0.199	0.002	0.195	3
8	65.68	66.45	-0.77	0.585	-0.137	0.001	-0.134	40
9	60.33	59.30	1.03	0.568	0.179	0.002	0.175	43
10	49.76	51.39	-1.63	0.295	-0.222	0.001	-0.217	9
11	64.03	63.22	0.81	0.649	0.157	0.002	0.153	1
12	66.87	60.26	6.61	0.243	0.868	0.011	0.863	2
13	59.44	52.92	6.52	0.522	1.078	0.060	1.083	32
14	50.27	41.57	8.70	0.501	1.408	0.095	1.442	16
15	62.73	61.98	0.75	0.507	0.121	0.001	0.119	30
16	61.09	58.16	2.93	0.515	0.481	0.012	0.473	14
17	57.62	57.94	-0.32	0.608	-0.058	0.000	-0.056	42
18	55.74	56.24	-0.50	0.450	-0.076	0.000	-0.075	25
19	62.34	64.04	-1.70	0.503	-0.276	0.004	-0.270	18
20	62.26	65.85	-3.59	0.504	-0.583	0.016	-0.574	19
21	25.34	45.30	-19.96	0.289	-2.705	0.141	-3.235	23
22	50.97	52.73	-1.76	0.773	-0.423	0.029	-0.415	21
23	72.58	68.24	4.34	0.287	0.587	0.007	0.578	37
24	59.46	50.65	8.81	0.762	2.065	0.652	2.247	20
25	62.79	69.16	-6.37	0.492	-1.022	0.048	-1.023	31
26	62.12	60.11	2.01	0.535	0.337	0.006	0.330	15
27	62.71	65.60	-2.89	0.506	-0.470	0.011	-0.462	33
28	65.43	61.26	4.17	0.524	0.691	0.025	0.682	12
29	32.93	31.02	1.91	0.501	0.309	0.005	0.303	26
30	61.86	67.89	-6.03	0.549	-1.027	0.061	-1.028	8
31	59.93	59.34	0.59	0.495	0.095	0.000	0.093	36
32	41.95	51.42	-9.47	0.483	-1.506	0.101	-1.554	35
33	60.01	58.81	1.20	0.538	0.202	0.002	0.197	34
34	48.63	45.42	3.21	0.581	0.567	0.021	0.558	17
35	65.71	63.05	2.66	0.510	0.435	0.009	0.427	27

36	62.62	58.74	3.88	0.490	0.621	0.018	0.612	10
37	70.06	70.74	-0.68	0.425	-0.102	0.000	-0.100	6
38	63.39	59.30	4.09	0.318	0.566	0.007	0.557	4
39	65.86	64.72	1.14	0.578	0.200	0.003	0.195	41
40	66.00	64.71	1.29	0.578	0.227	0.003	0.222	24
41	63.28	59.38	3.90	0.237	0.510	0.004	0.501	38
42	60.66	59.89	0.77	0.220	0.100	0.000	0.097	22
43	65.40	58.61	6.79	0.260	0.903	0.014	0.899	7

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Coal Seam:  Pittsburgh No. 8
Circuit:    Individual MGS
Response:   1b SO2/MM Btu
Data File:  P-MGS-00
Comments:   Analysis with Outliers Removed
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Grind Size      microns      100.000      300.000
B      Feed Rate       lbs/hr       100.000      300.000
C      Drum Speed      rpm          240.000      320.000
D      Wash Water      lpm          0.500        1.500
E      % Solids         w/w          15.000       35.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	369.060	1	369.060		
Linear	2.955	5	0.591	16.09	0.0001
Quadratic	0.752	15	0.050	1.880	0.0935
Cubic	0.534	20	0.027		
RESIDUAL	0.000	0			
TOTAL	373.301	41			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	35	0.192	0.6968	0.6535	1.755
Quadratic	21	20	0.163	0.8742	0.7483	2.370
Cubic	41	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.


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Coal Seam: Pittsburgh No. 8
Circuit: Individual MGS
Response: Separation Efficiency
Data File: P-MGS-00
Comments: Analysis with Outliers Removed
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FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Grind Size	microns	100.000	300.000
B	Feed Rate	lbs/hr	100.000	300.000
C	Drum Speed	rpm	240.000	320.000
D	Wash Water	lpm	0.500	1.500
E	% Solids	w/w	15.000	35.000

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	147982.1	1	147982.1		
Linear	1076.3	5	215.3	3.129	0.0191
Quadratic	1656.7	15	110.4	2.829	0.0144
Cubic	819.9	21	39.0		
RESIDUAL	0.0	0			
TOTAL	151535.0	42			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	36	8.29	0.3029	0.2061	3321.99
Quadratic	21	21	6.25	0.7692	0.5494	3407.73
Cubic	42	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1076.3	5	215.26	3.129	0.0191
RESIDUAL	2476.6	36	68.79		
COR TOTAL	3552.9	41			
ROOT MSE	8.29		R-SQUARED	0.3029	
DEP MEAN	59.36		ADJ R-SQUARED	0.2061	
C.V.	13.97%				

Predicted Residual Sum of Squares (PRESS) = 3322.0

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	59.12	1	1.28	46.03	
A	-1.96	1	2.14	-0.9152	0.3662
B	-1.92	1	2.13	-0.9013	0.3734
C	6.71	1	2.08	3.226	0.0027
D	-0.04	1	2.03	-1.98E-02	0.9843
E	3.56	1	2.08	1.710	0.0960

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Efficiency} = & 59.12 \\ & - 1.96 * A \\ & - 1.92 * B \\ & + 6.71 * C \\ & - 0.04 * D \\ & + 3.56 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Efficiency} = & 11.13 \\ & - 1.962E-02 * \text{Grind Size} \\ & - 1.920E-02 * \text{Feed Rate} \\ & + 0.16766 * \text{Drum Speed} \\ & - 8.054E-02 * \text{Wash Water} \\ & + 0.35560 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	69.67	63.34	6.33	0.156	0.830	0.021	0.827	28
2	64.13	58.89	5.24	0.149	0.685	0.014	0.680	13
3	61.10	59.11	1.99	0.184	0.265	0.003	0.262	29
5	52.22	53.23	-1.01	0.152	-0.133	0.001	-0.131	5
6	66.54	66.65	-0.11	0.140	-0.015	0.000	-0.014	39
7	51.53	53.49	-1.96	0.153	-0.257	0.002	-0.253	3
8	65.68	66.99	-1.31	0.168	-0.173	0.001	-0.170	40
9	60.33	57.48	2.85	0.126	0.368	0.003	0.363	43
10	49.76	54.75	-4.99	0.101	-0.635	0.008	-0.629	9
11	64.03	64.40	-0.37	0.133	-0.048	0.000	-0.047	1
12	66.87	62.00	4.87	0.093	0.617	0.006	0.611	2
13	59.44	54.22	5.22	0.152	0.684	0.014	0.678	32
14	50.27	50.29	-0.02	0.156	-0.002	0.000	-0.002	16
15	62.73	68.18	-5.45	0.148	-0.712	0.015	-0.707	30

16	61.09	63.71	-2.62	0.162	-0.345	0.004	-0.340	14
17	57.62	54.92	2.70	0.171	0.358	0.004	0.354	42
18	55.74	56.04	-0.30	0.139	-0.040	0.000	-0.039	25
19	62.34	62.86	-0.52	0.145	-0.067	0.000	-0.066	18
20	62.26	62.32	-0.06	0.150	-0.008	0.000	-0.008	19
21	25.34	53.98	-28.64	0.119	-3.678	0.305	-4.591	23
22	50.97	49.23	1.74	0.221	0.237	0.003	0.234	21
23	72.58	67.21	5.37	0.115	0.688	0.010	0.683	37
24	59.46	63.25	-3.79	0.213	-0.515	0.012	-0.510	20
25	62.79	61.04	1.75	0.146	0.228	0.001	0.225	31
26	62.12	57.43	4.69	0.165	0.618	0.013	0.613	15
27	62.71	61.39	1.32	0.146	0.172	0.001	0.169	33
28	65.43	57.18	8.25	0.162	1.086	0.038	1.089	12
29	32.93	48.96	-16.03	0.147	-2.093	0.126	-2.202	26
30	61.86	62.94	-1.08	0.164	-0.143	0.001	-0.141	8
31	59.93	55.70	4.23	0.149	0.553	0.009	0.548	36
32	41.95	69.23	-27.28	0.145	-3.556	0.357	-4.354	35
33	60.01	57.43	2.58	0.156	0.339	0.004	0.335	34
34	48.63	52.49	-3.86	0.180	-0.514	0.010	-0.509	17
35	65.71	65.72	-0.01	0.157	-0.001	0.000	-0.001	27
36	62.62	60.58	2.04	0.158	0.269	0.002	0.265	10
37	70.06	61.07	8.99	0.142	1.169	0.038	1.176	6
38	63.39	57.75	5.64	0.107	0.719	0.010	0.714	4
39	65.86	60.93	4.93	0.171	0.653	0.015	0.647	41
40	66.00	57.07	8.93	0.177	1.186	0.050	1.193	24
41	63.28	59.93	3.35	0.028	0.409	0.001	0.404	38
42	60.66	60.16	0.50	0.033	0.061	0.000	0.060	22
43	65.40	59.48	5.92	0.024	0.723	0.002	0.718	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2733.0	20	136.65	3.500	0.0031
RESIDUAL	819.9	21	39.04		
COR TOTAL	3552.9	41			
ROOT MSE	6.25		R-SQUARED	0.7692	
DEP MEAN	59.36		ADJ R-SQUARED	0.5494	
C.V.	10.53%				

Predicted Residual Sum of Squares (PRESS) = 3407.7

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	61.73	1	3.32	18.60	
A	-1.68	1	1.65	-1.018	0.3201
B	-1.30	1	1.78	-0.7294	0.4738
C	7.45	1	1.59	4.691	0.0001
D	-0.66	1	1.55	-0.4271	0.6736
E	3.99	1	1.60	2.496	0.0209
A2	1.75	1	2.34	0.7462	0.4638
B2	1.34	1	2.33	0.5756	0.5710
C2	-7.91	1	2.38	-3.327	0.0032
D2	2.14	1	2.29	0.9343	0.3608
E2	-4.27	1	2.57	-1.662	0.1114
AB	1.86	1	3.51	0.5305	0.6013
AC	2.37	1	3.14	0.7551	0.4586
AD	0.89	1	3.05	0.2934	0.7721
AE	1.14	1	3.05	0.3738	0.7123
BC	-6.63	1	2.70	-2.460	0.0226
BD	2.06	1	2.95	0.6959	0.4941
BE	3.06	1	4.45	0.6879	0.4990
CD	-0.85	1	3.25	-0.2625	0.7955
CE	-10.53	1	3.23	-3.261	0.0037
DE	1.44	1	3.08	0.4676	0.6449

Final Equation in Terms of Coded Factors:

Efficiency =

$$\begin{aligned}
 &61.73 \\
 &- 1.68 * A \\
 &- 1.30 * B \\
 &+ 7.45 * C \\
 &- 0.66 * D \\
 &+ 3.99 * E \\
 &+ 1.75 * A^2 \\
 &+ 1.34 * B^2 \\
 &- 7.91 * C^2 \\
 &+ 2.14 * D^2 \\
 &- 4.27 * E^2 \\
 &+ 1.86 * AB \\
 &+ 2.37 * AC \\
 &+ 0.89 * AD \\
 &+ 1.14 * AE \\
 &- 6.63 * BC \\
 &+ 2.06 * BD \\
 &+ 3.06 * BE \\
 &- 0.85 * CD \\
 &- 10.53 * CE \\
 &+ 1.44 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Efficiency =

$$\begin{aligned}
 & -594.56 \\
 & - 0.33632 * \text{Grind Size} \\
 & + 0.24277 * \text{Feed Rate} \\
 & + 3.8667 * \text{Drum Speed} \\
 & - 25.535 * \text{Wash Water} \\
 & + 8.7716 * \% \text{ Solids} \\
 & + 1.749\text{E-}04 * \text{Grind Size}^2 \\
 & + 1.341\text{E-}04 * \text{Feed Rate}^2 \\
 & - 4.941\text{E-}03 * \text{Drum Speed}^2 \\
 & + 8.5730 * \text{Wash Water}^2 \\
 & - 4.266\text{E-}02 * \% \text{ Solids}^2 \\
 & + 1.862\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 5.927\text{E-}04 * \text{Grind Size} * \text{Drum Speed} \\
 & + 1.788\text{E-}02 * \text{Grind Size} * \text{Wash Water} \\
 & + 1.140\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 1.658\text{E-}03 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 4.112\text{E-}02 * \text{Feed Rate} * \text{Wash Water} \\
 & + 3.063\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 4.261\text{E-}02 * \text{Drum Speed} * \text{Wash Water} \\
 & - 2.631\text{E-}02 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.28764 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	69.67	70.95	-1.28	0.640	-0.341	0.010	-0.334	28
2	64.13	62.73	1.40	0.561	0.337	0.007	0.330	13
3	61.10	63.87	-2.77	0.591	-0.693	0.033	-0.684	29
5	52.22	46.92	5.30	0.554	1.271	0.096	1.291	5
6	66.54	64.93	1.61	0.509	0.368	0.007	0.361	39
7	51.53	48.42	3.11	0.530	0.726	0.028	0.717	3
8	65.68	65.35	0.33	0.587	0.082	0.000	0.080	40
9	60.33	59.57	0.76	0.568	0.186	0.002	0.181	43
10	49.76	52.91	-3.15	0.297	-0.601	0.007	-0.591	9
11	64.03	60.90	3.13	0.655	0.852	0.066	0.846	1
12	66.87	62.29	4.58	0.247	0.844	0.011	0.838	2
13	59.44	52.48	6.96	0.522	1.611	0.135	1.680	32
14	50.27	46.00	4.27	0.524	0.991	0.051	0.990	16
15	62.73	61.81	0.92	0.507	0.211	0.002	0.206	30
16	61.09	62.59	-1.50	0.537	-0.353	0.007	-0.345	14
17	57.62	56.54	1.08	0.610	0.276	0.006	0.270	42
18	55.74	55.18	0.56	0.451	0.122	0.001	0.119	25
19	62.34	62.71	-0.37	0.505	-0.083	0.000	-0.081	18
20	62.26	65.12	-2.86	0.505	-0.651	0.021	-0.641	19
21	25.34	44.80	-19.46	0.289	-3.693	0.264	-6.087	23
22	50.97	55.05	-4.08	0.779	-1.389	0.324	-1.423	21
23	72.58	67.80	4.78	0.287	0.906	0.016	0.902	37
24	59.46	53.01	6.45	0.769	2.147	0.730	2.372	20
25	62.79	68.77	-5.98	0.492	-1.342	0.083	-1.370	31
26	62.12	64.48	-2.36	0.557	-0.568	0.019	-0.559	15
27	62.71	66.01	-3.30	0.506	-0.752	0.028	-0.744	33
28	65.43	65.35	0.08	0.543	0.018	0.000	0.018	12
29	32.93	29.56	3.37	0.503	0.765	0.028	0.758	26
30	61.86	66.09	-4.23	0.553	-1.012	0.060	-1.012	8
31	59.93	58.71	1.22	0.496	0.275	0.004	0.269	36
32	41.95	50.10	-8.15	0.485	-1.818	0.148	-1.933	35
33	60.01	57.85	2.16	0.539	0.508	0.014	0.499	34
34	48.63	50.09	-1.46	0.606	-0.371	0.010	-0.364	17
35	65.71	62.42	3.29	0.511	0.753	0.028	0.745	27
36	62.62	63.05	-0.43	0.512	-0.098	0.000	-0.095	10

37	70.06	68.81	1.25	0.429	0.264	0.002	0.258	6
38	63.39	62.60	0.79	0.330	0.154	0.001	0.150	4
39	65.86	64.09	1.77	0.578	0.435	0.012	0.427	41
40	66.00	65.87	0.13	0.580	0.032	0.000	0.032	24
41	63.28	62.44	0.84	0.248	0.155	0.000	0.151	38
42	60.66	62.67	-2.01	0.229	-0.366	0.002	-0.358	22
43	65.40	62.16	3.24	0.275	0.610	0.007	0.600	7

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Coal Seam:  Pittsburgh No. 8
Circuit:      Individual MGS
Response:     Separation Efficiency
Data File:    P-MGS-00
Comments:     Analysis with Outliers Removed
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FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Grind Size      microns        100.000       300.000
B    Feed Rate       lbs/hr         100.000       300.000
C    Drum Speed      rpm           240.000       320.000
D    Wash Water      lpm            0.500         1.500
E    % Solids        w/w           15.000        35.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	147106.6	1	147106.6		
Linear	1269.5	5	253.9	11.40	0.0001
Quadratic	581.9	15	38.8	4.209	0.0020
Cubic	175.1	19	9.2		
RESIDUAL	0.0	0			
TOTAL	149133.1	40			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	34	4.72	0.6265	0.5715	1071.50
Quadratic	21	19	3.04	0.9136	0.8226	786.97
Cubic	40	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1269.5	5	253.91	11.40	0.0001
RESIDUAL	757.0	34	22.26		
COR TOTAL	2026.5	39			
ROOT MSE	4.72		R-SQUARED	0.6265	
DEP MEAN	60.64		ADJ R-SQUARED	0.5715	
C.V.	7.78%				

Predicted Residual Sum of Squares (PRESS) = 1071.5

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	60.52	1	0.75	80.93	
A	-1.83	1	1.22	-1.502	0.1423
B	-2.99	1	1.23	-2.424	0.0208
C	6.54	1	1.27	5.139	0.0001
D	-0.24	1	1.16	-0.2072	0.8371
E	5.51	1	1.22	4.508	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Efficiency} = & 60.52 \\ & - 1.83 * A \\ & - 2.99 * B \\ & + 6.54 * C \\ & - 0.24 * D \\ & + 5.51 * E \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Efficiency} = & 11.11 \\ & - 1.832\text{E-}02 * \text{Grind Size} \\ & - 2.992\text{E-}02 * \text{Feed Rate} \\ & + 0.16340 * \text{Drum Speed} \\ & - 0.47882 * \text{Wash Water} \\ & + 0.55127 * \% \text{ Solids} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	69.67	65.71	3.96	0.160	0.915	0.027	0.913	28
2	64.13	61.42	2.71	0.154	0.624	0.012	0.618	13
3	61.10	59.29	1.81	0.187	0.425	0.007	0.420	29
5	52.22	55.43	-3.21	0.168	-0.747	0.019	-0.742	5
6	66.54	68.41	-1.87	0.152	-0.431	0.006	-0.426	39
7	51.53	55.40	-3.87	0.167	-0.898	0.027	-0.895	3
8	65.68	68.59	-2.91	0.174	-0.679	0.016	-0.673	40
9	60.33	58.02	2.31	0.132	0.525	0.007	0.519	43
10	49.76	53.78	-4.02	0.102	-0.898	0.015	-0.895	9
11	64.03	68.72	-4.69	0.144	-1.073	0.032	-1.075	1
12	66.87	64.97	1.90	0.101	0.424	0.003	0.418	2
13	59.44	55.58	3.86	0.163	0.893	0.026	0.890	32
14	50.27	51.80	-1.53	0.165	-0.354	0.004	-0.349	16
15	62.73	69.51	-6.78	0.159	-1.567	0.078	-1.602	30

16	61.09	64.90	-3.81	0.175	-0.889	0.028	-0.887	14
17	57.62	54.21	3.41	0.172	0.795	0.022	0.790	42
18	55.74	55.49	0.25	0.141	0.057	0.000	0.056	25
19	62.34	66.30	-3.96	0.155	-0.914	0.025	-0.911	18
20	62.26	65.31	-3.05	0.157	-0.704	0.015	-0.698	19
22	50.97	49.04	1.93	0.222	0.463	0.010	0.458	21
23	72.58	69.22	3.36	0.121	0.760	0.013	0.755	37
24	59.46	63.06	-3.60	0.236	-0.872	0.039	-0.869	20
25	62.79	62.48	0.31	0.147	0.072	0.000	0.071	31
26	62.12	59.22	2.90	0.167	0.674	0.015	0.669	15
27	62.71	62.67	0.04	0.147	0.009	0.000	0.009	33
28	65.43	58.55	6.88	0.163	1.595	0.083	1.633	12
29	32.93	48.45	-15.52	0.166	-3.601	0.429	-4.510	26
30	61.86	62.47	-0.61	0.166	-0.141	0.001	-0.139	8
31	59.93	58.99	0.94	0.157	0.216	0.001	0.213	36
33	60.01	56.70	3.31	0.159	0.765	0.018	0.761	34
34	48.63	51.45	-2.82	0.182	-0.660	0.016	-0.655	17
35	65.71	69.17	-3.46	0.167	-0.803	0.022	-0.799	27
36	62.62	63.91	-1.29	0.167	-0.299	0.003	-0.295	10
37	70.06	63.74	6.32	0.148	1.452	0.061	1.477	6
38	63.39	58.56	4.83	0.108	1.084	0.024	1.087	4
39	65.86	63.14	2.72	0.176	0.635	0.014	0.630	41
40	66.00	57.06	8.94	0.179	2.092	0.159	2.208	24
41	63.28	61.80	1.48	0.030	0.319	0.001	0.315	38
42	60.66	62.16	-1.50	0.035	-0.323	0.001	-0.319	22
43	65.40	61.09	4.31	0.026	0.925	0.004	0.923	7

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2.955	5	0.591	16.09	0.0001
RESIDUAL	1.286	35	0.037		
COR TOTAL	4.241	40			
ROOT MSE	0.192		R-SQUARED	0.6968	
DEP MEAN	3.000		ADJ R-SQUARED	0.6535	
C.V.	6.39%				

Predicted Residual Sum of Squares (PRESS) = 1.755

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	3.024	1	0.030	100.5	
A	0.133	1	0.050	2.691	0.0108
B	0.004	1	0.050	7.53E-02	0.9404
C	-0.326	1	0.050	-6.534	0.0001
D	0.036	1	0.047	0.7722	0.4452
E	-0.253	1	0.048	-5.267	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned}
 \text{SO2 emiss} = & 3.024 \\
 & + 0.133 * A \\
 & + 0.004 * B \\
 & - 0.326 * C \\
 & + 0.036 * D \\
 & - 0.253 * E
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned}
 \text{SO2 emiss} = & 5.592 \\
 & + 1.333\text{E-}03 * \text{Grind Size} \\
 & + 3.771\text{E-}05 * \text{Feed Rate} \\
 & - 8.149\text{E-}03 * \text{Drum Speed} \\
 & + 7.248\text{E-}02 * \text{Wash Water} \\
 & - 2.532\text{E-}02 * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	2.800	2.864	-0.064	0.160	-0.365	0.004	-0.361	28
2	3.170	3.147	0.023	0.154	0.128	0.000	0.126	13
3	3.000	2.869	0.131	0.185	0.760	0.022	0.755	29
5	3.460	3.314	0.146	0.165	0.831	0.023	0.828	5
6	2.730	2.630	0.100	0.141	0.563	0.009	0.557	39
7	3.230	3.350	-0.120	0.165	-0.686	0.015	-0.681	3
8	2.910	2.725	0.185	0.168	1.059	0.038	1.061	40
9	2.840	3.242	-0.402	0.130	-2.250	0.126	-2.398	43
10	2.910	3.248	-0.338	0.101	-1.858	0.065	-1.929	9
11	2.750	2.769	-0.019	0.138	-0.106	0.000	-0.105	1
12	2.630	2.774	-0.144	0.093	-0.787	0.011	-0.782	2
13	3.190	3.216	-0.026	0.160	-0.146	0.001	-0.143	32
14	3.870	3.477	0.393	0.164	2.240	0.164	2.386	16
15	2.740	2.538	0.202	0.150	1.144	0.039	1.149	30

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2080.0	20	104.00	7.236	0.0001
RESIDUAL	287.5	20	14.37		
COR TOTAL	2367.4	40			
ROOT MSE	3.79		R-SQUARED	0.8786	
DEP MEAN	60.19		ADJ R-SQUARED	0.7572	
C.V.	6.30%				

Predicted Residual Sum of Squares (PRESS) = 1228.1

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	63.06	1	2.03	31.14	
A	-1.68	1	1.00	-1.681	0.1083
B	-2.55	1	1.10	-2.320	0.0310
C	5.54	1	1.01	5.463	0.0001
D	-0.59	1	0.94	-0.6292	0.5364
E	4.07	1	0.97	4.197	0.0004
A2	0.74	1	1.43	0.5167	0.6111
B2	1.41	1	1.41	0.9948	0.3317
C2	-6.46	1	1.46	-4.421	0.0003
D2	0.97	1	1.41	0.6882	0.4992
E2	-5.17	1	1.56	-3.303	0.0035
AB	1.61	1	2.13	0.7551	0.4590
AC	2.08	1	1.91	1.093	0.2873
AD	0.85	1	1.85	0.4604	0.6502
AE	1.06	1	1.85	0.5727	0.5732
BC	-3.02	1	1.74	-1.735	0.0982
BD	1.78	1	1.79	0.9904	0.3338
BE	2.12	1	2.71	0.7836	0.4425
CD	-0.55	1	1.97	-0.2800	0.7824
CE	-11.19	1	1.96	-5.702	0.0001
DE	1.46	1	1.87	0.7838	0.4424

Final Equation in Terms of Coded Factors:

Efficiency =

	63.06
-	1.68 * A
-	2.55 * B
+	5.54 * C
-	0.59 * D
+	4.07 * E
+	0.74 * A2
+	1.41 * B2
-	6.46 * C2
+	0.97 * D2
-	5.17 * E2
+	1.61 * AB
+	2.08 * AC
+	0.85 * AD
+	1.06 * AE
-	3.02 * BC
+	1.78 * BD
+	2.12 * BE
-	0.55 * CD
-	11.19 * CE
+	1.46 * DE

Final Equation in Terms of Actual Factors:

Efficiency =

$$\begin{aligned}
 & -489.01 \\
 & - 0.26790 * \text{Grind Size} \\
 & + 8.902\text{E-}03 * \text{Feed Rate} \\
 & + 3.1728 * \text{Drum Speed} \\
 & - 19.022 * \text{Wash Water} \\
 & + 9.8921 * \% \text{ Solids} \\
 & + 7.396\text{E-}05 * \text{Grind Size}^2 \\
 & + 1.406\text{E-}04 * \text{Feed Rate}^2 \\
 & - 4.037\text{E-}03 * \text{Drum Speed}^2 \\
 & + 3.8679 * \text{Wash Water}^2 \\
 & - 5.168\text{E-}02 * \% \text{ Solids}^2 \\
 & + 1.609\text{E-}04 * \text{Grind Size} * \text{Feed Rate} \\
 & + 5.208\text{E-}04 * \text{Grind Size} * \text{Drum Speed} \\
 & + 1.703\text{E-}02 * \text{Grind Size} * \text{Wash Water} \\
 & + 1.059\text{E-}03 * \text{Grind Size} * \% \text{ Solids} \\
 & - 7.547\text{E-}04 * \text{Feed Rate} * \text{Drum Speed} \\
 & + 3.552\text{E-}02 * \text{Feed Rate} * \text{Wash Water} \\
 & + 2.120\text{E-}03 * \text{Feed Rate} * \% \text{ Solids} \\
 & - 2.758\text{E-}02 * \text{Drum Speed} * \text{Wash Water} \\
 & - 2.796\text{E-}02 * \text{Drum Speed} * \% \text{ Solids} \\
 & + 0.29253 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	69.67	71.97	-2.30	0.642	-1.013	0.088	-1.014	28
2	64.13	64.37	-0.24	0.566	-0.098	0.001	-0.095	13
3	61.10	62.99	-1.89	0.593	-0.779	0.042	-0.771	29
5	52.22	52.68	-0.46	0.617	-0.197	0.003	-0.193	5
6	66.54	63.99	2.55	0.511	0.963	0.046	0.961	39
7	51.53	53.36	-1.83	0.576	-0.742	0.036	-0.733	3
8	65.68	64.25	1.43	0.589	0.587	0.024	0.577	40
9	60.33	60.38	-0.05	0.570	-0.020	0.000	-0.019	43
10	49.76	53.20	-3.44	0.298	-1.083	0.024	-1.088	9
11	64.03	63.45	0.58	0.667	0.263	0.007	0.257	1
12	66.87	62.04	4.83	0.248	1.468	0.034	1.514	2
13	59.44	55.52	3.92	0.540	1.525	0.130	1.581	32
14	50.27	48.97	1.30	0.540	0.505	0.014	0.495	16
15	62.73	61.83	0.90	0.507	0.340	0.006	0.332	30
16	61.09	62.51	-1.42	0.537	-0.550	0.017	-0.541	14
17	57.62	55.27	2.35	0.613	0.995	0.075	0.995	42
18	55.74	54.64	1.10	0.452	0.390	0.006	0.382	25
19	62.34	61.58	0.76	0.508	0.284	0.004	0.278	18
20	62.26	64.11	-1.85	0.507	-0.695	0.024	-0.686	19
22	50.97	52.81	-1.84	0.789	-1.056	0.198	-1.059	21
23	72.58	66.97	5.61	0.288	1.753	0.059	1.857	37
24	59.46	57.16	2.30	0.801	1.361	0.356	1.393	20
25	62.79	67.73	-4.94	0.494	-1.830	0.156	-1.955	31
26	62.12	63.10	-0.98	0.561	-0.389	0.009	-0.380	15
27	62.71	65.38	-2.67	0.507	-1.001	0.049	-1.001	33
28	65.43	64.19	1.24	0.546	0.485	0.013	0.475	12
29	32.93	31.97	0.96	0.514	0.365	0.007	0.356	26
30	61.86	65.80	-3.94	0.553	-1.554	0.142	-1.615	8
31	59.93	61.81	-1.88	0.514	-0.710	0.025	-0.701	36
32	41.95	49.55	-7.60	0.486	-2.796	0.352	-3.491	35
33	60.01	57.11	2.90	0.540	1.128	0.071	1.136	34
34	48.63	49.14	-0.51	0.608	-0.214	0.003	-0.209	17
35	65.71	61.65	4.06	0.512	1.532	0.117	1.590	27
36	62.62	62.01	0.61	0.514	0.232	0.003	0.226	10
37	70.06	70.09	-0.03	0.432	-0.012	0.000	-0.012	6

38	63.39	62.14	1.25	0.331	0.402	0.004	0.393	4
39	65.86	65.47	0.39	0.582	0.160	0.002	0.156	41
40	66.00	64.46	1.54	0.583	0.629	0.026	0.619	24
41	63.28	64.09	-0.81	0.253	-0.248	0.001	-0.242	38
42	60.66	64.48	-3.82	0.235	-1.153	0.019	-1.163	22
43	65.40	63.47	1.93	0.278	0.599	0.007	0.589	7

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Coal Seam:  Pittsburgh No. 8
Circuit:      Individual MGS
Response:     1b SO2/MM Btu
Data File:    P-MGS-00
Comments:     Analysis of Complete Data Set
=====

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FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Grind Size      microns      100.000      300.000
B    Feed Rate       lbs/hr       100.000      300.000
C    Drum Speed      rpm          240.000      320.000
D    Wash Water      lpm          0.500        1.500
E    % Solids        w/w          15.000       35.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	403.553	1	403.553		
Linear	4.329	5	0.866	8.992	0.0001
Quadratic	1.135	15	0.076	0.6857	0.7717
Cubic	2.428	22	0.110		
RESIDUAL	0.000	0			
TOTAL	411.446	43			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	37	0.310	0.5486	0.4876	4.633
Quadratic	21	22	0.332	0.6924	0.4127	7.628
Cubic	43	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4.329	5	0.866	8.992	0.0001
RESIDUAL	3.563	37	0.096		
COR TOTAL	7.892	42			
ROOT MSE	0.310		R-SQUARED	0.5486	
DEP MEAN	3.063		ADJ R-SQUARED	0.4876	
C.V.	10.13%				

Predicted Residual Sum of Squares (PRESS) = 4.633

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	3.077	1	0.047	64.84	
A	0.193	1	0.078	2.492	0.0173
B	-0.020	1	0.079	-0.2572	0.7984
C	-0.410	1	0.078	-5.266	0.0001
D	0.035	1	0.076	0.4619	0.6468
E	-0.248	1	0.078	-3.186	0.0029

Final Equation in Terms of Coded Factors:

$$\begin{aligned}
 \text{SO2 emiss} = & \\
 & 3.077 \\
 & + 0.193 * A \\
 & - 0.020 * B \\
 & - 0.410 * C \\
 & + 0.035 * D \\
 & - 0.248 * E
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned}
 \text{SO2 emiss} = & \\
 & 6.148 \\
 & + 1.935\text{E-}03 * \text{Grind Size} \\
 & - 2.028\text{E-}04 * \text{Feed Rate} \\
 & - 1.024\text{E-}02 * \text{Drum Speed} \\
 & + 7.019\text{E-}02 * \text{Wash Water} \\
 & - 2.480\text{E-}02 * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	2.800	2.877	-0.077	0.149	-0.270	0.002	-0.267	28
2	3.170	3.283	-0.113	0.146	-0.393	0.004	-0.389	13
3	3.000	2.833	0.167	0.184	0.595	0.013	0.590	29
4	4.110	3.257	0.853	0.105	2.905	0.166	3.262	11
5	3.460	3.462	-0.002	0.152	-0.008	0.000	-0.008	5
6	2.730	2.603	0.127	0.139	0.443	0.005	0.438	39
7	3.230	3.492	-0.262	0.153	-0.917	0.025	-0.915	3
8	2.910	2.704	0.206	0.168	0.727	0.018	0.722	40
9	2.840	3.311	-0.471	0.126	-1.622	0.063	-1.660	43
10	2.910	3.282	-0.372	0.099	-1.262	0.029	-1.273	9
11	2.750	2.849	-0.099	0.133	-0.343	0.003	-0.339	1
12	2.630	2.824	-0.194	0.091	-0.655	0.007	-0.650	2
13	3.190	3.290	-0.100	0.151	-0.351	0.004	-0.347	32
14	3.870	3.668	0.202	0.147	0.704	0.014	0.700	16

15	2.740	2.448	0.292	0.147	1.017	0.030	1.018	30
16	2.810	2.844	-0.034	0.153	-0.119	0.000	-0.118	14
17	3.270	3.277	-0.007	0.169	-0.026	0.000	-0.025	42
18	3.120	3.324	-0.204	0.138	-0.708	0.013	-0.703	25
19	2.800	2.771	0.029	0.144	0.101	0.000	0.099	18
20	2.840	2.862	-0.022	0.149	-0.077	0.000	-0.075	19
21	4.610	3.473	1.137	0.119	3.902	0.343	5.018	23
22	3.330	3.480	-0.150	0.215	-0.547	0.014	-0.542	21
23	2.840	2.681	0.159	0.115	0.545	0.006	0.539	37
24	2.780	2.639	0.141	0.207	0.510	0.011	0.504	20
25	2.930	2.847	0.083	0.144	0.288	0.002	0.285	31
26	3.060	3.194	-0.134	0.156	-0.470	0.007	-0.465	15
27	2.830	2.893	-0.063	0.145	-0.219	0.001	-0.216	33
28	2.960	3.279	-0.319	0.153	-1.116	0.037	-1.120	12
29	4.040	3.711	0.329	0.146	1.149	0.038	1.154	26
30	2.950	2.918	0.032	0.164	0.113	0.000	0.111	8
31	3.110	3.221	-0.111	0.148	-0.386	0.004	-0.381	36
32	2.530	2.415	0.115	0.144	0.402	0.005	0.397	35
33	3.120	3.129	-0.009	0.155	-0.033	0.000	-0.032	34
34	3.700	3.537	0.163	0.170	0.576	0.011	0.571	17
35	2.630	2.569	0.061	0.156	0.213	0.001	0.210	27
36	2.740	3.006	-0.266	0.149	-0.929	0.025	-0.927	10
37	2.750	3.065	-0.315	0.142	-1.094	0.033	-1.097	6
38	2.740	3.030	-0.290	0.104	-0.986	0.019	-0.986	4
39	3.310	3.138	0.172	0.171	0.607	0.013	0.602	41
40	2.900	3.080	-0.180	0.173	-0.638	0.014	-0.632	24
41	2.970	3.056	-0.086	0.028	-0.281	0.000	-0.278	38
42	2.760	3.058	-0.298	0.033	-0.978	0.005	-0.977	22
43	2.960	3.049	-0.089	0.024	-0.290	0.000	-0.287	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	5.464	20	0.273	2.476	0.0208
RESIDUAL	2.428	22	0.110		
COR TOTAL	7.892	42			
ROOT MSE	0.332		R-SQUARED	0.6924	
DEP MEAN	3.063		ADJ R-SQUARED	0.4127	
C.V.	10.84%				

Predicted Residual Sum of Squares (PRESS) = 7.628

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	3.010	1	0.172	17.53	
A	0.195	1	0.085	2.279	0.0327
B	-0.025	1	0.092	-0.2696	0.7900
C	-0.426	1	0.084	-5.040	0.0001
D	0.036	1	0.083	0.4344	0.6683
E	-0.242	1	0.085	-2.845	0.0094
A2	0.088	1	0.124	0.7097	0.4853
B2	-0.003	1	0.124	-2.59E-02	0.9796
C2	0.210	1	0.123	1.702	0.1028
D2	-0.064	1	0.119	-0.5353	0.5978
E2	-0.052	1	0.133	-0.3911	0.6995
AB	0.064	1	0.176	0.3647	0.7189
AC	-0.169	1	0.167	-1.014	0.3218
AD	-0.004	1	0.162	-2.38E-02	0.9812
AE	-0.110	1	0.162	-0.6775	0.5052
BC	0.178	1	0.143	1.239	0.2283
BD	-0.142	1	0.157	-0.9066	0.3744
BE	-0.098	1	0.236	-0.4159	0.6815
CD	0.120	1	0.172	0.6970	0.4931
CE	0.100	1	0.172	0.5851	0.5645
DE	-0.001	1	0.163	-6.30E-03	0.9950

Final Equation in Terms of Coded Factors:

SO2 emiss =

$$\begin{aligned}
 & 3.010 \\
 & + 0.195 * A \\
 & - 0.025 * B \\
 & - 0.426 * C \\
 & + 0.036 * D \\
 & - 0.242 * E \\
 & + 0.088 * A^2 \\
 & - 0.003 * B^2 \\
 & + 0.210 * C^2 \\
 & - 0.064 * D^2 \\
 & - 0.052 * E^2 \\
 & + 0.064 * AB \\
 & - 0.169 * AC \\
 & - 0.004 * AD \\
 & - 0.110 * AE \\
 & + 0.178 * BC \\
 & - 0.142 * BD \\
 & - 0.098 * BE \\
 & + 0.120 * CD \\
 & + 0.100 * CE \\
 & - 0.001 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

SO2 emiss =

$$\begin{aligned}
 & 18.402 \\
 & + 1.179E-02 * \text{Grind Size} \\
 & - 8.545E-03 * \text{Feed Rate} \\
 & - 9.673E-02 * \text{Drum Speed} \\
 & - 0.51206 * \text{Wash Water} \\
 & - 2.661E-02 * \% \text{ Solids} \\
 & + 8.835E-06 * \text{Grind Size}^2 \\
 & - 3.204E-07 * \text{Feed Rate}^2 \\
 & + 1.310E-04 * \text{Drum Speed}^2 \\
 & - 0.25519 * \text{Wash Water}^2 \\
 & - 5.203E-04 * \% \text{ Solids}^2 \\
 & + 6.433E-06 * \text{Grind Size} * \text{Feed Rate} \\
 & - 4.230E-05 * \text{Grind Size} * \text{Drum Speed} \\
 & - 7.718E-05 * \text{Grind Size} * \text{Wash Water} \\
 & - 1.098E-04 * \text{Grind Size} * \% \text{ Solids} \\
 & + 4.440E-05 * \text{Feed Rate} * \text{Drum Speed} \\
 & - 2.839E-03 * \text{Feed Rate} * \text{Wash Water} \\
 & - 9.825E-05 * \text{Feed Rate} * \% \text{ Solids} \\
 & + 6.009E-03 * \text{Drum Speed} * \text{Wash Water} \\
 & + 2.510E-04 * \text{Drum Speed} * \% \text{ Solids} \\
 & - 2.060E-04 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	2.800	2.933	-0.133	0.612	-0.643	0.031	-0.634	28
2	3.170	3.225	-0.055	0.559	-0.248	0.004	-0.242	13
3	3.000	2.771	0.229	0.582	1.067	0.076	1.070	29
4	4.110	3.318	0.792	0.284	2.818	0.150	3.443	11
5	3.460	3.696	-0.236	0.551	-1.062	0.066	-1.065	5
6	2.730	2.535	0.195	0.504	0.834	0.034	0.828	39
7	3.230	3.560	-0.330	0.526	-1.441	0.110	-1.480	3
8	2.910	2.883	0.027	0.585	0.127	0.001	0.125	40
9	2.840	3.103	-0.263	0.568	-1.204	0.091	-1.217	43
10	2.910	3.230	-0.320	0.295	-1.148	0.026	-1.156	9
11	2.750	2.832	-0.082	0.649	-0.414	0.015	-0.406	1
12	2.630	2.673	-0.043	0.243	-0.148	0.000	-0.144	2
13	3.190	3.352	-0.162	0.522	-0.707	0.026	-0.698	32
14	3.870	4.046	-0.176	0.501	-0.748	0.027	-0.740	16
15	2.740	2.845	-0.105	0.507	-0.452	0.010	-0.444	30
16	2.810	2.928	-0.118	0.515	-0.510	0.013	-0.501	14
17	3.270	3.157	0.113	0.608	0.545	0.022	0.537	42
18	3.120	3.152	-0.032	0.450	-0.131	0.001	-0.128	25
19	2.800	2.596	0.204	0.503	0.871	0.037	0.866	18
20	2.840	2.643	0.197	0.504	0.842	0.034	0.836	19
21	4.610	3.743	0.867	0.289	3.094	0.185	4.022	23
22	3.330	3.401	-0.071	0.773	-0.448	0.033	-0.439	21
23	2.840	2.672	0.168	0.287	0.597	0.007	0.588	37
24	2.780	2.995	-0.215	0.762	-1.326	0.269	-1.350	20
25	2.930	2.799	0.131	0.492	0.552	0.014	0.543	31
26	3.060	3.156	-0.096	0.535	-0.425	0.010	-0.417	15
27	2.830	2.870	-0.040	0.506	-0.169	0.001	-0.166	33
28	2.960	3.207	-0.247	0.524	-1.077	0.061	-1.081	12
29	4.040	3.881	0.159	0.501	0.677	0.022	0.669	26
30	2.950	2.849	0.101	0.549	0.453	0.012	0.445	8
31	3.110	3.176	-0.066	0.495	-0.279	0.004	-0.273	36
32	2.530	2.591	-0.061	0.483	-0.254	0.003	-0.249	35
33	3.120	2.983	0.137	0.538	0.608	0.021	0.599	34
34	3.700	3.673	0.027	0.581	0.125	0.001	0.122	17
35	2.630	2.687	-0.057	0.510	-0.244	0.003	-0.239	27

36	2.740	2.867	-0.127	0.490	-0.537	0.013	-0.529	10
37	2.750	2.809	-0.059	0.425	-0.233	0.002	-0.227	6
38	2.740	2.998	-0.258	0.318	-0.940	0.020	-0.937	4
39	3.310	3.148	0.162	0.578	0.753	0.037	0.745	41
40	2.900	2.782	0.118	0.578	0.545	0.019	0.536	24
41	2.970	2.991	-0.021	0.237	-0.072	0.000	-0.071	38
42	2.760	2.994	-0.234	0.220	-0.799	0.009	-0.792	22
43	2.960	2.982	-0.022	0.260	-0.075	0.000	-0.074	7

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Coal Seam: Pittsburgh No. 8
Circuit: Individual MGS
Response: lb SO2/MM Btu
Data File: P-MGS-00
Comments: Analysis with Outliers Removed
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Grind Size      microns      100.000      300.000
B      Feed Rate       lbs/hr       100.000      300.000
C      Drum Speed      rpm          240.000      320.000
D      Wash Water      lpm          0.500        1.500
E      % Solids         w/w          15.000       35.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	384.750	1	384.750		
Linear	3.347	5	0.669	11.49	0.0001
Quadratic	0.725	15	0.048	0.7402	0.7216
Cubic	1.371	21	0.065		
RESIDUAL	0.000	0			
TOTAL	390.193	42			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	6	36	0.241	0.6148	0.5614	2.755
Quadratic	21	21	0.256	0.7481	0.5081	4.699
Cubic	42	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	3.347	5	0.669	11.49	0.0001
RESIDUAL	2.097	36	0.058		
COR TOTAL	5.444	41			
ROOT MSE	0.241		R-SQUARED	0.6148	
DEP MEAN	3.027		ADJ R-SQUARED	0.5614	
C.V.	7.97%				

Predicted Residual Sum of Squares (PRESS) = 2.755

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	3.046	1	0.037	81.33	
A	0.192	1	0.060	3.174	0.0031
B	0.038	1	0.062	0.6028	0.5504
C	-0.325	1	0.063	-5.169	0.0001
D	0.036	1	0.059	0.6133	0.5436
E	-0.253	1	0.061	-4.176	0.0002

Final Equation in Terms of Coded Factors:

$$\begin{aligned}
 \text{SO2 emiss} = & 3.046 \\
 & + 0.192 * A \\
 & + 0.038 * B \\
 & - 0.325 * C \\
 & + 0.036 * D \\
 & - 0.253 * E
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned}
 \text{SO2 emiss} = & 5.419 \\
 & + 1.916\text{E-}03 * \text{Grind Size} \\
 & + 3.761\text{E-}04 * \text{Feed Rate} \\
 & - 8.117\text{E-}03 * \text{Drum Speed} \\
 & + 7.246\text{E-}02 * \text{Wash Water} \\
 & - 2.528\text{E-}02 * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	2.800	2.794	0.006	0.154	0.029	0.000	0.028	28
2	3.170	3.197	-0.027	0.151	-0.121	0.000	-0.119	13
3	3.000	2.873	0.127	0.185	0.584	0.013	0.578	29
4	4.110	3.258	0.852	0.105	3.731	0.273	4.697	11
5	3.460	3.321	0.139	0.165	0.631	0.013	0.626	5
6	2.730	2.648	0.082	0.141	0.365	0.004	0.361	39
7	3.230	3.360	-0.130	0.164	-0.590	0.011	-0.584	3
8	2.910	2.730	0.180	0.168	0.820	0.023	0.816	40
9	2.840	3.236	-0.396	0.130	-1.760	0.077	-1.815	43
10	2.910	3.290	-0.380	0.099	-1.657	0.050	-1.700	9
11	2.750	2.760	-0.010	0.138	-0.047	0.000	-0.046	1
12	2.630	2.807	-0.177	0.091	-0.772	0.010	-0.767	2
13	3.190	3.180	0.010	0.159	0.044	0.000	0.043	32
14	3.870	3.562	0.308	0.155	1.390	0.059	1.409	16

15	2.740	2.502	0.238	0.149	1.069	0.033	1.072	30
16	2.810	2.907	-0.097	0.155	-0.439	0.006	-0.434	14
17	3.270	3.270	0.000	0.169	0.000	0.000	0.000	42
18	3.120	3.300	-0.180	0.139	-0.803	0.017	-0.799	25
19	2.800	2.743	0.057	0.144	0.253	0.002	0.250	18
20	2.840	2.836	0.004	0.149	0.019	0.000	0.018	19
22	3.330	3.449	-0.119	0.215	-0.559	0.014	-0.553	21
23	2.840	2.692	0.148	0.115	0.650	0.009	0.644	37
24	2.780	2.770	0.010	0.219	0.047	0.000	0.046	20
25	2.930	2.819	0.111	0.145	0.499	0.007	0.494	31
26	3.060	3.170	-0.110	0.156	-0.495	0.008	-0.490	15
27	2.830	2.864	-0.034	0.145	-0.150	0.001	-0.148	33
28	2.960	3.255	-0.295	0.153	-1.327	0.053	-1.341	12
29	4.040	3.610	0.430	0.153	1.937	0.113	2.018	26
30	2.950	2.963	-0.013	0.165	-0.058	0.000	-0.057	8
31	3.110	3.114	-0.004	0.155	-0.020	0.000	-0.020	36
32	2.530	2.468	0.062	0.146	0.280	0.002	0.276	35
33	3.120	3.107	0.013	0.155	0.058	0.000	0.057	34
34	3.700	3.531	0.169	0.170	0.766	0.020	0.762	17
35	2.630	2.541	0.089	0.156	0.402	0.005	0.397	27
36	2.740	2.979	-0.239	0.149	-1.073	0.034	-1.075	10
37	2.750	2.974	-0.224	0.147	-1.005	0.029	-1.005	6
38	2.740	3.039	-0.299	0.104	-1.309	0.033	-1.323	4
39	3.310	3.052	0.258	0.176	1.178	0.050	1.185	41
40	2.900	3.117	-0.217	0.173	-0.989	0.034	-0.989	24
41	2.970	3.010	-0.040	0.029	-0.168	0.000	-0.166	38
42	2.760	3.005	-0.245	0.034	-1.035	0.006	-1.036	22
43	2.960	3.017	-0.057	0.025	-0.238	0.000	-0.235	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4.072	20	0.204	3.118	0.0063
RESIDUAL	1.371	21	0.065		
COR TOTAL	5.444	41			
ROOT MSE	0.256		R-SQUARED	0.7481	
DEP MEAN	3.027		ADJ R-SQUARED	0.5081	
C.V.	8.44%				

Predicted Residual Sum of Squares (PRESS) = 4.699

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	2.949	1	0.133	22.17	
A	0.194	1	0.066	2.946	0.0077
B	0.030	1	0.072	0.4088	0.6868
C	-0.340	1	0.068	-4.982	0.0001
D	0.033	1	0.064	0.5151	0.6119
E	-0.245	1	0.065	-3.753	0.0012
A2	0.133	1	0.096	1.379	0.1823
B2	-0.006	1	0.095	-5.95E-02	0.9531
C2	0.147	1	0.096	1.531	0.1407
D2	-0.010	1	0.093	-0.1057	0.9169
E2	-0.010	1	0.103	-9.67E-02	0.9239
AB	0.072	1	0.136	0.5290	0.6023
AC	-0.156	1	0.128	-1.218	0.2368
AD	-0.002	1	0.125	-1.46E-02	0.9885
AE	-0.106	1	0.125	-0.8508	0.4045
BC	0.017	1	0.117	0.1427	0.8879
BD	-0.129	1	0.120	-1.068	0.2977
BE	-0.057	1	0.182	-0.3146	0.7562
CD	0.106	1	0.133	0.8012	0.4320
CE	0.130	1	0.132	0.9817	0.3374
DE	-0.002	1	0.126	-1.87E-02	0.9853

Final Equation in Terms of Coded Factors:

SO2 emiss =

$$\begin{aligned}
 & 2.949 \\
 & + 0.194 * A \\
 & + 0.030 * B \\
 & - 0.340 * C \\
 & + 0.033 * D \\
 & - 0.245 * E \\
 & + 0.133 * A^2 \\
 & - 0.006 * B^2 \\
 & + 0.147 * C^2 \\
 & - 0.010 * D^2 \\
 & - 0.010 * E^2 \\
 & + 0.072 * AB \\
 & - 0.156 * AC \\
 & - 0.002 * AD \\
 & - 0.106 * AE \\
 & + 0.017 * BC \\
 & - 0.129 * BD \\
 & - 0.057 * BE \\
 & + 0.106 * CD \\
 & + 0.130 * CE \\
 & - 0.002 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

SO2 emiss =

$$\begin{aligned}
 &13.787 \\
 &+ 8.820E-03 * \text{Grind Size} \\
 &+ 1.919E-03 * \text{Feed Rate} \\
 &- 6.642E-02 * \text{Drum Speed} \\
 &- 0.81098 * \text{Wash Water} \\
 &- 7.728E-02 * \% \text{ Solids} \\
 &+ 1.330E-05 * \text{Grind Size}^2 \\
 &- 5.663E-07 * \text{Feed Rate}^2 \\
 &+ 9.190E-05 * \text{Drum Speed}^2 \\
 &- 3.916E-02 * \text{Wash Water}^2 \\
 &- 9.942E-05 * \% \text{ Solids}^2 \\
 &+ 7.181E-06 * \text{Grind Size} * \text{Feed Rate} \\
 &- 3.911E-05 * \text{Grind Size} * \text{Drum Speed} \\
 &- 3.635E-05 * \text{Grind Size} * \text{Wash Water} \\
 &- 1.061E-04 * \text{Grind Size} * \% \text{ Solids} \\
 &+ 4.184E-06 * \text{Feed Rate} * \text{Drum Speed} \\
 &- 2.573E-03 * \text{Feed Rate} * \text{Wash Water} \\
 &- 5.725E-05 * \text{Feed Rate} * \% \text{ Solids} \\
 &+ 5.316E-03 * \text{Drum Speed} * \text{Wash Water} \\
 &+ 3.245E-04 * \text{Drum Speed} * \% \text{ Solids} \\
 &- 4.701E-04 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	2.800	2.884	-0.084	0.614	-0.530	0.021	-0.521	28
2	3.170	3.153	0.017	0.564	0.103	0.001	0.100	13
3	3.000	2.812	0.188	0.584	1.139	0.087	1.147	29
4	4.110	3.336	0.774	0.285	3.582	0.243	5.603	11
5	3.460	3.441	0.019	0.613	0.121	0.001	0.118	5
6	2.730	2.578	0.152	0.506	0.844	0.035	0.838	39
7	3.230	3.341	-0.111	0.571	-0.664	0.028	-0.654	3
8	2.910	2.932	-0.022	0.588	-0.137	0.001	-0.133	40
9	2.840	3.066	-0.226	0.570	-1.350	0.115	-1.379	43
10	2.910	3.216	-0.306	0.295	-1.426	0.041	-1.464	9
11	2.750	2.720	0.030	0.661	0.204	0.004	0.199	1
12	2.630	2.682	-0.052	0.243	-0.236	0.001	-0.230	2
13	3.190	3.217	-0.027	0.539	-0.158	0.001	-0.154	32
14	3.870	3.910	-0.040	0.518	-0.225	0.003	-0.220	16
15	2.740	2.845	-0.105	0.507	-0.584	0.017	-0.574	30
16	2.810	2.928	-0.118	0.515	-0.665	0.022	-0.656	14
17	3.270	3.214	0.056	0.611	0.351	0.009	0.343	42
18	3.120	3.177	-0.057	0.451	-0.300	0.004	-0.293	25
19	2.800	2.647	0.153	0.506	0.851	0.035	0.846	18
20	2.840	2.689	0.151	0.506	0.843	0.035	0.837	19
22	3.330	3.499	-0.169	0.782	-1.416	0.343	-1.453	21
23	2.840	2.710	0.130	0.288	0.605	0.007	0.596	37
24	2.780	2.808	-0.028	0.795	-0.245	0.011	-0.239	20
25	2.930	2.846	0.084	0.494	0.462	0.010	0.454	31
26	3.060	3.215	-0.155	0.539	-0.892	0.044	-0.888	15
27	2.830	2.898	-0.068	0.506	-0.377	0.007	-0.370	33
28	2.960	3.256	-0.296	0.526	-1.681	0.149	-1.763	12
29	4.040	3.775	0.265	0.511	1.484	0.110	1.531	26
30	2.950	2.863	0.087	0.549	0.507	0.015	0.498	8
31	3.110	3.038	0.072	0.513	0.402	0.008	0.394	36
32	2.530	2.616	-0.086	0.484	-0.469	0.010	-0.461	35
33	3.120	3.016	0.104	0.539	0.597	0.020	0.588	34
34	3.700	3.712	-0.012	0.582	-0.073	0.000	-0.071	17
35	2.630	2.721	-0.091	0.512	-0.512	0.013	-0.502	27
36	2.740	2.911	-0.171	0.492	-0.937	0.041	-0.934	10

37	2.750	2.753	-0.003	0.428	-0.015	0.000	-0.015	6
38	2.740	3.016	-0.276	0.318	-1.307	0.038	-1.331	4
39	3.310	3.087	0.223	0.581	1.350	0.120	1.378	41
40	2.900	2.844	0.056	0.582	0.336	0.007	0.329	24
41	2.970	2.915	0.055	0.242	0.246	0.001	0.240	38
42	2.760	2.911	-0.151	0.227	-0.674	0.006	-0.665	22
43	2.960	2.921	0.039	0.264	0.180	0.001	0.176	7

16	2.810	2.820	-0.010	0.165	-0.059	0.000	-0.058	14
17	3.270	3.237	0.033	0.171	0.191	0.001	0.189	42
18	3.120	3.279	-0.159	0.139	-0.892	0.021	-0.889	25
19	2.800	2.718	0.082	0.145	0.463	0.006	0.458	18
20	2.840	2.808	0.032	0.150	0.179	0.001	0.176	19
22	3.330	3.379	-0.049	0.221	-0.292	0.004	-0.288	21
23	2.840	2.694	0.146	0.115	0.810	0.014	0.806	37
24	2.780	2.702	0.078	0.224	0.464	0.010	0.459	20
25	2.930	2.854	0.076	0.147	0.430	0.005	0.425	31
26	3.060	3.085	-0.025	0.165	-0.140	0.001	-0.138	15
27	2.830	2.900	-0.070	0.147	-0.397	0.005	-0.392	33
28	2.960	3.170	-0.210	0.162	-1.195	0.046	-1.202	12
29	4.040	3.586	0.454	0.154	2.575	0.201	2.819	26
30	2.950	2.949	0.001	0.165	0.004	0.000	0.004	8
31	3.110	3.086	0.024	0.156	0.137	0.001	0.135	36
32	2.530	2.442	0.088	0.147	0.500	0.007	0.494	35
33	3.120	3.143	-0.023	0.157	-0.129	0.001	-0.127	34
34	3.700	3.439	0.261	0.180	1.505	0.083	1.534	17
35	2.630	2.578	0.052	0.158	0.295	0.003	0.291	27
36	2.740	2.893	-0.153	0.158	-0.870	0.024	-0.867	10
37	2.750	2.986	-0.236	0.147	-1.335	0.051	-1.350	6
38	2.740	2.993	-0.253	0.107	-1.395	0.039	-1.415	4
39	3.310	3.063	0.247	0.176	1.419	0.072	1.441	41
40	2.900	3.057	-0.157	0.178	-0.904	0.029	-0.902	24
41	2.970	2.996	-0.026	0.029	-0.140	0.000	-0.138	38
42	2.760	2.996	-0.236	0.035	-1.253	0.009	-1.263	22
43	2.960	2.995	-0.035	0.025	-0.185	0.000	-0.183	7

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	3.708	20	0.185	6.947	0.0001
RESIDUAL	0.534	20	0.027		
COR TOTAL	4.241	40			
ROOT MSE	0.163		R-SQUARED	0.8742	
DEP MEAN	3.000		ADJ R-SQUARED	0.7483	
C.V.	5.44%				

Predicted Residual Sum of Squares (PRESS) = 2.370

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	2.838	1	0.087	32.52	
A	0.140	1	0.043	3.240	0.0041
B	-0.027	1	0.047	-0.5780	0.5697
C	-0.344	1	0.044	-7.875	0.0001
D	0.033	1	0.041	0.8003	0.4330
E	-0.248	1	0.042	-5.951	0.0001
A2	0.119	1	0.062	1.923	0.0689
B2	0.014	1	0.061	0.2276	0.8223
C2	0.226	1	0.063	3.582	0.0019
D2	0.061	1	0.061	1.002	0.3284
E2	0.073	1	0.067	1.086	0.2902
AB	-0.096	1	0.092	-1.047	0.3078
AC	-0.159	1	0.082	-1.939	0.0667
AD	0.004	1	0.080	5.28E-02	0.9584
AE	-0.100	1	0.080	-1.253	0.2246
BC	0.023	1	0.075	0.3013	0.7663
BD	-0.094	1	0.077	-1.214	0.2388
BE	-0.101	1	0.117	-0.8669	0.3963
CD	0.085	1	0.085	1.007	0.3262
CE	0.130	1	0.085	1.542	0.1386
DE	-0.012	1	0.080	-0.1552	0.8782

Final Equation in Terms of Coded Factors:

SO2 emiss =

$$\begin{aligned}
 &2.838 \\
 &+ 0.140 * A \\
 &- 0.027 * B \\
 &- 0.344 * C \\
 &+ 0.033 * D \\
 &- 0.248 * E \\
 &+ 0.119 * A^2 \\
 &+ 0.014 * B^2 \\
 &+ 0.226 * C^2 \\
 &+ 0.061 * D^2 \\
 &+ 0.073 * E^2 \\
 &- 0.096 * AB \\
 &- 0.159 * AC \\
 &+ 0.004 * AD \\
 &- 0.100 * AE \\
 &+ 0.023 * BC \\
 &- 0.094 * BD \\
 &- 0.101 * BE \\
 &+ 0.085 * CD \\
 &+ 0.130 * CE \\
 &- 0.012 * DE
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

SO2 emiss =

$$\begin{aligned}
 & 17.613 \\
 & + 1.213\text{E-}02 * \text{Grind Size} \\
 & + 3.916\text{E-}03 * \text{Feed Rate} \\
 & - 9.312\text{E-}02 * \text{Drum Speed} \\
 & - 1.1959 * \text{Wash Water} \\
 & - 0.11004 * \% \text{ Solids} \\
 & + 1.186\text{E-}05 * \text{Grind Size}^2 \\
 & + 1.386\text{E-}06 * \text{Feed Rate}^2 \\
 & + 1.410\text{E-}04 * \text{Drum Speed}^2 \\
 & + 0.24264 * \text{Wash Water}^2 \\
 & + 7.324\text{E-}04 * \% \text{ Solids}^2 \\
 & - 9.607\text{E-}06 * \text{Grind Size} * \text{Feed Rate} \\
 & - 3.981\text{E-}05 * \text{Grind Size} * \text{Drum Speed} \\
 & + 8.416\text{E-}05 * \text{Grind Size} * \text{Wash Water} \\
 & - 9.989\text{E-}05 * \text{Grind Size} * \% \text{ Solids} \\
 & + 5.647\text{E-}06 * \text{Feed Rate} * \text{Drum Speed} \\
 & - 1.876\text{E-}03 * \text{Feed Rate} * \text{Wash Water} \\
 & - 1.011\text{E-}04 * \text{Feed Rate} * \% \text{ Solids} \\
 & + 4.273\text{E-}03 * \text{Drum Speed} * \text{Wash Water} \\
 & + 3.259\text{E-}04 * \text{Drum Speed} * \% \text{ Solids} \\
 & - 2.496\text{E-}03 * \text{Wash Water} * \% \text{ Solids}
 \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	2.800	2.731	0.069	0.642	0.704	0.042	0.695	28
2	3.170	3.199	-0.029	0.566	-0.265	0.004	-0.259	13
3	3.000	2.897	0.103	0.593	0.985	0.067	0.984	29
5	3.460	3.497	-0.037	0.617	-0.369	0.010	-0.361	5
6	2.730	2.643	0.087	0.511	0.760	0.029	0.752	39
7	3.230	3.404	-0.174	0.576	-1.639	0.174	-1.717	3
8	2.910	2.966	-0.056	0.589	-0.532	0.019	-0.522	40
9	2.840	3.059	-0.219	0.570	-2.041	0.262	-2.235	43
10	2.910	3.169	-0.259	0.298	-1.893	0.072	-2.036	9
11	2.750	2.794	-0.044	0.667	-0.463	0.020	-0.454	1
12	2.630	2.619	0.011	0.248	0.078	0.000	0.076	2
13	3.190	3.233	-0.043	0.540	-0.392	0.009	-0.383	32
14	3.870	3.774	0.096	0.540	0.863	0.042	0.857	16
15	2.740	2.850	-0.110	0.507	-0.961	0.045	-0.959	30
16	2.810	2.790	0.020	0.537	0.177	0.002	0.173	14
17	3.270	3.256	0.014	0.613	0.133	0.001	0.130	42
18	3.120	3.209	-0.089	0.452	-0.739	0.021	-0.730	25
19	2.800	2.688	0.112	0.508	0.979	0.047	0.978	18
20	2.840	2.711	0.129	0.507	1.128	0.062	1.136	19
22	3.330	3.425	-0.095	0.789	-1.266	0.285	-1.286	21
23	2.840	2.723	0.117	0.288	0.852	0.014	0.846	37
24	2.780	2.738	0.042	0.801	0.573	0.063	0.563	20
25	2.930	2.857	0.073	0.494	0.624	0.018	0.614	31
26	3.060	3.078	-0.018	0.561	-0.164	0.002	-0.160	15
27	2.830	2.884	-0.054	0.507	-0.474	0.011	-0.465	33
28	2.960	3.127	-0.167	0.546	-1.519	0.132	-1.574	12
29	4.040	3.822	0.218	0.514	1.913	0.184	2.062	26
30	2.950	2.919	0.031	0.553	0.283	0.005	0.277	8
31	3.110	3.060	0.050	0.514	0.435	0.010	0.426	36
32	2.530	2.657	-0.127	0.486	-1.083	0.053	-1.088	35
33	3.120	3.046	0.074	0.540	0.671	0.025	0.662	34
34	3.700	3.566	0.134	0.608	1.310	0.127	1.336	17
35	2.630	2.740	-0.110	0.512	-0.966	0.047	-0.964	27
36	2.740	2.776	-0.036	0.514	-0.314	0.005	-0.307	10
37	2.750	2.814	-0.064	0.432	-0.519	0.010	-0.509	6

APPENDIX 3-D

Box-Behnken Statistical Analyses

Independent MGS Tests
Illinois No. 6 Seam Coal

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Coal Seam:  Illinois No. 6
Circuit:    Individual MGS
Data File:  I-MGS-00
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FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Drum Speed	rpm	240.000	320.000
B	% Solids	w/w	17.000	33.000
C	Wash Water	lpm	0.000	1.500
D	Feed Rate	lbs/hr	150.000	300.000

				A	B	C	D	Y1
	Dsn	Run		Drum Speed	% Solids	Wash Water	Feed Rate	Comb. rec
Obs	ID	Ord	Blk	rpm	w/w	lpm	lbs/hr	%
24	24	1	1	280.0	30.71	0.760	345.2	90.48
25	0	2	1	280.0	24.16	0.760	198.6	87.24
16	16	3	1	281.0	34.63	1.630	199.6	87.05
20	20	4	1	321.0	25.81	1.510	212.4	87.07
13	13	5	1	280.0	18.95	0.000	234.4	87.98
23	23	6	1	280.0	17.14	0.760	306.2	94.37
26	0	7	1	281.0	29.60	0.800	241.9	87.55
8	8	8	1	283.0	24.46	1.510	272.4	90.57
7	7	9	1	280.0	26.32	0.000	293.4	83.08
22	22	10	1	281.0	33.89	0.830	140.9	87.59
27	0	11	1	283.0	25.56	0.680	210.4	83.73
2	2	12	1	320.0	17.06	0.830	206.8	88.56
19	19	13	1	241.0	26.40	1.550	216.3	94.66
10	10	14	1	320.0	28.13	0.760	141.2	82.80
4	4	15	1	320.0	37.77	0.800	229.7	82.35
11	11	16	1	240.0	24.36	0.760	267.4	92.87
5	5	17	1	280.0	30.11	0.000	154.6	76.39
3	3	18	1	241.0	37.18	0.800	225.2	93.42
12	12	19	1	320.0	25.38	0.760	279.1	84.35
21	21	20	1	281.0	18.24	0.830	135.9	90.42
6	6	21	1	280.0	28.63	1.590	148.1	87.18
9	9	22	1	240.0	29.61	0.800	153.0	89.54
1	1	23	1	241.0	17.22	0.830	209.5	96.46
15	15	24	1	281.0	17.30	1.590	213.9	94.61
18	18	25	1	322.0	25.72	0.000	216.8	78.35
17	17	26	1	241.0	26.20	0.000	226.6	90.87
14	14	27	1	281.0	37.75	0.000	260.0	84.50

				Y2	Y3	Y4	Y5	Y6
	Dsn	Run		Ash rej	Sulfur rej	Pyr rej	Energy rec	Efficiency
Obs	ID	Ord	Blk	%	%	%	%	%
24	24	1	1	38.65	43.22	49.65	92.14	40.12
25	0	2	1	50.09	56.49	64.01	89.76	51.25
16	16	3	1	50.05	57.55	66.46	89.61	53.51
20	20	4	1	49.93	53.01	64.65	89.28	51.72
13	13	5	1	42.23	55.50	59.97	90.24	47.95
23	23	6	1	24.23	36.81	38.00	95.61	32.38
26	0	7	1	51.07	54.69	59.85	89.73	47.40
8	8	8	1	43.08	48.85	55.50	92.52	46.07
7	7	9	1	52.95	56.50	63.70	85.11	46.77
22	22	10	1	44.93	53.58	61.72	89.62	49.31
27	0	11	1	54.47	62.01	65.56	86.49	49.29
2	2	12	1	41.02	52.28	56.33	90.61	44.89
19	19	13	1	32.64	44.91	49.19	96.32	43.84
10	10	14	1	55.76	56.95	67.83	84.99	50.62
4	4	15	1	52.47	59.88	71.08	84.65	53.43
11	11	16	1	33.08	46.68	50.85	94.46	43.72
5	5	17	1	62.28	63.43	68.51	78.90	44.90
3	3	18	1	32.98	50.65	51.75	95.23	45.18
12	12	19	1	52.00	55.47	62.51	86.38	46.86
21	21	20	1	42.72	52.73	60.41	92.64	50.83
6	6	21	1	51.24	60.36	67.91	89.97	55.10
9	9	22	1	45.29	58.49	64.63	92.23	54.17
1	1	23	1	13.84	33.27	50.13	97.31	46.60
15	15	24	1	23.14	36.13	53.76	95.84	48.37
18	18	25	1	55.37	61.80	80.03	80.70	58.38
17	17	26	1	25.91	42.78	60.62	92.20	51.48
14	14	27	1	46.01	54.02	77.23	86.47	61.72

				Y7
Obs	Dsn ID	Run Ord	Blk	SO2 emiss lbs/MMBtu
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24	24	1	1	4.570
25	0	2	1	4.430
16	16	3	1	4.510
20	20	4	1	4.400
13	13	5	1	4.750
23	23	6	1	5.290
26	0	7	1	4.410
8	8	8	1	4.650
7	7	9	1	4.290
22	22	10	1	4.230
27	0	11	1	4.830
2	2	12	1	4.860
19	19	13	1	5.210
10	10	14	1	4.420
4	4	15	1	4.320
11	11	16	1	5.110
5	5	17	1	4.430
3	3	18	1	5.050
12	12	19	1	4.170
21	21	20	1	4.750
6	6	21	1	4.790
9	9	22	1	5.310
1	1	23	1	6.470
15	15	24	1	5.510
18	18	25	1	4.220
17	17	26	1	5.740
14	14	27	1	4.700


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Coal Seam:  Illinois No. 6
Circuit:    Individual MGS
Response:   Combustible Recovery
Data File:  I-MGS-00
Comments:   Analysis of Complete Data Set
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FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Drum Speed	rpm	240.000	320.000
B	% Solids	w/w	17.000	33.000
C	Wash Water	lpm	0.000	1.500
D	Feed Rate	lbs/hr	150.000	300.000

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	208743.2	1	208743.2		
Linear	509.3	4	127.3	21.27	0.0001
Quadratic	88.7	10	8.9	2.476	0.0697
Cubic	43.0	12	3.6		
RESIDUAL	0.0	0			
TOTAL	209384.1	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	2.45	0.7945	0.7572	201.05
Quadratic	15	12	1.89	0.9329	0.8547	216.79
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	509.3	4	127.31	21.27	0.0001
RESIDUAL	131.7	22	5.99		
COR TOTAL	641.0	26			
ROOT MSE	2.45		R-SQUARED	0.7945	
DEP MEAN	87.93		ADJ R-SQUARED	0.7572	
C.V.	2.78%				

Predicted Residual Sum of Squares (PRESS) = 201.0

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	88.42	1	0.49	180.7	
A	-4.53	1	0.71	-6.398	0.0001
B	-2.20	1	0.61	-3.610	0.0016
C	3.36	1	0.69	4.901	0.0001
D	1.76	1	0.68	2.572	0.0174

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Comb. rec} = & 88.42 \\ & - 4.53 * A \\ & - 2.20 * B \\ & + 3.36 * C \\ & + 1.76 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Comb. rec} = & 118.36 \\ & - 0.11316 * \text{Drum Speed} \\ & - 0.27559 * \% \text{ Solids} \\ & + 4.4848 * \text{Wash Water} \\ & + 2.342\text{E-}02 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	96.46	94.97	1.49	0.209	0.684	0.025	0.676	23
2	88.56	86.01	2.55	0.208	1.170	0.072	1.180	12
3	93.42	89.70	3.72	0.228	1.728	0.176	1.816	18
4	82.35	80.71	1.64	0.245	0.772	0.039	0.765	15
5	76.39	82.00	-5.61	0.209	-2.577	0.350	-3.013	17
6	87.18	89.39	-2.21	0.179	-0.995	0.043	-0.994	21
7	83.08	86.29	-3.21	0.172	-1.443	0.087	-1.482	9
8	90.57	92.75	-2.18	0.167	-0.974	0.038	-0.973	8
9	89.54	90.21	-0.67	0.193	-0.306	0.004	-0.299	22
10	82.80	81.11	1.69	0.203	0.773	0.030	0.765	14
11	92.87	94.16	-1.29	0.157	-0.573	0.012	-0.565	16
12	84.35	85.10	-0.75	0.168	-0.336	0.005	-0.329	19
13	87.98	86.94	1.04	0.187	0.470	0.010	0.462	5
14	84.50	82.25	2.25	0.243	1.058	0.072	1.061	27
15	94.61	93.93	0.68	0.198	0.308	0.005	0.302	24
16	87.05	89.00	-1.95	0.208	-0.897	0.042	-0.893	3
17	90.87	89.17	1.70	0.205	0.777	0.031	0.770	26

18	78.35	79.91	-1.56	0.214	-0.720	0.028	-0.712	25
19	94.66	95.83	-1.17	0.200	-0.535	0.014	-0.526	13
20	87.07	86.67	0.40	0.194	0.183	0.002	0.179	4
21	90.42	88.44	1.98	0.211	0.910	0.044	0.907	20
22	87.59	84.24	3.35	0.167	1.498	0.090	1.544	10
23	94.37	92.53	1.84	0.215	0.848	0.039	0.843	6
24	90.48	89.71	0.77	0.276	0.372	0.011	0.365	1
25	87.24	88.08	-0.84	0.050	-0.351	0.001	-0.344	2
26	87.55	87.66	-0.11	0.054	-0.045	0.000	-0.044	7
27	83.73	87.27	-3.54	0.042	-1.478	0.019	-1.521	11

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	598.0	14	42.71	11.92	0.0001
RESIDUAL	43.0	12	3.58		
COR TOTAL	641.0	26			
ROOT MSE	1.89		R-SQUARED	0.9329	
DEP MEAN	87.93		ADJ R-SQUARED	0.8547	
C.V.	2.15%				

Predicted Residual Sum of Squares (PRESS) = 216.8

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	86.75	1	1.08	80.64	
A	-4.62	1	0.59	-7.858	0.0001
B	-3.20	1	0.57	-5.626	0.0001
C	3.40	1	0.57	5.971	0.0001
D	1.75	1	0.57	3.079	0.0096
A2	1.39	1	0.85	1.630	0.1290
B2	2.09	1	0.60	3.489	0.0045
C2	-0.92	1	0.81	-1.135	0.2784
D2	0.59	1	0.71	0.8351	0.4200
AB	-0.62	1	0.74	-0.8368	0.4191
AC	1.06	1	0.92	1.141	0.2760
AD	-0.94	1	1.11	-0.8453	0.4145
BC	-0.01	1	0.83	-1.47E-02	0.9885
BD	0.09	1	0.82	0.1146	0.9107
CD	-0.88	1	1.06	-0.8314	0.4220

Final Equation in Terms of Coded Factors:

Comb. rec =

$$\begin{aligned}
 &86.75 \\
 &- 4.62 * A \\
 &- 3.20 * B \\
 &+ 3.40 * C \\
 &+ 1.75 * D \\
 &+ 1.39 * A^2 \\
 &+ 2.09 * B^2 \\
 &- 0.92 * C^2 \\
 &+ 0.59 * D^2 \\
 &- 0.62 * AB \\
 &+ 1.06 * AC \\
 &- 0.94 * AD \\
 &- 0.01 * BC \\
 &+ 0.09 * BD \\
 &- 0.88 * CD
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Comb. rec =

$$\begin{aligned}
 &185.72 \\
 &- 0.51015 * \text{Drum Speed} \\
 &- 1.5236 * \% \text{ Solids} \\
 &+ 0.72237 * \text{Wash Water} \\
 &+ 7.184E-02 * \text{Feed Rate} \\
 &+ 8.697E-04 * \text{Drum Speed}^2 \\
 &+ 3.258E-02 * \% \text{ Solids}^2
 \end{aligned}$$

- 1.6290 * Wash Water^2
 + 1.051E-04 * Feed Rate^2
 - 1.927E-03 * Drum Speed * % Solids
 + 3.517E-02 * Drum Speed * Wash Water
 - 3.140E-04 * Drum Speed * Feed Rate
 - 2.028E-03 * % Solids * Wash Water
 + 1.564E-04 * % Solids * Feed Rate
 - 1.573E-02 * Wash Water * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	96.46	96.84	-0.38	0.547	-0.297	0.007	-0.286	23
2	88.56	89.71	-1.15	0.559	-0.918	0.071	-0.912	12
3	93.42	93.61	-0.19	0.682	-0.177	0.005	-0.170	18
4	82.35	83.08	-0.73	0.719	-0.730	0.091	-0.715	15
5	76.39	79.23	-2.84	0.652	-2.546	0.811	-3.595	17
6	87.18	88.18	-1.00	0.520	-0.761	0.042	-0.747	21
7	83.08	84.87	-1.79	0.469	-1.297	0.099	-1.339	9
8	90.57	89.96	0.61	0.444	0.435	0.010	0.420	8
9	89.54	90.08	-0.54	0.603	-0.453	0.021	-0.438	22
10	82.80	82.21	0.59	0.638	0.521	0.032	0.504	14
11	92.87	94.71	-1.84	0.450	-1.313	0.094	-1.359	16
12	84.35	84.29	0.06	0.506	0.047	0.000	0.045	19
13	87.98	86.37	1.61	0.529	1.242	0.116	1.274	5
14	84.50	83.89	0.61	0.695	0.582	0.051	0.565	27
15	94.61	94.29	0.32	0.548	0.254	0.005	0.244	24
16	87.05	88.32	-1.27	0.586	-1.044	0.103	-1.049	3
17	90.87	89.02	1.85	0.599	1.542	0.237	1.648	26
18	78.35	77.50	0.85	0.625	0.734	0.060	0.719	25
19	94.66	93.48	1.18	0.561	0.940	0.075	0.935	13
20	87.07	86.74	0.33	0.555	0.260	0.006	0.250	4
21	90.42	90.19	0.23	0.642	0.204	0.005	0.196	20
22	87.59	84.78	2.81	0.428	1.963	0.192	2.280	10
23	94.37	94.43	-0.06	0.708	-0.061	0.001	-0.059	6
24	90.48	89.98	0.50	0.795	0.579	0.086	0.562	1
25	87.24	86.62	0.62	0.291	0.390	0.004	0.376	2
26	87.55	86.12	1.43	0.331	0.927	0.028	0.921	7
27	83.73	85.54	-1.81	0.317	-1.156	0.041	-1.174	11

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Coal Seam:  Illinois No. 6
Circuit:    Individual MGS
Response:   Energy Recovery
Data File:  I-MGS-00
Comments:   Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Drum Speed      rpm           240.000       320.000
B      % Solids        w/w          17.000        33.000
C      Wash Water      lpm          0.000         1.500
D      Feed Rate       lbs/hr       150.000       300.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	218521.8	1	218521.8		
Linear	451.2	4	112.8	22.71	0.0001
Quadratic	73.6	10	7.4	2.477	0.0696
Cubic	35.7	12	3.0		
RESIDUAL	0.0	0			
TOTAL	219082.3	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	2.23	0.8050	0.7696	168.42
Quadratic	15	12	1.72	0.9364	0.8622	183.91
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	451.2	4	112.80	22.71	0.0001
RESIDUAL	109.3	22	4.97		
COR TOTAL	560.5	26			
ROOT MSE	2.23		R-SQUARED	0.8050	
DEP MEAN	89.96		ADJ R-SQUARED	0.7696	
C.V.	2.48%				

Predicted Residual Sum of Squares (PRESS) = 168.4

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	90.39	1	0.45	202.9	
A	-4.26	1	0.64	-6.611	0.0001
B	-1.98	1	0.56	-3.568	0.0017
C	3.32	1	0.63	5.317	0.0001
D	1.45	1	0.62	2.336	0.0290

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & 90.39 \\ & - 4.26 * A \\ & - 1.98 * B \\ & + 3.32 * C \\ & + 1.45 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & 118.73 \\ & - 0.10651 * \text{Drum Speed} \\ & - 0.24808 * \% \text{ Solids} \\ & + 4.4317 * \text{Wash Water} \\ & + 1.937\text{E-}02 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	97.31	96.53	0.78	0.209	0.396	0.008	0.388	23
2	90.61	88.10	2.51	0.208	1.266	0.084	1.285	12
3	95.23	91.74	3.49	0.228	1.780	0.187	1.879	18
4	84.65	83.27	1.38	0.245	0.711	0.033	0.703	15
5	78.90	84.43	-5.53	0.209	-2.791	0.411	-3.392	17
6	89.97	91.72	-1.75	0.179	-0.867	0.033	-0.861	21
7	85.11	88.06	-2.95	0.172	-1.455	0.088	-1.496	9
8	92.52	94.49	-1.97	0.167	-0.967	0.037	-0.966	8
9	92.23	92.33	-0.10	0.193	-0.050	0.000	-0.049	22
10	84.99	83.77	1.22	0.203	0.612	0.019	0.604	14
11	94.46	95.67	-1.21	0.157	-0.592	0.013	-0.583	16
12	86.38	87.13	-0.75	0.168	-0.367	0.005	-0.359	19
13	90.24	88.75	1.49	0.187	0.743	0.025	0.735	5
14	86.47	84.47	2.00	0.243	1.030	0.068	1.032	27
15	95.84	95.70	0.14	0.198	0.071	0.000	0.069	24
16	89.61	91.30	-1.69	0.208	-0.852	0.038	-0.846	3
17	92.20	90.95	1.25	0.205	0.629	0.020	0.620	26

18	80.70	82.25	-1.55	0.214	-0.786	0.034	-0.779	25
19	96.32	97.57	-1.25	0.200	-0.627	0.020	-0.618	13
20	89.28	88.94	0.34	0.194	0.169	0.001	0.165	4
21	92.64	90.59	2.05	0.211	1.037	0.057	1.039	20
22	89.62	86.80	2.82	0.167	1.386	0.077	1.417	10
23	95.61	93.95	1.66	0.215	0.838	0.039	0.833	6
24	92.14	91.34	0.80	0.276	0.420	0.013	0.412	1
25	89.76	90.13	-0.37	0.050	-0.170	0.000	-0.166	2
26	89.73	89.69	0.04	0.054	0.019	0.000	0.019	7
27	86.49	89.34	-2.85	0.042	-1.305	0.015	-1.327	11

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	524.8	14	37.49	12.62	0.0001
RESIDUAL	35.7	12	2.97		
COR TOTAL	560.5	26			
ROOT MSE	1.72		R-SQUARED	0.9364	
DEP MEAN	89.96		ADJ R-SQUARED	0.8622	
C.V.	1.92%				

Predicted Residual Sum of Squares (PRESS) = 183.9

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	89.16	1	0.98	91.02	
A	-4.27	1	0.54	-7.965	0.0001
B	-2.86	1	0.52	-5.510	0.0001
C	3.30	1	0.52	6.360	0.0001
D	1.41	1	0.52	2.725	0.0184
A2	1.03	1	0.78	1.324	0.2103
B2	1.83	1	0.54	3.359	0.0057
C2	-1.03	1	0.74	-1.404	0.1856
D2	0.43	1	0.64	0.6709	0.5150
AB	-0.78	1	0.67	-1.158	0.2695
AC	0.97	1	0.84	1.152	0.2716
AD	-0.66	1	1.01	-0.6465	0.5301
BC	0.25	1	0.76	0.3282	0.7484
BD	0.23	1	0.75	0.3128	0.7598
CD	-0.96	1	0.97	-0.9933	0.3402

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & 89.16 \\ & - 4.27 * A \\ & - 2.86 * B \\ & + 3.30 * C \\ & + 1.41 * D \\ & + 1.03 * A^2 \\ & + 1.83 * B^2 \\ & - 1.03 * C^2 \\ & + 0.43 * D^2 \\ & - 0.78 * AB \\ & + 0.97 * AC \\ & - 0.66 * AD \\ & + 0.25 * BC \\ & + 0.23 * BD \\ & - 0.96 * CD \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & 167.64 \\ & - 0.38106 * \text{Drum Speed} \\ & - 1.2241 * \% \text{ Solids} \\ & + 0.91539 * \text{Wash Water} \\ & + 4.854E-02 * \text{Feed Rate} \\ & + 6.429E-04 * \text{Drum Speed}^2 \\ & + 2.856E-02 * \% \text{ Solids}^2 \end{aligned}$$

- 1.8348 * Wash Water^2
 + 7.691E-05 * Feed Rate^2
 - 2.428E-03 * Drum Speed * % Solids
 + 3.234E-02 * Drum Speed * Wash Water
 - 2.187E-04 * Drum Speed * Feed Rate
 + 4.130E-02 * % Solids * Wash Water
 + 3.889E-04 * % Solids * Feed Rate
 - 1.711E-02 * Wash Water * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	97.31	97.95	-0.64	0.547	-0.548	0.024	-0.531	23
2	90.61	91.67	-1.06	0.559	-0.926	0.073	-0.921	12
3	95.23	95.52	-0.29	0.682	-0.299	0.013	-0.287	18
4	84.65	85.15	-0.50	0.719	-0.549	0.051	-0.533	15
5	78.90	81.60	-2.70	0.652	-2.658	0.883	-3.968	17
6	89.97	90.77	-0.80	0.520	-0.671	0.032	-0.654	21
7	85.11	86.92	-1.81	0.469	-1.443	0.122	-1.520	9
8	92.52	91.80	0.72	0.444	0.560	0.017	0.544	8
9	92.23	92.37	-0.14	0.603	-0.128	0.002	-0.123	22
10	84.99	84.44	0.55	0.638	0.526	0.033	0.509	14
11	94.46	95.95	-1.49	0.450	-1.167	0.074	-1.186	16
12	86.38	86.58	-0.20	0.506	-0.164	0.002	-0.157	19
13	90.24	88.50	1.74	0.529	1.469	0.162	1.553	5
14	86.47	85.73	0.74	0.695	0.780	0.092	0.766	27
15	95.84	95.67	0.17	0.548	0.143	0.002	0.137	24
16	89.61	90.93	-1.32	0.586	-1.194	0.135	-1.218	3
17	92.20	90.66	1.54	0.599	1.408	0.197	1.475	26
18	80.70	79.94	0.76	0.625	0.718	0.057	0.703	25
19	96.32	95.25	1.07	0.561	0.935	0.075	0.930	13
20	89.28	88.88	0.40	0.555	0.346	0.010	0.333	4
21	92.64	92.42	0.22	0.642	0.213	0.005	0.205	20
22	89.62	87.29	2.33	0.428	1.788	0.159	1.998	10
23	95.61	95.55	0.06	0.708	0.068	0.001	0.066	6
24	92.14	91.72	0.42	0.795	0.542	0.076	0.525	1
25	89.76	89.09	0.67	0.291	0.459	0.006	0.444	2
26	89.73	88.58	1.15	0.331	0.814	0.022	0.802	7
27	86.49	88.06	-1.57	0.317	-1.099	0.037	-1.109	11

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Coal Seam:  Illinois No. 6
Circuit:    Individual MGS
Response:   Ash Rejection
Data File:  I-MGS-00
Comments:   Analysis of Complete Data Set
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=====
FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Drum Speed      rpm            240.000      320.000
B    % Solids         w/w            17.000       33.000
C    Wash Water       lpm            0.000        1.500
D    Feed Rate        lbs/hr         150.000      300.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	50477.5	1	50477.5		
Linear	2309.7	4	577.4	9.807	0.0001
Quadratic	951.9	10	95.2	3.326	0.0263
Cubic	343.4	12	28.6		
RESIDUAL	0.0	0			
TOTAL	54082.6	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	7.67	0.6407	0.5754	1935.13
Quadratic	15	12	5.35	0.9047	0.7936	2123.42
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2309.7	4	577.44	9.807	0.0001
RESIDUAL	1295.3	22	58.88		
COR TOTAL	3605.1	26			
ROOT MSE	7.67		R-SQUARED	0.6407	
DEP MEAN	43.24		ADJ R-SQUARED	0.5754	
C.V.	17.75%				

Predicted Residual Sum of Squares (PRESS) = 1935.1

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	41.64	1	1.53	27.14	
A	10.26	1	2.22	4.623	0.0001
B	6.31	1	1.92	3.296	0.0033
C	-3.20	1	2.15	-1.484	0.1519
D	-4.37	1	2.14	-2.038	0.0537

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 41.64 \\ & + 10.26 * A \\ & + 6.31 * B \\ & - 3.20 * C \\ & - 4.37 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & -33.60 \\ & + 0.25647 * \text{Drum Speed} \\ & + 0.78917 * \% \text{ Solids} \\ & - 4.2604 * \text{Wash Water} \\ & - 5.821\text{E-}02 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	13.84	26.06	-12.22	0.209	-1.791	0.170	-1.894	23
2	41.02	46.35	-5.33	0.208	-0.781	0.032	-0.774	12
3	32.98	41.03	-8.05	0.228	-1.193	0.084	-1.206	18
4	52.47	61.49	-9.02	0.245	-1.352	0.119	-1.380	15
5	62.28	52.97	9.31	0.209	1.365	0.098	1.393	17
6	51.24	45.40	5.84	0.179	0.840	0.031	0.834	21
7	52.95	41.90	11.05	0.172	1.583	0.104	1.643	9
8	43.08	35.99	7.09	0.167	1.013	0.041	1.013	8
9	45.29	39.00	6.29	0.193	0.913	0.040	0.909	22
10	55.76	59.20	-3.44	0.203	-0.503	0.013	-0.494	14
11	33.08	28.37	4.71	0.157	0.669	0.017	0.660	16
12	52.00	49.01	2.99	0.168	0.428	0.007	0.420	19
13	42.23	39.51	2.72	0.187	0.392	0.007	0.385	5
14	46.01	53.12	-7.11	0.243	-1.064	0.073	-1.068	27
15	23.14	32.89	-9.75	0.198	-1.419	0.100	-1.455	24
16	50.05	47.23	2.82	0.208	0.413	0.009	0.405	3
17	25.91	35.69	-9.78	0.205	-1.430	0.105	-1.466	26

18	55.37	56.65	-1.28	0.214	-0.188	0.002	-0.184	25
19	32.64	29.84	2.80	0.200	0.408	0.008	0.400	13
20	49.93	50.29	-0.36	0.194	-0.053	0.000	-0.052	4
21	42.72	41.41	1.31	0.211	0.193	0.002	0.188	20
22	44.93	53.47	-8.54	0.167	-1.219	0.059	-1.233	10
23	24.23	30.67	-6.44	0.215	-0.947	0.049	-0.945	6
24	38.65	39.11	-0.46	0.276	-0.070	0.000	-0.068	1
25	50.09	42.47	7.62	0.050	1.019	0.011	1.020	2
26	51.07	44.33	6.74	0.054	0.903	0.009	0.899	7
27	54.47	44.00	10.47	0.042	1.394	0.017	1.427	11

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	3261.6	14	232.97	8.140	0.0004
RESIDUAL	343.4	12	28.62		
COR TOTAL	3605.1	26			
ROOT MSE	5.35		R-SQUARED	0.9047	
DEP MEAN	43.24		ADJ R-SQUARED	0.7936	
C.V.	12.37%				

Predicted Residual Sum of Squares (PRESS) = 2123.4

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	51.08	1	3.04	16.80	
A	11.31	1	1.66	6.803	0.0001
B	10.17	1	1.61	6.320	0.0001
C	-3.59	1	1.61	-2.230	0.0456
D	-4.82	1	1.61	-3.002	0.0110
A2	-7.06	1	2.41	-2.928	0.0126
B2	-7.65	1	1.69	-4.527	0.0007
C2	-1.73	1	2.28	-0.7575	0.4634
D2	-2.43	1	2.00	-1.215	0.2476
AB	-1.53	1	2.08	-0.7363	0.4757
AC	-2.55	1	2.61	-0.9741	0.3492
AD	2.73	1	3.15	0.8667	0.4031
BC	2.30	1	2.34	0.9794	0.3467
BD	1.99	1	2.31	0.8598	0.4068
CD	0.33	1	3.01	0.1083	0.9155

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 51.08 \\ & + 11.31 * A \\ & + 10.17 * B \\ & - 3.59 * C \\ & - 4.82 * D \\ & - 7.06 * A^2 \\ & - 7.65 * B^2 \\ & - 1.73 * C^2 \\ & - 2.43 * D^2 \\ & - 1.53 * AB \\ & - 2.55 * AC \\ & + 2.73 * AD \\ & + 2.30 * BC \\ & + 1.99 * BD \\ & + 0.33 * CD \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & -453.48 \\ & + 2.7337 * \text{Drum Speed} \\ & + 7.5549 * \% \text{ Solids} \\ & + 12.708 * \text{Wash Water} \\ & - 0.21175 * \text{Feed Rate} \\ & - 4.415E-03 * \text{Drum Speed}^2 \\ & - 0.11949 * \% \text{ Solids}^2 \end{aligned}$$

- 3.0718 * Wash Water^2
 - 4.324E-04 * Feed Rate^2
 - 4.793E-03 * Drum Speed * % Solids
 - 8.484E-02 * Drum Speed * Wash Water
 + 9.098E-04 * Drum Speed * Feed Rate
 + 0.38251 * % Solids * Wash Water
 + 3.317E-03 * % Solids * Feed Rate
 + 5.791E-03 * Wash Water * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	13.84	16.22	-2.38	0.547	-0.661	0.035	-0.644	23
2	41.02	39.14	1.88	0.559	0.529	0.024	0.513	12
3	32.98	33.52	-0.54	0.682	-0.178	0.005	-0.171	18
4	52.47	49.52	2.95	0.719	1.038	0.184	1.042	15
5	62.28	56.36	5.92	0.652	1.878	0.441	2.139	17
6	51.24	50.19	1.05	0.520	0.283	0.006	0.272	21
7	52.95	47.62	5.33	0.469	1.368	0.110	1.426	9
8	43.08	41.64	1.44	0.444	0.360	0.007	0.347	8
9	45.29	40.81	4.48	0.603	1.327	0.178	1.376	22
10	55.76	55.90	-0.14	0.638	-0.044	0.000	-0.042	14
11	33.08	26.57	6.51	0.450	1.640	0.147	1.782	16
12	52.00	52.93	-0.93	0.506	-0.249	0.004	-0.239	19
13	42.23	41.74	0.49	0.529	0.133	0.001	0.127	5
14	46.01	44.94	1.07	0.695	0.364	0.020	0.350	27
15	23.14	26.66	-3.52	0.548	-0.980	0.078	-0.979	24
16	50.05	49.44	0.61	0.586	0.176	0.003	0.169	3
17	25.91	33.80	-7.89	0.599	-2.327	0.539	-3.008	26
18	55.37	60.41	-5.04	0.625	-1.539	0.264	-1.645	25
19	32.64	33.18	-0.54	0.561	-0.152	0.002	-0.146	13
20	49.93	48.41	1.52	0.555	0.426	0.015	0.411	4
21	42.72	40.89	1.83	0.642	0.571	0.039	0.554	20
22	44.93	52.80	-7.87	0.428	-1.945	0.189	-2.250	10
23	24.23	23.44	0.79	0.708	0.275	0.012	0.264	6
24	38.65	42.72	-4.07	0.795	-1.681	0.729	-1.840	1
25	50.09	51.35	-1.26	0.291	-0.279	0.002	-0.268	2
26	51.07	53.56	-2.49	0.331	-0.570	0.011	-0.553	7
27	54.47	53.66	0.81	0.317	0.182	0.001	0.175	11

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Coal Seam:  Illinois No. 6
Circuit:    Individual MGS
Response:   Sulfur Rejection
Data File:  I-MGS-00
Comments:   Analysis of Complete Data Set
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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Drum Speed      rpm           240.000       320.000
B      % Solids         w/w           17.000        33.000
C      Wash Water       lpm           0.000         1.500
D      Feed Rate        lbs/hr        150.000       300.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	73428.8	1	73428.8		
Linear	1070.2	4	267.5	9.035	0.0002
Quadratic	425.8	10	42.6	2.264	0.0908
Cubic	225.7	12	18.8		
RESIDUAL	0.0	0			
TOTAL	75150.4	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	5.44	0.6216	0.5528	963.52
Quadratic	15	12	4.34	0.8689	0.7160	1235.91
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1070.2	4	267.55	9.035	0.0002
RESIDUAL	651.5	22	29.61		
COR TOTAL	1721.7	26			
ROOT MSE	5.44		R-SQUARED	0.6216	
DEP MEAN	52.15		ADJ R-SQUARED	0.5528	
C.V.	10.43%				

Predicted Residual Sum of Squares (PRESS) = 963.5

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	50.98	1	1.09	46.86	
A	5.21	1	1.57	3.310	0.0032
B	4.50	1	1.36	3.311	0.0032
C	-3.11	1	1.53	-2.040	0.0535
D	-4.70	1	1.52	-3.092	0.0053

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sulfur rej} = & 50.98 \\ & + 5.21 * A \\ & + 4.50 * B \\ & - 3.11 * C \\ & - 4.70 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sulfur rej} = & 17.67 \\ & + 0.13022 * \text{Drum Speed} \\ & + 0.56222 * \% \text{ Solids} \\ & - 4.1520 * \text{Wash Water} \\ & - 6.263\text{E-}02 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	33.27	42.17	-8.90	0.209	-1.839	0.179	-1.953	23
2	52.28	52.53	-0.25	0.208	-0.052	0.000	-0.051	12
3	50.65	52.53	-1.88	0.228	-0.393	0.009	-0.385	18
4	59.88	62.86	-2.98	0.245	-0.631	0.026	-0.622	15
5	63.43	61.37	2.06	0.209	0.425	0.010	0.417	17
6	60.36	54.35	6.01	0.179	1.220	0.065	1.234	21
7	56.50	50.55	5.95	0.172	1.201	0.060	1.214	9
8	48.85	44.94	3.91	0.167	0.787	0.025	0.780	8
9	58.49	52.66	5.83	0.193	1.192	0.068	1.204	22
10	56.95	63.15	-6.20	0.203	-1.277	0.083	-1.296	14
11	46.68	42.72	3.96	0.157	0.793	0.023	0.786	16
12	55.47	52.97	2.50	0.168	0.503	0.010	0.495	19
13	55.50	50.10	5.40	0.187	1.100	0.055	1.105	5
14	54.02	59.20	-5.18	0.243	-1.094	0.077	-1.099	27
15	36.13	43.99	-7.86	0.198	-1.613	0.129	-1.678	24
16	57.55	54.46	3.09	0.208	0.638	0.021	0.629	3
17	42.78	49.59	-6.81	0.205	-1.404	0.102	-1.438	26

18	61.80	60.48	1.32	0.214	0.274	0.004	0.268	25
19	44.91	43.91	1.00	0.200	0.205	0.002	0.201	13
20	53.01	54.41	-1.40	0.194	-0.287	0.004	-0.281	4
21	52.73	52.56	0.17	0.211	0.036	0.000	0.035	20
22	53.58	61.04	-7.46	0.167	-1.502	0.090	-1.549	10
23	36.81	41.43	-4.62	0.215	-0.959	0.050	-0.957	6
24	43.22	46.62	-3.40	0.276	-0.735	0.041	-0.727	1
25	56.49	52.12	4.37	0.050	0.825	0.007	0.818	2
26	54.69	52.43	2.26	0.054	0.427	0.002	0.419	7
27	62.01	52.89	9.12	0.042	1.712	0.026	1.797	11

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1496.0	14	106.85	5.681	0.0023
RESIDUAL	225.7	12	18.81		
COR TOTAL	1721.7	26			
ROOT MSE	4.34		R-SQUARED	0.8689	
DEP MEAN	52.15		ADJ R-SQUARED	0.7160	
C.V.	8.32%				

Predicted Residual Sum of Squares (PRESS) = 1235.9

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	57.24	1	2.46	23.22	
A	6.39	1	1.35	4.739	0.0005
B	6.49	1	1.30	4.977	0.0003
C	-3.93	1	1.31	-3.013	0.0108
D	-4.95	1	1.30	-3.795	0.0026
A2	-4.05	1	1.96	-2.071	0.0606
B2	-4.02	1	1.37	-2.939	0.0124
C2	-1.49	1	1.85	-0.8045	0.4368
D2	-3.01	1	1.62	-1.858	0.0878
AB	-2.05	1	1.69	-1.212	0.2489
AC	-2.24	1	2.12	-1.059	0.3106
AD	3.22	1	2.55	1.262	0.2308
BC	3.40	1	1.90	1.790	0.0986
BD	1.51	1	1.88	0.8048	0.4366
CD	-1.15	1	2.44	-0.4706	0.6464

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sulfur rej} = & 57.24 \\ & + 6.39 * A \\ & + 6.49 * B \\ & - 3.93 * C \\ & - 4.95 * D \\ & - 4.05 * A^2 \\ & - 4.02 * B^2 \\ & - 1.49 * C^2 \\ & - 3.01 * D^2 \\ & - 2.05 * AB \\ & - 2.24 * AC \\ & + 3.22 * AD \\ & + 3.40 * BC \\ & + 1.51 * BD \\ & - 1.15 * CD \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sulfur rej} = & -226.81 \\ & + 1.5515 * \text{Drum Speed} \\ & + 4.7545 * \% \text{ Solids} \\ & + 10.070 * \text{Wash Water} \\ & - 0.17318 * \text{Feed Rate} \\ & - 2.531\text{E-}03 * \text{Drum Speed}^2 \\ & - 6.287\text{E-}02 * \% \text{ Solids}^2 \end{aligned}$$

- 2.6447 * Wash Water^2
 - 5.360E-04 * Feed Rate^2
 - 6.395E-03 * Drum Speed * % Solids
 - 7.475E-02 * Drum Speed * Wash Water
 + 1.074E-03 * Drum Speed * Feed Rate
 + 0.56680 * % Solids * Wash Water
 + 2.517E-03 * % Solids * Feed Rate
 - 2.039E-02 * Wash Water * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	33.27	36.41	-3.14	0.547	-1.078	0.094	-1.086	23
2	52.28	50.80	1.48	0.559	0.515	0.022	0.499	12
3	50.65	50.97	-0.32	0.682	-0.129	0.002	-0.124	18
4	59.88	56.39	3.49	0.719	1.516	0.391	1.614	15
5	63.43	60.02	3.41	0.652	1.332	0.222	1.381	17
6	60.36	57.33	3.03	0.520	1.008	0.073	1.009	21
7	56.50	54.34	2.16	0.469	0.683	0.027	0.667	9
8	48.85	46.35	2.50	0.444	0.772	0.032	0.758	8
9	58.49	54.70	3.79	0.603	1.387	0.194	1.449	22
10	56.95	58.16	-1.21	0.638	-0.462	0.025	-0.447	14
11	46.68	40.41	6.27	0.450	1.948	0.207	2.256	16
12	55.47	56.93	-1.46	0.506	-0.478	0.016	-0.462	19
13	55.50	54.38	1.12	0.529	0.377	0.011	0.363	5
14	54.02	53.26	0.76	0.695	0.319	0.015	0.307	27
15	36.13	38.52	-2.39	0.548	-0.822	0.055	-0.810	24
16	57.55	58.54	-0.99	0.586	-0.354	0.012	-0.341	3
17	42.78	47.95	-5.17	0.599	-1.883	0.353	-2.147	26
18	61.80	64.33	-2.53	0.625	-0.952	0.101	-0.948	25
19	44.91	46.61	-1.70	0.561	-0.592	0.030	-0.575	13
20	53.01	52.80	0.21	0.555	0.072	0.000	0.069	4
21	52.73	51.52	1.21	0.642	0.468	0.026	0.452	20
22	53.58	59.47	-5.89	0.428	-1.795	0.161	-2.009	10
23	36.81	36.36	0.45	0.708	0.191	0.006	0.183	6
24	43.22	45.83	-2.61	0.795	-1.331	0.458	-1.380	1
25	56.49	57.88	-1.39	0.291	-0.381	0.004	-0.367	2
26	54.69	58.56	-3.87	0.331	-1.090	0.039	-1.099	7
27	62.01	59.23	2.78	0.317	0.777	0.019	0.763	11

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Coal Seam:  Illinois No. 6
Circuit:    Individual MGS
Response:   Pyritic Sulfur Rejection
Data File:  I-MGS-00
Comments:   Analysis of Complete Data Set
=====

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=====
FAC      FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A        Drum Speed      rpm           240.000       320.000
B        % Solids         w/w           17.000        33.000
C        Wash Water       lpm           0.000         1.500
D        Feed Rate        lbs/hr        150.000       300.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	99838.5	1	99838.5		
Linear	1536.8	4	384.2	13.05	0.0001
Quadratic	497.7	10	49.8	3.979	0.0135
Cubic	150.1	12	12.5		
RESIDUAL	0.0	0			
TOTAL	102023.1	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	5.43	0.7035	0.6496	1024.60
Quadratic	15	12	3.54	0.9313	0.8511	806.45
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1536.8	4	384.20	13.05	0.0001
RESIDUAL	647.8	22	29.45		
COR TOTAL	2184.6	26			
ROOT MSE	5.43		R-SQUARED	0.7035	
DEP MEAN	60.81		ADJ R-SQUARED	0.6496	
C.V.	8.92%				

Predicted Residual Sum of Squares (PRESS) = 1024.6

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	59.54	1	1.08	54.88	
A	6.31	1	1.57	4.020	0.0006
B	4.97	1	1.35	3.669	0.0013
C	-4.64	1	1.52	-3.048	0.0059
D	-5.47	1	1.51	-3.611	0.0015

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Pyr rej} = & 59.54 \\ & + 6.31 * A \\ & + 4.97 * B \\ & - 4.64 * C \\ & - 5.47 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Pyr rej} = & 20.90 \\ & + 0.15771 * \text{Drum Speed} \\ & + 0.62116 * \% \text{ Solids} \\ & - 6.1866 * \text{Wash Water} \\ & - 7.294\text{E-}02 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	50.13	49.19	0.94	0.209	0.194	0.002	0.190	23
2	56.33	61.75	-5.42	0.208	-1.122	0.066	-1.129	12
3	51.75	60.63	-8.88	0.228	-1.863	0.204	-1.983	18
4	71.08	73.13	-2.05	0.245	-0.434	0.012	-0.426	15
5	68.51	72.49	-3.98	0.209	-0.824	0.036	-0.818	17
6	67.91	62.20	5.71	0.179	1.160	0.059	1.170	21
7	63.70	60.01	3.69	0.172	0.747	0.023	0.739	9
8	55.50	51.52	3.98	0.167	0.804	0.026	0.797	8
9	64.63	61.04	3.59	0.193	0.737	0.026	0.729	22
10	67.83	73.84	-6.01	0.203	-1.241	0.078	-1.257	14
11	50.85	49.68	1.17	0.157	0.234	0.002	0.229	16
12	62.51	62.08	0.43	0.168	0.088	0.000	0.086	19
13	59.97	59.74	0.23	0.187	0.048	0.000	0.047	5
14	77.23	69.70	7.53	0.243	1.594	0.163	1.656	27
15	53.76	50.53	3.23	0.198	0.665	0.022	0.657	24
16	66.46	62.09	4.37	0.208	0.905	0.043	0.901	3
17	60.62	58.66	1.96	0.205	0.405	0.008	0.397	26

18	80.03	71.85	8.18	0.214	1.701	0.157	1.783	25
19	49.19	49.94	-0.75	0.200	-0.155	0.001	-0.152	13
20	64.65	62.73	1.92	0.194	0.394	0.008	0.387	4
21	60.41	61.50	-1.09	0.211	-0.226	0.003	-0.221	20
22	61.72	70.86	-9.14	0.167	-1.845	0.136	-1.961	10
23	38.00	48.67	-10.67	0.215	-2.220	0.271	-2.463	6
24	49.65	54.26	-4.61	0.276	-0.998	0.076	-0.998	1
25	64.01	60.88	3.13	0.050	0.592	0.004	0.583	2
26	59.85	61.01	-1.16	0.054	-0.220	0.001	-0.215	7
27	65.56	61.86	3.70	0.042	0.697	0.004	0.689	11

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2034.5	14	145.32	11.62	0.0001
RESIDUAL	150.1	12	12.51		
COR TOTAL	2184.6	26			
ROOT MSE	3.54		R-SQUARED	0.9313	
DEP MEAN	60.81		ADJ R-SQUARED	0.8511	
C.V.	5.82%				

Predicted Residual Sum of Squares (PRESS) = 806.5

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	61.79	1	2.01	30.74	
A	6.46	1	1.10	5.878	0.0001
B	6.40	1	1.06	6.012	0.0001
C	-4.84	1	1.06	-4.548	0.0007
D	-6.44	1	1.06	-6.065	0.0001
A2	-1.09	1	1.59	-0.6832	0.5074
B2	-3.13	1	1.12	-2.805	0.0159
C2	2.73	1	1.51	1.807	0.0958
D2	-3.21	1	1.32	-2.424	0.0321
AB	2.17	1	1.38	1.579	0.1404
AC	-0.87	1	1.73	-0.5036	0.6236
AD	3.66	1	2.08	1.757	0.1044
BC	-1.30	1	1.55	-0.8381	0.4184
BD	3.45	1	1.53	2.253	0.0438
CD	-3.58	1	1.99	-1.800	0.0971

Final Equation in Terms of Coded Factors:

$$\begin{aligned}
 \text{Pyr rej} = & 61.79 \\
 & + 6.46 * A \\
 & + 6.40 * B \\
 & - 4.84 * C \\
 & - 6.44 * D \\
 & - 1.09 * A^2 \\
 & - 3.13 * B^2 \\
 & + 2.73 * C^2 \\
 & - 3.21 * D^2 \\
 & + 2.17 * AB \\
 & - 0.87 * AC \\
 & + 3.66 * AD \\
 & - 1.30 * BC \\
 & + 3.45 * BD \\
 & - 3.58 * CD
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned}
 \text{Pyr rej} = & 46.44 \\
 & + 0.12045 * \text{Drum Speed} \\
 & + 0.21440 * \% \text{ Solids} \\
 & + 14.110 * \text{Wash Water} \\
 & - 0.26670 * \text{Feed Rate} \\
 & - 6.809\text{E-}04 * \text{Drum Speed}^2 \\
 & - 4.894\text{E-}02 * \% \text{ Solids}^2
 \end{aligned}$$

+ 4.8456 * Wash Water^2
 - 5.701E-04 * Feed Rate^2
 + 6.793E-03 * Drum Speed * % Solids
 - 2.900E-02 * Drum Speed * Wash Water
 + 1.219E-03 * Drum Speed * Feed Rate
 - 0.21637 * % Solids * Wash Water
 + 5.746E-03 * % Solids * Feed Rate
 - 6.359E-02 * Wash Water * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	50.13	49.77	0.36	0.547	0.150	0.002	0.144	23
2	56.33	56.53	-0.20	0.559	-0.087	0.001	-0.083	12
3	51.75	53.31	-1.56	0.682	-0.781	0.087	-0.768	18
4	71.08	72.50	-1.42	0.719	-0.755	0.097	-0.740	15
5	68.51	70.79	-2.28	0.652	-1.095	0.150	-1.105	17
6	67.91	67.12	0.79	0.520	0.323	0.008	0.311	21
7	63.70	65.78	-2.08	0.469	-0.805	0.038	-0.792	9
8	55.50	52.10	3.40	0.444	1.289	0.088	1.330	8
9	64.63	60.39	4.24	0.603	1.900	0.365	2.176	22
10	67.83	67.61	0.22	0.638	0.104	0.001	0.100	14
11	50.85	46.91	3.94	0.450	1.500	0.123	1.593	16
12	62.51	63.88	-1.37	0.506	-0.553	0.021	-0.536	19
13	59.97	61.01	-1.04	0.529	-0.427	0.014	-0.412	5
14	77.23	74.50	2.73	0.695	1.395	0.296	1.460	27
15	53.76	54.16	-0.40	0.548	-0.167	0.002	-0.160	24
16	66.46	63.19	3.27	0.586	1.440	0.196	1.515	3
17	60.62	61.81	-1.19	0.599	-0.533	0.028	-0.516	26
18	80.03	76.55	3.48	0.625	1.609	0.288	1.740	25
19	49.19	55.19	-6.00	0.561	-2.563	0.560	-3.646	13
20	64.65	65.87	-1.22	0.555	-0.519	0.022	-0.503	4
21	60.41	60.82	-0.41	0.642	-0.195	0.005	-0.187	20
22	61.72	63.83	-2.11	0.428	-0.789	0.031	-0.776	10
23	38.00	37.97	0.03	0.708	0.016	0.000	0.015	6
24	49.65	49.98	-0.33	0.795	-0.206	0.011	-0.198	1
25	64.01	63.03	0.98	0.291	0.329	0.003	0.316	2
26	59.85	63.06	-3.21	0.331	-1.109	0.040	-1.120	7
27	65.56	64.17	1.39	0.317	0.477	0.007	0.461	11

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Coal Seam:  Illinois No. 6
Circuit:    Individual MGS
Response:   Separation Efficiency
Data File:  I-MGS-00
Comments:   Analysis of Complete Data Set
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=====
FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Drum Speed      rpm           240.000       320.000
B      % Solids        w/w           17.000        33.000
C      Wash Water      lpm           0.000         1.500
D      Feed Rate       lbs/hr        150.000       300.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	64129.2	1	64129.2		
Linear	368.1	4	92.0	4.095	0.0125
Quadratic	341.8	10	34.2	2.690	0.0539
Cubic	152.5	12	12.7		
RESIDUAL	0.0	0			
TOTAL	64991.6	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	4.74	0.4268	0.3226	800.52
Quadratic	15	12	3.56	0.8232	0.6168	954.30
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	368.1	4	92.01	4.095	0.0125
RESIDUAL	494.3	22	22.47		
COR TOTAL	862.4	26			
ROOT MSE	4.74		R-SQUARED	0.4268	
DEP MEAN	48.74		ADJ R-SQUARED	0.3226	
C.V.	9.73%				

Predicted Residual Sum of Squares (PRESS) = 800.5

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	47.96	1	0.95	50.60	
A	1.78	1	1.37	1.299	0.2073
B	2.76	1	1.18	2.335	0.0291
C	-1.27	1	1.33	-0.9582	0.3484
D	-3.72	1	1.32	-2.808	0.0103

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Efficiency} = & 47.96 \\ & + 1.78 * A \\ & + 2.76 * B \\ & - 1.27 * C \\ & - 3.72 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Efficiency} = & 39.28 \\ & + 4.452\text{E-}02 * \text{Drum Speed} \\ & + 0.34537 * \% \text{ Solids} \\ & - 1.6989 * \text{Wash Water} \\ & - 4.954\text{E-}02 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	46.60	44.17	2.43	0.209	0.577	0.018	0.568	23
2	44.89	47.76	-2.87	0.208	-0.681	0.024	-0.672	12
3	45.18	50.33	-5.15	0.228	-1.237	0.090	-1.253	18
4	53.43	53.83	-0.40	0.245	-0.097	0.001	-0.095	15
5	44.90	54.48	-9.58	0.209	-2.273	0.273	-2.539	17
6	55.10	51.59	3.51	0.179	0.817	0.029	0.810	21
7	46.77	46.30	0.47	0.172	0.109	0.000	0.107	9
8	46.07	44.27	1.80	0.167	0.417	0.007	0.409	8
9	54.17	51.25	2.92	0.193	0.685	0.022	0.677	22
10	50.62	54.95	-4.33	0.203	-1.024	0.053	-1.025	14
11	43.72	43.84	-0.12	0.157	-0.028	0.000	-0.027	16
12	46.86	47.17	-0.31	0.168	-0.072	0.000	-0.071	19
13	47.95	46.68	1.27	0.187	0.298	0.004	0.291	5
14	61.72	51.95	9.77	0.243	2.370	0.361	2.684	27
15	48.37	44.47	3.90	0.198	0.920	0.042	0.917	24
16	53.51	51.09	2.42	0.208	0.573	0.017	0.564	3
17	51.48	47.83	3.65	0.205	0.863	0.038	0.858	26

18	58.38	51.76	6.62	0.214	1.576	0.135	1.635	25
19	43.84	45.78	-1.94	0.200	-0.457	0.010	-0.448	13
20	51.72	49.40	2.32	0.194	0.546	0.014	0.537	4
21	50.83	49.94	0.89	0.211	0.210	0.002	0.206	20
22	49.31	55.10	-5.79	0.167	-1.339	0.072	-1.365	10
23	32.38	41.20	-8.82	0.215	-2.101	0.242	-2.296	6
24	40.12	43.96	-3.84	0.276	-0.952	0.069	-0.950	1
25	51.25	48.96	2.29	0.050	0.496	0.003	0.488	2
26	47.40	48.67	-1.27	0.054	-0.275	0.001	-0.269	7
27	49.29	49.13	0.16	0.042	0.035	0.000	0.035	11

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	709.9	14	50.71	3.990	0.0107
RESIDUAL	152.5	12	12.71		
COR TOTAL	862.4	26			
ROOT MSE	3.56		R-SQUARED	0.8232	
DEP MEAN	48.74		ADJ R-SQUARED	0.6168	
C.V.	7.31%				

Predicted Residual Sum of Squares (PRESS) = 954.3

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	48.54	1	2.03	23.96	
A	1.84	1	1.11	1.658	0.1231
B	3.19	1	1.07	2.974	0.0116
C	-1.44	1	1.07	-1.340	0.2051
D	-4.69	1	1.07	-4.382	0.0009
A2	0.30	1	1.61	0.1871	0.8547
B2	-1.04	1	1.13	-0.9276	0.3719
C2	1.81	1	1.52	1.188	0.2576
D2	-2.62	1	1.33	-1.962	0.0733
AB	1.56	1	1.39	1.121	0.2841
AC	0.19	1	1.74	0.1063	0.9171
AD	2.72	1	2.10	1.296	0.2194
BC	-1.31	1	1.56	-0.8379	0.4185
BD	3.54	1	1.54	2.293	0.0407
CD	-4.46	1	2.00	-2.227	0.0459

Final Equation in Terms of Coded Factors:

Efficiency =

$$\begin{aligned}
 &48.54 \\
 &+ 1.84 * A \\
 &+ 3.19 * B \\
 &- 1.44 * C \\
 &- 4.69 * D \\
 &+ 0.30 * A^2 \\
 &- 1.04 * B^2 \\
 &+ 1.81 * C^2 \\
 &- 2.62 * D^2 \\
 &+ 1.56 * AB \\
 &+ 0.19 * AC \\
 &+ 2.72 * AD \\
 &- 1.31 * BC \\
 &+ 3.54 * BD \\
 &- 4.46 * CD
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Efficiency =

$$\begin{aligned}
 &132.15 \\
 &- 0.38945 * \text{Drum Speed} \\
 &- 1.3103 * \% \text{ Solids} \\
 &+ 14.833 * \text{Wash Water} \\
 &- 0.19491 * \text{Feed Rate} \\
 &+ 1.879\text{E-}04 * \text{Drum Speed}^2 \\
 &- 1.632\text{E-}02 * \% \text{ Solids}^2
 \end{aligned}$$

+ 3.2118 * Wash Water^2
 - 4.653E-04 * Feed Rate^2
 + 4.864E-03 * Drum Speed * % Solids
 + 6.171E-03 * Drum Speed * Wash Water
 + 9.063E-04 * Drum Speed * Feed Rate
 - 0.21806 * % Solids * Wash Water
 + 5.896E-03 * % Solids * Feed Rate
 - 7.931E-02 * Wash Water * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	46.60	46.62	-0.02	0.547	-0.006	0.000	-0.006	23
2	44.89	46.25	-1.36	0.559	-0.576	0.028	-0.559	12
3	45.18	46.92	-1.74	0.682	-0.866	0.107	-0.856	18
4	53.43	55.58	-2.15	0.719	-1.137	0.220	-1.152	15
5	44.90	50.02	-5.12	0.652	-2.437	0.742	-3.282	17
6	55.10	55.30	-0.20	0.520	-0.079	0.000	-0.076	21
7	46.77	50.64	-3.87	0.469	-1.488	0.130	-1.578	9
8	46.07	42.06	4.01	0.444	1.510	0.121	1.606	8
9	54.17	50.48	3.69	0.603	1.643	0.273	1.787	22
10	50.62	49.81	0.81	0.638	0.378	0.017	0.364	14
11	43.72	41.63	2.09	0.450	0.792	0.034	0.779	16
12	46.86	48.17	-1.31	0.506	-0.523	0.019	-0.507	19
13	47.95	47.38	0.57	0.529	0.234	0.004	0.225	5
14	61.72	58.39	3.33	0.695	1.692	0.435	1.857	27
15	48.37	48.45	-0.08	0.548	-0.032	0.000	-0.031	24
16	53.51	51.51	2.00	0.586	0.872	0.072	0.863	3
17	51.48	50.83	0.65	0.599	0.288	0.008	0.277	26
18	58.38	54.04	4.34	0.625	1.989	0.440	2.326	25
19	43.84	48.67	-4.83	0.561	-2.047	0.357	-2.429	13
20	51.72	52.61	-0.89	0.555	-0.376	0.012	-0.362	4
21	50.83	51.01	-0.18	0.642	-0.085	0.001	-0.081	20
22	49.31	48.62	0.69	0.428	0.257	0.003	0.247	10
23	32.38	32.41	-0.03	0.708	-0.016	0.000	-0.016	6
24	40.12	39.95	0.17	0.795	0.102	0.003	0.098	1
25	51.25	49.65	1.60	0.291	0.533	0.008	0.516	2
26	47.40	49.17	-1.77	0.331	-0.607	0.012	-0.591	7
27	49.29	49.70	-0.41	0.317	-0.140	0.001	-0.135	11

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Coal Seam:  Illinois No. 6
Circuit:    Individual MGS
Response:   1b SO2/MM Btu
Data File:  I-MGS-00
Comments:   Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Drum Speed      rpm           240.000      320.000
B      % Solids         w/w          17.000       33.000
C      Wash Water       lpm           0.000        1.500
D      Feed Rate        lbs/hr        150.000      300.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	620.353	1	620.353		
Linear	4.977	4	1.244	11.02	0.0001
Quadratic	1.611	10	0.161	2.218	0.0962
Cubic	0.872	12	0.073		
RESIDUAL	0.000	0			
TOTAL	627.814	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	0.336	0.6671	0.6066	3.800
Quadratic	15	12	0.270	0.8831	0.7468	4.889
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4.977	4	1.244	11.02	0.0001
RESIDUAL	2.483	22	0.113		
COR TOTAL	7.460	26			
ROOT MSE	0.336		R-SQUARED	0.6671	
DEP MEAN	4.793		ADJ R-SQUARED	0.6066	
C.V.	7.01%				

Predicted Residual Sum of Squares (PRESS) = 3.800

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	4.858	1	0.067	72.32	
A	-0.545	1	0.097	-5.611	0.0001
B	-0.293	1	0.084	-3.493	0.0021
C	0.059	1	0.094	0.6224	0.5400
D	-0.014	1	0.094	-0.1519	0.8807

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{SO2 emiss} = & 4.858 \\ & - 0.545 * A \\ & - 0.293 * B \\ & + 0.059 * C \\ & - 0.014 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{SO2 emiss} = & 9.573 \\ & - 1.363\text{E-}02 * \text{Drum Speed} \\ & - 3.662\text{E-}02 * \% \text{ Solids} \\ & + 7.822\text{E-}02 * \text{Wash Water} \\ & - 1.899\text{E-}04 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	6.470	5.684	0.786	0.209	2.632	0.367	3.107	23
2	4.860	4.613	0.247	0.208	0.824	0.036	0.818	12
3	5.050	4.947	0.103	0.228	0.347	0.007	0.340	18
4	4.320	3.848	0.472	0.245	1.615	0.169	1.681	15
5	4.430	4.626	-0.196	0.209	-0.655	0.023	-0.646	17
6	4.790	4.805	-0.015	0.179	-0.051	0.000	-0.050	21
7	4.290	4.738	-0.448	0.172	-1.466	0.089	-1.508	9
8	4.650	4.887	-0.237	0.167	-0.774	0.024	-0.767	8
9	5.310	5.252	0.058	0.193	0.192	0.002	0.188	22
10	4.420	4.215	0.205	0.203	0.683	0.024	0.675	14
11	5.110	5.419	-0.309	0.157	-1.003	0.037	-1.003	16
12	4.170	4.290	-0.120	0.168	-0.390	0.006	-0.383	19
13	4.750	5.019	-0.269	0.187	-0.888	0.036	-0.884	5
14	4.700	4.312	0.388	0.243	1.326	0.113	1.351	27
15	5.510	5.194	0.316	0.198	1.050	0.055	1.052	24
16	4.510	4.566	-0.056	0.208	-0.186	0.002	-0.181	3
17	5.740	5.287	0.453	0.205	1.513	0.118	1.562	26

18	4.220	4.202	0.018	0.214	0.059	0.000	0.058	25
19	5.210	5.403	-0.193	0.200	-0.641	0.020	-0.632	13
20	4.400	4.332	0.068	0.194	0.227	0.002	0.222	4
21	4.750	5.115	-0.365	0.211	-1.224	0.080	-1.238	20
22	4.230	4.541	-0.311	0.167	-1.015	0.041	-1.015	10
23	5.290	5.131	0.159	0.215	0.533	0.016	0.524	6
24	4.570	4.627	-0.057	0.276	-0.199	0.003	-0.195	1
25	4.430	4.895	-0.465	0.050	-1.419	0.021	-1.455	2
26	4.410	4.677	-0.267	0.054	-0.816	0.008	-0.810	7
27	4.830	4.794	0.036	0.042	0.109	0.000	0.107	11

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	6.589	14	0.471	6.478	0.0013
RESIDUAL	0.872	12	0.073		
COR TOTAL	7.460	26			
ROOT MSE	0.270		R-SQUARED	0.8831	
DEP MEAN	4.793		ADJ R-SQUARED	0.7468	
C.V.	5.62%				

Predicted Residual Sum of Squares (PRESS) = 4.889

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	4.519	1	0.153	29.50	
A	-0.593	1	0.084	-7.079	0.0001
B	-0.412	1	0.081	-5.079	0.0003
C	0.081	1	0.081	0.9949	0.3394
D	-0.011	1	0.081	-0.1300	0.8987
A2	0.335	1	0.122	2.756	0.0174
B2	0.230	1	0.085	2.699	0.0193
C2	0.094	1	0.115	0.8159	0.4305
D2	0.030	1	0.101	0.2984	0.7705
AB	0.160	1	0.105	1.524	0.1534
AC	0.160	1	0.132	1.217	0.2471
AD	0.026	1	0.159	0.1619	0.8741
BC	-0.143	1	0.118	-1.215	0.2477
BD	-0.039	1	0.117	-0.3337	0.7443
CD	-0.031	1	0.151	-0.2053	0.8408

Final Equation in Terms of Coded Factors:

$$\begin{aligned}
 \text{SO}_2 \text{ emiss} = & 4.519 \\
 & - 0.593 * A \\
 & - 0.412 * B \\
 & + 0.081 * C \\
 & - 0.011 * D \\
 & + 0.335 * A^2 \\
 & + 0.230 * B^2 \\
 & + 0.094 * C^2 \\
 & + 0.030 * D^2 \\
 & + 0.160 * AB \\
 & + 0.160 * AC \\
 & + 0.026 * AD \\
 & - 0.143 * BC \\
 & - 0.039 * BD \\
 & - 0.031 * CD
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned}
 \text{SO}_2 \text{ emiss} = & 33.182 \\
 & - 0.15049 * \text{Drum Speed} \\
 & - 0.33837 * \% \text{ Solids} \\
 & - 0.91520 * \text{Wash Water} \\
 & - 2.908\text{E-}03 * \text{Feed Rate} \\
 & + 2.093\text{E-}04 * \text{Drum Speed}^2 \\
 & + 3.589\text{E-}03 * \% \text{ Solids}^2
 \end{aligned}$$

+ 0.16670 * Wash Water^2
 + 5.349E-06 * Feed Rate^2
 + 4.999E-04 * Drum Speed * % Solids
 + 5.339E-03 * Drum Speed * Wash Water
 + 8.561E-06 * Drum Speed * Feed Rate
 - 2.391E-02 * % Solids * Wash Water
 - 6.487E-05 * % Solids * Feed Rate
 - 5.529E-04 * Wash Water * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	6.470	6.194	0.276	0.547	1.520	0.186	1.619	23
2	4.860	4.769	0.091	0.559	0.511	0.022	0.494	12
3	5.050	5.064	-0.014	0.682	-0.092	0.001	-0.088	18
4	4.320	4.442	-0.122	0.719	-0.854	0.124	-0.844	15
5	4.430	4.485	-0.055	0.652	-0.344	0.015	-0.331	17
6	4.790	4.611	0.179	0.520	0.961	0.067	0.957	21
7	4.290	4.532	-0.242	0.469	-1.230	0.089	-1.260	9
8	4.650	4.693	-0.043	0.444	-0.213	0.002	-0.204	8
9	5.310	5.269	0.041	0.603	0.240	0.006	0.230	22
10	4.420	4.238	0.182	0.638	1.123	0.148	1.137	14
11	5.110	5.484	-0.374	0.450	-1.870	0.191	-2.127	16
12	4.170	4.277	-0.107	0.506	-0.567	0.022	-0.550	19
13	4.750	4.873	-0.123	0.529	-0.665	0.033	-0.649	5
14	4.700	4.663	0.037	0.695	0.250	0.010	0.240	27
15	5.510	5.479	0.031	0.548	0.173	0.002	0.166	24
16	4.510	4.407	0.103	0.586	0.594	0.033	0.578	3
17	5.740	5.526	0.214	0.599	1.254	0.156	1.287	26
18	4.220	4.099	0.121	0.625	0.735	0.060	0.721	25
19	5.210	5.332	-0.122	0.561	-0.682	0.040	-0.666	13
20	4.400	4.574	-0.174	0.555	-0.968	0.078	-0.966	4
21	4.750	5.055	-0.305	0.642	-1.893	0.429	-2.164	20
22	4.230	4.429	-0.199	0.428	-0.975	0.047	-0.973	10
23	5.290	5.213	0.077	0.708	0.528	0.045	0.511	6
24	4.570	4.357	0.213	0.795	1.746	0.787	1.936	1
25	4.430	4.572	-0.142	0.291	-0.626	0.011	-0.609	2
26	4.410	4.340	0.070	0.331	0.317	0.003	0.305	7
27	4.830	4.445	0.385	0.317	1.727	0.092	1.907	11

APPENDIX 3-E

Box-Behnken Statistical Analyses

Combined Microcel/MGS Tests
Pittsburgh No. 8 Seam Coal

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Coal Seam:  Pittsburgh No. 8
Circuit:    Microcel/MGS Combined
Data File:  P-COM-00
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FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Column Feed	lbs/hr	300.000	500.000
B	MGS Feed	lbs/hr	150.000	350.000
C	Wash Water	lpm	0.500	1.500
D	Drum Speed	rpm	240.000	320.000

				A	B	C	D	Y1
	Dsn	Run		Column Feed	MGS Feed	Wash Water	Drum Speed	Comb. rec
Obs	ID	Ord	Blk	lbs/hr	lbs/hr	lpm	rpm	%
18	18	1	1	512.0	249.0	0.510	282.0	99.2
4	4	2	1	527.0	378.0	1.020	283.0	99.1
6	6	3	1	415.0	259.0	1.510	241.0	99.9
22	22	4	1	392.0	373.0	0.980	242.0	99.7
14	14	5	1	414.0	381.0	0.490	280.0	99.3
25	0	6	1	427.0	260.0	1.060	282.0	99.2
8	8	7	1	420.0	241.0	1.500	322.0	98.7
21	21	8	1	414.0	124.0	0.980	242.0	97.9
24	24	9	1	415.0	351.0	0.980	320.0	98.6
13	13	10	1	391.0	135.0	0.490	280.0	99.3
16	16	11	1	397.0	393.0	1.510	280.0	99.5
15	15	12	1	410.0	134.0	1.550	280.0	99.5
26	0	13	1	458.0	259.0	0.950	280.0	99.2
1	1	14	1	302.0	160.0	0.980	280.0	99.4
9	9	15	1	333.0	267.0	1.000	241.0	99.8
2	2	16	1	529.0	141.0	0.980	281.0	99.6
10	10	17	1	474.0	276.0	0.980	241.0	99.1
12	12	18	1	491.0	267.0	0.980	320.0	98.3
20	20	19	1	491.0	285.0	1.550	282.0	99.3
5	5	20	1	444.0	326.0	0.490	242.0	99.4
27	0	21	1	383.0	313.0	0.950	280.0	99.3
7	7	22	1	427.0	297.0	0.510	320.0	97.1
23	23	23	1	393.0	170.0	0.970	320.0	96.5
17	17	24	1	311.0	268.0	0.510	281.0	99.1
19	19	25	1	318.0	285.0	1.550	281.0	99.3
3	3	26	1	294.0	474.0	0.950	280.0	99.2
11	11	27	1	324.0	328.0	0.980	320.0	95.6

				Y2	Y3	Y4	Y5	Y6
Obs	Dsn ID	Run Ord	Blk	Ash rej %	Sulfur rej %	Pyr rej %	Efficiency %	SO2 emm lbs/MM Btu
18	18	1	1	12.09	24.04	48.17	47.32	2.650
4	4	2	1	14.42	28.57	54.37	53.46	2.550
6	6	3	1	1.16	2.93	6.77	6.69	3.590
22	22	4	1	3.17	6.94	7.98	7.70	3.290
14	14	5	1	12.15	25.00	32.64	31.89	2.590
25	0	6	1	13.30	25.98	52.98	52.20	2.670
8	8	7	1	21.26	32.00	63.08	61.74	2.510
21	21	8	1	7.74	17.83	31.97	29.88	3.180
24	24	9	1	17.71	27.01	57.53	56.16	2.710
13	13	10	1	12.27	26.59	52.95	52.24	2.750
16	16	11	1	8.54	18.17	41.85	41.40	3.040
15	15	12	1	9.61	22.54	46.40	45.87	2.770
26	0	13	1	12.63	27.41	52.88	52.09	2.820
1	1	14	1	11.51	25.23	51.23	50.60	2.650
9	9	15	1	2.71	6.51	13.07	12.87	3.270
2	2	16	1	7.27	15.86	35.95	35.54	2.640
10	10	17	1	7.60	18.68	36.93	36.00	2.620
12	12	18	1	21.62	31.84	57.38	55.70	2.130
20	20	19	1	12.14	25.14	50.31	49.62	2.640
5	5	20	1	5.97	12.68	24.91	24.34	3.180
27	0	21	1	11.68	22.45	47.67	47.01	2.700
7	7	22	1	24.64	31.49	65.03	62.09	2.440
23	23	23	1	30.38	34.52	69.93	66.46	2.330
17	17	24	1	13.27	23.70	51.38	50.50	2.720
19	19	25	1	11.78	23.99	50.24	49.56	2.660
3	3	26	1	12.46	24.48	49.92	49.16	2.720
11	11	27	1	28.69	37.05	65.30	60.89	2.380

				Y7
Obs	Dsn	Run		Energy rec
	ID	Ord	Blk	%
----	----	----	----	-----
18	18	1	1	99.3
4	4	2	1	99.2
6	6	3	1	99.9
22	22	4	1	99.8
14	14	5	1	99.3
25	0	6	1	99.3
8	8	7	1	98.8
21	21	8	1	98.0
24	24	9	1	98.8
13	13	10	1	99.4
16	16	11	1	99.6
15	15	12	1	99.5
26	0	13	1	99.3
1	1	14	1	99.5
9	9	15	1	99.8
2	2	16	1	99.6
10	10	17	1	99.1
12	12	18	1	98.5
20	20	19	1	99.4
5	5	20	1	99.5
27	0	21	1	99.4
7	7	22	1	97.2
23	23	23	1	96.8
17	17	24	1	99.2
19	19	25	1	99.4
3	3	26	1	99.3
11	11	27	1	95.8

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Coal Seam:  Pittsburgh No. 8
Circuit:    Microcel/MGS Combined
Response:   Combustible Recovery
Data File:  P-COM-00
Comments:   Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Column Feed    lbs/hr        300.000      500.000
B      MGS Feed       lbs/hr        150.000      350.000
C      Wash Water     lpm           0.500        1.500
D      Drum Speed     rpm           240.000      320.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	264064.98	1	264064.98		
Linear	11.85	4	2.96	4.298	0.0102
Quadratic	10.14	10	1.01	2.425	0.0742
Cubic	5.02	12	0.42		
RESIDUAL	0.00	0			
TOTAL	264091.99	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	0.830	0.4387	0.3366	23.665
Quadratic	15	12	0.647	0.8142	0.5974	29.801
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	11.85	4	2.963	4.298	0.0102
RESIDUAL	15.16	22	0.689		
COR TOTAL	27.02	26			
ROOT MSE	0.830		R-SQUARED	0.4387	
DEP MEAN	98.895		ADJ R-SQUARED	0.3366	
C.V.	0.84%				

Predicted Residual Sum of Squares (PRESS) = 23.66

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	98.861	1	0.169	585.0	
A	0.210	1	0.244	0.8599	0.3991
B	0.136	1	0.185	0.7328	0.4714
C	0.268	1	0.233	1.152	0.2616
D	-0.943	1	0.243	-3.880	0.0008

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Comb. rec} = & 98.861 \\ & + 0.210 * A \\ & + 0.136 * B \\ & + 0.268 * C \\ & - 0.943 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Comb. rec} = & 103.752 \\ & + 2.095\text{E-}03 * \text{Column Feed} \\ & + 1.356\text{E-}03 * \text{MGS Feed} \\ & + 0.53617 * \text{Wash Water} \\ & - 2.359\text{E-}02 * \text{Drum Speed} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	99.360	98.523	0.837	0.226	1.147	0.077	1.155	14
2	99.590	98.949	0.641	0.217	0.873	0.042	0.868	16
3	99.240	98.915	0.325	0.314	0.472	0.020	0.464	26
4	99.090	99.240	-0.150	0.227	-0.206	0.002	-0.201	2
5	99.430	99.679	-0.249	0.221	-0.339	0.007	-0.332	20
6	99.920	100.098	-0.178	0.205	-0.240	0.003	-0.235	3
7	97.060	97.775	-0.715	0.196	-0.960	0.045	-0.958	22
8	98.660	98.168	0.492	0.212	0.668	0.024	0.659	7
9	99.810	99.663	0.147	0.174	0.195	0.002	0.190	15
10	99.080	99.960	-0.880	0.158	-1.155	0.050	-1.165	17
11	95.590	97.853	-2.263	0.192	-3.033	0.438	-3.885	27
12	98.320	98.120	0.200	0.171	0.264	0.003	0.259	18
13	99.290	98.412	0.878	0.232	1.206	0.088	1.219	10
14	99.250	98.794	0.456	0.168	0.602	0.015	0.593	5
15	99.470	99.019	0.451	0.221	0.615	0.021	0.606	12
16	99.550	99.322	0.228	0.196	0.307	0.005	0.300	11
17	99.120	98.412	0.708	0.205	0.956	0.047	0.954	24

18	99.150	98.784	0.366	0.194	0.491	0.012	0.482	1
19	99.320	99.008	0.312	0.202	0.421	0.009	0.413	25
20	99.310	99.346	-0.036	0.196	-0.049	0.000	-0.048	19
21	97.910	99.605	-1.695	0.225	-2.319	0.313	-2.607	8
22	99.720	99.896	-0.176	0.169	-0.233	0.002	-0.228	4
23	96.520	97.778	-1.258	0.183	-1.676	0.126	-1.753	23
24	98.630	98.075	0.555	0.147	0.724	0.018	0.716	9
25	99.220	98.916	0.304	0.041	0.374	0.001	0.367	6
26	99.210	98.968	0.242	0.056	0.301	0.001	0.294	13
27	99.340	98.884	0.456	0.050	0.564	0.003	0.555	21

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	22.00	14	1.571	3.756	0.0136
RESIDUAL	5.02	12	0.418		
COR TOTAL	27.02	26			
ROOT MSE	0.647		R-SQUARED	0.8142	
DEP MEAN	98.895		ADJ R-SQUARED	0.5974	
C.V.	0.65%				

Predicted Residual Sum of Squares (PRESS) = 29.80

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	99.259	1	0.371	267.5	
A	0.156	1	0.215	0.7241	0.4829
B	0.166	1	0.161	1.027	0.3246
C	0.203	1	0.195	1.045	0.3168
D	-1.010	1	0.211	-4.784	0.0004
A2	-0.086	1	0.300	-0.2883	0.7780
B2	-0.076	1	0.162	-0.4683	0.6479
C2	0.190	1	0.268	0.7069	0.4931
D2	-0.919	1	0.319	-2.882	0.0138
AB	-0.078	1	0.231	-0.3368	0.7421
AC	0.058	1	0.330	0.1748	0.8641
AD	1.240	1	0.414	2.998	0.0111
BC	-0.009	1	0.239	-3.56E-02	0.9722
BD	-0.173	1	0.298	-0.5822	0.5712
CD	0.360	1	0.340	1.058	0.3111

Final Equation in Terms of Coded Factors:

Comb. rec =

```

          99.259
      +      0.156 * A
      +      0.166 * B
      +      0.203 * C
      -      1.010 * D
      -      0.086 * A2
      -      0.076 * B2
      +      0.190 * C2
      -      0.919 * D2
      -      0.078 * AB
      +      0.058 * AC
      +      1.240 * AD
      -      0.009 * BC
      -      0.173 * BD
      +      0.360 * CD

```

Final Equation in Terms of Actual Factors:

Comb. rec =

```

          95.141
      -      7.757E-02 * Column Feed
      +      2.087E-02 * MGS Feed
      -      6.5669 * Wash Water
      +      0.16515 * Drum Speed
      -      8.640E-06 * Column Feed^2
      -      7.593E-06 * MGS Feed ^2

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+ 0.75846 * Wash Water^2
 - 5.743E-04 * Drum Speed^2
 - 7.768E-06 * Column Feed * MGS Feed
 + 1.153E-03 * Column Feed * Wash Water
 + 3.101E-04 * Column Feed * Drum Speed
 - 1.704E-04 * MGS Feed * Wash Water
 - 4.334E-05 * MGS Feed * Drum Speed
 + 1.799E-02 * Wash Water * Drum Speed

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	99.360	98.738	0.622	0.585	1.492	0.209	1.583	14
2	99.590	99.162	0.428	0.629	1.088	0.134	1.097	16
3	99.240	99.161	0.079	0.816	0.286	0.024	0.275	26
4	99.090	99.311	-0.221	0.742	-0.673	0.087	-0.657	2
5	99.430	99.423	0.007	0.616	0.017	0.000	0.016	20
6	99.920	99.294	0.626	0.593	1.517	0.224	1.616	3
7	97.060	97.289	-0.229	0.563	-0.535	0.025	-0.518	22
8	98.660	98.258	0.402	0.609	0.993	0.102	0.992	7
9	99.810	100.101	-0.291	0.564	-0.682	0.040	-0.666	15
10	99.080	98.615	0.465	0.420	0.944	0.043	0.939	17
11	95.590	96.192	-0.602	0.618	-1.506	0.244	-1.601	27
12	98.320	98.489	-0.169	0.466	-0.357	0.007	-0.343	18
13	99.290	98.930	0.360	0.667	0.964	0.124	0.961	10
14	99.250	99.344	-0.094	0.475	-0.202	0.002	-0.193	5
15	99.470	99.459	0.011	0.674	0.031	0.000	0.030	12
16	99.550	99.730	-0.180	0.568	-0.422	0.016	-0.407	11
17	99.120	99.063	0.057	0.643	0.147	0.003	0.141	24
18	99.150	99.243	-0.093	0.528	-0.209	0.003	-0.200	1
19	99.320	99.499	-0.179	0.642	-0.462	0.026	-0.447	25
20	99.310	99.881	-0.571	0.543	-1.305	0.135	-1.349	19
21	97.910	98.727	-0.817	0.718	-2.376	0.956	-3.126	8
22	99.720	99.776	-0.056	0.447	-0.117	0.001	-0.112	4
23	96.520	97.151	-0.631	0.608	-1.560	0.252	-1.672	23
24	98.630	97.418	1.212	0.368	2.359	0.216	3.083	9
25	99.220	99.302	-0.082	0.317	-0.154	0.001	-0.148	6
26	99.210	99.309	-0.099	0.269	-0.178	0.001	-0.171	13
27	99.340	99.295	0.045	0.313	0.083	0.000	0.080	21

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Coal Seam:  Pittsburgh No. 8
Circuit:    Microcel/MGS Combined
Response:   Energy Recovery
Data File:  P-COM-00
Comments:   Analysis of Complete Data Set
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FAC	FACTOR	UNITS	-1 LEVEL	+1 LEVEL
A	Column Feed	lbs/hr	300.000	500.000
B	MGS Feed	lbs/hr	150.000	350.000
C	Wash Water	lpm	0.500	1.500
D	Drum Speed	rpm	240.000	320.000

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	264615.12	1	264615.12		
Linear	10.18	4	2.55	3.843	0.0162
Quadratic	9.75	10	0.98	2.429	0.0739
Cubic	4.82	12	0.40		
RESIDUAL	0.00	0			
TOTAL	264639.87	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	0.814	0.4114	0.3043	22.745
Quadratic	15	12	0.634	0.8053	0.5782	28.634
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	10.18	4	2.546	3.843	0.0162
RESIDUAL	14.57	22	0.662		
COR TOTAL	24.75	26			
ROOT MSE	0.814		R-SQUARED	0.4114	
DEP MEAN	98.998		ADJ R-SQUARED	0.3043	
C.V.	0.82%				

Predicted Residual Sum of Squares (PRESS) = 22.75

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	98.963	1	0.166	597.4	
A	0.204	1	0.239	0.8545	0.4020
B	0.132	1	0.181	0.7282	0.4742
C	0.261	1	0.228	1.143	0.2653
D	-0.868	1	0.238	-3.641	0.0014

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & 98.963 \\ & + 0.204 * A \\ & + 0.132 * B \\ & + 0.261 * C \\ & - 0.868 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & 103.370 \\ & + 2.041\text{E-}03 * \text{Column Feed} \\ & + 1.320\text{E-}03 * \text{MGS Feed} \\ & + 0.52148 * \text{Wash Water} \\ & - 2.170\text{E-}02 * \text{Drum Speed} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	99.470	98.634	0.836	0.226	1.168	0.080	1.178	14
2	99.640	99.051	0.589	0.217	0.819	0.037	0.812	16
3	99.340	99.017	0.323	0.314	0.480	0.021	0.471	26
4	99.220	99.337	-0.117	0.227	-0.163	0.002	-0.160	2
5	99.470	99.712	-0.242	0.221	-0.337	0.006	-0.330	20
6	99.940	100.118	-0.178	0.205	-0.245	0.003	-0.240	3
7	97.230	97.957	-0.727	0.196	-0.996	0.048	-0.996	22
8	98.850	98.342	0.508	0.212	0.703	0.027	0.695	7
9	99.830	99.695	0.135	0.174	0.182	0.001	0.178	15
10	99.140	99.984	-0.844	0.158	-1.131	0.048	-1.138	17
11	95.800	98.033	-2.233	0.192	-3.053	0.444	-3.929	27
12	98.480	98.293	0.187	0.171	0.252	0.003	0.247	18
13	99.390	98.527	0.863	0.232	1.210	0.088	1.223	10
14	99.350	98.899	0.451	0.168	0.608	0.015	0.599	5
15	99.550	99.117	0.433	0.221	0.602	0.021	0.593	12
16	99.610	99.412	0.198	0.196	0.271	0.004	0.266	11
17	99.220	98.528	0.692	0.205	0.953	0.047	0.951	24

18	99.250	98.892	0.358	0.194	0.490	0.012	0.482	1
19	99.410	99.107	0.303	0.202	0.416	0.009	0.408	25
20	99.400	99.439	-0.039	0.196	-0.053	0.000	-0.052	19
21	97.970	99.640	-1.670	0.225	-2.331	0.316	-2.624	8
22	99.750	99.923	-0.173	0.169	-0.234	0.002	-0.229	4
23	96.760	97.960	-1.200	0.183	-1.631	0.119	-1.700	23
24	98.780	98.249	0.531	0.147	0.706	0.017	0.698	9
25	99.340	99.020	0.320	0.041	0.402	0.001	0.394	6
26	99.320	99.068	0.252	0.056	0.319	0.001	0.313	13
27	99.430	98.986	0.444	0.050	0.560	0.003	0.551	21

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	19.93	14	1.424	3.546	0.0170
RESIDUAL	4.82	12	0.402		
COR TOTAL	24.75	26			
ROOT MSE	0.634		R-SQUARED	0.8053	
DEP MEAN	98.998		ADJ R-SQUARED	0.5782	
C.V.	0.64%				

Predicted Residual Sum of Squares (PRESS) = 28.63

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	99.360	1	0.364	273.3	
A	0.148	1	0.211	0.7026	0.4957
B	0.161	1	0.158	1.016	0.3298
C	0.199	1	0.191	1.044	0.3170
D	-0.928	1	0.207	-4.487	0.0007
A2	-0.086	1	0.294	-0.2917	0.7755
B2	-0.073	1	0.159	-0.4574	0.6556
C2	0.176	1	0.263	0.6696	0.5158
D2	-0.905	1	0.312	-2.896	0.0134
AB	-0.063	1	0.226	-0.2779	0.7858
AC	0.058	1	0.323	0.1790	0.8609
AD	1.206	1	0.405	2.974	0.0116
BC	-0.011	1	0.235	-4.90E-02	0.9617
BD	-0.184	1	0.292	-0.6293	0.5409
CD	0.362	1	0.333	1.085	0.2991

Final Equation in Terms of Coded Factors:

$$\begin{aligned}
 \text{Energy rec} = & 99.360 \\
 & + 0.148 * A \\
 & + 0.161 * B \\
 & + 0.199 * C \\
 & - 0.928 * D \\
 & - 0.086 * A^2 \\
 & - 0.073 * B^2 \\
 & + 0.176 * C^2 \\
 & - 0.905 * D^2 \\
 & - 0.063 * AB \\
 & + 0.058 * AC \\
 & + 1.206 * AD \\
 & - 0.011 * BC \\
 & - 0.184 * BD \\
 & + 0.362 * CD
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned}
 \text{Energy rec} = & 94.412 \\
 & - 7.566\text{E-}02 * \text{Column Feed} \\
 & + 2.083\text{E-}02 * \text{MGS Feed} \\
 & - 6.4806 * \text{Wash Water} \\
 & + 0.16622 * \text{Drum Speed} \\
 & - 8.565\text{E-}06 * \text{Column Feed}^2 \\
 & - 7.265\text{E-}06 * \text{MGS Feed}^2
 \end{aligned}$$


```

+      0.70383 * Wash Water^2
-      5.654E-04 * Drum Speed^2
-      6.280E-06 * Column Feed * MGS Feed
+      1.156E-03 * Column Feed * Wash Water
+      3.015E-04 * Column Feed * Drum Speed
-      2.299E-04 * MGS Feed * Wash Water
-      4.590E-05 * MGS Feed * Drum Speed
+      1.809E-02 * Wash Water * Drum Speed

```

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	99.470	98.869	0.601	0.585	1.473	0.204	1.558	14
2	99.640	99.245	0.395	0.629	1.025	0.119	1.027	16
3	99.340	99.242	0.098	0.816	0.361	0.039	0.348	26
4	99.220	99.429	-0.209	0.742	-0.649	0.081	-0.632	2
5	99.470	99.476	-0.006	0.616	-0.014	0.000	-0.014	20
6	99.940	99.313	0.627	0.593	1.551	0.234	1.661	3
7	97.230	97.461	-0.231	0.563	-0.551	0.026	-0.534	22
8	98.850	98.439	0.411	0.609	1.038	0.112	1.042	7
9	99.830	100.119	-0.289	0.564	-0.690	0.041	-0.674	15
10	99.140	98.674	0.466	0.420	0.964	0.045	0.961	17
11	95.800	96.404	-0.604	0.618	-1.541	0.256	-1.647	27
12	98.480	98.649	-0.169	0.466	-0.364	0.008	-0.350	18
13	99.390	99.031	0.359	0.667	0.982	0.129	0.980	10
14	99.350	99.441	-0.091	0.475	-0.197	0.002	-0.189	5
15	99.550	99.551	-0.001	0.674	-0.002	0.000	-0.002	12
16	99.610	99.807	-0.197	0.568	-0.473	0.020	-0.458	11
17	99.220	99.163	0.057	0.643	0.149	0.003	0.143	24
18	99.250	99.329	-0.079	0.528	-0.182	0.002	-0.175	1
19	99.410	99.582	-0.172	0.642	-0.454	0.025	-0.438	25
20	99.400	99.960	-0.560	0.543	-1.307	0.135	-1.351	19
21	97.970	98.764	-0.794	0.718	-2.357	0.941	-3.079	8
22	99.750	99.820	-0.070	0.447	-0.149	0.001	-0.143	4
23	96.760	97.367	-0.607	0.608	-1.531	0.243	-1.635	23
24	98.780	97.600	1.180	0.368	2.344	0.214	3.048	9
25	99.340	99.405	-0.065	0.317	-0.124	0.000	-0.119	6
26	99.320	99.407	-0.087	0.269	-0.160	0.001	-0.153	13
27	99.430	99.395	0.035	0.313	0.066	0.000	0.063	21

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Coal Seam:  Pittsburgh No. 8
Circuit:    Microcel/MGS Combined
Response:   Ash Rejection
Data File:  P-COM-00
Comments:   Analysis of Complete Data Set
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=====
FAC      FACTOR          UNITS      -1 LEVEL      +1 LEVEL
A      Column Feed      lbs/hr      300.000      500.000
B      MGS Feed          lbs/hr      150.000      350.000
C      Wash Water        lpm         0.500        1.500
D      Drum Speed        rpm         240.000      320.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	4479.4	1	4479.4		
Linear	1154.7	4	288.7	29.21	0.0001
Quadratic	111.5	10	11.1	1.263	0.3459
Cubic	105.9	12	8.8		
RESIDUAL	0.0	0			
TOTAL	5851.5	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	3.14	0.8415	0.8127	332.58
Quadratic	15	12	2.97	0.9228	0.8327	683.35
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1154.7	4	288.67	29.21	0.0001
RESIDUAL	217.4	22	9.88		
COR TOTAL	1372.1	26			
ROOT MSE	3.14		R-SQUARED	0.8415	
DEP MEAN	12.88		ADJ R-SQUARED	0.8127	
C.V.	24.41%				

Predicted Residual Sum of Squares (PRESS) = 332.6

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	12.82	1	0.64	20.04	
A	-0.74	1	0.92	-0.8023	0.4309
B	-0.32	1	0.70	-0.4525	0.6554
C	-1.38	1	0.88	-1.571	0.1305
D	9.83	1	0.92	10.68	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 12.82 \\ & - 0.74 * A \\ & - 0.32 * B \\ & - 1.38 * C \\ & + 9.83 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & -49.50 \\ & - 7.403\text{E-}03 * \text{Column Feed} \\ & - 3.169\text{E-}03 * \text{MGS Feed} \\ & - 2.7679 * \text{Wash Water} \\ & + 0.24586 * \text{Drum Speed} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	11.51	13.89	-2.38	0.226	-0.860	0.043	-0.854	14
2	7.27	12.51	-5.24	0.217	-1.885	0.197	-2.011	16
3	12.46	13.03	-0.57	0.314	-0.221	0.004	-0.216	26
4	14.42	12.16	2.26	0.227	0.819	0.039	0.812	2
5	5.97	4.32	1.65	0.221	0.593	0.020	0.584	20
6	1.16	1.68	-0.52	0.205	-0.186	0.002	-0.182	3
7	24.64	23.66	0.98	0.196	0.347	0.006	0.340	22
8	21.26	21.64	-0.38	0.212	-0.138	0.001	-0.134	7
9	2.71	3.67	-0.96	0.174	-0.338	0.005	-0.331	15
10	7.60	2.66	4.94	0.158	1.713	0.110	1.798	17
11	28.69	23.03	5.66	0.192	2.005	0.191	2.167	27
12	21.62	21.98	-0.36	0.171	-0.127	0.001	-0.124	18
13	12.27	14.66	-2.39	0.232	-0.869	0.046	-0.864	10
14	12.15	13.71	-1.56	0.168	-0.546	0.012	-0.537	5
15	9.61	11.59	-1.98	0.221	-0.714	0.029	-0.706	12
16	8.54	10.98	-2.44	0.196	-0.865	0.037	-0.860	11
17	13.27	15.03	-1.76	0.205	-0.626	0.020	-0.617	24

18	12.09	13.84	-1.75	0.194	-0.621	0.019	-0.612	1
19	11.78	12.04	-0.26	0.202	-0.093	0.000	-0.091	25
20	12.14	11.01	1.13	0.196	0.402	0.008	0.394	19
21	7.74	3.83	3.91	0.225	1.413	0.116	1.448	8
22	3.17	3.20	-0.03	0.169	-0.012	0.000	-0.011	4
23	30.38	23.04	7.34	0.183	2.582	0.298	3.021	23
24	17.71	22.28	-4.57	0.147	-1.574	0.085	-1.633	9
25	13.30	12.92	0.38	0.041	0.125	0.000	0.122	6
26	12.63	12.50	0.13	0.056	0.042	0.000	0.041	13
27	11.68	12.89	-1.21	0.050	-0.394	0.002	-0.386	21

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1266.2	14	90.44	10.25	0.0001
RESIDUAL	105.9	12	8.83		
COR TOTAL	1372.1	26			
ROOT MSE	2.97		R-SQUARED	0.9228	
DEP MEAN	12.88		ADJ R-SQUARED	0.8327	
C.V.	23.07%				

Predicted Residual Sum of Squares (PRESS) = 683.4

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	11.98	1	1.70	7.030	
A	-0.85	1	0.99	-0.8591	0.4071
B	-0.44	1	0.74	-0.5996	0.5599
C	-1.13	1	0.89	-1.267	0.2292
D	10.52	1	0.97	10.84	0.0001
A2	0.39	1	1.38	0.2829	0.7820
B2	0.18	1	0.74	0.2357	0.8176
C2	-0.98	1	1.23	-0.7968	0.4411
D2	2.58	1	1.46	1.763	0.1033
AB	1.01	1	1.06	0.9559	0.3580
AC	0.20	1	1.51	0.1328	0.8966
AD	-4.66	1	1.90	-2.451	0.0305
BC	-0.08	1	1.10	-7.00E-02	0.9454
BD	-1.08	1	1.37	-0.7859	0.4471
CD	-0.57	1	1.56	-0.3652	0.7213

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 11.98 \\ & - 0.85 * A \\ & - 0.44 * B \\ & - 1.13 * C \\ & + 10.52 * D \\ & + 0.39 * A^2 \\ & + 0.18 * B^2 \\ & - 0.98 * C^2 \\ & + 2.58 * D^2 \\ & + 1.01 * AB \\ & + 0.20 * AC \\ & - 4.66 * AD \\ & - 0.08 * BC \\ & - 1.08 * BD \\ & - 0.57 * CD \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & -70.86 \\ & + 0.25712 * \text{Column Feed} \\ & + 2.306E-02 * \text{MGS Feed} \\ & + 12.356 * \text{Wash Water} \\ & - 7.910E-02 * \text{Drum Speed} \\ & + 3.895E-05 * \text{Column Feed}^2 \\ & + 1.756E-05 * \text{MGS Feed}^2 \end{aligned}$$

- 3.9270 * Wash Water^2
 + 1.614E-03 * Drum Speed^2
 + 1.013E-04 * Column Feed * MGS Feed
 + 4.021E-03 * Column Feed * Wash Water
 - 1.165E-03 * Column Feed * Drum Speed
 - 1.539E-03 * MGS Feed * Wash Water
 - 2.688E-04 * MGS Feed * Drum Speed
 - 2.854E-02 * Wash Water * Drum Speed

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	11.51	14.67	-3.16	0.585	-1.653	0.257	-1.801	14
2	7.27	10.98	-3.71	0.629	-2.051	0.476	-2.437	16
3	12.46	10.94	1.52	0.816	1.191	0.420	1.214	26
4	14.42	13.11	1.31	0.742	0.866	0.144	0.856	2
5	5.97	6.40	-0.43	0.616	-0.232	0.006	-0.223	20
6	1.16	3.23	-2.07	0.593	-1.090	0.115	-1.100	3
7	24.64	23.79	0.85	0.563	0.432	0.016	0.417	22
8	21.26	22.20	-0.94	0.609	-0.507	0.027	-0.491	7
9	2.71	1.87	0.84	0.564	0.427	0.016	0.412	15
10	7.60	7.51	0.09	0.420	0.041	0.000	0.039	17
11	28.69	27.89	0.80	0.618	0.433	0.020	0.418	27
12	21.62	20.36	1.26	0.466	0.580	0.020	0.563	18
13	12.27	12.97	-0.70	0.667	-0.410	0.022	-0.396	10
14	12.15	11.99	0.16	0.475	0.076	0.000	0.073	5
15	9.61	10.22	-0.61	0.674	-0.361	0.018	-0.348	12
16	8.54	9.39	-0.85	0.568	-0.437	0.017	-0.422	11
17	13.27	13.54	-0.27	0.643	-0.155	0.003	-0.148	24
18	12.09	11.76	0.33	0.528	0.161	0.002	0.155	1
19	11.78	10.21	1.57	0.642	0.885	0.093	0.876	25
20	12.14	9.73	2.41	0.543	1.200	0.114	1.224	19
21	7.74	4.22	3.52	0.718	2.231	0.843	2.792	8
22	3.17	4.94	-1.77	0.447	-0.800	0.034	-0.787	4
23	30.38	26.95	3.43	0.608	1.843	0.352	2.083	23
24	17.71	23.14	-5.43	0.368	-2.298	0.205	-2.940	9
25	13.30	12.08	1.22	0.317	0.495	0.008	0.479	6
26	12.63	11.73	0.90	0.269	0.355	0.003	0.341	13
27	11.68	11.93	-0.25	0.313	-0.102	0.000	-0.098	21

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Coal Seam:  Pittsburgh No. 8
Circuit:    Microcel/MGS Combined
Response:   Sulfur Rejection
Data File:  P-COM-00
Comments:   Analysis of Complete Data Set
=====

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=====
FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Column Feed    lbs/hr        300.000      500.000
B    MGS Feed       lbs/hr        150.000      350.000
C    Wash Water     lpm           0.500        1.500
D    Drum Speed     rpm           240.000      320.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	14174.2	1	14174.2		
Linear	1413.2	4	353.3	18.78	0.0001
Quadratic	199.4	10	19.9	1.116	0.4223
Cubic	214.4	12	17.9		
RESIDUAL	0.0	0			
TOTAL	16001.3	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	4.34	0.7735	0.7323	628.08
Quadratic	15	12	4.23	0.8826	0.7457	1399.37
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1413.2	4	353.31	18.78	0.0001
RESIDUAL	413.9	22	18.81		
COR TOTAL	1827.1	26			
ROOT MSE	4.34		R-SQUARED	0.7735	
DEP MEAN	22.91		ADJ R-SQUARED	0.7323	
C.V.	18.93%				

Predicted Residual Sum of Squares (PRESS) = 628.1

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	22.81	1	0.88	25.83	
A	-0.13	1	1.27	-0.1043	0.9179
B	-0.52	1	0.97	-0.5337	0.5989
C	-1.54	1	1.22	-1.264	0.2196
D	10.89	1	1.27	8.571	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sulfur rej} = & 22.81 \\ & - 0.13 * A \\ & - 0.52 * B \\ & - 1.54 * C \\ & + 10.89 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sulfur rej} = & -48.52 \\ & - 1.328\text{E-}03 * \text{Column Feed} \\ & - 5.158\text{E-}03 * \text{MGS Feed} \\ & - 3.0720 * \text{Wash Water} \\ & + 0.27221 * \text{Drum Speed} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	25.23	23.46	1.77	0.226	0.463	0.013	0.454	14
2	15.86	23.53	-7.67	0.217	-2.000	0.222	-2.160	16
3	24.48	21.95	2.53	0.314	0.705	0.046	0.697	26
4	28.57	22.73	5.84	0.227	1.531	0.138	1.582	2
5	12.68	13.58	-0.90	0.221	-0.235	0.003	-0.230	20
6	2.93	10.56	-7.63	0.205	-1.973	0.201	-2.125	3
7	31.49	34.92	-3.43	0.196	-0.883	0.038	-0.878	22
8	32.00	32.72	-0.72	0.212	-0.188	0.002	-0.184	7
9	6.51	12.19	-5.68	0.174	-1.442	0.087	-1.480	15
10	18.68	12.02	6.66	0.158	1.673	0.105	1.750	17
11	37.05	33.46	3.59	0.192	0.922	0.040	0.919	27
12	31.84	33.55	-1.71	0.171	-0.433	0.008	-0.425	18
13	26.59	24.98	1.61	0.232	0.424	0.011	0.415	10
14	25.00	23.68	1.32	0.168	0.334	0.005	0.327	5
15	22.54	21.70	0.84	0.221	0.218	0.003	0.214	12
16	18.17	20.51	-2.34	0.196	-0.601	0.018	-0.592	11
17	23.70	24.61	-0.91	0.205	-0.236	0.003	-0.230	24

18	24.04	24.71	-0.67	0.194	-0.173	0.001	-0.169	1
19	23.99	21.32	2.67	0.202	0.689	0.024	0.681	25
20	25.14	21.36	3.78	0.196	0.971	0.046	0.970	19
21	17.83	13.16	4.67	0.225	1.224	0.087	1.239	8
22	6.94	11.90	-4.96	0.169	-1.255	0.064	-1.272	4
23	34.52	34.21	0.31	0.183	0.079	0.000	0.077	23
24	27.01	33.22	-6.21	0.147	-1.550	0.083	-1.604	9
25	25.98	23.08	2.90	0.041	0.683	0.004	0.674	6
26	27.41	22.84	4.57	0.056	1.085	0.014	1.090	13
27	22.45	22.66	-0.21	0.050	-0.050	0.000	-0.048	21

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1612.7	14	115.19	6.446	0.0013
RESIDUAL	214.4	12	17.87		
COR TOTAL	1827.1	26			
ROOT MSE	4.23		R-SQUARED	0.8826	
DEP MEAN	22.91		ADJ R-SQUARED	0.7457	
C.V.	18.45%				

Predicted Residual Sum of Squares (PRESS) = 1399.4

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	24.39	1	2.43	10.05	
A	-0.42	1	1.41	-0.3002	0.7692
B	-0.59	1	1.05	-0.5644	0.5829
C	-1.21	1	1.27	-0.9492	0.3613
D	11.39	1	1.38	8.252	0.0001
A2	0.26	1	1.96	0.1347	0.8951
B2	0.41	1	1.06	0.3898	0.7035
C2	-1.40	1	1.75	-0.7988	0.4399
D2	-2.81	1	2.08	-1.350	0.2020
AB	2.16	1	1.51	1.431	0.1779
AC	0.13	1	2.15	6.18E-02	0.9518
AD	-5.37	1	2.70	-1.985	0.0705
BC	-0.36	1	1.57	-0.2307	0.8214
BD	1.56	1	1.95	0.7996	0.4395
CD	2.43	1	2.22	1.091	0.2966

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sulfur rej} = & 24.39 \\ & - 0.42 * A \\ & - 0.59 * B \\ & - 1.21 * C \\ & + 11.39 * D \\ & + 0.26 * A^2 \\ & + 0.41 * B^2 \\ & - 1.40 * C^2 \\ & - 2.81 * D^2 \\ & + 2.16 * AB \\ & + 0.13 * AC \\ & - 5.37 * AD \\ & - 0.36 * BC \\ & + 1.56 * BD \\ & + 2.43 * CD \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sulfur rej} = & -254.66 \\ & + 0.29384 * \text{Column Feed} \\ & - 0.21462 * \text{MGS Feed} \\ & - 24.449 * \text{Wash Water} \\ & + 1.5875 * \text{Drum Speed} \\ & + 2.638\text{E-}05 * \text{Column Feed}^2 \\ & + 4.131\text{E-}05 * \text{MGS Feed}^2 \end{aligned}$$

- 5.6017 * Wash Water^2
 - 1.758E-03 * Drum Speed^2
 + 2.158E-04 * Column Feed * MGS Feed
 + 2.662E-03 * Column Feed * Wash Water
 - 1.342E-03 * Column Feed * Drum Speed
 - 7.222E-03 * MGS Feed * Wash Water
 + 3.890E-04 * MGS Feed * Drum Speed
 + 0.12135 * Wash Water * Drum Speed

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	25.23	27.86	-2.63	0.585	-0.967	0.088	-0.965	14
2	15.86	22.47	-6.61	0.629	-2.570	0.748	-3.670	16
3	24.48	20.95	3.53	0.816	1.949	1.126	2.258	26
4	28.57	28.12	0.45	0.742	0.210	0.008	0.201	2
5	12.68	14.87	-2.19	0.616	-0.834	0.074	-0.823	20
6	2.93	6.06	-3.13	0.593	-1.161	0.131	-1.180	3
7	31.49	29.83	1.66	0.563	0.594	0.030	0.578	22
8	32.00	31.91	0.09	0.609	0.032	0.000	0.031	7
9	6.51	6.91	-0.40	0.564	-0.142	0.002	-0.136	15
10	18.68	14.35	4.33	0.420	1.346	0.087	1.398	17
11	37.05	37.20	-0.15	0.618	-0.059	0.000	-0.056	27
12	31.84	28.37	3.47	0.466	1.124	0.073	1.137	18
13	26.59	25.24	1.35	0.667	0.552	0.041	0.535	10
14	25.00	24.90	0.10	0.475	0.034	0.000	0.033	5
15	22.54	22.79	-0.25	0.674	-0.106	0.002	-0.101	12
16	18.17	21.08	-2.91	0.568	-1.047	0.096	-1.052	11
17	23.70	24.90	-1.20	0.643	-0.475	0.027	-0.459	24
18	24.04	24.06	-0.02	0.528	-0.006	0.000	-0.006	1
19	23.99	21.32	2.67	0.642	1.054	0.132	1.059	25
20	25.14	22.20	2.94	0.543	1.028	0.084	1.031	19
21	17.83	14.69	3.14	0.718	1.396	0.330	1.461	8
22	6.94	8.67	-1.73	0.447	-0.551	0.016	-0.534	4
23	34.52	32.89	1.63	0.608	0.615	0.039	0.599	23
24	27.01	33.78	-6.77	0.368	-2.016	0.158	-2.374	9
25	25.98	24.64	1.34	0.317	0.383	0.005	0.369	6
26	27.41	24.39	3.02	0.269	0.834	0.017	0.823	13
27	22.45	24.16	-1.71	0.313	-0.487	0.007	-0.471	21

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Coal Seam:  Pittsburgh No. 8
Circuit:    Microcel/MGS Combined
Response:   Pyritic Sulfur Rejection
Data File:  P-COM-00
Comments:   Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Column Feed    lbs/hr        300.000      500.000
B      MGS Feed       lbs/hr        150.000      350.000
C      Wash Water     lpm           0.500        1.500
D      Drum Speed     rpm           240.000      320.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	55019.3	1	55019.3		
Linear	5625.2	4	1406.3	18.91	0.0001
Quadratic	785.6	10	78.6	1.108	0.4266
Cubic	850.6	12	70.9		
RESIDUAL	0.0	0			
TOTAL	62280.7	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	8.62	0.7747	0.7337	2472.29
Quadratic	15	12	8.42	0.8829	0.7462	6459.02
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	5625.2	4	1406.29	18.91	0.0001
RESIDUAL	1636.2	22	74.37		
COR TOTAL	7261.3	26			
ROOT MSE	8.62		R-SQUARED	0.7747	
DEP MEAN	45.14		ADJ R-SQUARED	0.7337	
C.V.	19.10%				

Predicted Residual Sum of Squares (PRESS) = 2472.3

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	45.27	1	1.76	25.79	
A	-0.86	1	2.53	-0.3406	0.7366
B	-2.11	1	1.92	-1.099	0.2835
C	-1.40	1	2.42	-0.5813	0.5670
D	21.80	1	2.53	8.633	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Pyr rej} = & 45.27 \\ & - 0.86 * A \\ & - 2.11 * B \\ & - 1.40 * C \\ & + 21.80 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Pyr rej} = & -95.82 \\ & - 8.622\text{E-}03 * \text{Column Feed} \\ & - 2.112\text{E-}02 * \text{MGS Feed} \\ & - 2.8098 * \text{Wash Water} \\ & + 0.54511 * \text{Drum Speed} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	51.23	48.07	3.16	0.226	0.416	0.010	0.408	14
2	35.95	47.06	-11.11	0.217	-1.456	0.118	-1.497	16
3	49.92	41.59	8.33	0.314	1.166	0.125	1.176	26
4	54.37	43.05	11.32	0.227	1.493	0.131	1.539	2
5	24.91	24.00	0.91	0.221	0.119	0.001	0.116	20
6	6.77	22.26	-15.49	0.205	-2.014	0.210	-2.179	3
7	65.03	67.23	-2.20	0.196	-0.284	0.004	-0.278	22
8	63.08	66.78	-3.70	0.212	-0.483	0.013	-0.474	7
9	13.07	24.23	-11.16	0.174	-1.424	0.085	-1.460	15
10	36.93	22.88	14.05	0.158	1.776	0.118	1.874	17
11	65.30	66.14	-0.84	0.192	-0.108	0.001	-0.106	27
12	57.38	65.99	-8.61	0.171	-1.096	0.050	-1.101	18
13	52.95	49.21	3.74	0.232	0.495	0.015	0.486	10
14	32.64	43.81	-11.17	0.168	-1.421	0.082	-1.457	5
15	46.40	46.09	0.31	0.221	0.041	0.000	0.040	12
16	41.85	40.84	1.01	0.196	0.130	0.001	0.127	11
17	51.38	47.58	3.80	0.205	0.494	0.013	0.486	24

18	48.17	46.79	1.38	0.194	0.178	0.002	0.174	1
19	50.24	44.24	6.00	0.202	0.779	0.031	0.772	25
20	50.31	43.29	7.02	0.196	0.908	0.040	0.904	19
21	31.97	27.15	4.82	0.225	0.635	0.023	0.626	8
22	7.98	22.08	-14.10	0.169	-1.794	0.131	-1.896	4
23	69.93	68.91	1.02	0.183	0.131	0.001	0.128	23
24	57.53	64.87	-7.34	0.147	-0.921	0.029	-0.918	9
25	52.98	45.75	7.23	0.041	0.856	0.006	0.851	6
26	52.88	44.72	8.16	0.056	0.974	0.011	0.973	13
27	47.67	44.23	3.44	0.050	0.410	0.002	0.402	21

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	6410.8	14	457.91	6.460	0.0013
RESIDUAL	850.6	12	70.88		
COR TOTAL	7261.3	26			
ROOT MSE	8.42		R-SQUARED	0.8829	
DEP MEAN	45.14		ADJ R-SQUARED	0.7462	
C.V.	18.65%				

Predicted Residual Sum of Squares (PRESS) = 6459.0

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	48.68	1	4.83	10.08	
A	-1.29	1	2.80	-0.4598	0.6539
B	-2.06	1	2.10	-0.9788	0.3470
C	-1.43	1	2.53	-0.5648	0.5826
D	22.81	1	2.75	8.297	0.0001
A2	1.29	1	3.90	0.3309	0.7464
B2	0.18	1	2.11	8.36E-02	0.9347
C2	-2.16	1	3.49	-0.6191	0.5474
D2	-6.58	1	4.15	-1.586	0.1388
AB	2.79	1	3.00	0.9284	0.3715
AC	0.39	1	4.29	9.13E-02	0.9287
AD	-10.30	1	5.39	-1.913	0.0799
BC	2.26	1	3.12	0.7265	0.4815
BD	2.37	1	3.88	0.6120	0.5520
CD	4.04	1	4.43	0.9116	0.3799

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Pyr rej} = & 48.68 \\ & - 1.29 * A \\ & - 2.06 * B \\ & - 1.43 * C \\ & + 22.81 * D \\ & + 1.29 * A^2 \\ & + 0.18 * B^2 \\ & - 2.16 * C^2 \\ & - 6.58 * D^2 \\ & + 2.79 * AB \\ & + 0.39 * AC \\ & - 10.30 * AD \\ & + 2.26 * BC \\ & + 2.37 * BD \\ & + 4.04 * CD \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Pyr rej} = & -555.29 \\ & + 0.52757 * \text{Column Feed} \\ & - 0.35220 * \text{MGS Feed} \\ & - 56.562 * \text{Wash Water} \\ & + 3.5536 * \text{Drum Speed} \\ & + 1.291\text{E-}04 * \text{Column Feed}^2 \\ & + 1.765\text{E-}05 * \text{MGS Feed}^2 \end{aligned}$$

- 8.6458 * Wash Water^2
 - 4.113E-03 * Drum Speed^2
 + 2.787E-04 * Column Feed * MGS Feed
 + 7.837E-03 * Column Feed * Wash Water
 - 2.576E-03 * Column Feed * Drum Speed
 + 4.529E-02 * MGS Feed * Wash Water
 + 5.930E-04 * MGS Feed * Drum Speed
 + 0.20190 * Wash Water * Drum Speed

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	51.23	55.78	-4.55	0.585	-0.839	0.066	-0.828	14
2	35.95	47.99	-12.04	0.629	-2.349	0.625	-3.060	16
3	49.92	40.81	9.11	0.816	2.525	1.889	3.530	26
4	54.37	52.32	2.05	0.742	0.479	0.044	0.463	2
5	24.91	24.01	0.90	0.616	0.172	0.003	0.165	20
6	6.77	13.71	-6.94	0.593	-1.293	0.162	-1.334	3
7	65.03	56.63	8.40	0.563	1.508	0.195	1.604	22
8	63.08	63.43	-0.35	0.609	-0.067	0.000	-0.064	7
9	13.07	13.84	-0.77	0.564	-0.138	0.002	-0.132	15
10	36.93	26.96	9.97	0.420	1.555	0.116	1.666	17
11	65.30	72.99	-7.69	0.618	-1.478	0.235	-1.564	27
12	57.38	55.78	1.60	0.466	0.260	0.004	0.250	18
13	52.95	53.59	-0.64	0.667	-0.132	0.002	-0.126	10
14	32.64	42.77	-10.13	0.475	-1.662	0.167	-1.813	5
15	46.40	43.82	2.58	0.674	0.537	0.040	0.520	12
16	41.85	45.60	-3.75	0.568	-0.677	0.040	-0.661	11
17	51.38	50.01	1.37	0.643	0.273	0.009	0.262	24
18	48.17	48.11	0.06	0.528	0.010	0.000	0.010	1
19	50.24	46.34	3.90	0.642	0.774	0.071	0.760	25
20	50.31	46.76	3.55	0.543	0.624	0.031	0.608	19
21	31.97	27.82	4.15	0.718	0.927	0.146	0.922	8
22	7.98	15.19	-7.21	0.447	-1.151	0.071	-1.168	4
23	69.93	65.68	4.25	0.608	0.806	0.067	0.794	23
24	57.53	63.92	-6.39	0.368	-0.954	0.035	-0.951	9
25	52.98	49.15	3.83	0.317	0.550	0.009	0.533	6
26	52.88	48.40	4.48	0.269	0.622	0.010	0.605	13
27	47.67	47.39	0.28	0.313	0.039	0.000	0.038	21


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Coal Seam:  Pittsburgh No. 8
Circuit:    Microcel/MGS Combined
Response:   Separation Efficiency
Data File:  P-COM-00
Comments:   Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Column Feed    lbs/hr        300.000      500.000
B      MGS Feed       lbs/hr        150.000      350.000
C      Wash Water     lpm           0.500        1.500
D      Drum Speed     rpm           240.000      320.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	52358.3	1	52358.3		
Linear	5141.2	4	1285.3	17.48	0.0001
Quadratic	802.7	10	80.3	1.182	0.3862
Cubic	814.8	12	67.9		
RESIDUAL	0.0	0			
TOTAL	59116.9	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	8.57	0.7607	0.7172	2445.90
Quadratic	15	12	8.24	0.8794	0.7388	6248.79
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	5141.2	4	1285.29	17.48	0.0001
RESIDUAL	1617.5	22	73.52		
COR TOTAL	6758.7	26			
ROOT MSE	8.57		R-SQUARED	0.7607	
DEP MEAN	44.04		ADJ R-SQUARED	0.7172	
C.V.	19.47%				

Predicted Residual Sum of Squares (PRESS) = 2445.9

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	44.13	1	1.75	25.28	
A	-0.65	1	2.52	-0.2598	0.7974
B	-1.98	1	1.91	-1.035	0.3118
C	-1.14	1	2.40	-0.4731	0.6408
D	20.86	1	2.51	8.308	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Efficiency} = & 44.13 \\ & - 0.65 * A \\ & - 1.98 * B \\ & - 1.14 * C \\ & + 20.86 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Efficiency} = & -92.08 \\ & - 6.539\text{E-}03 * \text{Column Feed} \\ & - 1.978\text{E-}02 * \text{MGS Feed} \\ & - 2.2739 * \text{Wash Water} \\ & + 0.52159 * \text{Drum Speed} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	50.60	46.60	4.00	0.226	0.531	0.016	0.522	14
2	35.54	46.01	-10.47	0.217	-1.380	0.106	-1.411	16
3	49.16	40.51	8.65	0.314	1.219	0.136	1.233	26
4	53.46	42.29	11.17	0.227	1.482	0.129	1.527	2
5	24.34	23.68	0.66	0.221	0.087	0.000	0.085	20
6	6.69	22.35	-15.66	0.205	-2.049	0.217	-2.225	3
7	62.09	65.00	-2.91	0.196	-0.379	0.007	-0.371	22
8	61.74	64.95	-3.21	0.212	-0.421	0.010	-0.413	7
9	12.87	23.89	-11.02	0.174	-1.414	0.084	-1.449	15
10	36.00	22.84	13.16	0.158	1.673	0.105	1.750	17
11	60.89	63.99	-3.10	0.192	-0.403	0.008	-0.395	27
12	55.70	64.11	-8.41	0.171	-1.077	0.048	-1.081	18
13	52.24	47.62	4.62	0.232	0.614	0.023	0.605	10
14	31.89	42.61	-10.72	0.168	-1.371	0.076	-1.400	5
15	45.87	45.11	0.76	0.221	0.101	0.001	0.098	12
16	41.40	40.16	1.24	0.196	0.161	0.001	0.157	11
17	50.50	45.99	4.51	0.205	0.590	0.018	0.581	24

18	47.32	45.58	1.74	0.194	0.227	0.002	0.222	1
19	49.56	43.25	6.31	0.202	0.824	0.034	0.818	25
20	49.62	42.64	6.98	0.196	0.908	0.040	0.905	19
21	29.88	26.76	3.12	0.225	0.414	0.010	0.406	8
22	7.70	21.97	-14.27	0.169	-1.826	0.135	-1.937	4
23	66.46	66.69	-0.23	0.183	-0.030	0.000	-0.029	23
24	56.16	62.94	-6.78	0.147	-0.857	0.025	-0.851	9
25	52.20	44.66	7.54	0.041	0.898	0.007	0.894	6
26	52.09	43.69	8.40	0.056	1.009	0.012	1.009	13
27	47.01	43.11	3.90	0.050	0.467	0.002	0.458	21

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	5943.8	14	424.56	6.252	0.0015
RESIDUAL	814.8	12	67.90		
COR TOTAL	6758.7	26			
ROOT MSE	8.24		R-SQUARED	0.8794	
DEP MEAN	44.04		ADJ R-SQUARED	0.7388	
C.V.	18.71%				

Predicted Residual Sum of Squares (PRESS) = 6248.8

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR HO COEFFICIENT=0	PROB > t
Intercept	47.93	1	4.73	10.14	
A	-1.13	1	2.74	-0.4135	0.6866
B	-1.89	1	2.05	-0.9204	0.3755
C	-1.23	1	2.48	-0.4950	0.6295
D	21.80	1	2.69	8.102	0.0001
A2	1.20	1	3.82	0.3154	0.7579
B2	0.10	1	2.07	4.95E-02	0.9613
C2	-1.97	1	3.42	-0.5771	0.5745
D2	-7.50	1	4.06	-1.846	0.0896
AB	2.71	1	2.94	0.9229	0.3743
AC	0.45	1	4.20	0.1069	0.9167
AD	-9.06	1	5.27	-1.719	0.1112
BC	2.26	1	3.05	0.7394	0.4739
BD	2.20	1	3.79	0.5788	0.5735
CD	4.40	1	4.34	1.014	0.3306

Final Equation in Terms of Coded Factors:

Efficiency =

$$\begin{aligned}
 &47.93 \\
 &- 1.13 * A \\
 &- 1.89 * B \\
 &- 1.23 * C \\
 &+ 21.80 * D \\
 &+ 1.20 * A^2 \\
 &+ 0.10 * B^2 \\
 &- 1.97 * C^2 \\
 &- 7.50 * D^2 \\
 &+ 2.71 * AB \\
 &+ 0.45 * AC \\
 &- 9.06 * AD \\
 &+ 2.26 * BC \\
 &+ 2.20 * BD \\
 &+ 4.40 * CD
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Efficiency =

$$\begin{aligned}
 &-560.31 \\
 &+ 0.45008 * \text{Column Feed} \\
 &- 0.33132 * \text{MGS Feed} \\
 &- 63.099 * \text{Wash Water} \\
 &+ 3.7196 * \text{Drum Speed} \\
 &+ 1.204E-04 * \text{Column Feed}^2 \\
 &+ 1.023E-05 * \text{MGS Feed}^2
 \end{aligned}$$

- 7.8890 * Wash Water^2
 - 4.688E-03 * Drum Speed^2
 + 2.712E-04 * Column Feed * MGS Feed
 + 8.975E-03 * Column Feed * Wash Water
 - 2.266E-03 * Column Feed * Drum Speed
 + 4.512E-02 * MGS Feed * Wash Water
 + 5.489E-04 * MGS Feed * Drum Speed
 + 0.21983 * Wash Water * Drum Speed

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	50.60	54.52	-3.92	0.585	-0.739	0.051	-0.724	14
2	35.54	47.15	-11.61	0.629	-2.315	0.606	-2.978	16
3	49.16	39.97	9.19	0.816	2.602	2.006	3.773	26
4	53.46	51.63	1.83	0.742	0.436	0.036	0.421	2
5	24.34	23.43	0.91	0.616	0.178	0.003	0.171	20
6	6.69	13.00	-6.31	0.593	-1.201	0.140	-1.226	3
7	62.09	53.92	8.17	0.563	1.499	0.193	1.591	22
8	61.74	61.69	0.05	0.609	0.009	0.000	0.009	7
9	12.87	13.93	-1.06	0.564	-0.196	0.003	-0.188	15
10	36.00	25.57	10.43	0.420	1.661	0.133	1.813	17
11	60.89	69.19	-8.30	0.618	-1.628	0.285	-1.766	27
12	55.70	54.27	1.43	0.466	0.238	0.003	0.229	18
13	52.24	52.53	-0.29	0.667	-0.060	0.000	-0.057	10
14	31.89	42.12	-10.23	0.475	-1.714	0.177	-1.888	5
15	45.87	43.28	2.59	0.674	0.550	0.042	0.533	12
16	41.40	45.33	-3.93	0.568	-0.725	0.046	-0.710	11
17	50.50	49.07	1.43	0.643	0.290	0.010	0.279	24
18	47.32	47.35	-0.03	0.528	-0.005	0.000	-0.005	1
19	49.56	45.84	3.72	0.642	0.754	0.068	0.740	25
20	49.62	46.64	2.98	0.543	0.536	0.023	0.519	19
21	29.88	26.54	3.34	0.718	0.762	0.098	0.748	8
22	7.70	14.96	-7.26	0.447	-1.185	0.075	-1.207	4
23	66.46	62.84	3.62	0.608	0.702	0.051	0.686	23
24	56.16	61.33	-5.17	0.368	-0.790	0.024	-0.777	9
25	52.20	48.45	3.75	0.317	0.550	0.009	0.533	6
26	52.09	47.71	4.38	0.269	0.622	0.009	0.605	13
27	47.01	46.69	0.32	0.313	0.047	0.000	0.045	21

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Coal Seam: Pittsburgh No. 8
Circuit: Microcel/MGS Combined
Response: 1b SO2/MM Btu
Data File: P-COM-00
Comments: Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Column Feed    lbs/hr        300.000      500.000
B      MGS Feed       lbs/hr        150.000      350.000
C      Wash Water     lpm           0.500        1.500
D      Drum Speed     rpm           240.000      320.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	203.913	1	203.913		
Linear	1.917	4	0.479	13.05	0.0001
Quadratic	0.308	10	0.031	0.7396	0.6791
Cubic	0.500	12	0.042		
RESIDUAL	0.000	0			
TOTAL	206.638	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	0.192	0.7035	0.6496	1.212
Quadratic	15	12	0.204	0.8166	0.6025	2.245
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	1.917	4	0.479	13.05	0.0001
RESIDUAL	0.808	22	0.037		
COR TOTAL	2.725	26			
ROOT MSE	0.192		R-SQUARED	0.7035	
DEP MEAN	2.748		ADJ R-SQUARED	0.6496	
C.V.	6.97%				

Predicted Residual Sum of Squares (PRESS) = 1.212

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	2.760	1	0.039	70.74	
A	-0.064	1	0.056	-1.137	0.2676
B	0.018	1	0.043	0.4242	0.6756
C	0.069	1	0.054	1.292	0.2097
D	-0.392	1	0.056	-6.981	0.0001

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{SO2 emm} = & 2.760 \\ & - 0.064 * A \\ & + 0.018 * B \\ & + 0.069 * C \\ & - 0.392 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{SO2 emm} = & 5.575 \\ & - 6.398\text{E-}04 * \text{Column Feed} \\ & + 1.811\text{E-}04 * \text{MGS Feed} \\ & + 0.13882 * \text{Wash Water} \\ & - 9.797\text{E-}03 * \text{Drum Speed} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	2.650	2.804	-0.154	0.226	-0.911	0.048	-0.907	14
2	2.640	2.645	-0.005	0.217	-0.030	0.000	-0.029	16
3	2.720	2.861	-0.141	0.314	-0.891	0.073	-0.886	26
4	2.550	2.675	-0.125	0.227	-0.743	0.033	-0.736	2
5	3.180	3.047	0.133	0.221	0.786	0.035	0.779	20
6	3.590	3.205	0.385	0.205	2.255	0.263	2.512	3
7	2.440	2.291	0.149	0.196	0.866	0.037	0.861	22
8	2.510	2.403	0.107	0.212	0.626	0.021	0.618	7
9	3.270	3.188	0.082	0.174	0.471	0.009	0.463	15
10	2.620	3.097	-0.477	0.158	-2.710	0.276	-3.244	17
11	2.380	2.428	-0.048	0.192	-0.279	0.004	-0.273	27
12	2.130	2.310	-0.180	0.171	-1.032	0.044	-1.034	18
13	2.750	2.674	0.076	0.232	0.452	0.012	0.444	10
14	2.590	2.704	-0.114	0.168	-0.651	0.017	-0.643	5
15	2.770	2.809	-0.039	0.221	-0.230	0.003	-0.225	12
16	3.040	2.859	0.181	0.196	1.056	0.054	1.059	11
17	2.720	2.742	-0.022	0.205	-0.130	0.001	-0.127	24

18	2.650	2.600	0.050	0.194	0.288	0.004	0.282	1
19	2.660	2.885	-0.225	0.202	-1.316	0.088	-1.339	25
20	2.640	2.765	-0.125	0.196	-0.726	0.026	-0.718	19
21	3.180	3.098	0.082	0.225	0.488	0.014	0.480	8
22	3.290	3.157	0.133	0.169	0.762	0.024	0.755	4
23	2.330	2.354	-0.024	0.183	-0.138	0.001	-0.135	23
24	2.710	2.374	0.336	0.147	1.899	0.124	2.029	9
25	2.670	2.733	-0.063	0.041	-0.337	0.001	-0.330	6
26	2.820	2.717	0.103	0.056	0.551	0.004	0.542	13
27	2.700	2.775	-0.075	0.050	-0.403	0.002	-0.395	21

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2.225	14	0.159	3.815	0.0128
RESIDUAL	0.500	12	0.042		
COR TOTAL	2.725	26			
ROOT MSE	0.204		R-SQUARED	0.8166	
DEP MEAN	2.748		ADJ R-SQUARED	0.6025	
C.V.	7.43%				

Predicted Residual Sum of Squares (PRESS) = 2.245

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	2.723	1	0.117	23.25	
A	-0.027	1	0.068	-0.4004	0.6959
B	0.023	1	0.051	0.4614	0.6528
C	0.042	1	0.061	0.6853	0.5062
D	-0.417	1	0.067	-6.254	0.0001
A2	-0.131	1	0.095	-1.388	0.1905
B2	0.017	1	0.051	0.3334	0.7446
C2	0.078	1	0.085	0.9246	0.3734
D2	0.090	1	0.101	0.8957	0.3880
AB	-0.024	1	0.073	-0.3281	0.7485
AC	0.000	1	0.104	1.60E-03	0.9988
AD	0.120	1	0.131	0.9219	0.3747
BC	0.060	1	0.076	0.8002	0.4392
BD	0.049	1	0.094	0.5259	0.6085
CD	-0.050	1	0.107	-0.4612	0.6529

Final Equation in Terms of Coded Factors:

```

SO2 emm =
          2.723
      -    0.027 * A
      +    0.023 * B
      +    0.042 * C
      -    0.417 * D
      -    0.131 * A2
      +    0.017 * B2
      +    0.078 * C2
      +    0.090 * D2
      -    0.024 * AB
      +    0.000 * AC
      +    0.120 * AD
      +    0.060 * BC
      +    0.049 * BD
      -    0.050 * CD

```

Final Equation in Terms of Actual Factors:

```

SO2 emm =
          11.950
      +    2.393E-03 * Column Feed
      -    4.332E-03 * MGS Feed
      -    0.15222 * Wash Water
      -    5.461E-02 * Drum Speed
      -    1.312E-05 * Column Feed^2
      +    1.706E-06 * MGS Feed ^2

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+      0.31305 * Wash Water^2
+      5.633E-05 * Drum Speed^2
-      2.388E-06 * Column Feed * MGS Feed
+      3.326E-06 * Column Feed * Wash Water
+      3.010E-05 * Column Feed * Drum Speed
+      1.209E-03 * MGS Feed * Wash Water
+      1.235E-05 * MGS Feed * Drum Speed
-      2.476E-03 * Wash Water * Drum Speed

```

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	2.650	2.596	0.054	0.585	0.413	0.016	0.398	14
2	2.640	2.491	0.149	0.629	1.199	0.163	1.224	16
3	2.720	2.782	-0.062	0.816	-0.710	0.150	-0.695	26
4	2.550	2.486	0.064	0.742	0.616	0.073	0.600	2
5	3.180	3.040	0.140	0.616	1.106	0.131	1.117	20
6	3.590	3.367	0.223	0.593	1.712	0.285	1.885	3
7	2.440	2.501	-0.061	0.563	-0.454	0.018	-0.438	22
8	2.510	2.456	0.054	0.609	0.424	0.019	0.409	7
9	3.270	3.252	0.018	0.564	0.134	0.002	0.129	15
10	2.620	3.022	-0.402	0.420	-2.586	0.322	-3.721	17
11	2.380	2.329	0.051	0.618	0.401	0.017	0.386	27
12	2.130	2.381	-0.251	0.466	-1.686	0.165	-1.848	18
13	2.750	2.827	-0.077	0.667	-0.651	0.057	-0.635	10
14	2.590	2.730	-0.140	0.475	-0.946	0.054	-0.941	5
15	2.770	2.781	-0.011	0.674	-0.096	0.001	-0.092	12
16	3.040	3.006	0.034	0.568	0.256	0.006	0.246	11
17	2.720	2.663	0.057	0.643	0.464	0.026	0.448	24
18	2.650	2.551	0.099	0.528	0.708	0.037	0.693	1
19	2.660	2.824	-0.164	0.642	-1.346	0.216	-1.398	25
20	2.640	2.740	-0.100	0.543	-0.722	0.041	-0.707	19
21	3.180	3.238	-0.058	0.718	-0.537	0.049	-0.520	8
22	3.290	3.204	0.086	0.447	0.569	0.017	0.553	4
23	2.330	2.344	-0.014	0.608	-0.109	0.001	-0.104	23
24	2.710	2.493	0.217	0.368	1.341	0.070	1.392	9
25	2.670	2.696	-0.026	0.317	-0.152	0.001	-0.146	6
26	2.820	2.660	0.160	0.269	0.917	0.021	0.911	13
27	2.700	2.741	-0.041	0.313	-0.240	0.002	-0.230	21

APPENDIX 3-F

Box-Behnken Statistical Analyses

**Combined Microcel/MGS Tests
Illinois No. 6 Seam Coal**

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Coal Seam:  Illinois No. 6
Circuit:    Microcel/MGS Combined
Data File:  I-COM-00
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				A	B	C	D	Y1
Obs	Dsn	Run		Drum Speed	Wash Water	Amplitude	Feed Rate	Comb. rec
	ID	Ord	Blk	rpm	lpm	mm	lbs/hr	%
14	14	1	1	283.0	1.510	10.00	269.0	98.5
25	0	2	1	283.0	0.950	15.00	269.0	98.6
15	15	3	1	280.0	0.470	20.00	257.1	98.6
11	11	4	1	239.0	1.060	15.00	341.5	99.0
19	19	5	1	239.0	0.950	20.00	276.0	99.2
26	0	6	1	280.0	0.950	15.00	267.9	97.8
3	3	7	1	240.0	1.510	15.00	272.8	99.6
22	22	8	1	280.0	1.510	15.00	161.0	98.9
18	18	9	1	323.0	1.100	10.00	306.1	90.0
1	1	10	1	239.0	0.450	15.00	259.5	99.2
20	20	11	1	322.0	0.910	20.00	281.6	93.4
10	10	12	1	322.0	0.980	15.00	148.1	90.7
16	16	13	1	280.0	1.590	20.00	241.0	99.0
27	0	14	1	282.0	0.950	15.00	299.9	98.2
21	21	15	1	280.0	0.450	15.00	147.5	98.1
12	12	16	1	321.0	1.060	15.00	342.9	93.6
23	23	17	1	282.0	0.450	15.00	356.6	96.0
8	8	18	1	282.0	0.930	20.00	377.8	98.4
9	9	19	1	240.0	0.960	15.00	163.1	99.3
24	24	20	1	282.0	1.510	15.00	352.7	97.9
13	13	21	1	283.0	0.530	10.00	287.1	92.3
17	17	22	1	241.0	1.060	10.00	219.2	99.9
4	4	23	1	322.0	1.550	15.00	238.4	92.9
5	5	24	1	281.0	1.100	10.00	160.4	96.3
2	2	25	1	320.0	0.530	15.00	305.5	90.7
6	6	26	1	280.0	0.980	20.00	134.7	99.4
7	7	27	1	281.0	1.100	10.00	376.8	92.8

				Y2	Y3	Y4	Y5	Y6
Obs	Dsn ID	Run Ord	Blk	Ash rej %	Sulfur rej %	Pyr rej %	Efficiency %	Energy rec %
14	14	1	1	15.79	17.13	43.01	41.49	98.7
25	0	2	1	16.20	20.00	52.09	50.69	98.8
15	15	3	1	17.73	26.80	51.78	50.38	98.8
11	11	4	1	13.32	24.70	45.87	44.90	99.2
19	19	5	1	11.89	22.26	40.46	39.63	99.3
26	0	6	1	25.77	35.39	69.97	67.73	98.1
3	3	7	1	5.71	10.92	23.91	23.51	99.7
22	22	8	1	17.58	27.41	48.98	47.87	99.1
18	18	9	1	44.94	38.89	70.66	60.68	90.5
1	1	10	1	11.84	21.62	39.28	38.48	99.3
20	20	11	1	43.02	42.53	71.02	64.46	93.9
10	10	12	1	49.77	49.14	77.54	68.29	91.3
16	16	13	1	16.19	23.80	49.14	48.12	99.2
27	0	14	1	22.51	28.03	54.44	52.61	98.4
21	21	15	1	27.29	40.19	63.51	61.59	98.4
12	12	16	1	33.10	34.47	64.16	57.71	93.9
23	23	17	1	33.31	41.00	64.58	60.55	96.3
8	8	18	1	21.19	30.86	51.51	49.87	98.6
9	9	19	1	9.98	19.74	34.32	33.63	99.4
24	24	20	1	28.98	29.00	60.75	58.61	98.2
13	13	21	1	38.62	40.85	70.04	62.35	92.7
17	17	22	1	1.65	2.57	7.64	7.55	99.9
4	4	23	1	40.17	40.87	68.45	61.33	93.3
5	5	24	1	38.86	38.95	70.43	66.74	96.8
2	2	25	1	41.30	41.66	70.10	60.75	91.0
6	6	26	1	9.98	15.49	35.15	34.58	99.5
7	7	27	1	40.70	44.91	73.64	66.41	93.3

				Y7
Obs	Dsn ID	Run Ord	Blk	SO2 emiss %
---	---	---	---	---
14	14	1	1	4.830
25	0	2	1	4.560
15	15	3	1	3.710
11	11	4	1	4.940
19	19	5	1	4.710
26	0	6	1	3.680
3	3	7	1	5.040
22	22	8	1	4.040
18	18	9	1	3.910
1	1	10	1	4.510
20	20	11	1	3.810
10	10	12	1	3.260
16	16	13	1	4.760
27	0	14	1	3.860
21	21	15	1	3.670
12	12	16	1	4.050
23	23	17	1	3.540
8	8	18	1	3.950
9	9	19	1	4.810
24	24	20	1	4.230
13	13	21	1	3.660
17	17	22	1	4.920
4	4	23	1	3.820
5	5	24	1	3.550
2	2	25	1	3.360
6	6	26	1	4.630
7	7	27	1	3.600

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Coal Seam:  Illinois No. 6
Circuit:    Microcel/MGS Combined
Response:   Combustible Recovery
Data File:  I-COM-00
Comments:   Analysis of Complete Data Set
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FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Drum Speed      rpm            240.000      320.000
B    Wash Water       lpm             0.500        1.500
C    Amplitude        mm             10.000       20.000
D    Feed Rate        lbs/hr         150.000      350.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	251925.1	1	251925.1		
Linear	207.7	4	51.9	19.23	0.0001
Quadratic	46.2	10	4.6	4.193	0.0110
Cubic	13.2	12	1.1		
RESIDUAL	0.0	0			
TOTAL	252192.2	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	1.64	0.7776	0.7372	88.95
Quadratic	15	12	1.05	0.9505	0.8928	76.01
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	207.7	4	51.93	19.23	0.0001
RESIDUAL	59.4	22	2.70		
COR TOTAL	267.1	26			
ROOT MSE	1.64		R-SQUARED	0.7776	
DEP MEAN	96.59		ADJ R-SQUARED	0.7372	
C.V.	1.70%				

Predicted Residual Sum of Squares (PRESS) = 88.9

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	96.75	1	0.32	300.6	
A	-3.61	1	0.46	-7.771	0.0001
B	0.84	1	0.45	1.873	0.0744
C	1.51	1	0.48	3.157	0.0046
D	-0.53	1	0.44	-1.195	0.2450

Final Equation in Terms of Coded Factors:

Comb. rec =
 96.75
 - 3.61 * A
 + 0.84 * B
 + 1.51 * C
 - 0.53 * D

Final Equation in Terms of Actual Factors:

Comb. rec =
 117.13
 - 9.018E-02 * Drum Speed
 + 1.6819 * Wash Water
 + 0.30100 * Amplitude
 - 5.297E-03 * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	99.19	99.47	-0.28	0.211	-0.193	0.002	-0.189	10
2	90.65	92.06	-1.41	0.189	-0.952	0.042	-0.950	25
3	99.60	101.09	-1.49	0.205	-1.019	0.054	-1.020	7
4	92.89	93.95	-1.06	0.211	-0.725	0.028	-0.717	23
5	96.30	95.80	0.50	0.204	0.343	0.006	0.336	24
6	99.43	98.83	0.60	0.233	0.415	0.010	0.407	26
7	92.77	94.65	-1.88	0.209	-1.287	0.088	-1.308	27
8	98.36	97.28	1.08	0.222	0.745	0.032	0.737	18
9	99.30	100.75	-1.45	0.182	-0.976	0.042	-0.975	19
10	90.75	93.47	-2.72	0.233	-1.889	0.217	-2.017	12
11	99.03	100.06	-1.03	0.182	-0.695	0.021	-0.687	4
12	93.55	92.66	0.89	0.154	0.588	0.013	0.579	16
13	92.31	93.99	-1.68	0.203	-1.143	0.067	-1.152	21
14	98.48	95.73	2.75	0.183	1.851	0.154	1.968	1
15	98.60	97.33	1.27	0.191	0.862	0.035	0.857	3
16	98.97	99.29	-0.32	0.241	-0.227	0.003	-0.222	13
17	99.91	99.03	0.88	0.214	0.607	0.020	0.598	22

18	90.02	91.24	-1.22	0.212	-0.835	0.037	-0.829	9
19	99.17	101.73	-2.56	0.209	-1.752	0.163	-1.846	5
20	93.44	94.15	-0.71	0.209	-0.485	0.012	-0.477	11
21	98.09	96.37	1.72	0.236	1.199	0.089	1.211	15
22	98.89	98.08	0.81	0.182	0.546	0.013	0.537	8
23	95.97	95.08	0.89	0.184	0.600	0.016	0.591	17
24	97.86	96.88	0.98	0.178	0.656	0.019	0.647	20
25	98.60	96.29	2.31	0.038	1.431	0.016	1.468	2
26	97.76	96.57	1.19	0.038	0.738	0.004	0.730	6
27	98.17	96.22	1.95	0.047	1.215	0.015	1.229	14

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	253.9	14	18.14	16.47	0.0001
RESIDUAL	13.2	12	1.10		
COR TOTAL	267.1	26			
ROOT MSE	1.05		R-SQUARED	0.9505	
DEP MEAN	96.59		ADJ R-SQUARED	0.8928	
C.V.	1.09%				

Predicted Residual Sum of Squares (PRESS) = 76.0

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	98.59	1	0.62	159.4	
A	-3.61	1	0.31	-11.67	0.0001
B	0.96	1	0.30	3.254	0.0069
C	1.57	1	0.32	4.953	0.0003
D	-0.49	1	0.29	-1.673	0.1202
A2	-2.27	1	0.44	-5.126	0.0003
B2	-0.26	1	0.42	-0.6166	0.5490
C2	-0.88	1	0.44	-1.989	0.0699
D2	-0.64	1	0.44	-1.468	0.1679
AB	0.55	1	0.50	1.093	0.2960
AC	0.76	1	0.53	1.421	0.1807
AD	0.91	1	0.51	1.763	0.1032
BC	-1.24	1	0.51	-2.439	0.0312
BD	0.34	1	0.48	0.7109	0.4907
CD	0.54	1	0.46	1.180	0.2609

Final Equation in Terms of Coded Factors:

```

Comb. rec =
          98.59
      -      3.61 * A
      +      0.96 * B
      +      1.57 * C
      -      0.49 * D
      -      2.27 * A2
      -      0.26 * B2
      -      0.88 * C2
      -      0.64 * D2
      +      0.55 * AB
      +      0.76 * AC
      +      0.91 * AD
      -      1.24 * BC
      +      0.34 * BD
      +      0.54 * CD

```

Final Equation in Terms of Actual Factors:

```

Comb. rec =
          31.99
      +      0.56387 * Drum Speed
      +      2.0584 * Wash Water
      +      0.53217 * Amplitude
      -      5.942E-02 * Feed Rate
      -      1.419E-03 * Drum Speed^2
      -      1.0410 * Wash Water^2

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- 3.508E-02 * Amplitude^2
 - 6.418E-05 * Feed Rate^2
 + 2.733E-02 * Drum Speed * Wash Water
 + 3.777E-03 * Drum Speed * Amplitude
 + 2.270E-04 * Drum Speed * Feed Rate
 - 0.49449 * Wash Water * Amplitude
 + 6.856E-03 * Wash Water * Feed Rate
 + 1.082E-03 * Amplitude * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	99.19	98.98	0.21	0.609	0.326	0.011	0.314	10
2	90.65	90.92	-0.27	0.543	-0.383	0.012	-0.369	25
3	99.60	99.82	-0.22	0.587	-0.319	0.010	-0.307	7
4	92.89	93.57	-0.68	0.585	-1.003	0.094	-1.003	23
5	96.30	96.79	-0.49	0.547	-0.700	0.040	-0.685	24
6	99.43	98.39	1.04	0.657	1.686	0.363	1.847	26
7	92.77	94.25	-1.48	0.611	-2.266	0.537	-2.868	27
8	98.36	98.18	0.18	0.688	0.299	0.013	0.288	18
9	99.30	100.65	-1.35	0.550	-1.916	0.299	-2.203	19
10	90.75	91.11	-0.36	0.687	-0.612	0.055	-0.595	12
11	99.03	98.16	0.87	0.479	1.152	0.081	1.170	4
12	93.55	92.58	0.97	0.401	1.190	0.063	1.213	16
13	92.31	92.91	-0.60	0.596	-0.900	0.080	-0.893	21
14	98.48	97.68	0.80	0.529	1.104	0.091	1.115	1
15	98.60	99.26	-0.66	0.587	-0.974	0.090	-0.972	3
16	98.97	98.55	0.42	0.685	0.708	0.073	0.693	13
17	99.91	98.96	0.95	0.583	1.402	0.183	1.468	22
18	90.02	89.19	0.83	0.610	1.271	0.169	1.308	9
19	99.17	99.63	-0.46	0.610	-0.694	0.050	-0.679	5
20	93.44	93.96	-0.52	0.618	-0.795	0.068	-0.782	11
21	98.09	97.43	0.66	0.705	1.156	0.213	1.174	15
22	98.89	98.92	-0.03	0.521	-0.039	0.000	-0.037	8
23	95.97	95.40	0.57	0.555	0.809	0.054	0.797	17
24	97.86	98.38	-0.52	0.498	-0.695	0.032	-0.679	20
25	98.60	98.10	0.50	0.335	0.586	0.012	0.569	2
26	97.76	98.38	-0.62	0.336	-0.727	0.018	-0.712	6
27	98.17	97.91	0.26	0.289	0.294	0.002	0.283	14

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Coal Seam:  Illinois No. 6
Circuit:    Microcel/MGS Combined
Response:   Energy Recovery
Data File:  I-COM-00
Comments:   Analysis of Complete Data Set
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FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Drum Speed      rpm            240.000       320.000
B    Wash Water       lpm             0.500         1.500
C    Amplitude        mm             10.000        20.000
D    Feed Rate        lbs/hr          150.000       350.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	253418.7	1	253418.7		
Linear	190.7	4	47.7	18.67	0.0001
Quadratic	44.8	10	4.5	4.729	0.0068
Cubic	11.4	12	0.9		
RESIDUAL	0.0	0			
TOTAL	253665.5	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	1.60	0.7724	0.7311	84.18
Quadratic	15	12	0.97	0.9539	0.9002	65.63
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	190.7	4	47.67	18.67	0.0001
RESIDUAL	56.2	22	2.55		
COR TOTAL	246.8	26			
ROOT MSE	1.60		R-SQUARED	0.7724	
DEP MEAN	96.88		ADJ R-SQUARED	0.7311	
C.V.	1.65%				

Predicted Residual Sum of Squares (PRESS) = 84.2

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	97.03	1	0.31	310.0	
A	-3.45	1	0.45	-7.645	0.0001
B	0.80	1	0.44	1.838	0.0796
C	1.45	1	0.46	3.125	0.0049
D	-0.52	1	0.43	-1.202	0.2421

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & 97.03 \\ & - 3.45 * A \\ & + 0.80 * B \\ & + 1.45 * C \\ & - 0.52 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & 116.53 \\ & - 8.627\text{E-}02 * \text{Drum Speed} \\ & + 1.6049 * \text{Wash Water} \\ & + 0.28979 * \text{Amplitude} \\ & - 5.184\text{E-}03 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	99.34	99.64	-0.30	0.211	-0.209	0.002	-0.204	10
2	91.04	92.54	-1.50	0.189	-1.041	0.051	-1.043	25
3	99.68	101.18	-1.50	0.205	-1.054	0.057	-1.057	7
4	93.33	94.35	-1.02	0.211	-0.719	0.028	-0.711	23
5	96.77	96.12	0.65	0.204	0.456	0.011	0.447	24
6	99.54	99.05	0.49	0.233	0.354	0.008	0.346	26
7	93.27	95.00	-1.73	0.209	-1.217	0.078	-1.231	27
8	98.61	97.53	1.08	0.222	0.765	0.033	0.757	18
9	99.44	100.87	-1.43	0.182	-0.988	0.044	-0.988	19
10	91.29	93.90	-2.61	0.233	-1.868	0.212	-1.989	12
11	99.21	100.19	-0.98	0.182	-0.678	0.020	-0.669	4
12	93.88	93.11	0.77	0.154	0.525	0.010	0.516	16
13	92.75	94.38	-1.63	0.203	-1.140	0.066	-1.148	21
14	98.67	96.04	2.63	0.183	1.819	0.149	1.928	1
15	98.81	97.59	1.22	0.191	0.847	0.034	0.842	3
16	99.15	99.47	-0.32	0.241	-0.232	0.003	-0.227	13
17	99.93	99.20	0.73	0.214	0.514	0.014	0.505	22

18	90.47	91.74	-1.27	0.212	-0.897	0.043	-0.892	9
19	99.32	101.80	-2.48	0.209	-1.747	0.162	-1.839	5
20	93.94	94.55	-0.61	0.209	-0.428	0.010	-0.420	11
21	98.44	96.68	1.76	0.236	1.260	0.098	1.278	15
22	99.12	98.31	0.81	0.182	0.560	0.014	0.551	8
23	96.35	95.42	0.93	0.184	0.642	0.019	0.633	17
24	98.17	97.14	1.03	0.178	0.708	0.022	0.700	20
25	98.78	96.59	2.19	0.038	1.396	0.015	1.428	2
26	98.07	96.86	1.21	0.038	0.774	0.005	0.766	6
27	98.41	96.52	1.89	0.047	1.212	0.015	1.226	14

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	235.5	14	16.82	17.75	0.0001
RESIDUAL	11.4	12	0.95		
COR TOTAL	246.8	26			
ROOT MSE	0.97		R-SQUARED	0.9539	
DEP MEAN	96.88		ADJ R-SQUARED	0.9002	
C.V.	1.00%				

Predicted Residual Sum of Squares (PRESS) = 65.6

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	98.82	1	0.57	172.3	
A	-3.44	1	0.29	-12.01	0.0001
B	0.92	1	0.27	3.342	0.0059
C	1.50	1	0.29	5.106	0.0003
D	-0.47	1	0.27	-1.755	0.1047
A2	-2.25	1	0.41	-5.477	0.0001
B2	-0.25	1	0.39	-0.6417	0.5331
C2	-0.85	1	0.41	-2.078	0.0599
D2	-0.59	1	0.41	-1.447	0.1735
AB	0.56	1	0.46	1.215	0.2477
AC	0.74	1	0.49	1.507	0.1577
AD	0.83	1	0.48	1.731	0.1090
BC	-1.19	1	0.47	-2.525	0.0267
BD	0.36	1	0.45	0.7960	0.4415
CD	0.57	1	0.43	1.343	0.2040

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Energy rec} = & 98.82 \\ & - 3.44 * A \\ & + 0.92 * B \\ & + 1.50 * C \\ & - 0.47 * D \\ & - 2.25 * A^2 \\ & - 0.25 * B^2 \\ & - 0.85 * C^2 \\ & - 0.59 * D^2 \\ & + 0.56 * AB \\ & + 0.74 * AC \\ & + 0.83 * AD \\ & - 1.19 * BC \\ & + 0.36 * BD \\ & + 0.57 * CD \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Energy rec} = & 32.11 \\ & + 0.56591 * \text{Drum Speed} \\ & + 1.2920 * \text{Wash Water} \\ & + 0.46823 * \text{Amplitude} \\ & - 5.751E-02 * \text{Feed Rate} \\ & - 1.406E-03 * \text{Drum Speed}^2 \\ & - 1.0048 * \text{Wash Water}^2 \end{aligned}$$

- 3.398E-02 * Amplitude^2
 - 5.869E-05 * Feed Rate^2
 + 2.819E-02 * Drum Speed * Wash Water
 + 3.714E-03 * Drum Speed * Amplitude
 + 2.067E-04 * Drum Speed * Feed Rate
 - 0.47473 * Wash Water * Amplitude
 + 7.119E-03 * Wash Water * Feed Rate
 + 1.143E-03 * Amplitude * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	99.34	99.15	0.19	0.609	0.317	0.010	0.304	10
2	91.04	91.35	-0.31	0.543	-0.465	0.017	-0.449	25
3	99.68	99.87	-0.19	0.587	-0.310	0.009	-0.298	7
4	93.33	93.98	-0.65	0.585	-1.043	0.102	-1.047	23
5	96.77	97.17	-0.40	0.547	-0.605	0.030	-0.588	24
6	99.54	98.61	0.93	0.657	1.637	0.343	1.779	26
7	93.27	94.63	-1.36	0.611	-2.246	0.527	-2.824	27
8	98.61	98.52	0.09	0.688	0.168	0.004	0.161	18
9	99.44	100.70	-1.26	0.550	-1.930	0.304	-2.226	19
10	91.29	91.67	-0.38	0.687	-0.696	0.071	-0.681	12
11	99.21	98.37	0.84	0.479	1.198	0.088	1.223	4
12	93.88	92.99	0.89	0.401	1.186	0.063	1.208	16
13	92.75	93.34	-0.59	0.596	-0.956	0.090	-0.952	21
14	98.67	97.94	0.73	0.529	1.094	0.089	1.104	1
15	98.81	99.46	-0.65	0.587	-1.032	0.101	-1.035	3
16	99.15	98.75	0.40	0.685	0.724	0.076	0.709	13
17	99.93	99.10	0.83	0.583	1.313	0.160	1.358	22
18	90.47	89.67	0.80	0.610	1.308	0.179	1.353	9
19	99.32	99.72	-0.40	0.610	-0.654	0.044	-0.637	5
20	93.94	94.32	-0.38	0.618	-0.626	0.042	-0.610	11
21	98.44	97.78	0.66	0.705	1.245	0.247	1.277	15
22	99.12	99.13	-0.01	0.521	-0.017	0.000	-0.017	8
23	96.35	95.76	0.59	0.555	0.909	0.069	0.902	17
24	98.17	98.66	-0.49	0.498	-0.712	0.034	-0.696	20
25	98.78	98.35	0.43	0.335	0.543	0.010	0.526	2
26	98.07	98.62	-0.55	0.336	-0.695	0.016	-0.679	6
27	98.41	98.17	0.24	0.289	0.292	0.002	0.280	14


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Coal Seam:  Illinois No. 6
Circuit:    Microcel/MGS Combined
Response:   Ash Rejection
Data File:  I-COM-00
Comments:   Analysis of Complete Data Set
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FAC      FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A        Drum Speed      rpm           240.000       320.000
B        Wash Water      lpm           0.500         1.500
C        Amplitude       mm            10.000        20.000
D        Feed Rate       lbs/hr        150.000       350.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	16994.7	1	16994.7		
Linear	3759.3	4	939.8	19.30	0.0001
Quadratic	439.8	10	44.0	0.8361	0.6062
Cubic	631.3	12	52.6		
RESIDUAL	0.0	0			
TOTAL	21825.1	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASSED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	6.98	0.7783	0.7379	1627.70
Quadratic	15	12	7.25	0.8693	0.7169	3656.75
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	3759.3	4	939.83	19.30	0.0001
RESIDUAL	1071.1	22	48.69		
COR TOTAL	4830.4	26			
ROOT MSE	6.98		R-SQUARED	0.7783	
DEP MEAN	25.09		ADJ R-SQUARED	0.7379	
C.V.	27.81%				

Predicted Residual Sum of Squares (PRESS) = 1627.7

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	24.49	1	1.37	17.92	
A	15.99	1	1.97	8.112	0.0001
B	-3.49	1	1.91	-1.828	0.0811
C	-5.01	1	2.02	-2.474	0.0216
D	1.66	1	1.88	0.8806	0.3881

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 24.49 \\ & + 15.99 * A \\ & - 3.49 * B \\ & - 5.01 * C \\ & + 1.66 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & -69.58 \\ & + 0.39971 * \text{Drum Speed} \\ & - 6.9708 * \text{Wash Water} \\ & - 1.0017 * \text{Amplitude} \\ & + 1.658\text{E-}02 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	11.84	12.09	-0.25	0.211	-0.041	0.000	-0.040	10
2	41.30	44.68	-3.38	0.189	-0.537	0.013	-0.528	25
3	5.71	5.33	0.38	0.205	0.062	0.000	0.060	7
4	40.17	37.25	2.92	0.211	0.471	0.012	0.462	23
5	38.86	27.72	11.14	0.204	1.790	0.164	1.892	24
6	9.98	17.71	-7.73	0.233	-1.265	0.097	-1.284	26
7	40.70	31.30	9.40	0.209	1.514	0.121	1.563	27
8	21.19	22.89	-1.70	0.222	-0.276	0.004	-0.270	18
9	9.98	7.34	2.64	0.182	0.418	0.008	0.410	19
10	49.77	39.73	10.04	0.233	1.643	0.164	1.714	12
11	13.32	9.20	4.12	0.182	0.652	0.019	0.644	4
12	33.10	42.00	-8.90	0.154	-1.387	0.070	-1.419	16
13	38.62	34.59	4.03	0.203	0.647	0.021	0.638	21
14	15.79	27.46	-11.67	0.183	-1.851	0.154	-1.968	1
15	17.73	23.30	-5.57	0.191	-0.887	0.037	-0.882	3
16	16.19	15.22	0.97	0.241	0.159	0.002	0.156	13
17	1.65	12.98	-11.33	0.214	-1.832	0.183	-1.945	22

18	44.94	46.92	-1.98	0.212	-0.320	0.005	-0.313	9
19	11.89	3.88	8.01	0.209	1.292	0.088	1.313	5
20	43.02	37.42	5.60	0.209	0.902	0.043	0.898	11
21	27.29	26.63	0.66	0.236	0.109	0.001	0.106	15
22	17.58	19.46	-1.88	0.182	-0.298	0.004	-0.292	8
23	33.31	30.89	2.42	0.184	0.384	0.007	0.376	17
24	28.98	23.44	5.54	0.178	0.876	0.033	0.871	20
25	16.20	26.35	-10.15	0.038	-1.484	0.018	-1.528	2
26	25.77	25.14	0.63	0.038	0.093	0.000	0.090	6
27	22.51	26.47	-3.96	0.047	-0.581	0.003	-0.572	14

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4199.2	14	299.94	5.702	0.0023
RESIDUAL	631.3	12	52.60		
COR TOTAL	4830.4	26			
ROOT MSE	7.25		R-SQUARED	0.8693	
DEP MEAN	25.09		ADJ R-SQUARED	0.7169	
C.V.	28.91%				

Predicted Residual Sum of Squares (PRESS) = 3656.8

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	20.08	1	4.27	4.699	
A	16.73	1	2.14	7.827	0.0001
B	-4.12	1	2.05	-2.016	0.0668
C	-6.03	1	2.19	-2.756	0.0174
D	1.68	1	2.01	0.8351	0.4200
A2	3.11	1	3.06	1.015	0.3300
B2	0.81	1	2.92	0.2787	0.7852
C2	1.93	1	3.05	0.6343	0.5378
D2	4.10	1	3.02	1.357	0.1996
AB	0.43	1	3.46	0.1252	0.9025
AC	-2.48	1	3.67	-0.6759	0.5119
AD	-6.12	1	3.56	-1.719	0.1113
BC	4.92	1	3.50	1.405	0.1855
BD	1.04	1	3.33	0.3108	0.7613
CD	2.49	1	3.17	0.7848	0.4478

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Ash rej} = & 20.08 \\ & + 16.73 * A \\ & - 4.12 * B \\ & - 6.03 * C \\ & + 1.68 * D \\ & + 3.11 * A^2 \\ & + 0.81 * B^2 \\ & + 1.93 * C^2 \\ & + 4.10 * D^2 \\ & + 0.43 * AB \\ & - 2.48 * AC \\ & - 6.12 * AD \\ & + 4.92 * BC \\ & + 1.04 * BD \\ & + 2.49 * CD \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Ash rej} = & 23.93 \\ & - 0.12281 * \text{Drum Speed} \\ & - 55.498 * \text{Wash Water} \\ & - 3.2601 * \text{Amplitude} \\ & + 0.14446 * \text{Feed Rate} \\ & + 1.943E-03 * \text{Drum Speed}^2 \\ & + 3.2512 * \text{Wash Water}^2 \end{aligned}$$

+ 7.730E-02 * Amplitude^2
 + 4.102E-04 * Feed Rate^2
 + 2.163E-02 * Drum Speed * Wash Water
 - 1.241E-02 * Drum Speed * Amplitude
 - 1.529E-03 * Drum Speed * Feed Rate
 + 1.9676 * Wash Water * Amplitude
 + 2.072E-02 * Wash Water * Feed Rate
 + 4.974E-03 * Amplitude * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	11.84	12.88	-1.04	0.609	-0.230	0.005	-0.221	10
2	41.30	42.36	-1.06	0.543	-0.217	0.004	-0.208	25
3	5.71	4.89	0.82	0.587	0.175	0.003	0.168	7
4	40.17	38.50	1.67	0.585	0.358	0.012	0.345	23
5	38.86	30.72	8.14	0.547	1.668	0.224	1.822	24
6	9.98	16.66	-6.68	0.657	-1.572	0.316	-1.689	26
7	40.70	32.38	8.32	0.611	1.838	0.353	2.075	27
8	21.19	28.05	-6.86	0.688	-1.693	0.421	-1.858	18
9	9.98	3.23	6.75	0.550	1.388	0.157	1.451	19
10	49.77	50.35	-0.58	0.687	-0.144	0.003	-0.138	12
11	13.32	16.48	-3.16	0.479	-0.604	0.022	-0.587	4
12	33.10	39.45	-6.35	0.401	-1.132	0.057	-1.147	16
13	38.62	38.42	0.20	0.596	0.044	0.000	0.042	21
14	15.79	21.26	-5.47	0.529	-1.099	0.090	-1.110	1
15	17.73	16.29	1.44	0.587	0.309	0.009	0.297	3
16	16.19	17.61	-1.42	0.685	-0.348	0.018	-0.335	13
17	1.65	9.90	-8.25	0.583	-1.761	0.289	-1.959	22
18	44.94	47.87	-2.93	0.610	-0.646	0.044	-0.630	9
19	11.89	7.59	4.30	0.610	0.950	0.094	0.945	5
20	43.02	33.81	9.21	0.618	2.055	0.456	2.444	11
21	27.29	29.36	-2.07	0.705	-0.524	0.044	-0.508	15
22	17.58	17.54	0.04	0.521	0.008	0.000	0.008	8
23	33.31	31.33	1.98	0.555	0.410	0.014	0.395	17
24	28.98	24.41	4.57	0.498	0.890	0.052	0.882	20
25	16.20	22.13	-5.93	0.335	-1.003	0.034	-1.003	2
26	25.77	20.91	4.86	0.336	0.822	0.023	0.810	6
27	22.51	23.00	-0.49	0.289	-0.080	0.000	-0.076	14

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Coal Seam:  Illinois No. 6
Circuit:    Microcel/MGS Combined
Response:   Sulfur Rejection
Data File:  I-COM-00
Comments:   Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Drum Speed      rpm           240.000       320.000
B      Wash Water      lpm           0.500         1.500
C      Amplitude       mm            10.000        20.000
D      Feed Rate       lbs/hr        150.000       350.000
=====
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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	24250.8	1	24250.8		
Linear	2136.7	4	534.2	8.830	0.0002
Quadratic	573.4	10	57.3	0.9084	0.5542
Cubic	757.5	12	63.1		
RESIDUAL	0.0	0			
TOTAL	27718.4	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	7.78	0.6162	0.5464	2035.43
Quadratic	15	12	7.95	0.7815	0.5267	4398.74
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2136.7	4	534.17	8.830	0.0002
RESIDUAL	1330.9	22	60.50		
COR TOTAL	3467.6	26			
ROOT MSE	7.78		R-SQUARED	0.6162	
DEP MEAN	29.97		ADJ R-SQUARED	0.5464	
C.V.	25.95%				

Predicted Residual Sum of Squares (PRESS) = 2035.4

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	29.53	1	1.52	19.38	
A	11.76	1	2.20	5.353	0.0001
B	-4.89	1	2.13	-2.301	0.0312
C	-1.98	1	2.26	-0.8787	0.3890
D	1.38	1	2.10	0.6562	0.5185

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sulfur rej} = & 29.53 \\ & + 11.76 * A \\ & - 4.89 * B \\ & - 1.98 * C \\ & + 1.38 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sulfur rej} = & -40.52 \\ & + 0.29404 * \text{Drum Speed} \\ & - 9.7814 * \text{Wash Water} \\ & - 0.39658 * \text{Amplitude} \\ & + 1.377\text{E-}02 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	21.62	22.98	-1.36	0.211	-0.197	0.002	-0.193	10
2	41.66	46.65	-4.99	0.189	-0.712	0.024	-0.704	25
3	10.92	13.09	-2.17	0.205	-0.313	0.005	-0.306	7
4	40.87	36.34	4.53	0.211	0.656	0.023	0.647	23
5	38.95	29.59	9.36	0.204	1.349	0.093	1.376	24
6	15.49	26.15	-10.66	0.233	-1.565	0.149	-1.622	26
7	44.91	32.57	12.34	0.209	1.784	0.168	1.884	27
8	30.86	30.58	0.28	0.222	0.041	0.000	0.040	18
9	19.74	16.96	2.78	0.182	0.395	0.007	0.388	19
10	49.14	40.67	8.47	0.233	1.244	0.094	1.260	12
11	24.70	18.14	6.56	0.182	0.932	0.039	0.929	4
12	34.47	42.27	-7.80	0.154	-1.091	0.043	-1.096	16
13	40.85	37.50	3.35	0.203	0.482	0.012	0.474	21
14	17.13	27.66	-10.53	0.183	-1.499	0.101	-1.545	1
15	26.80	32.83	-6.03	0.191	-0.861	0.035	-0.856	3
16	23.80	21.65	2.15	0.241	0.317	0.006	0.311	13
17	2.57	19.03	-16.46	0.214	-2.387	0.311	-2.710	22

18	38.89	43.95	-5.06	0.212	-0.732	0.029	-0.724	9
19	22.26	16.34	5.92	0.209	0.857	0.039	0.851	5
20	42.53	41.21	1.32	0.209	0.191	0.002	0.187	11
21	40.19	33.49	6.70	0.236	0.985	0.060	0.984	15
22	27.41	23.31	4.10	0.182	0.583	0.015	0.574	8
23	41.00	36.96	4.04	0.184	0.575	0.015	0.566	17
24	29.00	26.54	2.46	0.178	0.349	0.005	0.342	20
25	20.00	31.16	-11.16	0.038	-1.463	0.017	-1.504	2
26	35.39	30.26	5.13	0.038	0.672	0.004	0.664	6
27	28.03	31.29	-3.26	0.047	-0.430	0.002	-0.421	14

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	2710.1	14	193.58	3.067	0.0295
RESIDUAL	757.5	12	63.12		
COR TOTAL	3467.6	26			
ROOT MSE	7.95		R-SQUARED	0.7815	
DEP MEAN	29.97		ADJ R-SQUARED	0.5267	
C.V.	26.51%				

Predicted Residual Sum of Squares (PRESS) = 4398.7

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	26.40	1	4.68	5.638	
A	12.47	1	2.34	5.327	0.0002
B	-5.35	1	2.24	-2.386	0.0344
C	-3.02	1	2.40	-1.259	0.2319
D	1.39	1	2.20	0.6303	0.5403
A2	0.74	1	3.35	0.2214	0.8285
B2	1.32	1	3.20	0.4132	0.6868
C2	-0.38	1	3.34	-0.1149	0.9104
D2	5.17	1	3.31	1.563	0.1440
AB	1.57	1	3.79	0.4135	0.6866
AC	-3.41	1	4.02	-0.8473	0.4134
AD	-6.27	1	3.90	-1.608	0.1339
BC	4.84	1	3.84	1.262	0.2309
BD	0.35	1	3.65	9.71E-02	0.9243
CD	2.62	1	3.47	0.7552	0.4647

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Sulfur rej} = & 26.40 \\ & + 12.47 * A \\ & - 5.35 * B \\ & - 3.02 * C \\ & + 1.39 * D \\ & + 0.74 * A^2 \\ & + 1.32 * B^2 \\ & - 0.38 * C^2 \\ & + 5.17 * D^2 \\ & + 1.57 * AB \\ & - 3.41 * AC \\ & - 6.27 * AD \\ & + 4.84 * BC \\ & + 0.35 * BD \\ & + 2.62 * CD \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Sulfur rej} = & -82.96 \\ & + 0.62110 * \text{Drum Speed} \\ & - 74.000 * \text{Wash Water} \\ & + 1.3824 * \text{Amplitude} \\ & + 0.10809 * \text{Feed Rate} \\ & + 4.640E-04 * \text{Drum Speed}^2 \\ & + 5.2807 * \text{Wash Water}^2 \end{aligned}$$

- 1.534E-02 * Amplitude^2
 + 5.174E-04 * Feed Rate^2
 + 7.829E-02 * Drum Speed * Wash Water
 - 1.705E-02 * Drum Speed * Amplitude
 - 1.567E-03 * Drum Speed * Feed Rate
 + 1.9370 * Wash Water * Amplitude
 + 7.089E-03 * Wash Water * Feed Rate
 + 5.243E-03 * Amplitude * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	21.62	24.38	-2.76	0.609	-0.555	0.032	-0.539	10
2	41.66	43.03	-1.37	0.543	-0.256	0.005	-0.245	25
3	10.92	11.09	-0.17	0.587	-0.033	0.000	-0.032	7
4	40.87	38.47	2.40	0.585	0.469	0.021	0.453	23
5	38.95	32.79	6.16	0.547	1.153	0.107	1.170	24
6	15.49	25.29	-9.80	0.657	-2.108	0.568	-2.542	26
7	44.91	34.09	10.82	0.611	2.182	0.498	2.691	27
8	30.86	36.64	-5.78	0.688	-1.303	0.250	-1.347	18
9	19.74	12.51	7.23	0.550	1.357	0.150	1.412	19
10	49.14	51.14	-2.00	0.687	-0.449	0.029	-0.434	12
11	24.70	25.09	-0.39	0.479	-0.068	0.000	-0.065	4
12	34.47	39.36	-4.89	0.401	-0.795	0.028	-0.782	16
13	40.85	40.81	0.04	0.596	0.007	0.000	0.007	21
14	17.13	21.26	-4.13	0.529	-0.757	0.043	-0.743	1
15	26.80	25.30	1.50	0.587	0.295	0.008	0.283	3
16	23.80	23.89	-0.09	0.685	-0.019	0.000	-0.019	13
17	2.57	11.84	-9.27	0.583	-1.806	0.303	-2.026	22
18	38.89	42.51	-3.62	0.610	-0.730	0.056	-0.715	9
19	22.26	17.76	4.50	0.610	0.905	0.085	0.898	5
20	42.53	32.85	9.68	0.618	1.971	0.419	2.294	11
21	40.19	38.29	1.90	0.705	0.441	0.031	0.426	15
22	27.41	24.86	2.55	0.521	0.463	0.016	0.448	8
23	41.00	41.02	-0.02	0.555	-0.004	0.000	-0.003	17
24	29.00	29.95	-0.95	0.498	-0.169	0.002	-0.162	20
25	20.00	28.23	-8.23	0.335	-1.270	0.054	-1.307	2
26	35.39	27.35	8.04	0.336	1.242	0.052	1.274	6
27	28.03	29.37	-1.34	0.289	-0.200	0.001	-0.192	14

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Coal Seam:  Illinois No. 6
Circuit:    Microcel/MGS Combined
Response:   Pyritic Sulfur Rejection
Data File:  I-COM-00
Comments:   Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Drum Speed      rpm           240.000      320.000
B      Wash Water      lpm           0.500        1.500
C      Amplitude       mm            10.000       20.000
D      Feed Rate       lbs/hr        150.000      350.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	80298.2	1	80298.2		
Linear	4985.2	4	1246.3	10.70	0.0001
Quadratic	1134.3	10	113.4	0.9523	0.5240
Cubic	1429.3	12	119.1		
RESIDUAL	0.0	0			
TOTAL	87846.9	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	10.79	0.6604	0.5986	3949.92
Quadratic	15	12	10.91	0.8107	0.5898	8276.00
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4985.2	4	1246.29	10.70	0.0001
RESIDUAL	2563.6	22	116.53		
COR TOTAL	7548.8	26			
ROOT MSE	10.79		R-SQUARED	0.6604	
DEP MEAN	54.53		ADJ R-SQUARED	0.5986	
C.V.	19.79%				

Predicted Residual Sum of Squares (PRESS) = 3949.9

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	53.70	1	2.11	25.40	
A	18.52	1	3.05	6.075	0.0001
B	-5.04	1	2.95	-1.710	0.1014
C	-3.03	1	3.13	-0.9690	0.3431
D	3.03	1	2.91	1.039	0.3103

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Pyr rej} = & 53.70 \\ & + 18.52 * A \\ & - 5.04 * B \\ & - 3.03 * C \\ & + 3.03 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Pyr rej} = & -64.35 \\ & + 0.46312 * \text{Drum Speed} \\ & - 10.086 * \text{Wash Water} \\ & - 0.60694 * \text{Amplitude} \\ & + 3.025\text{E-}02 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	39.28	40.55	-1.27	0.211	-0.132	0.001	-0.129	10
2	70.10	78.65	-8.55	0.189	-0.879	0.036	-0.874	25
3	23.91	30.72	-6.81	0.205	-0.708	0.026	-0.700	7
4	68.45	67.25	1.20	0.211	0.125	0.001	0.122	23
5	70.43	53.48	16.95	0.204	1.760	0.159	1.855	24
6	35.15	47.38	-12.23	0.233	-1.294	0.102	-1.315	26
7	73.64	60.03	13.61	0.209	1.418	0.106	1.453	27
8	51.51	56.17	-4.66	0.222	-0.489	0.014	-0.480	18
9	34.32	32.95	1.37	0.182	0.140	0.001	0.137	19
10	77.54	70.27	7.27	0.233	0.769	0.036	0.761	12
11	45.87	36.88	8.99	0.182	0.921	0.038	0.918	4
12	64.16	74.90	-10.74	0.154	-1.081	0.043	-1.086	16
13	70.04	63.99	6.05	0.203	0.628	0.020	0.619	21
14	43.01	53.56	-10.55	0.183	-1.081	0.052	-1.085	1
15	51.78	56.23	-4.45	0.191	-0.458	0.010	-0.450	3
16	49.14	44.45	4.69	0.241	0.499	0.016	0.491	13
17	7.64	37.14	-29.50	0.214	-3.083	0.518	-3.996	22

18	70.66	77.34	-6.68	0.212	-0.697	0.026	-0.689	9
19	40.46	32.97	7.49	0.209	0.780	0.032	0.773	5
20	71.02	71.98	-0.96	0.209	-0.100	0.001	-0.098	11
21	63.51	56.15	7.36	0.236	0.780	0.037	0.773	15
22	48.98	45.87	3.11	0.182	0.319	0.005	0.312	8
23	64.58	63.40	1.18	0.184	0.121	0.001	0.118	17
24	60.75	52.59	8.16	0.178	0.834	0.030	0.828	20
25	52.09	56.17	-4.08	0.038	-0.385	0.001	-0.378	2
26	69.97	54.75	15.22	0.038	1.438	0.016	1.476	6
27	54.44	56.64	-2.20	0.047	-0.209	0.000	-0.204	14

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	6119.5	14	437.10	3.670	0.0149
RESIDUAL	1429.3	12	119.11		
COR TOTAL	7548.8	26			
ROOT MSE	10.91		R-SQUARED	0.8107	
DEP MEAN	54.53		ADJ R-SQUARED	0.5898	
C.V.	20.01%				

Predicted Residual Sum of Squares (PRESS) = 8276.0

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	58.00	1	6.43	9.019	
A	20.04	1	3.22	6.230	0.0001
B	-5.91	1	3.08	-1.922	0.0787
C	-3.93	1	3.29	-1.195	0.2552
D	3.25	1	3.02	1.076	0.3029
A2	-5.46	1	4.61	-1.185	0.2588
B2	-1.57	1	4.39	-0.3586	0.7261
C2	-2.96	1	4.58	-0.6447	0.5313
D2	1.76	1	4.55	0.3872	0.7054
AB	2.67	1	5.20	0.5124	0.6177
AC	-7.08	1	5.53	-1.282	0.2242
AD	-8.47	1	5.35	-1.583	0.1395
BC	6.16	1	5.27	1.169	0.2650
BD	2.72	1	5.01	0.5420	0.5977
CD	2.91	1	4.77	0.6097	0.5535

Final Equation in Terms of Coded Factors:

$$\begin{aligned}
 \text{Pyr rej} = & 58.00 \\
 & + 20.04 * A \\
 & - 5.91 * B \\
 & - 3.93 * C \\
 & + 3.25 * D \\
 & - 5.46 * A^2 \\
 & - 1.57 * B^2 \\
 & - 2.96 * C^2 \\
 & + 1.76 * D^2 \\
 & + 2.67 * AB \\
 & - 7.08 * AC \\
 & - 8.47 * AD \\
 & + 6.16 * BC \\
 & + 2.72 * BD \\
 & + 2.91 * CD
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned}
 \text{Pyr rej} = & -543.61 \\
 & + 3.3399 * \text{Drum Speed} \\
 & - 87.117 * \text{Wash Water} \\
 & + 8.7590 * \text{Amplitude} \\
 & + 0.39610 * \text{Feed Rate} \\
 & - 3.413\text{E-}03 * \text{Drum Speed}^2 \\
 & - 6.2959 * \text{Wash Water}^2
 \end{aligned}$$

- 0.11821 * Amplitude^2
 + 1.761E-04 * Feed Rate^2
 + 0.13327 * Drum Speed * Wash Water
 - 3.542E-02 * Drum Speed * Amplitude
 - 2.119E-03 * Drum Speed * Feed Rate
 + 2.4650 * Wash Water * Amplitude
 + 5.436E-02 * Wash Water * Feed Rate
 + 5.814E-03 * Amplitude * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	39.28	40.19	-0.91	0.609	-0.134	0.002	-0.128	10
2	70.10	70.47	-0.37	0.543	-0.050	0.000	-0.048	25
3	23.91	25.52	-1.61	0.587	-0.229	0.005	-0.220	7
4	68.45	68.02	0.43	0.585	0.061	0.000	0.058	23
5	70.43	58.00	12.43	0.547	1.693	0.231	1.858	24
6	35.15	46.47	-11.32	0.657	-1.771	0.401	-1.973	26
7	73.64	60.88	12.76	0.611	1.874	0.367	2.134	27
8	51.51	61.38	-9.87	0.688	-1.619	0.385	-1.754	18
9	34.32	24.51	9.81	0.550	1.340	0.146	1.391	19
10	77.54	80.83	-3.29	0.687	-0.539	0.042	-0.523	12
11	45.87	43.36	2.51	0.479	0.318	0.006	0.306	4
12	64.16	69.17	-5.01	0.401	-0.594	0.016	-0.577	16
13	70.04	69.94	0.10	0.596	0.014	0.000	0.013	21
14	43.01	47.77	-4.76	0.529	-0.635	0.030	-0.618	1
15	51.78	49.32	2.46	0.587	0.350	0.012	0.337	3
16	49.14	48.39	0.75	0.685	0.123	0.002	0.117	13
17	7.64	22.97	-15.33	0.583	-2.175	0.440	-2.675	22
18	70.66	75.86	-5.20	0.610	-0.763	0.061	-0.749	9
19	40.46	36.24	4.22	0.610	0.618	0.040	0.602	5
20	71.02	57.25	13.77	0.618	2.042	0.450	2.420	11
21	63.51	64.18	-0.67	0.705	-0.114	0.002	-0.109	15
22	48.98	46.37	2.61	0.521	0.346	0.009	0.333	8
23	64.58	65.27	-0.69	0.555	-0.095	0.001	-0.091	17
24	60.75	59.07	1.68	0.498	0.218	0.003	0.209	20
25	52.09	60.54	-8.45	0.335	-0.949	0.030	-0.945	2
26	69.97	59.17	10.80	0.336	1.215	0.050	1.242	6
27	54.44	61.27	-6.83	0.289	-0.742	0.015	-0.727	14

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Coal Seam:  Illinois No. 6
Circuit:    Microcel/MGS Combined
Response:   Separation Efficiency
Data File:  I-COM-00
Comments:   Analysis of Complete Data Set
=====

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=====
FAC  FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A    Drum Speed      rpm            240.000      320.000
B    Wash Water       lpm             0.500        1.500
C    Amplitude        mm             10.000       20.000
D    Feed Rate        lbs/hr          150.000      350.000
=====

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***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	70585.5	1	70585.5		
Linear	3208.8	4	802.2	7.300	0.0007
Quadratic	1176.3	10	117.6	1.137	0.4104
Cubic	1241.2	12	103.4		
RESIDUAL	0.0	0			
TOTAL	76211.9	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	10.48	0.5703	0.4922	3709.22
Quadratic	15	12	10.17	0.7794	0.5220	7218.41
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	3208.8	4	802.21	7.300	0.0007
RESIDUAL	2417.6	22	109.89		
COR TOTAL	5626.4	26			
ROOT MSE	10.48		R-SQUARED	0.5703	
DEP MEAN	51.13		ADJ R-SQUARED	0.4922	
C.V.	20.50%				

Predicted Residual Sum of Squares (PRESS) = 3709.2

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	50.45	1	2.05	24.57	
A	14.92	1	2.96	5.037	0.0001
B	-4.20	1	2.86	-1.467	0.1565
C	-1.53	1	3.04	-0.5030	0.6200
D	2.50	1	2.83	0.8820	0.3873

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{Efficiency} = & 50.45 \\ & + 14.92 * A \\ & - 4.20 * B \\ & - 1.53 * C \\ & + 2.50 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{Efficiency} = & -47.20 \\ & + 0.37289 * \text{Drum Speed} \\ & - 8.4033 * \text{Wash Water} \\ & - 0.30595 * \text{Amplitude} \\ & + 2.495E-02 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	38.48	40.02	-1.54	0.211	-0.166	0.001	-0.162	10
2	60.75	70.70	-9.95	0.189	-1.054	0.052	-1.057	25
3	23.51	31.82	-8.31	0.205	-0.889	0.041	-0.885	7
4	61.33	61.20	0.13	0.211	0.014	0.000	0.013	23
5	66.74	49.28	17.46	0.204	1.867	0.178	1.988	24
6	34.58	46.21	-11.63	0.233	-1.267	0.098	-1.286	26
7	66.41	54.68	11.73	0.209	1.258	0.084	1.276	27
8	49.87	53.45	-3.58	0.222	-0.387	0.009	-0.379	18
9	33.63	33.71	-0.08	0.182	-0.008	0.000	-0.008	19
10	68.29	63.74	4.55	0.233	0.496	0.015	0.487	12
11	44.90	36.94	7.96	0.182	0.839	0.031	0.833	4
12	57.71	67.55	-9.84	0.154	-1.021	0.038	-1.022	16
13	62.35	57.98	4.37	0.203	0.467	0.011	0.459	21
14	41.49	49.29	-7.80	0.183	-0.823	0.030	-0.817	1
15	50.38	53.55	-3.17	0.191	-0.337	0.005	-0.330	3
16	48.12	43.74	4.38	0.241	0.479	0.015	0.471	13
17	7.55	36.17	-28.62	0.214	-3.080	0.517	-3.989	22

18	60.68	68.58	-7.90	0.212	-0.848	0.039	-0.843	9
19	39.63	34.70	4.93	0.209	0.528	0.015	0.520	5
20	64.46	66.13	-1.67	0.209	-0.179	0.002	-0.175	11
21	61.59	52.52	9.07	0.236	0.990	0.060	0.989	15
22	47.87	43.95	3.92	0.182	0.414	0.008	0.406	8
23	60.55	58.48	2.07	0.184	0.219	0.002	0.214	17
24	58.61	49.48	9.13	0.178	0.961	0.040	0.959	20
25	50.69	52.47	-1.78	0.038	-0.173	0.000	-0.169	2
26	67.73	51.32	16.41	0.038	1.596	0.020	1.658	6
27	52.61	52.86	-0.25	0.047	-0.025	0.000	-0.024	14

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	4385.2	14	313.23	3.028	0.0308
RESIDUAL	1241.2	12	103.44		
COR TOTAL	5626.4	26			
ROOT MSE	10.17		R-SQUARED	0.7794	
DEP MEAN	51.13		ADJ R-SQUARED	0.5220	
C.V.	19.89%				

Predicted Residual Sum of Squares (PRESS) = 7218.4

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	56.60	1	5.99	9.444	
A	16.42	1	3.00	5.480	0.0001
B	-4.95	1	2.87	-1.727	0.1099
C	-2.37	1	3.07	-0.7713	0.4554
D	2.77	1	2.81	0.9822	0.3454
A2	-7.73	1	4.29	-1.801	0.0969
B2	-1.84	1	4.09	-0.4487	0.6616
C2	-3.83	1	4.27	-0.8967	0.3875
D2	1.12	1	4.24	0.2640	0.7962
AB	3.21	1	4.85	0.6627	0.5200
AC	-6.33	1	5.15	-1.229	0.2427
AD	-7.56	1	4.99	-1.516	0.1555
BC	4.93	1	4.91	1.004	0.3354
BD	3.06	1	4.67	0.6544	0.5252
CD	3.45	1	4.44	0.7762	0.4526

Final Equation in Terms of Coded Factors:

Efficiency =

$$\begin{aligned}
 & 56.60 \\
 & + 16.42 * A \\
 & - 4.95 * B \\
 & - 2.37 * C \\
 & + 2.77 * D \\
 & - 7.73 * A^2 \\
 & - 1.84 * B^2 \\
 & - 3.83 * C^2 \\
 & + 1.12 * D^2 \\
 & + 3.21 * AB \\
 & - 6.33 * AC \\
 & - 7.56 * AD \\
 & + 4.93 * BC \\
 & + 3.06 * BD \\
 & + 3.45 * CD
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

Efficiency =

$$\begin{aligned}
 & -611.54 \\
 & + 3.9035 * \text{Drum Speed} \\
 & - 85.059 * \text{Wash Water} \\
 & + 9.2886 * \text{Amplitude} \\
 & + 0.33651 * \text{Feed Rate} \\
 & - 4.832\text{E-}03 * \text{Drum Speed}^2 \\
 & - 7.3410 * \text{Wash Water}^2
 \end{aligned}$$

- 0.15323 * Amplitude^2
 + 1.119E-04 * Feed Rate^2
 + 0.16063 * Drum Speed * Wash Water
 - 3.165E-02 * Drum Speed * Amplitude
 - 1.891E-03 * Drum Speed * Feed Rate
 + 1.9715 * Wash Water * Amplitude
 + 6.116E-02 * Wash Water * Feed Rate
 + 6.899E-03 * Amplitude * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	38.48	39.17	-0.69	0.609	-0.109	0.001	-0.104	10
2	60.75	61.39	-0.64	0.543	-0.093	0.001	-0.089	25
3	23.51	25.33	-1.82	0.587	-0.279	0.007	-0.268	7
4	61.33	61.59	-0.26	0.585	-0.040	0.000	-0.038	23
5	66.74	54.80	11.94	0.547	1.745	0.246	1.935	24
6	34.58	44.86	-10.28	0.657	-1.727	0.381	-1.907	26
7	66.41	55.13	11.28	0.611	1.778	0.330	1.983	27
8	49.87	59.57	-9.70	0.688	-1.707	0.428	-1.878	18
9	33.63	25.17	8.46	0.550	1.241	0.126	1.273	19
10	68.29	71.94	-3.65	0.687	-0.641	0.060	-0.624	12
11	44.90	41.52	3.38	0.479	0.461	0.013	0.445	4
12	57.71	61.76	-4.05	0.401	-0.514	0.012	-0.498	16
13	62.35	62.86	-0.51	0.596	-0.079	0.001	-0.075	21
14	41.49	45.45	-3.96	0.529	-0.567	0.024	-0.550	1
15	50.38	48.58	1.80	0.587	0.276	0.007	0.265	3
16	48.12	46.95	1.17	0.685	0.206	0.006	0.197	13
17	7.55	21.94	-14.39	0.583	-2.190	0.446	-2.706	22
18	60.68	65.05	-4.37	0.610	-0.688	0.049	-0.672	9
19	39.63	35.87	3.76	0.610	0.591	0.036	0.574	5
20	64.46	51.21	13.25	0.618	2.109	0.480	2.545	11
21	61.59	61.61	-0.02	0.705	-0.004	0.000	-0.004	15
22	47.87	45.29	2.58	0.521	0.367	0.010	0.353	8
23	60.55	60.68	-0.13	0.555	-0.019	0.000	-0.018	17
24	58.61	57.44	1.17	0.498	0.163	0.002	0.156	20
25	50.69	58.64	-7.95	0.335	-0.958	0.031	-0.955	2
26	67.73	57.55	10.18	0.336	1.229	0.051	1.258	6
27	52.61	59.18	-6.57	0.289	-0.766	0.016	-0.752	14

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=====
Coal Seam:  Illinois No. 6
Circuit:    Microcel/MGS Combined
Response:   1b SO2/MM Btu
Data File:  I-COM-00
Comments:   Analysis of Complete Data Set
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FAC    FACTOR          UNITS          -1 LEVEL      +1 LEVEL
A      Drum Speed      rpm           240.000      320.000
B      Wash Water      lpm           0.500        1.500
C      Amplitude        mm            10.000       20.000
D      Feed Rate        lbs/hr        150.000      350.000
=====

```

***** WARNING: The Cubic Model is Aliased! *****

Sequential Model Sum of Squares

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MEAN	459.711	1	459.711		
Linear	5.400	4	1.350	11.99	0.0001
Quadratic	0.988	10	0.099	0.7959	0.6362
Cubic	1.489	12	0.124		
RESIDUAL	0.000	0			
TOTAL	467.587	27			

ANOVA Summary Statistics of Models Fit

SOURCE	UNALIASED TERMS	RESID DF	ROOT MSE	R-SQR	ADJ R-SQR	PRESS
Linear	5	22	0.336	0.6856	0.6284	3.641
Quadratic	15	12	0.352	0.8110	0.5904	6.956
Cubic	27	0				

Case(s) with leverage of 1.0000: PRESS statistic not defined.

ANOVA for Linear Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	5.400	4	1.350	11.99	0.0001
RESIDUAL	2.477	22	0.113		
COR TOTAL	7.876	26			
ROOT MSE	0.336		R-SQUARED	0.6856	
DEP MEAN	4.126		ADJ R-SQUARED	0.6284	
C.V.	8.13%				

Predicted Residual Sum of Squares (PRESS) = 3.641

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	4.136	1	0.066	62.93	
A	-0.552	1	0.095	-5.825	0.0001
B	0.345	1	0.092	3.761	0.0011
C	0.115	1	0.097	1.177	0.2518
D	0.012	1	0.091	0.1343	0.8944

Final Equation in Terms of Coded Factors:

$$\begin{aligned} \text{SO2 emiss} = & 4.136 \\ & - 0.552 * A \\ & + 0.345 * B \\ & + 0.115 * C \\ & + 0.012 * D \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned} \text{SO2 emiss} = & 6.937 \\ & - 1.380\text{E-}02 * \text{Drum Speed} \\ & + 0.68946 * \text{Wash Water} \\ & + 2.291\text{E-}02 * \text{Amplitude} \\ & + 1.216\text{E-}04 * \text{Feed Rate} \end{aligned}$$

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	4.510	4.324	0.186	0.211	0.625	0.021	0.616	10
2	3.360	3.266	0.094	0.189	0.309	0.004	0.303	25
3	5.040	5.042	-0.002	0.205	-0.008	0.000	-0.008	7
4	3.820	3.934	-0.114	0.211	-0.382	0.008	-0.375	23
5	3.550	4.066	-0.516	0.204	-1.722	0.152	-1.809	24
6	4.630	4.223	0.407	0.233	1.386	0.117	1.418	26
7	3.600	4.092	-0.492	0.209	-1.648	0.143	-1.720	27
8	3.950	4.190	-0.240	0.222	-0.811	0.038	-0.805	18
9	4.810	4.650	0.160	0.182	0.528	0.012	0.519	19
10	3.260	3.530	-0.270	0.233	-0.919	0.051	-0.916	12
11	4.940	4.754	0.186	0.182	0.612	0.017	0.603	4
12	4.050	3.623	0.427	0.154	1.385	0.070	1.416	16
13	3.660	3.660	-0.000	0.203	-0.001	0.000	-0.001	21
14	4.830	4.334	0.496	0.183	1.636	0.120	1.706	1
15	3.710	3.886	-0.176	0.191	-0.583	0.016	-0.574	3
16	4.760	4.656	0.104	0.241	0.355	0.008	0.348	13
17	4.920	4.597	0.323	0.214	1.085	0.064	1.090	22

18	3.910	3.504	0.406	0.212	1.364	0.100	1.393	9
19	4.710	4.785	-0.075	0.209	-0.252	0.003	-0.246	5
20	3.810	3.613	0.197	0.209	0.662	0.023	0.653	11
21	3.670	3.744	-0.074	0.236	-0.253	0.004	-0.248	15
22	4.040	4.477	-0.437	0.182	-1.439	0.092	-1.477	8
23	3.540	3.742	-0.202	0.184	-0.667	0.020	-0.658	17
24	4.230	4.472	-0.242	0.178	-0.797	0.027	-0.790	20
25	4.560	4.062	0.498	0.038	1.512	0.018	1.561	2
26	3.680	4.104	-0.424	0.038	-1.287	0.013	-1.308	6
27	3.860	4.080	-0.220	0.047	-0.671	0.004	-0.663	14

ANOVA for Quadratic Model

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F VALUE	PROB > F
MODEL	6.387	14	0.456	3.677	0.0148
RESIDUAL	1.489	12	0.124		
COR TOTAL	7.876	26			
ROOT MSE	0.352		R-SQUARED	0.8110	
DEP MEAN	4.126		ADJ R-SQUARED	0.5904	
C.V.	8.54%				

Predicted Residual Sum of Squares (PRESS) = 6.956

INDEPENDENT VARIABLE	COEFFICIENT ESTIMATE	DF	STANDARD ERROR	t FOR H0 COEFFICIENT=0	PROB > t
Intercept	4.116	1	0.208	19.83	
A	-0.581	1	0.104	-5.596	0.0001
B	0.336	1	0.099	3.382	0.0054
C	0.160	1	0.106	1.507	0.1577
D	0.018	1	0.097	0.1863	0.8553
A2	0.179	1	0.149	1.202	0.2524
B2	-0.036	1	0.142	-0.2511	0.8060
C2	0.065	1	0.148	0.4394	0.6682
D2	-0.160	1	0.147	-1.093	0.2958
AB	0.006	1	0.168	3.84E-02	0.9700
AC	0.070	1	0.178	0.3916	0.7022
AD	0.209	1	0.173	1.210	0.2495
BC	-0.016	1	0.170	-9.51E-02	0.9258
BD	0.093	1	0.162	0.5722	0.5777
CD	-0.178	1	0.154	-1.154	0.2709

Final Equation in Terms of Coded Factors:

$$\begin{aligned}
 \text{SO}_2 \text{ emiss} = & 4.116 \\
 & - 0.581 * A \\
 & + 0.336 * B \\
 & + 0.160 * C \\
 & + 0.018 * D \\
 & + 0.179 * A^2 \\
 & - 0.036 * B^2 \\
 & + 0.065 * C^2 \\
 & - 0.160 * D^2 \\
 & + 0.006 * AB \\
 & + 0.070 * AC \\
 & + 0.209 * AD \\
 & - 0.016 * BC \\
 & + 0.093 * BD \\
 & - 0.178 * CD
 \end{aligned}$$

Final Equation in Terms of Actual Factors:

$$\begin{aligned}
 \text{SO}_2 \text{ emiss} = & 19.437 \\
 & - 9.573\text{E-}02 * \text{Drum Speed} \\
 & + 0.50011 * \text{Wash Water} \\
 & - 4.853\text{E-}02 * \text{Amplitude} \\
 & - 2.959\text{E-}03 * \text{Feed Rate} \\
 & + 1.117\text{E-}04 * \text{Drum Speed}^2 \\
 & - 0.14226 * \text{Wash Water}^2
 \end{aligned}$$

+ 2.601E-03 * Amplitude^2
 - 1.604E-05 * Feed Rate^2
 + 3.224E-04 * Drum Speed * Wash Water
 + 3.493E-04 * Drum Speed * Amplitude
 + 5.228E-05 * Drum Speed * Feed Rate
 - 6.470E-03 * Wash Water * Amplitude
 + 1.852E-03 * Wash Water * Feed Rate
 - 3.553E-04 * Amplitude * Feed Rate

Obs Ord	ACTUAL VALUE	PREDICTED VALUE	RESIDUAL	LEVER	STUDENT RESID	COOK'S DIST	OUTLIER t	Run Ord
1	4.510	4.464	0.046	0.609	0.207	0.004	0.198	10
2	3.360	3.389	-0.029	0.543	-0.122	0.001	-0.117	25
3	5.040	5.144	-0.104	0.587	-0.461	0.020	-0.445	7
4	3.820	3.995	-0.175	0.585	-0.773	0.056	-0.759	23
5	3.550	3.748	-0.198	0.547	-0.837	0.056	-0.826	24
6	4.630	4.303	0.327	0.657	1.585	0.321	1.706	26
7	3.600	4.094	-0.494	0.611	-2.249	0.529	-2.832	27
8	3.950	3.802	0.148	0.688	0.754	0.084	0.740	18
9	4.810	4.900	-0.090	0.550	-0.383	0.012	-0.369	19
10	3.260	3.285	-0.025	0.687	-0.124	0.002	-0.119	12
11	4.940	4.635	0.305	0.479	1.201	0.088	1.226	4
12	4.050	3.837	0.213	0.401	0.782	0.027	0.768	16
13	3.660	3.634	0.026	0.596	0.114	0.001	0.109	21
14	4.830	4.348	0.482	0.529	1.992	0.297	2.332	1
15	3.710	3.943	-0.233	0.587	-1.030	0.101	-1.033	3
16	4.760	4.672	0.088	0.685	0.445	0.029	0.429	13
17	4.920	4.850	0.070	0.583	0.306	0.009	0.294	22
18	3.910	3.794	0.116	0.610	0.526	0.029	0.509	9
19	4.710	4.911	-0.201	0.610	-0.911	0.086	-0.904	5
20	3.810	3.939	-0.129	0.618	-0.595	0.038	-0.578	11
21	3.670	3.621	0.049	0.705	0.257	0.011	0.247	15
22	4.040	4.194	-0.154	0.521	-0.633	0.029	-0.616	8
23	3.540	3.414	0.126	0.555	0.535	0.024	0.518	17
24	4.230	4.351	-0.121	0.498	-0.483	0.015	-0.467	20
25	4.560	4.038	0.522	0.335	1.816	0.111	2.042	2
26	3.680	4.079	-0.399	0.336	-1.389	0.065	-1.451	6
27	3.860	4.023	-0.163	0.289	-0.549	0.008	-0.533	14

APPENDIX 4

Response Surface Plots and Computations

APPENDIX 4-A

Response Surface Plots and Computations

Independent Microcel Tests
Pittsburgh No. 8 Seam Coal

Pittsburgh No. 8 Seam
Individual Microcell

Pittsburgh No. 8 Seam
Individual Microcell

Pittsburgh No. 8 Seam
Individual Microcel

Pittsburgh No. 8 Seam
Individual Microcell

Pittsburgh No. 8 Seam
Individual Microcel

Cim Feed (lb/hr) 300

Cim Feed (lb/hr) 400

Cim Feed (lb/hr) 500

Pittsburgh No. 8 Seam
Individual Microcoal

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

Actual:			
Name	Size (um)	Cfm Feed (lb/hr)	Frother (ml/min)
Minimum	100	300	0.5
Maximum	300	500	1.5
Center	200	400	1
Range	200	200	1
Coded:			
Name	X1	X2	X3
Minimum	-1	-1	-1
Maximum	1	1	1
Center	0	0	0
Range	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	94.987
X1	COE1	-0.547
X2	COE2	-0.763
X3	COE3	1.78
X1*X1	COE11	0
X2*X2	COE22	0
X3*X3	COE33	0
X1*X2	COE12	0
X1*X3	COE13	0
X2*X3	COE23	0

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
1	-1.0	100	93	93	94	94	94	95	95	95	96	96	97
1	-0.8	120	93	93	94	94	94	95	95	95	96	96	96
1	-0.6	140	93	93	93	94	94	95	95	95	96	96	96
1	-0.4	160	93	93	93	94	94	94	95	95	96	96	96
1	-0.2	180	93	93	93	94	94	94	95	95	95	96	96
1	0.0	200	92	93	93	94	94	94	95	95	95	96	96
1	0.2	220	92	93	93	93	94	94	94	95	95	96	96
1	0.4	240	92	93	93	93	94	94	94	95	95	95	96
1	0.6	260	92	92	93	93	94	94	94	95	95	95	96
1	0.8	280	92	92	93	93	93	94	94	94	95	95	96
1	1.0	300	92	92	93	93	93	94	94	94	95	95	95

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
0	-1.0	100	94	94	94	95	95	96	96	96	97	97	97
0	-0.8	120	94	94	94	95	95	95	96	96	96	97	97
0	-0.6	140	94	94	94	95	95	95	96	96	96	97	97
0	-0.4	160	93	94	94	94	95	95	96	96	96	97	97
0	-0.2	180	93	94	94	94	95	95	95	96	96	97	97
0	0.0	200	93	94	94	94	95	95	95	96	96	96	97
0	0.2	220	93	93	94	94	95	95	95	96	96	96	97
0	0.4	240	93	93	94	94	94	95	95	95	96	96	97
0	0.6	260	93	93	94	94	94	95	95	95	96	96	96
0	0.8	280	93	93	93	94	94	95	95	95	96	96	96
0	1.0	300	93	93	93	94	94	94	95	95	96	96	96

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
-1	-1.0	100	95	95	95	96	96	96	97	97	97	98	98
-1	-0.8	120	94	95	95	95	96	96	97	97	97	98	98
-1	-0.6	140	94	95	95	95	96	96	96	97	97	98	98
-1	-0.4	160	94	95	95	95	96	96	96	97	97	97	98
-1	-0.2	180	94	94	95	95	96	96	96	97	97	97	98
-1	0.0	200	94	94	95	95	95	96	96	96	97	97	98
-1	0.2	220	94	94	95	95	95	96	96	96	97	97	97
-1	0.4	240	94	94	94	95	95	96	96	96	97	97	97
-1	0.6	260	94	94	94	95	95	95	96	96	96	97	97
-1	0.8	280	94	94	94	95	95	95	96	96	96	97	97
-1	1.0	300	93	94	94	94	95	95	96	96	96	97	97

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

Actual:			
Name	Size (um)	Cfm Feed (lb/hr)	Frother (ml/min)
Minimum	100	300	0.5
Maximum	300	500	1.5
Center	200	400	1
Range	200	200	1
Coded:			
Name	X1	X2	X3
Minimum	-1	-1	-1
Maximum	1	1	1
Center	0	0	0
Range	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	96.341
X1	COE1	-0.495
X2	COE2	-0.524
X3	COE3	1.623
X1*X1	COE11	0
X2*X2	COE22	0
X3*X3	COE33	0
X1*X2	COE12	0
X1*X3	COE13	0
X2*X3	COE23	0

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcell

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
1	-1.0	100	95	95	95	96	96	96	97	97	97	98	98
1	-0.8	120	95	95	95	96	96	96	97	97	97	98	98
1	-0.6	140	94	95	95	95	96	96	96	97	97	97	98
1	-0.4	160	94	95	95	95	96	96	96	97	97	97	98
1	-0.2	180	94	95	95	95	96	96	96	97	97	97	98
1	0.0	200	94	95	95	95	95	96	96	96	97	97	97
1	0.2	220	94	94	95	95	95	96	96	96	97	97	97
1	0.4	240	94	94	95	95	95	96	96	96	97	97	97
1	0.6	260	94	94	95	95	95	96	96	96	96	97	97
1	0.8	280	94	94	94	95	95	95	96	96	96	97	97
1	1.0	300	94	94	94	95	95	95	96	96	96	97	97

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
0	-1.0	100	95	96	96	96	97	97	97	97	98	98	98
0	-0.8	120	95	95	96	96	96	97	97	97	98	98	98
0	-0.6	140	95	95	96	96	96	97	97	97	98	98	98
0	-0.4	160	95	95	96	96	96	97	97	97	98	98	98
0	-0.2	180	95	95	95	96	96	96	97	97	97	98	98
0	0.0	200	95	95	95	96	96	96	97	97	97	98	98
0	0.2	220	95	95	95	96	96	96	97	97	97	98	98
0	0.4	240	95	95	95	95	96	96	96	97	97	97	98
0	0.6	260	94	95	95	95	96	96	96	97	97	97	98
0	0.8	280	94	95	95	95	96	96	96	97	97	97	98
0	1.0	300	94	95	95	95	96	96	96	96	97	97	97

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
-1	-1.0	100	96	96	96	97	97	97	98	98	98	99	99
-1	-0.8	120	96	96	96	97	97	97	98	98	98	99	99
-1	-0.6	140	96	96	96	97	97	97	97	98	98	98	99
-1	-0.4	160	95	96	96	96	97	97	97	98	98	98	99
-1	-0.2	180	95	96	96	96	97	97	97	98	98	98	99
-1	0.0	200	95	96	96	96	97	97	97	98	98	98	98
-1	0.2	220	95	95	96	96	96	97	97	97	98	98	98
-1	0.4	240	95	95	96	96	96	97	97	97	98	98	98
-1	0.6	260	95	95	96	96	96	97	97	97	98	98	98
-1	0.8	280	95	95	95	96	96	96	97	97	97	98	98
-1	1.0	300	95	95	95	96	96	96	97	97	97	98	98

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

Actual:			
Name	Size (um)	Cfm Feed (lb/hr)	Frother (ml/min)
Minimum	100	300	0.5
Maximum	300	500	1.5
Center	200	400	1
Range	200	200	1
Coded:			
Name	X1	X2	X3
Minimum	-1	-1	-1
Maximum	1	1	1
Center	0	0	0
Range	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	58.24
X1	COE1	1.5
X2	COE2	6.18
X3	COE3	-6.04
X1*X1	COE11	0
X2*X2	COE22	0
X3*X3	COE33	0
X1*X2	COE12	0
X1*X3	COE13	0
X2*X3	COE23	0

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
1	-1.0	100	69	68	67	65	64	63	62	61	59	58	57
1	-0.8	120	69	68	67	66	64	63	62	61	60	58	57
1	-0.6	140	70	68	67	66	65	64	62	61	60	59	57
1	-0.4	160	70	69	67	66	65	64	63	61	60	59	58
1	-0.2	180	70	69	68	67	65	64	63	62	60	59	58
1	0.0	200	70	69	68	67	66	64	63	62	61	60	58
1	0.2	220	71	70	68	67	66	65	64	62	61	60	59
1	0.4	240	71	70	69	67	66	65	64	63	61	60	59
1	0.6	260	71	70	69	68	67	65	64	63	62	60	59
1	0.8	280	72	70	69	68	67	66	64	63	62	61	60
1	1.0	300	72	71	70	68	67	66	65	64	62	61	60

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
0	-1.0	100	63	62	60	59	58	57	56	54	53	52	51
0	-0.8	120	63	62	61	59	58	57	56	55	53	52	51
0	-0.6	140	63	62	61	60	59	57	56	55	54	53	51
0	-0.4	160	64	62	61	60	59	58	56	55	54	53	52
0	-0.2	180	64	63	62	60	59	58	57	56	54	53	52
0	0.0	200	64	63	62	61	59	58	57	56	55	53	52
0	0.2	220	65	63	62	61	60	59	57	56	55	54	53
0	0.4	240	65	64	62	61	60	59	58	56	55	54	53
0	0.6	260	65	64	63	62	60	59	58	57	56	54	53
0	0.8	280	65	64	63	62	61	59	58	57	56	55	53
0	1.0	300	66	65	63	62	61	60	59	57	56	55	54

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
-1	-1.0	100	57	55	54	53	52	51	49	48	47	46	45
-1	-0.8	120	57	56	54	53	52	51	50	48	47	46	45
-1	-0.6	140	57	56	55	54	52	51	50	49	48	46	45
-1	-0.4	160	58	56	55	54	53	51	50	49	48	47	45
-1	-0.2	180	58	57	55	54	53	52	51	49	48	47	46
-1	0.0	200	58	57	56	54	53	52	51	50	48	47	46
-1	0.2	220	58	57	56	55	54	52	51	50	49	48	46
-1	0.4	240	59	57	56	55	54	53	51	50	49	48	47
-1	0.6	260	59	58	57	55	54	53	52	51	49	48	47
-1	0.8	280	59	58	57	56	54	53	52	51	50	48	47
-1	1.0	300	60	58	57	56	55	54	52	51	50	49	48

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

Actual:			
Name	Size (um)	Cfm Feed (lb/hr)	Frother (ml/min)
Minimum	100	300	0.5
Maximum	300	500	1.5
Center	200	400	1
Range	200	200	1
Coded:			
Name	X1	X2	X3
Minimum	-1	-1	-1
Maximum	1	1	1
Center	0	0	0
Range	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	17.95
X1	COE1	-0.46
X2	COE2	4.75
X3	COE3	-3.24
X1*X1	COE11	0
X2*X2	COE22	0
X3*X3	COE33	0
X1*X2	COE12	0
X1*X3	COE13	0
X2*X3	COE23	0

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
1	-1.0	100	26	26	25	24	24	23	23	22	21	21	20
1	-0.8	120	26	26	25	24	24	23	22	22	21	20	20
1	-0.6	140	26	26	25	24	24	23	22	22	21	20	20
1	-0.4	160	26	25	25	24	24	23	22	22	21	20	20
1	-0.2	180	26	25	25	24	23	23	22	21	21	20	20
1	0.0	200	26	25	25	24	23	23	22	21	21	20	19
1	0.2	220	26	25	25	24	23	23	22	21	21	20	19
1	0.4	240	26	25	24	24	23	23	22	21	21	20	19
1	0.6	260	26	25	24	24	23	22	22	21	20	20	19
1	0.8	280	26	25	24	24	23	22	22	21	20	20	19
1	1.0	300	25	25	24	24	23	22	22	21	20	20	19

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
0	-1.0	100	22	21	20	20	19	18	18	17	16	16	15
0	-0.8	120	22	21	20	20	19	18	18	17	16	16	15
0	-0.6	140	21	21	20	20	19	18	18	17	16	16	15
0	-0.4	160	21	21	20	19	19	18	17	17	16	16	15
0	-0.2	180	21	21	20	19	19	18	17	17	16	15	15
0	0.0	200	21	21	20	19	19	18	17	17	16	15	15
0	0.2	220	21	20	20	19	19	18	17	17	16	15	15
0	0.4	240	21	20	20	19	18	18	17	16	16	15	15
0	0.6	260	21	20	20	19	18	18	17	16	16	15	14
0	0.8	280	21	20	20	19	18	18	17	16	16	15	14
0	1.0	300	21	20	19	19	18	17	17	16	16	15	14

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
-1	-1.0	100	17	16	16	15	14	14	13	12	12	11	10
-1	-0.8	120	17	16	16	15	14	14	13	12	12	11	10
-1	-0.6	140	17	16	15	15	14	13	13	12	12	11	10
-1	-0.4	160	17	16	15	15	14	13	13	12	11	11	10
-1	-0.2	180	17	16	15	15	14	13	13	12	11	11	10
-1	0.0	200	16	16	15	14	14	13	13	12	11	11	10
-1	0.2	220	16	16	15	14	14	13	12	12	11	11	10
-1	0.4	240	16	16	15	14	14	13	12	12	11	10	10
-1	0.6	260	16	16	15	14	14	13	12	12	11	10	10
-1	0.8	280	16	15	15	14	13	13	12	12	11	10	10
-1	1.0	300	16	15	15	14	13	13	12	11	11	10	10

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

Actual:			
Name	Size (um)	Cfm Feed (lb/hr)	Frother (ml/min)
Minimum	100	300	0.5
Maximum	300	500	1.5
Center	200	400	1
Range	200	200	1
Coded:			
Name	X1	X2	X3
Minimum	-1	-1	-1
Maximum	1	1	1
Center	0	0	0
Range	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	36.21
X1	COE1	-6.21
X2	COE2	9.13
X3	COE3	-6.61
X1*X1	COE11	0
X2*X2	COE22	0
X3*X3	COE33	0
X1*X2	COE12	0
X1*X3	COE13	0
X2*X3	COE23	0

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
1	-1.0	100	58	57	56	54	53	52	50	49	48	46	45
1	-0.8	120	57	56	54	53	52	50	49	48	46	45	44
1	-0.6	140	56	54	53	52	50	49	48	46	45	44	42
1	-0.4	160	54	53	52	50	49	48	47	45	44	43	41
1	-0.2	180	53	52	51	49	48	47	45	44	43	41	40
1	0.0	200	52	51	49	48	47	45	44	43	41	40	39
1	0.2	220	51	49	48	47	45	44	43	41	40	39	37
1	0.4	240	49	48	47	46	44	43	42	40	39	38	36
1	0.6	260	48	47	46	44	43	42	40	39	38	36	35
1	0.8	280	47	46	44	43	42	40	39	38	36	35	34
1	1.0	300	46	44	43	42	40	39	38	36	35	34	33

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
0	-1.0	100	49	48	46	45	44	42	41	40	38	37	36
0	-0.8	120	48	46	45	44	43	41	40	39	37	36	35
0	-0.6	140	47	45	44	43	41	40	39	37	36	35	33
0	-0.4	160	45	44	43	41	40	39	37	36	35	33	32
0	-0.2	180	44	43	41	40	39	37	36	35	33	32	31
0	0.0	200	43	41	40	39	38	36	35	34	32	31	30
0	0.2	220	42	40	39	38	36	35	34	32	31	30	28
0	0.4	240	40	39	38	36	35	34	32	31	30	28	27
0	0.6	260	39	38	36	35	34	32	31	30	29	27	26
0	0.8	280	38	37	35	34	33	31	30	29	27	26	25
0	1.0	300	37	35	34	33	31	30	29	27	26	25	23

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
-1	-1.0	100	40	39	37	36	35	33	32	31	29	28	27
-1	-0.8	120	39	37	36	35	33	32	31	29	28	27	25
-1	-0.6	140	37	36	35	33	32	31	29	28	27	26	24
-1	-0.4	160	36	35	34	32	31	30	28	27	26	24	23
-1	-0.2	180	35	34	32	31	30	28	27	26	24	23	22
-1	0.0	200	34	32	31	30	28	27	26	24	23	22	20
-1	0.2	220	32	31	30	28	27	26	25	23	22	21	19
-1	0.4	240	31	30	29	27	26	25	23	22	21	19	18
-1	0.6	260	30	29	27	26	25	23	22	21	19	18	17
-1	0.8	280	29	27	26	25	23	22	21	19	18	17	16
-1	1.0	300	27	26	25	24	22	21	20	18	17	16	14

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

Actual:			
Name	Size (um)	Clm Feed (lb/hr)	Frother (ml/min)
Minimum	100	300	0.5
Maximum	300	500	1.5
Center	200	400	1
Range	200	200	1
Coded:			
Name	X1	X2	X3
Minimum	-1	-1	-1
Maximum	1	1	1
Center	0	0	0
Range	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	53.59
X1	COE1	0.84
X2	COE2	4.08
X3	COE3	-2.3
X1*X1	COE11	0
X2*X2	COE22	0
X3*X3	COE33	0
X1*X2	COE12	0
X1*X3	COE13	0
X2*X3	COE23	0

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)

Description: Pittsburgh No. 8 Seam

Circuit: Individual Microcel

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
1	-1.0	100	59	59	58	58	57	57	56	56	55	55	55
1	-0.8	120	59	59	58	58	57	57	57	56	56	55	55
1	-0.6	140	59	59	59	58	58	57	57	56	56	55	55
1	-0.4	160	60	59	59	58	58	57	57	56	56	55	55
1	-0.2	180	60	59	59	58	58	58	57	57	56	56	55
1	0.0	200	60	60	59	59	58	58	57	57	56	56	55
1	0.2	220	60	60	59	59	58	58	57	57	56	56	56
1	0.4	240	60	60	59	59	58	58	58	57	57	56	56
1	0.6	260	60	60	60	59	59	58	58	57	57	56	56
1	0.8	280	61	60	60	59	59	58	58	57	57	57	56
1	1.0	300	61	60	60	59	59	59	58	58	57	57	56

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
0	-1.0	100	55	55	54	54	53	53	52	52	51	51	50
0	-0.8	120	55	55	54	54	53	53	52	52	52	51	51
0	-0.6	140	55	55	54	54	54	53	53	52	52	51	51
0	-0.4	160	56	55	55	54	54	53	53	52	52	51	51
0	-0.2	180	56	55	55	54	54	53	53	53	52	52	51
0	0.0	200	56	55	55	55	54	54	53	53	52	52	51
0	0.2	220	56	56	55	55	54	54	53	53	52	52	51
0	0.4	240	56	56	55	55	54	54	53	53	53	52	52
0	0.6	260	56	56	55	55	55	54	54	53	53	52	52
0	0.8	280	57	56	56	55	55	54	54	53	53	52	52
0	1.0	300	57	56	56	55	55	54	54	54	53	53	52

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
-1	-1.0	100	51	51	50	50	49	49	48	48	47	47	46
-1	-0.8	120	51	51	50	50	49	49	48	48	47	47	47
-1	-0.6	140	51	51	50	50	49	49	49	48	48	47	47
-1	-0.4	160	51	51	51	50	50	49	49	48	48	47	47
-1	-0.2	180	52	51	51	50	50	49	49	48	48	48	47
-1	0.0	200	52	51	51	50	50	50	49	49	48	48	47
-1	0.2	220	52	52	51	51	50	50	49	49	48	48	47
-1	0.4	240	52	52	51	51	50	50	49	49	48	48	48
-1	0.6	260	52	52	51	51	50	50	50	49	49	48	48
-1	0.8	280	52	52	52	51	51	50	50	49	49	48	48
-1	1.0	300	53	52	52	51	51	50	50	49	49	49	48

QUADRATIC REGRESSION MODEL

Response: lb SO₂/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

Actual:			
Name	Size (um)	Clm Feed (lb/hr)	Frother (ml/min)
Minimum	100	300	0.5
Maximum	300	500	1.5
Center	200	400	1
Range	200	200	1
Coded:			
Name	X1	X2	X3
Minimum	-1	-1	-1
Maximum	1	1	1
Center	0	0	0
Range	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	4.14
X1	COE1	0.155
X2	COE2	-0.063
X3	COE3	0.157
X1*X1	COE11	0
X2*X2	COE22	0
X3*X3	COE33	0
X1*X2	COE12	0
X1*X3	COE13	0
X2*X3	COE23	0

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual Microcel

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
1	-1.0	100	3.8	3.8	3.8	3.9	3.9	3.9	4.0	4.0	4.0	4.0	4.1
1	-0.8	120	3.8	3.8	3.9	3.9	3.9	4.0	4.0	4.0	4.0	4.1	4.1
1	-0.6	140	3.8	3.9	3.9	3.9	4.0	4.0	4.0	4.0	4.1	4.1	4.1
1	-0.4	160	3.9	3.9	3.9	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2
1	-0.2	180	3.9	3.9	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2
1	0.0	200	3.9	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2
1	0.2	220	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3
1	0.4	240	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3
1	0.6	260	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3
1	0.8	280	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.4
1	1.0	300	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.4	4.4

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
0	-1.0	100	3.8	3.9	3.9	3.9	4.0	4.0	4.0	4.0	4.1	4.1	4.1
0	-0.8	120	3.9	3.9	3.9	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2
0	-0.6	140	3.9	3.9	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2
0	-0.4	160	3.9	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2
0	-0.2	180	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3
0	0.0	200	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3
0	0.2	220	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3
0	0.4	240	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.4
0	0.6	260	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.4	4.4
0	0.8	280	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.4	4.4	4.4
0	1.0	300	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.4	4.4	4.4	4.5

		X3	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
-1	-1.0	100	3.9	3.9	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2
-1	-0.8	120	3.9	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2
-1	-0.6	140	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3
-1	-0.4	160	4.0	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3
-1	-0.2	180	4.0	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3
-1	0.0	200	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.4
-1	0.2	220	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.4	4.4
-1	0.4	240	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.4	4.4	4.4
-1	0.6	260	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.4	4.4	4.4	4.5
-1	0.8	280	4.2	4.2	4.2	4.3	4.3	4.3	4.4	4.4	4.4	4.5	4.5
-1	1.0	300	4.2	4.2	4.3	4.3	4.3	4.4	4.4	4.4	4.5	4.5	4.5

APPENDIX 4-B

Response Surface Plots and Computations

Independent Microcel Tests
Illinois No. 6 Seam Coal

Illinois No. 6 Seam
Individual Microcel

Illinois No. 6 Seam
Individual Microcell

**Illinois No. 6 Seam
Individual Microcel**

Illinois No. 6 Seam
Individual Microcel

**Illinois No. 6 Seam
Individual Microcel**

Illinois No. 6 Seam
Individual Microcel

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual Microcel

Actual:		
Name	Collector (lb/ton)	Frother (ml/min)
Minimum	1	1
Maximum	3	3
Center	2	2
Range	2	2
Coded:		
Name	X1	X2
Minimum	-1	-1
Maximum	1	1
Center	0	0
Range	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	86.597
X1	COE1	0.283
X2	COE2	1.857
X1*X1	COE11	1.97
X2*X2	COE22	-3.19
X1*X2	COE12	-2.72

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual Microcel

		X2	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X1			1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3
	-1.0	1	81	83	84	86	87	88	89	90	90	90	90
	-0.8	1.2	80	82	84	86	87	88	88	89	89	89	88
	-0.6	1.4	80	82	84	85	86	87	88	88	88	88	87
	-0.4	1.6	81	82	84	85	86	87	87	87	87	87	87
	-0.2	1.8	81	83	84	85	86	87	87	87	87	86	86
	0.0	2	82	83	84	85	86	87	87	87	87	86	85
	0.2	2.2	82	84	85	86	86	87	87	87	86	86	85
	0.4	2.4	83	84	85	86	87	87	87	87	86	86	85
	0.6	2.6	84	85	86	87	87	87	87	87	86	86	85
	0.8	2.8	85	86	87	88	88	88	88	87	87	86	85
	1.0	3	87	87	88	89	89	89	89	88	87	86	85

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
Description: Illinois No. 6 Seam
Circuit: Individual Microcel

Actual:		
Name	Collector (lb/ton)	Frother (ml/min)
Minimum	1	1
Maximum	3	3
Center	2	2
Range	2	2
Coded:		
Name	X1	X2
Minimum	-1	-1
Maximum	1	1
Center	0	0
Range	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	90.634
X1	COE1	0.337
X2	COE2	1.71
X1*X1	COE11	1.803
X2*X2	COE22	-2.637
X1*X2	COE12	-0.21

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
Description: Illinois No. 6 Seam
Circuit: Individual Microcel

		X2	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
	X1		1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3
	-1.0	1	88	89	90	91	92	92	92	92	92	92	91
	-0.8	1.2	87	88	89	90	91	92	92	92	92	91	91
	-0.6	1.4	87	88	89	90	91	91	91	91	91	91	90
	-0.4	1.6	86	88	89	90	90	91	91	91	91	91	90
	-0.2	1.8	86	88	89	90	90	91	91	91	91	90	90
	0.0	2	86	88	89	90	90	91	91	91	91	90	90
	0.2	2.2	86	88	89	90	90	91	91	91	91	90	90
	0.4	2.4	87	88	89	90	91	91	91	91	91	91	90
	0.6	2.6	87	89	90	90	91	91	92	92	91	91	90
	0.8	2.8	88	89	90	91	92	92	92	92	92	92	91
	1.0	3	89	90	91	92	92	93	93	93	93	92	92

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
Description: Illinois No. 6 Seam
Circuit: Individual Microcel

Actual:		
Name	Collector (lb/ton)	Frother (ml/min)
Minimum	1	1
Maximum	3	3
Center	2	2
Range	2	2
Coded:		
Name	X1	X2
Minimum	-1	-1
Maximum	1	1
Center	0	0
Range	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	75.45
X1	COE1	2.76
X2	COE2	-5.61
X1*X1	COE11	2.18
X2*X2	COE22	6.85
X1*X2	COE12	-3.28

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
Description: Illinois No. 6 Seam
Circuit: Individual Microcel

		X2	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
	X1		1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3
	-1.0	1	84	81	79	77	76	75	75	75	76	77	79
	-0.8	1.2	84	81	79	77	76	75	74	75	75	77	79
	-0.6	1.4	85	82	79	77	76	75	74	74	75	76	78
	-0.4	1.6	86	83	80	78	76	75	74	74	75	76	77
	-0.2	1.8	87	83	80	78	76	75	74	74	74	75	77
	0.0	2	88	84	81	79	77	75	75	74	75	75	77
	0.2	2.2	89	85	82	80	78	76	75	75	75	75	77
	0.4	2.4	91	87	84	81	79	77	76	75	75	76	77
	0.6	2.6	92	88	85	82	80	78	77	76	76	76	77
	0.8	2.8	94	90	86	83	81	79	78	77	77	77	78
	1.0	3	96	92	88	85	82	80	79	78	78	78	78

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
Description: Illinois No. 6 Seam
Circuit: Individual Microcel

Actual:		
Name	Collector (lb/ton)	Frother (ml/min)
Minimum	1	1
Maximum	3	3
Center	2	2
Range	2	2
Coded:		
Name	X1	X2
Minimum	-1	-1
Maximum	1	1
Center	0	0
Range	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	41.17
X1	COE1	-0.38
X2	COE2	-2.02
X1*X1	COE11	-2.05
X2*X2	COE22	4.05
X1*X2	COE12	1.32

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual Microcel

		X2	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
	X1		1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3
	-1.0	1	47	45	43	41	40	40	39	39	39	39	40
	-0.8	1.2	47	45	43	42	41	40	40	40	40	40	41
	-0.6	1.4	48	46	44	42	41	41	40	40	40	41	42
	-0.4	1.6	48	46	44	43	42	41	41	41	41	42	42
	-0.2	1.8	47	46	44	43	42	41	41	41	41	42	43
	0.0	2	47	45	44	43	42	41	41	41	41	42	43
	0.2	2.2	47	45	44	42	42	41	41	41	41	42	43
	0.4	2.4	46	44	43	42	41	41	41	41	41	42	43
	0.6	2.6	45	44	42	41	41	40	40	40	41	42	43
	0.8	2.8	45	43	42	41	40	40	40	40	40	41	43
	1.0	3	43	42	41	40	39	39	39	39	40	41	42

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
Description: Illinois No. 6 Seam
Circuit: Individual Microcel

Actual:		
Name	Collector (lb/ton)	Frother (ml/min)
Minimum	1	1
Maximum	3	3
Center	2	2
Range	2	2
Coded:		
Name	X1	X2
Minimum	-1	-1
Maximum	1	1
Center	0	0
Range	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	54.7
X1	COE1	-0.16
X2	COE2	-3.08
X1*X1	COE11	-2.38
X2*X2	COE22	3.15
X1*X2	COE12	2.85

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual Microcel

		X2	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
	X1		1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3
	-1.0	1	62	59	57	55	54	52	51	51	50	50	50
	-0.8	1.2	62	60	58	56	55	53	52	52	51	51	51
	-0.6	1.4	62	60	58	56	55	54	53	53	52	52	52
	-0.4	1.6	62	60	58	57	55	54	54	53	53	53	53
	-0.2	1.8	61	60	58	57	55	55	54	54	54	54	54
	0.0	2	61	59	58	56	55	55	54	54	54	54	55
	0.2	2.2	60	59	57	56	55	55	54	54	54	55	55
	0.4	2.4	59	58	57	56	55	54	54	54	54	55	55
	0.6	2.6	58	57	56	55	54	54	54	54	54	55	56
	0.8	2.8	57	56	55	54	53	53	53	53	54	54	55
	1.0	3	56	54	53	53	52	52	52	53	53	54	55

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
Description: Illinois No. 6 Seam
Circuit: Individual Microcel

Actual:		
Name	Collector (lb/ton)	Frother (ml/min)
Minimum	1	1
Maximum	3	3
Center	2	2
Range	2	2
Coded:		
Name	X1	X2
Minimum	-1	-1
Maximum	1	1
Center	0	0
Range	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	67.856
X1	COE1	0.44
X2	COE2	-1.245
X1*X1	COE11	1.327
X2*X2	COE22	1.562
X1*X2	COE12	0.488

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual Microcel

		X2	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
	X1		1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3
	-1.0	1	72	71	70	70	69	69	68	68	68	68	69
	-0.8	1.2	72	71	70	69	69	68	68	68	68	68	68
	-0.6	1.4	71	70	70	69	68	68	68	68	68	68	68
	-0.4	1.6	71	70	69	69	68	68	68	68	68	68	68
	-0.2	1.8	71	70	69	69	68	68	68	68	68	68	68
	0.0	2	71	70	69	69	68	68	68	68	68	68	68
	0.2	2.2	71	70	69	69	68	68	68	68	68	68	68
	0.4	2.4	71	70	69	69	69	68	68	68	68	68	69
	0.6	2.6	71	70	70	69	69	69	68	68	69	69	69
	0.8	2.8	71	71	70	70	69	69	69	69	69	69	70
	1.0	3	72	71	71	70	70	70	70	70	70	70	70

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
Description: Illinois No. 6 Seam
Circuit: Individual Microcel

Actual:		
Name	Collector (lb/ton)	Frother (ml/min)
Minimum	1	1
Maximum	3	3
Center	2	2
Range	2	2
Coded:		
Name	X1	X2
Minimum	-1	-1
Maximum	1	1
Center	0	0
Range	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	6.211
X1	COE1	0.095
X2	COE2	0.052
X1*X1	COE11	-0.322
X2*X2	COE22	-0.032
X1*X2	COE12	0.163

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
Description: Illinois No. 6 Seam
Circuit: Individual Microcel

		X2	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
	X1		1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8	3
	-1.0	1	5.9	5.9	5.8	5.8	5.8	5.8	5.8	5.7	5.7	5.7	5.7
	-0.8	1.2	6.0	6.0	6.0	6.0	5.9	5.9	5.9	5.9	5.9	5.8	5.8
	-0.6	1.4	6.1	6.1	6.1	6.1	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	-0.4	1.6	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
	-0.2	1.8	6.1	6.1	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
	0.0	2	6.1	6.1	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
	0.2	2.2	6.1	6.1	6.2	6.2	6.2	6.2	6.2	6.2	6.3	6.3	6.3
	0.4	2.4	6.0	6.1	6.1	6.1	6.2	6.2	6.2	6.2	6.3	6.3	6.3
	0.6	2.6	6.0	6.0	6.1	6.1	6.1	6.2	6.2	6.2	6.2	6.3	6.3
	0.8	2.8	5.9	5.9	6.0	6.0	6.0	6.1	6.1	6.1	6.2	6.2	6.2
	1.0	3	5.7	5.8	5.8	5.9	5.9	6.0	6.0	6.1	6.1	6.1	6.2

APPENDIX 4-C

Response Surface Plots and Computations

Independent MGS Tests
Pittsburgh No. 8 Seam Coal

Pittsburgh No. 8 Seam
Individual MGS (Fine Grind)

Pittsburgh No. 8 Seam
Individual MGS (Coarse Grind)

Pittsburgh No. 8 Seam
Individual MGS (Intermediate Grind)

Pittsburgh No. 8 Seam
Individual MGS (Fine Grind)

Pittsburgh No. 8 Seam
Individual MGS (Intermediate Grind)

Pittsburgh No. 8 Seam
Individual MGS (Intermediate Grind)

Pittsburgh No. 8 Seam
Individual MGS (Intermediate Grind)

Pittsburgh No. 8 Seam
Individual MGS (Coarse Grind)

Pittsburgh No. 8 Seam
Individual MGS (Fine Grind)

Pittsburgh No. 8 Seam
Individual MGS (Coarse Grind)

Pittsburgh No. 8 Seam
Individual MGS (Intermediate Grind)

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	96.39
X1	COE1	-3.15
X2	COE2	-1.84
X3	COE3	1.3
X4	COE4	-1.93
X1*X1	COE11	-0.82
X2*X2	COE22	-0.73
X3*X3	COE33	-1.12
X4*X4	COE44	-0.26
X1*X2	COE12	-3.37
X1*X3	COE13	2.23
X1*X4	COE14	-1.39
X2*X3	COE23	0.79
X2*X4	COE24	-1.46
X3*X4	COE34	0.14

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	100	100	100	99	99	99	98	98	97	97	96
-1	-0.8	248	99	99	98	98	98	97	97	96	96	95	94
-1	-0.6	256	98	98	97	97	96	96	95	94	94	93	93
-1	-0.4	264	97	96	96	95	95	94	93	93	92	91	91
-1	-0.2	272	95	95	94	94	93	92	92	91	90	90	89
-1	0.0	280	94	93	93	92	91	91	90	89	88	88	87
-1	0.2	288	92	92	91	90	90	89	88	87	86	86	85
-1	0.4	296	91	90	89	89	88	87	86	85	84	84	83
-1	0.6	304	89	88	88	87	86	85	84	83	82	81	80
-1	0.8	312	87	87	86	85	84	83	82	81	80	79	78
-1	1.0	320	86	85	84	83	82	81	80	79	78	77	76

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	99	99	99	99	98	98	98	98	98
0	-0.8	248	98	98	98	98	98	98	98	97	97	97	97
0	-0.6	256	98	98	98	97	97	97	97	96	96	96	95
0	-0.4	264	97	97	97	97	96	96	96	95	95	95	94
0	-0.2	272	97	96	96	96	95	95	95	94	94	93	93
0	0.0	280	96	95	95	95	94	94	94	93	93	92	92
0	0.2	288	95	95	94	94	93	93	92	92	91	91	90
0	0.4	296	94	94	93	93	92	92	91	91	90	89	89
0	0.6	304	93	93	92	92	91	90	90	89	89	88	87
0	0.8	312	92	92	91	90	90	89	88	88	87	86	86
0	1.0	320	91	90	90	89	88	88	87	86	86	85	84

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	96	96	96	97	97	97	97	97	97	98	98
-1	-0.8	248	96	96	97	97	97	97	97	97	97	97	97
-1	-0.6	256	96	96	97	97	97	97	97	97	97	97	97
-1	-0.4	264	96	96	96	97	97	97	97	96	96	96	96
-1	-0.2	272	96	96	96	96	96	96	96	96	96	96	96
-1	0.0	280	96	96	96	96	96	96	96	96	95	95	95
-1	0.2	288	96	96	96	96	96	95	95	95	95	95	94
-1	0.4	296	96	96	96	95	95	95	95	94	94	94	94
-1	0.6	304	96	95	95	95	95	94	94	94	93	93	93
-1	0.8	312	95	95	95	94	94	94	93	93	93	92	92
-1	1.0	320	95	94	94	94	93	93	93	92	92	91	91

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	101	101	101	100	100	100	99	99	98	98	97
1	-0.8	248	101	100	100	99	99	99	98	98	97	97	96
1	-0.6	256	100	99	99	98	98	97	97	96	96	95	95
1	-0.4	264	99	98	98	97	97	96	96	95	95	94	93
1	-0.2	272	98	97	97	96	96	95	94	94	93	92	92
1	0.0	280	97	96	96	95	94	94	93	92	92	91	90
1	0.2	288	96	95	95	94	93	92	92	91	90	89	89
1	0.4	296	95	94	93	93	92	91	90	89	89	88	87
1	0.6	304	94	93	92	91	90	90	89	88	87	86	85
1	0.8	312	92	92	91	90	89	88	87	86	85	84	83
1	1.0	320	91	90	89	88	87	86	86	85	84	82	81

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	99	99	99	99	99	98	98	98	98
0	-0.8	248	99	99	99	99	99	98	98	98	98	98	97
0	-0.6	256	99	99	99	98	98	98	98	98	97	97	97
0	-0.4	264	99	98	98	98	98	98	97	97	97	96	96
0	-0.2	272	98	98	98	98	97	97	97	96	96	95	95
0	0.0	280	98	98	97	97	97	96	96	96	95	95	94
0	0.2	288	98	97	97	97	96	96	95	95	94	94	93
0	0.4	296	97	97	96	96	95	95	94	94	93	93	92
0	0.6	304	97	96	96	95	95	94	94	93	92	92	91
0	0.8	312	96	96	95	95	94	93	93	92	91	91	90
0	1.0	320	95	95	94	94	93	92	92	91	90	90	89

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	95	96	96	96	96	96	97	97	97	97	97
-1	-0.8	248	96	96	96	97	97	97	97	97	97	97	97
-1	-0.6	256	96	97	97	97	97	97	97	97	97	97	97
-1	-0.4	264	97	97	97	97	97	97	97	97	97	97	97
-1	-0.2	272	97	97	97	97	97	97	97	97	97	97	97
-1	0.0	280	98	98	98	98	98	98	97	97	97	97	97
-1	0.2	288	98	98	98	98	98	98	97	97	97	97	97
-1	0.4	296	98	98	98	98	98	97	97	97	97	96	96
-1	0.6	304	98	98	98	98	98	97	97	97	96	96	96
-1	0.8	312	98	98	98	98	97	97	97	96	96	96	95
-1	1.0	320	99	98	98	98	97	97	97	96	96	95	95

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	100	100	99	99	99	98	98	97	97	97	96
1	-0.8	248	100	99	99	99	98	98	97	97	96	96	95
1	-0.6	256	99	99	98	98	98	97	97	96	96	95	94
1	-0.4	264	99	98	98	97	97	96	96	95	95	94	93
1	-0.2	272	98	98	97	97	96	96	95	94	94	93	92
1	0.0	280	98	97	97	96	95	95	94	93	93	92	91
1	0.2	288	97	97	96	95	95	94	93	92	92	91	90
1	0.4	296	96	96	95	94	94	93	92	91	91	90	89
1	0.6	304	96	95	94	94	93	92	91	90	89	88	88
1	0.8	312	95	94	93	93	92	91	90	89	88	87	86
1	1.0	320	94	93	92	91	91	90	89	88	87	86	85

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	97	97	97	97	97	97	97	96	96	96	96
0	-0.8	248	97	97	97	97	97	97	97	96	96	96	96
0	-0.6	256	98	97	97	97	97	97	97	96	96	96	96
0	-0.4	264	98	98	97	97	97	97	97	96	96	96	95
0	-0.2	272	98	98	98	97	97	97	96	96	96	95	95
0	0.0	280	98	98	98	97	97	97	96	96	95	95	95
0	0.2	288	98	98	98	97	97	96	96	95	95	95	94
0	0.4	296	98	98	97	97	97	96	96	95	95	94	93
0	0.6	304	98	98	97	97	96	96	95	95	94	93	93
0	0.8	312	98	97	97	96	96	95	95	94	93	93	92
0	1.0	320	98	97	97	96	95	95	94	94	93	92	91

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	92	93	93	93	93	94	94	94	94	94	94
-1	-0.8	248	93	94	94	94	94	94	95	95	95	95	95
-1	-0.6	256	94	95	95	95	95	95	95	95	95	95	95
-1	-0.4	264	95	95	96	96	96	96	96	96	96	96	96
-1	-0.2	272	96	96	96	96	96	96	96	96	96	96	96
-1	0.0	280	97	97	97	97	97	97	97	97	97	96	96
-1	0.2	288	98	98	98	98	97	97	97	97	97	97	96
-1	0.4	296	98	98	98	98	98	98	98	97	97	97	97
-1	0.6	304	99	99	99	98	98	98	98	98	97	97	97
-1	0.8	312	100	99	99	99	99	98	98	98	97	97	97
-1	1.0	320	100	100	99	99	99	99	98	98	97	97	97

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	94.9
X1	COE1	-5.24
X2	COE2	-3.05
X3	COE3	1.45
X4	COE4	-1.24
X1*X1	COE11	-0.82
X2*X2	COE22	-0.73
X3*X3	COE33	-1.12
X4*X4	COE44	-0.26
X1*X2	COE12	-3.37
X1*X3	COE13	2.23
X1*X4	COE14	-1.39
X2*X3	COE23	0.79
X2*X4	COE24	-1.46
X3*X4	COE34	0.14

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	99	99	99	98	98	98	97	97	97	96	96
1	-0.8	248	97	97	97	97	96	96	96	95	95	94	94
1	-0.6	256	96	95	95	95	94	94	94	93	93	92	92
1	-0.4	264	94	94	93	93	92	92	91	91	91	90	89
1	-0.2	272	92	92	91	91	90	90	89	89	88	88	87
1	0.0	280	90	90	89	89	88	88	87	87	86	85	85
1	0.2	288	88	88	87	87	86	86	85	84	84	83	82
1	0.4	296	86	86	85	85	84	83	83	82	81	80	80
1	0.6	304	84	84	83	82	82	81	80	79	79	78	77
1	0.8	312	82	82	81	80	79	79	78	77	76	75	74
1	1.0	320	80	79	79	78	77	76	75	74	73	73	72

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	99	99	99	99	99	99	99	99	99
0	-0.8	248	98	98	98	98	98	98	98	98	98	97	97
0	-0.6	256	97	97	97	97	97	97	96	96	96	96	96
0	-0.4	264	96	96	96	95	95	95	95	95	95	94	94
0	-0.2	272	95	95	94	94	94	94	94	93	93	93	92
0	0.0	280	93	93	93	93	93	92	92	92	91	91	91
0	0.2	288	92	92	92	91	91	91	90	90	90	89	89
0	0.4	296	91	91	90	90	90	89	89	88	88	87	87
0	0.6	304	90	89	89	88	88	88	87	87	86	86	85
0	0.8	312	88	88	87	87	86	86	85	85	84	84	83
0	1.0	320	87	86	86	85	85	84	83	83	82	82	81

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	97	97	98	98	98	99	99	99	100	100	100
-1	-0.8	248	97	97	97	98	98	98	98	99	99	99	99
-1	-0.6	256	96	97	97	97	97	98	98	98	98	98	98
-1	-0.4	264	96	96	96	97	97	97	97	97	97	97	97
-1	-0.2	272	96	96	96	96	96	96	96	96	96	96	96
-1	0.0	280	95	95	95	95	95	95	95	95	95	95	95
-1	0.2	288	95	95	95	95	95	95	95	94	94	94	94
-1	0.4	296	94	94	94	94	94	94	94	93	93	93	93
-1	0.6	304	93	93	93	93	93	93	93	92	92	92	92
-1	0.8	312	92	92	92	92	92	92	91	91	91	91	90
-1	1.0	320	92	91	91	91	91	91	90	90	90	89	89

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	100	100	100	99	99	99	99	98	98	98	97
1	-0.8	248	99	99	98	98	98	97	97	97	96	96	96
1	-0.6	256	98	97	97	97	96	96	96	95	95	94	94
1	-0.4	264	96	96	96	95	95	94	94	94	93	93	92
1	-0.2	272	95	95	94	94	93	93	92	92	91	91	90
1	0.0	280	94	93	93	92	92	91	91	90	89	89	88
1	0.2	288	92	92	91	91	90	89	89	88	87	87	86
1	0.4	296	91	90	89	89	88	88	87	86	85	85	84
1	0.6	304	89	88	88	87	86	86	85	84	83	83	82
1	0.8	312	87	87	86	85	84	84	83	82	81	80	80
1	1.0	320	86	85	84	83	82	82	81	80	79	78	77

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	99	99	99	99	99	99	99	99	99
0	-0.8	248	98	99	99	99	99	99	99	98	98	98	98
0	-0.6	256	98	98	98	98	98	98	98	98	97	97	97
0	-0.4	264	97	97	97	97	97	97	97	97	96	96	96
0	-0.2	272	97	97	96	96	96	96	96	95	95	95	95
0	0.0	280	96	96	96	95	95	95	95	94	94	94	93
0	0.2	288	95	95	95	94	94	94	94	93	93	92	92
0	0.4	296	94	94	94	93	93	93	92	92	92	91	91
0	0.6	304	93	93	93	92	92	91	91	91	90	90	89
0	0.8	312	92	92	92	91	91	90	90	89	89	88	88
0	1.0	320	91	91	90	90	89	89	88	88	87	87	86

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	96	97	97	98	98	98	99	99	99	99	100
-1	-0.8	248	97	97	97	98	98	98	98	99	99	99	99
-1	-0.6	256	97	97	97	98	98	98	98	98	99	99	99
-1	-0.4	264	97	97	97	97	98	98	98	98	98	98	98
-1	-0.2	272	97	97	97	97	97	98	98	98	98	98	98
-1	0.0	280	97	97	97	97	97	97	97	97	97	97	97
-1	0.2	288	97	97	97	97	97	97	97	97	97	97	96
-1	0.4	296	96	96	96	96	96	96	96	96	96	96	96
-1	0.6	304	96	96	96	96	96	96	96	96	95	95	95
-1	0.8	312	96	96	96	96	95	95	95	95	95	94	94
-1	1.0	320	95	95	95	95	95	95	94	94	94	93	93

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	99	99	98	98	98	98	98	97	97	97	96
1	-0.8	248	98	98	98	97	97	97	97	96	96	95	95
1	-0.6	256	97	97	97	96	96	96	95	95	95	94	94
1	-0.4	264	96	96	96	95	95	95	94	94	93	93	92
1	-0.2	272	96	95	95	94	94	93	93	93	92	91	91
1	0.0	280	95	94	94	93	93	92	92	91	91	90	89
1	0.2	288	94	93	93	92	91	91	90	90	89	88	88
1	0.4	296	92	92	91	91	90	90	89	88	88	87	86
1	0.6	304	91	91	90	89	89	88	87	87	86	85	84
1	0.8	312	90	89	89	88	87	87	86	85	84	84	83
1	1.0	320	89	88	87	87	86	85	84	83	83	82	81

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	97	97	97	97	97	97	97	97	98	97	97
0	-0.8	248	97	97	97	97	97	97	97	97	97	97	97
0	-0.6	256	97	97	97	97	97	97	97	97	96	96	96
0	-0.4	264	97	97	97	96	96	96	96	96	96	96	95
0	-0.2	272	96	96	96	96	96	96	96	95	95	95	95
0	0.0	280	96	96	96	96	95	95	95	95	94	94	94
0	0.2	288	96	96	95	95	95	95	94	94	94	93	93
0	0.4	296	95	95	95	95	94	94	94	93	93	92	92
0	0.6	304	95	95	94	94	94	93	93	92	92	91	91
0	0.8	312	94	94	94	93	93	92	92	91	91	90	90
0	1.0	320	94	93	93	92	92	91	91	90	90	89	89

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	94	94	94	95	95	96	96	96	97	97	97
-1	-0.8	248	94	95	95	95	96	96	96	96	97	97	97
-1	-0.6	256	95	95	95	96	96	96	96	97	97	97	97
-1	-0.4	264	95	96	96	96	96	96	97	97	97	97	97
-1	-0.2	272	96	96	96	96	97	97	97	97	97	97	97
-1	0.0	280	96	96	96	97	97	97	97	97	97	97	97
-1	0.2	288	96	97	97	97	97	97	97	97	97	97	97
-1	0.4	296	97	97	97	97	97	97	97	97	97	96	96
-1	0.6	304	97	97	97	97	97	97	97	96	96	96	96
-1	0.8	312	97	97	97	97	97	97	96	96	96	96	96
-1	1.0	320	97	97	97	97	96	96	96	96	96	95	95

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	93.41
X1	COE1	-7.33
X2	COE2	-4.26
X3	COE3	1.6
X4	COE4	-0.55
X1*X1	COE11	-0.82
X2*X2	COE22	-0.73
X3*X3	COE33	-1.12
X4*X4	COE44	-0.26
X1*X2	COE12	-3.37
X1*X3	COE13	2.23
X1*X4	COE14	-1.39
X2*X3	COE23	0.79
X2*X4	COE24	-1.46
X3*X4	COE34	0.14

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	98	97	97	97	97	97	97	97	96	96	96
1	-0.8	248	96	95	95	95	95	95	95	94	94	94	93
1	-0.6	256	93	93	93	93	93	92	92	92	91	91	91
1	-0.4	264	91	91	91	91	90	90	90	89	89	89	88
1	-0.2	272	89	89	88	88	88	87	87	87	86	86	85
1	0.0	280	87	86	86	86	85	85	84	84	84	83	83
1	0.2	288	84	84	84	83	83	82	82	81	81	80	80
1	0.4	296	82	82	81	81	80	80	79	78	78	77	77
1	0.6	304	80	79	79	78	77	77	76	76	75	74	74
1	0.8	312	77	76	76	75	75	74	73	73	72	71	71
1	1.0	320	74	74	73	73	72	71	70	70	69	68	67

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	98	99	99	99	99	99	100	100	100	100	100
0	-0.8	248	97	97	97	98	98	98	98	98	98	98	98
0	-0.6	256	96	96	96	96	96	96	96	96	96	96	96
0	-0.4	264	94	94	94	94	94	94	94	94	94	94	94
0	-0.2	272	93	93	93	93	93	93	92	92	92	92	92
0	0.0	280	91	91	91	91	91	91	91	90	90	90	90
0	0.2	288	89	89	89	89	89	89	89	88	88	88	88
0	0.4	296	88	88	87	87	87	87	86	86	86	86	85
0	0.6	304	86	86	85	85	85	85	84	84	84	83	83
0	0.8	312	84	84	84	83	83	83	82	82	81	81	80
0	1.0	320	82	82	81	81	81	80	80	79	79	78	78

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	98	98	99	99	100	100	101	101	102	102	102
-1	-0.8	248	97	98	98	99	99	99	100	100	100	101	101
-1	-0.6	256	97	97	97	98	98	98	99	99	99	100	100
-1	-0.4	264	96	96	96	97	97	97	98	98	98	98	98
-1	-0.2	272	95	95	95	96	96	96	96	97	97	97	97
-1	0.0	280	94	94	94	95	95	95	95	95	95	95	96
-1	0.2	288	93	93	93	94	94	94	94	94	94	94	94
-1	0.4	296	92	92	92	92	92	92	92	92	92	92	92
-1	0.6	304	91	91	91	91	91	91	91	91	91	91	91
-1	0.8	312	90	90	90	90	90	90	89	89	89	89	89
-1	1.0	320	88	88	88	88	88	88	88	88	88	87	87

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	99	99	99	99	98	98	98	98	98	98	97
1	-0.8	248	97	97	97	97	97	96	96	96	96	96	95
1	-0.6	256	95	95	95	95	95	95	94	94	94	93	93
1	-0.4	264	94	94	94	93	93	93	92	92	92	91	91
1	-0.2	272	92	92	91	91	91	91	90	90	89	89	89
1	0.0	280	90	90	90	89	89	88	88	88	87	87	86
1	0.2	288	88	88	88	87	87	86	86	85	85	84	84
1	0.4	296	86	86	85	85	85	84	83	83	82	82	81
1	0.6	304	84	84	83	83	82	82	81	81	80	79	79
1	0.8	312	82	82	81	81	80	79	79	78	77	77	76
1	1.0	320	80	79	79	78	78	77	76	75	75	74	73

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	99	100	100	100	100	100	100	100	101
0	-0.8	248	98	98	98	98	99	99	99	99	99	99	99
0	-0.6	256	97	97	97	97	97	98	98	98	98	98	98
0	-0.4	264	96	96	96	96	96	96	96	96	96	96	96
0	-0.2	272	95	95	95	95	95	95	95	95	95	94	94
0	0.0	280	94	94	94	94	94	93	93	93	93	93	93
0	0.2	288	92	92	92	92	92	92	92	92	91	91	91
0	0.4	296	91	91	91	91	91	90	90	90	90	89	89
0	0.6	304	90	90	89	89	89	89	88	88	88	87	87
0	0.8	312	88	88	88	88	87	87	87	86	86	86	85
0	1.0	320	87	87	86	86	86	85	85	84	84	84	83

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	98	98	99	99	100	100	101	101	101	102	102
-1	-0.8	248	97	98	98	99	99	100	100	100	101	101	101
-1	-0.6	256	97	97	98	98	99	99	100	100	100	100	101
-1	-0.4	264	97	97	97	98	98	98	99	99	99	99	100
-1	-0.2	272	96	97	97	97	97	98	98	98	98	98	99
-1	0.0	280	96	96	96	97	97	97	97	97	97	98	98
-1	0.2	288	95	95	96	96	96	96	96	96	96	96	96
-1	0.4	296	95	95	95	95	95	95	95	95	95	95	95
-1	0.6	304	94	94	94	94	94	94	94	94	94	94	94
-1	0.8	312	93	93	93	93	93	93	93	93	93	93	93
-1	1.0	320	92	92	92	92	92	92	92	92	92	92	91

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	98	98	98	97	97	97	97	97	97	97	97
1	-0.8	248	96	96	96	96	96	96	96	96	95	95	95
1	-0.6	256	95	95	95	95	95	94	94	94	94	93	93
1	-0.4	264	94	94	94	93	93	93	93	92	92	92	91
1	-0.2	272	93	92	92	92	92	91	91	91	90	90	89
1	0.0	280	91	91	91	90	90	90	89	89	88	88	88
1	0.2	288	90	90	89	89	88	88	88	87	87	86	86
1	0.4	296	88	88	88	87	87	86	86	85	85	84	83
1	0.6	304	87	86	86	85	85	84	84	83	83	82	81
1	0.8	312	85	85	84	84	83	82	82	81	81	80	79
1	1.0	320	83	83	82	82	81	80	80	79	78	78	77

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	97	97	97	98	98	98	98	99	99	99	99
0	-0.8	248	96	97	97	97	97	97	98	98	98	98	98
0	-0.6	256	96	96	96	96	97	97	97	97	97	97	97
0	-0.4	264	95	96	96	96	96	96	96	96	96	96	96
0	-0.2	272	95	95	95	95	95	95	95	95	95	95	94
0	0.0	280	94	94	94	94	94	94	94	94	94	93	93
0	0.2	288	93	93	93	93	93	93	93	93	92	92	92
0	0.4	296	92	92	92	92	92	92	92	91	91	91	90
0	0.6	304	92	91	91	91	91	91	90	90	90	89	89
0	0.8	312	91	90	90	90	90	89	89	89	88	88	88
0	1.0	320	90	89	89	89	88	88	88	87	87	86	86

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	95	95	96	97	97	98	98	98	99	99	100
-1	-0.8	248	95	96	96	97	97	97	98	98	99	99	99
-1	-0.6	256	95	96	96	97	97	97	98	98	98	99	99
-1	-0.4	264	95	96	96	97	97	97	98	98	98	98	99
-1	-0.2	272	95	96	96	96	97	97	97	97	98	98	98
-1	0.0	280	95	96	96	96	96	97	97	97	97	97	97
-1	0.2	288	95	95	96	96	96	96	96	97	97	97	97
-1	0.4	296	95	95	95	96	96	96	96	96	96	96	96
-1	0.6	304	95	95	95	95	95	95	95	95	95	95	95
-1	0.8	312	95	95	95	95	95	95	95	95	95	95	94
-1	1.0	320	94	94	94	94	94	94	94	94	94	94	93

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	97.2
X1	COE1	-2.87
X2	COE2	-1.66
X3	COE3	1.23
X4	COE4	-1.97
X1*X1	COE11	-0.98
X2*X2	COE22	-0.76
X3*X3	COE33	-1.05
X4*X4	COE44	-0.15
X1*X2	COE12	-3.32
X1*X3	COE13	2.2
X1*X4	COE14	-1.51
X2*X3	COE23	0.85
X2*X4	COE24	-1.25
X3*X4	COE34	0.17

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	101	100	100	100	99	99	99	98	98	97	97
1	-0.8	248	100	99	99	99	98	98	97	97	96	96	95
1	-0.6	256	99	98	98	97	97	96	96	95	95	94	94
1	-0.4	264	97	97	96	96	95	95	94	94	93	93	92
1	-0.2	272	96	96	95	95	94	93	93	92	91	91	90
1	0.0	280	95	94	94	93	92	92	91	90	90	89	88
1	0.2	288	93	93	92	91	91	90	89	88	88	87	86
1	0.4	296	92	91	90	90	89	88	87	87	86	85	84
1	0.6	304	90	90	89	88	87	86	85	85	84	83	82
1	0.8	312	89	88	87	86	85	84	83	82	81	81	80
1	1.0	320	87	86	85	84	83	82	81	80	79	78	77

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	99	99	99	99	99	99	99	98	98
0	-0.8	248	99	99	99	99	99	98	98	98	98	98	97
0	-0.6	256	99	99	98	98	98	98	97	97	97	97	96
0	-0.4	264	98	98	98	97	97	96	96	96	95	95	95
0	-0.2	272	98	97	97	97	96	96	96	95	95	94	94
0	0.0	280	97	97	96	96	95	95	94	94	94	93	93
0	0.2	288	96	96	95	95	94	94	93	93	92	92	91
0	0.4	296	95	95	94	94	93	93	92	92	91	90	90
0	0.6	304	94	94	93	93	92	92	91	90	90	89	88
0	0.8	312	93	93	92	92	91	90	90	89	88	87	87
0	1.0	320	92	92	91	90	90	89	88	87	87	86	85

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	97	97	97	97	97	97	98	98	98	98	98
-1	-0.8	248	97	97	97	97	97	97	98	98	98	98	98
-1	-0.6	256	97	97	97	97	97	97	97	97	97	97	97
-1	-0.4	264	97	97	97	97	97	97	97	97	97	97	97
-1	-0.2	272	97	97	97	97	97	97	97	97	97	96	96
-1	0.0	280	97	97	97	97	97	97	96	96	96	96	96
-1	0.2	288	97	97	97	97	97	96	96	96	95	95	95
-1	0.4	296	97	97	97	96	96	96	96	95	95	95	94
-1	0.6	304	97	97	96	96	96	95	95	95	94	94	93
-1	0.8	312	97	96	96	95	95	95	94	94	93	93	92
-1	1.0	320	96	96	95	95	94	94	93	93	92	92	91

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	102	101	101	101	100	100	100	99	99	99	98
1	-0.8	248	101	101	100	100	100	99	99	98	98	97	97
1	-0.6	256	100	100	99	99	99	98	98	97	97	96	96
1	-0.4	264	100	99	99	98	98	97	97	96	95	95	94
1	-0.2	272	99	98	98	97	97	96	95	95	94	94	93
1	0.0	280	98	97	97	96	95	95	94	93	93	92	91
1	0.2	288	97	96	96	95	94	94	93	92	91	91	90
1	0.4	296	96	95	94	94	93	92	91	91	90	89	88
1	0.6	304	95	94	93	92	92	91	90	89	88	87	86
1	0.8	312	93	93	92	91	90	89	88	87	86	86	85
1	1.0	320	92	91	90	89	89	88	87	86	85	84	83

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	99	99	99	99	99	99	99	99	98
0	-0.8	248	99	99	99	99	99	99	99	99	98	98	98
0	-0.6	256	99	99	99	99	99	99	98	98	98	98	97
0	-0.4	264	99	99	99	99	98	98	98	98	97	97	97
0	-0.2	272	99	99	99	98	98	98	97	97	97	96	96
0	0.0	280	99	99	98	98	98	97	97	96	96	96	95
0	0.2	288	99	98	98	97	97	97	96	96	95	95	94
0	0.4	296	98	98	97	97	96	96	95	95	94	94	93
0	0.6	304	98	97	97	96	96	95	95	94	93	93	92
0	0.8	312	97	97	96	96	95	94	94	93	92	92	91
0	1.0	320	97	96	95	95	94	93	93	92	91	90	90

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	96	96	96	96	97	97	97	97	97	97	97
-1	-0.8	248	96	97	97	97	97	97	97	97	97	97	97
-1	-0.6	256	97	97	97	97	97	97	98	98	98	98	98
-1	-0.4	264	98	98	98	98	98	98	98	98	98	98	97
-1	-0.2	272	98	98	98	98	98	98	98	98	98	98	97
-1	0.0	280	99	99	98	98	98	98	98	98	98	97	97
-1	0.2	288	99	99	99	99	98	98	98	98	97	97	97
-1	0.4	296	99	99	99	99	98	98	98	98	97	97	97
-1	0.6	304	99	99	99	99	98	98	98	97	97	97	96
-1	0.8	312	100	99	99	99	98	98	97	97	97	96	96
-1	1.0	320	100	99	99	98	98	98	97	97	96	96	95

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	100	100	100	99	99	99	99	98	98	97	97
1	-0.8	248	100	100	99	99	99	98	98	98	97	97	96
1	-0.6	256	100	99	99	99	98	98	97	97	97	96	96
1	-0.4	264	100	99	99	98	98	97	97	96	96	95	95
1	-0.2	272	99	99	98	98	97	97	96	95	95	94	94
1	0.0	280	99	98	98	97	96	96	95	95	94	93	93
1	0.2	288	98	98	97	96	96	95	94	94	93	92	91
1	0.4	296	98	97	96	95	95	94	93	93	92	91	90
1	0.6	304	97	96	95	95	94	93	92	91	91	90	89
1	0.8	312	96	95	94	94	93	92	91	90	89	88	88
1	1.0	320	95	94	94	93	92	91	90	89	88	87	86

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	97	97	97	97	97	97	97	97	97	97	97
0	-0.8	248	98	98	98	98	97	97	97	97	97	97	97
0	-0.6	256	98	98	98	98	98	97	97	97	97	97	96
0	-0.4	264	99	98	98	98	98	97	97	97	97	96	96
0	-0.2	272	99	99	98	98	98	97	97	97	97	96	96
0	0.0	280	99	99	98	98	98	97	97	97	96	96	95
0	0.2	288	99	99	98	98	98	97	97	96	96	95	95
0	0.4	296	99	99	98	98	97	97	96	96	95	95	94
0	0.6	304	99	99	98	98	97	97	96	96	95	94	94
0	0.8	312	99	99	98	97	97	96	96	95	94	94	93
0	1.0	320	99	98	98	97	96	96	95	94	94	93	92

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	93	93	93	93	94	94	94	94	94	94	95
-1	-0.8	248	94	94	94	94	95	95	95	95	95	95	95
-1	-0.6	256	95	95	95	95	95	95	96	96	96	96	96
-1	-0.4	264	96	96	96	96	96	96	96	96	96	96	96
-1	-0.2	272	97	97	97	97	97	97	97	97	97	97	96
-1	0.0	280	98	98	98	98	98	97	97	97	97	97	97
-1	0.2	288	99	99	98	98	98	98	98	98	97	97	97
-1	0.4	296	99	99	99	99	99	98	98	98	98	97	97
-1	0.6	304	100	100	99	99	99	99	98	98	98	97	97
-1	0.8	312	101	100	100	100	99	99	99	98	98	97	97
-1	1.0	320	101	101	100	100	100	99	99	98	98	97	97

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	95.69
X1	COE1	-4.91
X2	COE2	-2.85
X3	COE3	1.4
X4	COE4	-1.37
X1*X1	COE11	-0.98
X2*X2	COE22	-0.76
X3*X3	COE33	-1.05
X4*X4	COE44	-0.15
X1*X2	COE12	-3.32
X1*X3	COE13	2.2
X1*X4	COE14	-1.51
X2*X3	COE23	0.85
X2*X4	COE24	-1.25
X3*X4	COE34	0.17

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	99	99	99	99	98	98	98	98	97	97	97
1	-0.8	248	98	98	97	97	97	96	96	96	95	95	95
1	-0.6	256	96	96	96	95	95	95	94	94	94	93	93
1	-0.4	264	95	94	94	94	93	93	92	92	91	91	90
1	-0.2	272	93	93	92	92	91	91	90	90	89	89	88
1	0.0	280	91	91	90	90	89	89	88	88	87	86	86
1	0.2	288	90	89	88	88	87	87	86	85	85	84	83
1	0.4	296	88	87	86	86	85	84	84	83	82	82	81
1	0.6	304	86	85	84	84	83	82	81	81	80	79	78
1	0.8	312	84	83	82	81	81	80	79	78	77	77	76
1	1.0	320	82	81	80	79	78	77	77	76	75	74	73

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	99	99	99	99	99	99	99	99	99
0	-0.8	248	98	98	98	98	98	98	98	98	98	98	98
0	-0.6	256	98	98	97	97	97	97	97	97	97	97	96
0	-0.4	264	97	97	96	96	96	96	96	96	95	95	95
0	-0.2	272	96	96	95	95	95	95	94	94	94	94	93
0	0.0	280	95	94	94	94	94	93	93	93	92	92	92
0	0.2	288	93	93	93	92	92	92	91	91	91	90	90
0	0.4	296	92	92	91	91	91	90	90	89	89	88	88
0	0.6	304	91	90	90	90	89	89	88	88	87	87	86
0	0.8	312	90	89	89	88	87	87	86	86	85	85	84
0	1.0	320	88	87	87	86	86	85	85	84	83	83	82

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	98	98	98	98	99	99	99	99	100	100	100
-1	-0.8	248	98	98	98	98	98	99	99	99	99	99	99
-1	-0.6	256	97	98	98	98	98	98	98	98	98	98	99
-1	-0.4	264	97	97	97	97	97	98	98	98	98	98	98
-1	-0.2	272	97	97	97	97	97	97	97	97	97	97	97
-1	0.0	280	96	96	96	96	96	96	96	96	96	96	96
-1	0.2	288	96	96	96	96	95	95	95	95	95	95	95
-1	0.4	296	95	95	95	95	95	95	94	94	94	94	93
-1	0.6	304	95	94	94	94	94	94	93	93	93	93	92
-1	0.8	312	94	94	93	93	93	93	92	92	92	91	91
-1	1.0	320	93	93	92	92	92	91	91	91	90	90	89

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	100	100	100	100	100	99	99	99	99	98	98
1	-0.8	248	99	99	99	99	98	98	98	97	97	97	96
1	-0.6	256	98	98	98	97	97	97	96	96	96	95	95
1	-0.4	264	97	97	96	96	96	95	95	94	94	94	93
1	-0.2	272	96	95	95	95	94	94	93	93	92	92	91
1	0.0	280	95	94	94	93	93	92	92	91	90	90	89
1	0.2	288	93	93	92	92	91	90	90	89	89	88	87
1	0.4	296	92	91	91	90	89	89	88	87	87	86	85
1	0.6	304	90	90	89	88	87	87	86	85	85	84	83
1	0.8	312	89	88	87	86	86	85	84	83	83	82	81
1	1.0	320	87	86	85	84	84	83	82	81	80	79	79

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	99	100	100	100	100	100	100	100	100
0	-0.8	248	99	99	99	99	99	99	99	99	99	99	99
0	-0.6	256	99	99	99	98	98	98	98	98	98	98	98
0	-0.4	264	98	98	98	98	98	97	97	97	97	97	97
0	-0.2	272	98	97	97	97	97	97	96	96	96	96	95
0	0.0	280	97	97	96	96	96	96	95	95	95	94	94
0	0.2	288	96	96	96	95	95	95	94	94	94	93	93
0	0.4	296	95	95	95	94	94	94	93	93	92	92	91
0	0.6	304	95	94	94	93	93	92	92	91	91	90	90
0	0.8	312	94	93	93	92	92	91	91	90	90	89	88
0	1.0	320	93	92	91	91	90	90	89	89	88	87	87

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	97	97	98	98	98	98	99	99	99	99	100
-1	-0.8	248	97	97	98	98	98	98	99	99	99	99	99
-1	-0.6	256	97	98	98	98	98	98	99	99	99	99	99
-1	-0.4	264	98	98	98	98	98	98	98	98	98	99	99
-1	-0.2	272	98	98	98	98	98	98	98	98	98	98	98
-1	0.0	280	98	98	98	98	98	98	98	98	98	98	98
-1	0.2	288	98	98	98	98	98	97	97	97	97	97	97
-1	0.4	296	98	97	97	97	97	97	97	97	96	96	96
-1	0.6	304	97	97	97	97	97	96	96	96	96	96	95
-1	0.8	312	97	97	97	96	96	96	96	95	95	95	94
-1	1.0	320	97	96	96	96	96	95	95	95	94	94	93

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	99	99	99	99	99	98	98	98	98	97	97
1	-0.8	248	99	98	98	98	98	97	97	97	97	96	96
1	-0.6	256	98	98	97	97	97	97	96	96	96	95	95
1	-0.4	264	97	97	97	96	96	96	95	95	94	94	94
1	-0.2	272	96	96	96	95	95	94	94	94	93	93	92
1	0.0	280	96	95	95	94	94	93	93	92	92	91	91
1	0.2	288	95	94	94	93	93	92	91	91	90	90	89
1	0.4	296	94	93	92	92	91	91	90	89	89	88	88
1	0.6	304	93	92	91	91	90	89	89	88	87	87	86
1	0.8	312	91	91	90	89	89	88	87	86	86	85	84
1	1.0	320	90	89	89	88	87	86	85	85	84	83	82

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	97	97	98	98	98	98	98	98	98	98	98
0	-0.8	248	97	97	98	98	98	98	98	98	98	97	97
0	-0.6	256	97	97	97	97	97	97	97	97	97	97	97
0	-0.4	264	97	97	97	97	97	97	97	97	97	96	96
0	-0.2	272	97	97	97	97	97	97	96	96	96	96	95
0	0.0	280	97	97	97	96	96	96	96	96	95	95	95
0	0.2	288	97	97	96	96	96	95	95	95	95	94	94
0	0.4	296	96	96	96	95	95	95	94	94	94	93	93
0	0.6	304	96	96	95	95	94	94	94	93	93	92	92
0	0.8	312	96	95	95	94	94	93	93	92	92	91	91
0	1.0	320	95	94	94	93	93	92	92	91	91	90	89

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	94	94	95	95	95	96	96	96	97	97	97
-1	-0.8	248	95	95	95	96	96	96	96	97	97	97	97
-1	-0.6	256	95	96	96	96	96	97	97	97	97	97	97
-1	-0.4	264	96	96	96	97	97	97	97	97	97	97	97
-1	-0.2	272	97	97	97	97	97	97	97	97	97	97	97
-1	0.0	280	97	97	97	97	97	97	97	97	97	97	97
-1	0.2	288	97	97	97	97	97	97	97	97	97	97	97
-1	0.4	296	98	98	98	98	97	97	97	97	97	97	97
-1	0.6	304	98	98	98	98	97	97	97	97	97	97	96
-1	0.8	312	98	98	98	98	97	97	97	97	96	96	96
-1	1.0	320	98	98	98	97	97	97	97	96	96	96	95

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	94.18
X1	COE1	-6.95
X2	COE2	-4.04
X3	COE3	1.57
X4	COE4	-0.77
X1*X1	COE11	-0.98
X2*X2	COE22	-0.76
X3*X3	COE33	-1.05
X4*X4	COE44	-0.15
X1*X2	COE12	-3.32
X1*X3	COE13	2.2
X1*X4	COE14	-1.51
X2*X3	COE23	0.85
X2*X4	COE24	-1.25
X3*X4	COE34	0.17

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	98	98	98	98	98	97	97	97	97	97	97
1	-0.8	248	96	96	96	96	95	95	95	95	95	94	94
1	-0.6	256	94	94	94	94	93	93	93	93	92	92	92
1	-0.4	264	92	92	92	91	91	91	90	90	90	89	89
1	-0.2	272	90	90	89	89	89	88	88	88	87	87	86
1	0.0	280	88	88	87	87	86	86	85	85	85	84	84
1	0.2	288	86	85	85	84	84	83	83	82	82	81	81
1	0.4	296	83	83	82	82	81	81	80	80	79	78	78
1	0.6	304	81	80	80	79	79	78	77	77	76	76	75
1	0.8	312	79	78	77	77	76	75	75	74	73	72	72
1	1.0	320	76	75	75	74	73	72	72	71	70	69	69

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	99	99	100	100	100	100	100	100	100
0	-0.8	248	98	98	98	98	98	98	98	98	98	98	98
0	-0.6	256	97	97	97	97	97	97	97	97	97	97	97
0	-0.4	264	95	95	95	95	95	95	95	95	95	95	95
0	-0.2	272	94	94	94	94	93	93	93	93	93	93	93
0	0.0	280	92	92	92	92	92	92	91	91	91	91	90
0	0.2	288	91	91	90	90	90	90	89	89	89	89	88
0	0.4	296	89	89	89	88	88	88	87	87	87	86	86
0	0.6	304	87	87	87	86	86	86	85	85	85	84	84
0	0.8	312	86	85	85	84	84	84	83	83	82	82	81
0	1.0	320	84	83	83	82	81	81	80	80	79	79	79

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	99	99	99	100	100	101	101	101	102	102	102
-1	-0.8	248	98	98	98	99	99	100	100	100	101	101	101
-1	-0.6	256	97	98	98	98	99	99	99	99	100	100	100
-1	-0.4	264	97	97	97	97	98	98	98	98	98	99	99
-1	-0.2	272	96	96	96	97	97	97	97	97	97	97	97
-1	0.0	280	95	95	95	96	96	96	96	96	96	96	96
-1	0.2	288	94	94	94	94	94	94	94	94	94	94	94
-1	0.4	296	93	93	93	93	93	93	93	93	93	93	93
-1	0.6	304	92	92	92	92	92	92	92	92	91	91	91
-1	0.8	312	91	91	91	91	91	90	90	90	90	90	89
-1	1.0	320	90	90	90	89	89	89	89	88	88	88	88

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	99	99	99	99	99	99	99	98	98	98	98
1	-0.8	248	98	98	97	97	97	97	97	97	96	96	96
1	-0.6	256	96	96	96	96	95	95	95	95	94	94	94
1	-0.4	264	95	94	94	94	94	93	93	93	92	92	92
1	-0.2	272	93	93	92	92	92	91	91	91	90	90	90
1	0.0	280	91	91	91	90	90	89	89	89	88	88	87
1	0.2	288	89	89	89	88	88	87	87	86	86	85	85
1	0.4	296	88	87	87	86	86	85	85	84	83	83	82
1	0.6	304	86	85	85	84	83	83	82	82	81	80	80
1	0.8	312	84	83	82	82	81	81	80	79	79	78	77
1	1.0	320	82	81	80	80	79	78	77	77	76	75	74

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	99	99	100	100	100	100	100	100	101	101	101
0	-0.8	248	99	99	99	99	99	99	99	99	99	99	99
0	-0.6	256	98	98	98	98	98	98	98	98	98	98	98
0	-0.4	264	97	97	97	97	97	97	97	97	97	97	96
0	-0.2	272	96	96	96	96	96	96	95	95	95	95	95
0	0.0	280	95	95	95	94	94	94	94	94	94	93	93
0	0.2	288	94	94	93	93	93	93	93	92	92	92	92
0	0.4	296	92	92	92	92	92	91	91	91	90	90	90
0	0.6	304	91	91	91	90	90	90	89	89	89	88	88
0	0.8	312	90	89	89	89	88	88	88	87	87	86	86
0	1.0	320	88	88	88	87	87	86	86	85	85	84	84

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	98	98	99	99	100	100	101	101	101	102	102
-1	-0.8	248	98	98	99	99	99	100	100	100	101	101	101
-1	-0.6	256	98	98	98	99	99	99	100	100	100	100	101
-1	-0.4	264	98	98	98	98	99	99	99	99	99	100	100
-1	-0.2	272	97	97	98	98	98	98	98	98	99	99	99
-1	0.0	280	97	97	97	97	97	97	98	98	98	98	98
-1	0.2	288	96	96	97	97	97	97	97	97	97	97	97
-1	0.4	296	96	96	96	96	96	96	96	96	96	96	96
-1	0.6	304	95	95	95	95	95	95	95	95	95	94	94
-1	0.8	312	95	94	94	94	94	94	94	94	93	93	93
-1	1.0	320	94	94	93	93	93	93	93	92	92	92	92

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	98	98	98	98	98	98	98	98	98	97	97
1	-0.8	248	97	97	97	97	97	97	96	96	96	96	96
1	-0.6	256	96	96	96	96	95	95	95	95	95	94	94
1	-0.4	264	95	95	95	94	94	94	94	93	93	93	92
1	-0.2	272	94	93	93	93	93	92	92	92	91	91	91
1	0.0	280	92	92	92	91	91	91	90	90	90	89	89
1	0.2	288	91	91	90	90	90	89	89	88	88	87	87
1	0.4	296	90	89	89	88	88	87	87	86	86	85	85
1	0.6	304	88	88	87	87	86	86	85	84	84	83	83
1	0.8	312	87	86	85	85	84	84	83	82	82	81	80
1	1.0	320	85	84	84	83	82	82	81	80	80	79	78

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	97	98	98	98	98	98	99	99	99	99	99
0	-0.8	248	97	97	97	98	98	98	98	98	98	98	98
0	-0.6	256	97	97	97	97	97	97	97	97	97	97	97
0	-0.4	264	96	96	96	96	96	96	96	96	96	96	96
0	-0.2	272	96	96	96	96	96	96	96	95	95	95	95
0	0.0	280	95	95	95	95	95	95	95	94	94	94	94
0	0.2	288	94	94	94	94	94	94	94	93	93	93	93
0	0.4	296	94	94	93	93	93	93	92	92	92	92	91
0	0.6	304	93	93	92	92	92	91	91	91	91	90	90
0	0.8	312	92	92	91	91	91	90	90	90	89	89	88
0	1.0	320	91	91	90	90	89	89	89	88	88	87	87

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	95	96	96	97	97	98	98	98	99	99	100
-1	-0.8	248	96	96	96	97	97	98	98	98	99	99	99
-1	-0.6	256	96	96	97	97	97	98	98	98	99	99	99
-1	-0.4	264	96	96	97	97	97	98	98	98	98	98	99
-1	-0.2	272	96	97	97	97	97	97	98	98	98	98	98
-1	0.0	280	96	97	97	97	97	97	97	97	97	98	98
-1	0.2	288	96	96	97	97	97	97	97	97	97	97	97
-1	0.4	296	96	96	96	96	96	96	96	96	96	96	96
-1	0.6	304	96	96	96	96	96	96	96	96	96	96	96
-1	0.8	312	96	96	96	96	95	95	95	95	95	95	95
-1	1.0	320	95	95	95	95	95	95	95	94	94	94	94

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	34.2
X1	COE1	13.5
X2	COE2	9.1
X3	COE3	-2.9
X4	COE4	-2.2
X1*X1	COE11	-5.7
X2*X2	COE22	0.2
X3*X3	COE33	0.3
X4*X4	COE44	2.4
X1*X2	COE12	10
X1*X3	COE13	-3
X1*X4	COE14	-2.3
X2*X3	COE23	1
X2*X4	COE24	10.5
X3*X4	COE34	0.8

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	6	7	8	10	12	14	16	18	20	23	26
1	-0.8	248	14	15	16	18	19	21	23	25	27	30	33
1	-0.6	256	21	22	23	25	26	28	30	32	34	36	39
1	-0.4	264	28	29	30	31	33	34	36	38	40	42	45
1	-0.2	272	35	35	36	37	39	40	42	44	46	48	51
1	0.0	280	41	41	42	43	44	46	47	49	51	53	56
1	0.2	288	46	47	47	48	49	51	52	54	56	58	60
1	0.4	296	51	52	52	53	54	55	57	58	60	62	64
1	0.6	304	56	56	57	57	58	60	61	62	64	66	68
1	0.8	312	60	60	61	61	62	63	64	66	68	69	71
1	1.0	320	64	64	64	65	66	67	68	69	70	72	74

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	18	17	16	16	15	15	15	15	16	16	17
0	-0.8	248	24	23	22	21	21	21	20	20	21	21	22
0	-0.6	256	29	28	27	26	26	25	25	25	25	26	26
0	-0.4	264	34	33	32	31	30	30	30	29	30	30	30
0	-0.2	272	39	37	36	35	34	34	33	33	33	33	34
0	0.0	280	43	41	40	39	38	37	37	37	36	37	37
0	0.2	288	46	45	43	42	41	40	40	39	39	39	39
0	0.4	296	49	48	46	45	44	43	42	42	42	41	42
0	0.6	304	52	50	49	47	46	45	44	44	43	43	43
0	0.8	312	54	52	51	49	48	47	46	45	45	45	45
0	1.0	320	56	54	52	51	49	48	47	46	46	45	45

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	31	28	25	22	20	17	15	13	11	10	9
-1	-0.8	248	35	32	29	26	23	21	18	16	15	13	11
-1	-0.6	256	38	35	32	29	26	24	21	19	17	15	14
-1	-0.4	264	41	38	34	31	29	26	24	21	19	17	16
-1	-0.2	272	43	40	37	34	31	28	25	23	21	19	17
-1	0.0	280	45	42	38	35	32	30	27	24	22	20	18
-1	0.2	288	47	43	40	37	33	31	28	25	23	21	19
-1	0.4	296	48	44	41	37	34	31	28	26	23	21	19
-1	0.6	304	49	45	41	38	34	31	28	26	23	21	19
-1	0.8	312	49	45	41	38	34	31	28	25	23	20	18
-1	1.0	320	49	44	41	37	34	30	27	24	22	19	17

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	6	7	9	10	12	14	17	19	22	24	27
1	-0.8	248	13	14	16	17	19	21	23	25	28	31	34
1	-0.6	256	20	21	22	24	26	27	29	32	34	37	39
1	-0.4	264	26	27	29	30	31	33	35	37	40	42	45
1	-0.2	272	32	33	34	35	37	39	40	42	45	47	50
1	0.0	280	38	38	39	41	42	44	45	47	49	52	54
1	0.2	288	43	43	44	45	47	48	50	51	54	56	58
1	0.4	296	47	48	48	49	51	52	54	55	57	59	62
1	0.6	304	51	52	52	53	54	56	57	59	61	63	65
1	0.8	312	55	55	56	56	57	59	60	62	63	65	68
1	1.0	320	58	58	59	59	60	61	63	64	66	68	70

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	17	16	16	15	15	15	15	15	16	17	18
0	-0.8	248	23	22	21	20	20	20	20	20	20	21	22
0	-0.6	256	27	26	25	25	24	24	24	24	24	25	26
0	-0.4	264	32	30	30	29	28	28	28	28	28	28	29
0	-0.2	272	35	34	33	32	32	31	31	31	31	31	32
0	0.0	280	39	37	36	35	35	34	34	34	34	34	34
0	0.2	288	42	40	39	38	37	37	36	36	36	36	36
0	0.4	296	44	43	41	40	39	39	38	38	38	38	38
0	0.6	304	46	45	43	42	41	40	40	39	39	39	39
0	0.8	312	48	46	45	43	42	41	41	40	40	40	40
0	1.0	320	49	47	46	44	43	42	41	41	40	40	40

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	29	26	23	21	18	16	14	12	11	9	8
-1	-0.8	248	32	29	26	24	21	19	17	15	13	12	10
-1	-0.6	256	35	32	29	26	24	21	19	17	15	14	12
-1	-0.4	264	37	34	31	28	25	23	21	19	17	15	14
-1	-0.2	272	39	36	33	30	27	24	22	20	18	16	15
-1	0.0	280	40	37	34	31	28	25	23	21	19	17	15
-1	0.2	288	41	38	35	31	29	26	23	21	19	17	15
-1	0.4	296	42	38	35	32	29	26	23	21	18	16	15
-1	0.6	304	42	38	35	31	28	25	23	20	18	16	14
-1	0.8	312	41	38	34	31	27	24	22	19	17	14	12
-1	1.0	320	41	37	33	29	26	23	20	17	15	13	11

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	7	8	10	12	14	16	18	21	23	26	30
1	-0.8	248	13	15	16	18	20	22	24	27	29	32	35
1	-0.6	256	19	21	22	24	26	28	30	32	35	37	40
1	-0.4	264	25	26	28	29	31	33	35	37	40	42	45
1	-0.2	272	30	31	33	34	36	38	40	42	44	47	50
1	0.0	280	35	36	37	39	40	42	44	46	48	51	53
1	0.2	288	40	40	41	43	44	46	48	50	52	54	57
1	0.4	296	43	44	45	46	48	49	51	53	55	57	60
1	0.6	304	47	48	48	49	51	52	54	56	58	60	62
1	0.8	312	50	50	51	52	53	55	56	58	60	62	64
1	1.0	320	52	53	53	54	55	57	58	60	62	64	66

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	17	16	16	15	15	15	16	16	17	18	19
0	-0.8	248	22	21	20	20	20	20	20	20	21	21	22
0	-0.6	256	26	25	24	24	23	23	23	24	24	25	26
0	-0.4	264	29	28	28	27	27	26	26	27	27	28	28
0	-0.2	272	33	32	31	30	30	29	29	29	30	30	31
0	0.0	280	35	34	33	33	32	32	31	31	32	32	33
0	0.2	288	38	36	35	35	34	33	33	33	33	34	34
0	0.4	296	40	38	37	36	35	35	35	34	34	35	35
0	0.6	304	41	40	38	37	37	36	35	35	35	35	35
0	0.8	312	42	40	39	38	37	36	36	35	35	35	36
0	1.0	320	43	41	39	38	37	36	36	35	35	35	35

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	28	25	22	20	18	16	14	12	11	9	8
-1	-0.8	248	30	27	25	22	20	18	16	14	12	11	10
-1	-0.6	256	32	29	27	24	22	19	17	16	14	12	11
-1	-0.4	264	34	31	28	25	23	21	18	17	15	13	12
-1	-0.2	272	35	32	29	26	24	21	19	17	15	14	12
-1	0.0	280	36	33	30	27	24	22	19	17	15	14	12
-1	0.2	288	36	33	30	27	24	22	19	17	15	13	12
-1	0.4	296	36	33	30	27	24	21	19	16	14	12	11
-1	0.6	304	36	32	29	26	23	20	17	15	13	11	9
-1	0.8	312	35	31	28	24	21	18	16	13	11	9	7
-1	1.0	320	33	29	26	23	19	17	14	11	9	7	5

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	36.5
X1	COE1	18.4
X2	COE2	11.8
X3	COE3	-2.8
X4	COE4	-0.1
X1*X1	COE11	-5.7
X2*X2	COE22	0.2
X3*X3	COE33	0.3
X4*X4	COE44	2.4
X1*X2	COE12	10
X1*X3	COE13	-3
X1*X4	COE14	-2.3
X2*X3	COE23	1
X2*X4	COE24	10.5
X3*X4	COE34	0.8

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	4	6	7	9	11	14	16	19	22	25	28
1	-0.8	248	13	14	16	18	20	22	24	27	30	33	36
1	-0.6	256	21	22	24	26	28	30	32	34	37	40	43
1	-0.4	264	29	30	32	33	35	37	39	42	44	47	50
1	-0.2	272	36	38	39	40	42	44	46	49	51	54	57
1	0.0	280	43	44	46	47	49	51	53	55	57	60	63
1	0.2	288	50	51	52	53	55	57	59	61	63	66	68
1	0.4	296	56	57	58	59	61	62	64	66	68	71	73
1	0.6	304	62	62	63	64	66	67	69	71	73	76	78
1	0.8	312	67	67	68	69	71	72	74	76	78	80	82
1	1.0	320	71	72	73	74	75	76	78	80	82	84	86

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	14	13	13	12	12	13	13	13	14	15	16
0	-0.8	248	20	20	19	19	19	19	19	20	20	21	22
0	-0.6	256	27	26	25	25	25	25	25	25	26	27	28
0	-0.4	264	33	32	31	31	30	30	30	31	31	32	33
0	-0.2	272	38	37	36	36	35	35	35	35	36	36	37
0	0.0	280	43	42	41	40	40	40	40	40	40	40	41
0	0.2	288	47	46	45	45	44	44	43	43	44	44	45
0	0.4	296	51	50	49	48	48	47	47	47	47	47	48
0	0.6	304	55	54	53	52	51	50	50	50	50	50	51
0	0.8	312	58	57	56	55	54	53	53	52	52	52	53
0	1.0	320	61	59	58	57	56	55	55	54	54	54	55

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	23	21	18	16	14	12	10	9	7	6	5
-1	-0.8	248	28	25	23	20	18	16	14	13	11	10	9
-1	-0.6	256	33	30	27	25	22	20	18	16	15	14	12
-1	-0.4	264	36	33	31	28	26	24	22	20	18	17	15
-1	-0.2	272	40	37	34	31	29	26	24	23	21	19	18
-1	0.0	280	43	40	37	34	31	29	27	25	23	21	20
-1	0.2	288	45	42	39	36	34	31	29	27	25	23	22
-1	0.4	296	47	44	41	38	35	33	30	28	26	24	23
-1	0.6	304	49	46	42	39	36	34	31	29	27	25	23
-1	0.8	312	50	47	43	40	37	34	32	30	27	25	24
-1	1.0	320	51	47	44	41	38	35	32	30	27	25	23

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	4	6	8	10	12	14	17	20	23	26	30
1	-0.8	248	12	14	16	18	20	22	25	27	30	33	37
1	-0.6	256	20	22	23	25	27	29	32	35	37	40	44
1	-0.4	264	27	29	30	32	34	36	39	41	44	47	50
1	-0.2	272	34	35	37	39	41	43	45	47	50	53	56
1	0.0	280	41	42	43	45	47	49	51	53	56	58	61
1	0.2	288	46	48	49	50	52	54	56	58	61	63	66
1	0.4	296	52	53	54	56	57	59	61	63	66	68	71
1	0.6	304	57	58	59	60	62	63	65	67	70	72	75
1	0.8	312	61	62	63	65	66	68	69	71	74	76	79
1	1.0	320	66	66	67	68	70	71	73	75	77	79	82

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	13	12	12	12	12	12	13	14	15	16	17
0	-0.8	248	19	18	18	18	18	18	19	19	20	21	22
0	-0.6	256	25	24	24	23	23	23	24	24	25	26	27
0	-0.4	264	30	29	29	28	28	28	28	29	30	30	31
0	-0.2	272	35	34	33	33	33	33	33	33	34	34	35
0	0.0	280	39	38	37	37	37	37	37	37	37	38	39
0	0.2	288	43	42	41	41	40	40	40	40	40	41	42
0	0.4	296	46	45	44	44	43	43	43	43	43	44	44
0	0.6	304	49	48	47	46	46	45	45	45	45	46	46
0	0.8	312	52	51	50	49	48	48	47	47	47	48	48
0	1.0	320	54	53	52	51	50	49	49	49	49	49	49

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	22	19	17	15	13	11	9	8	7	6	5
-1	-0.8	248	26	23	21	18	16	15	13	11	10	9	8
-1	-0.6	256	29	27	24	22	20	18	16	15	13	12	11
-1	-0.4	264	33	30	27	25	23	21	19	17	16	14	13
-1	-0.2	272	36	33	30	27	25	23	21	19	18	16	15
-1	0.0	280	38	35	32	30	27	25	23	21	19	18	17
-1	0.2	288	40	37	34	31	29	26	24	22	21	19	18
-1	0.4	296	41	38	35	32	30	27	25	23	21	20	18
-1	0.6	304	42	39	36	33	30	28	26	23	22	20	18
-1	0.8	312	43	39	36	33	31	28	26	23	21	20	18
-1	1.0	320	43	39	36	33	30	28	25	23	21	19	17

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	5	7	9	11	13	16	19	22	25	28	32
1	-0.8	248	12	14	16	18	21	23	26	29	32	35	38
1	-0.6	256	20	21	23	25	27	30	32	35	38	41	45
1	-0.4	264	26	28	30	31	34	36	38	41	44	47	50
1	-0.2	272	32	34	36	37	39	42	44	47	50	53	56
1	0.0	280	38	40	41	43	45	47	49	52	55	57	61
1	0.2	288	44	45	46	48	50	52	54	57	59	62	65
1	0.4	296	48	50	51	53	54	56	58	61	63	66	69
1	0.6	304	53	54	55	57	58	60	62	65	67	70	72
1	0.8	312	57	58	59	60	62	64	66	68	70	73	75
1	1.0	320	60	61	62	64	65	67	69	71	73	75	78

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	12	12	12	12	12	13	14	14	16	17	18
0	-0.8	248	18	18	17	17	18	18	19	19	20	22	23
0	-0.6	256	23	23	22	22	22	23	23	24	25	26	27
0	-0.4	264	28	27	27	27	27	27	27	28	29	30	31
0	-0.2	272	32	31	31	31	31	31	31	32	32	33	34
0	0.0	280	36	35	34	34	34	34	34	35	35	36	37
0	0.2	288	39	38	38	37	37	37	37	37	38	39	39
0	0.4	296	42	41	40	40	39	39	39	40	40	41	41
0	0.6	304	44	43	42	42	41	41	41	41	42	42	43
0	0.8	312	46	45	44	44	43	43	43	43	43	43	44
0	1.0	320	48	47	46	45	44	44	43	43	44	44	45

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	20	18	16	14	12	10	9	8	7	6	5
-1	-0.8	248	24	21	19	17	15	13	12	11	10	9	8
-1	-0.6	256	27	24	22	20	18	16	15	13	12	11	10
-1	-0.4	264	30	27	25	22	20	18	17	15	14	13	12
-1	-0.2	272	32	29	27	24	22	20	18	17	15	14	13
-1	0.0	280	34	31	28	26	23	21	20	18	16	15	14
-1	0.2	288	35	32	29	27	24	22	20	19	17	16	14
-1	0.4	296	36	33	30	27	25	23	21	19	17	16	14
-1	0.6	304	36	33	30	27	25	23	20	19	17	15	14
-1	0.8	312	36	33	30	27	24	22	20	18	16	14	13
-1	1.0	320	36	32	29	26	24	21	19	17	15	13	11

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	38.8
X1	COE1	23.3
X2	COE2	14.5
X3	COE3	-2.7
X4	COE4	2
X1*X1	COE11	-5.7
X2*X2	COE22	0.2
X3*X3	COE33	0.3
X4*X4	COE44	2.4
X1*X2	COE12	10
X1*X3	COE13	-3
X1*X4	COE14	-2.3
X2*X3	COE23	1
X2*X4	COE24	10.5
X3*X4	COE34	0.8

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	2	4	6	8	11	14	16	19	23	26	30
1	-0.8	248	12	14	16	18	20	23	26	29	32	35	39
1	-0.6	256	21	23	25	27	29	32	34	37	40	44	47
1	-0.4	264	30	32	33	35	38	40	43	46	49	52	55
1	-0.2	272	38	40	42	44	46	48	51	53	56	59	63
1	0.0	280	46	48	49	51	53	56	58	61	63	66	70
1	0.2	288	54	55	57	58	60	63	65	67	70	73	76
1	0.4	296	61	62	64	65	67	69	71	74	76	79	82
1	0.6	304	67	69	70	71	73	75	77	80	82	85	88
1	0.8	312	73	75	76	77	79	81	83	85	88	90	93
1	1.0	320	79	80	81	83	84	86	88	90	93	95	98

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	9	9	9	9	9	10	11	12	13	14	16
0	-0.8	248	16	16	16	16	17	17	18	19	20	21	23
0	-0.6	256	24	23	23	23	24	24	25	25	26	28	29
0	-0.4	264	31	30	30	30	30	30	31	32	33	34	35
0	-0.2	272	37	37	36	36	36	36	37	37	38	39	40
0	0.0	280	43	42	42	42	42	42	42	43	43	44	45
0	0.2	288	48	48	47	47	47	47	47	48	48	49	50
0	0.4	296	54	53	52	52	51	51	52	52	52	53	54
0	0.6	304	58	57	57	56	56	56	56	56	56	57	58
0	0.8	312	62	61	60	60	59	59	59	59	60	60	61
0	1.0	320	66	65	64	63	63	62	62	62	63	63	64

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	16	14	12	10	8	7	5	4	3	2	2
-1	-0.8	248	22	19	17	15	13	12	10	9	8	7	7
-1	-0.6	256	27	25	22	20	18	17	15	14	13	12	11
-1	-0.4	264	32	29	27	25	23	21	19	18	17	16	15
-1	-0.2	272	36	34	31	29	27	25	23	22	21	19	19
-1	0.0	280	40	37	35	33	30	29	27	25	24	23	22
-1	0.2	288	44	41	38	36	34	32	30	28	27	25	24
-1	0.4	296	47	44	41	39	36	34	32	30	29	27	26
-1	0.6	304	49	46	44	41	38	36	34	32	31	29	28
-1	0.8	312	51	48	45	43	40	38	36	34	32	31	29
-1	1.0	320	53	50	47	44	42	39	37	35	33	31	30

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	2	4	6	9	12	15	18	21	24	28	32
1	-0.8	248	11	13	15	18	20	23	26	29	33	36	40
1	-0.6	256	20	22	24	26	29	31	34	37	41	44	48
1	-0.4	264	28	30	32	34	37	39	42	45	48	52	55
1	-0.2	272	36	38	40	42	44	47	49	52	55	59	62
1	0.0	280	43	45	47	49	51	54	56	59	62	65	68
1	0.2	288	50	52	54	56	58	60	62	65	68	71	74
1	0.4	296	57	58	60	62	64	66	68	71	74	77	80
1	0.6	304	63	64	66	67	69	71	74	76	79	82	85
1	0.8	312	68	70	71	73	74	76	79	81	84	87	90
1	1.0	320	73	74	76	77	79	81	83	86	88	91	94

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	8	8	8	8	9	10	11	12	13	15	17
0	-0.8	248	15	15	15	15	16	17	17	18	20	21	23
0	-0.6	256	22	22	22	22	22	23	24	25	26	27	29
0	-0.4	264	28	28	28	28	28	29	29	30	31	32	34
0	-0.2	272	34	33	33	33	34	34	35	35	36	37	39
0	0.0	280	39	39	38	38	38	39	39	40	41	42	43
0	0.2	288	44	44	43	43	43	43	44	44	45	46	47
0	0.4	296	49	48	47	47	47	47	48	48	49	50	51
0	0.6	304	53	52	51	51	51	51	51	51	52	53	54
0	0.8	312	56	55	55	54	54	54	54	54	55	55	56
0	1.0	320	59	58	57	57	57	56	56	57	57	58	59

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	14	12	10	8	7	6	4	3	3	2	2
-1	-0.8	248	19	17	15	13	12	10	9	8	7	6	6
-1	-0.6	256	24	22	20	18	16	14	13	12	11	10	10
-1	-0.4	264	28	26	24	22	20	18	17	16	15	14	13
-1	-0.2	272	32	30	27	25	23	22	20	19	18	17	16
-1	0.0	280	35	33	30	28	26	25	23	21	20	19	18
-1	0.2	288	38	36	33	31	29	27	25	24	22	21	20
-1	0.4	296	41	38	35	33	31	29	27	26	24	23	22
-1	0.6	304	43	40	37	35	33	30	29	27	25	24	23
-1	0.8	312	44	41	39	36	34	31	30	28	26	25	24
-1	1.0	320	45	42	39	37	34	32	30	28	26	25	24

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	3	5	8	10	13	16	19	23	26	30	34
1	-0.8	248	11	14	16	19	21	24	27	31	34	38	42
1	-0.6	256	20	22	24	26	29	32	35	38	42	45	49
1	-0.4	264	27	29	31	34	36	39	42	45	48	52	56
1	-0.2	272	34	36	38	41	43	46	49	52	55	58	62
1	0.0	280	41	43	45	47	50	52	55	58	61	64	68
1	0.2	288	47	49	51	53	55	58	61	63	67	70	73
1	0.4	296	53	55	57	59	61	63	66	69	72	75	78
1	0.6	304	59	60	62	64	66	68	71	73	76	79	83
1	0.8	312	64	65	67	68	70	73	75	78	80	83	87
1	1.0	320	68	69	71	73	75	77	79	81	84	87	90

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	8	8	8	9	9	10	12	13	14	16	18
0	-0.8	248	14	14	15	15	16	17	18	19	20	22	24
0	-0.6	256	20	20	21	21	21	22	23	24	26	27	29
0	-0.4	264	26	26	26	26	27	27	28	29	30	32	33
0	-0.2	272	31	31	31	31	32	32	33	34	35	36	38
0	0.0	280	36	36	36	36	36	36	37	38	39	40	42
0	0.2	288	40	40	40	40	40	40	41	42	43	44	45
0	0.4	296	44	44	43	43	43	44	44	45	46	47	48
0	0.6	304	48	47	47	46	46	47	47	47	48	49	50
0	0.8	312	50	50	49	49	49	49	49	50	50	51	52
0	1.0	320	53	52	52	51	51	51	51	52	52	53	54

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	13	11	9	8	6	5	4	3	3	2	2
-1	-0.8	248	17	15	14	12	10	9	8	7	7	6	6
-1	-0.6	256	22	19	18	16	14	13	12	11	10	9	9
-1	-0.4	264	25	23	21	19	18	16	15	14	13	12	12
-1	-0.2	272	28	26	24	22	20	19	17	16	15	15	14
-1	0.0	280	31	29	27	25	23	21	20	18	17	16	16
-1	0.2	288	33	31	29	27	25	23	21	20	19	18	17
-1	0.4	296	35	33	30	28	26	24	23	21	20	19	18
-1	0.6	304	37	34	32	29	27	25	24	22	21	20	19
-1	0.8	312	38	35	32	30	28	26	24	22	21	20	19
-1	1.0	320	38	35	33	30	28	26	24	22	21	19	18

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	67.9
X1	COE1	8.19
X2	COE2	6.39
X3	COE3	-2.86
X4	COE4	-2.71
X1*X1	COE11	-3.89
X2*X2	COE22	-2.65
X3*X3	COE33	1.25
X4*X4	COE44	1.29
X1*X2	COE12	0.9
X1*X3	COE13	-2.56
X1*X4	COE14	-1.53
X2*X3	COE23	0.48
X2*X4	COE24	6.02
X3*X4	COE34	1.46

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	58	58	58	59	59	60	60	61	62	63	64
1	-0.8	248	62	62	62	62	63	63	64	65	66	67	68
1	-0.6	256	65	65	66	66	66	67	67	68	69	70	71
1	-0.4	264	69	69	69	69	70	70	71	71	72	73	74
1	-0.2	272	72	72	72	72	72	73	73	74	75	75	76
1	0.0	280	75	75	75	75	75	75	76	76	77	78	78
1	0.2	288	77	77	77	77	77	77	78	78	79	80	80
1	0.4	296	79	79	79	79	79	79	80	80	81	81	82
1	0.6	304	81	81	81	81	81	81	81	81	82	82	83
1	0.8	312	83	82	82	82	82	82	82	83	83	83	84
1	1.0	320	84	84	83	83	83	83	83	83	84	84	85

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	61	60	59	59	58	57	57	57	56	56	56
0	-0.8	248	65	64	63	62	62	61	60	60	60	59	59
0	-0.6	256	69	68	67	66	65	64	64	63	63	62	62
0	-0.4	264	72	71	70	69	68	67	66	66	65	65	65
0	-0.2	272	75	74	72	71	71	70	69	68	68	67	67
0	0.0	280	77	76	75	74	73	72	71	71	70	69	69
0	0.2	288	80	78	77	76	75	74	73	72	72	71	71
0	0.4	296	82	80	79	78	77	76	75	74	73	73	72
0	0.6	304	83	82	81	79	78	77	76	75	74	74	73
0	0.8	312	85	83	82	80	79	78	77	76	75	75	74
0	1.0	320	86	84	83	81	80	79	78	77	76	75	74

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	60	57	55	53	51	50	48	46	45	44	42
-1	-0.8	248	63	61	59	57	55	53	51	50	48	47	45
-1	-0.6	256	67	64	62	60	58	56	54	53	51	50	48
-1	-0.4	264	70	67	65	63	61	59	57	55	54	52	51
-1	-0.2	272	72	70	68	65	63	61	59	58	56	54	53
-1	0.0	280	75	72	70	68	66	63	61	60	58	56	55
-1	0.2	288	77	74	72	70	67	65	63	61	59	58	56
-1	0.4	296	79	76	74	71	69	67	65	63	61	59	57
-1	0.6	304	80	78	75	73	70	68	66	64	62	60	58
-1	0.8	312	82	79	76	74	71	69	67	64	62	61	59
-1	1.0	320	82	80	77	74	72	69	67	65	63	61	59

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	55	56	56	57	58	59	60	61	62	63	65
1	-0.8	248	59	59	60	60	61	62	63	64	65	66	68
1	-0.6	256	62	62	63	63	64	65	66	67	68	69	70
1	-0.4	264	65	65	65	66	67	67	68	69	70	71	73
1	-0.2	272	67	68	68	68	69	70	70	71	72	73	75
1	0.0	280	70	70	70	71	71	72	72	73	74	75	76
1	0.2	288	72	72	72	72	73	73	74	75	76	77	78
1	0.4	296	73	73	73	74	74	75	75	76	77	78	79
1	0.6	304	75	75	75	75	75	76	76	77	78	78	79
1	0.8	312	76	76	76	76	76	76	77	77	78	79	80
1	1.0	320	76	76	76	76	77	77	77	78	78	79	80

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	58	58	57	56	56	56	56	56	56	56	56
0	-0.8	248	62	61	60	60	59	59	59	58	58	58	59
0	-0.6	256	65	64	63	63	62	62	61	61	61	61	61
0	-0.4	264	67	67	66	65	64	64	64	63	63	63	63
0	-0.2	272	70	69	68	67	67	66	66	65	65	65	65
0	0.0	280	72	71	70	69	68	68	67	67	67	67	66
0	0.2	288	74	73	72	71	70	69	69	68	68	68	68
0	0.4	296	75	74	73	72	71	71	70	69	69	69	69
0	0.6	304	76	75	74	73	72	71	71	70	70	69	69
0	0.8	312	77	76	75	74	73	72	71	71	70	70	69
0	1.0	320	78	76	75	74	73	72	71	71	70	70	69

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	56	54	52	51	49	48	46	45	44	43	42
-1	-0.8	248	59	57	56	54	52	51	49	48	46	45	44
-1	-0.6	256	62	60	58	56	55	53	52	50	49	48	47
-1	-0.4	264	65	63	61	59	57	55	54	52	51	50	48
-1	-0.2	272	67	65	63	61	59	57	56	54	53	51	50
-1	0.0	280	69	67	65	63	61	59	57	56	54	53	51
-1	0.2	288	70	68	66	64	62	60	58	57	55	54	52
-1	0.4	296	72	69	67	65	63	61	59	58	56	55	53
-1	0.6	304	73	70	68	66	64	62	60	58	57	55	53
-1	0.8	312	73	71	69	66	64	62	60	58	57	55	54
-1	1.0	320	74	71	69	67	64	62	60	58	57	55	53

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	55	56	57	58	59	60	61	63	64	66	68
1	-0.8	248	58	59	60	61	62	63	64	65	67	68	70
1	-0.6	256	61	61	62	63	64	65	66	68	69	71	72
1	-0.4	264	63	64	65	65	66	67	68	70	71	72	74
1	-0.2	272	65	66	66	67	68	69	70	71	73	74	75
1	0.0	280	67	68	68	69	70	71	72	73	74	75	77
1	0.2	288	68	69	69	70	71	72	73	74	75	76	77
1	0.4	296	70	70	70	71	72	72	73	74	75	77	78
1	0.6	304	70	71	71	72	72	73	74	75	76	77	78
1	0.8	312	71	71	72	72	73	73	74	75	76	77	78
1	1.0	320	71	71	72	72	73	73	74	75	76	77	78

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	58	57	57	57	57	57	57	57	57	58	58
0	-0.8	248	61	60	60	60	59	59	59	59	60	60	61
0	-0.6	256	63	63	62	62	62	62	61	62	62	62	62
0	-0.4	264	65	65	64	64	64	63	63	63	63	64	64
0	-0.2	272	67	67	66	66	65	65	65	65	65	65	65
0	0.0	280	69	68	68	67	67	66	66	66	66	66	66
0	0.2	288	70	69	69	68	68	67	67	67	67	67	67
0	0.4	296	71	70	70	69	68	68	68	67	67	67	67
0	0.6	304	72	71	70	69	69	68	68	68	67	67	67
0	0.8	312	72	71	70	70	69	68	68	68	67	67	67
0	1.0	320	72	71	70	69	69	68	68	67	67	67	67

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	55	54	52	51	49	48	47	46	45	44	44
-1	-0.8	248	58	56	55	53	52	50	49	48	47	46	46
-1	-0.6	256	60	58	57	55	54	53	51	50	49	48	47
-1	-0.4	264	62	60	59	57	56	54	53	52	51	50	49
-1	-0.2	272	64	62	60	59	57	56	54	53	52	51	50
-1	0.0	280	65	63	62	60	58	57	55	54	53	52	51
-1	0.2	288	66	64	63	61	59	58	56	55	53	52	51
-1	0.4	296	67	65	63	61	60	58	57	55	54	53	51
-1	0.6	304	68	66	64	62	60	58	57	55	54	52	51
-1	0.8	312	68	66	64	62	60	58	56	55	53	52	51
-1	1.0	320	68	65	63	61	59	58	56	54	53	51	50

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	68.38
X1	COE1	12.63
X2	COE2	8.89
X3	COE3	-1.98
X4	COE4	-0.87
X1*X1	COE11	-3.89
X2*X2	COE22	-2.65
X3*X3	COE33	1.25
X4*X4	COE44	1.29
X1*X2	COE12	0.9
X1*X3	COE13	-2.56
X1*X4	COE14	-1.53
X2*X3	COE23	0.48
X2*X4	COE24	6.02
X3*X4	COE34	1.46

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	53	54	55	56	56	57	58	60	61	62	64
1	-0.8	248	58	59	60	60	61	62	63	64	65	67	68
1	-0.6	256	63	63	64	65	65	66	67	68	70	71	72
1	-0.4	264	67	68	68	69	70	70	71	72	73	75	76
1	-0.2	272	71	72	72	73	73	74	75	76	77	78	79
1	0.0	280	75	75	76	76	77	77	78	79	80	81	82
1	0.2	288	78	79	79	79	80	80	81	82	83	84	85
1	0.4	296	81	82	82	82	83	83	84	85	85	86	88
1	0.6	304	84	84	84	85	85	86	86	87	88	89	90
1	0.8	312	87	87	87	87	87	88	88	89	90	91	92
1	1.0	320	89	89	89	89	89	90	90	91	91	92	93

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	55	54	53	53	53	53	52	52	53	53	53
0	-0.8	248	59	59	58	58	57	57	57	57	57	57	57
0	-0.6	256	64	63	62	62	61	61	61	61	61	61	61
0	-0.4	264	68	67	66	66	65	65	65	64	64	64	64
0	-0.2	272	72	71	70	69	69	68	68	68	68	68	68
0	0.0	280	75	74	73	73	72	72	71	71	71	71	71
0	0.2	288	78	77	77	76	75	74	74	74	73	73	73
0	0.4	296	81	80	79	78	78	77	77	76	76	76	75
0	0.6	304	84	83	82	81	80	79	79	78	78	78	77
0	0.8	312	86	85	84	83	82	81	81	80	80	79	79
0	1.0	320	88	87	86	85	84	83	82	82	81	81	80

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	50	49	47	45	44	42	41	40	39	38	37
-1	-0.8	248	55	53	51	50	48	47	45	44	43	42	41
-1	-0.6	256	59	57	55	54	52	51	49	48	47	45	44
-1	-0.4	264	63	61	59	58	56	54	53	51	50	49	48
-1	-0.2	272	67	65	63	61	59	58	56	55	53	52	51
-1	0.0	280	70	68	66	64	62	61	59	57	56	55	53
-1	0.2	288	73	71	69	67	65	63	62	60	59	57	56
-1	0.4	296	76	74	71	69	67	66	64	62	61	59	58
-1	0.6	304	78	76	74	72	70	68	66	64	63	61	60
-1	0.8	312	80	78	76	74	71	69	68	66	64	63	61
-1	1.0	320	82	80	77	75	73	71	69	67	65	64	62

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	52	53	54	55	56	57	59	60	62	63	65
1	-0.8	248	56	57	58	59	60	61	63	64	66	67	69
1	-0.6	256	60	61	62	63	64	65	66	68	69	71	72
1	-0.4	264	64	65	66	66	67	69	70	71	73	74	76
1	-0.2	272	68	68	69	70	71	72	73	74	75	77	79
1	0.0	280	71	71	72	73	74	75	76	77	78	80	81
1	0.2	288	74	74	75	75	76	77	78	79	81	82	83
1	0.4	296	76	77	77	78	79	79	80	81	83	84	85
1	0.6	304	78	79	79	80	81	81	82	83	84	86	87
1	0.8	312	80	81	81	82	82	83	84	85	86	87	88
1	1.0	320	82	82	83	83	84	84	85	86	87	88	89

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	52	52	52	52	52	52	52	52	53	53	54
0	-0.8	248	57	56	56	56	56	56	56	56	56	57	57
0	-0.6	256	61	60	60	60	59	59	59	60	60	60	61
0	-0.4	264	64	64	63	63	63	63	63	63	63	63	64
0	-0.2	272	68	67	67	66	66	66	66	66	66	66	66
0	0.0	280	71	70	69	69	69	68	68	68	68	69	69
0	0.2	288	73	73	72	71	71	71	71	70	71	71	71
0	0.4	296	76	75	74	74	73	73	73	72	72	72	73
0	0.6	304	78	77	76	75	75	75	74	74	74	74	74
0	0.8	312	79	78	78	77	76	76	76	75	75	75	75
0	1.0	320	81	80	79	78	78	77	77	76	76	76	76

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	48	46	45	44	42	41	40	39	38	38	37
-1	-0.8	248	52	50	49	47	46	45	44	43	42	41	41
-1	-0.6	256	56	54	52	51	50	48	47	46	45	44	44
-1	-0.4	264	59	57	56	54	53	52	50	49	48	47	47
-1	-0.2	272	62	60	59	57	56	54	53	52	51	50	49
-1	0.0	280	65	63	61	60	58	57	56	54	53	52	51
-1	0.2	288	68	66	64	62	61	59	58	56	55	54	53
-1	0.4	296	70	68	66	64	62	61	59	58	57	56	55
-1	0.6	304	72	70	68	66	64	62	61	60	58	57	56
-1	0.8	312	73	71	69	67	65	64	62	61	59	58	57
-1	1.0	320	74	72	70	68	66	65	63	62	60	59	58

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	53	54	55	56	58	60	61	63	65	67	69
1	-0.8	248	57	58	59	60	62	63	65	66	68	70	72
1	-0.6	256	60	61	62	64	65	66	68	70	71	73	75
1	-0.4	264	63	64	65	67	68	69	71	72	74	76	78
1	-0.2	272	66	67	68	69	71	72	73	75	77	78	80
1	0.0	280	69	70	71	72	73	74	76	77	79	80	82
1	0.2	288	71	72	73	74	75	76	78	79	81	82	84
1	0.4	296	73	74	75	76	77	78	79	81	82	84	85
1	0.6	304	75	76	77	77	78	80	81	82	83	85	87
1	0.8	312	77	77	78	79	80	81	82	83	84	86	87
1	1.0	320	78	78	79	80	80	81	83	84	85	86	88

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	53	53	53	53	53	54	54	55	55	56	57
0	-0.8	248	57	56	56	57	57	57	58	58	59	59	60
0	-0.6	256	60	60	60	60	60	60	61	61	62	62	63
0	-0.4	264	63	63	63	63	63	63	63	64	64	65	65
0	-0.2	272	66	66	65	65	65	65	66	66	66	67	68
0	0.0	280	68	68	68	68	68	68	68	68	68	69	70
0	0.2	288	71	70	70	70	70	70	70	70	70	71	71
0	0.4	296	72	72	72	71	71	71	71	71	72	72	72
0	0.6	304	74	73	73	73	72	72	72	72	73	73	73
0	0.8	312	75	75	74	74	73	73	73	73	73	74	74
0	1.0	320	76	75	75	74	74	74	74	74	74	74	74

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	48	47	45	44	43	43	42	41	41	40	40
-1	-0.8	248	51	50	49	48	47	46	45	44	44	43	43
-1	-0.6	256	55	53	52	51	50	49	48	47	46	46	46
-1	-0.4	264	57	56	55	53	52	51	50	50	49	48	48
-1	-0.2	272	60	59	57	56	55	54	53	52	51	50	50
-1	0.0	280	62	61	59	58	57	56	55	54	53	52	51
-1	0.2	288	64	63	61	60	59	57	56	55	54	54	53
-1	0.4	296	66	64	63	61	60	59	58	56	56	55	54
-1	0.6	304	67	66	64	62	61	60	59	57	56	55	55
-1	0.8	312	68	67	65	63	62	60	59	58	57	56	55
-1	1.0	320	69	67	66	64	62	61	60	58	57	56	55

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	68.86
X1	COE1	17.07
X2	COE2	11.39
X3	COE3	-1.1
X4	COE4	0.97
X1*X1	COE11	-3.89
X2*X2	COE22	-2.65
X3*X3	COE33	1.25
X4*X4	COE44	1.29
X1*X2	COE12	0.9
X1*X3	COE13	-2.56
X1*X4	COE14	-1.53
X2*X3	COE23	0.48
X2*X4	COE24	6.02
X3*X4	COE34	1.46

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	49	50	51	52	54	55	57	58	60	62	63
1	-0.8	248	55	56	57	58	59	61	62	63	65	67	69
1	-0.6	256	61	61	62	63	65	66	67	69	70	72	73
1	-0.4	264	66	67	67	68	69	71	72	73	75	76	78
1	-0.2	272	71	71	72	73	74	75	76	78	79	81	82
1	0.0	280	75	76	77	77	78	79	81	82	83	85	86
1	0.2	288	79	80	81	82	82	83	85	86	87	88	90
1	0.4	296	83	84	85	85	86	87	88	89	90	92	93
1	0.6	304	87	88	88	89	90	90	91	92	94	95	96
1	0.8	312	90	91	91	92	93	93	94	95	96	98	99
1	1.0	320	93	94	94	95	95	96	97	98	99	100	101

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	48	48	48	47	48	48	48	48	49	49	50
0	-0.8	248	54	53	53	53	53	53	53	54	54	54	55
0	-0.6	256	59	59	58	58	58	58	58	58	59	59	60
0	-0.4	264	64	63	63	63	63	63	63	63	63	64	64
0	-0.2	272	69	68	68	67	67	67	67	67	67	68	68
0	0.0	280	73	72	72	72	71	71	71	71	71	72	72
0	0.2	288	77	76	76	76	75	75	75	75	75	75	75
0	0.4	296	81	80	80	79	79	78	78	78	78	78	79
0	0.6	304	84	84	83	82	82	82	81	81	81	81	81
0	0.8	312	87	87	86	85	85	84	84	84	84	84	84
0	1.0	320	90	89	89	88	87	87	87	86	86	86	86

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	41	40	38	37	36	35	34	33	33	32	31
-1	-0.8	248	47	45	44	42	41	40	39	38	37	37	36
-1	-0.6	256	52	50	49	47	46	45	44	43	42	41	41
-1	-0.4	264	57	55	54	52	51	50	48	47	46	46	45
-1	-0.2	272	61	60	58	56	55	54	53	51	50	50	49
-1	0.0	280	65	64	62	60	59	58	56	55	54	53	52
-1	0.2	288	69	68	66	64	63	61	60	59	58	57	56
-1	0.4	296	73	71	69	68	66	65	63	62	61	60	59
-1	0.6	304	76	74	72	71	69	67	66	65	63	62	61
-1	0.8	312	79	77	75	73	72	70	69	67	66	65	64
-1	1.0	320	82	80	78	76	74	72	71	69	68	67	66

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
Description: Pittsburgh No. 8 Seam
Circuit: Individual MGS (Coarse Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	49	50	51	53	54	56	57	59	61	63	66
1	-0.8	248	54	55	56	58	59	61	62	64	66	68	70
1	-0.6	256	59	60	61	62	64	65	67	69	71	73	75
1	-0.4	264	63	65	66	67	68	70	71	73	75	77	79
1	-0.2	272	68	69	70	71	72	74	75	77	79	81	82
1	0.0	280	72	73	74	75	76	78	79	81	82	84	86
1	0.2	288	76	77	77	79	80	81	82	84	86	87	89
1	0.4	296	79	80	81	82	83	84	85	87	88	90	92
1	0.6	304	82	83	84	85	86	87	88	90	91	93	94
1	0.8	312	85	86	86	87	88	89	91	92	93	95	97
1	1.0	320	88	88	89	90	91	92	93	94	95	97	98

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	47	47	47	47	47	48	48	49	50	51	52
0	-0.8	248	52	52	52	52	52	53	53	54	54	55	56
0	-0.6	256	57	57	57	57	57	57	58	58	59	60	60
0	-0.4	264	61	61	61	61	61	61	62	62	63	64	64
0	-0.2	272	65	65	65	65	65	65	66	66	67	67	68
0	0.0	280	69	69	69	69	69	69	69	69	70	70	71
0	0.2	288	73	72	72	72	72	72	72	73	73	73	74
0	0.4	296	76	76	75	75	75	75	75	75	76	76	77
0	0.6	304	79	78	78	78	78	78	78	78	78	79	79
0	0.8	312	82	81	81	80	80	80	80	80	80	81	81
0	1.0	320	84	83	83	82	82	82	82	82	82	82	83

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	40	38	37	36	36	35	34	34	33	33	33
-1	-0.8	248	45	43	42	41	40	39	39	38	38	37	37
-1	-0.6	256	49	48	47	46	45	44	43	42	42	41	41
-1	-0.4	264	53	52	51	50	49	48	47	46	46	45	45
-1	-0.2	272	57	56	55	54	52	51	51	50	49	48	48
-1	0.0	280	61	60	58	57	56	55	54	53	52	52	51
-1	0.2	288	65	63	62	60	59	58	57	56	55	54	54
-1	0.4	296	68	66	65	63	62	61	60	59	58	57	56
-1	0.6	304	70	69	67	66	64	63	62	61	60	59	58
-1	0.8	312	73	71	69	68	67	65	64	63	62	61	60
-1	1.0	320	75	73	72	70	68	67	66	65	64	63	62

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	50	52	53	55	57	59	61	63	65	68	70
1	-0.8	248	55	56	58	60	62	63	65	67	70	72	74
1	-0.6	256	60	61	62	64	66	68	70	72	74	76	78
1	-0.4	264	64	65	66	68	70	71	73	75	77	80	82
1	-0.2	272	68	69	70	72	73	75	77	79	81	83	85
1	0.0	280	71	72	74	75	77	78	80	82	84	86	88
1	0.2	288	74	75	77	78	80	81	83	85	87	88	91
1	0.4	296	77	78	80	81	82	84	85	87	89	91	93
1	0.6	304	80	81	82	83	85	86	88	89	91	93	95
1	0.8	312	82	83	84	85	87	88	90	91	93	95	97
1	1.0	320	84	85	86	87	88	90	91	93	94	96	98

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	48	48	49	49	50	51	51	52	53	55	56
0	-0.8	248	53	53	53	54	54	55	56	57	58	59	60
0	-0.6	256	57	57	57	58	58	59	60	60	61	62	64
0	-0.4	264	61	61	61	62	62	63	63	64	65	66	67
0	-0.2	272	65	65	65	65	65	66	67	67	68	69	70
0	0.0	280	68	68	68	68	69	69	70	70	71	72	73
0	0.2	288	71	71	71	71	71	72	72	73	73	74	75
0	0.4	296	74	74	74	74	74	74	75	75	76	76	77
0	0.6	304	76	76	76	76	76	76	77	77	78	78	79
0	0.8	312	78	78	78	78	78	78	78	79	79	80	81
0	1.0	320	80	80	80	79	80	80	80	80	81	81	82

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	40	39	39	38	37	37	37	36	36	36	36
-1	-0.8	248	45	44	43	42	42	41	41	40	40	40	40
-1	-0.6	256	49	48	47	46	46	45	44	44	44	44	44
-1	-0.4	264	53	52	51	50	49	48	48	47	47	47	47
-1	-0.2	272	56	55	54	53	52	52	51	51	50	50	50
-1	0.0	280	59	58	57	56	55	54	54	53	53	52	52
-1	0.2	288	62	61	60	59	58	57	56	56	55	55	54
-1	0.4	296	65	63	62	61	60	59	59	58	57	57	56
-1	0.6	304	67	66	64	63	62	61	60	60	59	58	58
-1	0.8	312	69	68	66	65	64	63	62	61	60	60	59
-1	1.0	320	71	69	68	66	65	64	63	62	62	61	60

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	42.23
X1	COE1	6.79
X2	COE2	6.33
X3	COE3	-2.35
X4	COE4	-1.87
X1*X1	COE11	-5.3
X2*X2	COE22	-3.27
X3*X3	COE33	1.49
X4*X4	COE44	1.42
X1*X2	COE12	1.18
X1*X3	COE13	-1.77
X1*X4	COE14	-2.45
X2*X3	COE23	1.53
X2*X4	COE24	8.21
X3*X4	COE34	-0.13

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	25	26	28	29	31	33	34	36	38	41	43
1	-0.8	248	29	31	32	33	35	36	38	40	42	44	46
1	-0.6	256	33	34	36	37	38	40	41	43	45	47	49
1	-0.4	264	37	38	39	40	41	43	44	46	48	50	52
1	-0.2	272	40	41	42	43	44	45	47	48	50	52	54
1	0.0	280	43	43	44	45	46	48	49	50	52	54	55
1	0.2	288	45	45	46	47	48	49	51	52	53	55	57
1	0.4	296	47	47	48	49	50	51	52	53	54	56	58
1	0.6	304	48	48	49	50	51	52	53	54	55	56	58
1	0.8	312	49	49	50	50	51	52	53	54	55	57	58
1	1.0	320	49	50	50	51	51	52	53	54	55	56	57

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	33	33	32	32	32	32	32	33	33	34	34
0	-0.8	248	37	37	36	36	36	36	36	36	36	37	37
0	-0.6	256	41	40	40	39	39	39	39	39	39	40	40
0	-0.4	264	44	43	43	42	42	42	42	42	42	42	42
0	-0.2	272	47	46	45	45	44	44	44	44	44	44	44
0	0.0	280	49	48	48	47	46	46	46	46	46	46	46
0	0.2	288	51	50	49	49	48	48	47	47	47	47	47
0	0.4	296	53	52	51	50	49	49	48	48	48	47	47
0	0.6	304	54	53	52	51	50	49	49	48	48	48	48
0	0.8	312	55	53	52	51	50	50	49	48	48	47	47
0	1.0	320	55	54	52	51	50	49	49	48	47	47	47

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	34	32	30	29	27	25	24	23	21	20	19
-1	-0.8	248	38	36	34	32	30	29	27	26	24	23	22
-1	-0.6	256	42	39	37	35	33	32	30	28	27	26	25
-1	-0.4	264	45	42	40	38	36	34	32	31	29	28	27
-1	-0.2	272	47	45	42	40	38	36	34	33	31	30	28
-1	0.0	280	49	47	44	42	40	38	36	34	33	31	29
-1	0.2	288	51	49	46	44	41	39	37	35	34	32	30
-1	0.4	296	52	50	47	45	42	40	38	36	34	32	31
-1	0.6	304	53	51	48	45	43	41	38	36	34	32	31
-1	0.8	312	54	51	48	46	43	41	38	36	34	32	30
-1	1.0	320	54	51	48	45	43	40	38	35	33	31	29

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	25	26	27	29	30	32	34	36	38	40	42
1	-0.8	248	29	30	31	32	34	36	37	39	41	43	45
1	-0.6	256	32	33	34	36	37	39	40	42	44	46	48
1	-0.4	264	35	36	37	39	40	41	43	44	46	48	50
1	-0.2	272	38	39	40	41	42	43	45	46	48	50	52
1	0.0	280	40	41	42	43	44	45	47	48	50	51	53
1	0.2	288	42	43	44	45	46	47	48	49	51	52	54
1	0.4	296	44	44	45	46	47	48	49	50	51	53	54
1	0.6	304	45	45	46	46	47	48	49	50	52	53	54
1	0.8	312	45	46	46	47	47	48	49	50	51	53	54
1	1.0	320	45	46	46	47	47	48	49	50	51	52	53

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	31	31	30	30	30	30	30	31	31	32	32
0	-0.8	248	35	34	34	34	33	33	33	34	34	34	35
0	-0.6	256	38	37	37	37	36	36	36	36	37	37	37
0	-0.4	264	41	40	40	39	39	39	39	39	39	39	39
0	-0.2	272	43	43	42	41	41	41	40	40	40	40	41
0	0.0	280	46	45	44	43	43	42	42	42	42	42	42
0	0.2	288	47	46	45	45	44	43	43	43	42	42	42
0	0.4	296	48	47	46	45	45	44	44	43	43	43	43
0	0.6	304	49	48	47	46	45	44	44	43	43	43	42
0	0.8	312	50	48	47	46	45	44	44	43	42	42	42
0	1.0	320	49	48	47	46	45	44	43	42	42	41	41

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	31	29	27	25	23	22	20	19	18	17	16
-1	-0.8	248	34	32	30	28	26	25	23	22	20	19	18
-1	-0.6	256	37	35	33	31	29	27	26	24	23	21	20
-1	-0.4	264	40	38	36	33	31	30	28	26	25	23	22
-1	-0.2	272	42	40	38	35	33	31	29	28	26	25	23
-1	0.0	280	44	42	39	37	35	33	31	29	27	25	24
-1	0.2	288	46	43	40	38	36	34	31	30	28	26	24
-1	0.4	296	47	44	41	39	36	34	32	30	28	26	24
-1	0.6	304	47	44	42	39	36	34	32	30	28	26	24
-1	0.8	312	47	44	41	39	36	34	31	29	27	25	23
-1	1.0	320	47	44	41	38	36	33	30	28	26	24	22

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	27	28	30	31	33	34	36	38	40	42	45
1	-0.8	248	31	32	33	35	36	38	39	41	43	45	47
1	-0.6	256	34	35	36	37	39	40	42	44	45	47	49
1	-0.4	264	37	38	39	40	41	43	44	46	47	49	51
1	-0.2	272	39	40	41	42	43	45	46	47	49	51	53
1	0.0	280	41	42	43	44	45	46	47	49	50	52	54
1	0.2	288	43	43	44	45	46	47	48	50	51	52	54
1	0.4	296	44	44	45	46	47	48	49	50	51	53	54
1	0.6	304	44	45	45	46	47	48	49	50	51	52	54
1	0.8	312	45	45	45	46	47	48	48	49	51	52	53
1	1.0	320	45	45	45	46	46	47	48	49	50	51	52

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	32	32	31	31	31	31	31	31	32	32	33
0	-0.8	248	35	35	34	34	34	34	34	34	34	35	35
0	-0.6	256	38	38	37	37	37	36	36	36	37	37	37
0	-0.4	264	41	40	40	39	39	39	38	38	38	39	39
0	-0.2	272	43	42	42	41	41	40	40	40	40	40	40
0	0.0	280	45	44	43	42	42	41	41	41	41	41	41
0	0.2	288	46	45	44	43	43	42	42	41	41	41	41
0	0.4	296	47	46	45	44	43	43	42	42	41	41	41
0	0.6	304	47	46	45	44	43	42	42	41	41	41	40
0	0.8	312	47	46	45	44	43	42	41	41	40	40	39
0	1.0	320	47	46	44	43	42	41	40	40	39	38	38

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	30	28	26	24	23	21	20	18	17	16	15
-1	-0.8	248	33	31	29	27	25	24	22	21	19	18	17
-1	-0.6	256	36	34	32	30	28	26	24	23	21	20	19
-1	-0.4	264	39	36	34	32	30	28	26	24	23	21	20
-1	-0.2	272	40	38	36	33	31	29	27	26	24	22	21
-1	0.0	280	42	39	37	35	32	30	28	26	25	23	21
-1	0.2	288	43	40	38	35	33	31	29	27	25	23	22
-1	0.4	296	44	41	38	36	33	31	29	27	25	23	21
-1	0.6	304	44	41	38	36	33	31	28	26	24	22	20
-1	0.8	312	44	41	38	35	32	30	28	25	23	21	19
-1	1.0	320	43	40	37	34	31	29	26	24	22	20	18

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	42.94
X1	COE1	10.91
X2	COE2	7.46
X3	COE3	-2.13
X4	COE4	0.56
X1*X1	COE11	-5.3
X2*X2	COE22	-3.27
X3*X3	COE33	1.49
X4*X4	COE44	1.42
X1*X2	COE12	1.18
X1*X3	COE13	-1.77
X1*X4	COE14	-2.45
X2*X3	COE23	1.53
X2*X4	COE24	8.21
X3*X4	COE34	-0.13

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	20	22	24	26	28	30	32	35	37	40	43
1	-0.8	248	25	27	29	31	33	35	37	39	42	44	47
1	-0.6	256	30	32	33	35	37	39	41	43	46	48	51
1	-0.4	264	34	36	37	39	41	43	45	47	49	52	54
1	-0.2	272	38	40	41	43	44	46	48	50	52	55	57
1	0.0	280	42	43	44	46	47	49	51	53	55	57	60
1	0.2	288	45	46	47	49	50	52	54	55	57	59	62
1	0.4	296	47	48	50	51	52	54	56	57	59	61	63
1	0.6	304	50	51	52	53	54	56	57	59	61	62	64
1	0.8	312	51	52	53	54	56	57	58	60	62	63	65
1	1.0	320	53	54	54	55	57	58	59	61	62	64	66

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	27	27	27	28	28	29	29	30	31	32	33
0	-0.8	248	32	32	32	32	33	33	34	34	35	36	37
0	-0.6	256	36	36	36	36	37	37	38	38	39	40	41
0	-0.4	264	40	40	40	40	40	41	41	42	42	43	44
0	-0.2	272	44	44	44	44	44	44	44	45	45	46	46
0	0.0	280	47	47	47	47	46	47	47	47	47	48	49
0	0.2	288	50	50	49	49	49	49	49	49	50	50	51
0	0.4	296	52	52	51	51	51	51	51	51	51	51	52
0	0.6	304	54	54	53	53	52	52	52	52	52	53	53
0	0.8	312	56	55	55	54	54	53	53	53	53	53	53
0	1.0	320	57	56	56	55	54	54	54	53	53	53	54

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	27	26	24	23	22	21	20	19	18	17	17
-1	-0.8	248	32	30	29	27	26	25	24	23	22	21	21
-1	-0.6	256	36	34	33	31	30	29	27	26	25	25	24
-1	-0.4	264	40	38	36	35	33	32	31	30	28	28	27
-1	-0.2	272	43	41	40	38	36	35	33	32	31	30	29
-1	0.0	280	46	44	42	41	39	37	36	35	33	32	31
-1	0.2	288	49	47	45	43	41	39	38	36	35	34	33
-1	0.4	296	51	49	47	45	43	41	39	38	37	35	34
-1	0.6	304	53	50	48	46	44	42	41	39	37	36	35
-1	0.8	312	54	52	49	47	45	43	41	40	38	36	35
-1	1.0	320	55	52	50	48	46	44	42	40	38	36	35

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	20	22	24	25	28	30	32	34	37	40	42
1	-0.8	248	25	26	28	30	32	34	36	39	41	44	46
1	-0.6	256	29	31	32	34	36	38	40	42	45	47	50
1	-0.4	264	33	35	36	38	40	41	43	46	48	50	53
1	-0.2	272	37	38	39	41	43	45	46	48	51	53	55
1	0.0	280	40	41	42	44	45	47	49	51	53	55	57
1	0.2	288	42	44	45	46	48	49	51	53	55	57	59
1	0.4	296	45	46	47	48	50	51	53	54	56	58	60
1	0.6	304	47	48	49	50	51	52	54	56	57	59	61
1	0.8	312	48	49	50	51	52	53	55	56	58	60	62
1	1.0	320	49	50	51	52	53	54	55	57	58	60	62

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	25	25	25	26	26	27	27	28	29	30	31
0	-0.8	248	30	30	30	30	30	31	31	32	33	34	35
0	-0.6	256	34	34	34	34	34	34	35	36	36	37	38
0	-0.4	264	38	37	37	37	37	38	38	39	39	40	41
0	-0.2	272	41	41	40	40	40	41	41	41	42	42	43
0	0.0	280	44	43	43	43	43	43	43	43	44	44	45
0	0.2	288	46	46	45	45	45	45	45	45	45	46	46
0	0.4	296	48	48	47	47	47	46	46	47	47	47	47
0	0.6	304	50	49	49	48	48	48	47	47	48	48	48
0	0.8	312	51	50	50	49	49	48	48	48	48	48	48
0	1.0	320	52	51	50	50	49	49	48	48	48	48	48

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	24	22	21	19	18	17	16	15	15	14	13
-1	-0.8	248	28	26	25	24	22	21	20	19	18	17	17
-1	-0.6	256	32	30	29	27	26	24	23	22	21	20	20
-1	-0.4	264	36	34	32	30	29	27	26	25	24	23	22
-1	-0.2	272	39	37	35	33	32	30	29	27	26	25	24
-1	0.0	280	41	39	37	35	34	32	31	29	28	27	26
-1	0.2	288	44	41	39	37	36	34	32	31	30	28	27
-1	0.4	296	45	43	41	39	37	35	34	32	31	29	28
-1	0.6	304	47	44	42	40	38	36	34	33	31	30	28
-1	0.8	312	48	45	43	41	39	37	35	33	31	30	28
-1	1.0	320	48	46	43	41	39	37	35	33	31	29	28

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	23	24	26	28	30	32	35	37	40	42	45
1	-0.8	248	27	29	31	32	34	36	39	41	43	46	48
1	-0.6	256	31	33	34	36	38	40	42	44	46	49	51
1	-0.4	264	35	36	38	39	41	43	45	47	49	52	54
1	-0.2	272	38	39	41	42	44	46	48	50	52	54	56
1	0.0	280	41	42	43	45	46	48	50	52	54	56	58
1	0.2	288	43	44	45	47	48	50	52	53	55	57	59
1	0.4	296	45	46	47	48	50	51	53	55	56	58	60
1	0.6	304	47	47	49	50	51	52	54	55	57	59	61
1	0.8	312	48	48	49	50	52	53	54	56	57	59	61
1	1.0	320	48	49	50	51	52	53	54	56	57	59	61

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	26	26	27	27	27	28	28	29	30	31	32
0	-0.8	248	31	31	31	31	31	32	32	33	34	34	35
0	-0.6	256	34	34	34	34	35	35	35	36	37	37	38
0	-0.4	264	38	38	37	37	38	38	38	39	39	40	41
0	-0.2	272	41	40	40	40	40	40	41	41	41	42	43
0	0.0	280	43	43	43	42	42	42	42	43	43	44	44
0	0.2	288	45	45	44	44	44	44	44	44	44	45	45
0	0.4	296	47	46	46	46	45	45	45	45	45	46	46
0	0.6	304	48	48	47	47	46	46	46	46	46	46	46
0	0.8	312	49	48	48	47	47	46	46	46	46	46	46
0	1.0	320	50	49	48	47	47	46	46	46	45	45	46

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	24	22	20	19	18	17	16	15	14	13	13
-1	-0.8	248	28	26	24	23	22	20	19	18	17	17	16
-1	-0.6	256	31	29	28	26	25	23	22	21	20	19	18
-1	-0.4	264	34	32	31	29	27	26	25	24	22	21	21
-1	-0.2	272	37	35	33	31	30	28	27	26	24	23	22
-1	0.0	280	39	37	35	33	32	30	29	27	26	25	24
-1	0.2	288	41	39	37	35	33	31	30	28	27	26	25
-1	0.4	296	43	40	38	36	34	32	31	29	28	26	25
-1	0.6	304	44	41	39	37	35	33	31	29	28	26	25
-1	0.8	312	44	42	39	37	35	33	31	29	28	26	25
-1	1.0	320	44	42	39	37	35	33	31	29	27	25	24

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	43.65
X1	COE1	15.03
X2	COE2	8.59
X3	COE3	-1.91
X4	COE4	2.99
X1*X1	COE11	-5.3
X2*X2	COE22	-3.27
X3*X3	COE33	1.49
X4*X4	COE44	1.42
X1*X2	COE12	1.18
X1*X3	COE13	-1.77
X1*X4	COE14	-2.45
X2*X3	COE23	1.53
X2*X4	COE24	8.21
X3*X4	COE34	-0.13

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	15	17	20	22	25	28	30	33	36	39	43
1	-0.8	248	21	23	26	28	30	33	36	39	42	45	48
1	-0.6	256	27	29	31	33	36	38	41	43	46	49	52
1	-0.4	264	32	34	36	38	40	43	45	48	51	54	57
1	-0.2	272	37	38	40	43	45	47	49	52	55	57	60
1	0.0	280	41	43	45	47	49	51	53	56	58	61	64
1	0.2	288	45	46	48	50	52	54	56	59	61	64	66
1	0.4	296	48	50	51	53	55	57	59	62	64	66	69
1	0.6	304	51	53	54	56	58	60	62	64	66	69	71
1	0.8	312	54	55	57	58	60	62	64	66	68	70	73
1	1.0	320	56	57	59	60	62	64	65	67	69	72	74

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	21	21	22	23	24	25	26	27	29	30	32
0	-0.8	248	27	27	28	28	29	30	31	32	34	35	37
0	-0.6	256	32	32	33	33	34	35	36	37	38	40	41
0	-0.4	264	37	37	38	38	39	39	40	41	42	44	45
0	-0.2	272	41	41	42	42	43	43	44	45	46	47	49
0	0.0	280	45	45	46	46	46	47	48	49	49	50	52
0	0.2	288	49	49	49	49	50	50	51	51	52	53	54
0	0.4	296	52	52	52	52	53	53	53	54	55	56	56
0	0.6	304	55	55	55	55	55	55	56	56	57	57	58
0	0.8	312	57	57	57	57	57	57	57	58	58	59	60
0	1.0	320	59	59	59	59	58	59	59	59	59	60	61

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	20	19	18	17	16	16	15	15	15	15	15
-1	-0.8	248	25	24	23	22	22	21	20	20	19	19	19
-1	-0.6	256	30	29	28	27	26	25	25	24	24	23	23
-1	-0.4	264	35	34	33	31	31	30	29	28	28	27	27
-1	-0.2	272	39	38	37	35	34	33	33	32	31	31	30
-1	0.0	280	43	42	40	39	38	37	36	35	34	34	33
-1	0.2	288	47	45	43	42	41	40	39	38	37	36	35
-1	0.4	296	50	48	46	45	43	42	41	40	39	38	37
-1	0.6	304	52	50	49	47	46	44	43	42	41	40	39
-1	0.8	312	54	52	51	49	47	46	44	43	42	41	40
-1	1.0	320	56	54	52	50	49	47	46	44	43	42	41

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	15	17	20	22	25	27	30	33	36	39	43
1	-0.8	248	21	23	25	28	30	33	35	38	41	44	47
1	-0.6	256	26	28	30	32	35	37	40	43	45	48	51
1	-0.4	264	31	33	35	37	39	42	44	47	49	52	55
1	-0.2	272	35	37	39	41	43	46	48	50	53	56	59
1	0.0	280	39	41	43	45	47	49	51	54	56	59	62
1	0.2	288	43	44	46	48	50	52	54	57	59	61	64
1	0.4	296	46	47	49	51	53	55	57	59	61	64	66
1	0.6	304	48	50	51	53	55	57	59	61	63	65	68
1	0.8	312	51	52	54	55	57	59	60	62	65	67	69
1	1.0	320	53	54	55	57	58	60	62	64	66	68	70

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	19	20	21	21	22	23	24	26	27	29	30
0	-0.8	248	25	25	26	26	27	28	29	30	32	33	35
0	-0.6	256	30	30	31	31	32	33	34	35	36	37	39
0	-0.4	264	34	35	35	35	36	37	38	39	40	41	42
0	-0.2	272	38	39	39	39	40	40	41	42	43	44	45
0	0.0	280	42	42	42	43	43	44	44	45	46	47	48
0	0.2	288	45	45	45	46	46	47	47	48	48	49	50
0	0.4	296	48	48	48	48	48	49	49	50	51	51	52
0	0.6	304	51	50	50	50	51	51	51	52	52	53	54
0	0.8	312	53	52	52	52	52	52	53	53	53	54	55
0	1.0	320	54	54	54	53	53	53	54	54	54	55	55

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	17	16	15	14	13	13	12	12	11	11	11
-1	-0.8	248	22	21	20	19	18	17	17	16	16	16	15
-1	-0.6	256	27	25	24	23	22	22	21	20	20	19	19
-1	-0.4	264	31	30	28	27	26	25	25	24	23	23	23
-1	-0.2	272	35	34	32	31	30	29	28	27	26	26	25
-1	0.0	280	38	37	35	34	33	32	31	30	29	29	28
-1	0.2	288	41	40	38	37	36	34	33	32	31	31	30
-1	0.4	296	44	42	41	39	38	36	35	34	33	32	32
-1	0.6	304	46	44	43	41	40	38	37	36	35	34	33
-1	0.8	312	48	46	44	43	41	39	38	37	36	35	34
-1	1.0	320	49	47	45	44	42	40	39	37	36	35	34

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	18	20	23	25	28	30	33	36	39	42	45
1	-0.8	248	24	26	28	30	33	35	38	41	43	46	50
1	-0.6	256	28	30	32	35	37	40	42	45	48	50	53
1	-0.4	264	33	35	37	39	41	43	46	49	51	54	57
1	-0.2	272	37	39	41	43	45	47	49	52	54	57	60
1	0.0	280	40	42	44	46	48	50	52	55	57	60	63
1	0.2	288	44	45	47	49	51	53	55	57	60	62	65
1	0.4	296	46	48	49	51	53	55	57	59	62	64	67
1	0.6	304	49	50	52	53	55	57	59	61	63	65	68
1	0.8	312	51	52	53	55	56	58	60	62	64	66	69
1	1.0	320	52	53	55	56	58	59	61	63	65	67	69

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	21	21	22	23	24	25	26	27	28	30	31
0	-0.8	248	26	26	27	28	28	29	30	31	33	34	35
0	-0.6	256	30	31	31	32	33	33	34	35	36	38	39
0	-0.4	264	35	35	35	36	36	37	38	39	40	41	42
0	-0.2	272	38	39	39	39	40	40	41	42	43	44	45
0	0.0	280	42	42	42	42	43	43	44	45	45	46	48
0	0.2	288	45	45	45	45	45	46	46	47	48	48	49
0	0.4	296	47	47	47	47	47	48	48	49	49	50	51
0	0.6	304	49	49	49	49	49	49	50	50	51	51	52
0	0.8	312	51	51	50	50	50	50	51	51	51	52	53
0	1.0	320	52	52	51	51	51	51	51	52	52	52	53

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	17	16	15	14	13	12	12	12	11	11	11
-1	-0.8	248	22	20	19	18	18	17	16	16	15	15	15
-1	-0.6	256	26	25	24	22	22	21	20	19	19	18	18
-1	-0.4	264	30	29	27	26	25	24	23	23	22	22	21
-1	-0.2	272	33	32	31	29	28	27	26	25	25	24	24
-1	0.0	280	37	35	34	32	31	30	29	28	27	26	26
-1	0.2	288	39	38	36	35	33	32	31	30	29	28	28
-1	0.4	296	42	40	38	37	35	34	33	32	31	30	29
-1	0.6	304	43	42	40	38	37	35	34	33	32	31	30
-1	0.8	312	45	43	41	39	38	36	35	33	32	31	30
-1	1.0	320	46	44	42	40	38	37	35	34	32	31	30

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	64
X1	COE1	3.46
X2	COE2	3.01
X3	COE3	-1.44
X4	COE4	-4.16
X1*X1	COE11	-6.46
X2*X2	COE22	-5.17
X3*X3	COE33	0.97
X4*X4	COE44	1.41
X1*X2	COE12	-11.19
X1*X3	COE13	-0.55
X1*X4	COE14	-3.02
X2*X3	COE23	1.46
X2*X4	COE24	2.12
X3*X4	COE34	1.78

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	66	65	64	64	64	64	63	63	64	64	64
1	-0.8	248	67	66	66	65	65	64	64	64	64	64	64
1	-0.6	256	68	67	66	66	65	65	64	64	64	64	64
1	-0.4	264	69	68	67	66	65	65	64	64	64	63	63
1	-0.2	272	69	67	66	65	65	64	63	63	63	62	62
1	0.0	280	68	67	66	65	64	63	62	61	61	61	60
1	0.2	288	67	66	64	63	62	61	60	60	59	58	58
1	0.4	296	65	64	62	61	60	59	58	57	56	56	55
1	0.6	304	63	62	60	59	57	56	55	54	53	53	52
1	0.8	312	61	59	57	56	54	53	52	51	50	49	48
1	1.0	320	57	56	54	52	51	49	48	47	46	45	44

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	60	59	58	57	57	56	55	55	55	55	54
0	-0.8	248	64	63	62	61	60	59	58	58	57	57	57
0	-0.6	256	67	66	65	64	63	62	61	60	60	59	59
0	-0.4	264	70	68	67	66	65	64	63	62	61	61	60
0	-0.2	272	72	71	69	68	66	65	64	63	63	62	61
0	0.0	280	74	72	70	69	68	66	65	64	63	63	62
0	0.2	288	75	73	71	70	68	67	66	65	64	63	62
0	0.4	296	76	74	72	70	68	67	66	64	63	62	61
0	0.6	304	76	74	72	70	68	66	65	64	62	61	60
0	0.8	312	75	73	71	69	67	65	64	62	61	60	59
0	1.0	320	74	72	70	68	66	64	62	61	59	58	56

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	44	43	42	40	39	38	37	36	36	35	34
-1	-0.8	248	50	49	47	46	45	43	42	41	41	40	39
-1	-0.6	256	56	54	53	51	50	48	47	46	45	44	43
-1	-0.4	264	61	59	57	56	54	53	51	50	49	48	47
-1	-0.2	272	65	63	61	60	58	56	55	54	52	51	50
-1	0.0	280	69	67	65	63	61	60	58	57	55	54	53
-1	0.2	288	73	70	68	66	64	62	61	59	58	56	55
-1	0.4	296	75	73	71	69	67	65	63	61	60	58	57
-1	0.6	304	78	75	73	71	69	66	65	63	61	59	58
-1	0.8	312	80	77	75	72	70	68	66	64	62	60	59
-1	1.0	320	81	78	76	73	71	68	66	64	62	60	59

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	64	63	63	63	63	63	63	64	64	65	66
1	-0.8	248	65	64	64	64	64	64	64	64	65	65	66
1	-0.6	256	66	65	65	64	64	64	64	64	65	65	65
1	-0.4	264	66	65	65	64	64	64	64	64	64	64	64
1	-0.2	272	66	65	64	64	63	63	63	63	63	63	63
1	0.0	280	65	64	64	63	62	62	61	61	61	61	61
1	0.2	288	64	63	62	61	61	60	60	59	59	59	59
1	0.4	296	62	61	60	59	58	58	57	57	56	56	56
1	0.6	304	60	59	58	57	56	55	54	54	53	53	52
1	0.8	312	57	56	55	54	52	52	51	50	49	49	48
1	1.0	320	54	53	51	50	49	48	47	46	45	45	44

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	57	56	55	55	54	54	54	54	54	54	54
0	-0.8	248	60	59	59	58	58	57	57	57	57	57	57
0	-0.6	256	63	62	62	61	60	60	59	59	59	59	59
0	-0.4	264	66	65	64	63	62	62	61	61	60	60	60
0	-0.2	272	68	67	66	65	64	63	62	62	61	61	61
0	0.0	280	70	68	67	66	65	64	63	63	62	62	61
0	0.2	288	71	69	68	67	65	64	64	63	62	62	61
0	0.4	296	71	70	68	67	65	64	63	62	62	61	60
0	0.6	304	71	69	68	66	65	64	63	62	61	60	59
0	0.8	312	71	69	67	65	64	63	61	60	59	58	57
0	1.0	320	70	68	66	64	62	61	60	58	57	56	55

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	39	38	37	36	35	35	34	34	33	33	33
-1	-0.8	248	45	44	43	42	41	40	39	39	38	38	38
-1	-0.6	256	51	49	48	47	46	45	44	43	43	42	42
-1	-0.4	264	55	54	52	51	50	49	48	47	46	46	45
-1	-0.2	272	60	58	57	55	54	53	52	51	50	49	48
-1	0.0	280	64	62	60	59	57	56	55	54	53	52	51
-1	0.2	288	67	65	63	61	60	58	57	56	55	54	53
-1	0.4	296	70	68	66	64	62	61	59	58	57	56	55
-1	0.6	304	72	70	68	66	64	62	61	59	58	57	56
-1	0.8	312	74	71	69	67	65	63	62	60	59	57	56
-1	1.0	320	75	72	70	68	66	64	62	61	59	57	56

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	63	63	64	64	64	65	65	66	67	68	69
1	-0.8	248	65	64	65	65	65	65	66	66	67	68	69
1	-0.6	256	65	65	65	65	65	65	66	66	67	68	68
1	-0.4	264	66	65	65	65	65	65	65	66	66	67	67
1	-0.2	272	65	65	65	64	64	64	64	65	65	65	66
1	0.0	280	65	64	63	63	63	63	63	63	63	64	64
1	0.2	288	63	63	62	61	61	61	61	61	61	61	61
1	0.4	296	61	61	60	59	59	58	58	58	58	58	58
1	0.6	304	59	58	57	57	56	56	55	55	55	55	55
1	0.8	312	56	55	54	53	53	52	52	51	51	51	51
1	1.0	320	53	52	51	50	49	48	47	47	47	46	46

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	55	55	54	54	54	54	54	55	55	56	56
0	-0.8	248	58	58	58	57	57	57	57	57	58	58	59
0	-0.6	256	61	61	60	60	60	59	59	59	60	60	60
0	-0.4	264	64	63	63	62	62	61	61	61	61	61	62
0	-0.2	272	66	65	64	64	63	63	62	62	62	62	62
0	0.0	280	67	66	65	65	64	64	63	63	63	63	63
0	0.2	288	68	67	66	65	65	64	63	63	63	62	62
0	0.4	296	69	67	66	65	64	64	63	62	62	62	61
0	0.6	304	69	67	66	65	64	63	62	61	61	60	60
0	0.8	312	68	66	65	64	63	62	61	60	59	59	58
0	1.0	320	67	65	64	62	61	60	59	58	57	57	56

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	36	35	35	34	34	33	33	33	33	33	33
-1	-0.8	248	42	41	40	40	39	38	38	38	38	38	38
-1	-0.6	256	47	46	45	44	44	43	43	42	42	42	42
-1	-0.4	264	52	51	50	49	48	47	47	46	46	45	45
-1	-0.2	272	56	55	54	53	52	51	50	49	49	49	48
-1	0.0	280	60	58	57	56	55	54	53	52	52	51	51
-1	0.2	288	63	61	60	59	58	56	55	55	54	53	53
-1	0.4	296	66	64	62	61	60	58	57	56	56	55	54
-1	0.6	304	68	66	64	63	61	60	59	58	57	56	55
-1	0.8	312	69	67	66	64	62	61	60	58	57	56	56
-1	1.0	320	70	68	67	65	63	62	60	59	58	56	55

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	63.06
X1	COE1	5.54
X2	COE2	4.07
X3	COE3	-0.59
X4	COE4	-2.55
X1*X1	COE11	-6.46
X2*X2	COE22	-5.17
X3*X3	COE33	0.97
X4*X4	COE44	1.41
X1*X2	COE12	-11.19
X1*X3	COE13	-0.55
X1*X4	COE14	-3.02
X2*X3	COE23	1.46
X2*X4	COE24	2.12
X3*X4	COE34	1.78

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
Description: Pittsburgh No. 8 Seam
Circuit: Individual MGS (Intermediate Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	61	61	61	61	61	61	61	61	62	62	63
1	-0.8	248	63	63	62	62	62	62	62	62	63	63	64
1	-0.6	256	65	64	64	63	63	63	63	63	63	63	64
1	-0.4	264	65	65	64	64	63	63	63	63	63	63	63
1	-0.2	272	66	65	64	64	63	63	63	62	62	62	63
1	0.0	280	66	65	64	63	63	62	62	61	61	61	61
1	0.2	288	65	64	63	62	61	61	60	60	60	59	59
1	0.4	296	64	63	62	61	60	59	58	58	57	57	57
1	0.6	304	62	61	60	59	58	57	56	55	55	54	54
1	0.8	312	60	58	57	56	55	54	53	52	52	51	51
1	1.0	320	57	56	54	53	52	51	50	49	48	47	47

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	55	54	53	53	52	52	52	52	52	52	52
0	-0.8	248	59	58	57	57	56	56	55	55	55	55	55
0	-0.6	256	63	62	61	60	59	59	58	58	58	58	58
0	-0.4	264	66	65	64	63	62	61	61	60	60	60	59
0	-0.2	272	68	67	66	65	64	63	62	62	61	61	61
0	0.0	280	70	69	68	67	66	65	64	63	63	62	62
0	0.2	288	72	70	69	68	67	66	65	64	63	63	62
0	0.4	296	73	71	70	68	67	66	65	64	63	62	62
0	0.6	304	74	72	70	69	67	66	65	64	63	62	61
0	0.8	312	74	72	70	68	67	65	64	63	62	61	60
0	1.0	320	73	71	69	67	66	64	63	62	60	59	58

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	38	37	36	35	34	33	32	32	32	31	31
-1	-0.8	248	44	43	42	41	40	39	38	37	37	37	36
-1	-0.6	256	50	49	47	46	45	44	43	43	42	41	41
-1	-0.4	264	56	54	53	51	50	49	48	47	46	46	45
-1	-0.2	272	60	59	57	56	54	53	52	51	50	49	49
-1	0.0	280	65	63	61	60	58	57	56	54	53	53	52
-1	0.2	288	69	67	65	63	62	60	59	57	56	55	54
-1	0.4	296	72	70	68	66	64	63	61	60	59	57	56
-1	0.6	304	75	72	70	68	67	65	63	62	60	59	58
-1	0.8	312	77	75	72	70	68	67	65	63	62	60	59
-1	1.0	320	79	76	74	72	70	68	66	64	62	61	60

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	60	60	60	60	61	61	62	62	63	64	65
1	-0.8	248	62	62	62	62	62	62	63	63	64	65	66
1	-0.6	256	63	63	63	63	63	63	63	64	64	65	66
1	-0.4	264	64	63	63	63	63	63	63	64	64	65	65
1	-0.2	272	64	64	63	63	63	63	63	63	63	64	64
1	0.0	280	64	63	63	62	62	62	62	62	62	63	63
1	0.2	288	63	62	62	61	61	61	60	60	60	61	61
1	0.4	296	62	61	60	60	59	59	58	58	58	58	58
1	0.6	304	60	59	58	57	57	56	56	56	55	55	55
1	0.8	312	58	56	56	55	54	53	53	52	52	52	52
1	1.0	320	55	54	52	51	51	50	49	49	48	48	48

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	52	52	51	51	51	51	51	51	52	52	53
0	-0.8	248	56	56	55	55	55	54	55	55	55	55	56
0	-0.6	256	60	59	58	58	58	57	57	57	57	58	58
0	-0.4	264	63	62	61	61	60	60	60	59	60	60	60
0	-0.2	272	65	64	63	63	62	62	61	61	61	61	61
0	0.0	280	67	66	65	64	64	63	63	62	62	62	62
0	0.2	288	68	67	66	65	65	64	63	63	63	62	62
0	0.4	296	69	68	67	66	65	64	64	63	62	62	62
0	0.6	304	70	68	67	66	65	64	63	63	62	61	61
0	0.8	312	70	68	67	66	64	63	62	62	61	60	60
0	1.0	320	69	67	66	65	63	62	61	60	59	59	58

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	34	33	32	32	31	31	30	30	30	30	30
-1	-0.8	248	40	39	38	37	37	36	36	36	35	35	35
-1	-0.6	256	46	45	44	43	42	41	41	41	40	40	40
-1	-0.4	264	51	50	49	48	47	46	45	45	45	44	44
-1	-0.2	272	56	54	53	52	51	50	49	49	48	48	48
-1	0.0	280	60	58	57	56	55	54	53	52	52	51	51
-1	0.2	288	64	62	61	59	58	57	56	55	54	54	53
-1	0.4	296	67	65	64	62	61	59	58	57	56	56	55
-1	0.6	304	69	68	66	64	63	62	60	59	58	57	56
-1	0.8	312	72	70	68	66	65	63	62	60	59	58	57
-1	1.0	320	73	71	69	67	66	64	63	61	60	59	58

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	61	61	61	62	63	64	64	66	67	68	69
1	-0.8	248	62	63	63	63	64	65	65	66	67	69	70
1	-0.6	256	63	64	64	64	65	65	66	67	68	69	70
1	-0.4	264	64	64	64	64	65	65	66	66	67	68	69
1	-0.2	272	64	64	64	64	64	65	65	66	66	67	68
1	0.0	280	64	64	63	63	64	64	64	65	65	66	67
1	0.2	288	63	63	62	62	62	62	63	63	63	64	64
1	0.4	296	62	61	61	60	60	60	60	61	61	61	62
1	0.6	304	60	59	59	58	58	58	58	58	58	58	59
1	0.8	312	57	56	56	55	55	55	55	55	55	55	55
1	1.0	320	54	53	53	52	52	51	51	51	51	51	51

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	51	51	51	51	52	52	52	53	54	55	56
0	-0.8	248	55	55	55	55	55	55	56	56	57	58	58
0	-0.6	256	58	58	58	58	58	58	58	59	59	60	61
0	-0.4	264	61	61	61	60	60	60	61	61	61	62	62
0	-0.2	272	64	63	63	62	62	62	62	62	63	63	63
0	0.0	280	66	65	64	64	64	63	63	63	63	64	64
0	0.2	288	67	66	66	65	65	64	64	64	64	64	64
0	0.4	296	68	67	66	65	65	64	64	64	64	64	64
0	0.6	304	68	67	66	65	65	64	64	63	63	63	63
0	0.8	312	68	67	66	65	64	63	63	62	62	62	62
0	1.0	320	67	66	65	64	63	62	61	61	60	60	60

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	31	31	31	30	30	30	30	30	31	31	32
-1	-0.8	248	38	37	36	36	36	36	36	36	36	36	37
-1	-0.6	256	43	42	42	41	41	41	41	41	41	41	41
-1	-0.4	264	48	47	47	46	46	45	45	45	45	45	45
-1	-0.2	272	53	52	51	50	50	49	49	49	48	48	48
-1	0.0	280	57	56	55	54	53	53	52	52	52	51	51
-1	0.2	288	61	59	58	57	56	56	55	55	54	54	54
-1	0.4	296	64	62	61	60	59	58	57	57	56	56	55
-1	0.6	304	66	65	63	62	61	60	59	58	58	57	57
-1	0.8	312	68	67	65	64	63	62	61	60	59	58	58
-1	1.0	320	70	68	67	65	64	62	61	60	59	59	58

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	62.12
X1	COE1	7.62
X2	COE2	5.13
X3	COE3	0.26
X4	COE4	-0.94
X1*X1	COE11	-6.46
X2*X2	COE22	-5.17
X3*X3	COE33	0.97
X4*X4	COE44	1.41
X1*X2	COE12	-11.19
X1*X3	COE13	-0.55
X1*X4	COE14	-3.02
X2*X3	COE23	1.46
X2*X4	COE24	2.12
X3*X4	COE34	1.78

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	57	57	57	57	57	58	58	59	60	61	62
1	-0.8	248	59	59	59	59	59	60	60	61	61	62	63
1	-0.6	256	61	61	61	61	61	61	61	62	62	63	63
1	-0.4	264	62	62	62	61	61	62	62	62	62	63	64
1	-0.2	272	63	63	62	62	62	62	62	62	62	63	63
1	0.0	280	63	63	62	62	62	61	61	61	61	62	62
1	0.2	288	63	62	62	61	61	60	60	60	60	60	61
1	0.4	296	62	61	61	60	60	59	59	59	59	59	59
1	0.6	304	61	60	59	58	58	57	57	56	56	56	56
1	0.8	312	59	58	57	56	55	55	54	54	53	53	53
1	1.0	320	57	56	55	54	53	52	51	51	50	50	50

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	49	49	49	48	48	48	48	49	49	49	50
0	-0.8	248	54	53	53	53	52	52	52	52	52	53	53
0	-0.6	256	58	57	57	56	56	56	55	55	56	56	56
0	-0.4	264	61	61	60	59	59	59	58	58	58	58	58
0	-0.2	272	64	64	63	62	61	61	61	60	60	60	60
0	0.0	280	67	66	65	64	63	63	62	62	62	62	62
0	0.2	288	69	68	67	66	65	64	64	63	63	62	62
0	0.4	296	70	69	68	67	66	65	64	64	63	63	63
0	0.6	304	71	70	69	67	66	65	65	64	63	63	62
0	0.8	312	72	70	69	68	66	65	64	63	63	62	62
0	1.0	320	72	70	68	67	66	65	63	62	62	61	60

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	31	31	30	29	29	28	28	28	28	28	28
-1	-0.8	248	38	37	36	36	35	34	34	34	33	33	33
-1	-0.6	256	44	43	42	41	41	40	39	39	39	39	38
-1	-0.4	264	50	49	48	47	46	45	45	44	44	43	43
-1	-0.2	272	56	54	53	52	51	50	49	48	48	47	47
-1	0.0	280	60	59	57	56	55	54	53	52	52	51	51
-1	0.2	288	64	63	61	60	59	58	57	56	55	54	54
-1	0.4	296	68	66	65	63	62	61	60	59	58	57	56
-1	0.6	304	71	70	68	66	65	63	62	61	60	59	58
-1	0.8	312	74	72	70	68	67	65	64	63	61	60	59
-1	1.0	320	76	74	72	70	69	67	65	64	63	62	60

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	56	57	57	58	58	59	60	61	62	63	65
1	-0.8	248	59	59	59	60	60	61	62	62	63	65	66
1	-0.6	256	60	60	61	61	61	62	63	63	64	65	66
1	-0.4	264	61	61	62	62	62	62	63	64	64	65	66
1	-0.2	272	62	62	62	62	62	63	63	63	64	65	66
1	0.0	280	62	62	62	62	62	62	62	63	63	64	65
1	0.2	288	62	62	61	61	61	61	61	62	62	62	63
1	0.4	296	61	61	60	60	60	60	60	60	60	60	61
1	0.6	304	60	59	58	58	58	58	58	58	58	58	58
1	0.8	312	58	57	56	56	55	55	55	55	55	55	55
1	1.0	320	55	54	54	53	52	52	52	51	51	51	52

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	47	47	47	47	48	48	49	49	50	51	52
0	-0.8	248	52	52	52	52	52	52	52	53	53	54	55
0	-0.6	256	56	55	55	55	55	55	55	56	56	57	58
0	-0.4	264	59	59	58	58	58	58	58	58	59	59	60
0	-0.2	272	62	62	61	61	60	60	60	60	61	61	61
0	0.0	280	64	64	63	63	62	62	62	62	62	62	63
0	0.2	288	66	66	65	64	64	63	63	63	63	63	63
0	0.4	296	68	67	66	65	65	64	64	64	63	63	63
0	0.6	304	69	67	67	66	65	64	64	63	63	63	63
0	0.8	312	69	68	67	66	65	64	63	63	63	62	62
0	1.0	320	69	67	66	65	64	63	63	62	61	61	61

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	28	27	27	27	27	27	27	27	27	27	28
-1	-0.8	248	35	34	34	33	33	33	33	33	33	33	33
-1	-0.6	256	41	40	39	39	39	38	38	38	38	38	38
-1	-0.4	264	47	46	45	44	44	43	43	43	43	43	43
-1	-0.2	272	52	51	50	49	48	48	47	47	47	47	47
-1	0.0	280	56	55	54	53	52	52	51	51	50	50	50
-1	0.2	288	60	59	58	57	56	55	55	54	54	53	53
-1	0.4	296	64	63	61	60	59	58	58	57	56	56	55
-1	0.6	304	67	66	64	63	62	61	60	59	58	58	57
-1	0.8	312	70	68	67	65	64	63	62	61	60	59	59
-1	1.0	320	72	70	68	67	65	64	63	62	61	60	60

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	58	59	59	60	61	62	64	65	67	68	70
1	-0.8	248	60	61	61	62	63	64	65	66	68	69	71
1	-0.6	256	62	62	63	63	64	65	66	67	68	70	71
1	-0.4	264	63	63	63	64	65	65	66	67	68	70	71
1	-0.2	272	63	63	64	64	65	65	66	67	68	69	70
1	0.0	280	63	63	64	64	64	65	65	66	67	68	69
1	0.2	288	63	63	63	63	63	64	64	65	66	66	67
1	0.4	296	62	62	62	62	62	62	62	63	64	64	65
1	0.6	304	60	60	60	60	60	60	60	61	61	62	63
1	0.8	312	58	58	58	57	57	57	58	58	58	59	59
1	1.0	320	56	55	55	54	54	54	54	54	55	55	56

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	47	48	48	49	49	50	51	52	53	54	55
0	-0.8	248	52	52	52	52	53	54	54	55	56	57	58
0	-0.6	256	56	56	56	56	56	57	57	58	59	60	61
0	-0.4	264	59	59	59	59	59	59	60	61	61	62	63
0	-0.2	272	62	61	61	61	61	62	62	62	63	64	65
0	0.0	280	64	64	63	63	63	63	64	64	64	65	66
0	0.2	288	66	65	65	65	65	65	65	65	65	66	66
0	0.4	296	67	66	66	66	65	65	65	65	65	66	66
0	0.6	304	68	67	66	66	66	65	65	65	65	65	66
0	0.8	312	68	67	66	66	65	65	65	64	64	65	65
0	1.0	320	68	67	66	65	64	64	64	63	63	63	63

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	27	26	26	26	27	27	27	28	28	29	30
-1	-0.8	248	33	33	33	33	33	33	33	34	34	35	35
-1	-0.6	256	39	39	38	38	38	38	38	39	39	40	40
-1	-0.4	264	45	44	44	44	43	43	43	43	44	44	45
-1	-0.2	272	50	49	49	48	48	48	48	48	48	48	48
-1	0.0	280	54	54	53	52	52	52	51	51	51	51	52
-1	0.2	288	58	57	57	56	55	55	55	54	54	54	55
-1	0.4	296	62	61	60	59	58	57	57	57	57	57	57
-1	0.6	304	65	64	63	62	61	60	60	59	59	59	59
-1	0.8	312	67	66	65	64	63	62	61	61	60	60	60
-1	1.0	320	69	68	66	65	64	63	63	62	61	61	61

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	2.579
X1	COE1	-0.185
X2	COE2	-0.148
X3	COE3	0.029
X4	COE4	0.069
X1*X1	COE11	0.226
X2*X2	COE22	0.073
X3*X3	COE33	0.061
X4*X4	COE44	0.014
X1*X2	COE12	0.13
X1*X3	COE13	0.085
X1*X4	COE14	0.023
X2*X3	COE23	-0.012
X2*X4	COE24	-0.101
X3*X4	COE34	-0.094

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
Description: Pittsburgh No. 8 Seam
Circuit: Individual MGS (Fine Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.0	3.0
1	-0.8	248	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.9
1	-0.6	256	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.8
1	-0.4	264	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7
1	-0.2	272	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7
1	0.0	280	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6
1	0.2	288	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6
1	0.4	296	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6
1	0.6	304	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6
1	0.8	312	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7
1	1.0	320	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	3.0	3.0	3.0	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.3
0	-0.8	248	2.8	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.1	3.1	3.1
0	-0.6	256	2.7	2.7	2.8	2.8	2.8	2.9	2.9	2.9	2.9	3.0	3.0
0	-0.4	264	2.6	2.6	2.7	2.7	2.7	2.8	2.8	2.8	2.9	2.9	2.9
0	-0.2	272	2.5	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.8	2.8	2.8
0	0.0	280	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.7	2.7	2.8	2.8
0	0.2	288	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.6	2.7	2.7	2.7
0	0.4	296	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.6	2.7	2.7
0	0.6	304	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.6	2.7	2.7
0	0.8	312	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.7	2.7	2.7
0	1.0	320	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.6	2.7	2.7	2.8

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	3.2	3.3	3.3	3.4	3.4	3.4	3.5	3.5	3.6	3.6	3.7
-1	-0.8	248	3.1	3.1	3.1	3.2	3.2	3.3	3.3	3.4	3.4	3.5	3.5
-1	-0.6	256	2.9	3.0	3.0	3.0	3.1	3.1	3.2	3.2	3.3	3.4	3.4
-1	-0.4	264	2.8	2.8	2.9	2.9	3.0	3.0	3.1	3.1	3.2	3.2	3.3
-1	-0.2	272	2.7	2.7	2.8	2.8	2.9	2.9	3.0	3.0	3.1	3.1	3.2
-1	0.0	280	2.6	2.6	2.7	2.7	2.8	2.8	2.9	2.9	3.0	3.0	3.1
-1	0.2	288	2.5	2.5	2.6	2.6	2.7	2.7	2.8	2.9	2.9	3.0	3.0
-1	0.4	296	2.4	2.5	2.5	2.6	2.6	2.7	2.8	2.8	2.9	2.9	3.0
-1	0.6	304	2.4	2.4	2.5	2.6	2.6	2.7	2.7	2.8	2.8	2.9	3.0
-1	0.8	312	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.8	2.8	2.9	2.9
-1	1.0	320	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.8	2.8	2.9	2.9

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.7	2.7
1	-0.8	248	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
1	-0.6	256	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
1	-0.4	264	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5
1	-0.2	272	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1	0.0	280	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1	0.2	288	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1	0.4	296	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1	0.6	304	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5
1	0.8	312	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
1	1.0	320	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.1
0	-0.8	248	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
0	-0.6	256	2.7	2.7	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
0	-0.4	264	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8
0	-0.2	272	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7
0	0.0	280	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7
0	0.2	288	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.6
0	0.4	296	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6
0	0.6	304	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6
0	0.8	312	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.7	2.7
0	1.0	320	2.5	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	3.2	3.2	3.3	3.3	3.3	3.3	3.4	3.4	3.4	3.5	3.5
-1	-0.8	248	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.3	3.3	3.3	3.4
-1	-0.6	256	2.9	3.0	3.0	3.0	3.0	3.1	3.1	3.1	3.2	3.2	3.2
-1	-0.4	264	2.8	2.8	2.9	2.9	2.9	3.0	3.0	3.0	3.1	3.1	3.1
-1	-0.2	272	2.7	2.7	2.8	2.8	2.8	2.9	2.9	2.9	3.0	3.0	3.1
-1	0.0	280	2.6	2.7	2.7	2.7	2.8	2.8	2.8	2.9	2.9	2.9	3.0
-1	0.2	288	2.6	2.6	2.6	2.7	2.7	2.7	2.8	2.8	2.9	2.9	2.9
-1	0.4	296	2.5	2.6	2.6	2.6	2.7	2.7	2.7	2.8	2.8	2.9	2.9
-1	0.6	304	2.5	2.6	2.6	2.6	2.7	2.7	2.7	2.8	2.8	2.8	2.9
-1	0.8	312	2.5	2.6	2.6	2.6	2.7	2.7	2.7	2.8	2.8	2.9	2.9
-1	1.0	320	2.5	2.6	2.6	2.6	2.7	2.7	2.8	2.8	2.8	2.9	2.9

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Fine Grind)

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	2.9	2.9	2.9	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.6
1	-0.8	248	2.9	2.8	2.8	2.8	2.7	2.7	2.7	2.6	2.6	2.6	2.6
1	-0.6	256	2.8	2.8	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.5	2.5
1	-0.4	264	2.8	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.5	2.5	2.5
1	-0.2	272	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5
1	0.0	280	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5
1	0.2	288	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5
1	0.4	296	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.5	2.5
1	0.6	304	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6
1	0.8	312	2.9	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7
1	1.0	320	3.0	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.7

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
0	-0.8	248	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
0	-0.6	256	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
0	-0.4	264	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.7
0	-0.2	272	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
0	0.0	280	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
0	0.2	288	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
0	0.4	296	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
0	0.6	304	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
0	0.8	312	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
0	1.0	320	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	3.3	3.3	3.3	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4
-1	-0.8	248	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.3	3.3	3.3	3.3
-1	-0.6	256	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.2	3.2	3.2
-1	-0.4	264	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.1	3.1	3.1	3.1
-1	-0.2	272	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0
-1	0.0	280	2.8	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0
-1	0.2	288	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9	3.0
-1	0.4	296	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9
-1	0.6	304	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9
-1	0.8	312	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9	3.0
-1	1.0	320	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0

QUADRATIC REGRESSION MODEL

Response: lb SO₂/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	2.838
X1	COE1	-0.344
X2	COE2	-0.248
X3	COE3	0.033
X4	COE4	-0.027
X1*X1	COE11	0.226
X2*X2	COE22	0.073
X3*X3	COE33	0.061
X4*X4	COE44	0.014
X1*X2	COE12	0.13
X1*X3	COE13	0.085
X1*X4	COE14	0.023
X2*X3	COE23	-0.012
X2*X4	COE24	-0.101
X3*X4	COE34	-0.094

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2
1	-0.8	248	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.0
1	-0.6	256	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9
1	-0.4	264	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8
1	-0.2	272	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.7	2.7
1	0.0	280	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
1	0.2	288	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6
1	0.4	296	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
1	0.6	304	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
1	0.8	312	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
1	1.0	320	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.6	3.6	3.6
0	-0.8	248	3.3	3.3	3.3	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4
0	-0.6	256	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.3	3.3
0	-0.4	264	3.0	3.0	3.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
0	-0.2	272	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0
0	0.0	280	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.9	2.9
0	0.2	288	2.7	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9
0	0.4	296	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.8	2.8	2.8
0	0.6	304	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.8
0	0.8	312	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.8
0	1.0	320	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.8

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	3.8	3.9	3.9	3.9	3.9	4.0	4.0	4.0	4.1	4.1	4.1
-1	-0.8	248	3.6	3.7	3.7	3.7	3.7	3.8	3.8	3.8	3.9	3.9	3.9
-1	-0.6	256	3.5	3.5	3.5	3.5	3.6	3.6	3.6	3.7	3.7	3.7	3.8
-1	-0.4	264	3.3	3.3	3.3	3.4	3.4	3.4	3.5	3.5	3.5	3.6	3.6
-1	-0.2	272	3.1	3.2	3.2	3.2	3.3	3.3	3.3	3.4	3.4	3.4	3.5
-1	0.0	280	3.0	3.0	3.1	3.1	3.1	3.2	3.2	3.2	3.3	3.3	3.4
-1	0.2	288	2.9	2.9	3.0	3.0	3.0	3.1	3.1	3.1	3.2	3.2	3.3
-1	0.4	296	2.8	2.9	2.9	2.9	3.0	3.0	3.0	3.1	3.1	3.1	3.2
-1	0.6	304	2.8	2.8	2.8	2.9	2.9	2.9	3.0	3.0	3.0	3.1	3.1
-1	0.8	312	2.7	2.7	2.8	2.8	2.8	2.9	2.9	2.9	3.0	3.0	3.1
-1	1.0	320	2.7	2.7	2.7	2.8	2.8	2.8	2.9	2.9	3.0	3.0	3.0

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	3.3	3.2	3.2	3.2	3.1	3.1	3.1	3.0	3.0	3.0	3.0
1	-0.8	248	3.1	3.1	3.1	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.8
1	-0.6	256	3.0	3.0	3.0	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.7
1	-0.4	264	2.9	2.9	2.9	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7
1	-0.2	272	2.9	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6
1	0.0	280	2.8	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.5
1	0.2	288	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.5	2.5
1	0.4	296	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.5	2.5	2.5
1	0.6	304	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.5	2.5
1	0.8	312	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.5
1	1.0	320	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
0	-0.8	248	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2
0	-0.6	256	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
0	-0.4	264	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
0	-0.2	272	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
0	0.0	280	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8
0	0.2	288	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
0	0.4	296	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
0	0.6	304	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
0	0.8	312	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
0	1.0	320	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	3.8	3.8	3.8	3.8	3.8	3.9	3.9	3.9	3.9	3.9	3.9
-1	-0.8	248	3.6	3.6	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.8
-1	-0.6	256	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.6	3.6	3.6	3.6
-1	-0.4	264	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.5
-1	-0.2	272	3.2	3.2	3.2	3.2	3.2	3.3	3.3	3.3	3.3	3.3	3.3
-1	0.0	280	3.1	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.2	3.2	3.2
-1	0.2	288	3.0	3.0	3.0	3.0	3.1	3.1	3.1	3.1	3.1	3.1	3.2
-1	0.4	296	2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.1	3.1	3.1
-1	0.6	304	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.1
-1	0.8	312	2.8	2.9	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0
-1	1.0	320	2.8	2.8	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Intermediate Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	3.4	3.3	3.3	3.2	3.1	3.1	3.1	3.0	3.0	2.9	2.9
1	-0.8	248	3.2	3.2	3.1	3.1	3.0	3.0	2.9	2.9	2.9	2.8	2.8
1	-0.6	256	3.2	3.1	3.1	3.0	3.0	2.9	2.9	2.8	2.8	2.7	2.7
1	-0.4	264	3.1	3.0	3.0	2.9	2.9	2.8	2.8	2.7	2.7	2.7	2.6
1	-0.2	272	3.0	3.0	2.9	2.9	2.8	2.8	2.7	2.7	2.6	2.6	2.6
1	0.0	280	3.0	2.9	2.9	2.8	2.8	2.7	2.7	2.7	2.6	2.6	2.5
1	0.2	288	3.0	2.9	2.9	2.8	2.8	2.7	2.7	2.6	2.6	2.6	2.5
1	0.4	296	3.0	2.9	2.9	2.8	2.8	2.7	2.7	2.6	2.6	2.6	2.5
1	0.6	304	3.0	2.9	2.9	2.8	2.8	2.7	2.7	2.7	2.6	2.6	2.6
1	0.8	312	3.0	3.0	2.9	2.9	2.8	2.8	2.7	2.7	2.7	2.6	2.6
1	1.0	320	3.1	3.0	3.0	2.9	2.9	2.8	2.8	2.8	2.7	2.7	2.7

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	3.6	3.5	3.5	3.5	3.4	3.4	3.4	3.4	3.3	3.3	3.3
0	-0.8	248	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2
0	-0.6	256	3.3	3.3	3.3	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.0
0	-0.4	264	3.2	3.2	3.2	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0
0	-0.2	272	3.1	3.1	3.1	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9
0	0.0	280	3.1	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.8	2.8
0	0.2	288	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8
0	0.4	296	3.0	3.0	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8
0	0.6	304	3.0	3.0	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8
0	0.8	312	3.0	3.0	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8
0	1.0	320	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
-1	-0.8	248	3.8	3.8	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
-1	-0.6	256	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
-1	-0.4	264	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4
-1	-0.2	272	3.4	3.4	3.4	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.3
-1	0.0	280	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
-1	0.2	288	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
-1	0.4	296	3.2	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1
-1	0.6	304	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
-1	0.8	312	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
-1	1.0	320	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1

QUADRATIC REGRESSION MODEL

Response: lb SO₂/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

Actual:				
Name	Speed (rpm)	Solids (%)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	15	0.5	100
Maximum	320	35	1.5	300
Center	280	25	1	200
Range	80	20	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	3.097
X1	COE1	-0.503
X2	COE2	-0.348
X3	COE3	0.037
X4	COE4	-0.123
X1*X1	COE11	0.226
X2*X2	COE22	0.073
X3*X3	COE33	0.061
X4*X4	COE44	0.014
X1*X2	COE12	0.13
X1*X3	COE13	0.085
X1*X4	COE14	0.023
X2*X3	COE23	-0.012
X2*X4	COE24	-0.101
X3*X4	COE34	-0.094

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	3.7	3.7	3.6	3.6	3.6	3.5	3.5	3.5	3.5	3.4	3.4
1	-0.8	248	3.5	3.5	3.5	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.2
1	-0.6	256	3.4	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.1	3.1	3.1
1	-0.4	264	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0
1	-0.2	272	3.1	3.1	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.8
1	0.0	280	3.0	3.0	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.7
1	0.2	288	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7
1	0.4	296	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6
1	0.6	304	2.8	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6
1	0.8	312	2.8	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.5
1	1.0	320	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.5	2.5

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	4.0	4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.9	3.9	3.9
0	-0.8	248	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.7	3.7	3.7	3.7
0	-0.6	256	3.6	3.6	3.6	3.6	3.6	3.6	3.5	3.5	3.5	3.5	3.5
0	-0.4	264	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
0	-0.2	272	3.3	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2
0	0.0	280	3.2	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
0	0.2	288	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
0	0.4	296	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
0	0.6	304	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8
0	0.8	312	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
0	1.0	320	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	4.4	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
-1	-0.8	248	4.2	4.2	4.2	4.2	4.2	4.2	4.3	4.3	4.3	4.3	4.3
-1	-0.6	256	4.0	4.0	4.0	4.0	4.0	4.0	4.1	4.1	4.1	4.1	4.1
-1	-0.4	264	3.8	3.8	3.8	3.8	3.8	3.9	3.9	3.9	3.9	3.9	3.9
-1	-0.2	272	3.6	3.6	3.6	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.8
-1	0.0	280	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.6	3.6	3.6	3.6
-1	0.2	288	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.5	3.5
-1	0.4	296	3.2	3.2	3.2	3.2	3.3	3.3	3.3	3.3	3.3	3.4	3.4
-1	0.6	304	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.2	3.2	3.3	3.3
-1	0.8	312	3.0	3.0	3.1	3.1	3.1	3.1	3.1	3.1	3.2	3.2	3.2
-1	1.0	320	3.0	3.0	3.0	3.0	3.0	3.0	3.1	3.1	3.1	3.1	3.1

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
Description: Pittsburgh No. 8 Seam
Circuit: Individual MGS (Coarse Grind)

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	3.7	3.6	3.6	3.5	3.5	3.4	3.4	3.3	3.3	3.2	3.2
1	-0.8	248	3.5	3.5	3.4	3.4	3.3	3.3	3.2	3.2	3.1	3.1	3.0
1	-0.6	256	3.4	3.3	3.3	3.2	3.2	3.1	3.1	3.0	3.0	2.9	2.9
1	-0.4	264	3.3	3.2	3.2	3.1	3.1	3.0	3.0	2.9	2.9	2.8	2.8
1	-0.2	272	3.1	3.1	3.0	3.0	3.0	2.9	2.9	2.8	2.8	2.7	2.7
1	0.0	280	3.1	3.0	3.0	2.9	2.9	2.8	2.8	2.7	2.7	2.7	2.6
1	0.2	288	3.0	2.9	2.9	2.8	2.8	2.8	2.7	2.7	2.6	2.6	2.6
1	0.4	296	2.9	2.9	2.8	2.8	2.8	2.7	2.7	2.6	2.6	2.5	2.5
1	0.6	304	2.9	2.9	2.8	2.8	2.7	2.7	2.6	2.6	2.6	2.5	2.5
1	0.8	312	2.9	2.8	2.8	2.8	2.7	2.7	2.6	2.6	2.5	2.5	2.5
1	1.0	320	2.9	2.8	2.8	2.8	2.7	2.7	2.6	2.6	2.6	2.5	2.5

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	4.0	4.0	3.9	3.9	3.9	3.8	3.8	3.8	3.7	3.7	3.7
0	-0.8	248	3.8	3.8	3.7	3.7	3.7	3.6	3.6	3.6	3.6	3.5	3.5
0	-0.6	256	3.6	3.6	3.6	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4
0	-0.4	264	3.5	3.4	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.2	3.2
0	-0.2	272	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.1	3.1	3.1
0	0.0	280	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0
0	0.2	288	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	2.9	2.9	2.9
0	0.4	296	3.1	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.8	2.8
0	0.6	304	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8
0	0.8	312	3.0	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.7
0	1.0	320	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.7	2.7

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.3	4.3
-1	-0.8	248	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.1
-1	-0.6	256	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
-1	-0.4	264	3.9	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
-1	-0.2	272	3.7	3.7	3.7	3.7	3.7	3.7	3.6	3.6	3.6	3.6	3.6
-1	0.0	280	3.6	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
-1	0.2	288	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
-1	0.4	296	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
-1	0.6	304	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
-1	0.8	312	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
-1	1.0	320	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Individual MGS (Coarse Grind)

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
1	-1.0	240	3.8	3.7	3.6	3.6	3.5	3.4	3.4	3.3	3.2	3.2	3.1
1	-0.8	248	3.6	3.6	3.5	3.4	3.4	3.3	3.2	3.2	3.1	3.0	3.0
1	-0.6	256	3.5	3.4	3.4	3.3	3.2	3.2	3.1	3.0	3.0	2.9	2.8
1	-0.4	264	3.4	3.3	3.3	3.2	3.1	3.1	3.0	2.9	2.9	2.8	2.7
1	-0.2	272	3.3	3.2	3.2	3.1	3.0	3.0	2.9	2.8	2.8	2.7	2.7
1	0.0	280	3.2	3.2	3.1	3.0	3.0	2.9	2.8	2.8	2.7	2.7	2.6
1	0.2	288	3.2	3.1	3.1	3.0	2.9	2.9	2.8	2.7	2.7	2.6	2.6
1	0.4	296	3.2	3.1	3.0	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5
1	0.6	304	3.1	3.1	3.0	2.9	2.9	2.8	2.8	2.7	2.6	2.6	2.5
1	0.8	312	3.1	3.1	3.0	2.9	2.9	2.8	2.8	2.7	2.6	2.6	2.5
1	1.0	320	3.2	3.1	3.0	3.0	2.9	2.8	2.8	2.7	2.7	2.6	2.6

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
0	-1.0	240	4.1	4.0	4.0	3.9	3.9	3.8	3.8	3.7	3.7	3.7	3.6
0	-0.8	248	3.9	3.9	3.8	3.8	3.7	3.7	3.6	3.6	3.5	3.5	3.5
0	-0.6	256	3.8	3.7	3.7	3.6	3.6	3.5	3.5	3.4	3.4	3.4	3.3
0	-0.4	264	3.6	3.6	3.5	3.5	3.4	3.4	3.4	3.3	3.3	3.2	3.2
0	-0.2	272	3.5	3.5	3.4	3.4	3.3	3.3	3.2	3.2	3.2	3.1	3.1
0	0.0	280	3.4	3.4	3.3	3.3	3.2	3.2	3.2	3.1	3.1	3.0	3.0
0	0.2	288	3.3	3.3	3.3	3.2	3.2	3.1	3.1	3.0	3.0	3.0	2.9
0	0.4	296	3.3	3.2	3.2	3.1	3.1	3.1	3.0	3.0	2.9	2.9	2.9
0	0.6	304	3.2	3.2	3.2	3.1	3.1	3.0	3.0	2.9	2.9	2.9	2.8
0	0.8	312	3.2	3.2	3.1	3.1	3.0	3.0	3.0	2.9	2.9	2.9	2.8
0	1.0	320	3.2	3.2	3.1	3.1	3.0	3.0	3.0	2.9	2.9	2.9	2.8

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		100	120	140	160	180	200	220	240	260	280	300
-1	-1.0	240	4.6	4.5	4.5	4.5	4.4	4.4	4.4	4.3	4.3	4.3	4.3
-1	-0.8	248	4.4	4.3	4.3	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.1
-1	-0.6	256	4.2	4.2	4.1	4.1	4.1	4.0	4.0	4.0	4.0	3.9	3.9
-1	-0.4	264	4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.8
-1	-0.2	272	3.9	3.9	3.8	3.8	3.8	3.7	3.7	3.7	3.7	3.7	3.6
-1	0.0	280	3.8	3.7	3.7	3.7	3.7	3.6	3.6	3.6	3.6	3.5	3.5
-1	0.2	288	3.7	3.6	3.6	3.6	3.6	3.5	3.5	3.5	3.5	3.4	3.4
-1	0.4	296	3.6	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.4
-1	0.6	304	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.3	3.3	3.3	3.3
-1	0.8	312	3.4	3.4	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.3	3.3
-1	1.0	320	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.2

APPENDIX 4-D

Response Surface Plots and Computations

Independent MGS Tests
Illinois No. 6 Seam Coal

Illinois No. 6 Seam
Individual MGS

Illinois No. 6 Seam
Individual MGS

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

Actual:				
Name	Speed (rpm)	Solids	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	17	0	150
Maximum	320	33	1.5	300
Center	280	25	0.75	225
Range	80	16	1.5	150
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	86.75
X1	COE1	-4.62
X2	COE2	-3.2
X3	COE3	3.4
X4	COE4	1.75
X1*X1	COE11	1.39
X2*X2	COE22	2.09
X3*X3	COE33	-0.92
X4*X4	COE44	0.59
X1*X2	COE12	-0.62
X1*X3	COE13	1.06
X1*X4	COE14	-0.94
X2*X3	COE23	-0.01
X2*X4	COE24	0.09
X3*X4	COE34	-0.88

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	86	86	87	88	88	89	90	91	91	92	93
1	-0.8	248	84	85	85	86	87	87	88	89	90	90	91
1	-0.6	256	83	83	84	84	85	86	86	87	88	89	89
1	-0.4	264	82	82	82	83	83	84	85	85	86	87	88
1	-0.2	272	80	81	81	82	82	83	83	84	85	85	86
1	0.0	280	79	80	80	80	81	81	82	83	83	84	85
1	0.2	288	78	78	79	79	80	80	81	81	82	83	83
1	0.4	296	77	78	78	78	79	79	80	80	81	81	82
1	0.6	304	76	77	77	77	78	78	79	79	80	80	81
1	0.8	312	76	76	76	76	77	77	78	78	79	79	80
1	1.0	320	75	75	76	76	76	76	77	77	78	78	79

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	87	87	88	88	89	90	90	91	92	93	94
0	-0.8	248	85	86	86	87	87	88	89	89	90	91	92
0	-0.6	256	84	84	85	85	86	86	87	88	88	89	90
0	-0.4	264	83	83	83	84	84	85	86	86	87	88	89
0	-0.2	272	81	82	82	83	83	84	84	85	86	86	87
0	0.0	280	80	81	81	81	82	82	83	84	84	85	86
0	0.2	288	79	80	80	80	81	81	82	82	83	84	84
0	0.4	296	79	79	79	80	80	80	81	81	82	83	83
0	0.6	304	78	78	78	79	79	80	80	80	81	82	82
0	0.8	312	77	78	78	78	78	79	79	80	80	81	81
0	1.0	320	77	77	77	78	78	78	79	79	79	80	80

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	91	92	92	93	93	94	95	96	96	97	98
-1	-0.8	248	90	90	91	91	92	93	93	94	95	96	97
-1	-0.6	256	89	89	90	90	91	91	92	93	93	94	95
-1	-0.4	264	88	88	88	89	89	90	91	91	92	93	93
-1	-0.2	272	87	87	87	88	88	89	89	90	91	91	92
-1	0.0	280	86	86	86	87	87	88	88	89	89	90	91
-1	0.2	288	85	85	86	86	86	87	87	88	88	89	90
-1	0.4	296	84	85	85	85	85	86	86	87	87	88	89
-1	0.6	304	84	84	84	84	85	85	86	86	87	87	88
-1	0.8	312	83	83	84	84	84	85	85	85	86	86	87
-1	1.0	320	83	83	83	83	84	84	84	85	85	86	86

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	90	90	91	91	92	92	93	93	94	95	96
1	-0.8	248	89	89	89	90	90	91	91	92	92	93	94
1	-0.6	256	87	88	88	88	89	89	90	90	91	92	92
1	-0.4	264	86	87	87	87	88	88	88	89	90	90	91
1	-0.2	272	85	85	86	86	86	87	87	88	88	89	89
1	0.0	280	84	85	85	85	85	86	86	86	87	87	88
1	0.2	288	84	84	84	84	84	85	85	85	86	86	87
1	0.4	296	83	83	83	83	83	84	84	84	85	85	86
1	0.6	304	82	82	82	83	83	83	83	84	84	84	85
1	0.8	312	82	82	82	82	82	82	83	83	83	84	84
1	1.0	320	81	81	81	82	82	82	82	82	83	83	83

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	91	91	91	92	92	93	93	94	95	95	96
0	-0.8	248	89	90	90	90	91	91	92	92	93	94	94
0	-0.6	256	88	89	89	89	90	90	91	91	92	92	93
0	-0.4	264	87	87	88	88	88	89	89	90	90	91	92
0	-0.2	272	86	87	87	87	87	88	88	89	89	90	90
0	0.0	280	86	86	86	86	86	87	87	88	88	89	89
0	0.2	288	85	85	85	85	86	86	86	87	87	88	88
0	0.4	296	84	84	85	85	85	85	85	86	86	87	87
0	0.6	304	84	84	84	84	84	84	85	85	85	86	86
0	0.8	312	84	84	84	84	84	84	84	84	85	85	86
0	1.0	320	83	83	83	83	83	84	84	84	84	85	85

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	95	96	96	96	97	97	98	99	99	100	101
-1	-0.8	248	94	95	95	95	96	96	97	97	98	98	99
-1	-0.6	256	93	94	94	94	95	95	95	96	96	97	98
-1	-0.4	264	92	93	93	93	93	94	94	95	95	96	96
-1	-0.2	272	92	92	92	92	93	93	93	94	94	95	95
-1	0.0	280	91	91	91	91	92	92	92	93	93	94	94
-1	0.2	288	90	90	91	91	91	91	92	92	92	93	93
-1	0.4	296	90	90	90	90	90	91	91	91	92	92	93
-1	0.6	304	90	90	90	90	90	90	90	91	91	91	92
-1	0.8	312	89	89	89	89	90	90	90	90	90	91	91
-1	1.0	320	89	89	89	89	89	89	90	90	90	90	91

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	92	93	93	93	93	94	94	95	95	96	96
1	-0.8	248	91	91	92	92	92	92	93	93	94	94	95
1	-0.6	256	90	90	90	91	91	91	91	92	92	93	93
1	-0.4	264	89	89	89	90	90	90	90	91	91	91	92
1	-0.2	272	88	88	89	89	89	89	89	90	90	90	91
1	0.0	280	88	88	88	88	88	88	88	89	89	89	90
1	0.2	288	87	87	87	87	87	87	88	88	88	88	89
1	0.4	296	87	87	87	87	87	87	87	87	87	88	88
1	0.6	304	86	86	86	86	86	86	86	86	87	87	87
1	0.8	312	86	86	86	86	86	86	86	86	86	86	86
1	1.0	320	86	86	86	85	85	85	85	85	86	86	86

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	93	93	93	94	94	94	95	95	95	96	97
0	-0.8	248	92	92	92	92	93	93	93	94	94	95	95
0	-0.6	256	91	91	91	91	92	92	92	93	93	93	94
0	-0.4	264	90	90	90	90	91	91	91	91	92	92	93
0	-0.2	272	90	90	90	90	90	90	90	91	91	91	92
0	0.0	280	89	89	89	89	89	89	89	90	90	90	91
0	0.2	288	88	88	88	88	88	89	89	89	89	89	90
0	0.4	296	88	88	88	88	88	88	88	88	89	89	89
0	0.6	304	88	88	88	88	88	88	88	88	88	88	88
0	0.8	312	88	88	87	87	87	87	87	87	88	88	88
0	1.0	320	88	87	87	87	87	87	87	87	87	87	88

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	98	98	98	98	99	99	99	100	100	101	101
-1	-0.8	248	97	97	97	97	97	98	98	98	99	99	100
-1	-0.6	256	96	96	96	96	97	97	97	97	98	98	99
-1	-0.4	264	95	95	95	96	96	96	96	96	97	97	98
-1	-0.2	272	95	95	95	95	95	95	95	96	96	96	97
-1	0.0	280	94	94	94	94	94	95	95	95	95	96	96
-1	0.2	288	94	94	94	94	94	94	94	94	95	95	95
-1	0.4	296	94	94	94	94	94	94	94	94	94	94	95
-1	0.6	304	94	93	93	93	93	93	93	93	94	94	94
-1	0.8	312	94	93	93	93	93	93	93	93	93	93	94
-1	1.0	320	94	93	93	93	93	93	93	93	93	93	93

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

Actual:				
Name	Speed (rpm)	Solids	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	17	0	150
Maximum	320	33	1.5	300
Center	280	25	0.75	225
Range	80	16	1.5	150
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	89.16
X1	COE1	-4.27
X2	COE2	-2.86
X3	COE3	3.3
X4	COE4	1.14
X1*X1	COE11	1.03
X2*X2	COE22	1.83
X3*X3	COE33	-1.03
X4*X4	COE44	0.43
X1*X2	COE12	-0.78
X1*X3	COE13	0.97
X1*X4	COE14	-0.66
X2*X3	COE23	0.25
X2*X4	COE24	0.23
X3*X4	COE34	-0.96

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	88	88	89	89	90	91	91	92	93	93	94
1	-0.8	248	87	87	87	88	88	89	90	90	91	92	92
1	-0.6	256	85	86	86	87	87	88	88	89	89	90	91
1	-0.4	264	84	84	85	85	86	86	87	87	88	88	89
1	-0.2	272	83	83	83	84	84	85	85	86	86	87	88
1	0.0	280	82	82	82	83	83	84	84	85	85	86	86
1	0.2	288	81	81	81	82	82	83	83	84	84	85	85
1	0.4	296	80	80	80	81	81	82	82	83	83	84	84
1	0.6	304	79	79	79	80	80	81	81	82	82	83	83
1	0.8	312	78	78	78	79	79	80	80	81	81	82	82
1	1.0	320	77	77	78	78	78	79	79	80	80	81	81

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	89	89	90	90	91	91	92	92	93	94	94
0	-0.8	248	87	88	88	89	89	90	90	91	91	92	93
0	-0.6	256	86	87	87	87	88	88	89	89	90	91	91
0	-0.4	264	85	85	86	86	87	87	88	88	89	89	90
0	-0.2	272	84	84	85	85	86	86	87	87	88	88	89
0	0.0	280	83	83	84	84	84	85	85	86	86	87	87
0	0.2	288	82	83	83	83	83	84	84	85	85	86	86
0	0.4	296	81	82	82	82	83	83	83	84	84	85	85
0	0.6	304	81	81	81	81	82	82	82	83	83	84	84
0	0.8	312	80	80	81	81	81	81	82	82	82	83	83
0	1.0	320	80	80	80	80	80	81	81	81	82	82	82

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	93	94	94	94	95	95	96	96	97	98	98
-1	-0.8	248	92	92	93	93	94	94	94	95	96	96	97
-1	-0.6	256	91	91	92	92	92	93	93	94	94	95	96
-1	-0.4	264	90	90	91	91	91	92	92	93	93	94	94
-1	-0.2	272	89	89	90	90	90	91	91	92	92	93	93
-1	0.0	280	88	89	89	89	89	90	90	91	91	92	92
-1	0.2	288	88	88	88	88	89	89	89	90	90	91	91
-1	0.4	296	87	87	87	88	88	88	88	89	89	90	90
-1	0.6	304	86	87	87	87	87	87	88	88	89	89	89
-1	0.8	312	86	86	86	86	87	87	87	87	88	88	89
-1	1.0	320	86	86	86	86	86	86	87	87	87	88	88

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	93	93	93	93	94	94	95	95	96	96	97
1	-0.8	248	91	92	92	92	92	93	93	94	94	95	95
1	-0.6	256	90	90	91	91	91	92	92	92	93	93	94
1	-0.4	264	89	89	89	90	90	90	91	91	91	92	92
1	-0.2	272	88	88	88	89	89	89	89	90	90	91	91
1	0.0	280	87	87	87	88	88	88	88	89	89	90	90
1	0.2	288	86	86	87	87	87	87	87	88	88	88	89
1	0.4	296	86	86	86	86	86	86	87	87	87	87	88
1	0.6	304	85	85	85	85	85	85	86	86	86	87	87
1	0.8	312	84	84	84	84	85	85	85	85	85	86	86
1	1.0	320	84	84	84	84	84	84	84	84	85	85	85

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	93	93	94	94	94	94	95	95	96	96	97
0	-0.8	248	92	92	92	93	93	93	94	94	94	95	95
0	-0.6	256	91	91	91	92	92	92	92	93	93	94	94
0	-0.4	264	90	90	90	91	91	91	91	92	92	92	93
0	-0.2	272	89	89	89	90	90	90	90	91	91	91	92
0	0.0	280	88	89	89	89	89	89	89	90	90	90	91
0	0.2	288	88	88	88	88	88	88	89	89	89	89	90
0	0.4	296	87	87	87	87	87	88	88	88	88	89	89
0	0.6	304	87	87	87	87	87	87	87	87	88	88	88
0	0.8	312	86	86	86	86	86	86	87	87	87	87	87
0	1.0	320	86	86	86	86	86	86	86	86	86	87	87

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	97	97	98	98	98	98	99	99	99	100	100
-1	-0.8	248	96	96	97	97	97	97	98	98	98	99	99
-1	-0.6	256	95	96	96	96	96	96	97	97	97	98	98
-1	-0.4	264	95	95	95	95	95	95	96	96	96	97	97
-1	-0.2	272	94	94	94	94	94	95	95	95	95	96	96
-1	0.0	280	93	93	93	94	94	94	94	94	95	95	95
-1	0.2	288	93	93	93	93	93	93	93	94	94	94	94
-1	0.4	296	92	92	92	92	93	93	93	93	93	93	94
-1	0.6	304	92	92	92	92	92	92	92	92	93	93	93
-1	0.8	312	92	92	92	92	92	92	92	92	92	92	93
-1	1.0	320	92	91	91	91	91	91	91	92	92	92	92

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	95	95	95	95	96	96	96	96	97	97	97
1	-0.8	248	94	94	94	94	94	95	95	95	95	96	96
1	-0.6	256	93	93	93	93	93	93	94	94	94	94	95
1	-0.4	264	92	92	92	92	92	92	93	93	93	93	94
1	-0.2	272	91	91	91	91	91	92	92	92	92	92	92
1	0.0	280	91	91	91	91	91	91	91	91	91	91	91
1	0.2	288	90	90	90	90	90	90	90	90	90	90	91
1	0.4	296	89	89	89	89	89	89	89	89	89	90	90
1	0.6	304	89	89	89	89	89	89	89	89	89	89	89
1	0.8	312	89	88	88	88	88	88	88	88	88	88	88
1	1.0	320	88	88	88	88	88	88	88	88	88	88	88

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	95	95	95	95	96	96	96	96	96	97	97
0	-0.8	248	94	94	94	95	95	95	95	95	95	96	96
0	-0.6	256	94	94	94	94	94	94	94	94	94	95	95
0	-0.4	264	93	93	93	93	93	93	93	93	93	94	94
0	-0.2	272	92	92	92	92	92	92	92	92	92	93	93
0	0.0	280	92	92	91	91	91	91	91	92	92	92	92
0	0.2	288	91	91	91	91	91	91	91	91	91	91	91
0	0.4	296	91	91	90	90	90	90	90	90	90	90	91
0	0.6	304	90	90	90	90	90	90	90	90	90	90	90
0	0.8	312	90	90	90	90	90	89	89	89	89	89	90
0	1.0	320	90	90	90	89	89	89	89	89	89	89	89

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	99	99	99	99	99	99	100	100	100	100	100
-1	-0.8	248	98	98	98	98	98	99	99	99	99	99	99
-1	-0.6	256	98	98	98	98	98	98	98	98	98	98	99
-1	-0.4	264	97	97	97	97	97	97	97	97	97	97	98
-1	-0.2	272	97	97	97	96	96	96	96	97	97	97	97
-1	0.0	280	96	96	96	96	96	96	96	96	96	96	96
-1	0.2	288	96	96	96	96	95	95	95	95	95	96	96
-1	0.4	296	96	96	95	95	95	95	95	95	95	95	95
-1	0.6	304	96	95	95	95	95	95	95	95	95	95	95
-1	0.8	312	96	95	95	95	95	95	94	94	94	94	94
-1	1.0	320	96	95	95	95	95	94	94	94	94	94	94

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

Actual:				
Name	Speed (rpm)	Solids	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	17	0	150
Maximum	320	33	1.5	300
Center	280	25	0.75	225
Range	80	16	1.5	150
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	51.08
X1	COE1	11.31
X2	COE2	10.17
X3	COE3	-3.59
X4	COE4	-4.82
X1*X1	COE11	-7.06
X2*X2	COE22	-7.65
X3*X3	COE33	-1.73
X4*X4	COE44	-2.43
X1*X2	COE12	-1.53
X1*X3	COE13	-2.55
X1*X4	COE14	2.73
X2*X3	COE23	2.3
X2*X4	COE24	1.99
X3*X4	COE34	0.33

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	37	37	36	36	35	34	32	31	29	28	25
1	-0.8	248	42	41	41	41	40	39	38	36	35	33	31
1	-0.6	256	46	46	45	45	44	43	42	41	39	38	36
1	-0.4	264	49	49	49	48	48	47	46	45	44	42	40
1	-0.2	272	52	52	52	52	51	50	50	49	47	46	44
1	0.0	280	54	54	54	54	54	53	52	52	50	49	48
1	0.2	288	56	56	56	56	56	55	55	54	53	52	50
1	0.4	296	57	57	57	57	57	57	56	56	55	54	52
1	0.6	304	57	58	58	58	58	58	58	57	56	55	54
1	0.8	312	57	58	58	59	59	59	58	58	57	56	55
1	1.0	320	56	57	58	58	58	58	58	58	57	57	56

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	37	37	36	35	33	32	30	28	26	24	22
0	-0.8	248	42	42	41	40	39	37	36	34	32	30	28
0	-0.6	256	46	46	45	44	43	42	41	39	37	35	33
0	-0.4	264	50	50	49	48	47	46	45	43	42	40	38
0	-0.2	272	53	53	52	52	51	50	49	47	46	44	42
0	0.0	280	56	56	55	55	54	53	52	50	49	47	45
0	0.2	288	58	58	57	57	56	55	54	53	52	50	48
0	0.4	296	59	59	59	59	58	57	56	55	54	53	51
0	0.6	304	60	60	60	60	59	59	58	57	56	54	53
0	0.8	312	60	60	60	60	60	60	59	58	57	56	54
0	1.0	320	60	60	60	60	60	60	59	58	57	56	55

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	22	21	20	19	17	15	13	11	8	6	3
-1	-0.8	248	27	26	25	24	22	21	19	16	14	12	9
-1	-0.6	256	32	31	30	29	27	26	24	22	20	17	14
-1	-0.4	264	36	35	34	33	32	30	28	26	24	22	19
-1	-0.2	272	39	39	38	37	35	34	32	31	29	26	24
-1	0.0	280	42	42	41	40	39	37	36	34	32	30	28
-1	0.2	288	44	44	43	42	41	40	39	37	35	33	31
-1	0.4	296	46	46	45	44	44	42	41	40	38	36	34
-1	0.6	304	47	47	47	46	45	44	43	42	40	38	36
-1	0.8	312	48	48	47	47	46	45	44	43	41	40	38
-1	1.0	320	48	48	48	47	47	46	45	44	42	41	39

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	40	40	39	39	38	37	36	34	33	31	29
1	-0.8	248	44	44	43	43	42	41	40	39	37	36	34
1	-0.6	256	47	47	47	47	46	45	44	43	42	40	38
1	-0.4	264	50	50	50	50	49	49	48	47	45	44	42
1	-0.2	272	52	53	53	52	52	51	51	50	48	47	46
1	0.0	280	54	54	54	54	54	53	52	51	50	48	46
1	0.2	288	55	56	56	56	56	55	55	54	53	52	51
1	0.4	296	56	56	57	57	57	56	56	55	54	53	52
1	0.6	304	56	56	57	57	57	57	57	56	55	54	53
1	0.8	312	55	56	56	57	57	57	57	56	56	55	54
1	1.0	320	54	55	56	56	56	56	56	55	55	55	54

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	38	37	36	35	34	33	31	29	27	25	23
0	-0.8	248	42	42	41	40	39	38	36	34	32	30	28
0	-0.6	256	46	45	45	44	43	42	40	39	37	35	33
0	-0.4	264	49	49	48	47	47	45	44	43	41	39	37
0	-0.2	272	51	51	51	50	50	49	47	46	44	43	41
0	0.0	280	53	53	53	53	52	51	50	49	47	46	44
0	0.2	288	55	55	55	54	54	53	52	51	50	48	46
0	0.4	296	56	56	56	56	55	54	53	51	50	48	46
0	0.6	304	56	56	56	56	56	55	54	53	51	50	48
0	0.8	312	56	56	56	56	56	56	55	54	53	52	51
0	1.0	320	55	55	56	56	56	55	55	54	53	52	51

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	20	19	18	17	15	13	11	9	7	4	1
-1	-0.8	248	25	24	23	22	20	18	17	14	12	10	7
-1	-0.6	256	29	28	27	26	25	23	21	19	17	15	12
-1	-0.4	264	32	32	31	30	28	27	25	23	21	19	17
-1	-0.2	272	35	35	34	33	32	30	29	27	25	23	21
-1	0.0	280	38	37	36	36	35	33	32	30	28	26	24
-1	0.2	288	39	39	38	38	37	36	34	33	31	29	27
-1	0.4	296	41	40	40	39	38	37	36	35	33	31	29
-1	0.6	304	41	41	41	40	39	38	37	36	34	33	31
-1	0.8	312	41	41	41	40	40	39	38	37	35	34	32
-1	1.0	320	41	41	41	40	40	39	38	37	36	34	33

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	39	39	39	38	37	36	35	34	32	31	29
1	-0.8	248	43	42	42	42	41	40	39	38	37	35	33
1	-0.6	256	45	45	45	45	44	44	43	42	40	39	37
1	-0.4	264	48	48	48	48	47	47	46	45	44	42	41
1	-0.2	272	49	50	50	50	49	49	48	47	46	45	43
1	0.0	280	51	51	51	51	51	51	50	49	48	47	46
1	0.2	288	51	52	52	52	52	52	51	51	50	49	47
1	0.4	296	51	52	52	53	53	52	52	51	51	50	49
1	0.6	304	51	52	52	52	52	52	52	52	51	50	49
1	0.8	312	50	51	51	52	52	52	52	51	51	50	49
1	1.0	320	48	49	50	50	51	51	51	50	50	49	49

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	35	34	33	32	31	30	28	27	25	23	20
0	-0.8	248	38	38	37	37	35	34	33	31	29	27	25
0	-0.6	256	42	41	41	40	39	38	37	35	33	32	29
0	-0.4	264	44	44	44	43	42	41	40	39	37	35	33
0	-0.2	272	46	46	46	45	45	44	43	41	40	38	36
0	0.0	280	48	48	48	47	47	46	45	44	42	41	39
0	0.2	288	49	49	49	48	48	47	46	45	44	43	41
0	0.4	296	49	49	49	49	49	48	47	46	45	44	42
0	0.6	304	49	49	49	49	49	48	48	47	46	45	43
0	0.8	312	48	49	49	49	49	48	48	47	46	45	44
0	1.0	320	47	47	48	48	48	47	47	46	46	44	43

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	15	14	13	12	10	8	6	4	2	-1	-3
-1	-0.8	248	19	18	17	16	15	13	11	9	7	4	2
-1	-0.6	256	23	22	21	20	18	17	15	13	11	9	6
-1	-0.4	264	26	25	24	23	22	20	19	17	15	13	10
-1	-0.2	272	28	27	27	26	25	23	22	20	18	16	14
-1	0.0	280	30	29	29	28	27	26	24	23	21	19	17
-1	0.2	288	31	31	30	29	29	27	26	25	23	21	19
-1	0.4	296	32	31	31	30	30	29	27	26	25	23	21
-1	0.6	304	32	32	31	31	30	29	28	27	25	24	22
-1	0.8	312	31	31	31	31	30	29	28	27	26	24	23
-1	1.0	320	30	30	30	30	30	29	28	27	26	24	23

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

Actual:				
Name	Speed (rpm)	Solids	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	17	0	150
Maximum	320	33	1.5	300
Center	280	25	0.75	225
Range	80	16	1.5	150
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	57.24
X1	COE1	6.39
X2	COE2	6.49
X3	COE3	-3.93
X4	COE4	-4.95
X1*X1	COE11	-4.05
X2*X2	COE22	-4.02
X3*X3	COE33	-1.49
X4*X4	COE44	-3.01
X1*X2	COE12	-2.05
X1*X3	COE13	-2.24
X1*X4	COE14	3.22
X2*X3	COE23	3.4
X2*X4	COE24	1.51
X3*X4	COE34	-1.15

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	51	51	50	50	49	48	47	45	44	42	40
1	-0.8	248	53	53	53	52	52	51	50	48	47	45	43
1	-0.6	256	55	55	55	55	54	53	52	51	50	48	46
1	-0.4	264	56	56	57	56	56	55	55	54	52	51	49
1	-0.2	272	57	58	58	58	58	57	57	56	54	53	51
1	0.0	280	58	59	59	59	59	59	58	57	56	55	53
1	0.2	288	59	59	60	60	60	60	59	59	58	57	55
1	0.4	296	59	60	60	61	61	61	60	60	59	58	57
1	0.6	304	59	60	60	61	61	61	61	61	60	59	58
1	0.8	312	58	59	60	61	61	61	61	61	61	60	59
1	1.0	320	57	59	60	60	61	61	61	61	61	60	59

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	51	51	50	49	48	47	45	44	42	39	37
0	-0.8	248	54	53	53	52	51	50	49	47	45	43	41
0	-0.6	256	56	56	55	55	54	53	52	50	49	47	44
0	-0.4	264	58	58	58	57	56	56	54	53	51	50	47
0	-0.2	272	59	59	59	59	59	58	57	56	54	52	50
0	0.0	280	60	61	61	61	61	60	59	58	56	55	53
0	0.2	288	61	62	62	62	62	61	60	60	58	57	55
0	0.4	296	62	63	63	63	63	62	62	61	60	59	57
0	0.6	304	62	63	63	64	64	63	63	62	61	60	59
0	0.8	312	62	63	64	64	64	64	64	63	62	61	60
0	1.0	320	62	63	64	64	64	64	64	64	63	62	61

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	43	43	42	41	39	38	36	34	32	29	26
-1	-0.8	248	46	46	45	44	43	41	40	38	36	33	31
-1	-0.6	256	49	49	48	47	46	45	43	41	39	37	34
-1	-0.4	264	51	51	51	50	49	48	46	45	43	40	38
-1	-0.2	272	53	53	53	52	51	50	49	47	46	44	41
-1	0.0	280	55	55	55	54	54	53	51	50	48	46	44
-1	0.2	288	56	56	56	56	55	55	53	52	51	49	47
-1	0.4	296	57	57	58	57	57	56	55	54	53	51	49
-1	0.6	304	58	58	58	58	58	58	57	56	54	53	51
-1	0.8	312	58	59	59	59	59	59	58	57	56	54	53
-1	1.0	320	58	59	59	60	59	59	59	58	57	56	54

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	55	55	54	54	53	51	50	48	46	44	42
1	-0.8	248	57	57	56	56	55	54	52	51	49	47	45
1	-0.6	256	58	58	58	57	57	56	54	53	51	49	47
1	-0.4	264	59	59	59	59	58	57	56	55	53	52	50
1	-0.2	272	60	60	60	60	59	59	58	57	55	53	52
1	0.0	280	60	61	61	61	60	60	59	58	57	55	53
1	0.2	288	60	61	61	61	61	60	60	59	58	56	55
1	0.4	296	60	61	61	61	61	61	60	59	58	57	56
1	0.6	304	59	60	61	61	61	61	60	60	59	58	56
1	0.8	312	58	59	60	60	61	61	60	60	59	58	57
1	1.0	320	57	58	59	60	60	60	60	59	59	58	57

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	52	51	51	50	48	47	45	43	41	38	36
0	-0.8	248	54	54	53	52	51	50	48	46	44	42	39
0	-0.6	256	56	56	55	54	53	52	50	49	47	45	42
0	-0.4	264	57	57	57	56	55	54	53	51	49	47	45
0	-0.2	272	58	58	58	58	57	56	55	53	51	49	47
0	0.0	280	59	59	59	59	58	57	56	55	53	51	49
0	0.2	288	60	60	60	60	59	58	57	56	55	53	51
0	0.4	296	60	60	60	60	60	59	58	57	56	54	52
0	0.6	304	60	60	60	60	60	60	59	58	57	55	54
0	0.8	312	59	60	60	60	60	60	59	58	57	56	54
0	1.0	320	58	59	60	60	60	60	59	58	57	56	55

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	41	40	39	38	36	34	32	30	27	25	22
-1	-0.8	248	43	43	42	41	39	37	35	33	31	28	25
-1	-0.6	256	46	45	44	43	42	40	38	36	34	32	29
-1	-0.4	264	47	47	46	45	44	43	41	39	37	35	32
-1	-0.2	272	49	49	48	47	46	45	43	42	40	37	35
-1	0.0	280	50	50	50	49	48	47	45	44	42	40	37
-1	0.2	288	51	51	51	50	49	48	47	45	44	42	39
-1	0.4	296	52	52	51	51	50	49	48	47	45	43	41
-1	0.6	304	52	52	52	52	51	50	49	48	47	45	43
-1	0.8	312	52	52	52	52	52	51	50	49	47	46	44
-1	1.0	320	51	52	52	52	52	51	50	49	48	47	45

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	56	56	55	54	53	52	50	48	46	43	41
1	-0.8	248	58	57	57	56	55	53	52	50	48	46	43
1	-0.6	256	58	58	58	57	56	55	54	52	50	48	45
1	-0.4	264	59	59	59	58	57	56	55	53	52	50	47
1	-0.2	272	59	59	59	59	58	57	56	55	53	51	49
1	0.0	280	59	59	59	59	58	58	57	55	54	52	50
1	0.2	288	59	59	59	59	59	58	57	56	54	53	51
1	0.4	296	58	59	59	59	58	58	57	56	55	53	52
1	0.6	304	57	58	58	58	58	57	57	56	55	53	52
1	0.8	312	56	56	57	57	57	57	56	55	54	53	52
1	1.0	320	54	55	55	56	56	56	55	55	54	53	51

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	50	49	48	47	45	44	42	39	37	34	31
0	-0.8	248	52	51	50	49	48	46	44	42	40	37	34
0	-0.6	256	53	52	52	51	49	48	46	44	42	40	37
0	-0.4	264	54	53	53	52	51	50	48	46	44	42	39
0	-0.2	272	55	54	54	53	52	51	49	48	46	44	41
0	0.0	280	55	55	54	54	53	52	50	49	47	45	43
0	0.2	288	55	55	55	54	53	52	51	50	48	46	44
0	0.4	296	55	55	55	54	54	53	52	50	49	47	45
0	0.6	304	54	54	54	54	54	53	52	51	49	48	46
0	0.8	312	53	53	54	53	53	53	52	51	49	48	46
0	1.0	320	52	52	53	53	52	52	51	50	49	48	46

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	35	34	33	32	30	28	25	23	20	17	14
-1	-0.8	248	38	37	35	34	32	30	28	26	23	20	17
-1	-0.6	256	39	38	37	36	35	33	31	28	26	23	20
-1	-0.4	264	41	40	39	38	36	35	33	31	28	26	23
-1	-0.2	272	42	41	40	39	38	37	35	33	30	28	25
-1	0.0	280	43	42	41	40	39	38	36	34	32	30	27
-1	0.2	288	43	43	42	41	40	39	37	36	34	31	29
-1	0.4	296	43	43	42	42	41	40	38	37	35	33	30
-1	0.6	304	43	43	42	42	41	40	39	37	36	34	31
-1	0.8	312	42	42	42	42	41	40	39	38	36	34	32
-1	1.0	320	41	42	42	41	41	40	39	38	36	35	33

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)

Description: Illinois No. 6 Seam

Circuit: Individual MGS

Actual:				
Name	Speed (rpm)	Solids	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	17	0	150
Maximum	320	33	1.5	300
Center	280	25	0.75	225
Range	80	16	1.5	150
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	61.79
X1	COE1	6.46
X2	COE2	6.4
X3	COE3	-4.84
X4	COE4	-6.44
X1*X1	COE11	-1.09
X2*X2	COE22	-3.13
X3*X3	COE33	2.73
X4*X4	COE44	-3.21
X1*X2	COE12	2.17
X1*X3	COE13	-0.87
X1*X4	COE14	3.66
X2*X3	COE23	-1.3
X2*X4	COE24	3.45
X3*X4	COE34	-3.58

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	63	64	64	64	64	63	63	62	60	59	57
1	-0.8	248	65	65	66	66	66	66	65	64	63	62	60
1	-0.6	256	66	67	68	68	68	68	67	67	66	64	63
1	-0.4	264	68	69	69	70	70	70	70	69	68	67	66
1	-0.2	272	69	70	71	72	72	72	72	71	71	70	69
1	0.0	280	70	71	72	73	74	74	74	74	73	72	71
1	0.2	288	71	73	74	75	75	76	76	76	75	75	74
1	0.4	296	72	74	75	76	77	78	78	78	78	77	76
1	0.6	304	73	75	76	78	79	79	80	80	80	79	79
1	0.8	312	74	76	78	79	80	81	81	82	82	82	81
1	1.0	320	75	77	79	80	81	82	83	84	84	84	83

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	64	64	64	63	62	61	60	58	56	54	51
0	-0.8	248	65	65	65	65	64	63	62	60	58	56	54
0	-0.6	256	66	67	66	66	65	65	63	62	60	58	56
0	-0.4	264	67	68	68	67	67	66	65	64	63	61	59
0	-0.2	272	68	69	69	69	68	68	67	66	65	63	61
0	0.0	280	69	70	70	70	70	69	69	68	66	65	63
0	0.2	288	70	70	71	71	71	71	70	69	68	67	65
0	0.4	296	70	71	72	72	72	72	72	71	70	69	68
0	0.6	304	71	72	73	73	73	73	73	73	72	71	69
0	0.8	312	71	72	73	74	74	75	74	74	73	73	71
0	1.0	320	72	73	74	75	75	76	76	75	75	74	73

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	59	58	57	56	54	52	50	48	45	42	39
-1	-0.8	248	60	59	58	57	55	54	52	49	47	44	41
-1	-0.6	256	60	60	59	58	57	55	53	51	49	46	43
-1	-0.4	264	61	60	60	59	58	56	55	53	50	48	45
-1	-0.2	272	61	61	61	60	59	57	56	54	52	50	47
-1	0.0	280	62	62	61	61	60	59	57	55	54	51	49
-1	0.2	288	62	62	62	61	61	60	58	57	55	53	51
-1	0.4	296	62	62	62	62	61	60	59	58	56	54	52
-1	0.6	304	62	62	63	62	62	61	60	59	58	56	54
-1	0.8	312	62	63	63	63	63	62	61	60	59	57	55
-1	1.0	320	62	63	63	63	63	63	62	61	60	58	57

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	59	59	58	57	57	55	54	52	50	48	45
1	-0.8	248	60	60	60	59	59	57	56	55	53	51	48
1	-0.6	256	61	62	61	61	60	59	58	57	55	53	51
1	-0.4	264	63	63	63	63	62	61	60	59	58	56	54
1	-0.2	272	64	64	64	64	64	63	62	61	60	58	56
1	0.0	280	65	65	66	66	66	65	64	63	62	61	59
1	0.2	288	66	66	67	67	67	67	66	65	64	63	61
1	0.4	296	67	68	68	68	69	68	68	67	66	65	64
1	0.6	304	67	68	69	70	70	70	70	69	68	67	66
1	0.8	312	68	69	70	71	71	71	71	71	70	69	68
1	1.0	320	69	70	71	72	72	73	73	72	72	71	70

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	61	60	59	58	56	54	52	50	47	44	41
0	-0.8	248	62	61	60	59	58	56	54	52	49	46	43
0	-0.6	256	63	62	62	60	59	58	56	54	51	49	46
0	-0.4	264	64	63	63	62	60	59	57	55	53	51	48
0	-0.2	272	64	64	64	63	62	60	59	57	55	53	50
0	0.0	280	65	65	64	64	63	62	60	59	57	55	52
0	0.2	288	66	66	65	65	64	63	62	60	58	56	54
0	0.4	296	66	66	66	66	65	64	63	62	60	58	56
0	0.6	304	66	67	67	66	66	65	64	63	62	60	58
0	0.8	312	67	67	67	67	67	66	65	64	63	61	60
0	1.0	320	67	67	68	68	68	67	66	66	64	63	61

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	57	56	54	52	49	47	44	41	38	34	30
-1	-0.8	248	58	56	55	53	51	48	45	42	39	36	32
-1	-0.6	256	58	57	55	54	52	49	47	44	41	38	34
-1	-0.4	264	59	57	56	54	53	50	48	45	42	39	36
-1	-0.2	272	59	58	57	55	53	51	49	47	44	41	38
-1	0.0	280	59	58	57	56	54	52	50	48	45	42	39
-1	0.2	288	59	58	57	56	55	53	51	49	46	44	41
-1	0.4	296	59	58	58	57	55	54	52	50	48	45	42
-1	0.6	304	59	59	58	57	56	54	53	51	49	46	44
-1	0.8	312	59	59	58	57	56	55	53	52	50	47	45
-1	1.0	320	58	58	58	57	57	55	54	52	51	48	46

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)

Description: Illinois No. 6 Seam

Circuit: Individual MGS

		X3	1	1	1	1	-1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	60	59	58	56	55	53	51	48	46	43	39
1	-0.8	248	61	60	59	58	57	55	53	50	48	45	42
1	-0.6	256	62	62	61	60	58	57	55	53	50	48	45
1	-0.4	264	63	63	62	61	60	58	57	55	52	50	47
1	-0.2	272	64	64	63	62	61	60	58	57	55	52	50
1	0.0	280	65	65	64	64	63	62	60	59	57	54	52
1	0.2	288	66	66	66	65	64	63	62	60	59	56	54
1	0.4	296	66	67	66	66	65	65	63	62	60	58	56
1	0.6	304	67	67	67	67	67	66	65	64	62	60	58
1	0.8	312	68	68	68	68	68	67	66	65	64	62	60
1	1.0	320	68	69	69	69	69	68	68	67	65	64	62

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	63	62	60	58	56	53	50	47	44	40	36
0	-0.8	248	64	63	61	59	57	55	52	49	46	42	38
0	-0.6	256	65	64	62	60	58	56	53	51	47	44	41
0	-0.4	264	66	64	63	61	59	57	55	52	49	46	43
0	-0.2	272	66	65	64	62	61	59	56	54	51	48	45
0	0.0	280	66	66	65	63	62	60	58	55	53	50	46
0	0.2	288	67	66	65	64	62	61	59	57	54	51	48
0	0.4	296	67	67	66	65	63	62	60	58	55	53	50
0	0.6	304	67	67	66	65	64	63	61	59	57	54	52
0	0.8	312	67	67	67	66	65	63	62	60	58	56	53
0	1.0	320	67	67	67	66	65	64	63	61	59	57	55

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	61	59	56	53	50	47	43	40	36	31	27
-1	-0.8	248	61	59	57	54	51	48	45	41	37	33	28
-1	-0.6	256	61	59	57	55	52	49	46	42	38	34	30
-1	-0.4	264	62	60	58	55	53	50	47	43	40	36	32
-1	-0.2	272	62	60	58	56	53	51	48	45	41	37	33
-1	0.0	280	62	60	58	56	54	51	49	46	42	39	35
-1	0.2	288	62	60	59	57	55	52	49	46	43	40	36
-1	0.4	296	61	60	59	57	55	53	50	47	44	41	37
-1	0.6	304	61	60	59	57	55	53	51	48	45	42	39
-1	0.8	312	61	60	59	57	55	53	51	49	46	43	40
-1	1.0	320	60	60	59	57	56	54	52	49	47	44	41

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

Actual:				
Name	Speed (rpm)	Solids	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	17	0	150
Maximum	320	33	1.5	300
Center	280	25	0.75	225
Range	80	16	1.5	150
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	48.54
X1	COE1	1.84
X2	COE2	3.19
X3	COE3	-1.44
X4	COE4	-4.69
X1*X1	COE11	0.3
X2*X2	COE22	-1.04
X3*X3	COE33	1.81
X4*X4	COE44	-2.62
X1*X2	COE12	1.56
X1*X3	COE13	0.19
X1*X4	COE14	2.72
X2*X3	COE23	-1.31
X2*X4	COE24	3.54
X3*X4	COE34	-4.46

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	49	50	51	52	52	52	52	52	52	51	50
1	-0.8	248	49	50	51	52	53	53	53	53	53	52	51
1	-0.6	256	49	50	51	52	53	53	54	54	54	53	52
1	-0.4	264	49	51	52	53	53	54	54	54	54	54	54
1	-0.2	272	49	51	52	53	54	55	55	55	55	55	55
1	0.0	280	49	51	52	54	54	55	56	56	56	56	56
1	0.2	288	49	51	53	54	55	56	57	57	57	57	57
1	0.4	296	50	51	53	54	56	57	57	58	58	58	58
1	0.6	304	50	52	53	55	56	57	58	59	59	60	60
1	0.8	312	50	52	54	55	57	58	59	60	60	61	61
1	1.0	320	50	52	54	56	57	59	60	61	61	62	62

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	51	51	51	51	51	50	50	49	48	46	45
0	-0.8	248	50	51	51	51	51	51	50	49	48	47	46
0	-0.6	256	50	51	51	51	51	51	50	50	49	48	46
0	-0.4	264	50	51	51	51	51	51	51	50	49	48	47
0	-0.2	272	50	50	51	51	52	51	51	51	50	49	48
0	0.0	280	49	50	51	51	52	52	52	51	51	50	49
0	0.2	288	49	50	51	52	52	52	52	52	51	51	50
0	0.4	296	49	50	51	52	52	52	53	52	52	52	51
0	0.6	304	49	50	51	52	53	53	53	53	53	52	52
0	0.8	312	49	50	51	52	53	53	54	54	54	53	53
0	1.0	320	49	50	51	52	53	54	54	54	54	54	54

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	50	50	49	49	48	46	45	43	42	40	37
-1	-0.8	248	50	49	49	48	47	46	45	44	42	40	38
-1	-0.6	256	49	49	49	48	47	46	45	44	42	40	38
-1	-0.4	264	49	48	48	48	47	46	45	44	42	41	39
-1	-0.2	272	48	48	48	48	47	46	45	44	43	41	39
-1	0.0	280	47	48	48	47	47	46	45	44	43	42	40
-1	0.2	288	47	47	47	47	47	46	46	45	43	42	40
-1	0.4	296	46	47	47	47	47	46	46	45	44	43	41
-1	0.6	304	46	46	47	47	47	46	46	45	44	43	42
-1	0.8	312	45	46	47	47	47	47	46	45	45	44	42
-1	1.0	320	45	46	46	47	47	47	46	46	45	44	43

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	49	49	49	49	48	48	47	46	44	43	41
1	-0.8	248	49	49	49	49	49	48	47	46	45	44	42
1	-0.6	256	49	49	49	49	49	49	48	47	46	45	43
1	-0.4	264	49	49	50	50	50	49	49	48	47	46	45
1	-0.2	272	49	50	50	50	50	50	50	49	48	47	46
1	0.0	280	49	50	50	51	51	51	50	50	49	48	47
1	0.2	288	49	50	51	51	51	51	51	51	50	49	48
1	0.4	296	50	50	51	52	52	52	52	52	51	50	49
1	0.6	304	50	51	52	52	53	53	53	53	52	52	51
1	0.8	312	50	51	52	53	53	54	54	54	53	52	52
1	1.0	320	50	51	53	53	54	54	55	55	54	54	53

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	52	51	51	50	48	47	45	44	42	39	37
0	-0.8	248	52	51	50	50	49	47	46	44	42	40	38
0	-0.6	256	51	51	50	50	49	48	46	45	43	41	39
0	-0.4	264	51	51	50	50	49	48	47	45	43	42	39
0	-0.2	272	51	51	50	50	49	48	47	46	44	42	40
0	0.0	280	51	51	50	50	49	49	47	46	45	43	41
0	0.2	288	50	51	50	50	50	49	48	47	45	44	42
0	0.4	296	50	51	51	50	50	49	48	47	46	45	43
0	0.6	304	50	51	51	51	50	50	49	48	47	46	44
0	0.8	312	50	51	51	51	51	50	50	49	48	47	45
0	1.0	320	50	51	51	51	51	51	50	49	49	47	46

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	53	51	50	48	46	44	42	40	37	34	31
-1	-0.8	248	52	51	50	48	46	44	42	40	37	34	31
-1	-0.6	256	51	50	49	48	46	44	42	40	37	35	32
-1	-0.4	264	51	50	49	48	46	44	42	40	38	35	32
-1	-0.2	272	50	50	49	47	46	44	42	40	38	36	33
-1	0.0	280	50	49	48	47	46	44	43	41	38	36	33
-1	0.2	288	49	49	48	47	46	44	43	41	39	37	34
-1	0.4	296	49	49	48	47	46	44	43	41	39	37	35
-1	0.6	304	49	48	48	47	46	45	43	42	40	38	35
-1	0.8	312	48	48	47	47	46	45	43	42	40	38	36
-1	1.0	320	48	48	47	47	46	45	44	42	41	39	37

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	52	51	51	49	48	46	45	43	41	38	36
1	-0.8	248	52	52	51	50	49	47	45	44	41	39	37
1	-0.6	256	52	52	51	50	49	48	46	44	42	40	38
1	-0.4	264	52	52	51	51	50	48	47	45	43	41	39
1	-0.2	272	53	52	52	51	50	49	48	46	44	42	40
1	0.0	280	53	53	52	52	51	50	49	47	45	44	42
1	0.2	288	53	53	53	52	51	50	49	48	46	45	43
1	0.4	296	53	53	53	53	52	51	50	49	48	46	44
1	0.6	304	53	54	53	53	53	52	51	50	49	47	45
1	0.8	312	54	54	54	54	53	53	52	51	50	48	47
1	1.0	320	54	54	54	54	54	54	53	52	51	50	48

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	56	55	53	52	49	47	45	42	39	36	33
0	-0.8	248	56	55	53	52	50	47	45	43	40	37	34
0	-0.6	256	56	55	53	52	50	48	46	43	40	37	34
0	-0.4	264	56	55	53	52	50	48	46	44	41	38	35
0	-0.2	272	56	55	53	52	50	49	46	44	42	39	36
0	0.0	280	55	55	53	52	51	49	47	45	42	40	37
0	0.2	288	55	55	54	52	51	49	48	45	43	41	38
0	0.4	296	55	55	54	53	51	50	48	46	44	42	39
0	0.6	304	55	55	54	53	52	50	49	47	45	43	40
0	0.8	312	55	55	54	53	52	51	49	48	46	43	41
0	1.0	320	55	55	54	53	52	51	50	48	46	44	42

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	59	56	54	52	49	46	43	39	36	32	28
-1	-0.8	248	58	56	54	51	49	46	43	39	36	32	28
-1	-0.6	256	58	56	53	51	49	46	43	40	36	33	29
-1	-0.4	264	57	55	53	51	49	46	43	40	37	33	29
-1	-0.2	272	57	55	53	51	48	46	43	40	37	34	30
-1	0.0	280	56	54	53	51	48	46	43	40	37	34	31
-1	0.2	288	56	54	52	51	48	46	44	41	38	35	31
-1	0.4	296	55	54	52	50	48	46	44	41	38	35	32
-1	0.6	304	55	54	52	50	48	46	44	42	39	36	33
-1	0.8	312	54	53	52	50	49	47	44	42	39	36	33
-1	1.0	320	54	53	52	50	49	47	45	42	40	37	34

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Illinois No. 6 Seam
 Circuit: Individual MGS

Actual:				
Name	Speed (rpm)	Solids	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	17	0	150
Maximum	320	33	1.5	300
Center	280	25	0.75	225
Range	80	16	1.5	150
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	4.519
X1	COE1	-0.593
X2	COE2	-0.412
X3	COE3	0.081
X4	COE4	-0.011
X1*X1	COE11	0.335
X2*X2	COE22	0.23
X3*X3	COE33	0.094
X4*X4	COE44	0.03
X1*X2	COE12	0.16
X1*X3	COE13	0.16
X1*X4	COE14	0.026
X2*X3	COE23	-0.143
X2*X4	COE24	-0.039
X3*X4	COE34	-0.031

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
Description: Illinois No. 6 Seam
Circuit: Individual MGS

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	5.5	5.5	5.5	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
1	-0.8	248	5.3	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
1	-0.6	256	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
1	-0.4	264	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
1	-0.2	272	4.7	4.7	4.7	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
1	0.0	280	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
1	0.2	288	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
1	0.4	296	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
1	0.6	304	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
1	0.8	312	4.3	4.3	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.3	4.3
1	1.0	320	4.3	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.3	4.3	4.3

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	5.7	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
0	-0.8	248	5.4	5.4	5.4	5.4	5.4	5.3	5.3	5.4	5.4	5.4	5.4
0	-0.6	256	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
0	-0.4	264	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
0	-0.2	272	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
0	0.0	280	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.6	4.6	4.6
0	0.2	288	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.5
0	0.4	296	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
0	0.6	304	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.3
0	0.8	312	4.1	4.1	4.1	4.1	4.1	4.1	4.2	4.2	4.2	4.2	4.2
0	1.0	320	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.2	4.2	4.2

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
-1	-0.8	248	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
-1	-0.6	256	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.8	5.8
-1	-0.4	264	5.4	5.4	5.4	5.4	5.4	5.4	5.5	5.5	5.5	5.5	5.5
-1	-0.2	272	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.3	5.3	5.3	5.3
-1	0.0	280	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.1	5.1	5.1	5.1
-1	0.2	288	4.8	4.8	4.8	4.8	4.9	4.9	4.9	4.9	4.9	4.9	5.0
-1	0.4	296	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.8	4.8	4.8	4.8
-1	0.6	304	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7
-1	0.8	312	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.6	4.6	4.6	4.6
-1	1.0	320	4.4	4.4	4.4	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.6

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
Description: Illinois No. 6 Seam
Circuit: Individual MGS

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	5.2	5.2	5.2	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
1	-0.8	248	5.0	5.0	5.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
1	-0.6	256	4.8	4.8	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
1	-0.4	264	4.7	4.6	4.6	4.6	4.6	4.6	4.6	4.5	4.5	4.5	4.5
1	-0.2	272	4.5	4.5	4.5	4.5	4.4	4.4	4.4	4.4	4.4	4.4	4.4
1	0.0	280	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.3	4.3	4.3
1	0.2	288	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.2	4.2	4.2
1	0.4	296	4.3	4.3	4.3	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
1	0.6	304	4.3	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
1	0.8	312	4.3	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
1	1.0	320	4.3	4.3	4.3	4.3	4.2	4.2	4.2	4.2	4.2	4.2	4.2

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	5.5	5.5	5.5	5.5	5.5	5.4	5.4	5.4	5.4	5.4	5.4
0	-0.8	248	5.3	5.3	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
0	-0.6	256	5.1	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
0	-0.4	264	4.9	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
0	-0.2	272	4.7	4.7	4.7	4.7	4.7	4.7	4.6	4.6	4.7	4.7	4.7
0	0.0	280	4.6	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
0	0.2	288	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
0	0.4	296	4.4	4.4	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.4	4.4
0	0.6	304	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
0	0.8	312	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
0	1.0	320	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	6.3	6.3	6.3	6.3	6.2	6.2	6.3	6.3	6.3	6.3	6.3
-1	-0.8	248	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
-1	-0.6	256	5.8	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.8	5.8	5.8
-1	-0.4	264	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.6
-1	-0.2	272	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.4	5.4
-1	0.0	280	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
-1	0.2	288	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.1	5.1	5.1
-1	0.4	296	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	5.0	5.0
-1	0.6	304	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.9	4.9	4.9	4.9
-1	0.8	312	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.9
-1	1.0	320	4.7	4.7	4.7	4.7	4.7	4.7	4.8	4.8	4.8	4.8	4.8

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
Description: Illinois No. 6 Seam
Circuit: Individual MGS

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
1	-1.0	240	5.1	5.1	5.1	5.0	5.0	5.0	5.0	4.9	4.9	4.9	4.9
1	-0.8	248	4.9	4.9	4.9	4.8	4.8	4.8	4.8	4.8	4.8	4.7	4.7
1	-0.6	256	4.8	4.7	4.7	4.7	4.7	4.7	4.6	4.6	4.6	4.6	4.6
1	-0.4	264	4.7	4.6	4.6	4.6	4.6	4.5	4.5	4.5	4.5	4.5	4.5
1	-0.2	272	4.6	4.5	4.5	4.5	4.5	4.4	4.4	4.4	4.4	4.4	4.4
1	0.0	280	4.5	4.5	4.4	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.3
1	0.2	288	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.3	4.3	4.3
1	0.4	296	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
1	0.6	304	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.3	4.3	4.3
1	0.8	312	4.5	4.4	4.4	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.3
1	1.0	320	4.5	4.5	4.5	4.5	4.4	4.4	4.4	4.4	4.4	4.4	4.4

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
0	-1.0	240	5.6	5.5	5.5	5.5	5.5	5.5	5.4	5.4	5.4	5.4	5.4
0	-0.8	248	5.3	5.3	5.3	5.3	5.3	5.3	5.2	5.2	5.2	5.2	5.2
0	-0.6	256	5.2	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.0	5.0
0	-0.4	264	5.0	5.0	5.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
0	-0.2	272	4.9	4.9	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
0	0.0	280	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
0	0.2	288	4.7	4.7	4.7	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
0	0.4	296	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
0	0.6	304	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.5	4.5	4.6	4.6
0	0.8	312	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
0	1.0	320	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	165	180	195	210	225	240	255	270	285	300
-1	-1.0	240	6.5	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
-1	-0.8	248	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
-1	-0.6	256	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
-1	-0.4	264	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
-1	-0.2	272	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
-1	0.0	280	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
-1	0.2	288	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
-1	0.4	296	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
-1	0.6	304	5.3	5.3	5.2	5.2	5.2	5.2	5.2	5.3	5.3	5.3	5.3
-1	0.8	312	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.3	5.3
-1	1.0	320	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.3	5.3

APPENDIX 4-E

Response Surface Plots and Computations

**Combined Microcel/MGS Tests
Pittsburgh No. 8 Seam Coal**

Pittsburgh No. 8 Seam
Micro/MGS Combined

Pittsburgh No. 8 Seam
Micro/MGS Combined

Pittsburgh No. 8 Seam
Microcel/MGS Combined

Pittsburgh No. 8 Seam
Microcel/MGS Combined

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Cfm Feed (lb/hr)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	300	0.5	150
Maximum	320	500	1.5	350
Center	280	400	1	250
Range	80	200	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	99.295
X1	COE1	-1.01
X2	COE2	0.156
X3	COE3	0.203
X4	COE4	0.166
X1*X1	COE11	-0.919
X2*X2	COE22	-0.086
X3*X3	COE33	0.19
X4*X4	COE44	-0.076
X1*X2	COE12	1.24
X1*X3	COE13	0.36
X1*X4	COE14	-0.173
X2*X3	COE23	0.058
X2*X4	COE24	-0.078
X3*X4	COE34	-0.009

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	98	98	98	98	98	99	99	99	99	99	99
1	-0.8	248	98	99	99	99	99	99	99	99	99	99	99
1	-0.6	256	99	99	99	99	99	99	99	99	99	99	99
1	-0.4	264	99	99	99	99	99	99	99	99	99	99	99
1	-0.2	272	99	99	99	99	99	99	99	99	99	99	99
1	0.0	280	99	99	99	99	99	99	99	99	99	99	99
1	0.2	288	99	99	99	99	99	99	99	99	99	99	99
1	0.4	296	99	99	99	99	99	99	99	99	99	99	99
1	0.6	304	99	99	99	99	99	99	99	99	99	99	99
1	0.8	312	99	99	99	99	99	99	99	99	99	99	98
1	1.0	320	98	98	98	98	98	98	98	98	98	98	98

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	99	99	99	100	100	100	100	100	100	100	100
0	-0.8	248	99	99	100	100	100	100	100	100	100	100	100
0	-0.6	256	99	100	100	100	100	100	100	100	100	100	100
0	-0.4	264	99	99	100	100	100	100	100	100	100	100	100
0	-0.2	272	99	99	99	99	99	100	100	100	100	100	100
0	0.0	280	99	99	99	99	99	99	99	99	99	99	99
0	0.2	288	99	99	99	99	99	99	99	99	99	99	99
0	0.4	296	98	98	98	99	99	99	99	99	99	99	99
0	0.6	304	98	98	98	98	98	98	98	98	98	98	98
0	0.8	312	97	98	98	98	98	98	98	98	98	98	98
0	1.0	320	97	97	97	97	97	97	97	97	97	97	97

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	100	100	101	101	101	101	101	101	101	101	101
-1	-0.8	248	100	100	100	100	101	101	101	101	101	101	101
-1	-0.6	256	100	100	100	100	100	100	100	100	101	101	101
-1	-0.4	264	100	100	100	100	100	100	100	100	100	100	100
-1	-0.2	272	99	99	99	99	100	100	100	100	100	100	100
-1	0.0	280	99	99	99	99	99	99	99	99	99	99	99
-1	0.2	288	98	98	98	98	98	99	99	99	99	99	99
-1	0.4	296	98	98	98	98	98	98	98	98	98	98	98
-1	0.6	304	97	97	97	97	97	97	97	97	97	97	97
-1	0.8	312	96	96	96	96	96	96	96	96	96	96	96
-1	1.0	320	95	95	95	96	96	96	96	96	96	96	96

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	98	98	98	98	98	98	98	98	98	98	98
1	-0.8	248	98	98	98	98	99	99	99	99	99	99	99
1	-0.6	256	99	99	99	99	99	99	99	99	99	99	99
1	-0.4	264	99	99	99	99	99	99	99	99	99	99	99
1	-0.2	272	99	99	99	99	99	99	99	99	99	99	99
1	0.0	280	99	99	99	99	99	99	99	99	99	99	99
1	0.2	288	99	99	99	99	99	99	99	99	99	99	99
1	0.4	296	99	99	99	99	99	99	99	99	99	99	99
1	0.6	304	99	99	99	99	99	99	99	99	99	99	99
1	0.8	312	99	99	99	99	99	99	99	99	99	99	99
1	1.0	320	99	99	99	99	99	99	99	99	99	99	99

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	99	99	99	99	99	99	99	100	100	100	100
0	-0.8	248	99	99	99	99	99	100	100	100	100	100	100
0	-0.6	256	99	99	99	99	100	100	100	100	100	100	100
0	-0.4	264	99	99	99	99	100	100	100	100	100	100	100
0	-0.2	272	99	99	99	99	99	99	99	100	100	100	100
0	0.0	280	99	99	99	99	99	99	99	99	99	99	99
0	0.2	288	99	99	99	99	99	99	99	99	99	99	99
0	0.4	296	99	99	99	99	99	99	99	99	99	99	99
0	0.6	304	98	98	98	98	98	98	98	98	98	98	98
0	0.8	312	98	98	98	98	98	98	98	98	98	98	98
0	1.0	320	97	97	97	97	97	97	97	97	97	97	97

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	100	100	100	100	100	100	100	101	101	101	101
-1	-0.8	248	100	100	100	100	100	100	100	100	100	101	101
-1	-0.6	256	100	100	100	100	100	100	100	100	100	100	100
-1	-0.4	264	99	100	100	100	100	100	100	100	100	100	100
-1	-0.2	272	99	99	99	99	99	99	100	100	100	100	100
-1	0.0	280	99	99	99	99	99	99	99	99	99	99	99
-1	0.2	288	98	98	98	98	98	98	98	98	98	98	98
-1	0.4	296	98	98	98	98	98	98	98	98	98	98	98
-1	0.6	304	97	97	97	97	97	97	97	97	97	97	97
-1	0.8	312	96	97	97	97	97	97	97	97	97	97	97
-1	1.0	320	96	96	96	96	96	96	96	96	96	96	96

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	98	98	98	98	98	98	98	98	98	98	98
1	-0.8	248	98	99	99	99	99	99	99	99	99	99	99
1	-0.6	256	99	99	99	99	99	99	99	99	99	99	99
1	-0.4	264	99	99	99	99	99	99	99	99	99	100	100
1	-0.2	272	99	100	100	100	100	100	100	100	100	100	100
1	0.0	280	100	100	100	100	100	100	100	100	100	100	100
1	0.2	288	100	100	100	100	100	100	100	100	100	100	100
1	0.4	296	100	100	100	100	100	100	100	100	100	100	100
1	0.6	304	100	100	100	100	100	100	100	100	100	100	100
1	0.8	312	100	100	100	100	100	100	100	100	100	100	100
1	1.0	320	100	100	100	100	100	99	99	99	99	99	99

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	99	99	99	99	99	99	99	100	100	100	100
0	-0.8	248	99	99	99	99	99	100	100	100	100	100	100
0	-0.6	256	99	99	100	100	100	100	100	100	100	100	100
0	-0.4	264	99	100	100	100	100	100	100	100	100	100	100
0	-0.2	272	100	100	100	100	100	100	100	100	100	100	100
0	0.0	280	99	100	100	100	100	100	100	100	100	100	100
0	0.2	288	99	99	99	99	99	100	100	100	100	100	100
0	0.4	296	99	99	99	99	99	99	99	99	99	99	99
0	0.6	304	99	99	99	99	99	99	99	99	99	99	99
0	0.8	312	98	99	99	99	99	99	99	99	99	99	99
0	1.0	320	98	98	98	98	98	98	98	98	98	98	98

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	100	100	100	100	100	100	100	101	101	101	101
-1	-0.8	248	100	100	100	100	100	100	100	100	101	101	101
-1	-0.6	256	100	100	100	100	100	100	100	100	100	100	100
-1	-0.4	264	100	100	100	100	100	100	100	100	100	100	100
-1	-0.2	272	99	99	100	100	100	100	100	100	100	100	100
-1	0.0	280	99	99	99	99	99	99	99	99	100	100	100
-1	0.2	288	99	99	99	99	99	99	99	99	99	99	99
-1	0.4	296	98	98	98	98	98	98	99	99	99	99	99
-1	0.6	304	98	98	98	98	98	98	98	98	98	98	98
-1	0.8	312	97	97	97	97	97	97	97	97	97	97	97
-1	1.0	320	96	96	97	97	97	97	97	97	97	97	97

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Cfm Feed (lb/hr)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	300	0.5	150
Maximum	320	500	1.5	350
Center	280	400	1	250
Range	80	200	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	99.36
X1	COE1	-0.928
X2	COE2	0.148
X3	COE3	0.199
X4	COE4	0.161
X1*X1	COE11	-0.905
X2*X2	COE22	-0.086
X3*X3	COE33	0.176
X4*X4	COE44	-0.073
X1*X2	COE12	1.206
X1*X3	COE13	0.362
X1*X4	COE14	-0.184
X2*X3	COE23	0.058
X2*X4	COE24	-0.063
X3*X4	COE34	-0.011

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	98	98	98	98	98	99	99	99	99	99	99
1	-0.8	248	98	99	99	99	99	99	99	99	99	99	99
1	-0.6	256	99	99	99	99	99	99	99	99	99	99	99
1	-0.4	264	99	99	99	99	99	99	99	99	99	99	99
1	-0.2	272	99	99	99	99	99	99	99	99	99	99	99
1	0.0	280	99	99	99	99	99	99	99	99	99	99	99
1	0.2	288	99	99	99	99	99	99	99	99	99	99	99
1	0.4	296	99	99	99	99	99	99	99	99	99	99	99
1	0.6	304	99	99	99	99	99	99	99	99	99	99	99
1	0.8	312	99	99	99	99	99	99	99	99	99	99	99
1	1.0	320	98	98	98	98	98	98	98	98	98	98	98

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	99	99	99	100	100	100	100	100	100	100	100
0	-0.8	248	99	99	100	100	100	100	100	100	100	100	100
0	-0.6	256	99	100	100	100	100	100	100	100	100	100	100
0	-0.4	264	99	99	100	100	100	100	100	100	100	100	100
0	-0.2	272	99	99	99	99	100	100	100	100	100	100	100
0	0.0	280	99	99	99	99	99	99	99	99	99	99	99
0	0.2	288	99	99	99	99	99	99	99	99	99	99	99
0	0.4	296	99	99	99	99	99	99	99	99	99	99	99
0	0.6	304	98	98	98	98	98	98	98	98	98	98	98
0	0.8	312	98	98	98	98	98	98	98	98	98	98	98
0	1.0	320	97	97	97	97	97	97	97	97	97	97	97

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	100	100	100	101	101	101	101	101	101	101	101
-1	-0.8	248	100	100	100	100	100	101	101	101	101	101	101
-1	-0.6	256	100	100	100	100	100	100	100	100	101	101	101
-1	-0.4	264	100	100	100	100	100	100	100	100	100	100	100
-1	-0.2	272	99	99	99	100	100	100	100	100	100	100	100
-1	0.0	280	99	99	99	99	99	99	99	99	99	99	99
-1	0.2	288	98	98	98	99	99	99	99	99	99	99	99
-1	0.4	296	98	98	98	98	98	98	98	98	98	98	98
-1	0.6	304	97	97	97	97	97	97	97	97	97	97	97
-1	0.8	312	96	96	97	97	97	97	97	97	97	97	97
-1	1.0	320	96	96	96	96	96	96	96	96	96	96	96

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	98	98	98	98	98	98	98	98	98	98	98
1	-0.8	248	98	98	98	99	99	99	99	99	99	99	99
1	-0.6	256	99	99	99	99	99	99	99	99	99	99	99
1	-0.4	264	99	99	99	99	99	99	99	99	99	99	99
1	-0.2	272	99	99	99	99	99	99	99	99	99	99	99
1	0.0	280	99	99	99	99	99	99	99	99	99	99	99
1	0.2	288	99	99	99	99	99	99	99	99	99	99	99
1	0.4	296	99	99	99	99	99	99	99	99	99	99	99
1	0.6	304	99	99	99	99	99	99	99	99	99	99	99
1	0.8	312	99	99	99	99	99	99	99	99	99	99	99
1	1.0	320	99	99	99	99	99	99	99	99	99	99	99

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	99	99	99	99	99	99	99	100	100	100	100
0	-0.8	248	99	99	99	99	99	100	100	100	100	100	100
0	-0.6	256	99	99	99	99	100	100	100	100	100	100	100
0	-0.4	264	99	99	99	99	100	100	100	100	100	100	100
0	-0.2	272	99	99	99	99	99	100	100	100	100	100	100
0	0.0	280	99	99	99	99	99	99	99	99	99	99	99
0	0.2	288	99	99	99	99	99	99	99	99	99	99	99
0	0.4	296	99	99	99	99	99	99	99	99	99	99	99
0	0.6	304	98	98	98	98	98	98	98	98	98	98	98
0	0.8	312	98	98	98	98	98	98	98	98	98	98	98
0	1.0	320	97	97	98	98	98	98	98	98	97	97	97

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	100	100	100	100	100	100	100	101	101	101	101
-1	-0.8	248	100	100	100	100	100	100	100	100	100	101	101
-1	-0.6	256	100	100	100	100	100	100	100	100	100	100	100
-1	-0.4	264	99	100	100	100	100	100	100	100	100	100	100
-1	-0.2	272	99	99	99	99	99	100	100	100	100	100	100
-1	0.0	280	99	99	99	99	99	99	99	99	99	99	99
-1	0.2	288	98	98	99	99	99	99	99	99	99	99	99
-1	0.4	296	98	98	98	98	98	98	98	98	98	98	98
-1	0.6	304	97	97	97	97	97	98	98	98	98	98	98
-1	0.8	312	97	97	97	97	97	97	97	97	97	97	97
-1	1.0	320	96	96	96	96	96	96	96	96	96	96	96

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	98	98	98	98	98	98	98	98	98	98	99
1	-0.8	248	98	99	99	99	99	99	99	99	99	99	99
1	-0.6	256	99	99	99	99	99	99	99	99	99	99	99
1	-0.4	264	99	99	99	99	99	99	99	100	100	100	100
1	-0.2	272	99	100	100	100	100	100	100	100	100	100	100
1	0.0	280	100	100	100	100	100	100	100	100	100	100	100
1	0.2	288	100	100	100	100	100	100	100	100	100	100	100
1	0.4	296	100	100	100	100	100	100	100	100	100	100	100
1	0.6	304	100	100	100	100	100	100	100	100	100	100	100
1	0.8	312	100	100	100	100	100	100	100	100	100	100	100
1	1.0	320	100	100	100	100	100	100	100	100	100	99	99

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	99	99	99	99	99	99	99	100	100	100	100
0	-0.8	248	99	99	99	99	100	100	100	100	100	100	100
0	-0.6	256	99	99	100	100	100	100	100	100	100	100	100
0	-0.4	264	100	100	100	100	100	100	100	100	100	100	100
0	-0.2	272	100	100	100	100	100	100	100	100	100	100	100
0	0.0	280	100	100	100	100	100	100	100	100	100	100	100
0	0.2	288	99	99	99	100	100	100	100	100	100	100	100
0	0.4	296	99	99	99	99	99	99	99	99	99	99	99
0	0.6	304	99	99	99	99	99	99	99	99	99	99	99
0	0.8	312	99	99	99	99	99	99	99	99	99	99	99
0	1.0	320	98	98	98	98	98	98	98	98	98	98	98

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	100	100	100	100	100	100	100	100	101	101	101
-1	-0.8	248	100	100	100	100	100	100	100	100	100	101	101
-1	-0.6	256	100	100	100	100	100	100	100	100	100	100	100
-1	-0.4	264	100	100	100	100	100	100	100	100	100	100	100
-1	-0.2	272	99	100	100	100	100	100	100	100	100	100	100
-1	0.0	280	99	99	99	99	99	99	99	100	100	100	100
-1	0.2	288	99	99	99	99	99	99	99	99	99	99	99
-1	0.4	296	98	98	98	98	98	98	98	98	98	98	98
-1	0.6	304	98	98	98	98	98	98	98	98	98	98	98
-1	0.8	312	97	97	97	97	97	97	97	97	97	97	97
-1	1.0	320	97	97	97	97	97	97	97	97	97	97	97

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Clm Feed (lb/hr)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	300	0.5	150
Maximum	320	500	1.5	350
Center	280	400	1	250
Range	80	200	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	11.98
X1	COE1	10.52
X2	COE2	-0.85
X3	COE3	-1.13
X4	COE4	-0.44
X1*X1	COE11	2.58
X2*X2	COE22	0.39
X3*X3	COE33	-0.98
X4*X4	COE44	0.18
X1*X2	COE12	-4.66
X1*X3	COE13	-0.57
X1*X4	COE14	-1.08
X2*X3	COE23	0.2
X2*X4	COE24	1.01
X3*X4	COE34	-0.08

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	6	6	7	7	7	8	8	8	9	9	10
1	-0.8	248	7	7	7	7	8	8	8	9	9	9	10
1	-0.6	256	7	8	8	8	8	9	9	9	9	10	10
1	-0.4	264	8	9	9	9	9	9	10	10	10	10	11
1	-0.2	272	10	10	10	10	10	10	10	11	11	11	11
1	0.0	280	11	11	11	11	11	11	12	12	12	12	12
1	0.2	288	13	13	13	13	13	13	13	13	13	13	13
1	0.4	296	14	14	14	14	14	14	15	15	15	15	15
1	0.6	304	16	16	16	16	16	16	16	16	16	16	16
1	0.8	312	19	19	18	18	18	18	18	18	18	18	18
1	1.0	320	21	21	21	21	21	20	20	20	20	20	20

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	3	3	3	3	3	4	4	4	4	4	5
0	-0.8	248	5	5	5	5	5	5	5	5	5	5	6
0	-0.6	256	6	6	6	6	6	6	6	7	7	7	7
0	-0.4	264	8	8	8	8	8	8	8	8	8	8	8
0	-0.2	272	10	10	10	10	10	10	10	10	10	10	10
0	0.0	280	13	13	12	12	12	12	12	12	12	12	12
0	0.2	288	15	15	15	15	15	14	14	14	14	14	14
0	0.4	296	18	18	18	17	17	17	17	17	17	16	16
0	0.6	304	21	21	20	20	20	20	20	19	19	19	19
0	0.8	312	24	24	23	23	23	23	22	22	22	22	22
0	1.0	320	27	27	27	26	26	26	26	25	25	25	25

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	1	1	1	1	0	0	0	0	0	0	0
-1	-0.8	248	3	3	3	3	3	3	3	2	2	2	2
-1	-0.6	256	6	6	6	5	5	5	5	5	5	5	5
-1	-0.4	264	9	9	8	8	8	8	8	7	7	7	7
-1	-0.2	272	12	12	11	11	11	11	10	10	10	10	10
-1	0.0	280	15	15	14	14	14	14	13	13	13	13	12
-1	0.2	288	19	18	18	17	17	17	17	16	16	16	15
-1	0.4	296	22	22	21	21	21	20	20	20	19	19	19
-1	0.6	304	26	26	25	25	24	24	24	23	23	22	22
-1	0.8	312	30	30	29	29	28	28	27	27	27	26	26
-1	1.0	320	35	34	33	33	32	32	31	31	30	30	30

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	7	7	7	8	8	8	9	9	9	10	10
1	-0.8	248	7	7	8	8	8	8	9	9	9	10	10
1	-0.6	256	8	8	8	8	9	9	9	9	10	10	10
1	-0.4	264	9	9	9	9	9	10	10	10	10	11	11
1	-0.2	272	10	10	10	10	10	10	11	11	11	11	11
1	0.0	280	11	11	11	11	11	12	12	12	12	12	12
1	0.2	288	13	13	13	13	13	13	13	13	13	13	13
1	0.4	296	14	14	14	14	14	14	14	14	14	15	15
1	0.6	304	16	16	16	16	16	16	16	16	16	16	16
1	0.8	312	18	18	18	18	18	18	18	18	18	18	18
1	1.0	320	21	20	20	20	20	20	20	20	20	20	20

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	4	4	4	4	4	4	4	4	4	5	5
0	-0.8	248	5	5	5	5	5	5	5	5	6	6	6
0	-0.6	256	7	7	7	7	7	7	7	7	7	7	7
0	-0.4	264	8	8	8	8	8	8	8	8	8	8	8
0	-0.2	272	10	10	10	10	10	10	10	10	10	10	10
0	0.0	280	13	12	12	12	12	12	12	12	12	12	12
0	0.2	288	15	15	15	14	14	14	14	14	14	14	14
0	0.4	296	18	17	17	17	17	17	16	16	16	16	16
0	0.6	304	20	20	20	20	19	19	19	19	19	18	18
0	0.8	312	24	23	23	23	22	22	22	22	21	21	21
0	1.0	320	27	26	26	26	25	25	25	25	24	24	24

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	1	1	1	1	1	1	1	1	0	0	0
-1	-0.8	248	3	3	3	3	3	3	3	3	2	2	2
-1	-0.6	256	6	6	6	5	5	5	5	5	5	5	4
-1	-0.4	264	9	8	8	8	8	8	7	7	7	7	7
-1	-0.2	272	12	11	11	11	11	10	10	10	10	9	9
-1	0.0	280	15	14	14	14	14	13	13	13	12	12	12
-1	0.2	288	18	18	17	17	17	16	16	16	15	15	15
-1	0.4	296	22	21	21	20	20	20	19	19	19	18	18
-1	0.6	304	26	25	25	24	24	23	23	22	22	22	21
-1	0.8	312	30	29	28	28	27	27	27	26	26	25	25
-1	1.0	320	34	33	33	32	31	31	30	30	30	29	29

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	6	6	6	6	7	7	7	8	8	8	9
1	-0.8	248	6	6	6	7	7	7	7	8	8	8	9
1	-0.6	256	6	7	7	7	7	7	8	8	8	8	9
1	-0.4	264	7	7	7	8	8	8	8	8	9	9	9
1	-0.2	272	8	8	8	8	9	9	9	9	9	9	10
1	0.0	280	9	9	9	9	10	10	10	10	10	10	10
1	0.2	288	11	11	11	11	11	11	11	11	11	11	11
1	0.4	296	12	12	12	12	12	12	12	12	12	12	12
1	0.6	304	14	14	14	14	14	14	14	14	14	14	14
1	0.8	312	16	16	16	16	16	15	15	15	15	15	15
1	1.0	320	18	18	18	18	18	17	17	17	17	17	17

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	2	2	2	2	3	3	3	3	3	3	3
0	-0.8	248	3	3	3	3	3	4	4	4	4	4	4
0	-0.6	256	5	5	5	5	5	5	5	5	5	5	5
0	-0.4	264	7	6	6	6	6	6	6	6	6	6	6
0	-0.2	272	8	8	8	8	8	8	8	8	8	8	8
0	0.0	280	11	10	10	10	10	10	10	10	10	10	10
0	0.2	288	13	13	12	12	12	12	12	12	12	11	11
0	0.4	296	15	15	15	15	14	14	14	14	14	14	13
0	0.6	304	18	18	18	17	17	17	17	16	16	16	16
0	0.8	312	21	21	20	20	20	19	19	19	19	18	18
0	1.0	320	24	24	23	23	23	22	22	22	22	21	21

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	-0.8	248	2	2	1	1	1	1	1	1	1	0	0
-1	-0.6	256	4	4	4	3	3	3	3	3	3	2	2
-1	-0.4	264	7	6	6	6	6	5	5	5	5	5	5
-1	-0.2	272	10	9	9	9	8	8	8	8	7	7	7
-1	0.0	280	13	12	12	12	11	11	11	10	10	10	10
-1	0.2	288	16	15	15	15	14	14	14	13	13	13	12
-1	0.4	296	19	19	18	18	18	17	17	16	16	16	15
-1	0.6	304	23	22	22	22	21	21	20	20	19	19	19
-1	0.8	312	27	26	26	25	25	24	24	23	23	22	22
-1	1.0	320	31	30	30	29	29	28	28	27	27	26	26

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Cfm Feed (lb/hr)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	300	0.5	150
Maximum	320	500	1.5	350
Center	280	400	1	250
Range	80	200	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	24.39
X1	COE1	11.39
X2	COE2	-0.42
X3	COE3	-1.21
X4	COE4	-0.59
X1*X1	COE11	-2.81
X2*X2	COE22	0.26
X3*X3	COE33	-1.4
X4*X4	COE44	0.41
X1*X2	COE12	-5.37
X1*X3	COE13	2.43
X1*X4	COE14	1.56
X2*X3	COE23	0.13
X2*X4	COE24	2.16
X3*X4	COE34	-0.36

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	18	17	17	17	17	18	18	18	18	18	18
1	-0.8	248	19	19	19	19	19	19	19	20	20	20	20
1	-0.6	256	20	20	20	20	21	21	21	21	21	22	22
1	-0.4	264	21	21	21	22	22	22	22	23	23	23	24
1	-0.2	272	22	22	22	22	23	23	23	24	24	25	25
1	0.0	280	22	23	23	23	24	24	24	25	25	26	26
1	0.2	288	23	23	23	24	24	25	25	25	26	27	27
1	0.4	296	23	23	24	24	24	25	25	26	27	27	28
1	0.6	304	23	23	23	24	24	25	26	26	27	28	28
1	0.8	312	22	23	23	24	24	25	26	26	27	28	29
1	1.0	320	22	22	23	23	24	25	25	26	27	28	29

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	15	14	14	13	13	12	12	12	12	11	11
0	-0.8	248	17	17	16	16	16	15	15	15	14	14	14
0	-0.6	256	19	19	19	18	18	18	18	17	17	17	17
0	-0.4	264	21	21	21	21	20	20	20	20	20	20	20
0	-0.2	272	23	23	23	23	22	22	22	22	22	22	22
0	0.0	280	25	25	24	24	24	24	24	24	24	24	24
0	0.2	288	26	26	26	26	26	26	26	26	26	26	26
0	0.4	296	27	27	27	27	27	27	27	28	28	28	28
0	0.6	304	28	28	28	28	28	29	29	29	29	29	30
0	0.8	312	29	29	29	29	29	30	30	30	30	31	31
0	1.0	320	29	30	30	30	30	30	31	31	31	32	32

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	12	11	10	10	9	8	7	6	6	5	4
-1	-0.8	248	16	15	14	13	12	12	11	10	10	9	9
-1	-0.6	256	19	18	18	17	16	15	15	14	14	13	12
-1	-0.4	264	22	22	21	20	19	19	18	18	17	17	16
-1	-0.2	272	25	24	24	23	23	22	22	21	21	20	20
-1	0.0	280	28	27	27	26	26	25	25	24	24	23	23
-1	0.2	288	30	30	29	29	28	28	27	27	27	26	26
-1	0.4	296	32	32	31	31	31	30	30	30	29	29	29
-1	0.6	304	34	34	34	33	33	33	32	32	32	32	32
-1	0.8	312	36	36	36	35	35	35	34	34	34	34	34
-1	1.0	320	38	37	37	37	37	37	36	36	36	36	36

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	16	16	16	15	15	15	15	15	16	16	16
1	-0.8	248	18	18	18	18	18	18	18	18	18	18	18
1	-0.6	256	19	19	19	19	19	20	20	20	20	20	21
1	-0.4	264	21	21	21	21	21	21	22	22	22	22	23
1	-0.2	272	22	22	22	22	23	23	23	23	24	24	25
1	0.0	280	23	23	23	24	24	24	25	25	25	26	26
1	0.2	288	24	24	24	25	25	25	26	26	27	27	28
1	0.4	296	24	25	25	25	26	26	27	27	28	28	29
1	0.6	304	25	25	25	26	26	27	27	28	28	29	30
1	0.8	312	25	25	26	26	27	27	28	28	29	30	30
1	1.0	320	25	25	26	26	27	27	28	29	29	30	31

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	13	12	12	11	11	10	10	9	9	9	8
0	-0.8	248	16	15	15	14	14	13	13	13	13	12	12
0	-0.6	256	18	18	18	17	17	17	16	16	16	16	15
0	-0.4	264	21	21	20	20	20	19	19	19	19	19	19
0	-0.2	272	23	23	23	22	22	22	22	22	22	22	22
0	0.0	280	25	25	25	25	25	24	24	24	24	24	24
0	0.2	288	27	27	27	27	27	27	27	27	27	27	27
0	0.4	296	29	29	29	29	29	28	29	29	29	29	29
0	0.6	304	30	30	30	30	30	30	30	30	31	31	31
0	0.8	312	31	31	31	32	32	32	32	32	32	32	33
0	1.0	320	32	32	33	33	33	33	33	33	34	34	34

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	10	9	8	7	6	6	5	4	3	2	2
-1	-0.8	248	14	13	12	12	11	10	9	8	8	7	6
-1	-0.6	256	18	17	16	16	15	14	13	13	12	11	11
-1	-0.4	264	22	21	20	19	19	18	17	17	16	15	15
-1	-0.2	272	25	24	24	23	22	22	21	20	20	19	19
-1	0.0	280	28	28	27	26	26	25	25	24	24	23	23
-1	0.2	288	31	31	30	29	29	28	28	27	27	27	26
-1	0.4	296	34	33	33	32	32	31	31	31	30	30	30
-1	0.6	304	36	36	35	35	34	34	34	33	33	33	33
-1	0.8	312	39	38	38	37	37	37	36	36	36	36	36
-1	1.0	320	41	40	40	40	39	39	39	39	38	38	38

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	11	11	11	11	11	10	10	10	10	10	11
1	-0.8	248	14	13	13	13	13	13	13	13	13	13	14
1	-0.6	256	16	16	16	16	16	16	16	16	16	16	16
1	-0.4	264	18	18	18	18	18	18	18	18	18	19	19
1	-0.2	272	19	19	20	20	20	20	20	20	21	21	21
1	0.0	280	21	21	21	21	22	22	22	22	23	23	23
1	0.2	288	22	22	23	23	23	23	24	24	24	25	25
1	0.4	296	23	23	24	24	24	25	25	25	26	26	27
1	0.6	304	24	24	25	25	25	26	26	27	27	28	28
1	0.8	312	25	25	26	26	26	27	27	28	28	29	30
1	1.0	320	25	25	26	26	27	27	28	29	29	30	31

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	8	7	7	6	6	5	5	4	4	3	3
0	-0.8	248	12	11	10	10	9	9	9	8	8	7	7
0	-0.6	256	15	14	14	13	13	12	12	12	11	11	11
0	-0.4	264	18	17	17	16	16	16	16	15	15	15	15
0	-0.2	272	21	20	20	19	19	19	19	18	18	18	18
0	0.0	280	23	23	22	22	22	22	22	21	21	21	21
0	0.2	288	25	25	25	25	25	24	24	24	24	24	24
0	0.4	296	28	27	27	27	27	27	27	27	27	27	27
0	0.6	304	29	29	29	29	29	29	29	29	29	29	29
0	0.8	312	31	31	31	31	31	31	31	31	31	32	32
0	1.0	320	33	33	33	33	33	33	33	33	33	34	34

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	5	4	3	2	1	0	-1	-1	-2	-3	-4
-1	-0.8	248	10	9	8	7	6	5	4	4	3	2	1
-1	-0.6	256	14	13	12	11	11	10	9	8	8	7	6
-1	-0.4	264	18	17	17	16	15	14	13	13	12	11	11
-1	-0.2	272	22	21	21	20	19	18	18	17	16	16	15
-1	0.0	280	26	25	24	24	23	22	22	21	21	20	20
-1	0.2	288	29	29	28	27	27	26	26	25	25	24	24
-1	0.4	296	32	32	31	31	30	30	29	29	28	28	27
-1	0.6	304	35	35	34	34	33	33	32	32	32	31	31
-1	0.8	312	38	38	37	37	36	36	36	35	35	35	34
-1	1.0	320	41	40	40	39	39	39	38	38	38	38	38

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Cfm Feed (lb/hr)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	300	0.5	150
Maximum	320	500	1.5	350
Center	280	400	1	250
Range	80	200	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	48.68
X1	COE1	22.81
X2	COE2	-1.29
X3	COE3	-1.43
X4	COE4	-2.06
X1*X1	COE11	-6.58
X2*X2	COE22	1.29
X3*X3	COE33	-2.16
X4*X4	COE44	0.18
X1*X2	COE12	-10.3
X1*X3	COE13	4.04
X1*X4	COE14	2.37
X2*X3	COE23	0.39
X2*X4	COE24	2.79
X3*X4	COE34	2.26

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	37	36	35	34	33	33	32	31	30	30	29
1	-0.8	248	40	39	39	38	37	37	36	35	35	34	33
1	-0.6	256	43	43	42	41	41	40	40	39	38	38	37
1	-0.4	264	46	45	45	44	44	43	43	42	42	41	41
1	-0.2	272	48	47	47	46	46	46	45	45	44	44	44
1	0.0	280	49	49	49	48	48	48	47	47	47	46	46
1	0.2	288	50	50	50	49	49	49	49	49	48	48	48
1	0.4	296	51	50	50	50	50	50	50	50	50	50	49
1	0.6	304	51	50	50	50	50	50	50	50	50	50	50
1	0.8	312	50	50	50	50	50	50	50	50	50	51	51
1	1.0	320	49	49	49	49	49	49	50	50	50	50	50

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	29	28	27	25	24	23	21	20	19	17	16
0	-0.8	248	35	34	33	31	30	29	27	26	25	24	23
0	-0.6	256	40	39	38	37	35	34	33	32	31	30	29
0	-0.4	264	45	44	43	42	40	39	38	37	36	35	34
0	-0.2	272	49	48	47	46	45	44	43	42	41	40	39
0	0.0	280	52	52	51	50	49	48	47	46	45	45	44
0	0.2	288	55	55	54	53	52	51	51	50	49	48	48
0	0.4	296	58	57	56	56	55	54	54	53	52	52	51
0	0.6	304	60	59	59	58	57	57	56	56	55	55	54
0	0.8	312	61	61	60	60	59	59	58	58	57	57	57
0	1.0	320	62	62	61	61	61	60	60	59	59	59	58

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	25	23	21	19	17	15	13	12	10	8	6
-1	-0.8	248	33	31	29	27	25	23	22	20	18	16	15
-1	-0.6	256	40	38	36	35	33	31	29	28	26	24	23
-1	-0.4	264	46	45	43	41	40	38	37	35	33	32	30
-1	-0.2	272	53	51	49	48	46	45	43	42	40	39	37
-1	0.0	280	58	57	55	54	52	51	50	48	47	45	44
-1	0.2	288	63	62	61	59	58	56	55	54	53	51	50
-1	0.4	296	68	67	65	64	63	61	60	59	58	57	56
-1	0.6	304	72	71	69	68	67	66	65	64	63	62	60
-1	0.8	312	75	74	73	72	71	70	69	68	67	66	65
-1	1.0	320	78	77	76	75	74	73	72	72	71	70	69

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	31	31	31	30	30	30	29	29	29	28	28
1	-0.8	248	36	36	35	35	35	34	34	34	34	34	33
1	-0.6	256	40	39	39	39	39	39	39	39	38	38	38
1	-0.4	264	43	43	43	43	43	43	43	43	43	43	43
1	-0.2	272	46	46	46	46	46	46	46	46	46	46	46
1	0.0	280	48	48	48	48	49	49	49	49	49	49	50
1	0.2	288	50	50	50	50	51	51	51	51	52	52	52
1	0.4	296	51	51	52	52	52	53	53	53	54	54	54
1	0.6	304	52	52	53	53	53	54	54	55	55	56	56
1	0.8	312	52	52	53	53	54	54	55	56	56	57	57
1	1.0	320	52	52	53	53	54	55	55	56	57	57	58

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	24	23	22	21	20	19	18	18	17	16	15
0	-0.8	248	30	30	29	28	27	26	25	25	24	23	22
0	-0.6	256	36	36	35	34	33	33	32	31	31	30	29
0	-0.4	264	42	41	40	40	39	39	38	37	37	36	36
0	-0.2	272	47	46	45	45	44	44	43	43	42	42	42
0	0.0	280	51	50	50	50	49	49	48	48	48	47	47
0	0.2	288	55	54	54	54	53	53	53	52	52	52	52
0	0.4	296	58	58	57	57	57	57	57	56	56	56	56
0	0.6	304	61	61	60	60	60	60	60	60	60	60	60
0	0.8	312	63	63	63	63	63	63	63	63	63	63	63
0	1.0	320	65	65	65	65	65	65	65	65	65	65	65

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	19	17	16	14	13	12	10	9	7	6	5
-1	-0.8	248	27	26	25	23	22	21	19	18	17	15	14
-1	-0.6	256	35	34	33	32	30	29	28	27	25	24	23
-1	-0.4	264	43	42	41	39	38	37	36	35	34	32	31
-1	-0.2	272	50	49	48	47	45	44	43	42	41	40	39
-1	0.0	280	56	55	54	53	52	51	50	49	48	47	47
-1	0.2	288	62	61	60	59	59	58	57	56	55	54	53
-1	0.4	296	68	67	66	65	64	63	63	62	61	60	60
-1	0.6	304	72	72	71	70	69	69	68	67	67	66	66
-1	0.8	312	77	76	75	75	74	74	73	72	72	71	71
-1	1.0	320	80	80	79	79	78	78	77	77	76	76	75

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	22	22	22	22	22	22	22	23	23	23	23
1	-0.8	248	27	27	27	28	28	28	28	28	29	29	29
1	-0.6	256	32	32	32	33	33	33	34	34	34	35	35
1	-0.4	264	36	36	37	37	37	38	38	39	39	40	40
1	-0.2	272	40	40	40	41	41	42	42	43	43	44	45
1	0.0	280	43	43	44	44	45	45	46	47	47	48	49
1	0.2	288	45	46	47	47	48	49	49	50	51	51	52
1	0.4	296	47	48	49	50	50	51	52	53	53	54	55
1	0.6	304	49	50	50	51	52	53	54	55	56	57	58
1	0.8	312	50	51	52	53	54	55	55	56	58	59	60
1	1.0	320	50	51	52	53	54	55	57	58	59	60	61

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	14	14	13	13	12	12	11	11	10	10	10
0	-0.8	248	21	21	20	20	20	19	19	19	18	18	18
0	-0.6	256	28	28	27	27	27	27	26	26	26	26	26
0	-0.4	264	34	34	34	34	33	33	33	33	33	33	33
0	-0.2	272	40	40	40	40	40	39	39	39	39	39	39
0	0.0	280	45	45	45	45	45	45	45	45	45	45	45
0	0.2	288	50	50	50	50	50	50	50	50	51	51	51
0	0.4	296	54	54	54	54	55	55	55	55	56	56	56
0	0.6	304	57	58	58	58	59	59	59	60	60	60	61
0	0.8	312	60	61	61	62	62	62	63	63	64	64	65
0	1.0	320	63	63	64	64	65	65	66	66	67	68	68

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	9	8	7	6	5	4	3	2	1	0	-1
-1	-0.8	248	18	17	16	15	14	13	12	12	11	10	9
-1	-0.6	256	27	26	25	24	23	23	22	21	20	20	19
-1	-0.4	264	35	34	34	33	32	31	31	30	29	29	28
-1	-0.2	272	43	42	41	41	40	40	39	38	38	37	37
-1	0.0	280	50	49	49	48	48	47	47	46	46	45	45
-1	0.2	288	57	56	56	55	55	54	54	54	53	53	53
-1	0.4	296	63	63	62	62	61	61	61	60	60	60	60
-1	0.6	304	69	68	68	68	67	67	67	67	67	66	66
-1	0.8	312	74	73	73	73	73	73	73	73	72	72	72
-1	1.0	320	78	78	78	78	78	78	78	78	78	78	78

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Clm Feed (lb/hr)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	300	0.5	150
Maximum	320	500	1.5	350
Center	280	400	1	250
Range	80	200	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	47.93
X1	COE1	21.8
X2	COE2	-1.13
X3	COE3	-1.23
X4	COE4	-1.89
X1*X1	COE11	-7.5
X2*X2	COE22	1.2
X3*X3	COE33	-1.97
X4*X4	COE44	0.1
X1*X2	COE12	-9.06
X1*X3	COE13	4.4
X1*X4	COE14	2.2
X2*X3	COE23	0.45
X2*X4	COE24	2.71
X3*X4	COE34	2.26

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	35	34	33	32	32	31	30	30	29	28	27
1	-0.8	248	39	38	37	37	36	35	35	34	33	33	32
1	-0.6	256	42	41	41	40	40	39	39	38	37	37	36
1	-0.4	264	45	44	44	43	43	42	42	41	41	40	40
1	-0.2	272	47	46	46	46	45	45	44	44	44	43	43
1	0.0	280	48	48	48	47	47	47	47	46	46	46	45
1	0.2	288	49	49	49	49	48	48	48	48	48	47	47
1	0.4	296	50	49	49	49	49	49	49	49	49	49	48
1	0.6	304	49	49	49	49	49	49	49	49	49	49	49
1	0.8	312	48	48	49	49	49	49	49	49	49	49	49
1	1.0	320	47	47	47	47	48	48	48	48	48	48	49

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	29	27	26	25	24	22	21	20	19	17	16
0	-0.8	248	34	33	32	31	30	28	27	26	25	24	23
0	-0.6	256	40	38	37	36	35	34	33	32	31	30	29
0	-0.4	264	44	43	42	41	40	39	38	37	36	35	34
0	-0.2	272	48	47	46	45	44	43	42	42	41	40	39
0	0.0	280	51	51	50	49	48	47	46	46	45	44	43
0	0.2	288	54	53	53	52	51	50	50	49	48	47	47
0	0.4	296	56	56	55	54	54	53	52	52	51	50	50
0	0.6	304	58	57	57	56	56	55	54	54	53	53	52
0	0.8	312	59	58	58	57	57	56	56	55	55	54	54
0	1.0	320	59	59	58	58	57	57	57	56	56	56	55

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	25	23	21	20	18	16	14	12	11	9	7
-1	-0.8	248	33	31	29	27	26	24	22	21	19	17	15
-1	-0.6	256	40	38	36	35	33	31	30	28	27	25	23
-1	-0.4	264	46	44	43	41	40	38	37	35	34	32	31
-1	-0.2	272	52	50	49	47	46	44	43	41	40	39	37
-1	0.0	280	57	56	54	53	51	50	49	47	46	45	43
-1	0.2	288	61	60	59	58	56	55	54	52	51	50	49
-1	0.4	296	65	64	63	62	61	59	58	57	56	55	53
-1	0.6	304	69	68	67	65	64	63	62	61	60	59	58
-1	0.8	312	72	70	69	68	67	66	65	64	63	62	61
-1	1.0	320	74	73	72	71	70	69	68	67	66	65	64

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	29	29	29	28	28	28	27	27	27	27	26
1	-0.8	248	34	34	34	33	33	33	33	33	32	32	32
1	-0.6	256	38	38	38	38	38	38	38	37	37	37	37
1	-0.4	264	42	42	42	42	42	42	42	42	42	42	42
1	-0.2	272	45	45	45	45	45	45	45	45	45	46	46
1	0.0	280	47	47	48	48	48	48	48	48	49	49	49
1	0.2	288	49	49	50	50	50	50	51	51	51	51	52
1	0.4	296	50	51	51	51	52	52	52	53	53	53	54
1	0.6	304	51	51	52	52	53	53	53	54	54	55	55
1	0.8	312	51	51	52	52	53	53	54	54	55	56	56
1	1.0	320	50	51	51	52	53	53	54	54	55	56	56

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	23	22	21	20	19	19	18	17	16	15	15
0	-0.8	248	29	29	28	27	26	26	25	24	24	23	22
0	-0.6	256	35	35	34	33	33	32	32	31	30	30	29
0	-0.4	264	41	40	40	39	39	38	37	37	36	36	35
0	-0.2	272	46	45	45	44	44	43	43	42	42	41	41
0	0.0	280	50	50	49	49	48	48	48	47	47	46	46
0	0.2	288	54	53	53	53	52	52	52	51	51	51	51
0	0.4	296	57	56	56	56	56	55	55	55	55	55	55
0	0.6	304	59	59	59	59	58	58	58	58	58	58	58
0	0.8	312	61	61	61	61	61	61	61	61	61	61	61
0	1.0	320	62	62	62	62	62	62	62	62	62	63	63

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	19	17	16	15	13	12	11	9	8	7	5
-1	-0.8	248	27	26	25	23	22	21	20	18	17	16	15
-1	-0.6	256	35	34	33	31	30	29	28	27	26	24	23
-1	-0.4	264	42	41	40	39	38	37	36	35	33	32	31
-1	-0.2	272	49	48	47	46	45	44	43	42	41	40	39
-1	0.0	280	55	54	53	52	51	50	49	48	48	47	46
-1	0.2	288	60	60	59	58	57	56	55	54	54	53	52
-1	0.4	296	65	64	64	63	62	61	61	60	59	58	58
-1	0.6	304	69	69	68	67	67	66	65	65	64	64	63
-1	0.8	312	73	72	72	71	71	70	70	69	68	68	67
-1	1.0	320	76	76	75	75	74	74	73	73	72	72	71

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	20	20	20	20	20	21	21	21	21	21	22
1	-0.8	248	26	26	26	26	26	27	27	27	28	28	28
1	-0.6	256	31	31	31	32	32	32	33	33	33	34	34
1	-0.4	264	35	35	36	36	37	37	38	38	39	39	39
1	-0.2	272	39	39	40	40	41	42	42	43	43	44	44
1	0.0	280	42	43	43	44	45	45	46	46	47	48	48
1	0.2	288	45	46	46	47	48	48	49	50	51	51	52
1	0.4	296	47	48	49	49	50	51	52	53	53	54	55
1	0.6	304	49	49	50	51	52	53	54	55	56	56	57
1	0.8	312	49	50	51	52	53	54	55	56	57	58	59
1	1.0	320	50	51	52	53	54	55	56	57	58	59	60

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	13	13	12	12	11	11	11	10	10	10	9
0	-0.8	248	20	20	20	20	19	19	19	18	18	18	18
0	-0.6	256	27	27	27	27	27	26	26	26	26	26	25
0	-0.4	264	34	34	33	33	33	33	33	33	33	33	33
0	-0.2	272	39	39	39	39	39	39	39	39	39	39	39
0	0.0	280	44	44	45	45	45	45	45	45	45	45	45
0	0.2	288	49	49	49	49	50	50	50	50	50	50	51
0	0.4	296	53	53	53	54	54	54	54	55	55	55	55
0	0.6	304	56	56	57	57	57	58	58	58	59	59	60
0	0.8	312	59	59	60	60	60	61	61	62	62	63	63
0	1.0	320	61	61	62	62	63	63	64	64	65	66	66

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	8	8	7	6	5	4	3	2	1	0	-1
-1	-0.8	248	18	17	16	15	14	14	13	12	11	10	10
-1	-0.6	256	27	26	25	24	23	23	22	21	21	20	19
-1	-0.4	264	35	34	33	33	32	31	31	30	29	29	28
-1	-0.2	272	42	42	41	40	40	39	39	38	38	37	37
-1	0.0	280	49	49	48	48	47	47	46	46	45	45	44
-1	0.2	288	55	55	55	54	54	53	53	53	52	52	52
-1	0.4	296	61	61	60	60	60	60	59	59	59	58	58
-1	0.6	304	66	66	66	65	65	65	65	65	64	64	64
-1	0.8	312	71	71	70	70	70	70	70	70	70	70	70
-1	1.0	320	75	75	74	74	74	74	74	74	74	74	74

QUADRATIC REGRESSION MODEL

Response: lb SO₂/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Cfm Feed (lb/hr)	Water (lpm)	MGS Feed (lb/hr)
Minimum	240	300	0.5	150
Maximum	320	500	1.5	350
Center	280	400	1	250
Range	80	200	1	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	2.723
X1	COE1	-0.417
X2	COE2	-0.027
X3	COE3	0.042
X4	COE4	0.023
X1*X1	COE11	0.09
X2*X2	COE22	-0.131
X3*X3	COE33	0.078
X4*X4	COE44	0.017
X1*X2	COE12	0.12
X1*X3	COE13	-0.05
X1*X4	COE14	0.049
X2*X3	COE23	0
X2*X4	COE24	-0.024
X3*X4	COE34	0.06

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	3.1	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.8
1	-0.8	248	3.0	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8
1	-0.6	256	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7
1	-0.4	264	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
1	-0.2	272	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6
1	0.0	280	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
1	0.2	288	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5
1	0.4	296	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1	0.6	304	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1	0.8	312	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1	1.0	320	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.1
0	-0.8	248	3.2	3.2	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
0	-0.6	256	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
0	-0.4	264	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
0	-0.2	272	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8
0	0.0	280	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7
0	0.2	288	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
0	0.4	296	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
0	0.6	304	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
0	0.8	312	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
0	1.0	320	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2
-1	-0.8	248	3.2	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
-1	-0.6	256	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
-1	-0.4	264	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.8
-1	-0.2	272	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.8
-1	0.0	280	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
-1	0.2	288	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
-1	0.4	296	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
-1	0.6	304	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
-1	0.8	312	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.4
-1	1.0	320	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.3	2.3	2.3	2.3

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
Description: Pittsburgh No. 8 Seam
Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9
1	-0.8	248	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8
1	-0.6	256	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
1	-0.4	264	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
1	-0.2	272	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
1	0.0	280	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
1	0.2	288	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1	0.4	296	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
1	0.6	304	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5
1	0.8	312	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
1	1.0	320	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.4	2.4	2.4

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
0	-0.8	248	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
0	-0.6	256	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
0	-0.4	264	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
0	-0.2	272	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
0	0.0	280	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.8
0	0.2	288	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7
0	0.4	296	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
0	0.6	304	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6
0	0.8	312	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5
0	1.0	320	2.3	2.3	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.3	3.3	3.3
-1	-0.8	248	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
-1	-0.6	256	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
-1	-0.4	264	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9
-1	-0.2	272	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.8	2.8
-1	0.0	280	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7
-1	0.2	288	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6
-1	0.4	296	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5
-1	0.6	304	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.4
-1	0.8	312	2.2	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.3	2.4
-1	1.0	320	2.1	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.3	2.3

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Pittsburgh No. 8 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
1	-0.8	248	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.1
1	-0.6	256	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.0	3.0
1	-0.4	264	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9
1	-0.2	272	2.7	2.7	2.7	2.7	2.7	2.8	2.8	2.8	2.8	2.8	2.8
1	0.0	280	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8
1	0.2	288	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7
1	0.4	296	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.7
1	0.6	304	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6
1	0.8	312	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.6	2.6
1	1.0	320	2.3	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.6

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.5
0	-0.8	248	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
0	-0.6	256	3.1	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.2	3.2	3.2
0	-0.4	264	3.0	3.0	3.0	3.0	3.0	3.0	3.1	3.1	3.1	3.1	3.1
0	-0.2	272	2.9	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0
0	0.0	280	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9
0	0.2	288	2.7	2.7	2.7	2.7	2.7	2.8	2.8	2.8	2.8	2.8	2.9
0	0.4	296	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.8	2.8
0	0.6	304	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7
0	0.8	312	2.4	2.4	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.7
0	1.0	320	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.6

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.5	3.5	3.5
-1	-0.8	248	3.2	3.2	3.2	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.4
-1	-0.6	256	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.2
-1	-0.4	264	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.1	3.1
-1	-0.2	272	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9	3.0
-1	0.0	280	2.6	2.7	2.7	2.7	2.7	2.7	2.8	2.8	2.8	2.8	2.9
-1	0.2	288	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.8
-1	0.4	296	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.7
-1	0.6	304	2.3	2.3	2.3	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.6
-1	0.8	312	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.4	2.4	2.5	2.5
-1	1.0	320	2.1	2.1	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.4

APPENDIX 4-F

Response Surface Plots and Computations

Combined Microcel/MGS Tests
Illinois No. 6 Seam Coal

Illinois No. 6 Seam
Microcel/MGS Combined

Illinois No. 6 Seam
Microcel/MGS Combined

Illinois No. 6 Seam
Microcel/MGS Combined

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Water (lpm)	Amplitude (mm)	MGS Feed (lb/hr)
Minimum	240	0.5	10	150
Maximum	320	1.5	20	350
Center	280	1	15	250
Range	80	1	10	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	98.59
X1	COE1	-3.61
X2	COE2	0.96
X3	COE3	1.57
X4	COE4	-0.49
X1*X1	COE11	-2.27
X2*X2	COE22	-0.26
X3*X3	COE33	-0.88
X4*X4	COE44	-0.64
X1*X2	COE12	0.55
X1*X3	COE13	0.76
X1*X4	COE14	0.91
X2*X3	COE23	-1.24
X2*X4	COE24	0.34
X3*X4	COE34	0.54

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	101	101	100	100	100	100	99	99	98	98	97
1	-0.8	248	100	100	100	100	100	100	99	99	99	98	98
1	-0.6	256	100	100	100	100	100	100	99	99	99	98	98
1	-0.4	264	100	100	100	100	99	99	99	99	98	98	98
1	-0.2	272	99	99	99	99	99	99	99	98	98	98	97
-1	0.0	280	98	98	98	98	98	98	98	98	97	97	97
1	0.2	288	97	97	97	97	97	97	97	97	97	96	96
1	0.4	296	96	96	96	96	96	96	96	96	96	96	95
1	0.6	304	94	95	95	95	95	95	95	95	95	94	94
1	0.8	312	93	93	93	93	94	94	94	93	93	93	93
1	1.0	320	91	91	92	92	92	92	92	92	92	92	92

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	100	99	99	99	99	98	98	97	97	96	96
0	-0.8	248	99	99	99	99	99	98	98	97	97	96	96
0	-0.6	256	99	99	99	98	98	98	98	97	97	96	96
0	-0.4	264	98	98	98	98	98	98	97	97	96	96	95
0	-0.2	272	97	97	97	97	97	97	97	96	96	96	95
0	0.0	280	97	97	97	96	96	96	96	96	95	95	94
0	0.2	288	95	95	95	95	95	95	95	95	94	94	94
0	0.4	296	94	94	94	94	94	94	94	94	93	93	93
0	0.6	304	93	93	93	93	93	93	93	92	92	92	92
0	0.8	312	91	91	91	91	91	91	91	91	91	91	90
0	1.0	320	89	89	89	89	89	90	89	89	89	89	89

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	98	98	97	97	97	96	96	95	95	94	93
-1	-0.8	248	98	97	97	97	97	96	96	95	95	94	93
-1	-0.6	256	97	97	97	96	96	96	95	95	94	94	93
-1	-0.4	264	96	96	96	96	96	95	95	94	94	93	93
-1	-0.2	272	95	95	95	95	95	95	94	94	93	93	92
-1	0.0	280	94	94	94	94	94	94	93	93	93	92	92
-1	0.2	288	93	93	93	93	93	93	92	92	92	91	91
-1	0.4	296	92	92	92	92	92	91	91	91	91	90	90
-1	0.6	304	90	90	90	90	90	90	90	89	89	89	88
-1	0.8	312	88	88	88	88	88	88	88	88	88	87	87
-1	1.0	320	86	86	87	87	87	86	86	86	86	86	85

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	101	101	100	100	100	100	100	100	99	99	98
1	-0.8	248	101	101	101	101	100	100	100	100	100	99	99
1	-0.6	256	100	100	100	100	100	100	100	100	100	99	99
1	-0.4	264	100	100	100	100	100	100	100	100	100	99	99
1	-0.2	272	100	100	100	100	100	100	100	100	99	99	99
1	0.0	280	99	99	99	99	99	99	99	99	99	99	99
1	0.2	288	98	98	98	98	99	99	99	98	98	98	98
1	0.4	296	97	97	97	98	98	98	98	98	98	97	97
1	0.6	304	96	96	96	96	97	97	97	97	97	97	96
1	0.8	312	94	95	95	95	95	95	95	96	96	95	95
1	1.0	320	93	93	93	94	94	94	94	94	94	94	94

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	101	101	101	100	100	100	100	99	99	98	98
0	-0.8	248	101	101	101	100	100	100	100	99	99	99	98
0	-0.6	256	100	100	100	100	100	100	100	99	99	99	98
0	-0.4	264	100	100	100	100	100	100	99	99	99	99	98
0	-0.2	272	99	99	99	99	99	99	99	99	99	98	98
0	0.0	280	98	99	99	99	99	99	98	98	98	98	97
0	0.2	288	97	98	98	98	98	98	98	98	97	97	97
0	0.4	296	96	96	97	97	97	97	97	97	96	96	96
0	0.6	304	95	95	95	95	96	96	96	96	95	95	95
0	0.8	312	93	94	94	94	94	94	94	94	94	94	94
0	1.0	320	92	92	92	92	93	93	93	93	93	93	92

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	100	100	100	100	100	99	99	98	98	97	97
-1	-0.8	248	100	100	100	100	100	99	99	99	98	98	97
-1	-0.6	256	100	100	100	99	99	99	99	98	98	98	97
-1	-0.4	264	99	99	99	99	99	99	98	98	98	97	97
-1	-0.2	272	98	99	98	98	98	98	98	98	97	97	96
-1	0.0	280	98	98	98	98	98	97	97	97	97	96	96
-1	0.2	288	96	97	97	97	97	96	96	96	96	96	95
-1	0.4	296	95	95	95	95	95	95	95	95	95	95	94
-1	0.6	304	94	94	94	94	94	94	94	94	94	93	93
-1	0.8	312	92	92	92	93	93	93	93	92	92	92	92
-1	1.0	320	90	90	91	91	91	91	91	91	91	91	90

QUADRATIC REGRESSION MODEL

Response: Comb. Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	99	99	99	99	99	99	99	98	98	98	98
1	-0.8	248	99	99	99	99	99	99	99	99	99	98	98
1	-0.6	256	99	99	99	99	99	99	99	99	99	99	99
1	-0.4	264	99	99	99	99	99	99	99	99	99	99	99
1	-0.2	272	98	99	99	99	99	99	99	99	99	99	99
1	0.0	280	98	98	98	98	99	99	99	99	99	99	98
1	0.2	288	97	97	98	98	98	98	98	98	98	98	98
1	0.4	296	96	96	97	97	97	97	98	98	98	98	98
1	0.6	304	95	95	96	96	96	97	97	97	97	97	97
1	0.8	312	94	94	95	95	95	95	96	96	96	96	96
1	1.0	320	92	93	93	94	94	94	94	95	95	95	95

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	100	100	100	100	100	100	100	99	99	99	98
0	-0.8	248	100	100	100	100	100	100	100	100	99	99	99
0	-0.6	256	100	100	100	100	100	100	100	100	100	99	99
0	-0.4	264	100	100	100	100	100	100	100	100	100	99	99
0	-0.2	272	99	99	100	100	100	100	100	100	99	99	99
0	0.0	280	99	99	99	99	99	99	99	99	99	99	99
0	0.2	288	98	98	98	98	99	99	99	99	99	98	98
0	0.4	296	97	97	97	98	98	98	98	98	98	98	98
0	0.6	304	96	96	96	96	97	97	97	97	97	97	97
0	0.8	312	94	95	95	95	95	96	96	96	96	96	96
0	1.0	320	93	93	93	94	94	94	94	94	95	95	94

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	101	101	101	101	101	100	100	100	99	99	99
-1	-0.8	248	101	101	101	101	101	101	100	100	100	99	99
-1	-0.6	256	101	101	101	101	101	101	100	100	100	99	99
-1	-0.4	264	100	100	100	100	100	100	100	100	100	99	99
-1	-0.2	272	100	100	100	100	100	100	100	100	99	99	99
-1	0.0	280	99	99	99	99	99	99	99	99	99	99	98
-1	0.2	288	98	98	98	98	99	99	98	98	98	98	98
-1	0.4	296	97	97	97	97	98	98	98	98	97	97	97
-1	0.6	304	96	96	96	96	96	96	96	96	96	96	96
-1	0.8	312	94	94	95	95	95	95	95	95	95	95	95
-1	1.0	320	92	93	93	93	93	94	94	94	94	94	94

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Water (lpm)	Amplitude (mm)	MGS Feed (lb/hr)
Minimum	240	0.5	10	150
Maximum	320	1.5	20	350
Center	280	1	15	250
Range	80	1	10	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	98.82
X1	COE1	-3.44
X2	COE2	0.92
X3	COE3	1.5
X4	COE4	-0.47
X1*X1	COE11	-2.25
X2*X2	COE22	-0.25
X3*X3	COE33	-0.85
X4*X4	COE44	-0.59
X1*X2	COE12	0.56
X1*X3	COE13	0.74
X1*X4	COE14	0.83
X2*X3	COE23	-1.19
X2*X4	COE24	0.36
X3*X4	COE34	0.57

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	101	101	100	100	100	100	99	99	99	98	98
1	-0.8	248	101	100	100	100	100	100	99	99	99	98	98
1	-0.6	256	100	100	100	100	100	100	99	99	99	98	98
1	-0.4	264	100	100	100	100	100	99	99	99	99	98	98
1	-0.2	272	99	99	99	99	99	99	99	99	98	98	98
1	0.0	280	98	98	99	99	98	98	98	98	98	97	97
1	0.2	288	97	98	98	98	98	98	97	97	97	97	96
1	0.4	296	96	96	97	97	97	97	96	96	96	96	96
1	0.6	304	95	95	95	95	95	95	95	95	95	95	95
1	0.8	312	93	94	94	94	94	94	94	94	94	94	93
1	1.0	320	92	92	92	92	92	92	92	92	92	92	92

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	100	100	99	99	99	98	98	98	97	97	96
0	-0.8	248	99	99	99	99	99	98	98	98	97	97	96
0	-0.6	256	99	99	99	99	98	98	98	97	97	97	96
0	-0.4	264	99	99	98	98	98	98	97	97	97	96	96
0	-0.2	272	98	98	98	98	97	97	97	97	96	96	95
0	0.0	280	97	97	97	97	97	96	96	96	96	95	95
0	0.2	288	96	96	96	96	96	96	95	95	95	94	94
0	0.4	296	95	95	95	95	95	94	94	94	94	93	93
0	0.6	304	93	93	93	93	93	93	93	93	93	92	92
0	0.8	312	91	92	92	92	92	92	92	91	91	91	91
0	1.0	320	90	90	90	90	90	90	90	90	90	89	89

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	98	98	98	97	97	97	96	96	95	94	94
-1	-0.8	248	98	98	97	97	97	96	96	96	95	94	94
-1	-0.6	256	97	97	97	97	97	96	96	95	95	94	94
-1	-0.4	264	97	97	96	96	96	96	95	95	94	94	93
-1	-0.2	272	96	96	96	96	95	95	95	94	94	93	93
-1	0.0	280	95	95	95	95	94	94	94	93	93	93	92
-1	0.2	288	94	94	94	93	93	93	93	92	92	92	91
-1	0.4	296	92	92	92	92	92	92	92	91	91	91	90
-1	0.6	304	91	91	91	91	91	90	90	90	90	89	89
-1	0.8	312	89	89	89	89	89	89	89	88	88	88	88
-1	1.0	320	87	87	87	87	87	87	87	87	87	86	86

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	100	100	100	100	100	100	100	100	99	99	99
1	-0.8	248	101	101	101	101	100	100	100	100	100	99	99
1	-0.6	256	100	101	101	101	101	100	100	100	100	100	99
1	-0.4	264	100	100	100	100	100	100	100	100	100	100	99
1	-0.2	272	100	100	100	100	100	100	100	100	100	99	99
1	0.0	280	99	99	99	99	99	99	99	99	99	99	99
1	0.2	288	98	98	99	99	99	99	99	99	99	98	98
1	0.4	296	97	97	98	98	98	98	98	98	98	98	98
1	0.6	304	96	96	97	97	97	97	97	97	97	97	97
1	0.8	312	95	95	95	95	96	96	96	96	96	96	96
1	1.0	320	93	93	94	94	94	94	94	95	95	95	94

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	101	101	101	100	100	100	100	99	99	99	98
0	-0.8	248	101	101	101	100	100	100	100	100	99	99	98
0	-0.6	256	100	100	100	100	100	100	100	100	99	99	99
0	-0.4	264	100	100	100	100	100	100	100	99	99	99	98
0	-0.2	272	99	100	100	100	100	99	99	99	99	99	98
0	0.0	280	99	99	99	99	99	99	99	99	98	98	98
0	0.2	288	98	98	98	98	98	98	98	98	98	97	97
0	0.4	296	97	97	97	97	97	97	97	97	97	97	96
0	0.6	304	95	96	96	96	96	96	96	96	96	96	95
0	0.8	312	94	94	94	94	95	95	95	95	95	94	94
0	1.0	320	92	92	93	93	93	93	93	93	93	93	93

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	100	100	100	100	100	99	99	99	98	98	97
-1	-0.8	248	100	100	100	100	100	99	99	99	98	98	97
-1	-0.6	256	100	100	100	100	99	99	99	99	98	98	97
-1	-0.4	264	99	99	99	99	99	99	99	98	98	98	97
-1	-0.2	272	99	99	99	99	99	98	98	98	98	97	97
-1	0.0	280	98	98	98	98	98	98	97	97	97	97	96
-1	0.2	288	97	97	97	97	97	97	97	96	96	96	96
-1	0.4	296	96	96	96	96	96	96	96	95	95	95	95
-1	0.6	304	94	94	94	94	94	94	94	94	94	94	94
-1	0.8	312	93	93	93	93	93	93	93	93	93	92	92
-1	1.0	320	91	91	91	91	91	91	91	91	91	91	91

QUADRATIC REGRESSION MODEL

Response: Energy Recovery (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	99	99	99	99	99	99	99	99	98	98	98
1	-0.8	248	99	99	99	99	99	99	99	99	99	99	98
1	-0.6	256	99	99	99	99	99	99	99	99	99	99	99
1	-0.4	264	99	99	99	99	99	99	99	99	99	99	99
1	-0.2	272	98	99	99	99	99	99	99	99	99	99	99
1	0.0	280	98	98	98	99	99	99	99	99	99	99	99
1	0.2	288	97	98	98	98	98	98	99	99	99	99	98
1	0.4	296	96	97	97	97	98	98	98	98	98	98	98
1	0.6	304	95	96	96	96	97	97	97	97	97	97	97
1	0.8	312	94	95	95	95	96	96	96	96	96	96	96
1	1.0	320	93	93	94	94	94	95	95	95	95	95	95

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	100	100	100	100	100	100	100	100	99	99	99
0	-0.8	248	100	100	100	100	100	100	100	100	100	99	99
0	-0.6	256	100	100	100	100	100	100	100	100	100	100	99
0	-0.4	264	100	100	100	100	100	100	100	100	100	100	99
0	-0.2	272	99	100	100	100	100	100	100	100	100	99	99
0	0.0	280	99	99	99	99	99	99	99	99	99	99	99
0	0.2	288	98	98	98	99	99	99	99	99	99	99	99
0	0.4	296	97	97	98	98	98	98	98	98	98	98	98
0	0.6	304	96	96	96	97	97	97	97	97	97	97	97
0	0.8	312	95	95	95	95	96	96	96	96	96	96	96
0	1.0	320	93	93	94	94	94	95	95	95	95	95	95

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	101	101	101	101	101	101	100	100	100	99	99
-1	-0.8	248	101	101	101	101	101	101	100	100	100	100	99
-1	-0.6	256	101	101	101	101	101	101	100	100	100	100	99
-1	-0.4	264	100	101	101	101	101	100	100	100	100	100	99
-1	-0.2	272	100	100	100	100	100	100	100	100	100	99	99
-1	0.0	280	99	99	99	99	100	99	99	99	99	99	99
-1	0.2	288	98	98	99	99	99	99	99	99	98	98	98
-1	0.4	296	97	97	98	98	98	98	98	98	98	98	97
-1	0.6	304	96	96	96	97	97	97	97	97	97	97	96
-1	0.8	312	94	95	95	95	95	95	95	96	95	95	95
-1	1.0	320	93	93	93	94	94	94	94	94	94	94	94

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Water (lpm)	Amplitude (mm)	MGS Feed (lb/hr)
Minimum	240	0.5	10	150
Maximum	320	1.5	20	350
Center	280	1	15	250
Range	80	1	10	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	20.08
X1	COE1	16.73
X2	COE2	-4.12
X3	COE3	-6.03
X4	COE4	1.68
X1*X1	COE11	3.11
X2*X2	COE22	0.81
X3*X3	COE33	1.93
X4*X4	COE44	4.1
X1*X2	COE12	0.43
X1*X3	COE13	-2.48
X1*X4	COE14	-6.12
X2*X3	COE23	4.92
X2*X4	COE24	1.04
X3*X4	COE34	2.49

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	1	1	1	1	2	3	5	6	9	11	14
-1	-0.8	248	5	5	4	5	5	6	7	9	11	13	15
-1	-0.6	256	9	9	8	8	9	9	10	11	13	15	17
-1	-0.4	264	14	13	12	12	12	12	13	14	16	17	19
-1	-0.2	272	19	17	17	16	16	16	16	17	18	20	22
-1	0.0	280	24	22	21	20	20	20	20	21	21	23	24
-1	0.2	288	29	27	26	25	24	24	24	24	25	26	27
-1	0.4	296	34	33	31	30	29	28	28	28	28	29	30
-1	0.6	304	40	38	36	35	34	33	32	32	32	33	33
-1	0.8	312	46	44	42	40	39	38	37	36	36	36	37
-1	1.0	320	53	50	48	46	44	43	42	41	41	40	41

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	11	10	10	10	11	12	13	15	17	19	21
0	-0.8	248	15	14	14	14	14	15	16	17	19	21	23
0	-0.6	256	19	18	17	17	17	18	18	19	21	23	25
0	-0.4	264	23	22	21	21	21	21	22	23	25	27	27
0	-0.2	272	28	27	26	25	24	24	25	25	26	27	29
0	0.0	280	33	31	30	29	28	28	28	28	29	30	31
0	0.2	288	38	36	35	33	33	32	32	32	32	33	34
0	0.4	296	44	41	40	38	37	36	36	36	36	36	37
0	0.6	304	49	47	45	43	42	41	40	40	39	40	40
0	0.8	312	55	53	50	48	47	45	44	44	43	43	44
0	1.0	320	61	59	56	54	52	50	49	48	48	47	48

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	22	21	21	21	22	22	23	25	26	28	31
-1	-0.8	248	26	25	25	24	24	25	26	27	28	30	32
-1	-0.6	256	30	29	28	28	28	28	28	29	30	32	34
-1	-0.4	264	34	33	32	31	31	31	31	32	33	34	36
-1	-0.2	272	39	37	36	35	35	34	34	35	35	36	38
-1	0.0	280	44	42	40	39	38	38	38	38	38	39	40
-1	0.2	288	49	47	45	44	43	42	41	41	41	42	43
-1	0.4	296	54	52	50	48	47	46	45	45	45	45	46
-1	0.6	304	60	57	55	53	52	50	49	49	48	48	49
-1	0.8	312	66	63	60	58	56	55	54	53	52	52	52
-1	1.0	320	72	69	66	64	62	60	58	57	56	56	56

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	-2	-2	-1	0	1	3	5	7	10	12	16
1	-0.8	248	2	2	2	3	4	5	7	9	11	14	17
1	-0.6	256	5	5	5	6	6	8	9	11	13	15	18
1	-0.4	264	9	9	9	9	10	10	12	13	15	17	20
1	-0.2	272	14	13	13	13	13	13	14	16	17	19	22
1	0.0	280	18	17	17	16	16	17	17	19	20	22	24
1	0.2	288	23	22	21	20	20	20	21	22	23	24	26
1	0.4	296	28	27	25	25	24	24	24	25	26	27	29
1	0.6	304	33	32	30	29	29	28	28	28	29	30	31
1	0.8	312	39	37	35	34	33	32	32	32	33	33	34
1	1.0	320	45	42	41	39	38	37	37	36	36	37	38

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	3	3	3	4	5	6	8	10	13	15	18
0	-0.8	248	6	6	6	7	8	9	10	12	14	17	19
0	-0.6	256	10	10	9	10	10	11	12	14	16	18	21
0	-0.4	264	14	13	13	13	13	14	15	16	18	20	22
0	-0.2	272	18	17	17	16	16	17	18	19	20	22	24
0	0.0	280	23	21	21	20	20	20	21	21	23	24	26
0	0.2	288	27	26	25	24	24	24	24	24	25	27	28
0	0.4	296	32	31	29	28	28	27	27	28	28	29	31
0	0.6	304	37	35	34	33	32	31	31	31	32	32	33
0	0.8	312	43	41	39	37	36	35	35	35	35	36	36
0	1.0	320	48	46	44	42	41	40	39	39	39	39	40

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	9	9	9	10	11	12	13	15	17	20	23
-1	-0.8	248	13	12	12	12	13	14	15	17	19	21	24
-1	-0.6	256	16	16	15	15	16	16	17	19	20	22	25
-1	-0.4	264	20	19	19	18	19	19	20	21	22	24	26
-1	-0.2	272	24	23	22	22	22	22	22	23	24	26	28
-1	0.0	280	28	27	26	25	25	25	25	26	27	28	30
-1	0.2	288	33	31	30	29	29	28	28	29	30	31	32
-1	0.4	296	38	36	35	33	33	32	32	32	32	33	34
-1	0.6	304	43	41	39	38	37	36	35	35	36	36	37
-1	0.8	312	48	46	44	42	41	40	39	39	39	39	40
-1	1.0	320	54	51	49	47	46	44	43	43	43	43	43

QUADRATIC REGRESSION MODEL

Response: Ash Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	-1	0	1	2	4	6	8	11	14	18	21
1	-0.8	248	2	2	3	4	6	8	10	13	15	19	22
1	-0.6	256	5	5	6	7	8	10	12	14	17	20	23
1	-0.4	264	9	9	9	10	11	12	14	16	18	21	24
1	-0.2	272	12	12	12	13	14	15	16	18	20	23	25
1	0.0	280	16	16	16	16	17	18	19	20	22	24	27
1	0.2	288	21	20	20	20	20	21	22	23	25	26	29
1	0.4	296	25	24	24	24	24	24	25	26	27	29	31
1	0.6	304	30	29	28	28	27	28	28	29	30	31	33
1	0.8	312	35	34	33	32	31	31	32	32	33	34	36
1	1.0	320	40	39	37	36	36	35	35	36	36	37	39

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	-1	-1	0	1	3	5	7	10	12	16	19
0	-0.8	248	2	2	3	4	5	7	9	11	13	16	20
0	-0.6	256	5	5	5	6	7	9	10	12	15	17	20
0	-0.4	264	8	8	8	9	10	11	12	14	16	19	21
0	-0.2	272	12	12	11	12	12	13	14	16	18	20	23
0	0.0	280	16	15	15	15	15	16	17	18	20	22	24
0	0.2	288	20	19	19	18	19	19	20	21	22	24	26
0	0.4	296	25	23	23	22	22	22	23	24	25	26	28
0	0.6	304	29	28	27	26	26	26	26	27	27	29	30
0	0.8	312	34	33	31	30	30	29	29	30	30	31	33
0	1.0	320	39	38	36	35	34	33	33	33	34	34	35

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	0	1	1	2	4	5	7	10	12	15	19
-1	-0.8	248	3	3	4	4	5	7	9	11	13	16	19
-1	-0.6	256	6	6	6	7	8	9	10	12	14	17	20
-1	-0.4	264	9	9	9	9	10	11	12	14	16	18	21
-1	-0.2	272	13	12	12	12	13	13	14	16	17	19	22
-1	0.0	280	17	16	16	15	16	16	17	18	19	21	23
-1	0.2	288	21	20	19	19	19	19	19	20	21	23	25
-1	0.4	296	25	24	23	22	22	22	22	23	24	25	27
-1	0.6	304	30	28	27	26	26	25	25	26	27	28	29
-1	0.8	312	35	33	32	30	30	29	29	29	29	30	31
-1	1.0	320	40	38	36	35	34	33	32	32	33	33	34

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Water (lpm)	Amplitude (mm)	MGS Feed (lb/hr)
Minimum	240	0.5	10	150
Maximum	320	1.5	20	350
Center	280	1	15	250
Range	80	1	10	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	26.4
X1	COE1	12.47
X2	COE2	-5.35
X3	COE3	-3.02
X4	COE4	1.39
X1*X1	COE11	0.74
X2*X2	COE22	1.32
X3*X3	COE33	-0.38
X4*X4	COE44	5.17
X1*X2	COE12	1.57
X1*X3	COE13	-3.41
X1*X4	COE14	-6.27
X2*X3	COE23	4.84
X2*X4	COE24	0.35
X3*X4	COE34	2.62

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	3	2	2	2	3	3	5	6	9	11	14
-1	-0.8	248	8	7	6	6	6	7	8	9	11	13	16
-1	-0.6	256	12	11	10	10	10	10	11	12	14	16	18
-1	-0.4	264	17	15	14	13	13	13	14	15	16	18	20
-1	-0.2	272	22	20	18	17	17	17	17	18	19	20	22
-1	0.0	280	26	24	23	21	21	20	20	21	22	23	24
1	0.2	288	31	29	27	25	24	24	23	24	24	25	27
1	0.4	296	36	33	31	29	28	27	27	27	27	28	29
-1	0.6	304	41	38	36	34	32	31	30	30	30	31	31
1	0.8	312	46	43	40	38	36	35	34	33	33	33	34
1	1.0	320	51	47	45	42	40	38	37	36	36	36	36

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	14	13	13	13	13	14	15	17	19	21	24
0	-0.8	248	18	17	16	16	16	17	18	19	21	23	26
0	-0.6	256	22	21	20	20	19	20	20	22	23	25	27
0	-0.4	264	27	25	24	23	23	23	23	24	25	27	29
0	-0.2	272	31	29	28	27	26	26	26	27	28	29	31
0	0.0	280	35	33	32	30	29	29	29	29	30	31	33
0	0.2	288	40	38	36	34	33	32	32	32	33	34	35
0	0.4	296	44	42	40	38	36	36	35	35	35	36	37
0	0.6	304	49	46	44	42	40	39	38	38	38	38	39
0	0.8	312	54	51	48	46	44	42	41	41	40	41	41
0	1.0	320	58	55	52	49	47	46	44	43	43	43	43

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	27	27	26	26	26	27	28	30	32	34	37
-1	-0.8	248	31	30	29	29	29	30	30	32	33	36	38
-1	-0.6	256	35	34	33	32	32	32	33	34	35	37	40
-1	-0.4	264	39	38	36	35	35	35	35	36	37	39	41
-1	-0.2	272	43	41	40	39	38	38	38	38	39	41	43
-1	0.0	280	47	45	43	42	41	41	40	41	41	43	44
-1	0.2	288	51	49	47	45	44	43	43	43	44	44	46
-1	0.4	296	56	53	51	49	47	46	46	46	46	46	47
-1	0.6	304	60	57	54	52	51	49	49	48	48	48	49
-1	0.8	312	64	61	58	56	54	52	51	51	50	51	51
-1	1.0	320	69	65	62	60	57	56	54	53	53	53	53

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	6	6	6	7	8	9	11	13	16	19	22
1	-0.8	248	10	10	9	10	10	12	13	15	18	20	24
1	-0.6	256	14	13	13	13	13	14	16	17	19	22	25
1	-0.4	264	18	17	16	16	16	17	18	19	21	24	26
1	-0.2	272	22	21	20	19	19	20	20	22	23	25	28
1	0.0	280	26	24	23	23	22	22	23	24	25	27	29
1	0.2	288	30	28	27	26	25	25	26	26	27	29	31
1	0.4	296	34	32	30	29	28	28	28	29	30	31	33
1	0.6	304	38	36	34	33	32	31	31	31	32	33	34
1	0.8	312	43	40	38	36	35	34	34	34	34	35	36
1	1.0	320	47	44	42	40	38	37	36	36	36	37	38

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	12	12	12	12	13	15	16	19	21	24	28
0	-0.8	248	16	15	15	15	16	17	18	20	23	25	28
0	-0.6	256	19	18	18	18	18	19	20	22	24	27	30
0	-0.4	264	23	22	21	21	21	22	23	24	26	28	31
0	-0.2	272	26	25	24	24	24	24	25	26	27	29	32
0	0.0	280	30	29	27	27	26	26	27	28	29	31	33
0	0.2	288	34	32	31	30	29	29	29	30	31	32	34
0	0.4	296	38	36	34	33	32	32	31	32	33	34	36
0	0.6	304	42	39	37	36	35	34	34	34	35	36	37
0	0.8	312	46	43	41	39	38	37	36	36	37	37	38
0	1.0	320	50	47	44	42	41	40	39	38	39	39	40

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	21	20	20	21	22	23	25	27	29	32	35
-1	-0.8	248	24	23	23	23	24	25	26	28	30	33	36
-1	-0.6	256	27	26	26	26	26	27	28	30	32	34	37
-1	-0.4	264	30	29	29	28	28	29	30	31	33	35	38
-1	-0.2	272	34	32	31	31	31	31	32	33	34	36	38
-1	0.0	280	37	36	34	33	33	33	33	34	36	37	39
-1	0.2	288	41	39	37	36	36	35	35	36	37	38	40
-1	0.4	296	44	42	40	39	38	38	37	38	39	40	41
-1	0.6	304	48	45	43	42	41	40	40	40	40	41	42
-1	0.8	312	51	49	47	45	43	42	42	42	42	42	43
-1	1.0	320	55	52	50	48	46	45	44	43	43	44	45

QUADRATIC REGRESSION MODEL

Response: Sulfur Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	8	9	9	10	12	14	16	19	22	26	30
1	-0.8	248	12	12	12	13	14	16	18	20	23	27	30
1	-0.6	256	15	15	15	15	16	18	20	22	24	28	31
1	-0.4	264	18	17	17	18	19	20	21	23	26	28	32
1	-0.2	272	21	21	20	20	21	22	23	25	27	30	32
1	0.0	280	25	24	23	23	23	24	25	26	28	31	33
1	0.2	288	28	27	26	26	26	26	27	28	30	32	34
1	0.4	296	31	30	29	28	28	28	29	30	31	33	35
1	0.6	304	35	33	32	31	31	30	31	32	33	34	36
1	0.8	312	39	37	35	34	33	33	33	33	34	36	37
1	1.0	320	42	40	38	37	36	35	35	35	36	37	38

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	10	10	10	11	13	15	17	20	23	26	30
0	-0.8	248	12	12	13	13	15	16	18	21	24	27	30
0	-0.6	256	15	15	15	16	16	18	20	22	24	27	31
0	-0.4	264	18	18	17	18	18	19	21	23	25	28	31
0	-0.2	272	21	20	20	20	21	22	24	26	29	32	
0	0.0	280	24	23	22	22	22	23	24	25	27	30	32
0	0.2	288	27	26	25	25	24	25	26	27	28	30	33
0	0.4	296	30	29	28	27	27	27	27	28	30	31	33
0	0.6	304	34	32	30	29	29	29	29	30	31	32	34
0	0.8	312	37	35	33	32	31	31	31	31	32	33	35
0	1.0	320	40	38	36	35	33	33	33	33	33	34	36

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	13	13	14	15	16	18	20	23	26	29	33
-1	-0.8	248	16	16	16	17	18	19	21	24	26	30	33
-1	-0.6	256	18	18	18	18	19	21	22	24	27	30	33
-1	-0.4	264	21	20	20	20	21	22	23	25	28	30	33
-1	-0.2	272	24	23	22	22	23	23	25	26	28	31	33
-1	0.0	280	26	25	24	24	24	25	26	27	29	31	34
-1	0.2	288	29	28	27	26	26	26	27	28	30	32	34
-1	0.4	296	32	30	29	28	28	28	28	29	30	32	34
-1	0.6	304	35	33	32	30	30	30	30	30	31	33	35
-1	0.8	312	38	36	34	33	32	31	31	32	32	34	35
-1	1.0	320	41	38	36	35	34	33	33	33	33	34	36

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Water (lpm)	Amplitude (mm)	MGS Feed (lb/hr)
Minimum	240	0.5	10	150
Maximum	320	1.5	20	350
Center	280	1	15	250
Range	80	1	10	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	58
X1	COE1	20.04
X2	COE2	-5.91
X3	COE3	-3.93
X4	COE4	3.25
X1*X1	COE11	-5.46
X2*X2	COE22	-1.57
X3*X3	COE33	-2.96
X4*X4	COE44	1.76
X1*X2	COE12	2.67
X1*X3	COE13	-7.08
X1*X4	COE14	-8.47
X2*X3	COE23	6.16
X2*X4	COE24	2.72
X3*X4	COE34	2.91

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	0	2	4	6	8	10	12	15	18	20	23
1	-0.8	248	10	11	13	14	16	18	20	22	25	27	30
1	-0.6	256	19	20	21	23	24	25	27	29	31	33	35
1	-0.4	264	28	29	29	30	31	33	34	35	37	39	41
1	-0.2	272	36	36	37	38	38	39	40	41	43	44	46
1	0.0	280	44	44	44	44	45	45	46	47	48	49	50
1	0.2	288	51	51	51	51	51	51	51	52	53	53	54
1	0.4	296	58	58	57	57	57	56	56	57	57	57	58
1	0.6	304	65	64	63	62	62	61	61	61	61	61	61
1	0.8	312	71	70	69	67	66	66	65	64	64	64	64
1	1.0	320	77	75	74	72	71	70	69	68	67	66	66

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	19	20	22	23	25	26	28	30	32	35	37
0	-0.8	248	28	29	30	31	32	34	35	37	39	41	43
0	-0.6	256	37	38	38	39	40	41	42	43	45	46	48
0	-0.4	264	45	45	46	46	47	47	48	49	50	51	53
0	-0.2	272	53	53	53	53	53	53	54	54	55	56	57
0	0.0	280	60	60	59	59	59	59	59	59	60	60	61
0	0.2	288	67	66	66	65	65	64	64	64	64	64	65
0	0.4	296	74	73	71	70	70	69	68	68	68	68	68
0	0.6	304	80	78	77	75	74	73	72	72	71	71	70
0	0.8	312	85	83	82	80	79	77	76	75	74	73	72
0	1.0	320	91	88	86	84	82	81	79	78	76	75	74

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	35	36	37	37	38	40	41	42	44	46	47
-1	-0.8	248	44	44	44	45	46	46	47	48	50	51	53
-1	-0.6	256	52	52	52	52	52	53	53	54	55	56	57
-1	-0.4	264	60	59	59	59	59	59	59	60	60	61	62
-1	-0.2	272	67	66	65	65	65	64	64	64	65	65	65
-1	0.0	280	74	73	72	71	70	69	69	69	69	69	69
-1	0.2	288	80	79	77	76	75	74	73	73	72	72	72
-1	0.4	296	86	84	82	81	80	78	77	76	76	75	74
-1	0.6	304	91	89	87	85	84	82	81	79	78	77	76
-1	0.8	312	96	94	92	89	87	86	84	82	81	79	78
-1	1.0	320	101	98	96	93	91	88	86	84	83	81	79

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	10	12	14	17	20	22	25	28	32	35	39
1	-0.8	248	18	20	22	24	26	29	31	34	37	40	43
1	-0.6	256	26	27	29	31	33	35	37	40	42	45	48
1	-0.4	264	33	34	36	37	39	41	43	45	47	49	52
1	-0.2	272	40	41	42	43	44	46	47	49	51	53	55
1	0.0	280	46	47	48	48	49	51	52	53	55	56	58
1	0.2	288	52	53	53	53	54	55	56	57	58	59	61
1	0.4	296	58	58	58	58	58	59	59	60	61	62	63
1	0.6	304	63	63	62	62	62	62	62	63	63	64	65
1	0.8	312	68	67	66	66	65	65	65	65	65	66	66
1	1.0	320	72	71	70	69	68	68	67	67	67	67	67

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	23	24	26	28	30	33	35	37	40	43	46
0	-0.8	248	30	32	33	35	37	38	41	43	45	48	50
0	-0.6	256	37	38	40	41	42	44	46	48	50	52	54
0	-0.4	264	44	45	46	47	48	49	51	52	54	56	58
0	-0.2	272	51	51	51	52	53	54	55	56	57	59	60
0	0.0	280	57	57	57	57	57	58	59	60	61	62	63
0	0.2	288	62	62	61	61	62	62	62	63	63	64	65
0	0.4	296	67	66	66	65	65	65	65	65	66	66	67
0	0.6	304	72	71	70	69	68	68	68	68	68	68	68
0	0.8	312	76	74	73	72	71	71	70	69	69	69	69
0	1.0	320	80	78	76	75	74	73	72	71	70	70	69

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	32	33	35	36	38	40	41	43	46	48	50
-1	-0.8	248	39	40	41	42	44	45	46	48	50	52	54
-1	-0.6	256	46	47	47	48	49	50	51	52	54	56	57
-1	-0.4	264	52	53	53	53	54	55	55	56	58	59	60
-1	-0.2	272	58	58	58	58	58	59	59	60	61	62	63
-1	0.0	280	64	63	63	62	62	62	63	63	63	64	65
-1	0.2	288	69	68	67	66	66	66	65	65	66	66	66
-1	0.4	296	73	72	71	70	69	68	68	68	67	67	67
-1	0.6	304	77	76	74	73	72	71	70	69	69	68	68
-1	0.8	312	81	79	77	76	74	73	72	71	70	69	68
-1	1.0	320	84	82	80	78	76	74	73	71	70	69	68

QUADRATIC REGRESSION MODEL

Response: Pyritic Rejection (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	13	16	19	22	25	29	32	36	40	44	48
1	-0.8	248	20	22	25	28	31	34	37	40	44	47	51
1	-0.6	256	26	28	31	33	36	38	41	44	47	51	54
1	-0.4	264	32	34	36	38	40	43	45	48	51	54	57
1	-0.2	272	38	39	41	42	44	46	49	51	53	56	59
1	0.0	280	43	44	45	47	48	50	52	54	56	58	60
1	0.2	288	47	48	49	50	51	53	54	56	58	60	62
1	0.4	296	51	52	53	53	54	55	56	58	59	61	62
1	0.6	304	55	55	56	56	57	57	58	59	60	61	63
1	0.8	312	58	58	58	58	58	59	59	60	61	62	63
1	1.0	320	61	61	60	60	60	60	60	60	61	61	62

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	20	22	25	27	30	33	36	39	42	46	49
0	-0.8	248	26	28	30	32	35	37	40	43	46	49	52
0	-0.6	256	32	34	35	37	39	41	44	46	49	51	54
0	-0.4	264	37	39	40	42	43	45	47	49	51	54	56
0	-0.2	272	42	43	44	45	47	48	50	52	54	56	58
0	0.0	280	47	47	48	49	50	51	52	54	55	57	59
0	0.2	288	51	51	51	52	53	53	54	56	57	58	60
0	0.4	296	54	54	54	55	55	55	56	57	58	59	60
0	0.6	304	58	57	57	57	57	57	57	58	58	59	60
0	0.8	312	60	60	59	59	58	58	58	58	58	59	59
0	1.0	320	63	62	61	60	59	59	58	58	58	58	58

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	23	25	27	29	31	34	36	39	41	44	47
-1	-0.8	248	29	31	32	34	36	38	40	42	44	47	50
-1	-0.6	256	34	35	37	38	40	41	43	45	47	49	51
-1	-0.4	264	39	40	41	42	43	44	46	47	49	51	53
-1	-0.2	272	44	44	45	45	46	47	48	49	51	52	54
-1	0.0	280	48	48	48	48	49	49	50	51	52	53	54
-1	0.2	288	51	51	51	51	51	51	52	52	53	54	55
-1	0.4	296	54	54	53	53	53	53	53	53	53	54	54
-1	0.6	304	57	56	55	54	54	53	53	53	53	53	54
-1	0.8	312	59	58	57	56	55	54	53	53	53	52	52
-1	1.0	320	61	59	58	56	55	54	53	52	52	51	51

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Water (lpm)	Amplitude (mm)	MGS Feed (lb/hr)
Minimum	240	0.5	10	150
Maximum	320	1.5	20	350
Center	280	1	15	250
Range	80	1	10	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	56.6
X1	COE1	16.42
X2	COE2	-4.95
X3	COE3	-2.37
X4	COE4	2.77
X1*X1	COE11	-7.73
X2*X2	COE22	-1.84
X3*X3	COE33	-3.83
X4*X4	COE44	1.12
X1*X2	COE12	3.21
X1*X3	COE13	-6.33
X1*X4	COE14	-7.56
X2*X3	COE23	4.93
X2*X4	COE24	3.06
X3*X4	COE34	3.45

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	1	2	4	6	8	10	12	14	16	18	21
1	-0.8	248	10	12	13	15	16	18	19	21	23	25	27
1	-0.6	256	19	20	21	22	24	25	26	28	30	31	33
1	-0.4	264	28	28	29	30	31	32	33	34	35	37	38
1	-0.2	272	35	36	36	37	37	38	39	40	41	42	43
1	0.0	280	42	42	42	43	43	43	44	45	45	46	47
1	0.2	288	49	48	48	48	48	48	49	49	49	50	50
1	0.4	296	54	54	53	53	53	53	52	52	53	53	53
1	0.6	304	59	59	58	57	57	56	56	56	55	55	55
1	0.8	312	64	63	62	61	60	59	59	58	57	57	57
1	1.0	320	68	67	65	64	63	62	61	60	59	58	58

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	19	20	21	22	23	25	26	28	29	31	33
0	-0.8	248	28	28	29	30	31	32	33	34	36	37	38
0	-0.6	256	36	36	37	37	38	39	40	40	41	43	44
0	-0.4	264	44	44	44	44	44	45	45	46	47	47	48
0	-0.2	272	51	50	50	50	50	50	51	51	51	52	52
0	0.0	280	57	56	56	56	55	55	55	55	55	55	56
0	0.2	288	63	62	61	60	60	59	59	59	58	58	58
0	0.4	296	68	67	66	65	64	63	62	62	61	61	60
0	0.6	304	72	71	70	68	67	66	65	64	63	63	62
0	0.8	312	76	74	73	71	70	68	67	66	65	64	63
0	1.0	320	80	77	76	74	72	70	69	67	66	64	63

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	33	34	34	35	35	36	37	38	39	40	41
-1	-0.8	248	41	41	42	42	42	43	43	44	44	45	46
-1	-0.6	256	49	49	49	49	49	49	49	49	50	50	51
-1	-0.4	264	56	55	55	55	54	54	54	54	54	54	55
-1	-0.2	272	62	61	61	60	59	59	59	58	58	58	58
-1	0.0	280	68	67	66	65	64	63	62	62	61	61	61
-1	0.2	288	73	72	70	69	68	67	66	65	64	63	63
-1	0.4	296	78	76	74	73	71	70	68	67	66	65	64
-1	0.6	304	82	79	77	76	74	72	71	69	68	66	65
-1	0.8	312	85	82	80	78	76	74	72	70	68	67	65
-1	1.0	320	87	85	82	80	77	75	73	71	69	67	65

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	10	12	15	17	20	22	25	28	31	34	37
1	-0.8	248	18	20	22	25	27	29	32	34	37	39	42
1	-0.6	256	26	28	29	31	33	35	37	40	42	44	47
1	-0.4	264	33	34	36	37	39	41	43	44	46	49	51
1	-0.2	272	39	40	42	43	44	46	47	49	50	52	54
1	0.0	280	45	46	47	48	49	50	51	52	54	55	57
1	0.2	288	50	51	51	52	53	53	54	55	56	58	59
1	0.4	296	55	55	55	55	56	56	57	58	59	59	60
1	0.6	304	59	58	58	58	59	59	59	60	60	61	61
1	0.8	312	62	61	61	61	61	61	61	61	61	61	61
1	1.0	320	65	64	63	63	62	62	61	61	61	61	61

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	23	25	27	28	30	32	35	37	39	41	44
0	-0.8	248	31	32	34	35	37	39	40	42	44	46	48
0	-0.6	256	38	39	40	41	43	44	45	47	49	51	52
0	-0.4	264	44	45	46	47	48	49	50	51	53	54	56
0	-0.2	272	50	50	51	51	52	53	54	55	56	57	58
0	0.0	280	55	55	55	56	56	57	57	58	59	60	60
0	0.2	288	59	59	59	59	59	60	60	60	61	61	62
0	0.4	296	63	63	62	62	62	62	62	62	62	62	63
0	0.6	304	67	66	65	65	64	64	63	63	63	63	63
0	0.8	312	69	68	67	66	65	65	64	64	63	63	63
0	1.0	320	71	70	69	67	66	65	64	64	63	62	62

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	33	34	35	36	37	39	40	42	44	45	47
-1	-0.8	248	40	40	41	42	43	44	45	47	48	50	51
-1	-0.6	256	46	46	47	47	48	49	50	51	52	53	54
-1	-0.4	264	52	52	52	52	53	53	54	54	55	56	57
-1	-0.2	272	57	56	56	56	57	57	57	57	58	58	59
-1	0.0	280	61	61	60	60	60	60	60	60	60	60	61
-1	0.2	288	65	64	64	63	62	62	62	62	61	61	61
-1	0.4	296	68	67	66	65	64	64	63	63	62	62	62
-1	0.6	304	71	69	68	67	66	65	64	63	62	62	61
-1	0.8	312	73	71	70	68	67	65	64	63	62	61	60
-1	1.0	320	74	72	70	69	67	65	64	62	61	60	58

QUADRATIC REGRESSION MODEL

Response: Efficiency (%)
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	12	15	18	21	24	28	31	34	38	42	45
1	-0.8	248	19	21	24	27	30	33	36	39	43	46	49
1	-0.6	256	25	27	30	32	35	38	41	43	46	50	53
1	-0.4	264	31	33	35	37	40	42	44	47	50	53	55
1	-0.2	272	36	38	39	41	43	46	48	50	52	55	57
1	0.0	280	40	42	43	45	47	49	50	52	55	57	59
1	0.2	288	44	45	47	48	49	51	52	54	56	58	60
1	0.4	296	47	48	49	50	51	53	54	55	57	58	60
1	0.6	304	50	51	51	52	53	54	55	56	57	58	60
1	0.8	312	52	52	53	53	54	54	55	56	57	58	59
1	1.0	320	54	53	53	54	54	54	54	55	56	56	57

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	20	22	25	27	30	33	35	38	41	44	47
0	-0.8	248	26	28	30	33	35	37	40	42	45	48	51
0	-0.6	256	32	34	36	37	39	42	44	46	48	51	53
0	-0.4	264	37	38	40	42	43	45	47	49	51	53	55
0	-0.2	272	41	43	44	45	47	48	50	51	53	55	57
0	0.0	280	45	46	47	48	49	50	52	53	55	56	58
0	0.2	288	49	49	50	50	51	52	53	54	55	57	58
0	0.4	296	51	51	52	52	53	53	54	55	56	56	58
0	0.6	304	53	53	53	53	53	54	54	55	55	56	56
0	0.8	312	54	54	54	54	54	54	54	54	54	54	55
0	1.0	320	55	55	54	53	53	53	53	52	52	52	53

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	24	26	28	30	32	34	36	38	41	43	46
-1	-0.8	248	30	31	33	35	36	38	40	42	44	46	48
-1	-0.6	256	35	36	37	39	40	42	43	45	47	49	50
-1	-0.4	264	40	40	41	42	43	45	46	47	49	50	52
-1	-0.2	272	43	44	44	45	46	47	48	49	50	51	53
-1	0.0	280	47	47	47	47	48	49	49	50	51	52	53
-1	0.2	288	49	49	49	49	49	50	50	50	51	52	52
-1	0.4	296	51	51	50	50	50	50	50	50	51	51	51
-1	0.6	304	52	52	51	51	50	50	50	50	50	50	50
-1	0.8	312	53	52	51	50	50	49	49	48	48	48	47
-1	1.0	320	53	52	51	50	49	48	47	46	45	45	44

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

Actual:				
Name	Speed (rpm)	Water (lpm)	Amplitude (mm)	MGS Feed (lb/hr)
Minimum	240	0.5	10	150
Maximum	320	1.5	20	350
Center	280	1	15	250
Range	80	1	10	200
Coded:				
Name	X1	X2	X3	X4
Minimum	-1	-1	-1	-1
Maximum	1	1	1	1
Center	0	0	0	0
Range	2	2	2	2

Regression Equation Term	Coded Coefficient Name	Coded Coefficient Estimate
Intercept	INTCP	4.116
X1	COE1	-0.581
X2	COE2	0.336
X3	COE3	0.16
X4	COE4	0.018
X1*X1	COE11	0.179
X2*X2	COE22	-0.036
X3*X3	COE33	0.065
X4*X4	COE44	-0.16
X1*X2	COE12	0.006
X1*X3	COE13	0.07
X1*X4	COE14	0.209
X2*X3	COE23	-0.016
X2*X4	COE24	0.093
X3*X4	COE34	-0.178

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	4.9	5.0	5.1	5.1	5.1	5.2	5.2	5.2	5.2	5.1	5.1
1	-0.8	248	4.7	4.8	4.8	4.9	4.9	5.0	5.0	5.0	5.0	5.0	4.9
1	-0.6	256	4.5	4.6	4.6	4.7	4.7	4.8	4.8	4.8	4.8	4.8	4.8
1	-0.4	264	4.3	4.4	4.4	4.5	4.6	4.6	4.7	4.7	4.7	4.7	4.7
1	-0.2	272	4.1	4.2	4.3	4.3	4.4	4.5	4.5	4.5	4.6	4.6	4.6
1	0.0	280	3.9	4.0	4.1	4.2	4.3	4.3	4.4	4.4	4.5	4.5	4.5
1	0.2	288	3.7	3.8	4.0	4.1	4.1	4.2	4.3	4.3	4.4	4.4	4.4
1	0.4	296	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.2	4.3	4.3	4.3
1	0.6	304	3.4	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.2	4.2	4.3
1	0.8	312	3.3	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.2	4.2
1	1.0	320	3.2	3.4	3.5	3.6	3.8	3.9	4.0	4.0	4.1	4.2	4.2

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	4.7	4.8	4.8	4.8	4.8	4.9	4.8	4.8	4.8	4.7	4.7
0	-0.8	248	4.5	4.5	4.6	4.6	4.6	4.7	4.7	4.6	4.6	4.6	4.5
0	-0.6	256	4.2	4.3	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.4	4.4
0	-0.4	264	4.0	4.1	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3
0	-0.2	272	3.8	3.9	4.0	4.1	4.1	4.2	4.2	4.2	4.2	4.2	4.2
0	0.0	280	3.7	3.8	3.8	3.9	4.0	4.0	4.1	4.1	4.1	4.1	4.1
0	0.2	288	3.5	3.6	3.7	3.8	3.8	3.9	3.9	4.0	4.0	4.0	4.0
0	0.4	296	3.3	3.5	3.6	3.7	3.7	3.8	3.8	3.9	3.9	3.9	3.9
0	0.6	304	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.8	3.8	3.8	3.9
0	0.8	312	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.7	3.8	3.8	3.8
0	1.0	320	3.0	3.1	3.2	3.4	3.5	3.5	3.6	3.7	3.7	3.8	3.8

		X3	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	4.4	4.5	4.5	4.5	4.5	4.5	4.4	4.4	4.3	4.3	4.2
-1	-0.8	248	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.2	4.2	4.1	4.0
-1	-0.6	256	4.0	4.0	4.0	4.1	4.1	4.1	4.1	4.1	4.0	4.0	3.9
-1	-0.4	264	3.7	3.8	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.8	3.8
-1	-0.2	272	3.6	3.6	3.7	3.7	3.8	3.8	3.8	3.8	3.8	3.7	3.7
-1	0.0	280	3.4	3.4	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
-1	0.2	288	3.2	3.3	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5
-1	0.4	296	3.1	3.1	3.2	3.3	3.4	3.4	3.4	3.4	3.5	3.4	3.4
-1	0.6	304	2.9	3.0	3.1	3.2	3.3	3.3	3.3	3.4	3.4	3.4	3.4
-1	0.8	312	2.8	2.9	3.0	3.1	3.2	3.2	3.3	3.3	3.3	3.3	3.3
-1	1.0	320	2.7	2.8	2.9	3.0	3.1	3.2	3.2	3.3	3.3	3.3	3.3

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	5.1	5.1	5.2	5.2	5.2	5.2	5.1	5.1	5.1	5.0	4.9
1	-0.8	248	4.9	4.9	5.0	5.0	5.0	5.0	5.0	4.9	4.9	4.8	4.8
1	-0.6	256	4.7	4.7	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.7	4.7
1	-0.4	264	4.5	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.6	4.6	4.5
1	-0.2	272	4.3	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.4
1	0.0	280	4.1	4.2	4.3	4.3	4.4	4.4	4.4	4.4	4.4	4.4	4.4
1	0.2	288	4.0	4.1	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3
1	0.4	296	3.9	4.0	4.0	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.2
1	0.6	304	3.7	3.8	3.9	4.0	4.1	4.1	4.2	4.2	4.2	4.2	4.2
1	0.8	312	3.6	3.7	3.8	3.9	4.0	4.1	4.1	4.2	4.2	4.2	4.2
1	1.0	320	3.5	3.7	3.8	3.9	3.9	4.0	4.1	4.1	4.2	4.2	4.2

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	4.9	4.9	4.9	4.9	4.9	4.9	4.8	4.8	4.7	4.6	4.5
0	-0.8	248	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.6	4.5	4.5	4.4
0	-0.6	256	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.4	4.3	4.3
0	-0.4	264	4.3	4.3	4.4	4.4	4.4	4.4	4.4	4.3	4.3	4.2	4.2
0	-0.2	272	4.1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.1
0	0.0	280	3.9	4.0	4.0	4.1	4.1	4.1	4.1	4.1	4.1	4.0	4.0
0	0.2	288	3.8	3.9	3.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.9
0	0.4	296	3.7	3.7	3.8	3.8	3.9	3.9	3.9	3.9	3.9	3.9	3.9
0	0.6	304	3.5	3.6	3.7	3.7	3.8	3.8	3.9	3.9	3.9	3.8	3.8
0	0.8	312	3.4	3.5	3.6	3.7	3.7	3.8	3.8	3.8	3.8	3.8	3.8
0	1.0	320	3.3	3.4	3.5	3.6	3.7	3.7	3.8	3.8	3.8	3.8	3.8

		X3	0	0	0	0	0	0	0	0	0	0	0
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	4.6	4.6	4.6	4.6	4.6	4.5	4.4	4.4	4.3	4.2	4.1
-1	-0.8	248	4.4	4.4	4.4	4.4	4.4	4.3	4.3	4.2	4.1	4.0	3.9
-1	-0.6	256	4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.0	3.9	3.8
-1	-0.4	264	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.9	3.9	3.8	3.7
-1	-0.2	272	3.8	3.9	3.9	3.9	3.9	3.9	3.8	3.8	3.7	3.7	3.6
-1	0.0	280	3.7	3.7	3.7	3.7	3.8	3.7	3.7	3.7	3.6	3.6	3.5
-1	0.2	288	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.5	3.4
-1	0.4	296	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.4	3.4
-1	0.6	304	3.2	3.3	3.4	3.4	3.4	3.5	3.5	3.5	3.4	3.4	3.3
-1	0.8	312	3.1	3.2	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4	3.3
-1	1.0	320	3.0	3.1	3.2	3.3	3.3	3.3	3.4	3.4	3.4	3.3	3.3

QUADRATIC REGRESSION MODEL

Response: lb SO2/MM Btu
 Description: Illinois No. 6 Seam
 Circuit: Microcel/MGS Combined

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
1	-1.0	240	5.4	5.4	5.4	5.4	5.4	5.3	5.2	5.2	5.1	5.0	4.9
1	-0.8	248	5.2	5.2	5.2	5.2	5.2	5.1	5.1	5.0	4.9	4.9	4.7
1	-0.6	256	5.0	5.0	5.1	5.0	5.0	5.0	4.9	4.9	4.8	4.7	4.6
1	-0.4	264	4.8	4.9	4.9	4.9	4.9	4.9	4.8	4.8	4.7	4.6	4.5
1	-0.2	272	4.7	4.7	4.7	4.8	4.7	4.7	4.7	4.7	4.6	4.5	4.5
1	0.0	280	4.5	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.5	4.5	4.4
1	0.2	288	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.4	4.3
1	0.4	296	4.3	4.3	4.4	4.4	4.4	4.5	4.4	4.4	4.4	4.4	4.3
1	0.6	304	4.2	4.2	4.3	4.3	4.4	4.4	4.4	4.4	4.4	4.3	4.3
1	0.8	312	4.1	4.2	4.2	4.3	4.3	4.3	4.3	4.4	4.3	4.3	4.3
1	1.0	320	4.0	4.1	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
0	-1.0	240	5.2	5.2	5.2	5.2	5.1	5.0	5.0	4.9	4.8	4.6	4.5
0	-0.8	248	5.0	5.0	5.0	5.0	4.9	4.9	4.8	4.7	4.6	4.5	4.4
0	-0.6	256	4.8	4.8	4.8	4.8	4.8	4.7	4.6	4.6	4.5	4.4	4.3
0	-0.4	264	4.7	4.7	4.7	4.6	4.6	4.6	4.5	4.5	4.4	4.3	4.2
0	-0.2	272	4.5	4.5	4.5	4.5	4.5	4.5	4.4	4.3	4.3	4.2	4.1
0	0.0	280	4.3	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.2	4.1	4.0
0	0.2	288	4.2	4.2	4.3	4.3	4.3	4.2	4.2	4.2	4.1	4.0	4.0
0	0.4	296	4.1	4.1	4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.0	3.9
0	0.6	304	4.0	4.0	4.1	4.1	4.1	4.1	4.1	4.1	4.0	4.0	3.9
0	0.8	312	3.9	3.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.9
0	1.0	320	3.8	3.9	3.9	4.0	4.0	4.0	4.0	4.0	4.0	3.9	3.9

		X3	1	1	1	1	1	1	1	1	1	1	1
		X4	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
X2	X1		150	170	190	210	230	250	270	290	310	330	350
-1	-1.0	240	5.0	4.9	4.9	4.8	4.8	4.7	4.6	4.5	4.3	4.2	4.1
-1	-0.8	248	4.8	4.7	4.7	4.7	4.6	4.5	4.4	4.3	4.2	4.1	3.9
-1	-0.6	256	4.6	4.6	4.5	4.5	4.4	4.4	4.3	4.2	4.1	4.0	3.8
-1	-0.4	264	4.4	4.4	4.4	4.3	4.3	4.2	4.1	4.1	4.0	3.8	3.7
-1	-0.2	272	4.2	4.2	4.2	4.2	4.1	4.1	4.0	4.0	3.9	3.8	3.6
-1	0.0	280	4.1	4.1	4.1	4.1	4.0	4.0	3.9	3.9	3.8	3.7	3.6
-1	0.2	288	3.9	4.0	4.0	3.9	3.9	3.9	3.8	3.8	3.7	3.6	3.5
-1	0.4	296	3.8	3.8	3.9	3.8	3.8	3.8	3.8	3.7	3.6	3.6	3.5
-1	0.6	304	3.7	3.7	3.8	3.8	3.8	3.7	3.7	3.7	3.6	3.5	3.5
-1	0.8	312	3.6	3.7	3.7	3.7	3.7	3.7	3.7	3.6	3.6	3.5	3.4
-1	1.0	320	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.5	3.4

APPENDIX 5

Test Data and Performance Calculations

Combined Microcel/WOC/MGS Tests

Total Circuit Microcel/WOC/MGS Tests Results - Illinois #6

Ash

Test No.	Microcel						WOC						MGS					
	Measured Microcel	Adjusted Microcel	Measured Microcel	Adjusted Microcel	Measured Microcel	Adjusted Microcel	Measured WOC	Adjusted WOC	Measured WOC	Adjusted WOC	Measured WOC	Adjusted WOC	Measured MGS	Adjusted MGS	Measured MGS	Adjusted MGS	Measured MGS	Adjusted MGS
	Feed Ash %	Feed Ash %	Product Ash %	Product Ash %	Reject Ash %	Reject Ash %	Feed Ash %	Feed Ash %	Lights Ash %	Lights Ash %	Heavies Ash %	Heavies Ash %	Feed Ash %	Feed Ash %	Lights Ash %	Lights Ash %	Heavies Ash %	Heavies Ash %
701	22.42	22.39	8.57	8.31	63.40	63.46	8.25	8.31	7.26	7.31	8.67	8.85	8.98	8.85	6.00	6.03	28.60	28.70
702	22.41	22.39	8.24	8.24	65.55	65.58	8.28	8.24	7.18	7.19	8.48	8.62	8.73	8.62	6.31	6.31	29.66	29.65
703	23.02	23.02	7.79	8.05	66.27	66.27	8.28	8.05	7.31	7.28	8.80	8.77	8.73	8.77	6.42	6.40	31.78	31.73

Yields

Test No.	Measured Microcel Ash Yield %	Adjusted Microcel Ash Yield %	Measured WOC Ash Yield %	Adjusted WOC Ash Yield %	Measured MGS Ash Yield %	Adjusted MGS Ash Yield %	Measured Combined Ash Yield %	Adjusted Combined Ash Yield %
701	74.74	74.47	29.79	35.06	86.81	87.56	67.82	68.45
702	75.27	75.32	15.38	26.57	89.64	90.10	68.67	69.85
703	73.96	74.29	34.90	48.32	90.89	90.64	69.57	70.70

Total Circuit Performance

(MGS Lights + WOC Overflow)

Test No.	Circuit Product Ash %	Circuit Reject Ash %	Circuit Product T. Sulfur %	Circuit Reject T. Sulfur %	Circuit Product Pyritic S %	Circuit Reject Pyritic S %
701	6.52	56.83	1.98	4.49	0.60	3.53
702	6.56	59.06	1.97	4.70	0.56	3.95
703	6.85	62.04	2.06	4.24	0.63	3.50

Total Circuit Microcel/WOC/MGS Tests Results - Illinois #6

Total Sulfur

Test No.	Microcel						WOC						MGS					
	Measured Microcel Feed	Adjusted Microcel Feed	Measured Microcel Product	Adjusted Microcel Product	Measured Microcel Reject	Adjusted Microcel Reject	Measured WOC Feed	Adjusted WOC Feed	Measured WOC Lights	Adjusted WOC Lights	Measured WOC Heavies	Adjusted WOC Heavies	Measured MGS Feed	Adjusted MGS Feed	Measured MGS Lights	Adjusted MGS Lights	Measured MGS Heavies	Adjusted MGS Heavies
	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %	T. Sulfur %
701	2.69	2.77	2.64	2.68	3.07	3.04	2.60	2.68	2.18	2.14	2.84	2.97	3.05	2.97	1.96	1.88	11.00	10.64
702	2.65	2.79	2.56	2.59	3.45	3.39	2.65	2.59	2.14	2.12	2.76	2.77	2.93	2.77	1.88	1.91	10.50	10.59
703	2.74	2.70	2.56	2.56	3.07	3.08	2.69	2.56	2.18	2.23	2.86	2.88	2.87	2.88	1.86	1.88	12.40	12.51

Pyritic Sulfur

Test Number	Microcel						WOC						MGS					
	Measured Microcel Feed	Adjusted Microcel Feed	Measured Microcel Product	Adjusted Microcel Product	Measured Microcel Reject	Adjusted Microcel Reject	Measured WOC Feed	Adjusted WOC Feed	Measured WOC Lights	Adjusted WOC Lights	Measured WOC Heavies	Adjusted WOC Heavies	Measured MGS Feed	Adjusted MGS Feed	Measured MGS Lights	Adjusted MGS Lights	Measured MGS Heavies	Adjusted MGS Heavies
	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %	Pyritic S %
701	1.41	1.52	1.26	1.25	2.40	2.32	1.22	1.25	0.82	0.81	1.35	1.49	1.59	1.49	0.49	0.47	9.50	8.65
702	1.50	1.58	1.16	1.22	2.74	2.68	1.23	1.22	0.80	0.79	1.32	1.38	1.52	1.38	0.47	0.47	9.84	9.66
703	1.46	1.47	1.11	1.13	2.47	2.46	1.26	1.13	0.75	0.77	1.56	1.46	1.42	1.46	0.48	0.49	10.41	10.92

Total Circuit Microcel/WOC/MGS Tests Results - Illinois #6

Ash Performance

Test No.	Microcel			WOC			MGS			Total Circuit		
	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %
701	87.98	72.36	60.34	35.45	69.15	4.60	90.27	40.34	30.61	82.45	80.07	62.52
702	89.06	72.28	61.34	26.88	76.81	3.69	92.38	34.04	26.42	84.09	79.53	63.62
703	88.73	74.02	62.76	48.73	56.30	5.03	93.00	33.85	26.85	85.55	78.97	64.52

Total Sulfur Performance

Test No.	Microcel			WOC			MGS			Total Circuit		
	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %
701	87.98	27.95	15.93	35.45	72.00	7.45	90.27	44.57	34.84	82.45	51.09	33.54
702	89.06	30.08	19.13	26.88	78.25	5.13	92.38	37.87	30.25	84.09	50.68	34.77
703	88.73	29.56	18.30	48.73	57.91	6.63	93.00	40.83	33.83	85.55	46.12	31.67

Pyritic Sulfur Performance

Test No.	Microcel			WOC			MGS			Total Circuit		
	Comb. Recovery %	Pyritic S Rejection %	Pyritic S Separation Efficiency %	Comb. Recovery %	Pyritic S Rejection %	Pyritic S Separation Efficiency %	Comb. Recovery %	Pyritic S Rejection %	Pyritic S Separation Efficiency %	Comb. Recovery %	Pyritic S Rejection %	Pyritic S Separation Efficiency %
701	87.98	38.76	26.74	35.45	77.28	12.73	89.50	72.38	61.88	82.45	72.99	55.45
702	89.06	41.84	30.90	26.88	82.79	9.67	91.90	69.31	61.21	84.09	75.17	59.26
703	88.73	42.89	31.63	48.73	67.07	15.80	93.25	69.58	62.83	85.55	69.60	55.15

APPENDIX 6

Long-Duration Test Data and Performance Calculations

Combined Microcel/MGS Tests

APPENDIX 6-A

Long-Duration Test Data and **Performance Calculations**

Combined Microcel/MGS Tests
Pittsburgh No. 8 Seam Coal

Microcel/MGS Long Duration Testing - Pittsburgh #8

All Conditions Held Constant

Microcel

Feed Rate (lbs/hr):	500
Wash Water (lpm):	39
Percent Solids (w/w):	12-14
Grind Size (d80 (microns)):	200
Air Flow Rate (SCFM):	8.89
Diesel dosage (lbs/ton):	1.00
Frother Dosage (ml/min):	0.80

MGS

Feed Rate (lbs/hr):	273
Drum Speed (rpm):	320
Wash water (lpm):	0.50 - 0.56
Percent Solids (w/w):	19 - 20
Shake Amplitude (mm):	15
Shake Frequency (cps):	5
Tilt Angle (degrees):	6

Combined Microcel/MGS Tests Results - Pittsburgh #8

Long Duration Tests - Ash

Time hours	Microcel						MGS					
	Measured Microcel Feed Ash %	Adjusted Microcel Feed Ash %	Measured Microcel Product Ash %	Adjusted Microcel Product Ash %	Measured Microcel Reject Ash %	Adjusted Microcel Reject Ash %	Measured MGS Feed Ash %	Adjusted MGS Feed Ash %	Measured MGS Lights Ash %	Adjusted MGS Lights Ash %	Measured MGS Heavies Ash %	Adjusted MGS Heavies Ash %
1	19.84	19.78	7.01	6.98	69.04	69.20	6.92	6.98	5.56	5.54	34.03	33.99
2	19.14	19.11	7.10	7.05	67.85	67.92	7.01	7.05	5.67	5.68	40.30	40.32
3	19.11	19.21	7.12	7.16	70.63	70.37	7.26	7.16	5.75	5.78	35.81	35.86
4	19.50	19.52	7.13	7.17	69.59	69.53	7.21	7.17	5.80	5.79	40.90	40.08
5	19.33	19.14	7.59	7.39	67.52	67.98	7.25	7.39	6.00	6.05	42.34	42.43
6	18.67	18.83	7.13	7.29	65.81	65.42	7.41	7.29	6.12	6.07	41.99	41.91
7	19.11	19.39	6.99	7.17	66.26	65.56	7.49	7.17	5.67	5.71	40.33	40.43
8	18.93	18.86	7.08	7.02	65.19	65.35	6.95	7.02	5.79	5.79	39.93	39.93
9	18.69	18.64	7.43	7.35	67.75	67.86	7.32	7.35	5.88	5.92	40.73	40.80

Time hours	Yields					
	Measured Microcel Ash Yield %	Adjusted Microcel Ash Yield %	Measured MGS Ash Yield %	Adjusted MGS Ash Yield %	Measured Combined Ash Yield %	Adjusted Combined Ash Yield %
1	79.32	79.43	95.22	94.94	75.53	75.41
2	80.18	80.19	96.13	96.05	77.08	77.02
3	81.12	80.94	94.98	95.41	77.05	77.22
4	80.20	80.20	95.98	95.98	76.97	76.97
5	80.41	80.61	96.56	96.32	77.64	77.64
6	80.33	80.15	96.40	96.60	77.44	77.42
7	79.55	79.07	94.75	95.79	75.37	75.75
8	79.61	79.70	96.60	96.40	76.90	76.83
9	81.33	81.34	95.87	95.90	77.97	78.01

Combined Microcel/MGS Tests Results - Pittsburgh #8

Long Duration Tests - Total Sulfur

Time hours	Microcel						MGS					
	Measured Microcel Feed T. Sulfur %	Adjusted Microcel Feed T. Sulfur %	Measured Microcel Product T. Sulfur %	Adjusted Microcel Product T. Sulfur %	Measured Microcel Reject T. Sulfur %	Adjusted Microcel Reject T. Sulfur %	Measured MGS Feed T. Sulfur %	Adjusted MGS Feed T. Sulfur %	Measured MGS Lights T. Sulfur %	Adjusted MGS Lights T. Sulfur %	Measured MGS Heavies T. Sulfur %	Adjusted MGS Heavies T. Sulfur %
1	2.54	2.48	2.37	2.34	2.99	3.01	2.36	2.34	1.62	1.66	14.79	14.98
2	2.56	2.49	2.29	2.34	3.06	3.08	2.38	2.34	1.71	1.73	17.32	17.38
3	2.59	2.51	2.35	2.38	3.02	3.04	2.39	2.38	1.71	1.73	15.80	15.88
4	2.53	2.46	2.42	2.42	2.61	2.62	2.37	2.42	1.71	1.71	19.53	19.51
5	2.47	2.44	2.40	2.36	2.77	2.78	2.32	2.36	1.68	1.69	20.03	20.06
6	2.44	2.38	2.34	2.32	2.59	2.60	2.33	2.32	1.68	1.72	19.30	19.47
7	2.51	2.51	2.34	2.37	3.04	3.04	2.34	2.37	1.70	1.67	18.51	18.36
8	2.39	2.42	2.38	2.30	2.90	2.89	2.31	2.30	1.68	1.72	17.70	17.85
9	2.42	2.42	2.36	2.41	2.46	2.46	2.41	2.41	1.72	1.70	18.95	18.85

Long Duration Tests - Pyritic Sulfur

Time hours	Microcel						MGS					
	Measured Microcel Feed Pyritic S %	Adjusted Microcel Feed Pyritic S %	Measured Microcel Product Pyritic S %	Adjusted Microcel Product Pyritic S %	Measured Microcel Reject Pyritic S %	Adjusted Microcel Reject Pyritic S %	Measured MGS Feed Pyritic S %	Adjusted MGS Feed Pyritic S %	Measured MGS Lights Pyritic S %	Adjusted MGS Lights Pyritic S %	Measured MGS Heavies Pyritic S %	Adjusted MGS Heavies Pyritic S %
1	1.33	1.26	1.03	1.01	2.16	2.20	0.96	1.01	0.41	0.41	12.30	12.27
2	1.26	1.25	0.93	0.99	2.31	2.31	0.95	0.99	0.43	0.41	16.38	15.17
3	1.27	1.38	0.94	1.02	3.00	2.89	1.02	1.02	0.42	0.40	15.70	14.02
4	1.28	1.20	1.00	1.02	1.91	1.94	0.99	1.02	0.40	0.40	15.90	15.80
5	1.22	1.21	1.04	1.01	2.04	2.04	0.91	1.01	0.43	0.41	17.68	16.62
6	1.18	1.16	0.95	0.98	1.87	1.88	1.06	0.98	0.41	0.42	16.70	17.09
7	1.34	1.26	0.94	1.00	2.19	2.24	0.88	1.00	0.44	0.41	16.57	14.51
8	1.15	1.18	0.94	0.95	2.11	2.09	0.97	0.95	0.41	0.41	15.73	15.58
9	1.13	1.17	1.03	1.03	1.78	1.76	0.97	1.03	0.42	0.40	16.94	15.78

Combined Microcel/MGS Tests Results - Pittsburgh #8

Long Duration Tests - Ash Performance

Time hours	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %	Comb. Recovery %	Ash Rejection %	Ash Separation Efficiency %
1	92.10	71.97	64.07	96.41	24.65	21.06	88.79	78.88	67.67
2	92.14	70.42	62.56	97.46	22.62	20.08	89.80	77.11	66.91
3	93.01	69.83	62.84	96.83	22.98	19.81	90.06	76.76	66.83
4	92.50	70.54	63.04	97.40	22.50	19.90	90.10	77.17	67.27
5	92.32	68.88	61.20	97.71	21.15	18.86	90.21	75.46	65.67
6	91.54	68.97	60.51	97.87	19.57	17.44	89.59	75.04	64.63
7	91.06	70.76	61.82	97.30	23.71	21.01	88.60	77.69	66.30
8	91.33	70.33	61.67	97.67	20.49	18.17	89.21	76.41	65.62
9	92.63	67.93	60.56	97.38	22.76	20.14	90.20	75.23	65.43

Long Duration Tests - Total Sulfur Performance

Time hours	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %	Comb. Recovery %	T. Sulfur Rejection %	T. Sulfur Separation Efficiency %
1	92.10	25.06	17.16	96.41	32.65	29.06	88.79	49.53	38.32
2	92.14	24.64	16.79	97.46	28.99	26.45	89.80	46.49	36.29
3	93.01	23.26	16.26	96.83	30.65	27.48	90.06	46.77	36.83
4	92.50	21.11	13.61	97.40	32.18	29.58	90.10	46.50	36.60
5	92.32	22.04	14.36	97.71	31.03	28.74	90.21	46.23	36.43
6	91.54	21.87	13.42	97.87	28.39	26.25	89.59	44.05	33.64
7	91.06	25.34	16.40	97.30	32.50	29.80	88.60	49.60	38.20
8	91.33	24.25	15.58	97.67	27.91	25.58	89.21	45.39	34.60
9	92.63	18.99	11.62	97.38	32.35	29.73	90.20	45.20	35.40

Long Duration Tests - Pyritic Sulfur Performance

Time hours	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery %	Pyritic S Rejection %	Pyritic S Separation Efficiency %	Comb. Recovery %	Pyritic S Rejection %	Pyritic S Separation Efficiency %	Comb. Recovery %	Pyritic S Rejection %	Pyritic S Separation Efficiency %
1	92.10	36.33	28.43	96.41	61.46	57.87	88.79	75.46	64.26
2	92.14	36.49	28.63	97.46	60.22	57.68	89.80	74.74	64.54
3	93.01	40.18	33.19	96.83	62.58	59.41	90.06	77.62	67.68
4	92.50	31.83	24.34	97.40	62.36	59.76	90.10	74.34	64.44
5	92.32	32.72	25.04	97.71	60.90	58.61	90.21	73.69	63.90
6	91.54	32.29	23.83	97.87	58.60	56.47	89.59	71.97	61.56
7	91.06	37.24	28.30	97.30	60.72	58.03	88.60	75.35	63.95
8	91.33	35.83	27.17	97.67	58.40	56.07	89.21	73.30	62.51
9	92.63	28.39	21.02	97.38	62.76	60.14	90.20	73.33	63.53

Combined Microcel/MGS Tests Results - Pittsburgh #8

Long Duration Tests - Energy Performance

<i>Combined</i>							
Time hours	Feed Calorific Value Btu/lb	Product Calorific Value Btu/lb	Reject Calorific Value Btu/lb	Energy Recovery %	SO2 Emission lb/MM Btu	Pyritic S Rejection %	Pyritic S Separation Efficiency %
1	11941	14345	4571	90.59	2.31	75.46	66.05
2	12055	14321	4459	91.50	2.42	74.74	66.24
3	12038	14304	4352	91.77	2.42	77.62	69.38
4	11985	14303	4241	91.85	2.39	74.34	66.19
5	12049	14259	4378	91.87	2.37	73.69	65.57
6	12102	14256	4717	91.20	2.41	71.97	63.17
7	12007	14316	4796	90.31	2.33	75.35	65.67
8	12097	14303	4781	90.84	2.41	73.30	64.15
9	12134	14281	4519	91.81	2.38	73.33	65.14

APPENDIX 6-B

Long-Duration Test Data and Performance Calculations

Combined Microcel/MGS Tests
Illinois No. 6 Seam Coal

Microcel/MGS Long Duration Testing - Illinois #6

All Conditions Held Constant

Microcel

Feed Rate (lbs/hr):	600
Wash Water (lpm):	40.1
Percent Solids (w/w):	11-12
Grind Size (d80 (microns)):	200
Air Flow Rate (SCFM):	8.89
Diesel dosage (lbs/ton):	1
Frother Dosage (ml/min):	1.7

MGS

Feed Rate (lbs/hr):	340
Drum Speed (rpm):	283
Wash water (lpm):	0.49
Percent Solids (w/w):	23 - 24
Shake Amplitude (mm):	15
Shake Frequency (cps):	5
Tilt Angle (degrees):	6

Combined Microcel/MGS Tests Results - Illinois #6

Long Duration Tests - Ash

Time hours	Microcel						MGS					
	Measured Microcel Feed Ash %	Adjusted Microcel Feed Ash %	Measured Microcel Product Ash %	Adjusted Microcel Product Ash %	Measured Microcel Reject Ash %	Adjusted Microcel Reject Ash %	Measured MGS Feed Ash %	Adjusted MGS Feed Ash %	Measured MGS Lights Ash %	Adjusted MGS Lights Ash %	Measured MGS Heavies Ash %	Adjusted MGS Heavies Ash %
1	35.06	35.05	10.17	9.84	77.21	77.24	9.51	9.84	7.50	7.47	45.75	45.69
2	27.66	27.59	8.31	8.79	75.67	75.81	9.51	8.79	7.18	7.23	46.22	46.31
3	29.49	29.57	8.33	8.38	72.54	72.38	8.41	8.38	6.97	6.96	49.42	49.40
4	28.41	28.53	8.03	8.14	72.42	72.16	8.25	8.14	6.85	6.85	51.29	51.28
5	25.53	25.74	7.79	7.94	71.45	70.99	8.18	7.94	6.69	6.72	54.51	54.57

Time hours	Yields					
	Measured Microcel Ash Yield %	Adjusted Microcel Ash Yield %	Measured MGS Ash Yield %	Adjusted MGS Ash Yield %	Measured Combined Ash Yield %	Adjusted Combined Ash Yield %
1	62.87	62.60	94.75	93.80	59.57	58.71
2	71.27	71.95	94.03	96.01	67.02	69.08
3	67.05	66.89	96.61	96.65	64.77	64.65
4	68.35	68.15	96.85	97.10	66.20	66.17
5	72.13	71.77	96.88	97.45	69.89	69.94

Combined Microcel/MGS Tests Results - Illinois #6

Long Duration Tests - Total Sulfur

Time hours	Microcel						MGS					
	Measured Microcel Feed T. Sulfur %	Adjusted Microcel Feed T. Sulfur %	Measured Microcel Product T. Sulfur %	Adjusted Microcel Product T. Sulfur %	Measured Microcel Reject T. Sulfur %	Adjusted Microcel Reject T. Sulfur %	Measured MGS Feed T. Sulfur %	Adjusted MGS Feed T. Sulfur %	Measured MGS Lights T. Sulfur %	Adjusted MGS Lights T. Sulfur %	Measured MGS Heavies T. Sulfur %	Adjusted MGS Heavies T. Sulfur %
1	3.98	4.30	3.87	4.15	4.73	4.56	3.78	4.15	2.81	3.02	20.60	21.33
2	3.14	3.56	3.16	3.31	4.42	4.19	3.78	3.31	2.65	2.56	21.70	21.45
3	3.33	3.40	3.12	3.22	3.79	3.76	3.40	3.22	2.48	2.49	24.10	24.14
4	3.29	3.42	3.14	3.15	4.04	3.98	3.26	3.15	2.42	2.43	27.30	27.33
5	3.00	3.38	2.76	2.81	5.12	4.81	2.98	2.81	2.23	2.15	28.60	28.24

Long Duration Tests - Pyritic Sulfur

Time hours	Microcel						MGS					
	Measured Microcel Feed Pyritic S %	Adjusted Microcel Feed Pyritic S %	Measured Microcel Product Pyritic S %	Adjusted Microcel Product Pyritic S %	Measured Microcel Reject Pyritic S %	Adjusted Microcel Reject Pyritic S %	Measured MGS Feed Pyritic S %	Adjusted MGS Feed Pyritic S %	Measured MGS Lights Pyritic S %	Adjusted MGS Lights Pyritic S %	Measured MGS Heavies Pyritic S %	Adjusted MGS Heavies Pyritic S %
1	2.28	2.29	1.66	1.67	3.12	3.16	1.52	1.67	0.69	0.66	18.41	17.02
2	1.56	1.85	1.25	1.37	3.53	3.11	1.52	1.37	0.69	0.65	20.20	18.67
3	1.96	1.89	1.38	1.37	2.89	2.94	1.37	1.37	0.67	0.68	21.16	21.41
4	1.58	1.70	1.63	1.30	2.66	2.55	1.16	1.3	0.64	0.63	23.90	23.64
5	1.40	1.73	1.13	1.15	3.92	3.19	1.21	1.15	0.61	0.57	24.73	23.22

Combined Microcel/MGS Tests Results - Illinois #6

Long Duration Tests - Ash Performance

Time hours	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery	Ash Rejection	Ash Separation Efficiency	Comb. Recovery	Ash Rejection	Ash Separation Efficiency	Comb. Recovery	Ash Rejection	Ash Separation Efficiency
	%	%	%	%	%	%	%	%	%
1	86.89	82.43	69.32	96.26	28.79	25.06	83.65	87.49	71.13
2	90.63	77.08	67.71	97.65	21.03	18.68	88.50	81.90	70.40
3	87.02	81.04	68.06	98.15	19.72	17.88	85.41	84.78	70.19
4	87.59	80.56	68.15	98.46	18.29	16.75	86.24	84.11	70.36
5	88.97	77.86	66.83	98.74	17.52	16.26	87.85	81.74	69.59

Long Duration Tests - Total Sulfur Performance

Time hours	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery	T. Sulfur Rejection	T. Sulfur Separation Efficiency	Comb. Recovery	T. Sulfur Rejection	T. Sulfur Separation Efficiency	Comb. Recovery	T. Sulfur Rejection	T. Sulfur Separation Efficiency
	%	%	%	%	%	%	%	%	%
1	86.89	39.59	26.48	96.26	31.74	28.01	83.65	58.76	42.41
2	90.63	33.10	23.73	97.65	25.75	23.40	88.50	50.33	38.83
3	87.02	36.65	23.67	98.15	25.26	23.41	85.41	52.65	38.06
4	87.59	37.23	24.82	98.46	25.10	23.56	86.24	52.98	39.23
5	88.97	40.33	29.31	98.74	25.44	24.18	87.85	55.51	43.36

Long Duration Tests - Pyritic Sulfur Performance

Time hours	Microcel			MGS			Combined Microcel/MGS		
	Comb. Recovery	Pyritic S Rejection	Pyritic S Separation Efficiency	Comb. Recovery	Pyritic S Rejection	Pyritic S Separation Efficiency	Comb. Recovery	Pyritic S Rejection	Pyritic S Separation Efficiency
	%	%	%	%	%	%	%	%	%
1	86.89	54.35	41.24	96.26	62.93	59.19	83.65	83.08	66.73
2	90.63	46.72	37.35	97.65	54.45	52.10	88.50	75.73	64.23
3	87.02	51.51	38.53	98.15	52.03	50.18	85.41	76.74	62.15
4	87.59	47.88	35.48	98.46	52.95	51.41	86.24	75.48	61.72
5	88.97	52.29	41.26	98.74	51.70	50.44	87.85	76.96	64.81

APPENDIX 7

MGS Partition Curve Data

APPENDIX 7-A

MGS Partition Curve Data

**Sample Precleaned by Microcel
Pittsburgh No. 8 Seam Coal**

Effect of particle size on the partition curves for the MGS unit from Long Duration testing of Pittsburgh No. 8 seam coal.

APPENDIX 7-B

MGS Partition Curve Data

**Sample Precleaned by Microcel
Illinois No. 6 Seam Coal**

Effect of particle size on the partition curves for the MGS unit from Long Duration testing of Illinois No. 6 seam coal.

APPENDIX 8

Near-Term Test Data and Performance Calculations

APPENDIX 8-A

Near-Term Test Data and Performance Calculations

Pittsburgh No. 8 Seam Coal

Near-Term Testing - Pittsburgh #8

MGS Conditions Held Constant

Shake Amplitude (mm): 15
Shake Frequency (cps): 5
Tilt Angle (degrees): 6
% Solids (w/w): 18 - 22

MGS Variables

Test Number	Feed Rate lbs/hr	Drum Speed rpm	Wash Water lpm
901	248	323	1.63
902	253	281	1.02
903	293	281	1.51
904	305	320	1.97
905	139	280	0.57

Near-Term Test Results - Pittsburgh #8
MGS Only

Test No. 901

Size (mesh)	Feed				Product				Reject			
	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)
+ 48	53.38	12.05	1.83	0.96	57.78	5.88	1.62	0.73	36.56	49.35	3.09	2.35
48 x 100	17.28	25.66	2.91	1.90	13.86	8.18	1.70	0.77	30.33	56.24	5.03	3.87
100 x 200	9.30	19.44	3.46	2.41	8.06	5.67	1.54	0.56	14.11	49.51	7.67	6.45
200 x 325	4.99	18.62	4.11	3.03	4.23	5.01	1.56	0.69	7.90	46.51	9.33	7.81
- 325	15.05	45.36	2.29	2.08	16.07	41.38	1.18	0.57	11.10	67.60	8.46	10.43
Cum.	100.00	20.43	2.35	1.53	100.00	11.85	1.55	0.69	100.00	53.26	5.41	4.72

Test No. 902

Size (mesh)	Feed				Product				Reject			
	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)
+ 48	51.53	11.66	1.85	0.78	55.12	6.77	1.65	0.55	29.30	68.83	4.14	3.54
48 x 100	18.33	21.44	2.66	1.53	15.98	8.78	1.58	0.65	32.87	59.62	5.91	4.17
100 x 200	9.11	20.37	3.53	2.60	7.45	6.15	1.48	0.70	19.42	54.23	8.41	7.10
200 x 325	5.60	15.40	3.31	2.34	5.12	5.62	1.36	0.49	8.60	51.52	10.53	9.19
- 325	15.43	45.25	2.13	2.10	16.33	42.81	1.29	0.63	9.81	70.81	10.77	17.26
Cum.	100.00	19.64	2.28	1.37	100.00	12.87	1.55	0.59	100.00	61.67	6.75	6.27

Test No. 903

Size (mesh)	Feed				Product				Reject			
	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)
+ 48	39.54	8.60	1.78	0.68	40.68	5.17	1.53	0.45	27.91	59.47	5.39	4.08
48 x 100	14.12	13.78	2.36	0.98	12.62	7.06	1.38	0.47	29.39	43.14	6.64	3.22
100 x 200	11.34	9.85	2.11	0.81	10.67	3.50	1.09	0.24	18.07	48.03	8.25	4.24
200 x 325	6.57	12.57	2.65	1.61	6.21	4.35	1.24	0.30	10.22	63.37	11.35	9.68
- 325	28.43	45.21	1.81	1.73	29.82	44.94	1.32	0.62	14.41	75.51	12.78	25.49
Cum.	100.00	20.14	1.97	1.10	100.00	17.04	1.38	0.47	100.00	55.31	7.95	7.51

Test No. 904

Size (mesh)	Feed				Product				Reject			
	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)
+ 48	40.12	10.97	1.87	0.78	41.60	5.69	1.64	0.51	31.18	53.50	3.71	2.99
48 x 100	20.88	15.04	2.24	1.01	19.34	5.60	1.39	0.44	30.20	51.50	5.53	3.22
100 x 200	11.00	9.74	2.11	0.93	11.42	4.86	1.25	0.34	8.52	49.17	9.04	5.71
200 x 325	7.24	15.33	2.74	1.70	5.90	4.65	1.26	0.33	15.30	40.16	6.19	4.88
- 325	20.76	46.05	2.08	1.78	21.74	43.43	1.19	0.66	14.80	69.53	9.96	11.80
Cum.	100.00	19.28	2.08	1.12	100.00	13.72	1.43	0.50	100.00	52.86	6.02	4.88

Test No. 905

Size (mesh)	Feed				Product				Reject			
	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)	Wt. (%)	Ash (%)	T. Sulfur (%)	Pyritic S (%)
+ 48	33.15	6.52	1.68	0.90	33.40	3.68	1.51	0.72	30.19	44.59	3.91	3.37
48 x 100	20.95	9.80	2.02	0.74	20.19	5.58	1.42	0.60	30.07	44.08	6.93	1.85
100 x 200	12.46	8.76	2.01	0.92	12.78	6.22	1.53	0.48	8.59	54.28	10.80	8.89
200 x 325	7.53	13.12	2.77	1.82	6.81	5.75	1.30	0.44	16.13	50.79	10.24	8.89
- 325	25.91	46.47	1.73	1.54	26.82	45.25	1.29	0.72	15.02	72.09	11.07	19.07
Cum.	100.00	18.33	1.89	1.10	100.00	15.68	1.42	0.65	100.00	50.40	7.51	6.64

Near-Term Test Results - Pittsburgh #8
MGS Performance

Test No. 901

Size	Yield	Comb. Recovery	Ash Rejection	T. Sulfur Rejection	Pyritic S Rejection	Ash Separation Efficiency	T. Sulfur Separation Efficiency	Pyritic S Separation Efficiency
(mesh)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
+ 48	85.81	91.83	58.13	24.04	34.75	49.96	15.87	26.58
48 x 100	63.63	78.59	79.72	62.83	74.21	58.31	41.42	52.80
100 x 200	68.59	80.31	79.99	69.47	84.06	60.31	49.79	64.38
200 x 325	67.20	78.44	81.92	74.49	84.70	60.36	52.94	63.14
- 325	84.82	91.00	22.62	56.29	76.76	13.62	47.29	67.75
Cum.	79.28	87.83	54.01	47.69	64.00	41.85	35.52	51.83

Test No. 902

Size	Yield	Comb. Recovery	Ash Rejection	T. Sulfur Rejection	Pyritic S Rejection	Ash Separation Efficiency	T. Sulfur Separation Efficiency	Pyritic S Separation Efficiency
(mesh)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
+ 48	92.12	97.22	46.51	17.84	35.04	43.73	15.06	32.26
48 x 100	75.10	87.20	69.25	55.39	68.10	56.45	42.59	55.30
100 x 200	70.42	83.00	78.74	70.47	81.04	61.74	53.47	64.04
200 x 325	78.69	87.79	71.28	67.67	83.52	59.07	55.46	71.31
- 325	91.29	95.35	13.64	44.71	72.61	8.99	40.07	67.97
Cum.	86.13	93.39	43.55	41.26	63.20	36.93	34.65	56.59

Test No. 903

Size	Yield	Comb. Recovery	Ash Rejection	T. Sulfur Rejection	Pyritic S Rejection	Ash Separation Efficiency	T. Sulfur Separation Efficiency	Pyritic S Separation Efficiency
(mesh)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
+ 48	93.68	97.20	43.68	19.47	38.00	40.88	16.67	35.20
48 x 100	81.37	87.72	58.31	52.42	60.97	46.03	40.13	48.69
100 x 200	85.74	91.78	69.53	55.71	74.60	61.31	47.49	66.37
200 x 325	86.07	94.16	70.21	59.72	83.96	64.38	53.89	78.13
- 325	99.12	99.61	1.48	27.72	64.48	1.08	27.32	64.08
Cum.	91.89	95.46	22.27	35.30	60.49	17.73	30.77	55.96

Test No. 904

Size	Yield	Comb. Recovery	Ash Rejection	T. Sulfur Rejection	Pyritic S Rejection	Ash Separation Efficiency	T. Sulfur Separation Efficiency	Pyritic S Separation Efficiency
(mesh)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
+ 48	88.96	94.23	53.86	21.98	41.84	48.09	16.22	36.07
48 x 100	79.43	88.26	70.42	50.71	65.40	58.68	38.97	53.65
100 x 200	88.99	93.80	55.60	47.28	67.47	49.40	41.08	61.27
200 x 325	69.92	78.74	78.79	67.85	86.43	57.53	46.59	65.17
- 325	89.96	94.33	15.16	48.53	66.64	9.49	42.86	60.97
Cum.	85.79	91.70	38.95	41.16	61.73	30.66	32.86	53.43

Test No. 905

Size	Yield	Comb. Recovery	Ash Rejection	T. Sulfur Rejection	Pyritic S Rejection	Ash Separation Efficiency	T. Sulfur Separation Efficiency	Pyritic S Separation Efficiency
(mesh)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
+ 48	93.06	95.89	47.48	16.36	25.55	43.36	12.24	21.44
48 x 100	89.04	93.20	49.30	37.41	27.81	42.51	30.61	21.01
100 x 200	94.71	97.35	32.75	27.90	50.58	30.10	25.26	47.94
200 x 325	83.64	90.73	63.35	60.75	79.78	54.08	51.48	70.51
- 325	95.45	97.63	7.05	28.82	55.37	4.68	26.45	53.00
Cum.	92.35	95.35	21.03	30.47	45.96	16.38	25.82	41.32

Near-Term Tests - Pittsburgh #8 Raw

MGS Ash Rejection by Size

Near-Term Tests - Pittsburgh #8 Raw

MGS Total Sulfur Rejection by Size

Near-Term Tests - Pittsburgh #8 Raw

MGS Pyritic Sulfur Rejection by Size

APPENDIX 8-B

Near-Term Test Data and Performance Calculations

Illinois No. 6 Seam Coal

Microcel/MGS Near-Term Testing - Illinois #6

Microcel

Feed Rate (lbs/ton):	500
Wash Water (lpm):	38.99
Percent Solids (w/w):	12.22
Grind Size (d80 (microns)):	600
Air Flow Rate (SCFM):	8.88
Diesel dosage (lbs/ton):	1.50
Frother Dosage (ml/min):	1.60

MGS

Feed Rate (lbs/hr):	200
Drum Speed (rpm):	280
Wash water (lpm):	0.49
Percent Solids (w/w):	15
Shake Amplitude (mm):	15
Shake Frequency (cps):	5
Tilt Angle (degrees):	6

Combined Microcel/MGS Tests Results - Illinois #6

Near-Term Tests - Ash

Test No.	Microcel						MGS					
	Measured Microcel Feed Ash %	Adjusted Microcel Feed Ash %	Measured Microcel Product Ash %	Adjusted Microcel Product Ash %	Measured Microcel Reject Ash %	Adjusted Microcel Reject Ash %	Measured MGS Feed Ash %	Adjusted MGS Feed Ash %	Measured MGS Lights Ash %	Adjusted MGS Lights Ash %	Measured MGS Heavies Ash %	Adjusted MGS Heavies Ash %
803	26.33	26.39	6.36	6.54	50.01	49.92	6.63	6.54	6.60	6.50	40.46	40.46

Test No.	Yields					
	Measured Microcel Ash Yield %	Adjusted Microcel Ash Yield %	Measured MGS Ash Yield %	Adjusted MGS Ash Yield %	Measured Combined Ash Yield %	Adjusted Combined Ash Yield %
803	54.25	54.24	99.91	99.88	54.20	54.18

Near-Term Tests - T. Sulfur

Test No.	Microcel						MGS					
	Measured Microcel Feed T. Sulfur %	Adjusted Microcel Feed T. Sulfur %	Measured Microcel Product T. Sulfur %	Adjusted Microcel Product T. Sulfur %	Measured Microcel Reject T. Sulfur %	Adjusted Microcel Reject T. Sulfur %	Measured MGS Feed T. Sulfur %	Adjusted MGS Feed T. Sulfur %	Measured MGS Lights T. Sulfur %	Adjusted MGS Lights T. Sulfur %	Measured MGS Heavies T. Sulfur %	Adjusted MGS Heavies T. Sulfur %
803	1.70	1.70	1.65	1.65	1.75	1.75	1.66	1.65	1.61	1.62	31.00	31.00

Near-Term Tests - Pyritic Sulfur

Test No.	Microcel						MGS					
	Measured Microcel Feed Pyritic S %	Adjusted Microcel Feed Pyritic S %	Measured Microcel Product Pyritic S %	Adjusted Microcel Product Pyritic S %	Measured Microcel Reject Pyritic S %	Adjusted Microcel Reject Pyritic S %	Measured MGS Feed Pyritic S %	Adjusted MGS Feed Pyritic S %	Measured MGS Lights Pyritic S %	Adjusted MGS Lights Pyritic S %	Measured MGS Heavies Pyritic S %	Adjusted MGS Heavies Pyritic S %
803	0.90	0.91	0.75	0.76	1.10	1.09	0.77	0.76	0.72	0.72	26.86	26.87

Combined Microcel/MGS Tests Results - Illinois #6

Near-Term Tests - Ash Performance

Test No.	<i>Microcel</i>			<i>MGS</i>			<i>Combined Microcel/MGS</i>		
	Comb. Recovery	Ash Rejection	Ash Separation Efficiency	Comb. Recovery	Ash Rejection	Ash Separation Efficiency	Comb. Recovery	Ash Rejection	Ash Separation Efficiency
	%	%	%	%	%	%	%	%	%
803	68.87	86.56	55.43	99.92	0.73	0.65	68.82	86.66	55.47

Near-Term Tests - Total Sulfur Performance

Test No.	<i>Microcel</i>			<i>MGS</i>			<i>Combined Microcel/MGS</i>		
	Comb. Recovery	T. Sulfur Rejection	T. Sulfur Separation Efficiency	Comb. Recovery	T. Sulfur Rejection	T. Sulfur Separation Efficiency	Comb. Recovery	T. Sulfur Rejection	T. Sulfur Separation Efficiency
	%	%	%	%	%	%	%	%	%
803	68.87	47.35	16.22	99.92	1.93	1.86	68.82	48.37	17.19

Near-Term Tests - Pyritic Sulfur Performance

Test No.	<i>Microcel</i>			<i>MGS</i>			<i>Combined Microcel/MGS</i>		
	Comb. Recovery	Pyritic S Rejection	Pyritic S Separation Efficiency	Comb. Recovery	Pyritic S Rejection	Pyritic S Separation Efficiency	Comb. Recovery	Pyritic S Rejection	Pyritic S Separation Efficiency
	%	%	%	%	%	%	%	%	%
803	68.87	54.70	23.57	99.92	5.37	5.30	68.82	57.13	25.95

APPENDIX 9

Economic Evaluation

APPENDIX 9-A

Economic Evaluation

Pittsburgh #8 Seam Case

Pittsburgh No. 8 Seam - Microcel Only

OPERATING DATA:

Circuit Feed Rate (tph):	75	Shifts/Day:	2
Circuit Availability (%):	90	Hours/Shift:	8
Operating Time (hr/yr):	3600	Days/Year:	250

Product Stream	Mass Yield (%)	Ash Assay (%)	Comb. Assay (%)	Sulfur Assay (%)	Pyritic Assay (%)	Energy Assay (Btu/lb)
Clean Coal	79.43	6.98	93.02	2.34	1.01	14102
Reject	20.57	69.20	30.80	3.01	2.20	3600
Feed	100.00	19.78	80.22	2.48	1.25	11941

Product Stream	Mass Distribution (%)	Ash Distribution (%)	Comb Distribution (%)	Sulfur Distribution (%)	Pyritic Distribution (%)	Energy Distribution (%)
Clean Coal	79.43	28.03	92.10	75.01	63.93	93.80
Reject	20.57	71.97	7.90	24.99	36.07	6.20
Feed	100.00	100.00	100.00	100.00	100.00	100.00

Product Stream	Production Rate (tph)	Ash Rate (tph)	Comb. Rate (tph)	Sulfur Rate (tph)	Pyritic Rate (tph)	Energy Rate (MM Btu/hr)
Clean Coal	59.57	4.16	55.41	1.39	0.60	1680.12
Reject	15.43	10.68	4.75	0.46	0.34	111.08
Feed	75.00	14.84	60.17	1.86	0.94	1791.20

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Comb. Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	214455.16	14968.97	199486.19	5018.25	2166.00	6048427
Reject	55544.84	38437.03	17107.81	1671.90	1221.99	399893
Feed	270000.00	53406.00	216594.00	6690.15	3387.98	6448320

Product Stream	SO ₂ Rate (tph)	SO ₂ Rate (tpy)	lb Ash per MM Btu	lb Sulfur per MM Btu	lb Pyritic per MM Btu	lb SO ₂ per MM Btu
Clean Coal	2.79	10036.50	4.95	1.66	0.72	3.32
Reject	0.93	3343.80	192.24	8.36	6.11	16.72
Feed	3.72	13380.30	16.56	2.08	1.05	4.15

ESTIMATION FACTORS:

Installation Cost Factor:	1	Overhead Rate (%):	20
Maintenance Cost Factor:	0.1	Engineering/Permitting (%)	10
Power Fee (\$/KW-hr):	0.05		

EQUIPMENT:

Equipment Description	Number of Units	Unit Equipment Cost (\$)	Equipment Cost (\$)	Unit Power (HP)	Connected Power (HP)	Load Factor (%)	Power Requirement (KW)
Microcel	4	\$110,000	\$440,000	60	240	80	143.232
Compressor	1	\$90,000	\$90,000	150	150	80	89.52
Centrifuge	2	\$175,000	\$350,000	250	500	80	298.4
Feed Sump	1	\$10,000	\$10,000	0	0	0	0
Feed Pump	1	\$12,000	\$12,000	40	40	80	23.872
Product Sump	1	\$10,000	\$10,000	0	0	0	0
Product Pump	1	\$10,500	\$10,500	30	30	80	17.904
Frother Pump	4	\$1,000	\$4,000	0.1	0.4	15	0.04476
Collector Pump	1	\$1,000	\$1,000	0.1	0.1	15	0.01119
Heat/Light	1	\$10,000	\$10,000	60	60	15	6.714
Total Equipment Cost (\$)			\$937,500	Total	1020.5	Total	579.69795
Installation Cost (\$)			\$937,500	Power Cost (\$/yr)			\$104,346
Overhead Cost (\$)			\$187,500				
Engineering/Permitting Cost (\$)			\$93,750				
Maintenance Cost (\$/yr)			\$93,750				

CONSUMABLES:

Item Description	Unit Cost (\$/lb)	Dosage (lb/t feed)	Dosage (lb/t conc)	Unit Cost (\$/t feed)	Unit Cost (\$/t conc)	Annual Cost (\$)
M150 Frother	\$0.86	1.00	1.26	\$0.86	\$1.08	\$232,200
Fuel Oil (#2)	\$0.11	1.00	1.26	\$0.11	\$0.14	\$29,700
Lubricants	\$0.10	0.10	0.13	\$0.01	\$0.01	\$2,700
Clarification	\$0.90			\$0.05		\$13,500
Subtotal	**	2.10	2.64	\$1.03	\$1.23	\$278,100

PERSONNEL:

Position Description	Salary (\$/yr)	Benefits (%)	Benefits (\$/yr)	Utilization Factor	Number Staffed	Annual Cost (\$)
Operator	\$35,000	50	\$17,500	0.25	1	\$26,250
Mech/Elec	\$45,000	50	\$22,500	0.05	1	\$6,750
Total (\$/yr)						\$33,000

FIXED COSTS:

Equipment Cost (\$):	\$937,500
Installed Cost (\$):	\$937,500
Overhead (\$):	\$187,500
Engineering Cost (\$):	\$93,750
Total Fixed Cost (\$):	\$2,156,250

O&M COSTS:

Maintenance Cost (\$/yr):	\$93,750
Power Cost (\$/yr):	\$104,346
Consumables Cost (\$/yr):	\$278,100
Personnel Cost (\$/yr):	\$33,000
Total O&M Cost (\$/yr):	\$509,196

LOAN INFORMATION:

Debt Carried (%):	0
Debt Carried (\$):	\$0
Loan Duration (yrs):	20
Interest Rate (%):	10

COSTING FACTORS:

Circuit Life (yrs):	20
Inflation Rate (%):	4

Year	Loan Cost (\$)	Principal Cost (\$)	Interest Cost (\$)	Principal/Loan Ratio (%)	O&M Cost (\$)	Total Cost (\$)
0	\$2,156,250	\$0	\$0	0.00	\$0	\$2,156,250
1	\$0	\$0	\$0	N/A	\$509,196	\$509,196
2	\$0	\$0	\$0	N/A	\$529,563	\$529,563
3	\$0	\$0	\$0	N/A	\$550,746	\$550,746
4	\$0	\$0	\$0	N/A	\$572,776	\$572,776
5	\$0	\$0	\$0	N/A	\$595,687	\$595,687
6	\$0	\$0	\$0	N/A	\$619,514	\$619,514
7	\$0	\$0	\$0	N/A	\$644,295	\$644,295
8	\$0	\$0	\$0	N/A	\$670,067	\$670,067
9	\$0	\$0	\$0	N/A	\$696,869	\$696,869
10	\$0	\$0	\$0	N/A	\$724,744	\$724,744
11	\$0	\$0	\$0	N/A	\$753,734	\$753,734
12	\$0	\$0	\$0	N/A	\$783,883	\$783,883
13	\$0	\$0	\$0	N/A	\$815,239	\$815,239
14	\$0	\$0	\$0	N/A	\$847,848	\$847,848
15	\$0	\$0	\$0	N/A	\$881,762	\$881,762
16	\$0	\$0	\$0	N/A	\$917,033	\$917,033
17	\$0	\$0	\$0	N/A	\$953,714	\$953,714
18	\$0	\$0	\$0	N/A	\$991,862	\$991,862
19	\$0	\$0	\$0	N/A	\$1,031,537	\$1,031,537
20	\$0	\$0	\$0	N/A	\$1,072,798	\$1,072,798
Total	\$2,156,250	\$0	\$0	0.00	\$15,162,868	\$17,319,118

PERFORMANCE SUMMARY:

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	SO2 Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	214455.16	14968.97	5018.25	2166.00	10036.50	6048427
Reject	55544.84	38437.03	1671.90	1221.99	3343.80	399893
Feed	270000.00	53406.00	6690.15	3387.98	13380.30	6448320

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Clean Coal	4289103	299379	100365	43320	200730	120968543
Reject	1110897	768741	33438	24440	66876	7997862
Feed	5400000	1068120	133803	67760	267606	128966405

Product Stream	Coal Production Cost (\$/t)	Ash Removal Cost (\$/t)	Sulfur Removal Cost (\$/t)	Pyritic Removal Cost (\$/t)	SO2 Removal Cost (\$/t)	Energy Production Cost (\$/MM Btu)
Coal	\$4.04	\$57.85	\$172.56	\$399.80	\$86.28	\$0.143
Reject	\$15.59	\$22.53	\$517.95	\$708.65	\$258.97	\$2.165
Feed	\$3.21	\$16.21	\$129.44	\$255.60	\$64.72	\$0.134

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Removal	1110897	768741	33438	24440	66876	7997862

Product Stream	Total Production (\$/t)	Total Ash (\$/t)	Total Sulfur (\$/t)	Total Pyritic (\$/t)	Total SO2 (\$/t)	Total Energy (\$/MM Btu)
Removal Cost	\$15.59	\$22.53	\$517.95	\$708.65	\$258.97	\$2.17

MARKET DATA:

Heat Value (\$/MM Btu):	\$1.30
Shipping Cost (\$/t):	\$10.00
Mining Cost (\$/t):	\$0.00

DERATING FACTORS:

Coal Moisture (%):	15
Loss (Btu/lb H ₂ O):	1114
Loss (MMBtu/t H ₂ O):	2.228

	Solids	Water	Net
Production Rate (tph)	59.57	10.51	70.08
Production Rate (tpy)	214455.16	37845.03	252300.19
Production (tons)	4289103.18	756900.56	5046003.74
Energy Rate (MM Btu/hr)	1680.12	-23.42	1656.70
Energy Rate (MM Btu/yr)	6048427	-84319	5964108
Energy (MM Btu)	120968543	-1686374	119282169
Shipping Cost (\$/hr)	\$595.71	\$105.13	\$700.83
Shipping Cost (\$/yr)	\$2,144,552	\$378,450	\$2,523,002
Energy Value (\$/hr)	\$2,184	(\$30)	\$2,154
Energy Value (\$/yr)	\$7,862,955	(\$109,614)	\$7,753,341
Energy Content (MM Btu/t)	28.20	-2.23	23.64
Energy Value (\$/t)	\$36.66	(\$2.90)	\$30.73
Production Cost (\$/MM Btu)	\$0.143	(\$10.270)	\$0.145

	Clean Coal Basis	Feed Coal Basis
Net Energy Value (\$/t)	\$30.73	\$24.41
Market Ash Adjustment (\$/t)	\$2.00	\$1.59
Market Sulfur Adjustment (\$/t)	(\$5.00)	(\$3.97)
Mining/Coal Cost (\$/t)	\$0.00	\$0.00
Net Coal Value (\$/t)	\$27.73	\$22.03
Net Coal Value (\$/hr)	\$1,943	\$1,544
Net Coal Value (\$/yr)	\$6,996,440	\$5,557,121

TAX INFORMATION:

Depr. Period (yrs): 20
Income Tax (%): 38

ROYALTIES/FEES:

Royalty (%): 6.50
Severance (%): 4.50
Black Lung (%): 1.00
Reclamation (%): 1.20
Totals (%): 13.20

Year	Gross Revenue (\$)	O&M Cost (\$)	Interest Deduction (\$)	Depreciation Deduction (\$)	Shipping Cost (\$)	Net Taxable Income (\$)	Income Tax (\$)	Royalties/ Fees (\$)
0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
1	\$6,996,440	\$509,196	\$0	\$107,813	\$2,523,002	\$3,856,430	\$1,465,444	\$923,530
2	\$7,276,298	\$529,563	\$0	\$107,813	\$2,623,922	\$4,015,000	\$1,525,700	\$960,471
3	\$7,567,350	\$550,746	\$0	\$107,813	\$2,728,879	\$4,179,913	\$1,588,367	\$998,890
4	\$7,870,044	\$572,776	\$0	\$107,813	\$2,838,034	\$4,351,422	\$1,653,540	\$1,038,846
5	\$8,184,846	\$595,687	\$0	\$107,813	\$2,951,555	\$4,529,791	\$1,721,321	\$1,080,400
6	\$8,512,240	\$619,514	\$0	\$107,813	\$3,069,618	\$4,715,295	\$1,791,812	\$1,123,616
7	\$8,852,729	\$644,295	\$0	\$107,813	\$3,192,402	\$4,908,219	\$1,865,123	\$1,168,560
8	\$9,206,838	\$670,067	\$0	\$107,813	\$3,320,098	\$5,108,861	\$1,941,367	\$1,215,303
9	\$9,575,112	\$696,869	\$0	\$107,813	\$3,452,902	\$5,317,528	\$2,020,661	\$1,263,915
10	\$9,958,116	\$724,744	\$0	\$107,813	\$3,591,018	\$5,534,541	\$2,103,126	\$1,314,471
11	\$10,356,441	\$753,734	\$0	\$107,813	\$3,734,659	\$5,760,235	\$2,188,889	\$1,367,050
12	\$10,770,699	\$783,883	\$0	\$107,813	\$3,884,045	\$5,994,957	\$2,278,084	\$1,421,732
13	\$11,201,527	\$815,239	\$0	\$107,813	\$4,039,407	\$6,239,068	\$2,370,846	\$1,478,602
14	\$11,649,588	\$847,848	\$0	\$107,813	\$4,200,984	\$6,492,943	\$2,467,318	\$1,537,746
15	\$12,115,571	\$881,762	\$0	\$107,813	\$4,369,023	\$6,756,974	\$2,567,650	\$1,599,255
16	\$12,600,194	\$917,033	\$0	\$107,813	\$4,543,784	\$7,031,565	\$2,671,995	\$1,663,226
17	\$13,104,202	\$953,714	\$0	\$107,813	\$4,725,535	\$7,317,140	\$2,780,513	\$1,729,755
18	\$13,628,370	\$991,862	\$0	\$107,813	\$4,914,557	\$7,614,138	\$2,893,373	\$1,798,945
19	\$14,173,505	\$1,031,537	\$0	\$107,813	\$5,111,139	\$7,923,016	\$3,010,746	\$1,870,903
20	\$14,740,445	\$1,072,798	\$0	\$107,813	\$5,315,584	\$8,244,249	\$3,132,815	\$1,945,739
Total	\$208,340,553	\$15,162,868	\$0	\$2,156,250	\$75,130,148	\$115,891,287	\$44,038,689	\$27,500,953

FINANCIAL DATA:

Discount Rate (%)

10

Year	Gross Revenue (\$)	O&M Cost (\$)	Shipping Cost (\$)	Loan Cost (\$)	Income Tax (\$)	Royalties/Fees (\$)	Net Income (\$)
0	\$0	\$0	\$0	\$2,156,250	\$0	\$0	(\$2,156,250)
1	\$6,996,440	\$509,196	\$2,523,002	\$0	\$1,465,444	\$923,530	\$1,575,269
2	\$7,276,298	\$529,563	\$2,623,922	\$0	\$1,525,700	\$960,471	\$1,636,641
3	\$7,567,350	\$550,746	\$2,728,879	\$0	\$1,588,367	\$998,890	\$1,700,468
4	\$7,870,044	\$572,776	\$2,838,034	\$0	\$1,653,540	\$1,038,846	\$1,766,848
5	\$8,184,846	\$595,687	\$2,951,555	\$0	\$1,721,321	\$1,080,400	\$1,835,883
6	\$8,512,240	\$619,514	\$3,069,618	\$0	\$1,791,812	\$1,123,616	\$1,907,680
7	\$8,852,729	\$644,295	\$3,192,402	\$0	\$1,865,123	\$1,168,560	\$1,982,348
8	\$9,206,838	\$670,067	\$3,320,098	\$0	\$1,941,367	\$1,215,303	\$2,060,004
9	\$9,575,112	\$696,869	\$3,452,902	\$0	\$2,020,661	\$1,263,915	\$2,140,765
10	\$9,958,116	\$724,744	\$3,591,018	\$0	\$2,103,126	\$1,314,471	\$2,224,757
11	\$10,356,441	\$753,734	\$3,734,659	\$0	\$2,188,889	\$1,367,050	\$2,312,108
12	\$10,770,699	\$783,883	\$3,884,045	\$0	\$2,278,084	\$1,421,732	\$2,402,954
13	\$11,201,527	\$815,239	\$4,039,407	\$0	\$2,370,846	\$1,478,602	\$2,497,433
14	\$11,649,588	\$847,848	\$4,200,984	\$0	\$2,467,318	\$1,537,746	\$2,595,692
15	\$12,115,571	\$881,762	\$4,369,023	\$0	\$2,567,650	\$1,599,255	\$2,697,881
16	\$12,600,194	\$917,033	\$4,543,784	\$0	\$2,671,995	\$1,663,226	\$2,804,157
17	\$13,104,202	\$953,714	\$4,725,535	\$0	\$2,780,513	\$1,729,755	\$2,914,685
18	\$13,628,370	\$991,862	\$4,914,557	\$0	\$2,893,373	\$1,798,945	\$3,029,633
19	\$14,173,505	\$1,031,537	\$5,111,139	\$0	\$3,010,746	\$1,870,903	\$3,149,180
20	\$14,740,445	\$1,072,798	\$5,315,584	\$0	\$3,132,815	\$1,945,739	\$3,273,508
Total	\$208,340,553	\$15,162,868	\$75,130,148	\$2,156,250	\$44,038,689	\$27,500,953	\$44,351,645

FINANCIAL SUMMARY:

Total Net Income (\$):	\$208,340,553
Total Net Payout (\$):	\$163,988,908
Total Net Profit (\$):	\$44,351,645
Internal Rate of Return:	76.96%
Net Present Value:	\$15,435,610
Payback Period (yrs):	1.37

Pittsburgh No. 8 Seam - MGS Only

OPERATING DATA:

Circuit Feed Rate (tph):	75	Shifts/Day:	2
Circuit Availability (%):	90	Hours/Shift:	8
Operating Time (hr/yr):	3600	Days/Year:	250

Product Stream	Mass Yield (%)	Ash Assay (%)	Comb. Assay (%)	Sulfur Assay (%)	Pyritic Assay (%)	Energy Assay (Btu/lb)
Clean Coal	84.31	14.10	85.90	1.89	0.30	12900
Reject	15.69	66.03	33.97	11.39	6.26	4135
Feed	100.00	22.25	77.75	3.38	1.24	11524

Product Stream	Mass Distribution (%)	Ash Distribution (%)	Comb Distribution (%)	Sulfur Distribution (%)	Pyritic Distribution (%)	Energy Distribution (%)
Clean Coal	84.31	53.43	93.14	47.13	20.47	94.37
Reject	15.69	46.57	6.86	52.87	79.53	5.63
Feed	100.00	100.00	100.00	100.00	100.00	100.00

Product Stream	Production Rate (tph)	Ash Rate (tph)	Comb. Rate (tph)	Sulfur Rate (tph)	Pyritic Rate (tph)	Energy Rate (MM Btu/hr)
Clean Coal	63.23	8.92	54.31	1.20	0.19	1631.32
Reject	11.77	7.77	4.00	1.34	0.74	97.34
Feed	75.00	16.69	58.31	2.54	0.93	1728.66

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Comb. Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	227625.65	32095.22	195530.43	4302.12	682.88	5872770
Reject	42374.35	27979.78	14394.57	4826.44	2652.63	350419
Feed	270000.00	60075.00	209925.00	9128.56	3335.51	6223188

Product Stream	SO2 Rate (tph)	SO2 Rate (tpy)	lb Ash per MM Btu	lb Sulfur per MM Btu	lb Pyritic per MM Btu	lb SO2 per MM Btu
Clean Coal	2.39	8604.25	10.93	1.47	0.23	2.93
Reject	2.68	9652.88	159.69	27.55	15.14	55.09
Feed	5.07	18257.13	19.31	2.93	1.07	5.87

ESTIMATION FACTORS:

Installation Cost Factor: 1
 Maintenance Cost Factor: 0.1
 Power Fee (\$/KW-hr): 0.05

Overhead Rate (%): 20
 Engineering/Permitting (%) 10

EQUIPMENT:

Equipment Description	Number of Units	Unit Equipment Cost (\$)	Equipment Cost (\$)	Unit Power (HP)	Connected Power (HP)	Load Factor (%)	Power Requirement (KW)
MGS	4	\$110,000	\$440,000	60	240	80	143.232
Centrifuge	2	\$175,000	\$350,000	250	500	80	298.4
Feed Sump	1	\$10,000	\$10,000	0	0	0	0
Feed Pump	1	\$12,000	\$12,000	40	40	80	23.872
Product Sump	1	\$10,000	\$10,000	0	0	0	0
Product Pump	1	\$10,500	\$10,500	30	30	80	17.904
Heat/Light	1	\$10,000	\$10,000	60	60	15	6.714
Total Equipment Cost (\$)			\$842,500	Total	870	Total	490.122
Installation Cost (\$)			\$842,500	Power Cost (\$/yr)			
Overhead Cost (\$)			\$168,500				
Engineering/Permitting Cost (\$)			\$84,250				
Maintenance Cost (\$/yr)			\$84,250				

CONSUMABLES:

Item Description	Unit Cost (\$/lb)	Dosage (lb/t feed)	Dosage (lb/t conc)	Unit Cost (\$/t feed)	Unit Cost (\$/t conc)	Annual Cost (\$)
Lubricants	\$0.10	0.10	0.12	\$0.01	\$0.01	\$2,700
Clarification	\$0.90			\$0.05		\$13,500
Subtotal	**	0.10	0.12	\$0.06	\$0.01	\$16,200

PERSONNEL:

Position Description	Salary (\$/yr)	Benefits (%)	Benefits (\$/yr)	Utilization Factor	Number Shifts	Annual Cost (\$)
Operator	\$35,000	50	\$17,500	0.25	2	\$26,250
Mech/Elec	\$45,000	50	\$22,500	0.05	2	\$6,750
Total (\$/yr)						\$33,000

FIXED COSTS:

Equipment Cost (\$):	\$842,500
Installed Cost (\$):	\$842,500
Overhead (\$):	\$168,500
Engineering Cost (\$):	\$84,250
Total Fixed Cost (\$):	\$1,937,750

O&M COSTS:

Maintenance Cost (\$/yr):	\$84,250
Power Cost (\$/yr):	\$88,222
Consumables Cost (\$/yr):	\$16,200
Personnel Cost (\$/yr):	\$33,000
Total O&M Cost (\$/yr):	\$221,672

LOAN INFORMATION:

Debt Carried (%):	0
Debt Carried (\$):	\$0
Loan Duration (yrs):	20
Interest Rate (%):	10

COSTING FACTORS:

Circuit Life (yrs):	20
Inflation Rate (%):	4

Year	Loan Cost (\$)	Principal Cost (\$)	Interest Cost (\$)	Principal/Loan Ratio (%)	O&M Cost (\$)	Total Cost (\$)
0	\$1,937,750	\$0	\$0	0.00	\$0	\$1,937,750
1	\$0	\$0	\$0	N/A	\$221,672	\$221,672
2	\$0	\$0	\$0	N/A	\$230,539	\$230,539
3	\$0	\$0	\$0	N/A	\$239,760	\$239,760
4	\$0	\$0	\$0	N/A	\$249,351	\$249,351
5	\$0	\$0	\$0	N/A	\$259,325	\$259,325
6	\$0	\$0	\$0	N/A	\$269,698	\$269,698
7	\$0	\$0	\$0	N/A	\$280,486	\$280,486
8	\$0	\$0	\$0	N/A	\$291,705	\$291,705
9	\$0	\$0	\$0	N/A	\$303,373	\$303,373
10	\$0	\$0	\$0	N/A	\$315,508	\$315,508
11	\$0	\$0	\$0	N/A	\$328,129	\$328,129
12	\$0	\$0	\$0	N/A	\$341,254	\$341,254
13	\$0	\$0	\$0	N/A	\$354,904	\$354,904
14	\$0	\$0	\$0	N/A	\$369,100	\$369,100
15	\$0	\$0	\$0	N/A	\$383,864	\$383,864
16	\$0	\$0	\$0	N/A	\$399,219	\$399,219
17	\$0	\$0	\$0	N/A	\$415,187	\$415,187
18	\$0	\$0	\$0	N/A	\$431,795	\$431,795
19	\$0	\$0	\$0	N/A	\$449,067	\$449,067
20	\$0	\$0	\$0	N/A	\$467,029	\$467,029
Total	\$1,937,750	\$0	\$0	0.00	\$6,600,965	\$8,538,715

PERFORMANCE SUMMARY:

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	SO2 Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	227625.65	32095.22	4302.12	682.88	8604.25	5872770
Reject	42374.35	27979.78	4826.44	2652.63	9652.88	350419
Feed	270000.00	60075.00	9128.56	3335.51	18257.13	6223188

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Clean Coal	4552513	641904	86042	13658	172085	117455391
Reject	847487	559596	96529	53053	193058	7008372
Feed	5400000	1201500	182571	66710	365143	124463763

Product Stream	Coal Production Cost (\$/t)	Ash Removal Cost (\$/t)	Sulfur Removal Cost (\$/t)	Pyritic Removal Cost (\$/t)	SO2 Removal Cost (\$/t)	Energy Production Cost (\$/MM Btu)
Coal	\$1.88	\$13.30	\$99.24	\$625.20	\$49.62	\$0.073
Reject	\$10.08	\$15.26	\$88.46	\$160.95	\$44.23	\$1.218
Feed	\$1.58	\$7.11	\$46.77	\$128.00	\$23.38	\$0.069

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Removal	847487	559596	96529	53053	193058	7008372

Product Stream	Total Production (\$/t)	Total Ash (\$/t)	Total Sulfur (\$/t)	Total Pyritic (\$/t)	Total SO2 (\$/t)	Total Energy (\$/MM Btu)
Removal Cost	\$10.08	\$15.26	\$88.46	\$160.95	\$44.23	\$1.22

MARKET DATA:

Heat Value (\$/MM Btu):	\$1.30
Shipping Cost (\$/t):	\$10.00
Mining Cost (\$/t):	\$0.00

DERATING FACTORS:

Coal Moisture (%):	15
Loss (Btu/lb H ₂ O):	1114
Loss (MMBtu/t H ₂ O):	2.228

	Solids	Water	Net
Production Rate (tph)	63.23	11.16	74.39
Production Rate (tpy)	227625.65	40169.23	267794.88
Production (tons)	4552513.00	803384.65	5355897.65
Energy Rate (MM Btu/hr)	1631.32	-24.86	1606.46
Energy Rate (MM Btu/yr)	5872770	-89497	5783272
Energy (MM Btu)	117455391	-1789941	115665450
Shipping Cost (\$/hr)	\$632.29	\$111.58	\$743.87
Shipping Cost (\$/yr)	\$2,276,256	\$401,692	\$2,677,949
Energy Value (\$/hr)	\$2,121	(\$32)	\$2,088
Energy Value (\$/yr)	\$7,634,600	(\$116,346)	\$7,518,254
Energy Content (MM Btu/t)	25.80	-2.23	21.60
Energy Value (\$/t)	\$33.54	(\$2.90)	\$28.07
Production Cost (\$/MM Btu)	\$0.073	(\$4.770)	\$0.074

	Clean Coal Basis	Feed Coal Basis
Net Energy Value (\$/t)	\$28.07	\$23.67
Market Ash Adjustment (\$/t)	(\$2.00)	(\$1.69)
Market Sulfur Adjustment (\$/t)	(\$5.00)	(\$4.22)
Mining/Coal Cost (\$/t)	\$0.00	\$0.00
Net Coal Value (\$/t)	\$21.07	\$17.77
Net Coal Value (\$/hr)	\$1,568	\$1,322
Net Coal Value (\$/yr)	\$5,643,690	\$4,757,958

TAX INFORMATION:

Depr. Period (yrs): 20
Income Tax (%): 38

ROYALTIES/FEES:

Royalty (%): 6.50
Severance (%): 4.50
Black Lung (%): 1.00
Reclamation (%): 1.20
Totals (%): 13.20

Year	Gross Revenue (\$)	O&M Cost (\$)	Interest Deduction (\$)	Depreciation Deduction (\$)	Shipping Cost (\$)	Net Taxable Income (\$)	Income Tax (\$)	Royalties/ Fees (\$)
0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
1	\$5,643,690	\$221,672	\$0	\$96,888	\$2,677,949	\$2,647,182	\$1,005,929	\$744,967
2	\$5,869,438	\$230,539	\$0	\$96,888	\$2,785,067	\$2,756,945	\$1,047,639	\$774,766
3	\$6,104,215	\$239,760	\$0	\$96,888	\$2,896,469	\$2,871,098	\$1,091,017	\$805,756
4	\$6,348,384	\$249,351	\$0	\$96,888	\$3,012,328	\$2,989,817	\$1,136,131	\$837,987
5	\$6,602,319	\$259,325	\$0	\$96,888	\$3,132,821	\$3,113,285	\$1,183,048	\$871,506
6	\$6,866,412	\$269,698	\$0	\$96,888	\$3,258,134	\$3,241,692	\$1,231,843	\$906,366
7	\$7,141,068	\$280,486	\$0	\$96,888	\$3,388,460	\$3,375,236	\$1,282,590	\$942,621
8	\$7,426,711	\$291,705	\$0	\$96,888	\$3,523,998	\$3,514,120	\$1,335,366	\$980,326
9	\$7,723,780	\$303,373	\$0	\$96,888	\$3,664,958	\$3,658,561	\$1,390,253	\$1,019,539
10	\$8,032,731	\$315,508	\$0	\$96,888	\$3,811,556	\$3,808,779	\$1,447,336	\$1,060,320
11	\$8,354,040	\$328,129	\$0	\$96,888	\$3,964,018	\$3,965,005	\$1,506,702	\$1,102,733
12	\$8,688,202	\$341,254	\$0	\$96,888	\$4,122,579	\$4,127,481	\$1,568,443	\$1,146,843
13	\$9,035,730	\$354,904	\$0	\$96,888	\$4,287,482	\$4,296,456	\$1,632,653	\$1,192,716
14	\$9,397,159	\$369,100	\$0	\$96,888	\$4,458,982	\$4,472,190	\$1,699,432	\$1,240,425
15	\$9,773,045	\$383,864	\$0	\$96,888	\$4,637,341	\$4,654,953	\$1,768,882	\$1,290,042
16	\$10,163,967	\$399,219	\$0	\$96,888	\$4,822,835	\$4,845,026	\$1,841,110	\$1,341,644
17	\$10,570,526	\$415,187	\$0	\$96,888	\$5,015,748	\$5,042,703	\$1,916,227	\$1,395,309
18	\$10,993,347	\$431,795	\$0	\$96,888	\$5,216,378	\$5,248,286	\$1,994,349	\$1,451,122
19	\$11,433,081	\$449,067	\$0	\$96,888	\$5,425,033	\$5,462,093	\$2,075,595	\$1,509,167
20	\$11,890,404	\$467,029	\$0	\$96,888	\$5,642,034	\$5,684,453	\$2,160,092	\$1,569,533
Total	\$168,058,246	\$6,600,965	\$0	\$1,937,750	\$79,744,170	\$79,775,361	\$30,314,637	\$22,183,688

FINANCIAL DATA:

Discount Rate (%)

10

Year	Gross Revenue (\$)	O&M Cost (\$)	Shipping Cost (\$)	Loan Cost (\$)	Income Tax (\$)	Royalties/ Fees (\$)	Net Income (\$)
0	\$0	\$0	\$0	\$1,937,750	\$0	\$0	(\$1,937,750)
1	\$5,643,690	\$221,672	\$2,677,949	\$0	\$1,005,929	\$744,967	\$993,173
2	\$5,869,438	\$230,539	\$2,785,067	\$0	\$1,047,639	\$774,766	\$1,031,427
3	\$6,104,215	\$239,760	\$2,896,469	\$0	\$1,091,017	\$805,756	\$1,071,212
4	\$6,348,384	\$249,351	\$3,012,328	\$0	\$1,136,131	\$837,987	\$1,112,588
5	\$6,602,319	\$259,325	\$3,132,821	\$0	\$1,183,048	\$871,506	\$1,155,618
6	\$6,866,412	\$269,698	\$3,258,134	\$0	\$1,231,843	\$906,366	\$1,200,370
7	\$7,141,068	\$280,486	\$3,388,460	\$0	\$1,282,590	\$942,621	\$1,246,913
8	\$7,426,711	\$291,705	\$3,523,998	\$0	\$1,335,366	\$980,326	\$1,295,316
9	\$7,723,780	\$303,373	\$3,664,958	\$0	\$1,390,253	\$1,019,539	\$1,345,656
10	\$8,032,731	\$315,508	\$3,811,556	\$0	\$1,447,336	\$1,060,320	\$1,398,010
11	\$8,354,040	\$328,129	\$3,964,018	\$0	\$1,506,702	\$1,102,733	\$1,452,458
12	\$8,688,202	\$341,254	\$4,122,579	\$0	\$1,568,443	\$1,146,843	\$1,509,083
13	\$9,035,730	\$354,904	\$4,287,482	\$0	\$1,632,653	\$1,192,716	\$1,567,974
14	\$9,397,159	\$369,100	\$4,458,982	\$0	\$1,699,432	\$1,240,425	\$1,629,220
15	\$9,773,045	\$383,864	\$4,637,341	\$0	\$1,768,882	\$1,290,042	\$1,692,916
16	\$10,163,967	\$399,219	\$4,822,835	\$0	\$1,841,110	\$1,341,644	\$1,759,160
17	\$10,570,526	\$415,187	\$5,015,748	\$0	\$1,916,227	\$1,395,309	\$1,828,054
18	\$10,993,347	\$431,795	\$5,216,378	\$0	\$1,994,349	\$1,451,122	\$1,899,703
19	\$11,433,081	\$449,067	\$5,425,033	\$0	\$2,075,595	\$1,509,167	\$1,974,219
20	\$11,890,404	\$467,029	\$5,642,034	\$0	\$2,160,092	\$1,569,533	\$2,051,715
Total	\$168,058,246	\$6,600,965	\$79,744,170	\$1,937,750	\$30,314,637	\$22,183,688	\$27,277,035

FINANCIAL SUMMARY:

Total Net Income (\$):	\$168,058,246
Total Net Payout (\$):	\$140,781,211
Total Net Profit (\$):	\$27,277,035
Internal Rate of Return:	55.10%
Net Present Value:	\$9,123,598
Payback Period (yrs):	1.95

Pittsburgh No. 8 Seam - Combined Microcel/MGS

OPERATING DATA:

Circuit Feed Rate (tph):	75	Shifts/Day:	2
Circuit Availability (%):	90	Hours/Shift:	8
Operating Time (hr/yr):	3600	Days/Year:	250

Product Stream	Mass Yield (%)	Ash Assay (%)	Comb. Assay (%)	Sulfur Assay (%)	Pyritic Assay (%)	Energy Assay (Btu/lb)
Clean Coal	75.41	5.54	94.46	1.66	0.41	14345
Reject	24.59	63.44	36.56	4.99	3.87	4572
Feed	100.00	19.78	80.22	2.48	1.26	11941

Product Stream	Mass Distribution (%)	Ash Distribution (%)	Comb Distribution (%)	Sulfur Distribution (%)	Pyritic Distribution (%)	Energy Distribution (%)
Clean Coal	75.41	21.12	88.79	50.49	24.52	90.58
Reject	24.59	78.88	11.21	49.51	75.48	9.42
Feed	100.00	100.00	100.00	100.00	100.00	100.00

Product Stream	Production Rate (tph)	Ash Rate (tph)	Comb. Rate (tph)	Sulfur Rate (tph)	Pyritic Rate (tph)	Energy Rate (MM Btu/hr)
Clean Coal	56.55	3.13	53.42	0.94	0.23	1622.53
Reject	18.45	11.70	6.74	0.92	0.71	168.67
Feed	75.00	14.84	60.17	1.86	0.95	1791.20

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Comb. Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	203595.85	11279.21	192316.64	3379.69	834.74	5841126
Reject	66404.15	42126.79	24277.36	3313.57	2569.84	607195
Feed	270000.00	53406.00	216594.00	6693.26	3404.58	6448320

Product Stream	SO2 Rate (tph)	SO2 Rate (tpy)	lb Ash per MM Btu	lb Sulfur per MM Btu	lb Pyritic per MM Btu	lb SO2 per MM Btu
Clean Coal	1.88	6759.38	3.86	1.16	0.29	2.31
Reject	1.84	6627.13	138.76	10.91	8.46	21.83
Feed	3.72	13386.52	16.56	2.08	1.06	4.15

ESTIMATION FACTORS:

Installation Cost Factor:	1	Overhead Rate (%):	20
Maintenance Cost Factor:	0.1	Engineering/Permitting (%):	10
Power Fee (\$/KW-hr):	0.05		

EQUIPMENT:

Equipment Description	Number of Units	Unit Equipment Cost (\$)	Equipment Cost (\$)	Unit Power (HP)	Connected Power (HP)	Load Factor (%)	Power Requirement (KW)
Microcel	4	\$110,000	\$440,000	60	240	80	143.232
MGS	4	\$120,000	\$480,000	10	40	80	23.872
Compressor	1	\$90,000	\$90,000	150	150	80	89.52
Centrifuge	2	\$175,000	\$350,000	250	500	80	298.4
Feed Sump	1	\$10,000	\$10,000	0	0	0	0
Feed Pump	1	\$12,000	\$12,000	40	40	80	23.872
Product Sump	1	\$10,000	\$10,000	0	0	0	0
Product Pump	1	\$10,500	\$10,500	30	30	80	17.904
Frother Pump	4	\$1,000	\$4,000	0.1	0.4	15	0.04476
Collector Pump	1	\$1,000	\$1,000	0.1	0.1	15	0.01119
Heat/Light	1	\$10,000	\$10,000	60	60	15	6.714
Total Equipment Cost (\$)			\$1,417,500	Total	1060.5	Total	603.56995
Installation Cost (\$)			\$1,417,500	Power Cost (\$/yr)			
Overhead Cost (\$)			\$283,500				
Engineering/Permitting Cost (\$)			\$141,750				
Maintenance Cost (\$/yr)			\$141,750				

CONSUMABLES:

Item Description	Unit Cost (\$/lb)	Dosage (lb/t feed)	Dosage (lb/t conc)	Unit Cost (\$/t feed)	Unit Cost (\$/t conc)	Annual Cost (\$)
M150 Frother	\$0.86	1.00	1.33	\$0.86	\$1.14	\$232,200
Fuel Oil (#2)	\$0.11	1.00	1.33	\$0.11	\$0.15	\$29,700
Lubricants	\$0.10	0.10	0.13	\$0.01	\$0.01	\$2,700
Clarification	\$0.90			\$0.05		\$13,500
Subtotal	**	2.10	2.78	\$1.03	\$1.30	\$278,100

PERSONNEL:

Position Description	Salary (\$/yr)	Benefits (%)	Benefits (\$/yr)	Utilization Factor	Number Shifts	Annual Cost (\$)
Operator	\$35,000	50	\$17,500	0.5	2	\$52,500
Mech/Elec	\$45,000	50	\$22,500	0.1	2	\$13,500
Total (\$/yr)						\$66,000

FIXED COSTS:

Equipment Cost (\$):	\$1,417,500
Installed Cost (\$):	\$1,417,500
Overhead (\$):	\$283,500
Engineering Cost (\$):	\$141,750
Total Fixed Cost (\$):	\$3,260,250

O&M COSTS:

Maintenance Cost (\$/yr):	\$141,750
Power Cost (\$/yr):	\$108,643
Consumables Cost (\$/yr):	\$278,100
Personnel Cost (\$/yr):	\$66,000
Total O&M Cost (\$/yr):	\$594,493

LOAN INFORMATION:

Debt Carried (%):	0
Debt Carried (\$):	\$0
Loan Duration (yrs):	20
Interest Rate (%):	10

COSTING FACTORS:

Circuit Life (yrs):	20
Inflation Rate (%):	4

Year	Loan Cost (\$)	Principal Cost (\$)	Interest Cost (\$)	Principal/Loan Ratio (%)	O&M Cost (\$)	Total Cost (\$)
0	\$3,260,250	\$0	\$0	0.00	\$0	\$3,260,250
1	\$0	\$0	\$0	N/A	\$594,493	\$594,493
2	\$0	\$0	\$0	N/A	\$618,272	\$618,272
3	\$0	\$0	\$0	N/A	\$643,003	\$643,003
4	\$0	\$0	\$0	N/A	\$668,723	\$668,723
5	\$0	\$0	\$0	N/A	\$695,472	\$695,472
6	\$0	\$0	\$0	N/A	\$723,291	\$723,291
7	\$0	\$0	\$0	N/A	\$752,223	\$752,223
8	\$0	\$0	\$0	N/A	\$782,312	\$782,312
9	\$0	\$0	\$0	N/A	\$813,604	\$813,604
10	\$0	\$0	\$0	N/A	\$846,148	\$846,148
11	\$0	\$0	\$0	N/A	\$879,994	\$879,994
12	\$0	\$0	\$0	N/A	\$915,194	\$915,194
13	\$0	\$0	\$0	N/A	\$951,802	\$951,802
14	\$0	\$0	\$0	N/A	\$989,874	\$989,874
15	\$0	\$0	\$0	N/A	\$1,029,469	\$1,029,469
16	\$0	\$0	\$0	N/A	\$1,070,648	\$1,070,648
17	\$0	\$0	\$0	N/A	\$1,113,473	\$1,113,473
18	\$0	\$0	\$0	N/A	\$1,158,012	\$1,158,012
19	\$0	\$0	\$0	N/A	\$1,204,333	\$1,204,333
20	\$0	\$0	\$0	N/A	\$1,252,506	\$1,252,506
Total	\$3,260,250	\$0	\$0	0.00	\$17,702,847	\$20,963,097

PERFORMANCE SUMMARY:

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	SO2 Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	203595.85	11279.21	3379.69	834.74	6759.38	5841126
Reject	66404.15	42126.79	3313.57	2569.84	6627.13	607195
Feed	270000.00	53406.00	6693.26	3404.58	13386.52	6448320

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Clean Coal	4071917	225584	67594	16695	135188	116822515
Reject	1328083	842536	66271	51397	132543	12143890
Feed	5400000	1068120	133865	68092	267730	128966405

Product Stream	Coal Production Cost (\$/t)	Ash Removal Cost (\$/t)	Sulfur Removal Cost (\$/t)	Pyritic Removal Cost (\$/t)	SO2 Removal Cost (\$/t)	Energy Production Cost (\$/MM Btu)
Coal	\$5.15	\$92.93	\$310.13	\$1,255.66	\$155.07	\$0.179
Reject	\$15.78	\$24.88	\$316.32	\$407.87	\$158.16	\$1.726
Feed	\$3.88	\$19.63	\$156.60	\$307.87	\$78.30	\$0.163

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Removal	1328083	842536	66271	51397	132543	12143890

Product Stream	Total Production (\$/t)	Total Ash (\$/t)	Total Sulfur (\$/t)	Total Pyritic (\$/t)	Total SO2 (\$/t)	Total Energy (\$/MM Btu)
Removal Cost	\$15.78	\$24.88	\$316.32	\$407.87	\$158.16	\$1.73

MARKET DATA:

Heat Value (\$/MM Btu):	\$1.30
Shipping Cost (\$/t):	\$10.00
Mining Cost (\$/t):	\$0.00

DERATING FACTORS:

Coal Moisture (%):	15
Loss (Btu/lb H ₂ O):	1114
Loss (MMBtu/t H ₂ O):	2.228

	Solids	Water	Net
Production Rate (tph)	56.55	9.98	66.53
Production Rate (tpy)	203595.85	35928.68	239524.54
Production (tons)	4071917.10	718573.61	4790490.70
Energy Rate (MM Btu/hr)	1622.53	-22.24	1600.30
Energy Rate (MM Btu/yr)	5841126	-80049	5761077
Energy (MM Btu)	116822515	-1600982	115221533
Shipping Cost (\$/hr)	\$565.54	\$99.80	\$665.35
Shipping Cost (\$/yr)	\$2,035,959	\$359,287	\$2,395,245
Energy Value (\$/hr)	\$2,109	(\$29)	\$2,080
Energy Value (\$/yr)	\$7,593,463	(\$104,064)	\$7,489,400
Energy Content (MM Btu/t)	28.69	-2.23	24.05
Energy Value (\$/t)	\$37.30	(\$2.90)	\$31.27
Production Cost (\$/MM Btu)	\$0.179	(\$13.094)	\$0.182

	Clean Coal Basis	Feed Coal Basis
Net Energy Value (\$/t)	\$31.27	\$23.58
Market Ash Adjustment (\$/t)	\$2.00	\$1.51
Market Sulfur Adjustment (\$/t)	(\$5.00)	(\$3.77)
Mining/Coal Cost (\$/t)	\$0.00	\$0.00
Net Coal Value (\$/t)	\$28.27	\$21.32
Net Coal Value (\$/hr)	\$1,881	\$1,418
Net Coal Value (\$/yr)	\$6,770,826	\$5,105,600

TAX INFORMATION:

Depr. Period (yrs): 20
Income Tax (%): 38

ROYALTIES/FEES:

Royalty (%): 6.50
Severance (%): 4.50
Black Lung (%): 1.00
Reclamation (%): 1.20
Totals (%): 13.20

Year	Gross Revenue (\$)	O&M Cost (\$)	Interest Deduction (\$)	Depreciation Deduction (\$)	Snipping Cost (\$)	Net Taxable Income (\$)	Income Tax (\$)	Royalties/ Fees (\$)
0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
1	\$6,770,826	\$594,493	\$0	\$163,013	\$2,395,245	\$3,618,076	\$1,374,869	\$893,749
2	\$7,041,659	\$618,272	\$0	\$163,013	\$2,491,055	\$3,769,319	\$1,432,341	\$929,499
3	\$7,323,325	\$643,003	\$0	\$163,013	\$2,590,697	\$3,926,612	\$1,492,113	\$966,679
4	\$7,616,258	\$668,723	\$0	\$163,013	\$2,694,325	\$4,090,197	\$1,554,275	\$1,005,346
5	\$7,920,909	\$695,472	\$0	\$163,013	\$2,802,098	\$4,260,326	\$1,618,924	\$1,045,560
6	\$8,237,745	\$723,291	\$0	\$163,013	\$2,914,182	\$4,437,259	\$1,686,159	\$1,087,382
7	\$8,567,255	\$752,223	\$0	\$163,013	\$3,030,749	\$4,621,270	\$1,756,083	\$1,130,878
8	\$8,909,945	\$782,312	\$0	\$163,013	\$3,151,979	\$4,812,641	\$1,828,804	\$1,176,113
9	\$9,266,343	\$813,604	\$0	\$163,013	\$3,278,059	\$5,011,668	\$1,904,434	\$1,223,157
10	\$9,636,997	\$846,148	\$0	\$163,013	\$3,409,181	\$5,218,655	\$1,983,089	\$1,272,084
11	\$10,022,477	\$879,994	\$0	\$163,013	\$3,545,548	\$5,433,922	\$2,064,890	\$1,322,967
12	\$10,423,376	\$915,194	\$0	\$163,013	\$3,687,370	\$5,657,799	\$2,149,964	\$1,375,886
13	\$10,840,311	\$951,802	\$0	\$163,013	\$3,834,865	\$5,890,631	\$2,238,440	\$1,430,921
14	\$11,273,923	\$989,874	\$0	\$163,013	\$3,988,260	\$6,132,777	\$2,330,455	\$1,488,156
15	\$11,724,880	\$1,029,469	\$0	\$163,013	\$4,147,790	\$6,384,609	\$2,426,151	\$1,547,684
16	\$12,193,875	\$1,070,648	\$0	\$163,013	\$4,313,702	\$6,646,514	\$2,525,675	\$1,609,592
17	\$12,681,630	\$1,113,473	\$0	\$163,013	\$4,486,250	\$6,918,895	\$2,629,180	\$1,673,975
18	\$13,188,895	\$1,158,012	\$0	\$163,013	\$4,665,700	\$7,202,171	\$2,736,825	\$1,740,934
19	\$13,716,451	\$1,204,333	\$0	\$163,013	\$4,852,128	\$7,496,778	\$2,848,776	\$1,810,572
20	\$14,265,109	\$1,252,506	\$0	\$163,013	\$5,046,421	\$7,803,170	\$2,965,205	\$1,882,994
Total	\$201,622,190	\$17,702,847	\$0	\$3,260,250	\$71,325,804	\$109,333,288	\$41,546,650	\$26,614,129

FINANCIAL DATA:

Discount Rate (%)

10

Year	Gross Revenue (\$)	O&M Cost (\$)	Shipping Cost (\$)	Loan Cost (\$)	Income Tax (\$)	Royalties/ Fees (\$)	Net Income (\$)
0	\$0	\$0	\$0	\$3,260,250	\$0	\$0	(\$3,260,250)
1	\$6,770,826	\$594,493	\$2,395,245	\$0	\$1,374,869	\$893,749	\$1,512,470
2	\$7,041,659	\$618,272	\$2,491,055	\$0	\$1,432,341	\$929,499	\$1,570,491
3	\$7,323,325	\$643,003	\$2,590,697	\$0	\$1,492,113	\$966,679	\$1,630,833
4	\$7,616,258	\$668,723	\$2,694,325	\$0	\$1,554,275	\$1,005,346	\$1,693,589
5	\$7,920,909	\$695,472	\$2,802,098	\$0	\$1,618,924	\$1,045,560	\$1,758,855
6	\$8,237,745	\$723,291	\$2,914,182	\$0	\$1,686,159	\$1,087,382	\$1,826,731
7	\$8,567,255	\$752,223	\$3,030,749	\$0	\$1,756,083	\$1,130,878	\$1,897,322
8	\$8,909,945	\$782,312	\$3,151,979	\$0	\$1,828,804	\$1,176,113	\$1,970,737
9	\$9,266,343	\$813,604	\$3,278,059	\$0	\$1,904,434	\$1,223,157	\$2,047,089
10	\$9,636,997	\$846,148	\$3,409,181	\$0	\$1,983,089	\$1,272,084	\$2,126,495
11	\$10,022,477	\$879,994	\$3,545,548	\$0	\$2,064,890	\$1,322,967	\$2,209,077
12	\$10,423,376	\$915,194	\$3,687,370	\$0	\$2,149,964	\$1,375,886	\$2,294,962
13	\$10,840,311	\$951,802	\$3,834,865	\$0	\$2,238,440	\$1,430,921	\$2,384,283
14	\$11,273,923	\$989,874	\$3,988,260	\$0	\$2,330,455	\$1,488,158	\$2,477,176
15	\$11,724,880	\$1,029,469	\$4,147,790	\$0	\$2,426,151	\$1,547,684	\$2,573,786
16	\$12,193,875	\$1,070,648	\$4,313,702	\$0	\$2,525,675	\$1,609,592	\$2,674,259
17	\$12,681,630	\$1,113,473	\$4,486,250	\$0	\$2,629,180	\$1,673,975	\$2,778,752
18	\$13,188,895	\$1,158,012	\$4,665,700	\$0	\$2,736,825	\$1,740,934	\$2,887,424
19	\$13,716,451	\$1,204,333	\$4,852,328	\$0	\$2,848,776	\$1,810,572	\$3,000,443
20	\$14,265,109	\$1,252,506	\$5,046,421	\$0	\$2,965,205	\$1,882,994	\$3,117,983
Total	\$201,622,190	\$17,702,847	\$71,325,804	\$3,260,250	\$41,546,650	\$26,614,129	\$41,172,510

FINANCIAL SUMMARY:

Total Net Income (\$):	\$201,622,190
Total Net Payout (\$):	\$160,449,680
Total Net Profit (\$):	\$41,172,510
Internal Rate of Return:	50.21%
Net Present Value:	\$13,568,695
Payback Period (yrs):	2.16

APPENDIX 9-B

Economic Evaluation

Illinois #6 Seam Case

Illinois No. 6 Seam - Microcel Only

OPERATING DATA:

Circuit Feed Rate (tph):	75	Shifts/Day:	2
Circuit Availability (%):	90	Hours/Shift:	8
Operating Time (hr/yr):	3600	Days/Year:	250

Product Stream	Mass Yield (%)	Ash Assay (%)	Comb. Assay (%)	Sulfur Assay (%)	Pyritic Assay (%)	Energy Assay (Btu/lb)
Clean Coal	64.54	10.20	89.80	3.58	1.70	13121
Reject	35.46	78.22	21.78	5.60	4.64	1894
Feed	100.00	34.32	65.68	4.30	2.74	9140

Product Stream	Mass Distribution (%)	Ash Distribution (%)	Comb Distribution (%)	Sulfur Distribution (%)	Pyritic Distribution (%)	Energy Distribution (%)
Clean Coal	64.54	19.18	88.24	53.78	40.01	92.65
Reject	35.46	80.82	11.76	46.22	59.99	7.35
Feed	100.00	100.00	100.00	100.00	100.00	100.00

Product Stream	Production Rate (tph)	Ash Rate (tph)	Comb. Rate (tph)	Sulfur Rate (tph)	Pyritic Rate (tph)	Energy Rate (MM Btu/hr)
Clean Coal	48.40	4.94	43.47	1.73	0.82	1270.22
Reject	26.60	20.80	5.79	1.49	1.23	100.75
Feed	75.00	25.74	49.26	3.22	2.06	1370.96

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Comb. Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	174257.57	17774.27	156483.30	6238.42	2962.38	4572783
Reject	95742.43	74889.73	20852.70	5361.58	4442.45	362683
Feed	270000.00	92664.00	177336.00	11600.00	7404.83	4935467

Product Stream	SO2 Rate (tph)	SO2 Rate (tpy)	lb Ash per MM Btu	lb Sulfur per MM Btu	lb Pyritic per MM Btu	lb SO2 per MM Btu
Clean Coal	3.47	12476.84	7.77	2.73	1.30	5.46
Reject	2.98	10723.15	412.98	29.57	24.50	59.13
Feed	6.44	23199.99	37.55	4.70	3.00	9.40

ESTIMATION FACTORS:

Installation Cost Factor: 1
 Maintenance Cost Factor: 0.1
 Power Fee (\$/KW-hr): 0.05

Overhead Rate (%): 20
 Engineering/Permitting (%) 10

EQUIPMENT:

Equipment Description	Number of Units	Unit Equipment Cost (\$)	Equipment Cost (\$)	Unit Power (HP)	Connected Power (HP)	Load Factor (%)	Power Requirement (KW)
Microcel	4	\$110,000	\$440,000	60	240	80	143.232
Compressor	1	\$90,000	\$90,000	150	150	80	89.52
Centrifuge	2	\$175,000	\$350,000	250	500	80	298.4
Feed Sump	1	\$10,000	\$10,000	0	0	0	0
Feed Pump	1	\$12,000	\$12,000	40	40	80	23.872
Product Sump	1	\$10,000	\$10,000	0	0	0	0
Product Pump	1	\$10,500	\$10,500	30	30	80	17.904
Frother Pump	4	\$1,000	\$4,000	0.1	0.4	15	0.04476
Collector Pump	1	\$1,000	\$1,000	0.1	0.1	15	0.01119
Heat/Light	1	\$10,000	\$10,000	60	60	15	6.714
Total Equipment Cost (\$)			\$937,500	Total	1020.5	Total	579.69795
Installation Cost (\$)			\$937,500	Power Cost (\$/yr)			
Overhead Cost (\$)			\$187,500				
Engineering/Permitting Cost (\$)			\$93,750				
Maintenance Cost (\$/yr)			\$93,750				

CONSUMABLES:

Item Description	Unit Cost (\$/lb)	Dosage (lb/t feed)	Dosage (lb/t conc)	Unit Cost (\$/t feed)	Unit Cost (\$/t conc)	Annual Cost (\$)
M150 Frother	\$0.86	1.00	1.55	\$0.86	\$1.33	\$232,200
Fuel Oil (#2)	\$0.11	1.00	1.55	\$0.11	\$0.17	\$29,700
Lubricants	\$0.10	0.10	0.15	\$0.01	\$0.02	\$2,700
Clarification	\$0.90			\$0.05		\$13,500
Subtotal	**	2.10	3.25	\$1.03	\$1.52	\$278,100

PERSONNEL:

Position Description	Salary (\$/yr)	Benefits (%)	Benefits (\$/yr)	Utilization Factor	Number Shifts	Annual Cost (\$)
Operator	\$35,000	50	\$17,500	0.25	2	\$26,250
Mech/Elec	\$45,000	50	\$22,500	0.25	2	\$6,750
Total (\$/yr)						\$33,000

FIXED COSTS:

Equipment Cost (\$):	\$937,500
Installed Cost (\$):	\$937,500
Overhead (\$):	\$187,500
Engineering Cost (\$):	\$93,750
Total Fixed Cost (\$):	\$2,156,250

O&M COSTS:

Maintenance Cost (\$/yr):	\$93,750
Power Cost (\$/yr):	\$104,346
Consumables Cost (\$/yr):	\$278,100
Personnel Cost (\$/yr):	\$33,000
Total O&M Cost (\$/yr):	\$509,196

LOAN INFORMATION:

Debt Carried (%):	0
Debt Carried (\$):	\$0
Loan Duration (yrs):	20
Interest Rate (%):	10

COSTING FACTORS:

Circuit Life (yrs):	20
Inflation Rate (%):	4

Year	Loan Cost (\$)	Principal Cost (\$)	Interest Cost (\$)	Principal/Loan Ratio (%)	O&M Cost (\$)	Total Cost (\$)
0	\$2,156,250	\$0	\$0	0.00	\$0	\$2,156,250
1	\$0	\$0	\$0	N/A	\$509,196	\$509,196
2	\$0	\$0	\$0	N/A	\$529,563	\$529,563
3	\$0	\$0	\$0	N/A	\$550,746	\$550,746
4	\$0	\$0	\$0	N/A	\$572,776	\$572,776
5	\$0	\$0	\$0	N/A	\$595,687	\$595,687
6	\$0	\$0	\$0	N/A	\$619,514	\$619,514
7	\$0	\$0	\$0	N/A	\$644,295	\$644,295
8	\$0	\$0	\$0	N/A	\$670,067	\$670,067
9	\$0	\$0	\$0	N/A	\$696,869	\$696,869
10	\$0	\$0	\$0	N/A	\$724,744	\$724,744
11	\$0	\$0	\$0	N/A	\$753,734	\$753,734
12	\$0	\$0	\$0	N/A	\$783,883	\$783,883
13	\$0	\$0	\$0	N/A	\$815,239	\$815,239
14	\$0	\$0	\$0	N/A	\$847,848	\$847,848
15	\$0	\$0	\$0	N/A	\$881,762	\$881,762
16	\$0	\$0	\$0	N/A	\$917,033	\$917,033
17	\$0	\$0	\$0	N/A	\$953,714	\$953,714
18	\$0	\$0	\$0	N/A	\$991,862	\$991,862
19	\$0	\$0	\$0	N/A	\$1,031,537	\$1,031,537
20	\$0	\$0	\$0	N/A	\$1,072,798	\$1,072,798
Total	\$2,156,250	\$0	\$0	0.00	\$15,162,868	\$17,319,118

PERFORMANCE SUMMARY:

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	SO2 Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	174257.57	17774.27	6238.42	2962.38	12476.84	4572783
Reject	95742.43	74889.73	5361.58	4442.45	10723.15	362683
Feed	270000.00	92664.00	11600.00	7404.83	23199.99	4935467

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Clean Coal	3485151	355485	124768	59248	249537	91455664
Reject	1914849	1497795	107232	88849	214463	7253669
Feed	5400000	1853280	232000	148097	464000	98709332

Product Stream	Coal Production Cost (\$/t)	Ash Removal Cost (\$/t)	Sulfur Removal Cost (\$/t)	Pyritic Removal Cost (\$/t)	SO2 Removal Cost (\$/t)	Energy Production Cost (\$/MM Btu)
Coal	\$4.97	\$48.72	\$138.81	\$292.32	\$69.41	\$0.189
Reject	\$9.04	\$11.56	\$161.51	\$194.93	\$80.76	\$2.388
Feed	\$3.21	\$9.35	\$74.65	\$116.94	\$37.33	\$0.175

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Removal	1914849	1497795	107232	88849	214463	7253669

Product Stream	Total Production (\$/t)	Total Ash (\$/t)	Total Sulfur (\$/t)	Total Pyritic (\$/t)	Total SO2 (\$/t)	Total Energy (\$/MM Btu)
Removal Cost	\$9.04	\$11.56	\$161.51	\$194.93	\$80.76	\$2.39

MARKET DATA:

Heat Value (\$/MM Btu):	\$1.30
Shipping Cost (\$/t):	\$10.00
Mining Cost (\$/t):	\$0.00

DERATING FACTORS:

Coal Moisture (%):	15
Loss (Btu/lb H ₂ O):	1114
Loss (MMBtu/t H ₂ O):	2.228

	Solids	Water	Net
Production Rate (tph)	48.40	8.54	56.95
Production Rate (tpy)	174257.57	30751.34	205008.91
Production (tons)	3485151.43	615026.72	4100178.15
Energy Rate (MM Btu/hr)	1270.22	-19.03	1251.19
Energy Rate (MM Btu/yr)	4572783	-68514	4504269
Energy (MM Btu)	91455664	-1370280	90085384
Shipping Cost (\$/hr)	\$484.05	\$85.42	\$569.47
Shipping Cost (\$/yr)	\$1,742,576	\$307,513	\$2,050,089
Energy Value (\$/hr)	\$1,651	(\$25)	\$1,627
Energy Value (\$/yr)	\$5,944,618	(\$89,068)	\$5,855,550
Energy Content (MM Btu/t)	26.24	-2.23	21.97
Energy Value (\$/t)	\$34.11	(\$2.90)	\$28.56
Production Cost (\$/MM Btu)	\$0.189	(\$12.639)	\$0.192

	Clean Coal Basis	Feed Coal Basis
Net Energy Value (\$/t)	\$28.56	\$18.43
Market Ash Adjustment (\$/t)	\$0.00	\$0.00
Market Sulfur Adjustment (\$/t)	(\$6.00)	(\$3.87)
Mining/Coal Cost (\$/t)	\$0.00	\$0.00
Net Coal Value (\$/t)	\$22.56	\$14.56
Net Coal Value (\$/hr)	\$1,285	\$829
Net Coal Value (\$/yr)	\$4,625,497	\$2,985,288

TAX INFORMATION:

Depr. Period (yrs): 20
Income Tax (%): 38

ROYALTIES/FEES:

Royalty (%): 6.50
Severance (%): 4.50
Black Lung (%): 1.00
Reclamation (%): 1.20
Totals (%): 13.20

Year	Gross Revenue (\$)	O&M Cost (\$)	Interest Deduction (\$)	Depreciation Deduction (\$)	Shipping Cost (\$)	Net Taxable Income (\$)	Income Tax (\$)	Royalties/ Fees (\$)
0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
1	\$4,625,497	\$509,196	\$0	\$107,813	\$2,050,089	\$1,958,399	\$744,192	\$610,566
2	\$4,810,516	\$529,563	\$0	\$107,813	\$2,132,093	\$2,041,048	\$775,598	\$634,988
3	\$5,002,937	\$550,746	\$0	\$107,813	\$2,217,376	\$2,127,002	\$808,261	\$660,388
4	\$5,203,055	\$572,776	\$0	\$107,813	\$2,306,071	\$2,216,395	\$842,230	\$686,803
5	\$5,411,177	\$595,687	\$0	\$107,813	\$2,398,314	\$2,309,363	\$877,558	\$714,275
6	\$5,627,624	\$619,514	\$0	\$107,813	\$2,494,247	\$2,406,050	\$914,299	\$742,846
7	\$5,852,729	\$644,295	\$0	\$107,813	\$2,594,017	\$2,506,605	\$952,510	\$772,560
8	\$6,086,838	\$670,067	\$0	\$107,813	\$2,697,777	\$2,611,181	\$992,249	\$803,463
9	\$6,330,311	\$696,869	\$0	\$107,813	\$2,805,688	\$2,719,941	\$1,033,578	\$835,601
10	\$6,583,524	\$724,744	\$0	\$107,813	\$2,917,916	\$2,833,051	\$1,076,559	\$869,025
11	\$6,846,865	\$753,734	\$0	\$107,813	\$3,034,633	\$2,950,686	\$1,121,261	\$903,786
12	\$7,120,739	\$783,883	\$0	\$107,813	\$3,156,018	\$3,073,026	\$1,167,750	\$939,938
13	\$7,405,569	\$815,239	\$0	\$107,813	\$3,282,259	\$3,200,259	\$1,216,099	\$977,535
14	\$7,701,792	\$847,848	\$0	\$107,813	\$3,413,549	\$3,332,582	\$1,266,381	\$1,016,637
15	\$8,009,863	\$881,762	\$0	\$107,813	\$3,550,091	\$3,470,198	\$1,318,675	\$1,057,302
16	\$8,330,258	\$917,033	\$0	\$107,813	\$3,692,095	\$3,613,318	\$1,373,061	\$1,099,594
17	\$8,663,468	\$953,714	\$0	\$107,813	\$3,839,778	\$3,762,164	\$1,429,622	\$1,143,578
18	\$9,010,007	\$991,862	\$0	\$107,813	\$3,993,370	\$3,916,963	\$1,488,446	\$1,189,321
19	\$9,370,407	\$1,031,537	\$0	\$107,813	\$4,153,104	\$4,077,954	\$1,549,622	\$1,236,894
20	\$9,745,224	\$1,072,798	\$0	\$107,813	\$4,319,228	\$4,245,384	\$1,613,246	\$1,286,370
Total	\$137,738,399	\$15,162,868	\$0	\$2,156,250	\$61,047,714	\$59,371,568	\$22,561,196	\$18,181,469

FINANCIAL DATA:
Discount Rate (%)

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Year	Gross Revenue (\$)	O&M Cost (\$)	Shipping Cost (\$)	Loan Cost (\$)	Income Tax (\$)	Royalties/ Fees (\$)	Net Income (\$)
0	\$0	\$0	\$0	\$2,156,250	\$0	\$0	(\$2,156,250)
1	\$4,625,497	\$509,196	\$2,050,089	\$0	\$744,192	\$610,566	\$711,455
2	\$4,810,516	\$529,563	\$2,132,093	\$0	\$775,598	\$634,988	\$738,274
3	\$5,002,937	\$550,746	\$2,217,376	\$0	\$808,261	\$660,388	\$766,166
4	\$5,203,055	\$572,776	\$2,306,071	\$0	\$842,230	\$686,803	\$795,174
5	\$5,411,177	\$595,687	\$2,398,314	\$0	\$877,558	\$714,275	\$825,342
6	\$5,627,624	\$619,514	\$2,494,247	\$0	\$914,299	\$742,846	\$856,717
7	\$5,852,729	\$644,295	\$2,594,017	\$0	\$952,510	\$772,560	\$889,347
8	\$6,086,838	\$670,067	\$2,697,777	\$0	\$992,249	\$803,463	\$923,282
9	\$6,330,311	\$696,869	\$2,805,688	\$0	\$1,033,578	\$835,601	\$958,575
10	\$6,583,524	\$724,744	\$2,917,916	\$0	\$1,076,559	\$869,025	\$995,279
11	\$6,846,865	\$753,734	\$3,034,633	\$0	\$1,121,261	\$903,786	\$1,033,452
12	\$7,120,739	\$783,883	\$3,156,018	\$0	\$1,167,750	\$939,938	\$1,073,151
13	\$7,405,569	\$815,239	\$3,282,259	\$0	\$1,216,099	\$977,535	\$1,114,438
14	\$7,701,792	\$847,848	\$3,413,549	\$0	\$1,266,381	\$1,016,637	\$1,157,377
15	\$8,009,863	\$881,762	\$3,550,091	\$0	\$1,318,675	\$1,057,302	\$1,202,033
16	\$8,330,258	\$917,033	\$3,692,095	\$0	\$1,373,061	\$1,099,594	\$1,248,476
17	\$8,663,468	\$953,714	\$3,839,778	\$0	\$1,429,622	\$1,143,578	\$1,296,776
18	\$9,010,007	\$991,862	\$3,993,370	\$0	\$1,488,446	\$1,189,321	\$1,347,008
19	\$9,370,407	\$1,031,537	\$4,153,104	\$0	\$1,549,622	\$1,236,894	\$1,399,250
20	\$9,745,224	\$1,072,798	\$4,319,228	\$0	\$1,613,246	\$1,286,370	\$1,453,581
Total	\$137,738,399	\$15,162,868	\$61,047,714	\$2,156,250	\$22,561,196	\$18,181,469	\$18,628,904

FINANCIAL SUMMARY:

Total Net Income (\$):	\$137,738,399
Total Net Payout (\$):	\$119,109,496
Total Net Profit (\$):	\$18,628,904
Internal Rate of Return:	36.65%
Net Present Value:	\$5,727,722
Payback Period (yrs):	3.03

Illinois No. 6 Seam - MGS Only

OPERATING DATA.

Circuit Feed Rate (tph):	75	Shifts/Day:	2
Circuit Availability (%):	90	Hours/Shift:	8
Operating Time (hr/yr):	3600	Days/Year:	250

Product Stream	Mass Yield (%)	Ash Assay (%)	Comb. Assay (%)	Sulfur Assay (%)	Pyritic Assay (%)	Energy Assay (Btu/lb)
Clean Coal	73.93	25.29	74.71	2.50	0.73	10630
Reject	26.07	61.12	38.88	8.30	7.01	4716
Feed	100.00	34.63	65.37	4.01	2.37	9089

Product Stream	Mass Distribution (%)	Ash Distribution (%)	Comb Distribution (%)	Sulfur Distribution (%)	Pyritic Distribution (%)	Energy Distribution (%)
Clean Coal	73.93	53.99	84.50	46.07	22.80	86.47
Reject	26.07	46.01	15.50	53.93	77.20	13.53
Feed	100.00	100.00	100.00	100.00	100.00	100.00

Product Stream	Production Rate (tph)	Ash Rate (tph)	Comb. Rate (tph)	Sulfur Rate (tph)	Pyritic Rate (tph)	Energy Rate (MM Btu/hr)
Clean Coal	55.45	14.02	41.43	1.39	0.40	1178.87
Reject	19.55	11.95	7.60	1.62	1.37	184.42
Feed	75.00	25.97	49.03	3.01	1.78	1363.29

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Comb. Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	199617.64	50483.30	149134.34	4990.44	1457.21	4243933
Reject	70382.36	43017.70	27364.66	5841.74	4933.80	663905
Feed	270000.00	93501.00	176499.00	10832.18	6391.01	4907837

Product Stream	SO2 Rate (tph)	SO2 Rate (tpy)	lb Ash per MM Btu	lb Sulfur per MM Btu	lb Pyritic per MM Btu	lb SO2 per MM Btu
Clean Coal	2.77	9980.88	23.79	2.35	0.69	4.70
Reject	3.25	11683.47	129.59	17.60	14.86	35.20
Feed	6.02	21664.35	38.10	4.41	2.60	8.83

ESTIMATION FACTORS:

Installation Cost Factor: 1
 Maintenance Cost Factor: 0.1
 Power Fee (\$/KW-hr): 0.05

Overhead Rate (%): 20
 Engineering/Permitting (%) 10

EQUIPMENT:

Equipment Description	Number of Units	Unit Equipment Cost (\$)	Equipment Cost (\$)	Unit Power (HP)	Connected Power (HP)	Load Factor (%)	Power Requirement (KW)
MGS	4	\$110,000	\$440,000	60	240	80	143.232
Centrifuge	2	\$175,000	\$350,000	250	500	80	298.4
Feed Sump	1	\$10,000	\$10,000	0	0	0	0
Feed Pump	1	\$12,000	\$12,000	40	40	80	23.872
Product Sump	1	\$10,000	\$10,000	0	0	0	0
Product Pump	1	\$10,500	\$10,500	30	30	80	17.904
Heat/Light	1	\$10,000	\$10,000	60	60	15	6.714
Total Equipment Cost (\$)			\$842,500	Total	870	Total	490.122
Installation Cost (\$)			\$842,500	Power Cost (\$/yr)			
Overhead Cost (\$)			\$168,500				
Engineering/Permitting Cost (\$)			\$84,250				
Maintenance Cost (\$/yr)			\$84,250				

CONSUMABLES:

Item Description	Unit Cost (\$/lb)	Dosage (lb/t feed)	Dosage (lb/t conc)	Unit Cost (\$/t feed)	Unit Cost (\$/t conc)	Annual Cost (\$)
Lubricants	\$0.10	0.10	0.14	\$0.01	\$0.01	\$2,700
Clarification	\$0.90			\$0.05		\$13,500
Subtotal	**	0.10	0.14	\$0.06	\$0.01	\$16,200

PERSONNEL:

Position Description	Salary (\$/yr)	Benefits (%)	Benefits (\$/yr)	Utilization Factor	Number Shifts	Annual Cost (\$)
Operator	\$35,000	50	\$17,500	0.25	2	\$26,250
Mech/Elec	\$45,000	50	\$22,500	0.05	2	\$6,750
Total (\$/yr)						\$33,000

FIXED COSTS:

Equipment Cost (\$):	\$842,500
Installed Cost (\$):	\$842,500
Overhead (\$):	\$168,500
Engineering Cost (\$):	\$84,250
Total Fixed Cost (\$):	\$1,937,750

O&M COSTS:

Maintenance Cost (\$/yr):	\$84,250
Power Cost (\$/yr):	\$88,222
Consumables Cost (\$/yr):	\$16,200
Personnel Cost (\$/yr):	\$33,000
Total O&M Cost (\$/yr):	\$221,672

LOAN INFORMATION:

Debt Carried (%):	0
Debt Carried (\$):	\$0
Loan Duration (yrs):	20
Interest Rate (%):	10

COSTING FACTORS:

Circuit Life (yrs):	20
Inflation Rate (%):	4

Year	Loan Cost (\$)	Principal Cost (\$)	Interest Cost (\$)	Principal/Loan Ratio (%)	O&M Cost (\$)	Total Cost (\$)
0	\$1,937,750	\$0	\$0	0.00	\$0	\$1,937,750
1	\$0	\$0	\$0	N/A	\$221,672	\$221,672
2	\$0	\$0	\$0	N/A	\$230,539	\$230,539
3	\$0	\$0	\$0	N/A	\$239,760	\$239,760
4	\$0	\$0	\$0	N/A	\$249,351	\$249,351
5	\$0	\$0	\$0	N/A	\$259,325	\$259,325
6	\$0	\$0	\$0	N/A	\$269,698	\$269,698
7	\$0	\$0	\$0	N/A	\$280,486	\$280,486
8	\$0	\$0	\$0	N/A	\$291,705	\$291,705
9	\$0	\$0	\$0	N/A	\$303,373	\$303,373
10	\$0	\$0	\$0	N/A	\$315,508	\$315,508
11	\$0	\$0	\$0	N/A	\$328,129	\$328,129
12	\$0	\$0	\$0	N/A	\$341,254	\$341,254
13	\$0	\$0	\$0	N/A	\$354,904	\$354,904
14	\$0	\$0	\$0	N/A	\$369,100	\$369,100
15	\$0	\$0	\$0	N/A	\$383,864	\$383,864
16	\$0	\$0	\$0	N/A	\$399,219	\$399,219
17	\$0	\$0	\$0	N/A	\$415,187	\$415,187
18	\$0	\$0	\$0	N/A	\$431,795	\$431,795
19	\$0	\$0	\$0	N/A	\$449,067	\$449,067
20	\$0	\$0	\$0	N/A	\$467,029	\$467,029
Total	\$1,937,750	\$0	\$0	0.00	\$6,600,965	\$8,538,715

PERFORMANCE SUMMARY:

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	SO2 Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	199617.64	50483.30	4990.44	1457.21	9980.88	4243933
Reject	70382.36	43017.70	5841.74	4933.80	11683.47	663905
Feed	270000.00	93501.00	10832.18	6391.01	21664.35	4907837

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Clean Coal	3992353	1009666	99809	29144	199618	84878654
Reject	1407647	860354	116835	98676	233669	13278091
Feed	5400000	1870020	216644	127820	433287	98156745

Product Stream	Coal Production Cost (\$/t)	Ash Removal Cost (\$/t)	Sulfur Removal Cost (\$/t)	Pyritic Removal Cost (\$/t)	SO2 Removal Cost (\$/t)	Energy Production Cost (\$/MM Btu)
Coal	\$2.14	\$8.46	\$85.55	\$292.98	\$42.78	\$0.101
Reject	\$6.07	\$9.92	\$73.08	\$86.53	\$36.54	\$0.643
Feed	\$1.58	\$4.57	\$39.41	\$66.80	\$19.71	\$0.087

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Removal	1407647	860354	116835	98676	233669	13278091

Product Stream	Total Production (\$/t)	Total Ash (\$/t)	Total Sulfur (\$/t)	Total Pyritic (\$/t)	Total SO2 (\$/t)	Total Energy (\$/MM Btu)
Removal Cost	\$6.07	\$9.92	\$73.08	\$86.53	\$36.54	\$0.64

MARKET DATA:

Heat Value (\$/MM Btu):	\$1.30
Shipping Cost (\$/t):	\$10.00
Mining Cost (\$/t):	\$0.00

DERATING FACTORS:

Coal Moisture (%):	15
Loss (Btu/lb H ₂ O):	1114
Loss (MMBtu/t H ₂ O):	2.228

	Solids	Water	Net
Production Rate (tph)	55.45	9.79	65.23
Production Rate (tpy)	199617.64	35226.64	234844.28
Production (tons)	3992352.78	704532.84	4696885.62
Energy Rate (MM Btu/hr)	1178.87	-21.80	1157.07
Energy Rate (MM Btu/yr)	4243933	-78485	4165448
Energy (MM Btu)	84878654	-1569699	83308955
Shipping Cost (\$/hr)	\$554.49	\$97.85	\$652.35
Shipping Cost (\$/yr)	\$1,996,176	\$352,266	\$2,348,443
Energy Value (\$/hr)	\$1,533	(\$28)	\$1,504
Energy Value (\$/yr)	\$5,517,112	(\$102,030)	\$5,415,082
Energy Content (MM Btu/t)	21.26	-2.23	17.74
Energy Value (\$/t)	\$27.64	(\$2.90)	\$23.06
Production Cost (\$/MM Btu)	\$0.101	(\$5.440)	\$0.102

	Clean Coal Basis	Feed Coal Basis
Net Energy Value (\$/t)	\$23.06	\$17.05
Market Ash Adjustment (\$/t)	(\$4.00)	(\$2.96)
Market Sulfur Adjustment (\$/t)	(\$6.00)	(\$4.44)
Mining/Coal Cost (\$/t)	\$0.00	\$0.00
Net Coal Value (\$/t)	\$13.06	\$9.65
Net Coal Value (\$/hr)	\$852	\$630
Net Coal Value (\$/yr)	\$3,066,639	\$2,267,242

TAX INFORMATION:

Depr. Period (yrs): 20
Income Tax (%): 38

ROYALTIES/FEEES:

Royalty (%): 6.50
Severance (%): 4.50
Black Lung (%): 1.00
Reclamation (%): 1.20
Totals (%): 13.20

Year	Gross Revenue (\$)	O&M Cost (\$)	Interest Deduction (\$)	Depreciation Deduction (\$)	Shipping Cost (\$)	Net Taxable Income (\$)	Income Tax (\$)	Royalties/ Fees (\$)
0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
1	\$3,066,639	\$221,672	\$0	\$96,888	\$2,348,443	\$399,637	\$151,862	\$404,796
2	\$3,189,305	\$230,539	\$0	\$96,888	\$2,442,381	\$419,498	\$159,409	\$420,988
3	\$3,316,877	\$239,760	\$0	\$96,888	\$2,540,076	\$440,153	\$167,258	\$437,828
4	\$3,449,552	\$249,351	\$0	\$96,888	\$2,641,679	\$461,635	\$175,421	\$455,341
5	\$3,587,534	\$259,325	\$0	\$96,888	\$2,747,346	\$483,976	\$183,911	\$473,555
6	\$3,731,036	\$269,698	\$0	\$96,888	\$2,857,240	\$507,210	\$192,740	\$492,497
7	\$3,880,277	\$280,486	\$0	\$96,888	\$2,971,529	\$531,374	\$201,922	\$512,197
8	\$4,035,488	\$291,705	\$0	\$96,888	\$3,090,391	\$556,505	\$211,472	\$532,684
9	\$4,196,908	\$303,373	\$0	\$96,888	\$3,214,006	\$582,641	\$221,403	\$553,992
10	\$4,364,784	\$315,508	\$0	\$96,888	\$3,342,566	\$609,822	\$231,732	\$576,151
11	\$4,539,375	\$328,129	\$0	\$96,888	\$3,476,269	\$638,090	\$242,474	\$599,198
12	\$4,720,950	\$341,254	\$0	\$96,888	\$3,615,320	\$667,489	\$253,646	\$623,165
13	\$4,909,788	\$354,904	\$0	\$96,888	\$3,759,933	\$698,064	\$265,264	\$648,092
14	\$5,106,180	\$369,100	\$0	\$96,888	\$3,910,330	\$729,862	\$277,348	\$674,016
15	\$5,310,427	\$383,864	\$0	\$96,888	\$4,066,743	\$762,932	\$289,914	\$700,976
16	\$5,522,844	\$399,219	\$0	\$96,888	\$4,229,413	\$797,325	\$302,984	\$729,015
17	\$5,743,758	\$415,187	\$0	\$96,888	\$4,398,589	\$833,094	\$316,576	\$758,176
18	\$5,973,508	\$431,795	\$0	\$96,888	\$4,574,533	\$870,293	\$330,711	\$788,503
19	\$6,212,448	\$449,067	\$0	\$96,888	\$4,757,514	\$908,980	\$345,412	\$820,043
20	\$6,460,946	\$467,029	\$0	\$96,888	\$4,947,815	\$949,215	\$360,702	\$852,845
Total	\$91,318,624	\$6,600,965	\$0	\$1,937,750	\$69,932,115	\$12,847,794	\$4,882,162	\$12,054,058

FINANCIAL DATA:
Discount Rate (%)

10

Year	Gross Revenue (\$)	O&M Cost (\$)	Shipping Cost (\$)	Loan Cost (\$)	Income Tax (\$)	Royalties/ Fees (\$)	Net Income (\$)
0	\$0	\$0	\$0	\$1,937,750	\$0	\$0	(\$1,937,750)
1	\$3,066,639	\$221,672	\$2,348,443	\$0	\$151,862	\$404,796	(\$60,134)
2	\$3,189,305	\$230,539	\$2,442,381	\$0	\$159,409	\$420,988	(\$64,012)
3	\$3,316,877	\$239,760	\$2,540,076	\$0	\$167,258	\$437,828	(\$68,045)
4	\$3,449,552	\$249,351	\$2,641,679	\$0	\$175,421	\$455,341	(\$72,240)
5	\$3,587,534	\$259,325	\$2,747,346	\$0	\$183,911	\$473,555	(\$76,602)
6	\$3,731,036	\$269,698	\$2,857,240	\$0	\$192,740	\$492,497	(\$81,139)
7	\$3,880,277	\$280,486	\$2,971,529	\$0	\$201,922	\$512,197	(\$85,857)
8	\$4,035,488	\$291,705	\$3,090,391	\$0	\$211,472	\$532,684	(\$90,764)
9	\$4,196,908	\$303,373	\$3,214,006	\$0	\$221,403	\$553,992	(\$95,867)
10	\$4,364,784	\$315,508	\$3,342,566	\$0	\$231,732	\$576,151	(\$101,175)
11	\$4,539,375	\$328,129	\$3,476,269	\$0	\$242,474	\$599,198	(\$106,694)
12	\$4,720,950	\$341,254	\$3,615,320	\$0	\$253,646	\$623,165	(\$112,435)
13	\$4,909,788	\$354,904	\$3,759,933	\$0	\$265,264	\$648,092	(\$118,405)
14	\$5,106,180	\$369,100	\$3,910,330	\$0	\$277,348	\$674,016	(\$124,614)
15	\$5,310,427	\$383,864	\$4,066,743	\$0	\$289,914	\$700,976	(\$131,071)
16	\$5,522,844	\$399,219	\$4,229,413	\$0	\$302,984	\$729,015	(\$137,786)
17	\$5,743,758	\$415,187	\$4,398,589	\$0	\$316,576	\$758,176	(\$144,771)
18	\$5,973,508	\$431,795	\$4,574,533	\$0	\$330,711	\$788,503	(\$152,034)
19	\$6,212,448	\$449,067	\$4,757,514	\$0	\$345,412	\$820,043	(\$159,588)
20	\$6,460,946	\$467,029	\$4,947,815	\$0	\$360,702	\$852,845	(\$167,444)
Total	\$91,318,624	\$6,600,965	\$69,932,115	\$1,937,750	\$4,882,162	\$12,054,058	(\$4,088,426)

FINANCIAL SUMMARY:

Total Net Income (\$):	\$91,318,624
Total Net Payout (\$):	\$95,407,050
Total Net Profit (\$):	(\$4,088,426)
Internal Rate of Return:	#NUM!
Net Present Value:	(\$2,713,880)
Payback Period (yrs):	-32.22

Illinois No. 6 Seam - Combined Microcel/MGS

OPERATING DATA:

Circuit Feed Rate (tph):	75	Shifts/Day:	2
Circuit Availability (%):	90	Hours/Shift:	8
Operating Time (hr/yr):	3600	Days/Year:	250

Product Stream	Mass Yield (%)	Ash Assay (%)	Comb. Assay (%)	Sulfur Assay (%)	Pyritic Assay (%)	Energy Assay (Btu/lb)
Clean Coal	58.71	7.47	92.53	3.02	0.66	13571
Reject	41.29	74.27	25.73	6.12	4.61	2546
Feed	100.00	35.05	64.95	4.30	2.29	9019

Product Stream	Mass Distribution (%)	Ash Distribution (%)	Comb Distribution (%)	Sulfur Distribution (%)	Pyritic Distribution (%)	Energy Distribution (%)
Clean Coal	58.71	12.51	83.64	41.24	16.92	88.35
Reject	41.29	87.49	16.36	58.76	83.08	11.65
Feed	100.00	100.00	100.00	100.00	100.00	100.00

Product Stream	Production Rate (tph)	Ash Rate (tph)	Comb. Rate (tph)	Sulfur Rate (tph)	Pyritic Rate (tph)	Energy Rate (MM Btu/hr)
Clean Coal	44.03	3.29	40.75	1.33	0.29	1195.21
Reject	30.97	23.00	7.97	1.90	1.43	157.68
Feed	75.00	26.29	48.71	3.22	1.72	1352.89

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Comb. Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	158523.95	11841.74	146682.21	4787.42	1046.26	4302767
Reject	111476.05	82793.26	28682.79	6822.33	5139.05	567637
Feed	270000.00	94635.00	175365.00	11609.76	6185.30	4870404

Product Stream	SO2 Rate (tph)	SO2 Rate (tpy)	lb Ash per MM Btu	lb Sulfur per MM Btu	lb Pyritic per MM Btu	lb SO2 per MM Btu
Clean Coal	2.66	9574.85	5.50	2.23	0.49	4.45
Reject	3.79	13644.67	291.71	24.04	18.11	48.08
Feed	6.45	23219.51	38.86	4.77	2.54	9.53

ESTIMATION FACTORS:

Installation Cost Factor: 1
 Maintenance Cost Factor: 0.1
 Power Fee (\$/KW-hr): 0.05

Overhead Rate (%): 20
 Engineering/Permitting (%) 10

EQUIPMENT:

Equipment Description	Number of Units	Unit Equipment Cost (\$)	Equipment Cost (\$)	Unit Power (HP)	Connected Power (HP)	Load Factor (%)	Power Requirement (KW)
Microcel	4	\$110,000	\$440,000	60	240	80	143.232
MGS	4	\$120,000	\$480,000	10	40	80	23.872
Compressor	1	\$90,000	\$90,000	150	150	80	89.52
Centrifuge	2	\$175,000	\$350,000	250	500	80	298.4
Feed Pump	1	\$10,000	\$10,000	0	0	0	0
Feed Pump	1	\$12,000	\$12,000	40	40	80	23.872
Product Pump	1	\$10,000	\$10,000	0	0	0	0
Product Pump	1	\$10,500	\$10,500	30	30	80	17.904
Frother Pump	4	\$1,000	\$4,000	0.1	0.4	15	0.04476
Collector Pump	1	\$1,000	\$1,000	0.1	0.1	15	0.01119
Heat/Light	1	\$10,000	\$10,000	60	60	15	6.714
Total Equipment Cost (\$)			\$1,417,500	Total	1060.5	Total	603.56995
Installation Cost (\$)			\$1,417,500	Power Cost (\$/yr)			
Overhead Cost (\$)			\$283,500				
Engineering/Permitting Cost (\$)			\$141,750				
Maintenance Cost (\$/yr)			\$141,750				

CONSUMABLES:

Item Description	Unit Cost (\$/lb)	Dosage (lb/t feed)	Dosage (lb/t conc)	Unit Cost (\$/t feed)	Unit Cost (\$/t conc)	Annual Cost (\$)
M150 Frother	\$0.86	1.00	1.70	\$0.86	\$1.46	\$232,200
Fuel Oil (#2)	\$0.11	1.00	1.70	\$0.11	\$0.19	\$29,700
Lubricants	\$0.10	0.10	0.17	\$0.01	\$0.02	\$2,700
Clarification	\$0.90			\$0.05		\$13,500
Subtotal	**	2.10	3.58	\$1.03	\$1.67	\$278,100

PERSONNEL:

Position Description	Salary (\$/yr)	Benefits (%)	Benefits (\$/yr)	Utilization Factor	Number Shifts	Annual Cost (\$)
Operator	\$35,000	50	\$17,500	0.5	2	\$52,500
Mech/Elec	\$45,000	50	\$22,500	0.1	2	\$13,500
Total (\$/yr)						\$66,000

FIXED COSTS:

Equipment Cost (\$):	\$1,417,500
Installed Cost (\$):	\$1,417,500
Overhead (\$):	\$283,500
Engineering Cost (\$):	\$141,750
Total Fixed Cost (\$):	\$3,260,250

O&M COSTS:

Maintenance Cost (\$/yr):	\$141,750
Power Cost (\$/yr):	\$108,643
Consumables Cost (\$/yr):	\$278,100
Personnel Cost (\$/yr):	\$66,000
Total O&M Cost (\$/yr):	\$594,493

LOAN INFORMATION:

Debt Carried (%):	0
Debt Carried (\$):	\$0
Loan Duration (yrs):	20
Interest Rate (%):	10

COSTING FACTORS:

Circuit Life (yrs):	20
Inflation Rate (%):	4

Year	Loan Cost (\$)	Principal Cost (\$)	Interest Cost (\$)	Principal/Loan Ratio (%)	O&M Cost (\$)	Total Cost (\$)
0	\$3,260,250	\$0	\$0	0.00	\$0	\$3,260,250
1	\$0	\$0	\$0	N/A	\$594,493	\$594,493
2	\$0	\$0	\$0	N/A	\$618,272	\$618,272
3	\$0	\$0	\$0	N/A	\$643,003	\$643,003
4	\$0	\$0	\$0	N/A	\$668,723	\$668,723
5	\$0	\$0	\$0	N/A	\$695,472	\$695,472
6	\$0	\$0	\$0	N/A	\$723,291	\$723,291
7	\$0	\$0	\$0	N/A	\$752,223	\$752,223
8	\$0	\$0	\$0	N/A	\$782,312	\$782,312
9	\$0	\$0	\$0	N/A	\$813,604	\$813,604
10	\$0	\$0	\$0	N/A	\$846,148	\$846,148
11	\$0	\$0	\$0	N/A	\$879,994	\$879,994
12	\$0	\$0	\$0	N/A	\$915,194	\$915,194
13	\$0	\$0	\$0	N/A	\$951,802	\$951,802
14	\$0	\$0	\$0	N/A	\$989,874	\$989,874
15	\$0	\$0	\$0	N/A	\$1,029,469	\$1,029,469
16	\$0	\$0	\$0	N/A	\$1,070,648	\$1,070,648
17	\$0	\$0	\$0	N/A	\$1,113,473	\$1,113,473
18	\$0	\$0	\$0	N/A	\$1,158,012	\$1,158,012
19	\$0	\$0	\$0	N/A	\$1,204,333	\$1,204,333
20	\$0	\$0	\$0	N/A	\$1,252,506	\$1,252,506
Total	\$3,260,250	\$0	\$0	0.00	\$17,702,847	\$20,963,097

PERFORMANCE SUMMARY:

Product Stream	Production Rate (tpy)	Ash Rate (tpy)	Sulfur Rate (tpy)	Pyritic Rate (tpy)	SO2 Rate (tpy)	Energy Rate (MM Btu/yr)
Clean Coal	158523.95	11841.74	4787.42	1046.26	9574.85	4302767
Reject	111476.05	82793.26	6822.33	5139.05	13644.67	567637
Feed	270000.00	94635.00	11609.76	6185.30	23219.51	4870404

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Clean Coal	3170479	236835	95748	20925	191497	86055333
Reject	2229521	1655865	136447	102781	272893	11352745
Feed	5400000	1892700	232195	123706	464390	97408078

Product Stream	Coal Production Cost (\$/t)	Ash Removal Cost (\$/t)	Sulfur Removal Cost (\$/t)	Pyritic Removal Cost (\$/t)	SO2 Removal Cost (\$/t)	Energy Production Cost (\$/MM Btu)
Coal	\$6.61	\$88.51	\$218.94	\$1,001.81	\$109.47	\$0.244
Reject	\$9.40	\$12.66	\$153.64	\$203.96	\$76.82	\$1.847
Feed	\$3.88	\$11.08	\$90.28	\$169.46	\$45.14	\$0.215

Product Stream	Total Production (tons)	Total Ash (tons)	Total Sulfur (tons)	Total Pyritic (tons)	Total SO2 (tons)	Total Energy (MM Btu)
Removal	2229521	1655865	136447	102781	272893	11352745

Product Stream	Total Production (\$/t)	Total Ash (\$/t)	Total Sulfur (\$/t)	Total Pyritic (\$/t)	Total SO2 (\$/t)	Total Energy (\$/MM Btu)
Removal Cost	\$9.40	\$12.66	\$153.64	\$203.96	\$76.82	\$1.85

MARKET DATA:

Heat Value (\$/MM Btu):	\$1.30
Shipping Cost (\$/t):	\$10.00
Mining Cost (\$/t):	\$0.00

DERATING FACTORS:

Coal Moisture (%):	15
Loss (Btu/lb H ₂ O):	1114
Loss (MMBtu/t H ₂ O):	2.228

	Solids	Water	Net
Production Rate (tph)	44.03	7.77	51.81
Production Rate (tpy)	158523.95	27974.82	186498.77
Production (tons)	3170479.04	559496.30	3729975.34
Energy Rate (MM Btu/hr)	1195.21	-17.31	1177.90
Energy Rate (MM Btu/yr)	4302767	-62328	4240439
Energy (MM Btu)	86055333	-1246558	84808775
Shipping Cost (\$/hr)	\$440.34	\$77.71	\$518.05
Shipping Cost (\$/yr)	\$1,585,240	\$279,748	\$1,864,988
Energy Value (\$/hr)	\$1,554	(\$23)	\$1,531
Energy Value (\$/yr)	\$5,593,597	(\$81,026)	\$5,512,570
Energy Content (MM Btu/t)	27.14	-2.23	22.74
Energy Value (\$/t)	\$35.29	(\$2.90)	\$29.56
Production Cost (\$/MM Btu)	\$0.244	(\$16.817)	\$0.247

	Clean Coal Basis	Feed Coal Basis
Net Energy Value (\$/t)	\$29.56	\$17.35
Market Ash Adjustment (\$/t)	\$2.00	\$1.17
Market Sulfur Adjustment (\$/t)	(\$6.00)	(\$3.52)
Mining/Coal Cost (\$/t)	\$0.00	\$0.00
Net Coal Value (\$/t)	\$25.56	\$15.01
Net Coal Value (\$/hr)	\$1,324	\$777
Net Coal Value (\$/yr)	\$4,766,575	\$2,798,579

TAX INFORMATION:

Depr. Period (yrs): 20
Income Tax (%): 38

ROYALTIES/FEES:

Royalty (%): 6.50
Severance (%): 4.50
Black Lung (%): 1.00
Reclamation (%): 1.20
Totals (%): 13.20

Year	Gross Revenue (\$)	O&M Cost (\$)	Interest Deduction (\$)	Depreciation Deduction (\$)	Shipping Cost (\$)	Net Taxable Income (\$)	Income Tax (\$)	Royalties/ Fees (\$)
0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
1	\$4,766,575	\$594,493	\$0	\$163,013	\$1,864,988	\$2,144,083	\$814,751	\$629,188
2	\$4,957,238	\$618,272	\$0	\$163,013	\$1,939,587	\$2,236,366	\$849,819	\$654,355
3	\$5,155,528	\$643,003	\$0	\$163,013	\$2,017,171	\$2,332,342	\$886,290	\$680,530
4	\$5,361,749	\$668,723	\$0	\$163,013	\$2,097,857	\$2,432,156	\$924,219	\$707,751
5	\$5,576,219	\$695,472	\$0	\$163,013	\$2,181,772	\$2,535,962	\$963,666	\$736,061
6	\$5,799,268	\$725,291	\$0	\$163,013	\$2,269,043	\$2,643,921	\$1,004,690	\$765,503
7	\$6,031,238	\$752,223	\$0	\$163,013	\$2,359,804	\$2,756,199	\$1,047,356	\$796,123
8	\$6,272,488	\$782,312	\$0	\$163,013	\$2,454,197	\$2,872,967	\$1,091,728	\$827,968
9	\$6,523,387	\$813,604	\$0	\$163,013	\$2,552,364	\$2,994,406	\$1,137,874	\$861,087
10	\$6,784,323	\$846,148	\$0	\$163,013	\$2,654,459	\$3,120,703	\$1,185,867	\$895,531
11	\$7,055,696	\$879,994	\$0	\$163,013	\$2,760,637	\$3,252,052	\$1,235,780	\$931,352
12	\$7,337,924	\$915,194	\$0	\$163,013	\$2,871,063	\$3,388,654	\$1,287,689	\$968,606
13	\$7,631,441	\$951,802	\$0	\$163,013	\$2,985,905	\$3,530,721	\$1,341,674	\$1,007,350
14	\$7,936,698	\$989,874	\$0	\$163,013	\$3,105,342	\$3,678,470	\$1,397,819	\$1,047,644
15	\$8,254,166	\$1,029,469	\$0	\$163,013	\$3,229,555	\$3,832,130	\$1,456,209	\$1,089,550
16	\$8,584,333	\$1,070,648	\$0	\$163,013	\$3,358,737	\$3,991,935	\$1,516,935	\$1,133,132
17	\$8,927,706	\$1,113,473	\$0	\$163,013	\$3,493,087	\$4,158,133	\$1,580,091	\$1,178,457
18	\$9,284,814	\$1,158,012	\$0	\$163,013	\$3,632,810	\$4,330,979	\$1,645,772	\$1,225,596
19	\$9,656,207	\$1,204,333	\$0	\$163,013	\$3,778,123	\$4,510,739	\$1,714,081	\$1,274,619
20	\$10,042,455	\$1,252,506	\$0	\$163,013	\$3,929,248	\$4,697,689	\$1,785,122	\$1,325,604
Total	\$141,939,454	\$17,702,847	\$0	\$3,260,250	\$55,535,749	\$65,440,608	\$24,867,431	\$18,736,008

FINANCIAL DATA:

Discount Rate (%)

10

Year	Gross Revenue (\$)	O&M Cost (\$)	Shipping Cost (\$)	Loan Cost (\$)	Income Tax (\$)	Royalties/ Fees (\$)	Net Income (\$)
0	\$0	\$0	\$0	\$3,260,250	\$0	\$0	(\$3,260,250)
1	\$4,766,575	\$594,493	\$1,864,988	\$0	\$814,751	\$629,188	\$863,156
2	\$4,957,238	\$618,272	\$1,939,587	\$0	\$849,819	\$654,355	\$895,204
3	\$5,155,528	\$643,003	\$2,017,171	\$0	\$886,290	\$680,530	\$928,535
4	\$5,361,749	\$668,723	\$2,097,857	\$0	\$924,219	\$707,751	\$963,198
5	\$5,576,219	\$695,472	\$2,181,772	\$0	\$963,666	\$736,061	\$999,248
6	\$5,799,268	\$723,291	\$2,269,043	\$0	\$1,004,690	\$765,503	\$1,036,740
7	\$6,031,238	\$752,223	\$2,359,804	\$0	\$1,047,356	\$796,123	\$1,075,732
8	\$6,272,488	\$782,312	\$2,454,197	\$0	\$1,091,728	\$827,968	\$1,116,284
9	\$6,523,387	\$813,604	\$2,552,364	\$0	\$1,137,874	\$861,087	\$1,158,457
10	\$6,784,323	\$846,148	\$2,654,459	\$0	\$1,185,867	\$895,531	\$1,202,318
11	\$7,055,696	\$879,994	\$2,760,637	\$0	\$1,235,780	\$931,352	\$1,247,933
12	\$7,337,924	\$915,194	\$2,871,063	\$0	\$1,287,689	\$968,606	\$1,295,372
13	\$7,631,441	\$951,802	\$2,985,905	\$0	\$1,341,674	\$1,007,350	\$1,344,709
14	\$7,936,698	\$989,874	\$3,105,342	\$0	\$1,397,819	\$1,047,644	\$1,396,020
15	\$8,254,166	\$1,029,469	\$3,229,555	\$0	\$1,456,209	\$1,089,550	\$1,449,383
16	\$8,584,333	\$1,070,648	\$3,358,737	\$0	\$1,516,935	\$1,133,132	\$1,504,880
17	\$8,927,706	\$1,113,473	\$3,493,087	\$0	\$1,580,091	\$1,178,457	\$1,562,598
18	\$9,284,814	\$1,158,012	\$3,632,810	\$0	\$1,645,772	\$1,225,596	\$1,622,624
19	\$9,656,207	\$1,204,333	\$3,778,123	\$0	\$1,714,081	\$1,274,619	\$1,685,051
20	\$10,042,455	\$1,252,506	\$3,929,248	\$0	\$1,785,122	\$1,325,604	\$1,749,975
Total	\$141,939,454	\$17,702,847	\$55,535,749	\$3,260,250	\$24,867,431	\$18,736,008	\$21,837,169

FINANCIAL SUMMARY:

Total Net Income (\$):	\$141,939,454
Total Net Payout (\$):	\$120,102,285
Total Net Profit (\$):	\$21,837,169
Internal Rate of Return:	29.93%
Net Present Value:	\$6,271,444
Payback Period (yrs):	3.78

APPENDIX 10

CPPRF Circuit Drawings

PLAN @ EL. 1106'-6" T/PLATFORM

DOE CONTRACT NO. DE-AC22-92PC92205

ROBERTS & SCHAEFER
DIVISION OF RSC NATIONAL INDUSTRIES, INC.
DESIGNERS AND CONTRACTORS
CHICAGO - PITTSBURGH - SALT LAKE CITY

LAYOUT - PLAN VIEWS
VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY
BENCH-SCALE TESTING OF MCS & MICROCEL UNITS
AT PITTSBURGH ENERGY TECHNOLOGY CENTER

DATE BY J. DeRemo

SCALE 1" = 1'-0" DATE 1-25-93

CHECKED BY C. W. J.

APPROVED BY

9234-L1

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NO.	DATE	DESCRIPTION OF REVISION	NO.	DATE	DESCRIPTION OF REVISION

DOE CONTRACT NO. DE-AC22-92 PC 92205

ROBERTS & SCHAMPER
Company
DIVISION OF EARTH SYSTEMS ENGINEERING INC.
ENGINEERS AND CONTRACTORS
CHICAGO - PITTSBURGH - SALT LAKE CITY

LAYOUT - ELEVATION SECTIONS
VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY
BRAIN-SOFT TESTING OF MGS & MICROCEL UNITS
AT PITTSBURGH ENERGY TECHNOLOGY CENTER

DATE BY J. DeMaggio
APPROVED BY C. L. L. L.
DATE 11-1-92

SCALE 1" = 1'-0"
DATE 11-1-92
9234-L2

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PLAN 9 PL 1106-6 T/PLATFORM

DOE CONTRACT NO DE-AC22-92PC92205

ROBERTS & SCHAEFER
ENGINEERS AND CONTRACTORS
CHICAGO - PITTSBURGH SALT LAKE CITY

PIPING - PLAN VIEWS
VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY
SCALE TESTS OF PDS & MICROCEL UNITS
AT PITTSBURGH ENERGY TECHNOLOGY CENTER

DATE: J. DeRamus
DESIGNED BY: R. Schaefer
CHECKED BY: R. Schaefer
APPROVED BY:

SCALE: 1"=10'
DATE: 1-25-98
9234-PI

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D.O.E. CONTRACT NO. DE-AC22-92PC92205

ROBERTS & SCHAEFER
 COMPANY
 CHICAGO - PITTSBURGH - SALT LAKE CITY

PIPING - ELEVATION SECTIONS
 VARIUM POLYTECHNIC INSTITUTE & STATE UNIVERSITY
 BENCH-SCALE TESTING OF MCS & MICROCEL UNITS
 AT PITTSBURGH ENERGY TECHNOLOGY CENTER

DATE: 11/27/92
 CHECKED BY: J. EVANS
 DESIGNED BY: J. EVANS

SCALE: 1/2" = 1'-0"
 SHEET: 1-35-R
 9234-P2

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NO.	DATE	DESCRIPTION OF REVISION	NO.	DATE	DESCRIPTION OF REVISION

LEGEND

(C) — CORIOLIS MASS FLOW METER
(P) — PRESSURE GAGE
(F) — FLOW METER

LEGEND

(X-1)	DEVICE LOCATED AT CONTROL PANEL
(X-2)	DEVICE LOCATED IN FIELD
---	AIR PIPING
---	ELECTRICAL SIGNAL
0-X	PNEUMATIC PUNCH VALVE
X	MANUAL BALL VALVE
I/P-X	CURRENT TO PRESSURE TRANSDUCER
P-C-X	PRESSURE GAUGE
P-R-X	PRESSURE REGULATOR
P-T-X	PRESSURE TRANSMITTER
F-T-X	FLOW TRANSMITTER
L-T-X	LEVEL TRANSMITTER
L-E-D-X	LEVEL DISPLAY
L-C-X	LEVEL CONTROLLER
A-F-C-X	AIR FLOW CONTROLLER
W-F-T-X	MASS FLOW TRANSMITTER

COLUMN/MGS/CYCLONE

REV.	DATE	DESCRIPTION OF REVISION	REV.	DATE	DESCRIPTION OF REVISION

4'-0"

REV	DATE	DESCRIPTION OF REVISION	REV	DATE	DESCRIPTION OF REVISION

DOE CONTRACT NO. DE-AC22-92PC92205

ROBERTS & SCHAEFER
DIVISION OF ELLER NATIONAL INDUSTRIES, INC.
ENGINEERS AND CONTRACTORS
CHICAGO-SALT LAKE CITY-PITTSBURGH

CONTROL PANEL LAYOUT
VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY
BENCH-SCALE TESTING OF MGS & MICROCELL UNITS
AT PITTSBURGH ENERGY TECHNOLOGY CENTER

DATE OF VIX	SCALE 3'-0"	DATE 1-19-93
DESIGNED BY	CHECKED BY	APPROVED BY
9234-E1		

3-#6 THHN
1-#6 GROUND THHN

SIZE 3
50A MAIN
PDC

REV	DATE	DESCRIPTION OF REVISION	REV	DATE	DESCRIPTION OF REVISION

DOE CONTRACT NO. DE-AC22-92PC92205

ROBERTS & SCHAEFER
DIVISION OF ECH NATIONAL INDUSTRIES, INC.
ENGINEERS AND CONTRACTORS
CHICAGO-SALT LAKE CITY-PITTSBURGH

INSTRUMENTATION & CONTROL PANEL WIRING
VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY
BENCH-SCALE TESTING OF MGS & MICROCEL UNITS
AT PITTSBURGH ENERGY TECHNOLOGY CENTER

DATE OF REVISION	BY WLK	REASON NONE	DATE 1/19/93
DESIGNED BY	APPROVED BY WLK	DRAWING NO. 9234-E4	
CHECKED BY		REVISIONS	

NOT BE USED IN ANY MANNER WITHOUT THE WRITTEN PERMISSION OF THE ENGINEER OR CONTRACTOR.

DOE CONTRACT NO. DE-AC22-92PC92205

ROBERTS & SCHAEFER
DIVISION OF E.L. & B. COMPANY, PITTSBURGH, PA.
DESIGNERS AND CONTRACTORS
CHICAGO-SALT LAKE CITY-PITTSBURGH

INSTRUMENTATION & CONTROL PANEL WIRING
VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY
BENCH-SCALE TESTING OF MGS & MICROCEL UNITS
AT PITTSBURGH ENERGY TECHNOLOGY CENTER

DATE BY	W.L.K.	PLANT	NONE	DATE	2-2-83
DESIGNED BY		REVIEWED BY		APPROVED BY	
9234-E7					

MOTOR DATA

[illegible][illegible]

[illegible]

ROBERTS & SCHAEFER DIVISION OF ELLERRE NATIONAL INDUSTRIES, INC. ENGINEERS AND CONTRACTORS CHICAGO-SALT LAKE CITY-PITTSBURGH	MOTOR DATA CHART		MAKE OF VLX	SCALE NONE	DATE 1-18-83
	VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY		PROJECT NO.	DRAWING NO.	9234-E0
	BENCH-SCALE TESTING OF MGS & MICROCEL UNITS		PROJECT BY	DRAWING BY	
	AT PITTSBURGH ENERGY TECHNOLOGY CENTER		PROJECT FOR	DRAWING FOR	

DATE	NONE	DATE	1-12-11
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9234-EO

SIDE PANEL

MCC

REV	DATE	DESCRIPTION OF REVISION	REV	DATE	DESCRIPTION OF REVISION

#	QTY.	DESCRIPTION	CATALOG #
①	1	HOFFMAN ENCLOSURE & BACKPLATE	#A-60X6118LP #A-60P60
②	1	POWER DISTRIBUTION CONTACTOR	ALLEN-BRADLEY #500F-000930
③	1	POWER DISTRIBUTION CONTACTOR	ALLEN-BRADLEY #500F-000930
④	1	POWER DISTRIBUTION TERMINAL BLOCK	ALLEN-BRADLEY #1492-PDW3141
⑤	10	SIZE 1 FVNR STARTER	ALLEN-BRADLEY #509-800
⑥	80	300V, 25A TERMINAL BLOCKS	ALLEN-BRADLEY #1492-F8
⑦	24	1-POLE, 2A, 277V RATED CIRCUIT BREAKERS	ALLEN-BRADLEY #1492-CB10020
⑧	10'	3" WIDE X 3" DEEP PANDUIT	
⑨	5'	4" WIDE X 3" DEEP PANDUIT	
⑩	1	3-POLE, 50A, 480V RATED CIRCUIT BREAKER	WESTINGHOUSE #EH03050L
⑪	6'	2" WIDE X 3" DEEP PANDUIT	
⑫	5'	4" WIDE X 3" DEEP PANDUIT	
⑬	2'	1"Wx12"Lx1/4" COPPER BAR	1"Wx12"Lx1/4" COPPER BAR
⑭	3	10A, 120V, DPDT, RELAY, ALLEN-BRADLEY	#700-HA321 #700-HN125
⑮	3	3-POLE, 3A, 600V, MAG. CIRCUIT BRKR	WESTINGHOUSE #HMCP0030A0
⑯	4	3-POLE, 7A, 600V, MAG. CIRCUIT BRKR	WESTINGHOUSE #HMCP0070C0
⑰	2	3-POLE, 15A, 600V, MAG. CIRCUIT BRKR	WESTINGHOUSE #HMCP015E0
⑱	1	3-POLE, 30A, 600V, MAG. CIRCUIT BRKR	WESTINGHOUSE #HMCP030H1
⑲	6'	MOUNTING RAIL	ALLEN-BRADLEY #1492-H1
⑳	6	HEAVY DUTY END BARRIERS	ALLEN-BRADLEY #1492-H23
㉑	3'	MOUNTING RAIL	ALLEN-BRADLEY #199-DR1
㉒	6	HEAVY DUTY END BARRIERS	ALLEN-BRADLEY #1492-H96
㉓	6	HEAVY DUTY END ANCHORS	ALLEN-BRADLEY #1492-H78
㉔	1	OPERATING MECHANISM	ALLEN-BRADLEY #1494V-M40
㉕	1	CONNECTING RODS	ALLEN-BRADLEY #1494V-RA2
㉖	1	OPERATING HANDLE	ALLEN-BRADLEY #1494V-H11

- 1) ALL 480V WIRING TO BE BLACK, 600V RATED THHN
- 2) ALL 120V WIRING TO BE RED, 600V RATED #14 MTW
- 3) ALL 24V DC WIRING TO BE BLUE, 300V RATED #14 MTW
- 4) ALL NEUTRALS TO BE WHITE

HOLD

REV	DATE	DESCRIPTION OF REVISION	REV	DATE	DESCRIPTION OF REVISION

DOE CONTRACT NO. DE-AC22-92PC92205

ROBERTS & SCHAEFER
 DIVISION OF L&L MACHINERY WORKS, INC.
 ENGINEERS AND CONTRACTORS
 CHICAGO-SALT LAKE CITY-PITTSBURGH

MCC SINGLE LINE
 VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY
 BENCH-SCALE TESTING OF MGS & MICROCEL UNITS
 AT PITTSBURGH ENERGY TECHNOLOGY CENTER

NAME OF PROJECT	S. GRAHAM	DATE	3/1/93
APPROVED BY	W. J. K.	REVISION	9234-E3

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LEGEND	
○	LOCATED IN MCC
—	TERMINAL IN MCC
△	LOCATED IN CONTROL PANEL
□	TERMINAL IN CONTROL PANEL
*	LOCATED IN FIELD

REV	DATE	DESCRIPTION OF REVISION	REV	DATE	DESCRIPTION OF REVISION

CONT'D ON E6

CONT'D ON E6

DOE CONTRACT NO. DE-AC22-92PC92205

ROBERTS & SCHAEFER
DIVISION OF CLARK MCDONALD INDUSTRIES INC.
ENGINEERS AND CONTRACTORS
CHICAGO-SALT LAKE CITY-PITTSBURGH

MCC PANEL WIRING
VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY
BENCH-SCALE TESTING OF MGS & MICROCEL UNITS
AT PITTSBURGH ENERGY TECHNOLOGY CENTER

DESIGNED BY S. GRAHAM
CHECKED BY W. L. K.
APPROVED BY

SCALE NONE
DATE 2-2-93
9234-E5

✓

[illegible]

CONT'D FROM ES

LEGEND	
○	- LOCATED IN MCC
△	- LOCATED IN CONTROL PANEL
□	- TERMINAL IN CONTROL PANEL
*	- LOCATED IN FIELD

DOE CONTRACT NO. DE-AC22-92PC92205

ROBERTS & SCHAEFER
DIVISION OF ELMER NATIONAL INDUSTRIES, INC.
ENGINEERS AND CONTRACTORS
CHICAGO-SALT LAKE CITY-PITTSBURGH

MCC PANEL WIRING
VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY
BENCH-SCALE TESTING OF MGS & MICROCELL UNITS
AT PITTSBURGH ENERGY TECHNOLOGY CENTER

DESIGNED BY S. GRAHAM	DRAWN BY NONE	DATE 2-2-93
CHECKED BY WJK	APPROVED BY	
9234-E6		◇

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