DOE/PC/91257-T25

**MOLTEN-CAUSTIC-LEACHING (GRAVIMELT)
SYSTEM INTEGRATION PROJECT**

QUARTERLY REPORT FOR APRIL THROUGH JUNE, 1989

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1. EXECUTIVE SUMMARY

Operation of the Gravimelt Integrated Test Circuit for desulfurization and demineralization of coal has been completed. A 48-test process matrix was performed over 750 hours of operational time resulting in production of 3,000 pounds of treated coal suitable for further test and evaluation. Optimization testing was performed resulting in product coal containing 0.4 percent sulfur (0.6 lbs SO₂/MMBtu) and 0.15 percent ash with more than 85 percent organic sulfur removal, 95 percent SO₂ reduction from ROM coal and 91 percent SO₂ reduction from precleaned process feed. This report contains all of the product sulfur, ash, volatiles and heat content data obtained to date.

2. INTRODUCTION AND PROCESS DESCRIPTION

TRW, under sponsorship of the Department of Energy's Pittsburgh Energy Technology Center (Contract No. DE-AC22-86-PC91257) is evaluating the Gravimelt Process in commercial equipment installed in an Integrated Test Circuit. The circuit is located at the TRW San Juan Capistrano test site in California.

The process utilizes a melt of sodium hydroxide or mixtures of sodium and potassium hydroxides at temperatures of 325° to 415°C to remove virtually all of the sulfur and mineral matter from coal. The results of an initial ten weeks of shakedown and operation of the integrated test circuit show that Eastern coals can be treated to meet New Source Performance Standards for sulfur oxides control while providing a product with heat content of 14,000 Btu per pound or greater and an ash content as low as a few hundreds of a percent.

The process is seen as a potential replacement for the costly flue gas desulfurization systems contemplated for smaller utilities and industrial boilers. The product coal might also displace oil in some turbine and diesel engines and may have application as an inexpensive preactivated or activated carbon for extraction of pollutants from waste water and can potentially be used to clean-up and concentrate radioactive or toxic waste. Process and plant descriptions are presented in the next

two sections and a summary of the tests and results of operation of the integrated test circuit are presented in the conclusion of this section.

2.1 PROCESS DESCRIPTION

A schematic of the Gravimelt process is shown in Figure 1. Feed coal is first combined with a mixture of dry sodium hydroxide or mixed sodium and potassium hydroxides in a rotary kiln reactor where the mixture is heated to reaction temperatures of 325° to 415°C causing the caustic to 1) become sorbed in the coal matrix, 2) react and then 3) dissolve the coal sulfur and mineral matter.

The reaction mixture exits the rotary kiln in the form of pellets which are next washed with water in a countercurrent separation system of filters and centrifuges. As an example, the use of four weights of wash water per weight of coal results in a coal cake containing up to two parts of wash water per part of coal exiting the last stage of the countercurrent system, and also a 50 percent aqueous reacted caustic solution exiting the first stage of filtration which contains nearly all of the coal-derived silicon, aluminum, carbonate and sulfur content. The coal-derived iron (usually 2-3 percent of the weight of the coal) and a small amount of sodium and/or potassium (0.1-2 percent of the weight of the coal) remains with the coal exiting the countercurrent filtration system.

The coal cake is next washed to remove the residual iron and caustic with, for example, three weights of process water, again in a countercurrent mode. Sulfuric acid is added to the first stage to dissolve the residual alkali and iron hydroxide. A typical coal cake entering the acid wash filtration train contains two (or as little as one-half) weights of sorbed water while the product coal exiting the train contains one tenth to one weight of sorbed water. Where two weights of wash water enter the acid wash section on the coal cake and the product coal carries one weight of water, the acid extract leaving the first stage of the acid wash section consists of four weights of water containing 250 to 5,000 ppm of mixed sodium and potassium and 5,000 to 10,000 ppm of iron.

MCL (Gravimelt) System Test Circuit Conditions

Figure 1. Gravimelt Process Flow Schematic

All of the iron sulfate and a portion of the alkali sulfates in this stream can be removed by a sequence of heating and lime treatment to form insoluble minerals. The water can be recycled.

The aqueous caustic is limed at 40° to 125°C to remove the coal derived minerals and carbonate, and the purified liquid is sent to a caustic evaporator where two weights of wash water are recovered for recycle to the first wash train while producing anhydrous caustic for reuse in extraction of coal.

2.2 INTEGRATED TEST CIRCUIT DESCRIPTION

The test circuit consists of six unit operations (see Figure 1) which together provide a continuous system for leaching coal and regenerating the caustic reactant and wash water. These units are a) a kiln for reacting molten caustic with coal, b) a seven stage water washing section for recovering caustic from the coal, c) a three stage acid washing section for removing the last traces of metals and alkali and providing an ultra pure coal product, d) a water treatment section to provide either dischargeable or recyclable water, e) a regeneration section to provide purified aqueous caustic and f) an evaporator section to provide molten caustic for recycle to the kiln reactor.

The integrated test circuit facility contains more than 160 pieces of equipment including filters, centrifuges, tanks, reactors, feeders and the kiln and rising film evaporator. It occupies 3,700 square feet and is fitted with more than 6,000 feet of piping, 425 valves, 80 instruments and controls as well as a control room with computer control and data acquisition and reduction system.

2.3 RESULTS OF SHAKEDOWN AND OPERATION

The Integrated Test Circuit was operated on an around-the-clock basis for ten operating weeks resulting in 750 hours of matrix testing over the period of time from January through May of 1989. More than 4,000 separate analyses were obtained on process streams such as product coal, slurries and filtrates. Various solids and additional analyses are yet to be performed. These data are to be assessed in detail. An initial summary is presented below.

- 1) A 48 test main parameter operational matrix has been performed with variation in kiln temperature, 325-415°C; residence time, 1-4 hours; sodium hydroxide or mixtures with potassium hydroxide; ratio of caustic to coal, 1:1 to 3:1; coal particle size 14 mesh or 6 mesh x 0; and two coals (Pittsburgh No. 8 and Kentucky No. 9) - with the Pittsburgh No. 8 seam being emphasized in this test series.

- 2) As a part of the above matrix, the plant was operated to produce Gravimelt coal with virtually no loss of heat content, no loss of volatiles, near-zero carbonate formation, 0.5 to 2 weights of moisture per weight of coal in the caustic wash section, 0.1 to 1 weights of moisture to coal in the acid wash section and can utilize sodium hydroxide in place of mixed sodium and potassium hydroxides or 6 mesh x 0 coal in place of 14 mesh x 0 coal.
- 3) Produced 3,000 lbs (dry basis) of Gravimelt coal varying in quality from 0.4 percent sulfur to 2.5 percent sulfur, 0.1 percent ash to 2.8 percent ash, 14,250 Btu/lb to 12,600 Btu/lb and volatiles from 40 percent to 21 percent.
- 4) Organic sulfur removal was at least 30 percent at the lowest temperatures utilized, where zero loss of volatiles and heat content was observed and maximized at 85 percent removal where there was minimal heat content loss.
- 5) Both Pittsburgh No. 8 and Kentucky No. 9 coals were reduced to NSPS compliance levels.
- 6) Optimization testing was performed on the Pittsburgh No. 8 coal with sodium hydroxide resulting in product coal containing 0.4 percent sulfur (.06 lbs SO₂/mmBtu) and 0.15 percent ash with more than 85 percent organic sulfur removal.
- 7) Best overall coal products (Pittsburgh No. 8) to date were prepared with NaOH at 0.40 to 0.75 percent sulfur; 0.1 to 0.65 percent ash; averaging 14,200 Btu/lb; 25 percent vols; 0.60 lbs SO₂/10⁶ Btu (95 percent SO₂ reduction from ROM and 91 percent from precleaned process feed); and 0.90 lbs SO₂/10⁶ Btu (92 percent SO₂ reduction from ROM and 86 percent from precleaned process feed).

All of the product sulfur and ash data obtained in the concluding week of operation (Pittsburgh No. 8 coal) is presented in Figure 2. This was a 4-day week due to the Memorial Day holiday. The run was made under a single set of conditions, varying only in use of NaOH for the latter part of the week and mixed sodium and potassium hydroxides at the beginning of the week. Sulfur removed averaged 93 percent from ROM and 88 percent from mine cleaned feed. Ash reduction averaged 98 percent from coal feed to the process. For several periods during the latter part of the week, the ash content was so low as to be essentially immeasurable by the standard ASTM technique.

9.

Figure 2. Integrated Test Circuit Product Data

3. PROJECT DESCRIPTION

The objective of this project is to design, construct and operate an integrated test circuit (as shown in Figure 1) for evaluation of the Gravimelt Process and production of desulfurized and demineralized coal samples.

The project consists of eight tasks for planning, design, equipment procurement, construction and shakedown, test planning, operation, data assessment and management.

4. PROJECT STATUS

Test circuit operation, product coal samples analyses and regeneration analyses are presented in the three sections to follow. The Integrated Test Circuit Operation Topical Report, which is in preparation, will contain additional data on the unit operations and data assessment. Parameter assessment and modeling of the process based on the data obtained will be performed and presented in the Final Report.

4.1 TEST CIRCUIT OPERATION SPECIFICATION

The test matrix performed during the Task 6 operation effort is presented on the following pages on a run-conditions basis.

PITT 8
KOH/NaOH=1
Caustic/Coal=1

Run	1A	3A1	3A2	3A3	6E1	6F1
Temp, C	390	427	427	427	427	427
Res Time, hr	2-2.2	2-2.8	2-3.6	2.1	2-2.8	2-2.8
Kiln RPM	2	1	1	1	1	1
Auger Speed, % max	30	30	15	30	30	30
Auger sec F/sec B	20/10	20/10	20/10	17/13	20/10	20/10

PITT 8
KOH/NaOH=1
Caustic/Coal=1.5

Run	1B	1C	8A	8B
Temp, C	390	410	427	427
Res Time, hr	2-2.2	2-2.2	2-3.0	2-3.0
Kiln RPM	2	2	0.8	0.8
Auger Speed, % max	30	30	30	30
Auger sec F/sec B	20/10	20/10	20/10	20/10

*Nitrogen flow was countercurrent to coal feed in Runs 8A and 8B. Also, 6 mesh coal was used in Run 8B.

PITT 8
KOH/NaOH=1
Caustic/Coal=2

Run	1D	2A	2B	2C	3B3	3B2	3B1	5A1	7D	7E
Temp, C	410	390	390	427	432	438	438	413	427	427
Res Time, hr	2-2.2	2-3.0	2-3.0	2-3.0	2-3.0	2-3.6	2-3.0	2-3.0	2-3.0	2-3.0
Kiln RPM	2	2/1.5/1	1	1	1	1	1	1	0.8	0.8
Auger Speed, % max	30	30	30	30	30	15	30	30	30	30
Auger sec F/sec B	20/10	20/10	20/10	20/10	17/13	20/10	20/10	20/10	20/10	20/10

*Nitrogen flow was countercurrent to coal feed in Runs 7D and 7E. Also, recycled caustic was fed with coal in Run 7D.

PITT 8
KOH/NaOH=1
Caustic/Coal=2.5

Run	9A	9A1	9B
Temp, C	427	438	438
Res Time, hr	2-3.0	2-3.0	2-3.0
Kiln RPM	0.8	0.8	0.8
Auger Speed, % max	30	30	30
Auger sec F/sec B	20/10	20/10	20/10

*Nitrogen flow was countercurrent to coal feed in Runs 9A, 9A1 and 9B. Also, recycled caustic was fed with coal in Run 9B.

PITT 8

KOH/NaOH=1

Caustic/Coal=3

Run	3C1	7C
Temp, C	438	427
Res Time, hr	2-3.0	2-3.0
Kiln RPM	1	0.8
Auger Speed, % max	30	30
Auger sec F/sec B	20/10	20/10

Nitrogen flow was countercurrent to 6 mesh coal feed in Run 7C.

PITT 8

KOH/NaOH=0

Caustic/Coal=0

Run	4A
Temp, C	410
Res Time, hr	2-2.8
Kiln RPM	1
Auger Speed, % max	30
Auger sec F/sec B	20/10

PITT 8

KOH/NaOH=0

Caustic/Coal=1

Run	6A1	6C1
Temp, C	427	410
Res Time, hr	2-2.8	2-2.8
Kiln RPM	1	1
Auger Speed, % max	30	30
Auger sec F/sec B	20/10	20/10

PITT 8

KOH/NaOH=0

Caustic/Coal=1.5

Run	6B1	6D1	8C	8D	8E
Temp, C	427	410	427	442	412
Res Time, hr	2-2.9	2-2.9	2-3.0	2-3.0	2-3.0
Kiln RPM	1	1	0.8	0.8	0.8
Auger Speed, % max	30	30	30	30	30
Auger sec F/sec B	20/10	20/10	20/10	20/10	20/10

Nitrogen flow was countercurrent to 6 mesh coal feed in Runs 8C, 8D and 8E.

PITT 8
KOH/NaOH=0
Caustic/Coal=2

Run	4C1	4C2	4C3	4C4	4C5	4C6	4C7
Temp, C	413	416	420	423	430	435	441
Res Time, hr	2-3.0	2-3.0	2-3.0	1.5-2.3*	1-1.5*	1-1.5*	1-1.5*
Kiln RPM	1	1	1	1	1	1	1
Auger Speed, % max	30	30	30	30	30	30	30
Auger sec F/sec B	20/10	20/10	20/10	20/10	20/10	20/10	20/10

* Residence time based on heated zones only.

PITT 8
KOH/NaOH=0
Caustic/Coal=2

Run	5B1	5B2	5B3	5B4	5B5	8F
Temp, C	413	420	423	430	427	412
Res Time, hr	2-3.0	2-3.0	1.5-2.3*	1-1.5*	2-3.0	2-3.0
Kiln RPM	1	1	1	1	1	0.8
Auger Speed, % max	30	30	30	30	30	30
Auger sec F/sec B	20/10	20/10	20/10	20/10	20/10	20/10

* Residence time based on heated zones only.

Nitrogen flow was countercurrent to coal feed in Run 8F.

PITT 8
KOH/NaOH=0
Caustic/Coal=2.5

Run	9C
Temp, C	438
Res Time, hr	2-3.0
Kiln RPM	0.8
Auger Speed, % max	30
Auger sec F/sec B	20/10

*Nitrogen flow was countercurrent to coal feed in Run 9C.

KENT 9
KOH/NaOH=1
Caustic/Coal=2

Run	2D	2E
Temp, C	427	438
Res Time, hr	2-3.0	2-3.0
Kiln RPM	1	1
Auger Speed, % max	30	30
Auger sec F/sec B	20/10	20/10

KENT 9
KOH/NaOH=0
Caustic/Coal=2

Run	505	504	501	502	503
Temp, C	427	427	427	399	371
Res Time, hr	2-3.0	1.5-2.3*	1-1.5*	2-3.0	2-3.0
Kiln RPM	1	1	1	1	1
Auger Speed, % max	30	30	30	30	30
Auger sec F/sec B	20/10	20/10	20/10	20/10	20/10

* Residence time based on heated zones only.

KENT 9
KOH/NaOH=1
Caustic/Coal=2.5

Run	7A
Temp, C	427
Res Time, hr	2-3.0
Kiln RPM	0.8
Auger Speed, % max	30
Auger sec F/sec B	20/10

KENT 9
KOH/NaOH=1
Caustic/Coal=3

Run	7B
Temp, C	427
Res Time, hr	2-3.0
Kiln RPM	0.8
Auger Speed, % max	30
Auger sec F/sec B	20/10

4.2. PRODUCT COAL ANALYSES

The sulfur and ash content of Integrated Test Circuit product coal is presented on an hour-by-hour basis in the plots to follow. These data are line-connected and each is followed by a run condition specification table.

Volatiles versus sulfur content and volatiles versus heat content are shown on the next set of plots.

Analyses of intermediate samples taken at the kiln exit are also shown. Approximately four hours should be added to the abscissa of these samples to align with the time of exit of the product coal collected at the final wash station. This is to correct for residence time in the water and acid wash sections.

As a point of reference it should be noted that the feed Pittsburgh No. 8 coal analyses are: 4.27 percent total sulfur; 38 percent volatiles; 2.54 percent organic sulfur; 11.57 percent ash; 13,016 Btu/lb; 14,719 MAF Btu/lb; and the feed Kentucky No. 9 analyses are: 3.53 percent total sulfur; 1.85 percent organic sulfur; 9.21 percent ash; 13,259 Btu/lb; and 14,604 MAF Btu/lb.

The final section contains a listing of all product coal together with analyses to aid in selection of samples for delivery to the DOE for testing.

**4.2.1 Sulfur and Ash Data for Product Coal
as a Function of Coal Exit Time**

MCL OPERATING DATA

RUN NUMBER 31; DEC 12-16, 1988

Product Coal From:

S10
S1E

□ PROD SUL + PROD ASH DATE / HOUR X KILN SUL Δ KILN ASH

Run Condition Summary

Shakedown Run No. 1, 12/12-12/16/88

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps 'C**
	Date From/To	Time From/To				
S1A	12/12 12/13	0800 - 1200	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	380
S1B	12/13	1200-1500	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	290
S1C	12/13	1700-2100	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	335 (Zone 1), -315 (Zones 2-4)
S1D	12/13 12/15	2200 - 2100	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	350 (Zone 1), -330 (Zones 2-4)
S1E	12/15 12/16	2200 - 0800	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	360 - ~100 @ 12/16, 0800

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* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 1; JAN 23-27, 1989

Run Condition Summary

Operating Run No. 1, 1/23-1/27/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps °C**
	Date From/To	Time From/To				
1A	1/23	0400-1430	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	390
1B1	1/23 1/24	1430 - 1630	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1.5:1	390
1B2	1/24 1/26	1630 - 0300	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1.5:1	427
1C1	1/26	0300-2330	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	427
1C2	1/26 1/27	2330 - 1400	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	438

* It has been calculated that it takes -8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature -20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 2; FEB 06-10, 1989

Run Condition Summary

Operating Run No. 2, 2/06-2/10/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps °C**
	Date From/To	Time From/To				
2A	2/06 2/07	0145 - 0225	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	390
2B	2/07	0225-1535	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	390
2C	2/07 2/08	1535 - 1815	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	427
2D	2/08 2/09	1815 - 1500	Kentucky #9 14 Mesh	NaOH:KOH (50:50)	2:1	427
2E	2/09 2/10	1500 - 1300	Kentucky #9 14 Mesh	NaOH:KOH (50:50)	2:1	438

* It has been calculated that it takes -8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature -20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 3; FEB 20-24, 1989

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Run Condition Summary

Operating Run No. 3, 2/20-2/24/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps °C****
	Date From/To	Time From/To				
3A1, A2,A3**	2/20 2/21	0130 - 0650	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	427
3B3	2/21	0720-1520	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	427
3B1,B21 B11***	2/21 2/24	1520 - 0000	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	438
3C11	2/24	0100-0830	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	3:1	438

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- * It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.
- ** Tests A1-A3 differ in kiln internal auger setting.
- *** Tests B11-B31 differ in kiln internal auger setting.
- **** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 4: MAR 06-10, 1989

Run Condition Summary

Operating Run No. 4, 3/06-3/10/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**, °C			
	Date From/To	Time From/To				Zone #1	Zone #2	Zone #3	Zone #4
4A	3/06	0130-1020	Pittsburgh #8 14 Mesh	None	Coal only	410	410	410	410
4C1	3/06 3/07	1630 - 2200	Pittsburgh #8 14 Mesh	NaOH only	2:1	421	410	410	410
4C2	3/07 3/08	2200 - 1430	Pittsburgh #8 14 Mesh	NaOH only	2:1	432	410	410	410
4C3	3/08	1540-2300	Pittsburgh #8 14 Mesh	NaOH only	2:1	449	410	410	410
23 4C4	3/09	0100-0700	Pittsburgh #8 14 Mesh	NaOH only	2:1	Heater Off	449	410	410
4C5	3/09	0810-1500	Pittsburgh #8 14 Mesh	NaOH only	2:1	Heater Off	Heater Off	449	410
4C6	3/09	1515-2300	Pittsburgh #8 14 Mesh	NaOH only	2:1	Heater Off	Heater Off	449	421
4C7	3/09 3/10	2315 - 1300	Pittsburgh #8 14 Mesh	NaOH only	2:1	Heater Off	Heater Off	449	432

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 5; MAR 20-24, 1989

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Run Condition Summary

Operating Run No. 5, 3/20-3/24/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**, °C			
	Date From/To	Time From/To				Zone #1	Zone #2	Zone #3	Zone #4
5A1	3/20 3/21	0100 - 0055	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	421	410	410	410
5B1	3/21	0055-1900	Pittsburgh #8 14 Mesh	NaOH	2:1	421	410	410	410
5B2	3/21 3/22	1900 - 0150	Pittsburgh #8 14 Mesh	NaOH	2:1	449	410	410	410
5B3	3/22	0150-1215	Pittsburgh #8 14 Mesh	NaOH	2:1	Heater Off	449	410	410
5B4	3/22	1215-1600	Pittsburgh #8 14 Mesh	NaOH	2:1	Heater Off	Heater Off	449	410
5B5	3/22 3/23	1600 - 0230	Pittsburgh #8 14 Mesh	NaOH	2:1	427	427	427	427
5C5	3/23	0230-1005	Kentucky #9 14 Mesh	NaOH	2:1	427	427	427	427
5C4	3/23	1005-1800	Kentucky #9 14 Mesh	NaOH	2:1	Heater Off	427	427	427

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

Run Condition Summary

Operating Run No. 5, 3/20-3/24/89
(Continued)

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**, °C			
	Date From/To	Time From/To				Zone #1	Zone #2	Zone #3	Zone #4
5D1	3/23 3/24	1800 - 0030	Kentucky #9 14 Mesh	NaOH	2:1	Heater Off	Heater Off	427	427
5D2	3/24	0030-0630	Kentucky #9 14 Mesh	NaOH	2:1	399	399	399	399
5D3	3/24	0630-1220	Kentucky #9 14 Mesh	NaOH	2:1	371	371	371	371

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 6; APR 03-07, 1989

□ PROD SUL

+ PROD ASH

◇ KILN SUL

△ KILN ASH

Run Condition Summary

Operating Run No. 6, 4/03-4/07/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Feed Rate lbs/hr	Kiln Skin Temps °C**
	Date From/To	Time From/To					
6A1	4/03 4/04	0400 - 0000	Pittsburgh #8 14 Mesh	NaOH	1:1	30	All zones @ 427°C
6B1	4/04	0130-1645	Pittsburgh #8 14 Mesh	NaOH	1.5:1	30	All zones @ 427°C
6C1	4/04	1645-2130	Pittsburgh #8 14 Mesh	NaOH	1:1	30	All zones @ 410°C
6D1	4/05 4/06	0000 - 0400	Pittsburgh #8 14 Mesh	NaOH	1.5:1	30	All zones @ 410°C
6E1	4/06	0515-1900	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	30	All zones @ 427°C
6F1	4/06 4/07	1900 - 0200	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	50	All zones @ 427°C
6G1	4/07	0200-1130	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	40	All zones @ 427°C

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 7; MAY 01-05, 1989

Product Coal From:

7A*: 600 Section Water Recycled to 300 Section

Run Condition Summary

Operating Run No. 7, 5/01-5/05/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**
	Date From/To	Time From/To				
7A	5/01 5/03	0000 - 2330	Kentucky #9 14 Mesh	NaOH:KOH (50:50), fresh	2.5:1	All zones @ 427°C
7B	5/04	0000-0930	Kentucky #9 14 Mesh	NaOH:KOH (50:50), fresh	3:1	All zones @ 427°C
7C	5/04	0930-2250	Pittsburgh #8 6 Mesh	NaOH:KOH (50:50), fresh	3:1	All zones @ 427°C
7D	5/04 5/05	2330 - 0730	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50), <u>partially</u> <u>regenerated</u>	2:1	All zones @ 427°C
7E	5/05	0730-1230	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50), fresh	2:1	All zones @ 427°C

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Internally measured temperature -20-25°C lower.

MCL OPERATING DATA
RUN NUMBER 8; MAY 15-19, 1989

Product Coal From:

← 9A → ← 8B → ← 8C → ← 8D → ← 8E → ← 8F →

PERCENT SULFUR or ASH

PROD SUL
 PROD ASH
 KILN SUL
 KILN ASH

Run Condition Summary

Operating Run No. 8, 5/15-5/19/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**
	Date From/To	Time From/To				
8A	5/15 5/16	0200 - 0300	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1.5:1	All zones @ 427°C
8B	5/16	0300-1820	Pittsburgh #8 6 Mesh	NaOH:KOH (50:50)	1.5:1	All zones @ 427°C
8C	5/16 5/17	1820 - 1300	Pittsburgh #8 6 Mesh	NaOH only	1.5:1	All zones @ 427°C
8D	5/17 5/18	1300 - 0415	Pittsburgh #8 6 Mesh	NaOH only	1.5:1	All zones @ 442°C
8E	5/18	0415-2000	Pittsburgh #8 6 Mesh	NaOH only	1.5:1	All zones @ 412°C
8F	5/18 5/19	2000 - 1300	Pittsburgh #8 14 Mesh	NaOH only	2:1	All zones @ 412°C

* It has been calculated that it takes -8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Internally measured temperature -20-25°C lower.

MCL OPERATING DATA RUN NUMBER 9: MAY 29-JUNE 02, 1989

Run Condition Summary

Operating Run No. 9, 5/30-6/2/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**
	Date From/To	Time From/To				
9A	5/30	0230-1730	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50), fresh	2.5:1	All zones @ 427°C
9A1	5/30 5/31	1730 - 0430	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50), fresh	2.5:1	All zones @ 438°C
9B	5/31	0530-1115	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50), regenerated	2.5:1	All zones @ 438°C
9C	5/31 6/02	1315 - 1530	Pittsburgh #8 14 Mesh	NaOH only, fresh	2.5:1	All zones @ 438°C

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Internally measured temperature ~20-25°C lower.

4.2.2 Volatiles and Heat Content Data for Product Coal as a Function of Coal Exit Time

MCL OPERATING DATA
RUN NUMBER S1; DEC 12-16, 1988

* Volatiles reading must be multiplied by a factor of 10.

Run Condition Summary

Shakedown Run No. 1, 12/12-12/16/88

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps °C**
	Date From/To	Time From/To				
S1A	12/12 12/13	0800 - 1200	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	380
S1B	12/13	1200-1500	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	290
S1C	12/13	1700-2100	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	335 (Zone 1), -315 (Zones 2-4)
S1D	12/13 12/15	2200 - 2100	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	350 (Zone 1), -330 (Zones 2-4)
S1E	12/15 12/16	2200 - 0800	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	360 - -100 @ 12/16, 0800

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 1; JAN 23-27, 1989

* Volatiles reading must be multiplied by a factor of 10.

Run Condition Summary

Operating Run No. 1, 1/23-1/27/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps °C**
	Date From/To	Time From/To				
1A	1/23	0400-1430	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	390
1B1	1/23 1/24	1430 - 1630	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1.5:1	390
1B2	1/24 1/26	1630 - 0300	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1.5:1	427
1C1	1/26	0300-2330	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	427
1C2	1/26 1/27	2330 - 1400	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	438

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 2; FEB 06-10, 1989

* Volatiles reading must be multiplied by a factor of 10.

MCL OPERATING DATA
RUN NUMBER 2; FEB 06-10, 1989

Run Condition Summary

Operating Run No. 2, 2/06-2/10/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps °C**
	Date From/To	Time From/To				
2A	2/06 2/07	0145 - 0225	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	390
2B	2/07	0225-1535	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	390
2C	2/07 2/08	1535 - 1815	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	427
2D	2/08 2/09	1815 - 1500	Kentucky #9 14 Mesh	NaOH:KOH (50:50)	2:1	427
2E	2/09 2/10	1500 - 1300	Kentucky #9 14 Mesh	NaOH:KOH (50:50)	2:1	438

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 3; FEB 20-24, 1989

* Volatiles reading must be multiplied by a factor of 10.

MCL OPERATING DATA

RUN NUMBER 3; FEB 20-24, 1989

Run Condition Summary

Operating Run No. 3, 2/20-2/24/89

Run No.	<u>Operating Time Span for Kiln*</u> Date From/To	Time From/To	Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps °C****
3A1, A2, A3**	2/20	0130 -	Pittsburgh #8	NaOH:KOH	1:1	427
	2/21	0650	14 Mesh	(50:50)		
3B3	2/21	0720-1520	Pittsburgh #8	NaOH:KOH	2:1	427
			14 Mesh	(50:50)		
3B1, B21	2/21	1520 -	Pittsburgh #8	NaOH:KOH	2:1	438
B11***	2/24	0000	14 Mesh	(50:50)		
3C11	2/24	0100-0830	Pittsburgh #8	NaOH:KOH	3:1	438
			14 Mesh	(50:50)		

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Tests A1-A3 differ in kiln internal auger setting.

*** Tests B11-B31 differ in kiln internal auger setting.

**** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA **RUN NUMBER 4; MAR 06-10, 1989**

* Volatiles reading must be multiplied by a factor of 10.

MCL OPERATING DATA RUN NUMBER 4; MAR 06-10, 1989

Run Condition Summary

Operating Run No. 4, 3/06-3/10/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**, °C			
	Date From/To	Time From/To				Zone #1	Zone #2	Zone #3	Zone #4
4A	3/06	0130-1020	Pittsburgh #8 14 Mesh	None	Coal only	410	410	410	410
4C1	3/06 3/07	1630 - 2200	Pittsburgh #8 14 Mesh	NaOH only	2:1	421	410	410	410
4C2	3/07 3/08	2200 - 1430	Pittsburgh #8 14 Mesh	NaOH only	2:1	432	410	410	410
4C3	3/08	1540-2300	Pittsburgh #8 14 Mesh	NaOH only	2:1	449	410	410	410
4C4	3/09	0100-0700	Pittsburgh #8 14 Mesh	NaOH only	2:1	Heater Off	449	410	410
4C5	3/09	0810-1500	Pittsburgh #8 14 Mesh	NaOH only	2:1	Heater Off	Heater Off	449	410
4C6	3/09	1515-2300	Pittsburgh #8 14 Mesh	NaOH only	2:1	Heater Off	Heater Off	449	421
4C7	3/09 3/10	2315 - 1300	Pittsburgh #8 14 Mesh	NaOH only	2:1	Heater Off	Heater Off	449	432

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA **RUN NUMBER 5; MAR 20-24, 1989**

* Volatiles reading must be multiplied by a factor of 10.

MCL OPERATING DATA RUN NUMBER 5; MAR 20-24, 1989

Run Condition Summary

Operating Run No. 5, 3/20-3/24/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**, °C			
	Date From/To	Time From/To				Zone #1	Zone #2	Zone #3	Zone #4
5A1	3/20 3/21	0100 - 0055	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	2:1	421	410	410	410
5B1	3/21	0055-1900	Pittsburgh #8 14 Mesh	NaOH	2:1	421	410	410	410
5B2	3/21 3/22	1900 - 0150	Pittsburgh #8 14 Mesh	NaOH	2:1	449	410	410	410
5B3	3/22	0150-1215	Pittsburgh #8 14 Mesh	NaOH	2:1	Heater Off	449	410	410
5B4	3/22	1215-1600	Pittsburgh #8 14 Mesh	NaOH	2:1	Heater Off	Heater Off	449	410
5B5	3/22 3/23	1600 - 0230	Pittsburgh #8 14 Mesh	NaOH	2:1	427	427	427	427
5C5	3/23	0230-1005	Kentucky #9 14 Mesh	NaOH	2:1	427	427	427	427
5C4	3/23	1005-1800	Kentucky #9 14 Mesh	NaOH	2:1	Heater Off	427	427	427

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

Run Condition Summary

Operating Run No. 5, 3/20-3/24/89
(Continued)

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**, °C			
	Date From/To	Time From/To				Zone #1	Zone #2	Zone #3	Zone #4
5D1	3/23 3/24	1800 - 0030	Kentucky #9 14 Mesh	NaOH	2:1	Heater Off	Heater Off	427	427
5D2	3/24	0030-0630	Kentucky #9 14 Mesh	NaOH	2:1	399	399	399	399
5D3	3/24	0630-1220	Kentucky #9 14 Mesh	NaOH	2:1	371	371	371	371

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature ~20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA

RUN NUMBER 6; APR 03-07, 1989

* Volatiles reading must be multiplied by a factor of 10.

MCL OPERATING DATA
RUN NUMBER 6: APR 03-07, 1989

Run Condition Summary

Operating Run No. 6, 4/03-4/07/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Feed Rate lbs/hr	Kiln Skin Temps °C**
	Date From/To	Time From/To					
6A1	4/03 4/04	0400 - 0000	Pittsburgh #8 14 Mesh	NaOH	1:1	30	All zones @ 427°C
6B1	4/04	0130-1645	Pittsburgh #8 14 Mesh	NaOH	1.5:1	30	All zones @ 427°C
6C1	4/04	1645-2130	Pittsburgh #8 14 Mesh	NaOH	1:1	30	All zones @ 410°C
6D1	4/05 4/06	0000 - 0400	Pittsburgh #8 14 Mesh	NaOH	1.5:1	30	All zones @ 410°C
6E1	4/06	0515-1900	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	30	All zones @ 427°C
6F1	4/06 4/07	1900 - 0200	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	50	All zones @ 427°C
6G1	4/07	0200-1130	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1:1	40	All zones @ 427°C

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Established in later runs that kiln internal equilibrium process temperature -20-25°C lower than external kiln wall skin temperature.

MCL OPERATING DATA RUN NUMBER 7; MAY 01-05, 1989

MCL OPERATING DATA
RUN NUMBER 7: MAY 01-05, 1989

Run Condition Summary

Operating Run No. 7, 5/01-5/05/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**
	Date From/To	Time From/To				
7A	5/01 5/03	0000 - 2330	Kentucky #9 14 Mesh	NaOH:KOH (50:50),fresh	2.5:1	All zones @ 427°C
7B	5/04	0000-0930	Kentucky #9 14 Mesh	NaOH:KOH (50:50),fresh	3:1	All zones @ 427°C
7C	5/04	0930-2250	Pittsburgh #8 6 Mesh	NaOH:KOH (50:50),fresh	3:1	All zones @ 427°C
7D	5/04 5/05	2330 - 0730	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50), <u>partially regenerated</u>	2:1	All zones @ 427°C
7E	5/05	0730-1230	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50),fresh	2:1	All zones @ 427°C

* It has been calculated that it takes -8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Internally measured temperature -20-25°C lower.

MCL OPERATING DATA
RUN NUMBER 8; MAY 15-19, 1989

* Volatiles reading must be multiplied by a factor of 10.

MCL OPERATING DATA
RUN NUMBER 8; MAY 15-19, 1989

Run Condition Summary

Operating Run No. 8, 5/15-5/19/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**
	Date From/To	Time From/To				
8A	5/15 5/16	0200 - 0300	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50)	1.5:1	All zones @ 427°C
8B	5/16	0300-1820	Pittsburgh #8 6 Mesh	NaOH:KOH (50:50)	1.5:1	All zones @ 427°C
8C	5/16 5/17	1820 - 1300	Pittsburgh #8 6 Mesh	NaOH only	1.5:1	All zones @ 427°C
8D	5/17 5/18	1300 - 0415	Pittsburgh #8 6 Mesh	NaOH only	1.5:1	All zones @ 442°C
8E	5/18	0415-2000	Pittsburgh #8 6 Mesh	NaOH only	1.5:1	All zones @ 412°C
8F	5/18 5/19	2000 - 1300	Pittsburgh #8 14 Mesh	NaOH only	2:1	All zones @ 412°C

* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Internally measured temperature ~20-25°C lower.

MCL OPERATING DATA

RUN NUMBER 9; MAY 29-JUNE 02, 1989

* Volatiles reading must be multiplied by a factor of 10.

Run Condition Summary

Operating Run No. 9, 5/30-6/2/89

Run No.	Operating Time Span for Kiln*		Coal Type	Caustic Type	Caustic:Coal	Kiln Skin Temps**
	Date From/To	Time From/To				
9A	5/30	0230-1730	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50), fresh	2.5:1	All zones @ 427°C
9A1	5/30 5/31	1730 - 0430	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50), fresh	2.5:1	All zones @ 438°C
9B	5/31	0530-1115	Pittsburgh #8 14 Mesh	NaOH:KOH (50:50), regenerated	2.5:1	All zones @ 438°C
9C	5/31 6/02	1315 - 1530	Pittsburgh #8 14 Mesh	NaOH only, fresh	2.5:1	All zones @ 438°C

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* It has been calculated that it takes ~8 hours for the coal to get thru the kiln and wash trains. Therefore, when relating product coal collected to kiln conditions this 8 hour lag time must be taken into account.

** Internally measured temperature ~20-25°C lower.

4.2.3 Tabulation of Product Coal Analysis Data

Quantities and Characteristics of Coal Products Collected
from MCL Operations

Run	Coal Type	Coal Product As Collected	Dry Coal Product	% Sulfur (Dry Basis)	% Ash (Dry Basis)	% Vol (Dry Basis)	Btu/lb (Dry Basis)	% Moisture
Shake-down No. 2	Pitt 8	241 lb	186 lb	2.5*	2.8*	40*	13000*	23*
1A	Pitt 8	62 lb	30 lb	1.93*	2.32	32.77	13000*	51.59*
1B	Pitt 8	192 lb	93 lb	1.93	2.08	34.88	13000*	51.59
1C	Pitt 8	125 lb	56 lb	1.43	1.32	27.40	13000*	55.10
1D	Pitt 8	171 lb	77 lb	1.39	1.12	30.36	13000*	55.17
1E	Pitt 8	42 lb	20 lb	1.93*	2.43*	30.68*	13000*	51.59*
		<u>592 lb</u>	<u>276 lb</u>					
2B	Pitt 8	84 lb	44 lb	1.93*	2.43	30.68	13000*	47.03
2C	Pitt 8	216 lb	89 lb	0.77	0.64	28.37	13092	58.83
2D	Kent 9	189 lb	84 lb	0.78	0.47	29.94	13226	55.72
2E	Kent 9	192 lb	89 lb	0.89	0.43	30.27	13000*	53.89
		<u>681 lb</u>	<u>306 lb</u>					
3B1	Pitt 8	144 lb	64 lb	0.71	0.23	20.84	12617	55.74
3C1	Pitt 8	32 lb	14 lb	0.72	0.23	20.93	12617*	56.35
		<u>176 lb</u>	<u>78 lb</u>					
4C1	Pitt 8	151 lb	72 lb	1.14	0.68	24.65	14226	52.45
4C1 ⁺	Pitt 8	19 lb	9 lb	0.77	0.64	23.73	14241	54.16
4C2	Pitt 8	154 lb	73 lb	1.25	0.54	23.91	14219	52.38
4C3	Pitt 8	85 lb	40 lb	1.22	0.52	22.36	14000*	52.52
4C4	Pitt 8	65 lb	31 lb	1.17	0.46	24.59	14201	52.89
4C5	Pitt 8	58 lb	27 lb	1.35	0.68	27.22	14000*	53.14
4C6	Pitt 8	76 lb	37 lb	1.42	0.72	27.65	14268	51.31
4C7	Pitt 8	69 lb	33 lb	1.22	0.64	26.05	14291	52.45
		<u>658 lb</u>	<u>313 lb</u>					

*Estimated values

Quantities of coal products collected are subject to confirmation

4C1⁺ represents coal product collected at 13:45, 16:00, 17:10 and 18:10 on 3/7/1989, or the first hours of Run 4C1. Compliance coal was produced during this period.

Quantities and Characteristics of Coal Products Collected
from MCL Operations (Continued)

Run	Coal Type	Coal Product As Collected	Dry Coal Product	% Sulfur (Dry Basis)	% Ash (Dry Basis)	% Vol (Dry Basis)	Btu/lb (Dry Basis)	% Moisture
5A1	Pitt 8	227 lb	124 lb	1.31	1.23	24.52	13686	55.28
5B1	Pitt 8	181 lb	81 lb	1.32	0.67	24.47	14052	55.16
5B2	Pitt 8	70 lb	30 lb	1.20	0.58	24.65	14059	56.61
5B3	Pitt 8	91 lb	41 lb	1.46	0.63	24.69	14023	54.40
5B4	Pitt 8	42 lb	19 lb	1.60	0.95	26.39	14047	55.23
5B5	Pitt 8	106 lb	48 lb	1.19	0.45	21.49	13656	54.81
5C5	Kent 9	73 lb	35 lb	1.10	0.37	22.57	13651	51.69
5C4	Kent 9	78 lb	35 lb	1.11	0.50	23.66	13918	55.73
5D1	Kent 9	40 lb	19 lb	1.46	1.03	29.48	14130	53.65
5D2	Kent 9	43 lb	21 lb	1.27	0.80	27.64	14152	52.05
		<u>1001 lb</u>	<u>453 lb</u>					
5A1	Pitt 8	91 lb	43 lb	1.60	1.14	27.65	13948*	52.24
5B1	Pitt 8	160 lb	74 lb	1.55	0.64	25.15	13948	53.93
5C1	Pitt 8	11 lb	5 lb	1.74*	1.14*	32.56*	14000*	52.24
5D1	Pitt 8	419 lb	190 lb	1.74	0.87	32.56	14150	54.74
5E1	Pitt 8	140 lb	73 lb	1.72	2.02	30.84	13000*	47.73
		<u>821 lb</u>	<u>385 lb</u>					
7A	Kent 9	571 lb	238 lb	0.71	0.55	26.36	13262	58.26
7A ⁺	Kent 9	30 lb	12 lb	0.58	0.38	25.49	13262	59.29
7B	Kent 9	85 lb	35 lb	0.56	0.27	29.07	13285	59.37
7C	Pitt 8	80 lb	33 lb	0.64	0.68	28.13	13349	58.35
7D	Pitt 8	29 lb	13 lb	0.56	0.58	28.94	12976	55.86
7E	Pitt 8	13 lb	6 lb	1.32	1.42	29.15	13349*	51.35
		<u>778 lb</u>	<u>325 lb</u>					
3A	Pitt 8	253 lb	113 lb	1.22	1.01	26.54	13359	55.14
3B	Pitt 8	106 lb	50 lb	1.35	1.95	26.12	13616	52.66
3C	Pitt 8	169 lb	82 lb	1.18	1.20	23.91	13278	51.58
3D	Pitt 8	126 lb	60 lb	0.96	1.03	24.41	13694	52.12
3D	Pitt 8	99 lb	48 lb	1.46	1.18	26.45	14001	51.34
3F	Pitt 8	112 lb	52 lb	0.97	0.54	26.19	14177	54.03
		<u>865 lb</u>	<u>405 lb</u>					

*Estimated values

Quantities of coal products collected are subject to confirmation

7A⁺ represents coal product collected at 8:15, 9:15, 10:15 and 1215 on 5/2/1989.
Compliance coal was produced during this period of 7A.

Quantities and Characteristics of Coal Products Collected
from MCL Operations (Continued)

Run	Coal Type	Coal Product As Collected	Dry Coal Product	% Sulfur (Dry Basis)	% Ash (Dry Basis)	% Vol (Dry Basis)	Btu/lb (Dry Basis)	% Moisture
DA	Pitt 8	100 lb	41 lb	0.59	0.27	25.97	13000*	58.83
DA1	Pitt 8	82 lb	35 lb	0.65	0.33	25.63	13000*	57.39
DB	Pitt 8	58 lb	26 lb	0.49	0.24	24.84	13000*	56.11
DC	Pitt 8	<u>345 lb</u>	<u>150 lb</u>	0.40	0.15	23.65**	14000*	56.49
		585 lb	252 lb					

*Estimated values

Quantities of coal products collected are subject to confirmation

**Volatile content of product coal approaches 30% near end of run

4.3 REGENERATION OF CAUSTIC SOLUTION

Although the caustic solution obtained from the current MCL operation contained less than 15 percent caustic, analysis results of the regenerator inlet (VF2037) and outlet (VF4024) samples indicate significant removal of silicon and aluminum compounds. Regeneration was conducted by the addition of lime to the caustic solution, typically at a temperature of 110°F (43°C). The VF4024 samples were acquired after the the regenerated solution was centrifuged for solids removal, followed by passing the centrate through a bag filter. The spent caustic solution was also passed through a bag filter prior to entering the regenerator. During selected runs, samples (VP2023) of the spent caustic solution were collected upstream of this bag filter. Comparison of the VF2037 and VP2023 data would provide an indication whether some of the mineral matter was removed in the bag filter even before entering the regenerator unit.

The concentration levels of aluminum, silicon and iron present in the VF2037, VF4024 and VP2023 samples are presented in Table 1. Also presented in this table are the computed concentration levels based on the coal product generation rate, assuming that all the mineral matter from coal is in solution. These computed concentration levels can be compared with the concentration levels of aluminum, silicon and iron in the VF2037 and VP2023 samples.

The data presented in Table 1 show that essentially all calculated aluminum and silicon in the coal feed were found in the caustic regenerator feed (VP2023 and VF2037). The expected aluminum and silicon concentrations in this stream are in fairly good agreement with the measured values.

For Runs 3C1, 7A, 8A, 8E and 8F, some silicon and aluminum in the caustic regeneration feed was precipitated in the bag filter. The amount precipitated is a function of the residence time in the filter tank prior to pumping to the caustic regenerator, and may also depend on the temperature and pH of the feed solution.

Table 1. Concentration Levels of Aluminum, Silicon and Iron in Spent and Regenerated Caustic

<u>Run</u>	<u>Sample</u>	<u>Al (mg/L)</u>	<u>Si (mg/L)</u>	<u>Fe (mg/L)</u>
2C	VF2037	540	1120	36
2C	VF4024	374	142	44
2C	Computed	451	805	787
3B1	VP2023	430	950	110
3B1	VF2037	453	888	105
3B1	VF4024	353	612	31
3B1	Computed	380	678	663
3C1	VP2023	540	1300	140
3C1	VF2037	515	1170	140
3C1	VF4024	400	650	30
3C1	Computed	418	746	729
5B	VF2037	482	989	65
5B	VF4024	664	411	31
5B	Computed	574	1024	1002
7A	VP2023	378	864	378
7A	VF2037	302	756	30
7A	VF4024	352	264	44
7A	Computed	521	783	711
8A	VP2023	949	2077	748
8A	VF2037	860	1873	483
8A	VF4024	659	395	28
8A	Computed	918	1637	1601
8C	VP2023	489	917	58
8C	VF2037	482	959	120
8C	VF4024	163	178	5
8C	Computed	518	924	903
8E	VP2023	311	642	88
8E	VF2037	250	531	89
8E	VF4024	379	139	11
8E	Computed	427	761	744
8F	VP2023	774	1473	225
8F	VF2037	512	1050	152
8F	VF4024	348	165	11
8F	Computed	542	966	945

For Runs 7A and 8A, iron removed from the coal feed was equally partitioned between the caustic regeneration feed (before filtration) and the acid wash water. However, a significant fraction of the iron that partitioned to the caustic regeneration feed was removed in the bag filter. For the other runs, most of the iron was found in the acid wash water and not in the caustic regeneration feed. The amount of iron in the caustic regeneration feed may depend on the concentration of the caustic solutions.

The aluminum concentration levels in VF2037 were usually higher but sometimes lower than those in the corresponding VF4024 samples. This is because the sample concentration levels represent instantaneous values which fluctuated during the course of the run. The calculated removal efficiency for aluminum ranges from 0 to 66.2 percent and averages 21.9 percent. Removal efficiency for silicon ranges from 31.1 to 87.3 percent and averages 67.2 percent. The iron concentration in the spent caustic solution was typically fairly low, as most of the iron in coal feed is partitioned to the acid wash water. Regardless of the the iron concentration in the spent caustic solution, the regenerated caustic contained 5 to 44 mg/L iron. In a concentrated caustic solution, and for treatment at higher temperatures, the removal efficiencies for both silicon and aluminum compounds are expected to be even higher.

Sulfur analyses of the solutions are being assembled and will be presented in a later report along with analyses of centrifuge solids and flaked caustic.

5. PLANNED ACTIVITIES

During the next quarter, the plant will be inspected for corrosion and erosion and mothballed for an estimated 9 month shutdown. Coal will be packaged for shipment and processing wastes will be disposed. Data assessment will be continued and topical reports will be prepared for shakedown and operation.