**Integration and Testing of Hot Desulfurization and
Entrained-Flow Gasification for Power Generation Systems,
Phase II, Process Optimization
Volume II -- Study of Zinc Titanate Desulfurization Sorbents**

Topical Report

**S.M. Harkins
G.G. Folsom
S.K. Gangwal**

Work Performed Under Contract No.: DE-FC21-87MC23277

**For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
P.O. Box 880
Morgantown, West Virginia 26507-0880**

**By
Texaco Inc.
Montebello Research Laboratory
P.O. Box 400
Montebello, California 90640**

September 1991

TABLE OF CONTENTS

Section	Page
1.0 Introduction	1
2.0 Procedures	2
2.1 Sulfidation Procedure	2
2.2 Regeneration Procedure	2
3.0 Results	4
4.0 Description of Appendices	6
5.0 Conclusions	9

LIST OF APPENDICES

Appendix A: Sorbent L-3014, Air-Blown Test	A-1
Appendix B: Sorbent L-3196, Air-Blown Test	B-1
Appendix C: Sorbent L-3014, O ₂ -Blown Test	C-1
Appendix D: Sorbent L-3196, O ₂ -Blown Test	D-1
Appendix E: Crush Strength Results	E-1
Appendix F: Samples Submitted To Texaco	F-1

LIST OF TABLES

Table 1: Average Sulfidation Conditions, Air-Blown Tests	3
Table 2: Average Sulfidation Conditions, O ₂ -Blown Test	4
Table 3: Sulfidation Test Results Summary	5
Table 4: Crush Strength Results Summary	7

1.0 INTRODUCTION

The Research Triangle Institute (RTI) performed four high-temperature desulfurization tests of zinc titanate sorbents for Texaco, Inc. Two zinc titanate sorbents (L-3196 and L-3014) were tested in fixed-bed mode with simulated oxygen-blown (medium Btu) and air-blown (low Btu) Texaco gas. The zinc titanate sorbents were manufactured as 3/16-in. cylindrical extrudates by United Catalysts, Inc. Tests were performed in a high-temperature, high-pressure, fixed-bed sorbent test unit originally constructed and used on Department of Energy (DOE) contract DE-AC21-86 MC23126, DOE Office of Fossil Energy, Morgantown Energy Technology Center (METC). The test unit is described in detail in the December 1988 final report for this contract.

Of the four tests conducted, two tests were conducted for the L-3014 sorbent and two tests were conducted for the L-3196 sorbent. The main difference between the two sorbents was their zinc to titanium molar ratio (0.8 for L-3014, 1.5 for L-3196). Properties of these sorbents are described in detail in the Final Report for DOE Contract No. DE-AC21-86MC23126. Two tests were conducted for each sorbent; one test was conducted with simulated Texaco air-blown gasifier gas and one test was conducted with simulated Texaco oxygen-blown gasifier gas.

Each test consisted of five cycles. Each cycle was composed of reductive regeneration, sulfidation, and oxidative regeneration steps. After the fifth sulfidation and after the fifth oxidative regeneration of each test, samples were collected and sent to Texaco. In the following sections, the test procedures are briefly described followed by details of the important results.

2.0 PROCEDURES

2.1 Sulfidation Procedure

Each sulfidation began with approximately 35 min of reductive regeneration. The reduction regeneration time was intended to simulate conditions in a long fixed bed where a majority of the sorbent would be exposed to nearly H₂S-free reducing gas. The inlet gas used during reductive regeneration was identical to the sulfidation gas, except that N₂ or H₂ was substituted for H₂S. Both reductive regeneration and sulfidation were performed with gas flowing from the bottom to the top of the sorbent bed. The outlet gas was analyzed at 6-min intervals by gas chromatography (GC) with a flame photometric detector (FPD). The gas was analyzed for H₂S, COS, and SO₂. Sulfur in the gas was reported on a dry gas basis since steam was condensed prior to analysis. The GC-FPD was calibrated just prior to the start of each sulfidation test using 10 ppm H₂S in N₂. Analysis of the fixed gases (N₂, CO, CO₂, H₂, and CH₄) was performed at 25-min intervals. The sulfidation began (time = 0 min) after the reductive regeneration, with the addition of H₂S to the inlet gas. Average sulfidation conditions for tests with simulated air- and oxygen- blown Texaco gasifier gases are listed in Tables 1 and 2, respectively. Each sulfidation continued until the outlet gas H₂S concentration exceeded 120 ppm H₂S.

2.2 Regeneration Procedure

The sulfided sorbent was oxidatively regenerated at 150 psia using a mixture of air and nitrogen. Regeneration was performed in the reverse direction from sulfidation, with regeneration gas entering the top of the bed and exiting the bottom. Regeneration began with an initial bed temperature of approximately 675 °C (1247 °F) with air and nitrogen (N₂/air molar ratio of 11 to 18) at a total flow of 50 slpm. Reactor furnace zones were set at 675 °C

Table 1. Average Sulfidation Conditions, Air-Blown Tests

Pressure	23.8 atm = 350 psia	
Bed Temperature	707.6 °C = 1306 °F	
Space Velocity	1950 scf/(cf × h)	
Sorbent Volume	1737 cm ³	
Bed Dimensions	3" dia × 15" high	
Sulfidation Gas Compositions	Inlet (%)	Outlet (%)
H ₂	10.96	14.32
CO ₂	6.37	10.43
H ₂ O	11.20	9.23
H ₂ S	1.02	0.00
N ₂	54.92	54.20
CO	15.53	11.91
CH ₄	0.00	0.01
Total	100.00	100.00

top zone, 675 °C middle zone, and 680 °C bottom zone. Temperatures within the bed were monitored with thermocouples spaced at 2.5 in. intervals. The air flow rate into the bed was adjusted during the test to keep maximum bed temperatures below 780 °C. The outlet gas O₂, SO₂, and N₂ concentrations were measured at 25-min intervals using a Carle GC with a thermal conductivity detector. When the maximum bed temperature dropped below 750 °C (with an N₂/air ratio of approximately 7), additional heat was introduced by heating the bottom furnace zone to 800 °C. The air and nitrogen flows were each reduced 50% after significant amounts of oxygen were detected in the outlet gas. This flow reduction allowed more even heating of the bed by the furnaces during this part of the regeneration. Toward the

Table 2. Average Sulfidation Conditions, O₂-Blown Tests

Pressure	23.8 atm = 350 psia	
Bed Temperature	713.8 °C = 1317 °F	
Space Velocity	1949 scf/(cf × h)	
Sorbent Volume	1737 cm ³	
Sulfidation Gas Compositions		
	Inlet (%)	Outlet (%)
H ₂	31.10	38.66
CO ₂	9.42	13.80
H ₂ O	18.24	11.53
H ₂ S	1.03	0.53
N ₂	0.00	0.35
CO	40.21	35.62
CH ₄	0.00	0.04
Total	100.00	100.00

end of the regeneration the outlet gas was analyzed by the GC-FPD. When the measured SO₂ concentration fell below 500 ppm, the oxidative regeneration was terminated. Hot spots occurred in the bed during most oxidative regenerations, and this required frequent adjustment of the inlet air flow to maintain proper bed temperatures.

3.0 RESULTS

A summary of the sulfidation results is provided in Table 3. This table lists the test, measured breakthrough time and concentration, average prebreakthrough H₂S concentration, and sorbent sulfur loading at breakthrough. Average prebreakthrough H₂S concentrations did not show significant differences between the two sorbents. Prebreakthrough H₂S

Table 3. Sulfidation Test Results Summary

Run #	Test	Description	Sulf. No.	Sorbent Weight (g)	Breakthrough time (min)	H ₂ S Conc. (ppm)	Sorbent Loading (lb sulfur)/(100 lb sorbent)	Average Prebreakthrough H ₂ S Concentration (ppm)	Times (min)	
									Start	End
90503	L-3014	Air Blown	1	1529.3	190	131	10.3	12.4	28	130
90505	L-3014	Air Blown	2	1529.3	196	199	10.6	7.2	28	130
90508	L-3014	Air Blown	3	1529.3	184	201	10.0	7.0	28	130
90509	L-3014	Air Blown	4	1529.3	184	165	10.0	8.3	28	130
90510	L-3014	Air Blown	5	1529.3	184	176	10.0	8.3	28	130
Average							10.2	8.6		
90516	L-3196	Air Blown	1	1575.0	258	161	13.6	7.7	30	180
90517	L-3196	Air Blown	2	1575.0	252	139	13.2	8.6	30	180
90518	L-3196	Air Blown	3	1575.0	252	146	13.2	9.0	30	180
90519	L-3196	Air Blown	4	1575.0	240	146	12.6	8.7	30	180
90522	L-3196	Air Blown	5	1575.0	240	149	12.6	7.5	30	180
Average							13.0	8.3		
90525	L-3014	O ₂ Blown	1	1501.7	186	126	10.2	11.6	30	120
90526	L-3014	O ₂ Blown	2	1501.7	168	110	9.2	12.8	30	120
90530	L-3014	O ₂ Blown	3	1501.7	174	177	9.6	13.6	30	120
90531	L-3014	O ₂ Blown	4	1501.7	174	166	9.6	14.7	30	120
90601	L-3014	O ₂ Blown	5	1501.7	174	154	9.6	15.4	30	120
Average							9.6	13.6		
90606	L-3196	O ₂ Blown	1	1527.8	210	115	11.3	16.3	30	150
90607	L-3196	O ₂ Blown	2	1527.8	198	137	10.6	17.7	30	150
90608	L-3196	O ₂ Blown	3	1527.8	210	126	11.3	14.0	30	150
90609	L-3196	O ₂ Blown	4	1527.8	216	165	11.7	13.4	30	150
90613	L-3196	O ₂ Blown	5	1527.8	228	136	12.3	11.7	30	150
Average							11.4	14.6		

concentrations for the air-blown tests were slightly lower than for the oxygen-blown tests (8.6 and 8.3 ppm v. 13.6 and 14.6 ppm). Due to its higher ZnO content, sorbent L-3196 showed a higher sorbent loading at breakthrough than sorbent L-3014. This increase in sorbent loading

was smaller for the oxygen-blown tests (18.7% increase in sorbent loading for L-3196 as compared to L-3014) than for the air-blown tests (28.1% increase).

Crush strength tests were performed on sorbent samples removed after the fifth sulfidation for each test series. These results (and the crush strength of the original sorbents) are summarized in Table 4. The original sorbents had crush strengths of 2.78 lb/mm (L-3014) and 2.39 lb/mm (L-3196). There was no significant decrease in sorbent crush strength and some samples showed higher crush strengths than the original material. Also, oxygen-blown gasifier gas did not weaken the sorbents any more than the air-blown gasifier gas. This is a very significant result and shows zinc titanate's clear superiority over zinc ferrite.

4.0 DESCRIPTION OF APPENDICES

The collected data during the tests are organized into four appendices, as described below:

Appendix A Sorbent L-3014, Air-Blown Test Data

Appendix B Sorbent L-3196, Air-Blown Test Data

Appendix C Sorbent L-3014, O₂-Blown Test Data

Appendix D Sorbent L-3196, O₂-Blown Test Data

Each appendix contains a run summary for the five sulfidation cycles performed. These run summaries show run conditions and sorbent sulfur loading at breakthrough. Average temperatures were calculated from the in-bed thermocouple outputs (stored at 10-min intervals).

Three plots in each appendix summarize the outlet H₂S, COS, and SO₂ gas concentrations measured during the sulfidations. The breakthrough curves begin before time = 0 so that data collected during reductive regeneration are also shown. The sulfidation for

Table 4. Crush Strength Results Summary

Sample	Crush Strength		Density (g/cc)
	Ave. (lb/mm)	SDev (lb/mm)	
L-3014, Unused	2.78	0.61	1.50
L-3196, Unused	2.39	0.47	1.70
L-3014, Air Blown, Sulfided, 90510			
Zone #1, Top	3.00	0.51	1.65
Zone #2	2.24	0.58	1.69
Zone #3	2.35	0.47	1.86
Zone #4	2.09	0.20	1.57
Zone #5, Bottom	2.14	0.69	1.78
L-3196, Air Blown, Sulfided, 90522			
Zone #1, Top	3.95	1.01	1.80
Zone #2	2.68	0.88	1.77
Zone #3	2.16	0.43	1.90
Zone #4	2.57	0.32	1.92
Zone #5, Bottom	1.95	0.96	2.02
L-3014, O₂ Blown, Sulfided, 90601			
Zone #1, Top	3.18	1.06	1.56
Zone #2	2.84	0.57	1.65
Zone #3	2.54	0.53	1.71
Zone #4	2.82	0.48	1.82
Zone #5, Bottom	2.96	0.64	1.96
L-3196, O₂ Blown, Sulfided, 90613			
Zone #1, Top	3.56	0.87	1.66
Zone #2	4.17	1.44	1.84
Zone #3	2.47	0.71	1.80
Zone #4	1.86	0.37	1.91
Zone #5, Bottom	2.22	0.47	1.70

these plots begins at time = 0. Carbonyl sulfide (COS) appeared in the outlet gas during reductive regeneration and at the end of the sulfidations as H₂S concentrations began to increase rapidly. The detection limit for COS was approximately 0.5 ppm. No COS was

detected during reductive regeneration of sorbent L-3014. SO_2 concentrations were measured during reductive regeneration and for several minutes after the start of sulfidation. SO_2 concentrations early in reductive regeneration are approximate since these concentrations were not within the linear range of the GC-FPD. Reductive regeneration time was not identical for each test, so time shifts in the SO_2 curves are not significant.

Regeneration summaries are included for each oxidative regeneration of sulfided sorbents. These list the measured outlet gas compositions, inlet composition and flow rate, and N_2/air molar ratio at 25-min intervals during regeneration. The total oxidative regeneration times are also listed.

Fresh sorbent samples were loaded for each of the four test series. The sorbent was used for five sulfidations, after which the sorbent was removed from the bed in five sections and sampled. The sulfided sorbent sections were then replaced into the reactor in the same positions they originally occupied. The sorbent was then oxidatively regenerated (fifth regeneration), cooled, and removed from the bed in sections. The sorbent sample summary sheet summarizes the weight and volume of sorbent used for each test, the weight and volumes of sections removed after the fifth sulfidation, the sulfided samples removed, and the regenerated samples removed after the fifth regeneration. The bulk density of sorbent in each bed section and the total bed are calculated.

Five pellets from each sulfided bed section were removed for crush strength measurement. The dimensions, weight, and crush strength of each tested pellet are listed. The crushed pressure (psi) in these tables refers to the measured air pressure on a piston used in the test. The force (in lb) applied to the pellet is 3.98 times this measured pressure. The

pellet densities reported here are based solely on the measured weight and geometric dimensions of the pellets.

Appendix E contains the crush strength results for the original, unused sorbent pellets. Ten pellets were tested for each of these fresh sorbents. Appendix F lists the samples submitted to Texaco from the testing. Three of the regenerated samples were destroyed and discarded by UPS in transit to Texaco.

5.0 CONCLUSIONS

Based on the results of testing, the following major conclusions are made:

- Both zinc titanate sorbents performed very well with either simulated air-blown or oxygen-blown Texaco syn-gas.
- Up to 60% of theoretical sulfur capacity was achieved with a bed of height to diameter ratio of 5 and with a wet gas space velocity of $\sim 2000 \text{ h}^{-1}$ at 350 psia by both sorbents.
- The sorbents did not show a statistically significant decline in either capacity or crush strength over five cycles.
- Due to its higher capacity, L-3196 is preferred over L-3014 for commercial application at $\sim 700^\circ\text{C}$.

APPENDIX A
SORBENT L-3014, AIR-BLOWN TEST

RUN SUMMARY

RUN NUMBER: TEXACO 90503

DATE: 5/3/89

SORBENT: L-3014

RUN TYPE: Sulfidation

CYCLE NO.: 1

SORBENT LOADED:

Weight (g): 1529.3
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	702.1	1295.8
Maximum Bed	725.7	1338.3
Minimum Bed	682.3	1260.1

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1938

LINEAR VELOCITY (cm/s): 3.09

RUN TIME (min): 190

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	10.99	14.14
CO2	6.12	10.18
H2O	11.24	9.64
H2S	1.02	—
N2	55.07	54.03
CH4	0.000	0.000
CO	15.57	12.01
Total	100.000	100.000
Flow Rate (SLPM)	56.750	55.467

11

2.31 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 10.27

RUN SUMMARY

RUN NUMBER: TEXACO 90505

DATE: 5/5/89

SORBENT: L-3014

RUN TYPE: Sulfidation

CYCLE NO. 2

SORBENT LOADED:

Weight (g):	1529.3
Volume (cm3):	1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	706.5	1303.7
Maximum Bed	725.2	1337.4
Minimum Bed	685.1	1265.2

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1942

LINEAR VELOCITY (cm/s): 3.11

RUN TIME (min): 196

GAS COMPOSITIONS (%):

INLET

OUTLET

H2	10.99	13.83
CO2	6.10	10.08
H2O	11.24	9.85
H2S	1.02	—
N2	55.08	54.24
CH4	0.000	0.000
CO	15.57	12.00

Total	100.000	100.000
-------	---------	---------

Flow Rate (SLPM)	56.738	—	—	55.701

1.86 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 10.60

RUN SUMMARY

RUN NUMBER: TEXACO 90508

DATE: 5/8/89

SORBENT: L-3014

RUN TYPE: Sulfidation

CYCLE NO. 3

SORBENT LOADED:

Weight (g):	1529.3
Volume (cm3):	1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	705.9	1302.6
Maximum Bed	713.3	1315.9
Minimum Bed	682.9	1261.2

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1936

LINEAR VELOCITY (cm/s): 3.09

RUN TIME (min): 184

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	11.00	13.86
CO2	6.05	10.30
H2O	11.24	9.96
H2S	1.02	—
N2	55.11	54.03
CH4	0.000	0.018
CO	15.58	11.83
Total	100.000	100.000
Flow Rate (SLPM)	56.709	55.387

11

2.39 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 9.95

RUN SUMMARY

RUN NUMBER: TEXACO 90509

DATE: 5/9/89

SORBENT: L-3014

RUN TYPE: Sulfidation

CYCLE NO. 4

SORBENT LOADED:

Weight (g): 1529.3
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	711.4	1312.5
Maximum Bed	728.4	1343.1
Minimum Bed	686	1266.8

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1951

LINEAR VELOCITY (cm/s): 3.14

RUN TIME (min): 184

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	10.97	13.99
CO2	6.31	10.36
H2O	11.21	9.52
H2S	1.02	—
N2	54.95	54.35
CH4	0.000	0.018
CO	15.54	11.76
Total	100.000	100.000
Flow Rate (SLPM)	56.866	— — 56.117

11

1.33 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 9.95

RUN SUMMARY

RUN NUMBER: TEXACO 90510

DATE: 5/10/89

SORBENT: L-3014

RUN TYPE: Sulfidation

CYCLE NO. 5

SORBENT LOADED:

Weight (g): 1529.3
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	710.6	1311.1
Maximum Bed	725.5	1337.9
Minimum Bed	684.7	1264.5

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1949

LINEAR VELOCITY (cm/s): 3.13

RUN TIME (min): 184

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	10.97	14.29
CO2	6.26	10.39
H2O	11.22	9.26
H2S	1.02	—
N2	54.98	54.33
CH4	0.000	0.009
CO	15.55	11.72
Total	100.000	100.000
Flow Rate (SLPM)	56.834	— — 56.019

1 1

1.46 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 9.95

H2S BREAKTHROUGH

L-3014, AIR BLOWN

COS BREAKTHROUGH

L-3014, AIR BLOWN

OUTLET SO2 L-3014, AIR BLOWN

SORBENT L-3014, AIR BLOWN GAS, 1ST REGENERATION, 90503

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
35	0.45	2.80	96.75	3.25	96.75	59.2	5.5
60	1.06	0.17	98.77	1.23	98.77	53.1	16.1
85	0.99	0.17	98.84	1.16	98.84	52.9	17.0
110	0.97	0.17	98.86	1.15	98.86	52.9	17.3
135	0.91	0.13	98.96	1.04	98.96	52.6	19.2
160	0.98	0.24	98.79	1.21	98.79	53.1	16.3
185	0.99	0.42	98.59	1.42	98.59	53.6	13.8
210	1.17	0.19	98.64	1.36	98.64	53.5	14.5
235	0.55	2.77	96.68	3.32	96.68	29.7	5.3

SORBENT L-3014, AIR BLOWN GAS, 2ND REGENERATION, 90505

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
18	1.61	0.03	98.36	1.64	98.36	48.8	11.8
43	1.48	0.14	98.38	1.62	98.38	48.8	12.0
68	1.08	0.16	98.77	1.23	98.77	47.8	16.0
93	1.25	0.39	98.36	1.64	98.36	48.8	11.8
118	1.15	1.06	97.79	2.21	97.79	50.3	8.5
143	0.78	2.67	96.56	3.44	96.56	53.8	5.1

SORBENT L-3014, AIR BLOWN GAS, 3RD REGENERATION, 90509

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
11	2.09	0.03	97.88	2.12	97.79	50.3	8.5
36	1.75	0.03	98.21	1.79	98.13	49.4	10.2
61	2.29	0.26	97.45	2.55	97.40	51.4	7.1
86	1.27	1.12	97.60	2.39	97.53	51.0	7.5
111	1.03	1.54	97.43	2.57	97.37	51.4	7.0
136	1.98	0.45	97.57	2.43	97.52	51.0	7.5
161	0.76	1.02	98.21	1.78	98.14	49.4	10.3
186	0.75	1.45	97.80	2.20	97.75	50.4	8.3
211	0.35	2.08	97.57	2.43	97.49	25.6	7.4
236	0.06	2.76	97.18	2.82	97.11	26.1	6.3

SORBENT L-3014, AIR BLOWN GAS, 4TH REGENERATION, 90510

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
8	1.45	0.04	98.51	1.48	98.43	48.6	12.3
33	1.91	0.10	97.99	2.01	97.94	49.9	9.2
58	2.30	0.15	97.55	2.45	97.49	51.1	7.4
83	2.52	0.38	97.09	2.91	97.04	52.4	6.1
108	1.18	1.03	97.80	2.20	97.48	51.1	7.3
133	1.72	0.05	98.23	1.76	97.74	50.4	8.3
158	0.63	1.85	97.53	2.47	97.48	51.1	7.3
183	0.83	1.35	97.82	2.18	97.77	25.2	8.4

SORBENT L-3014, AIR BLOWN GAS, 5TH REGENERATION, 90511

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
20	1.59	0.04	98.37	1.63	98.30	49.0	11.4
45	1.28	1.12	97.60	2.40	97.55	50.9	7.6
70	1.85	0.54	97.61	2.39	97.56	50.9	7.6
95	2.40	0.84	96.76	3.24	96.72	53.3	5.4
120	1.25	1.62	97.13	2.87	97.13	52.1	6.3
145	2.00	0.40	97.60	2.40	97.55	50.9	7.6
170	0.53	1.88	97.59	2.41	97.54	51.0	7.5
195	0.07	2.67	97.26	2.74	97.20	26.0	6.5

L-3014 AIR BLOWN TESTS

	WEIGHT (g)	VOLUME (cm ³)	BULK DENSITY (lb/ft ³)
SORBENT LOADED	1529.3	1737	54.96

REMOVED AFTER 5TH SULFIDATION (90510)

SECTION	WEIGHT (g)	VOLUME (cm ³)	SAMPLE REMOVED (g)	SAMPLE REPLACED (g)	BULK DENSITY (lb/ft ³)
1, TOP	285.22	330	30.21	255.01	53.96
2	321.15	350	29.55	291.60	57.28
3	337.22	350	29.36	307.86	60.15
4	319.97	350	30.04	289.93	57.07
5, BOTTOM	335.60	350	31.14	304.46	59.86
TOTAL	1599.16	1730	150.30	1448.86	57.71 (AVE)

REMOVED AFTER 5TH REGENERATION (90511)

SECTION	WEIGHT (g)	VOLUME (cm ³)	BULK DENSITY (lb/ft ³)
1, TOP	284.20	325	54.59
2	261.20	310	52.60
3	299.43	340	54.98
4	273.47	320	53.35
5, BOTTOM	278.61	325	53.52
TOTAL	1396.91	1620	53.83 (AVE)

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90510 #1	1	0.64	14.50	5.9	10.9	2.99
	2	0.28	7.20	5.5	7.0	3.87
	3	0.50	12.50	5.6	8.8	2.80
	4	0.36	8.70	5.6	5.0	2.29
	5	0.31	7.80	5.6	6.0	3.06
	AVE	0.42	10.14	5.64	7.54	3.00
	SDEV	0.13	2.86	0.14	2.10	0.51
Average Pellet Density (g/cc)					1.65	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90510 #2	1	0.48	12.00	5.5	5.7	1.89
	2	0.42	9.00	5.7	6.2	2.74
	3	0.35	8.50	5.8	4.6	2.15
	4	0.59	14.50	5.7	5.1	1.40
	5	0.43	10.20	5.4	7.7	3.00
	AVE	0.45	10.84	5.62	5.86	2.24
	SDEV	0.08	2.19	0.15	1.07	0.58
Average Pellet Density (g/cc)					1.69	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90510 #3	1	0.30	6.10	5.5	3.9	2.54
	2	0.43	10.80	5.5	8.6	3.17
	3	0.35	7.50	5.5	3.5	1.86
	4	0.39	7.50	5.7	3.7	1.96
	5	0.39	9.90	5.4	5.5	2.21
	AVE	0.37	8.36	5.52	5.04	2.35
	SDEV	0.04	1.73	0.10	1.92	0.47
Average Pellet Density (g/cc)					1.86	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90510 #4	1	0.33	9.60	5.5	5.9	2.45
	2	0.29	7.50	5.5	4.0	2.12
	3	0.47	10.80	5.8	5.2	1.92
	4	0.34	8.80	5.6	4.2	1.90
	5	0.31	8.50	5.5	4.4	2.06
	AVE	0.35	9.04	5.58	4.74	2.09
	SDEV	0.06	1.11	0.12	0.71	0.20
Average Pellet Density (g/cc)					1.57	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90510 #5	1	0.47	10.60	5.4	3.9	1.46
	2	0.40	9.20	5.5	5.0	2.16
	3	0.31	8.70	5.3	3.5	1.60
	4	0.23	7.00	5.1	6.0	3.41
	5	0.39	8.60	5.7	4.5	2.08
	AVE	0.36	8.82	5.40	4.58	2.14
	SDEV	0.08	1.16	0.20	0.87	0.69
Average Pellet Density (g/cc)					1.78	

APPENDIX B
SORBENT L-3196, AIR-BLOWN TEST

RUN SUMMARY

RUN NUMBER: TEXACO 90516

DATE: 5/16/89

SORBENT: L-3196

RUN TYPE: Sulfidation

CYCLE NO. 1

SORBENT LOADED:

Weight (g): 1575
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	718.3	1324.9
Maximum Bed	743.8	1370.8
Minimum Bed	692.3	1278.1

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1953

LINEAR VELOCITY (cm/s): 3.16

RUN TIME (min): 258

GAS COMPOSITIONS (%):

INLET

OUTLET

H2	10.95	14.50
CO2	6.41	10.41
H2O	11.20	9.01
H2S	1.02	—
N2	54.90	54.26
CH4	0.000	0.009
CO	15.52	11.82

Total	100.000	100.000
-------	---------	---------

Flow Rate (SLPM)	56.923	—	—	56.129
------------------	--------	---	---	--------

11

1.42 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 13.55

RUN SUMMARY

RUN NUMBER: TEXACO 90517

DATE: 5/17/89

SORBENT: L-3196

RUN TYPE: Sulfidation

CYCLE NO. 2

SORBENT LOADED:

Weight (g): 1575
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	717	1322.6
Maximum Bed	740.4	1364.7
Minimum Bed	695.8	1284.4

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1964

LINEAR VELOCITY (cm/s): 3.17

RUN TIME (min): 252

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	10.92	14.60
CO2	6.72	10.48
H2O	11.16	8.71
H2S	1.01	—
N2	54.72	54.30
CH4	0.000	0.027
CO	15.47	11.89
Total	100.000	100.000
Flow Rate (SLPM)	57.113	56.592

11

0.92 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 13.23

RUN SUMMARY

RUN NUMBER: TEXACO 90518

DATE: 5/18/89

SORBENT: L-3196

RUN TYPE: Sulfidation

CYCLE NO. 3

SORBENT LOADED:

Weight (g): 1575
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	703	1297.4
Maximum Bed	730	1346.0
Minimum Bed	650.4	1202.7

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1953

LINEAR VELOCITY (cm/s): 3.11

RUN TIME (min): 252

GAS COMPOSITIONS (%):

INLET

OUTLET

H2	10.96	14.42
CO2	6.35	10.46
H2O	11.21	9.05
H2S	1.02	—
N2	54.93	54.40
CH4	0.000	0.009
CO	15.53	11.67
Total	100.000	100.000

Flow Rate (SLPM)	56.886	— —	56.217
		1 1	

1.19 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 13.23

RUN SUMMARY

RUN NUMBER: TEXACO 30519

DATE: 5/19/89

SORBENT: L-3196

RUN TYPE: Sulfidation

CYCLE NO. 4

SORBENT LOADED:

Weight (g):	1575
Volume (cm3):	1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	712.3	1314.1
Maximum Bed	735.4	1355.7
Minimum Bed	689.4	1272.9

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1941

LINEAR VELOCITY (cm/s): 3.12

RUN TIME (min): 240

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	10.99	14.40
CO2	6.14	10.54
H2O	11.23	3.33
H2S	1.02	—
N2	55.05	54.11
CH4	0.000	0.009
CO	15.57	11.62
Total	100.000	100.000
Flow Rate (SLPM)	56.762	— — 55.595

11

2.10 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 12.60

RUN SUMMARY

RUN NUMBER: TEXACO 90522

DATE: 5/22/89

SORBENT: L-3196

RUN TYPE: Sulfidation

CYCLE NO. 5

SORBENT LOADED:

Weight (g):	1575
Volume (cm3):	1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	688.5	1271.3
Maximum Bed	710.9	1311.6
Minimum Bed	664.6	1228.3

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1976

LINEAR VELOCITY (cm/s): 3.10

RUN TIME (min): 240

GAS COMPOSITIONS (%):

INLET

OUTLET

H2	10.85	15.21
CO2	7.28	11.07
H2O	11.10	7.95
H2S	1.01	—
N2	54.39	53.99
CH4	0.000	0.028
CO	15.38	11.75

Total	100.000	100.000
-------	---------	---------

Flow Rate (SLPM)	57.458	—	—	56.957
------------------	--------	---	---	--------

11

0.88 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 12.60

H2S BREAKTHROUGH

L-3196, AIR BLOWN

COS BREAKTHROUGH

L-3196, AIR BLOWN

OUTLET SO2 L-3196, AIR BLOWN

SORBENT L-3196, AIR BLOWN GAS, 1ST REGENERATION, 90516

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
10	1.52	0.07	98.41	1.59	98.41	48.7	12.2
35	1.75	0.07	98.18	1.82	98.18	49.3	10.5
60	2.41	0.06	97.53	2.47	97.53	51.0	7.5
85	1.58	0.05	98.36	1.64	98.36	48.8	11.8
110	2.48	0.08	97.44	2.56	97.44	51.3	7.2
135	1.72	0.18	98.10	1.90	98.10	49.5	10.1
160	2.83	0.41	96.76	3.24	96.76	53.2	5.5
185	1.48	0.95	97.57	2.43	97.57	50.9	7.7
210	1.02	1.56	97.43	2.57	97.43	51.3	7.2
235	0.56	2.13	97.31	2.69	97.31	25.8	6.8

SORBENT L-3196, AIR BLOWN GAS, 2ND REGENERATION, 90518

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
27	1.65	0.10	98.26	1.74	98.26	49.1	11.0
52	2.33	0.05	97.61	2.39	97.61	50.8	7.8
77	1.82	0.05	98.13	1.87	98.13	49.4	10.2
102	1.76	0.11	98.13	1.87	98.13	49.4	10.2
127	2.13	0.21	97.66	2.34	97.66	50.6	8.0
152	2.23	0.17	97.60	2.40	97.60	25.4	7.8
177	2.02	0.26	97.72	2.28	97.72	25.2	8.2
202	3.61	0.91	95.49	4.51	95.49	28.7	3.7
227	1.50	1.95	96.55	3.45	96.55	26.9	5.1
252	1.35	2.36	96.29	3.71	96.29	27.3	4.7
277	0.46	3.58	95.97	4.03	95.97	27.9	4.2
302	0.11	4.10	95.79	4.21	95.79	28.1	4.0

SORBENT L-3196, AIR BLOWN GAS, 3RD REGENERATION, 90519

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
16	1.83	0.07	98.11	1.89	98.11	49.5	10.1
41	1.76	0.29	97.95	2.05	97.95	49.9	9.2
81	1.63	0.04	98.33	1.67	98.33	48.9	11.5
106	1.60	0.04	98.36	1.64	98.36	48.8	11.8
131	1.46	0.13	98.41	1.59	98.41	48.7	12.2
156	1.29	0.30	98.41	1.59	98.41	48.7	12.2
181	1.52	0.86	97.62	2.38	97.62	50.8	7.8
206	0.86	1.61	97.53	2.47	97.53	51.0	7.5
231	0.38	2.73	96.89	3.11	96.89	52.8	5.7

SORBENT L-3196, AIR BLOWN GAS, 4TH REGENERATION, 90522

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
7	1.22	0.04	98.74	1.26	98.74	47.9	15.7
32	1.78	0.04	98.18	1.82	98.18	49.3	10.5
84	1.61	0.04	98.35	1.65	98.35	48.8	11.7
109	1.26	0.04	98.71	1.29	98.71	48.0	15.2
134	1.25	0.04	98.71	1.29	98.71	47.9	15.3
159	1.58	0.07	98.36	1.64	98.36	48.8	11.8
184	1.42	0.20	98.39	1.61	98.39	48.7	12.0
209	1.61	0.65	97.74	2.26	97.74	50.4	8.3
234	1.04	1.42	97.54	2.46	97.54	25.5	7.5
259	1.06	3.14	95.79	4.21	95.79	28.1	4.0
284	0.11	4.93	94.97	5.03	94.97	29.6	3.2
309	0.01	5.14	94.85	5.15	94.85	29.8	3.1

SORBENT L-3196, AIR BLOWN GAS, 5TH REGENERATION, 90523

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
23	1.41	0.04	98.54	1.46	98.54	48.4	13.4
48	1.44	0.06	98.50	1.50	98.50	48.5	13.0
73	1.52	0.04	98.45	1.55	98.45	48.6	12.5
98	1.48	0.04	98.48	1.52	98.48	48.5	12.8
123	1.54	0.04	98.43	1.57	98.43	48.6	12.4
148	2.07	0.17	97.76	2.24	97.76	50.4	8.4
173	1.41	0.09	98.50	1.50	98.50	24.2	13.0
198	0.33	2.80	96.87	3.13	96.87	26.4	5.7

L-3196 AIR BLOWN TESTS

	WEIGHT (g)	VOLUME (cm ³)	BULK DENSITY (lb/ft ³)
SORBENT LOADED	1575.0	1737	56.61

REMOVED AFTER 5TH SULFIDATION (90522)

SECTION	WEIGHT (g)	VOLUME (cm ³)	SAMPLE REMOVED (g)	SAMPLE REPLACED (g)	BULK DENSITY (lb/ft ³)
1, TOP	375.41	420	31.96	343.45	55.80
2	318.77	340	30.05	288.72	58.53
3	316.42	325	29.70	286.72	60.78
4	323.20	325	31.87	291.33	62.08
5, BOTTOM	328.58	320	31.93	296.65	64.10
TOTAL	1662.38	1730	155.51	1506.87	59.99 (AVE)

REMOVED AFTER 5TH REGENERATION (90523)

SECTION	WEIGHT (g)	VOLUME (cm ³)	BULK DENSITY (lb/ft ³)
1, TOP	314.16	350	56.03
2	259.31	300	53.96
3	248.53	280	55.41
4	295.26	325	56.71
5, BOTTOM	307.03	340	56.37
TOTAL	1424.29	1595	55.75 (AVE)

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90522 #1	1	0.27	7.00	5.6	10.2	5.80
	2	0.54	11.00	5.6	11.0	3.98
	3	0.55	11.90	5.7	8.3	2.78
	4	0.43	10.50	5.6	9.0	3.41
	5	0.36	8.50	5.4	8.1	3.79
	AVE	0.43	9.78	5.58	9.32	3.95
	SDEV	0.11	1.78	0.10	1.12	1.01
	Average Pellet Density (g/cc)				1.80	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90522 #2	1	0.32	7.40	5.5	3.7	1.99
	2	0.28	5.50	5.8	5.7	4.12
	3	0.34	7.50	5.6	3.0	1.59
	4	0.38	8.50	5.7	5.6	2.62
	5	0.29	7.80	5.5	6.0	3.06
	AVE	0.32	7.34	5.62	4.80	2.68
	SDEV	0.04	1.00	0.12	1.21	0.88
	Average Pellet Density (g/cc)				1.77	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90522 #3	1	0.40	9.40	5.3	4.5	1.91
	2	0.46	9.20	5.7	4.5	1.95
	3	0.51	10.70	5.6	7.2	2.68
	4	0.42	10.20	5.6	6.8	2.65
	5	0.36	7.50	5.5	3.0	1.59
	AVE	0.43	9.40	5.54	5.20	2.16
	SDEV	0.05	1.09	0.14	1.57	0.43
	Average Pellet Density (g/cc)				1.90	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90522 #4	1	0.29	7.60	5.3	5.2	2.72
	2	0.57	13.90	5.3	8.0	2.29
	3	0.61	11.00	5.6	8.2	2.97
	4	0.35	8.50	5.4	5.9	2.76
	5	0.29	6.60	5.5	3.5	2.11
	AVE	0.42	9.52	5.42	6.16	2.57
	SDEV	0.14	2.63	0.12	1.77	0.32
Average Pellet Density (g/cc)					1.92	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90522 #5	1	0.52	11.70	5.4	3.1	1.05
	2	0.64	14.50	5.3	4.0	1.10
	3	0.42	9.80	5.2	3.7	1.50
	4	0.36	7.90	5.4	7.0	3.53
	5	0.32	6.00	5.4	3.9	2.59
	AVE	0.45	9.98	5.34	4.34	1.95
	SDEV	0.12	2.95	0.08	1.37	0.96
Average Pellet Density (g/cc)					2.02	

APPENDIX C
SORBENT L-3014, O₂-BLOWN TEST

RUN SUMMARY

RUN NUMBER: TEXACO 90525

DATE: 5/25/89

SORBENT: L-3014

RUN TYPE: Sulfidation

CYCLE NO.: 1

SORBENT LOADED:

Weight (g): 1501.69
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	698.8	1289.8
Maximum Bed	721.1	1330.0
Minimum Bed	662.3	1224.1

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1958

LINEAR VELOCITY (cm/s): 3.11

RUN TIME (min): 186

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	30.91	38.87
CO2	9.98	16.28
H2O	18.12	11.11
H2S	1.02	—
N2	0.00	0.13
CH4	0.000	0.187
CO	39.97	33.41
Total	100.000	100.000
Flow Rate (SLPM)	56.632	56.708

11

0.13 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 10.21

RUN SUMMARY

RUN NUMBER: TEXACO 90526

DATE: 5/26/89

SORBENT: L-3014

RUN TYPE: Sulfidation

CYCLE NO. 2

SORBENT LOADED:

Weight (g): 1501.69
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	700.7	1293.3
Maximum Bed	723.1	1333.6
Minimum Bed	664.8	1228.6

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1962

LINEAR VELOCITY (cm/s): 3.12

RUN TIME (min): 168

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	30.88	35.98
CO2	10.07	16.94
H2O	18.11	13.79
H2S	1.02	—
N2	0.00	0.46
CH4	0.000	0.026
CO	39.93	32.80
Total	100.000	100.000

Flow Rate (SLPM)	56.684	---	---	56.944

0.46 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 9.22

RUN SUMMARY

RUN NUMBER: TEXACO 90530

DATE: 5/30/89

SORBENT: L-3014

RUN TYPE: Sulfidation

CYCLE NO. 3

SORBENT LOADED:

Weight (g): 1501.69
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	721.1	1330.0
Maximum Bed	764.1	1407.4
Minimum Bed	668.5	1235.3

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1966

LINEAR VELOCITY (cm/s): 3.19

RUN TIME (min): 174

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	30.77	35.74
CO2	10.37	16.74
H2O	18.05	14.01
H2S	1.02	—
N2	0.00	0.18
CH4	0.000	0.026
CO	39.79	33.31
Total	100.000	100.000
Flow Rate (SLPM)	56.877	56.980

11

0.18 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 9.55

RUN SUMMARY

RUN NUMBER: TEXACO 90531

DATE: 5/31/89

SORBENT: L-3014

RUN TYPE: Sulfidation

CYCLE NO. 4

SORBENT LOADED:

Weight (g): 1501.69
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	723.9	1335.0
Maximum Bed	747.1	1376.8
Minimum Bed	690.2	1274.4

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1954

LINEAR VELOCITY (cm/s): 3.18

RUN TIME (min): 174

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	30.98	35.37
CO2	9.76	16.70
H2O	18.17	14.66
H2S	1.02	—
N2	0.00	0.29
CH4	0.000	0.034
CO	40.07	32.94
Total	100.000	100.000
Flow Rate (SLPM)	56.492	56.656

11

0.29 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 9.55

RUN SUMMARY

RUN NUMBER: TEXACO 90601

DATE: 6/1/89

SORBENT: L-3014

RUN TYPE: Sulfidation

CYCLE NO. 5

SORBENT LOADED:

Weight (g): 1501.69
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	723.9	1335.0
Maximum Bed	749.7	1381.5
Minimum Bed	686.9	1268.4

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1867

LINEAR VELOCITY (cm/s): 3.04

RUN TIME (min): 174

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	32.47	43.19
CO2	5.45	8.64
H2O	19.04	9.10
H2S	1.07	--
N2	0.00	0.55
CH4	0.000	0.027
CO	41.98	38.50
Total	100.000	100.000
Flow Rate (SLPM)	53.914	54.210

0.55 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 9.55

H2S BREAKTHROUGH

L-3014, O2 BLOWN

COS BREAKTHROUGH

L-3014, O2 BLOWN

OUTLET SO2 L-3014, O2 BLOWN

SORBENT L-3014, O2 BLOWN GAS, 1ST REGENERATION, 90526

NO OUTLET SO2 DATA COLLECTED

SORBENT L-3014, O2 BLOWN GAS, 2ND REGENERATION, 90530

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
12	1.14	0.17	98.69	1.31	98.69	48.0	15.1
37	1.17	0.11	98.72	1.28	98.72	47.9	15.4
62	1.34	0.12	98.54	1.46	98.54	48.4	13.4
87	1.06	0.10	98.84	1.16	98.84	47.6	17.1
112	1.73	0.23	98.03	1.97	98.03	49.6	9.7
137	1.57	0.16	98.27	1.73	98.27	49.0	11.2
162	1.25	0.43	98.32	1.68	98.32	48.9	11.5
187	0.72	1.13	98.15	1.85	98.15	49.3	10.3
212	0.35	2.34	97.31	2.69	97.31	51.6	6.8
237	0.13	4.74	95.14	4.86	95.14	29.3	3.3

SORBENT L-3014, O2 BLOWN GAS, 3RD REGENERATION, 90531

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
12	1.16	0.13	98.71	1.29	98.71	47.9	15.3
37	1.10	0.11	98.79	1.21	98.79	47.7	16.4
62	1.35	0.12	98.53	1.47	98.53	48.4	13.3
87	1.35	0.12	98.53	1.47	98.53	48.4	13.3
112	1.61	0.14	98.25	1.75	98.25	49.1	11.0
137	1.37	0.28	98.35	1.65	98.35	48.9	11.7
162	1.01	1.32	97.67	2.33	97.67	50.6	8.0
187	0.38	2.23	97.39	2.61	97.39	51.4	7.0
212	0.12	4.74	95.14	4.86	95.14	29.3	3.3

SORBENT L-3014, O2 BLOWN GAS, 4TH REGENERATION, 90601

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
13	0.99	0.11	98.90	1.10	98.90	47.5	18.2
38	1.27	0.12	98.61	1.39	98.61	48.2	14.1
63	1.12	0.11	98.78	1.22	98.78	47.8	16.1
88	1.16	0.11	98.73	1.27	98.73	47.9	15.6
113	1.86	0.11	98.03	1.97	98.03	49.7	9.6
138	1.12	0.11	98.76	1.24	98.76	47.8	16.0
163	1.05	0.12	98.83	1.17	98.83	47.7	17.0
188	1.17	0.52	98.31	1.69	98.31	49.0	11.4
213	0.78	1.63	97.59	2.41	97.59	50.8	7.7
238	0.12	2.55	97.34	2.66	97.34	51.5	6.9

SORBENT L-3014, O2 BLOWN GAS, 5TH REGENERATION, 90602

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
11	1.95	0.14	97.92	2.08	97.92	50.0	9.1
36	1.05	0.11	98.84	1.16	98.84	47.6	17.0
61	1.73	0.18	98.09	1.91	98.09	49.5	10.0
111	1.63	0.26	98.10	1.90	98.10	49.5	10.1
136	1.18	0.13	98.69	1.31	98.69	48.0	15.1
161	1.42	0.37	98.21	1.79	98.21	49.2	10.7
186	0.83	0.91	98.26	1.74	98.26	49.1	11.1
211	0.91	3.19	95.89	4.11	95.89	28.0	4.1
236	0.02	5.14	94.84	5.16	94.84	29.8	3.1

L-3014 O2 BLOWN TESTS

	WEIGHT (g)	VOLUME (cm ³)	BULK DENSITY (lb/ft ³)
SORBENT LOADED	1501.7	1737	53.97

REMOVED AFTER 5TH SULFIDATION (90601)

SECTION	WEIGHT (g)	VOLUME (cm ³)	SAMPLE REMOVED (g)	SAMPLE REPLACED (g)	BULK DENSITY (lb/ft ³)
1, TOP	320.16	335	30.21	288.15	59.66
2	355.05	375	29.55	322.86	59.11
3	325.75	365	29.36	294.33	55.71
4	295.10	350	30.04	263.81	52.64
5, BOTTOM	265.59	325	31.14	234.02	51.02
TOTAL	1561.65	1750	150.30	1403.17	55.71 (AVE)

REMOVED AFTER 5TH REGENERATION (90602)

SECTION	WEIGHT (g)	VOLUME (cm ³)	BULK DENSITY (lb/ft ³)
1, TOP	242.47	285	53.11
2	309.88	350	55.27
3	317.55	360	55.07
4	244.93	285	53.65
5, BOTTOM	236.48	275	53.68
TOTAL	1351.31	1555	54.25 (AVE)

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90601 #1	1	0.48	12.50	5.5	7.0	2.23
	2	0.25	7.40	5.1	6.5	3.50
	3	0.30	8.70	5.5	3.7	1.69
	4	0.29	7.20	5.6	7.2	3.98
	5	0.26	6.20	5.7	7.0	4.49
	AVE	0.32	8.40	5.54	6.28	3.18
	SDEV	0.08	2.20	0.10	1.31	1.06
Average Pellet Density (g/cc)					1.56	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90601 #2	1	0.28	8.00	5.5	6.1	3.03
	2	0.34	7.90	5.5	6.2	3.12
	3	0.33	9.00	5.5	6.9	3.05
	4	0.30	7.20	5.5	5.9	3.26
	5	0.43	10.20	5.7	4.4	1.72
	AVE	0.34	8.46	5.54	5.90	2.84
	SDEV	0.05	1.04	0.08	0.82	0.57
Average Pellet Density (g/cc)					1.65	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90601 #3	1	0.35	9.20	5.7	5.4	2.34
	2	0.32	7.50	5.6	5.7	3.02
	3	0.36	8.20	5.5	6.8	3.30
	4	0.24	5.80	5.4	3.0	2.06
	5	0.28	7.00	5.5	3.5	1.99
	AVE	0.31	7.54	5.54	4.88	2.54
	SDEV	0.04	1.14	0.10	1.42	0.53
Average Pellet Density (g/cc)					1.71	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90601 #4	1	0.53	13.50	5.5	9.8	2.89
	2	0.64	14.00	5.5	11.2	3.18
	3	0.44	9.20	5.5	7.0	3.03
	4	0.28	7.40	5.5	3.5	1.88
	5	0.44	8.90	5.7	7.0	3.13
	AVE	0.47	10.60	5.54	7.70	2.82
	SDEV	0.12	2.65	0.08	2.66	0.48
Average Pellet Density (g/cc)					1.82	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90601 #5	1	0.45	9.90	5.5	6.8	2.73
	2	0.54	12.50	5.3	6.6	2.10
	3	0.46	10.50	5.6	10.5	3.98
	4	0.66	14.50	5.6	9.7	2.66
	5	0.44	7.40	5.5	6.2	3.33
	AVE	0.51	10.96	5.50	7.96	2.96
	SDEV	0.08	2.40	0.11	1.78	0.64
Average Pellet Density (g/cc)					1.96	

APPENDIX D
SORBENT I-3196, O₂-BLOWN TEST

RUN SUMMARY

RUN NUMBER: TEXACO 90606

DATE: 6/6/89

SORBENT: L-3196

RUN TYPE: Sulfidation

CYCLE NO. 1

SORBENT LOADED:

Weight (g): 1527.8
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	712.4	1314.3
Maximum Bed	737.1	1358.8
Minimum Bed	680.3	1256.5

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1910

LINEAR VELOCITY (cm/s): 3.07

RUN TIME (min): 210

GAS COMPOSITIONS (%):

INLET

OUTLET

H2	31.74	40.59
CO2	7.56	10.58
H2O	18.61	10.53
H2S	1.05	—
N2	0.00	0.54
CH4	0.000	0.027
CO	41.04	37.74
Total	100.000	100.000

Flow Rate (SLPM) 55.150 — — 55.448

11

0.54 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 11.33

RUN SUMMARY

RUN NUMBER: TEXACO 90607

DATE: 6/7/89

SORBENT: L-3196

RUN TYPE: Sulfidation

CYCLE NO. 2

SORBENT LOADED:

Weight (g): 1527.8
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	718.4	1325.1
Maximum Bed	742.6	1368.7
Minimum Bed	678.6	1253.5

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1921

LINEAR VELOCITY (cm/s): 3.11

RUN TIME (min): 196

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	31.51	42.67
CO2	8.22	10.07
H2O	18.48	8.25
H2S	1.04	—
N2	0.00	0.23
CH4	0.000	0.018
CO	40.75	38.77
Total	100.000	100.000

Flow Rate (SLPM)	55.546	---	---	55.674
		1	1	

0.23 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 10.57

RUN SUMMARY

RUN NUMBER: TEXACO 90608

DATE: 6/8/89

SORBENT: L-3196

RUN TYPE: Sulfidation

CYCLE NO. 3

SORBENT LOADED:

Weight (g): 1527.8
Volume (cm3): 1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	714.1	1317.4
Maximum Bed	740	1364.0
Minimum Bed	676.3	1249.3

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 1869

LINEAR VELOCITY (cm/s): 3.01

RUN TIME (min): 210

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	32.44	45.60
CO2	5.53	5.96
H2O	19.02	6.65
H2S	1.07	—
N2	0.00	0.52
CH4	0.000	0.028
CO	41.94	41.23
Total	100.000	100.000
Flow Rate (SLPM)	53.962	54.246

11

0.53 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 11.33

RUN SUMMARY

RUN NUMBER: TEXACO 90609

DATE: 6/9/89

SORBENT: L-3196

RUN TYPE: Sulfidation

CYCLE NO. 4

SORBENT LOADED:

Weight (g):	1527.8
Volume (cm3):	1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	714.5	1318.1
Maximum Bed	745.5	1373.9
Minimum Bed	688.7	1271.7

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 2050

LINEAR VELOCITY (cm/s): 3.31

RUN TIME (min): 216

GAS COMPOSITIONS (%):	INLET	OUTLET
H2	29.51	34.13
CO2	14.04	18.05
H2O	17.31	13.58
H2S	0.97	—
N2	0.00	0.18
CH4	0.000	0.026
CO	38.16	34.03
Total	100.000	100.000
Flow Rate (SLPM)	59.306	59.414

0.18 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 11.65

RUN SUMMARY

RUN NUMBER: TEXACO 90613

DATE: 6/13/89

SORBENT: L-3196

RUN TYPE: Sulfidation

CYCLE NO. 5

SORBENT LOADED:

Weight (g):	1527.8
Volume (cm3):	1737

TEMPERATURE:

	degrees C	degrees F
Average Bed	710.4	1310.7
Maximum Bed	736.8	1358.2
Minimum Bed	670.7	1239.3

PRESSURE (psia): 350

SPACE VELOCITY ((SCF/HR)/CF): 2033

LINEAR VELOCITY (cm/s): 3.26

RUN TIME (min): 228

GAS COMPOSITIONS (%):

INLET

OUTLET

H2	29.80	34.42
CO2	13.22	17.99
H2O	17.47	13.64
H2S	0.98	—
N2	0.00	0.39
CH4	0.000	0.026
CO	38.53	33.53
Total	100.000	100.000
Flow Rate (SLPM)	58.743	58.972

| |

0.39 % Difference

PARTICULATES COLLECTED: N/A

SULFUR LOADED PRIOR TO BREAKTHROUGH (lbs/100 lb sorbent): 12.30

H2S BREAKTHROUGH

L-3196, O2 BLOWN

COS BREAKTHROUGH

L-3196, O2 BLOWN

OUTLET SO2 L-3196, O2 BLOWN

SORBENT L-3196, O2 BLOWN GAS, 1ST REGENERATION, 90607

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
28	0.54	0.54	98.93	1.07	98.93	47.4	18.5
53	1.17	0.11	98.72	1.28	98.72	47.9	15.4
78	1.41	0.13	98.46	1.54	98.46	48.6	12.6
103	1.40	0.20	98.41	1.59	98.41	48.7	12.2
128	1.15	0.11	98.75	1.25	98.75	47.9	15.8
153	1.12	0.11	98.77	1.23	98.77	47.8	16.1
178	1.03	0.18	98.79	1.21	98.79	47.7	16.4
203	0.83	0.31	98.85	1.15	98.85	47.6	17.3
228	0.85	0.58	98.57	1.43	98.57	48.3	13.7
253	0.73	1.12	98.15	1.85	98.15	49.3	10.3
278	0.44	2.19	97.37	2.63	97.37	51.4	7.0
303	0.23	4.69	95.08	4.92	95.08	29.4	3.3
328	0.01	5.17	94.82	5.18	94.82	29.9	3.1

SORBENT L-3196, O2 BLOWN GAS, 2ND REGENERATION, 90608

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
14	1.55	0.14	98.30	1.70	98.30	49.0	11.4
39	1.28	0.28	98.44	1.56	98.44	48.6	12.5
64	1.21	0.95	97.84	2.16	97.84	50.2	8.7
89	1.38	0.13	98.49	1.51	98.49	48.5	12.9
114	1.27	0.12	98.61	1.39	98.61	48.2	14.1
139	1.19	0.18	98.63	1.37	98.63	48.2	14.3
164	1.13	0.34	98.54	1.46	98.54	48.4	13.3
189	1.18	0.64	98.18	1.82	98.18	49.3	10.5
214	0.87	1.04	98.09	1.91	98.09	49.5	10.0
239	0.82	1.98	97.20	2.80	97.20	51.9	6.5
264	0.40	4.43	95.17	4.83	95.17	29.2	3.3
289	0.08	5.10	94.82	5.18	94.82	29.9	3.1

SORBENT L-3196, O2 BLOWN GAS, 3RD REGENERATION, 90609

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
8	0.93	0.14	98.93	1.07	98.93	47.4	18.6
33	1.09	0.49	98.42	1.58	98.42	48.7	12.3
83	1.41	0.14	98.44	1.56	98.44	48.6	12.5
108	1.40	0.33	98.27	1.73	98.27	49.0	11.1
133	1.39	0.12	98.48	1.52	98.48	48.5	12.8
158	1.23	0.23	98.54	1.46	98.54	48.4	13.4
183	1.15	0.45	98.40	1.60	98.40	48.7	12.1
233	0.69	0.76	98.55	1.45	98.55	48.4	13.4
258	0.72	1.26	98.03	1.97	98.03	24.8	9.6
283	0.53	2.17	97.30	2.70	97.30	25.8	6.8
308	0.41	4.39	95.20	4.80	95.20	29.2	3.4
333	0.03	5.13	94.84	5.16	94.84	29.8	3.1

SORBENT L-3196, O2 BLOWN GAS, 4TH REGENERATION, 90612

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
5	2.45	0.12	97.43	2.57	97.43	51.3	7.2
30	1.15	0.10	98.74	1.26	98.74	47.9	15.7
105	1.29	0.13	98.58	1.42	98.58	48.3	13.7
130	1.27	0.11	98.62	1.38	98.62	48.2	14.2
155	1.24	0.13	98.63	1.37	98.63	48.1	14.4
180	0.98	0.26	98.76	1.24	98.76	47.8	15.9
205	0.95	0.44	98.61	1.39	98.61	48.2	14.1
230	0.88	0.74	98.37	1.63	98.37	48.8	11.9
255	0.78	1.65	97.57	2.43	97.57	50.9	7.7
280	0.30	2.37	97.33	2.67	97.33	51.6	6.9
305	0.21	4.60	95.19	4.81	95.19	29.2	3.4
330	0.02	5.06	94.92	5.08	94.92	29.7	3.1
355	0.004	5.11	94.89	5.11	94.89	29.7	3.1

SORBENT L-3196, O2 BLOWN GAS, 5TH REGENERATION, 90614

TIME (min)	OUTLET CONCENTRATIONS			INLET CONDITIONS		FLOW (slpm)	DILUENT
	SO2 (%)	O2 (%)	N2 (%)	O2 (%)	N2 (%)		----- AIR
20	0.58	0.09	99.33	0.67	99.33	46.5	30.6
45	1.13	0.11	98.77	1.23	98.77	47.8	16.0
70	1.12	0.07	98.80	1.20	98.80	47.7	16.5
95	1.45	0.21	98.34	1.66	98.34	48.9	11.6
120	1.58	0.15	98.27	1.73	98.27	49.1	11.1
145	2.33	0.47	97.21	2.79	97.21	51.9	6.5
170	1.39	0.18	98.42	1.58	98.42	48.7	12.3
195	0.99	1.56	97.46	2.54	97.46	51.2	7.3
220	0.51	4.30	95.19	4.81	95.19	29.2	3.4
245	0.00	5.23	94.77	5.23	94.77	30.0	3.0

L-3196 O2 BLOWN TESTS

	WEIGHT (g)	VOLUME (cm ³)	BULK DENSITY (lb/ft ³)
SORBENT LOADED	1527.8	1737	54.91

REMOVED AFTER 5TH SULFIDATION (90613)

SECTION	WEIGHT (g)	VOLUME (cm ³)	SAMPLE REMOVED (g)	SAMPLE REPLACED (g)	BULK DENSITY (lb/ft ³)
1, TOP	219.79	250	37.72	182.07	54.88
2	355.75	390	32.25	323.50	56.94
3	369.33	400	33.05	336.28	57.64
4	356.76	370	33.14	323.62	60.19
5, BOTTOM	306.13	305	32.71	273.42	62.66
TOTAL	1607.76	1715	168.87	1438.89	58.52 (AVE)

REMOVED AFTER 5TH REGENERATION (90614)

SECTION	WEIGHT (g)	VOLUME (cm ³)	BULK DENSITY (lb/ft ³)
1, TOP	276.37	320	53.92
2	276.59	325	53.13
3	248.67	285	54.47
4	246.92	285	54.09
5, BOTTOM	321.15	360	55.69
TOTAL	1369.70	1575	54.29 (AVE)

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90613 #1	1	0.31	7.00	5.8	6.0	3.41
	2	0.38	10.00	5.5	6.8	2.71
	3	0.34	7.30	5.7	8.9	4.85
	4	0.35	8.50	5.5	9.0	4.21
	5	0.34	9.50	5.4	6.2	2.60
	AVE	0.34	8.46	5.58	7.38	3.56
	SDEV	0.02	1.18	0.15	1.31	0.87
	Average Pellet Density (g/cc)				1.66	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90613 #2	1	0.51	12.00	5.5	11.7	3.88
	2	0.29	7.30	5.3	12.0	6.54
	3	0.32	6.10	5.4	7.0	4.57
	4	0.58	14.00	5.3	7.3	2.08
	5	0.36	8.30	5.8	7.9	3.79
	AVE	0.41	9.54	5.46	9.18	4.17
	SDEV	0.11	2.98	0.19	2.20	1.44
	Average Pellet Density (g/cc)				1.84	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90613 #3	1	0.63	15.50	5.2	10.5	2.70
	2	0.52	11.50	5.3	9.5	3.29
	3	0.52	13.30	5.5	9.2	2.75
	4	0.43	11.00	5.3	6.8	2.46
	5	0.56	13.80	5.6	4.0	1.15
	AVE	0.53	13.02	5.38	8.00	2.47
	SDEV	0.06	1.63	0.15	2.34	0.71
	Average Pellet Density (g/cc)				1.80	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90613 #4	1	0.77	17.20	5.5	6.0	1.39
	2	0.71	17.40	5.5	6.9	1.58
	3	0.53	11.00	5.6	6.5	2.35
	4	0.31	7.20	5.5	4.0	2.21
	5	0.49	10.10	5.2	4.5	1.77
	AVE	0.56	12.58	5.46	5.58	1.86
	SDEV	0.16	4.05	0.14	1.13	0.37
Average Pellet Density (g/cc)					1.91	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
90613 #5	1	0.39	9.20	5.5	6.7	2.90
	2	0.36	8.50	5.4	5.5	2.58
	3	0.68	15.50	5.5	6.0	1.54
	4	0.63	15.40	5.5	7.9	2.04
	5	0.51	15.50	5.5	8.0	2.05
	AVE	0.51	12.82	5.48	6.82	2.22
	SDEV	0.13	3.25	0.04	1.00	0.47
Average Pellet Density (g/cc)					1.70	

APPENDIX E
CRUSH STRENGTH RESULTS

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
L-3014	1	0.36	10.25	5.7	8.5	3.30
	2	0.42	11.20	5.6	7.0	2.49
	3	0.27	7.20	5.5	6.0	3.32
	4	0.35	8.90	6.0	5.5	2.46
	5	0.27	7.20	5.5	6.0	3.32
	6	0.46	13.20	5.4	7.4	2.23
	7	0.56	13.20	5.8	5.6	1.69
	8	0.34	10.90	5.5	7.0	2.56
	9	0.27	7.80	5.5	7.5	3.83
	10	0.48	12.50	5.5	8.1	2.58
AVE		0.38	10.24	5.60	6.86	2.78
SDEV		0.09	2.24	0.17	0.99	0.61
Average Pellet Density (g/cc)					1.50	

Sample	Pellet #	Weight (g)	Length (mm)	Diameter (mm)	Crushed (psi)	Force/mm (lb/mm)
L3196	1	0.32	8.40	5.5	6.5	3.08
	2	0.43	10.70	5.4	6.5	2.42
	3	0.53	12.60	5.6	7.6	2.40
	4	0.54	13.60	5.5	6.4	1.87
	5	0.55	12.10	5.6	7.2	2.37
	6	0.36	9.00	5.7	6.4	2.83
	7	0.40	9.40	5.8	6.1	2.58
	8	0.28	7.30	5.6	5.4	2.94
	9	0.64	14.10	5.5	6.3	1.78
	10	0.59	14.30	5.7	5.9	1.64
AVE		0.46	11.15	5.58	6.43	2.39
SDEV		0.12	2.41	0.11	0.59	0.47
Average Pellet Density (g/cc)					1.70	

APPENDIX F
SAMPLES SUBMITTED TO TEXACO

Run #	Sample	Sulf. Gas	Section
90510	Sulfided, L-3014	Air Blown	1, top
90510	Sulfided, L-3014	Air Blown	2
90510	Sulfided, L-3014	Air Blown	3
90510	Sulfided, L-3014	Air Blown	4
90510	Sulfided, L-3014	Air Blown	5, bottom
90510	Zn Flakes from sorbent cage		
90511	Regenerated, L-3014	Air Blown	1, top
90511	Regenerated, L-3014	Air Blown	2
90511	Regenerated, L-3014	Air Blown	3
90511	Regenerated, L-3014	Air Blown	4
***90511	Regenerated, L-3014	Air Blown	5, bottom
90522	Sulfided, L-3196	Air Blown	1, top
90522	Sulfided, L-3196	Air Blown	2
90522	Sulfided, L-3196	Air Blown	3
90522	Sulfided, L-3196	Air Blown	4
90522	Sulfided, L-3196	Air Blown	5, bottom
90522	Zn Flakes from sorbent cage		
***90523	Regenerated, L-3196	Air Blown	1, top
90523	Regenerated, L-3196	Air Blown	2
90523	Regenerated, L-3196	Air Blown	3
90523	Regenerated, L-3196	Air Blown	4
90523	Regenerated, L-3196	Air Blown	5, bottom
90601	Sulfided, L-3014	Oxygen Blown	1, top
90601	Sulfided, L-3014	Oxygen Blown	2
90601	Sulfided, L-3014	Oxygen Blown	3
90601	Sulfided, L-3014	Oxygen Blown	4
90601	Sulfided, L-3014	Oxygen Blown	5, bottom
90601	Zn Flakes from sorbent cage		
90602	Regenerated, L-3014	Oxygen Blown	1, top
90602	Regenerated, L-3014	Oxygen Blown	2
***90602	Regenerated, L-3014	Oxygen Blown	3
90602	Regenerated, L-3014	Oxygen Blown	4
90602	Regenerated, L-3014	Oxygen Blown	5, bottom
90613	Sulfided, L-3196	Oxygen Blown	1, top
90613	Sulfided, L-3196	Oxygen Blown	2
90613	Sulfided, L-3196	Oxygen Blown	3
90613	Sulfided, L-3196	Oxygen Blown	4
90613	Sulfided, L-3196	Oxygen Blown	5, bottom
90613	Zn Flakes from sorbent cage		
90614	Regenerated, L-3196	Oxygen Blown	1, top
90614	Regenerated, L-3196	Oxygen Blown	2
90614	Regenerated, L-3196	Oxygen Blown	3
90614	Regenerated, L-3196	Oxygen Blown	4
90614	Regenerated, L-3196	Oxygen Blown	5, bottom

original sample, L-3014
original sample, L-3196

... • Lost due to UPS breakage

END

**DATE
FILMED**

4 / 7 / 93