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Gentlemen:

This letter with attachments covers operations on Retort No. 3 from C1053 through C1054-3. These runs were made to test the hypothesis of liquid removal from the shale bed to improve yields and extend the range of operability in the Gas Combustion process. This work is a result of the success in removing liquid from the bed in the 3.6 inch bench scale moving bed reactor. So far, we have not been able to duplicate the amount of liquid removal (50-60% of liquid product) obtained in the 3.6 inch unit; however, we have been able to collect a much smaller amount through the liquid removal system. Further modifications to the system are being made to increase the amount of drawoff from the bed. The following modifications were made before these runs:

1. Installation of six cyclones above the air distributor to allow a major portion of the product to flow through with provisions for liquid removal from the cyclone legs (see drawings RB138 and RC156).

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2. Installation of a deck with grids above the cyclones with six down comers to allow the shale to flow through. Provisions are available for liquid removal from the deck. (See drawing RB138 and RC156.)
3. Installation of pump around flush system to keep liquid drawoff lines clean. (See drawing RB138 and RC156.)
4. Installation of 54 bayonet type air distributor. (See drawing RB144 and RE94.)
5. Revised thermocouple layout. (See drawing RE92.)

C1053 and C1054 were made at nominal conditions of 500 lbs/(hr)(ft<sup>2</sup>) shale rate, 4,300 SCF/T air and 15,000 SCF/T recycle gas rates, using 1/4 to 1 inch shale. A summary of the operations is given in Table 1 along with a "Log of Operations" in Table 2.

## C1053

The oil pump around flush system was lined out before the normal startup procedure for C1053 was started. The normal procedure is to fire the line burner at 700 F and then raise to 900 F after two hours. The unit is then brought up to 300 mass rate conditions using the air equivalent (5,000-5,200 SCF/T) constant oxygen consumption method. During the transition to 500 mass rate condition the line burner is phased out of the system and the retort is brought on nominal conditions of 500 lbs/(hr)(ft<sup>2</sup>) shale rate, 4,300 SCF/T air and 15,000 SCF/T recycle gas rates. C1053 had to be aborted 16 hours after the line burner was fired due to a bearing failure on the recycle blower motor. The last eight hours of the period (SUC1053) was worked up to obtain a rough evaluation of the yield. The "quickie" type yield was 85.4% of Fischer Assay during the transition from about 380 to 500 lbs/(hr)(ft<sup>2</sup>). It was estimated that approximately 7% of this yield came from the liquid removal system.

The retort was found to be free of clinkers. The grids above the deck, the cyclone legs and part of the flush headers were plugged.

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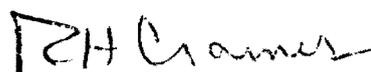
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## PTC1054 through C1054-3

Before starting up C1054, the shale chutes below the deck were lengthened six inches to increase the cyclones' temperatures. The C1053 startup procedure was used in C1054. Four 12-hour material balances were made with a progressive decrease in yields as follows: 81.6% for PTC1054, 76.7% for C1054-1, 74.5% for C1054-2, and 65.7% for C1054-3. (An estimate of 2 to 5% of this yield came from the liquid recovery system.) There was a corresponding progressive increase in the oil content on spent shale (1.2, 3.3, 4.7 and 6.7 gallons per ton). Due to the low yields and high oil content of the spent shale, the unit was shut down for mechanical modifications. A small clinker was found resting between the first two yokes on the north header in the north-west corner. The grids above the deck were approximately 80% plugged with shale. There was a large accumulation of dust coke and oil underneath the grids which appeared to have been plastered on the grates.

Modifications to the shale chutes below the deck will be made before the next startup, to more evenly distribute the shale and to enhance liquid recovery. Also, changes will be made to determine the amount of oil recovered from the cyclones and the amount from the grid deck system.

Yours truly,



R. H. Cramer  
Program Manager

EETurner:gw  
Attachments

cc: S. L. Meisel w/o attach

TABLE 1

## RESULTS FROM RETORT NO. 3 WITH LIQUID REMOVAL SYSTEM

Run No.	SUC1053	PTC1054	C1054-1	C1054-2	C1054-3
Date	7/28/67	8/1/67	8/2/67	8/2/67	8/3/67
Shale Size, inches	1/4 to 1	1/4 to 1	1/4 to 1	1/4 to 1	1/4 to 1
Da	No Ty-Lab	0.615	0.625	0.629	0.609
Dv		0.704	0.713	0.723	0.709
Fischer Assay, gal/ton	(28.7)	28.6	28.4	28.9	29.6
Shale rate, lbs/(hr) (ft <sup>2</sup> )	(448)	488	493	492	475
Air, SCF/T	(4,420)	4,360	4,360	4,360	4,670
Recycle, SCF/T	(15,700)	15,450	15,370	15,280	15,880
Gas Loss, SCF/T	--	1,015	480	730	915
Offgas Temperature, F	(160)	159	162	160	161
Retort Pressures, in/ft					
Overall	1.05	1.23	1.12	1.11	1.17
Above air distributor	1.54	1.58	1.63	1.65	1.74
Above deck					
Yield, % Fischer Assay	(85.4)	81.6	76.7	74.5	65.7
% removed from liquid removal system	←----- Estimated 2 to 5 ----->				
Spent Shale					
Gallons per ton	0.0	1.2	3.3	4.7	6.7
Temperature	--	383	431	469	554
Material Balances, Wt %	Aborted due				
Overall	to failure	100.8	100.5	100.7	100.8
Organic Carbon	of recycle	97.4	96.7	99.4	94.6
Water	blower	240.3	106.6	122.7	130.8
Remarks	motor bearing.				
	Free of clinker.				Small clinker between first two yokes in northwest corner

(1) Bed height 7 feet, 3 1/2 feet above air distributor and 3 1/2 feet above the deck. Effective bed height between 4 and 5 feet for SUC1053. Bed height = 6 1/2 feet for C1054 with only 3 feet above the air distributor.

TABLE 2

LOG OF OPERATIONS

July 18 through August 3, 1967

- 7/18-7/28/67 Turnaround to test hypothesis of liquid removal from bed. Major items were:
1. Installation of 6 cyclones above the air distributor to allow a major portion of product to flow through with provisions for liquid removal.
  2. Installation of deck above the cyclones with down comer chutes to allow shale to pass through with provisions for liquid removal.
  3. Installation of pump around flush system to keep lines clean.
- 7/28/67
4. Revised thermocouple layout.
  5. Installation of 54 bayonet type air distributor.
- 0230 Retort full.
- 1300 Started 3-hour circulation at 300 mass rate.
- 0600 - 1115 Made drawdown tests.  
Started liquid pump around system.
- 1545 Fired line burner at 400 F.
- 1600 Increased line burner temperature to 700 F for C1053 startup using the air equivalent constant oxygen consumption procedure with 1/4 to 1 inch shale.
- 1800 Increased line burner to 900 F.
- 1942 Electrostatic precipitator turned on.
- 2100 Unit looking good. Started transition to 500 mass rate.  
 TR2-1 = 900 F      TR2-4 = 1,090 F      TR2-7 = 995 F  
 TR2-2 = 605 F      TR2-5 = 690 F      TR2-8 = 760 F  
 TR5-2 = 139 F      TR5-4 = 139 F  
 TR5-3 = 139 F      TR5-5 = 139 F

Sequence of transition to 500 mass rate

	Air, SCFM	Recycle, SCFM	Shale, T/hr	Temperatures, F			
				LB	TR2-1	TR2-4	TR2-7
Base	725	2,170	8.4	900	900	1,090	995
2100	753	2,301	8.95	--	--	--	--
2200	753	2,432	10.60	800	810	1,190	850
2300	781	2,432	10.60	700	700	1,060	880
2336	809	2,694	11.5	700	--	--	--
<u>7/29/67</u>							
0005	809	2,825	11.5	700	--	--	--
0010	837	2,825	11.5	600	--	--	--
0020	837	2,825	11.5	600	775	1,085	970

	Air, SCFM	Recycle, SCFM	Shale, T/hr	Temperatures, F			
				LB	TR2-1	TR2-4	TR2-7
035-0040	865	2,956	11.5	600	--	--	--
0105-0110	893	3,087	11.6	600	--	--	--
0120-0130	893	3,087	11.6	out	12 F split in offgas		
0135	893	3,218	11.6	--	860	1,330	1,160
0210	893	3,218	12.6	--	--	--	--
0240-0245	921	3,218	13.05	--	--	--	--
0250	921	3,349	13.05	--	20 F split (150-170 F) in offgas		
0410-0420	949	3,480	13.90	--	--	--	--
0440	977	3,480	13.90	--	--	--	--

On 500 mass rate conditions - west side of retort at 1,380F and east at 980 F. Offgas temperatures are hot on both outside headers.

- 0600 High level on LR-3 chart cut off raw shale feed belts.
- 0650 Recycle blower vibrating on north end.
- 0810 Started shutdown because noise and vibration on recycle blower getting worse.
- 0820 Recycle blower shut down.
- 1400 Retort empty and free of clinkers.  
Grids on top of deck partially plugged.  
Raw shale apparently leaked behind grates and filled the space between the wall and grate to the top of the grate. (Solid agglomerates formed.)  
Cyclone legs and part of flush headers plugged.

7/30-7/31/67 Regular maintenance plus following items:  
Shale chutes from deck lengthened 6 inches.  
Grids cleaned.

8/1/67

- 0015 Started filling the retort with 1/4 to 1 inch shale.
- 0400 Started 3-hour circulation period at 300 mass rate.
- 0645 Fired line burner at 400 F.
- 0700 Increased line burner temperature to 700 F for C1054 startup using the same general procedure as used in C1053.
- 0725 Adjusted recycle distribution to headers to decrease flow to west header about 3% as west side heating up faster than other side and center.

0850 TR4-2 broke out and peaked at 1,550 F.

0900 Increased line burner temperature to 900 F.

0930 West side temperature increasing faster than other sections. Reduced recycle gas to west header about 2 to 3%.

1021 Electrostatic precipitator on.

1021-1400 Bringing to 300 mass rate condition. Combustion zone temperatures split.

1400-2030 Started transition to 500 mass rate phasing out the line burner

2030 Approaching 500 mass rate conditions.

2100 Start PTC1054

2115 Increased recycle from 3,349 to 3,480 SCFM.  
Increased air from 940 to 970 SCFM.  
TR2-1 = 1,340 F TR2-4 = 970 F TR2-7 = 1,320 F  
TR2-2 = 840 F TR2-5 = 630 F TR2-8 = 900 F

2300 Retort looks good.

8/2/67

0030 Cut in liquid drawoff system.

0350-0535 Circulating pump packing leaking. Turned off at 0435 for repairs. Back in service at 0535.

0725 Oil circulating pump leaking again.  
End PTC1054  
On C1054-1

1030 West side combustion zone temperatures higher than center and east side.

1200 Retort still showing a split in combustion zone temperature.  
Circulation liquid pump leaking excessively at packing gland.

1230 Temperature split between east and west combustion zone is increasing.

1400 First net oil through A. O. Smith meter from retort bed. Small amount.

1500 No oil recovered from the shale bed.

1600 Leak in recirculation pump getting worse.

1845                    East                    Center                    West  
TR2-1 = 860 F      TR2-4 = 950 F      TR2-7 = 1,430 F  
TR2-2 = 720 F      TR2-5 = 610 F      TR2-8 = 1,020 F  
TR2-3 = 580 F      TR2-6 = 440 F      TR2-9 = 630 F

2100                    End C1054-1  
                         Start C1054-2

2150                    O<sub>2</sub> concentration in vent gas slowly increasing.

2205-0045                Recirculation pump off for repair. Back on at 0045  
                         on 8/3/67.

8/3/67

0030                    High level on LR-3 - obtaining very little oil from  
                         liquid removal system.

0200                    TR2-1 = 1,190 F  
                         TR2-4 = 955 F  
                         TR2-7 = 1,510 F

0300                    Recycle blower started making noise on north end. Blew  
                         high pressure stage of blower.

0900                    End C1054-2  
                         Start C1054-3

0920-1000                Roll feeders off for repair - air cut back to low  
                         rate 100 SCFM to keep bayonets open. Started back up  
                         at 1000 when rolls put back into service.

1020                    Retort does not look good.  
TR2-1 = 1,010 F      TR2-4 = 1,000 F      TR2-7 = 1,340 F  
TR2-2 = 860 F      TR2-5 = 665 F      TR2-8 = 1,335 F  
TR5-2 = 198 F      TR5-3 = 165 F      TR5-4 = 158 F  
TR5-5 = 202 F

1130                    Back on conditions except air increased to 1,090 SCFM  
                         or 4,750 SCF/T. Recycle gas 3,480 SCFM.

1145                    TR2-1 = 1,090 F      TR2-4 = 790 F      TR2-7 = 1,765 F  
                         TR2-2 = 810 F      TR2-5 = 575 F      TR2-8 = 1,000 F

1500                    Adjusted recirculation pump packing.

1615                    Stopped circulation pump to determine effect on oil  
                         drawoff.

1700                    Offgas temperature split increasing. TR5-2 = 163F;

1700 TR5-3 = 144 F; TR5-4 = 144 F; TR5-5 = 193 F  
1740 Checked color of mist through taps up and down the unit. All levels showed grey-white smoke - no yellow colored smoke.

Temperature survey at manway - south side at 39 feet 8 inch level. Observed oil on the 3/8 inch probe.

1845 Temperature profile at elevation 35 feet 7 inches or 7 feet above air inlet.

<u>Location</u>	<u>Temperature, F</u>
Wall	620
in 2 "	690
4	780
6	870
8	970
10	975
12	925
14	875
15	860

1900 TR5-2 = 167 F TR5-4 = 146 F  
TR5-3 = 146 F TR5-5 = 204 F  
TR2-1 = 1,110 F; TR2-4 = 880 F; TR2-7 = 1,405 F  
TR2-2 = 890 F; TR2-5 = 630 F; TR2-8 = 1,180 F  
TR2-3 = 700 F; TR2-6 = 465 F; TR2-9 = 750 F  
O<sub>2</sub> = 1.45%; CO<sub>2</sub> = 27%

2100 End C1054-3

2130 Collected oil sample from tap at elevation of 39 feet 8 inches.

2205 Started shutdown.  
Caught spent shale sample from screw conveyor No. 2 every 15 minutes.

8/4/67

0440 Retort empty.  
Small clinker found resting between the first two yokes (first 2 bayonets on north two rows of bayonets from west wall).  
Grids above deck were partially plugged with shale.  
Turnaround before starting C1055.