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- R. V. Smith - Phillips Petroleum Company
- W. O. Taff - Humble Oil and Refining Company

Gentlemen:

This letter with attachments covers operations on Retort No. 3 from Runs PTC1050 through C1052-3. These runs were attempted to improve stability of operations and yields with the 1/4 to 1 inch shale. Before these tests a modified 36 bayonet air distributor was installed. Two headers, with yokes, were used instead of the three headers without the yokes. Also the headers were designed to give even air distribution with either hot or cold air. The bayonets were spaced to give more uniform air distribution in the retort. (See Drawings RB-133, RB-271 and RB-272.) An average yield of 88.6% Fischer Assay was obtained during three 12-hour balances at nominal 300 lbs/(hr)(ft²) shale rate and with hot dilution gas. The retort failed before good yield data could be obtained without dilution gas. The average yield was 81.3% for three 12-hour balances without dilution at nominal 300 lbs/(hr)(ft²) shale rate conditions. A summary of the operations is given in Table 1 along with a "Log of Operations" in Table 2.

PTC1050 through C1050-1 - With Hot Dilution Gas

C1050 was started up with 1/4 to 1 inch shale using low line burner temperatures and the air equivalent constant oxygen consumption procedure. Hot dilution gas was added when the oxygen concentration was approximately 4%. The startup was hampered by line burner difficulties and water leakage into

air through the air blower seals. One 12-hour balance, PTC1050, was made but the operations were not good. The unit had to be shut down during C1050-1 due to skewed offgas and retort temperatures. Line burner failures and water leakage into the air were the probable causes for the run failure. A clinker was found on the west end extending over the first four yokes on the north header and extending across and over the first three yokes on the south header.

PTC1051 through C1051-3 - With Hot Dilution Gas

C1051 was started up using the same general procedure as used in C1050. Three 12-hour balances, C1051-1 through C1051-3, with hot dilution gas were made. A split (up to 19 F) in the offgas temperatures was observed although the reason for the split was not clear. The average yield for the C1051-1 through C1051-3 was 88.6% at 297 lbs/(hr) (ft²) shale rate, 5,240 SCF/T air, 11,340 SCF/T recycle, and 1,560 SCF/T dilution gas rates. There was 0.4 gallon per ton of oil in the spent shale.

PTC1052 through C1052-3 - Without Dilution Gas

At the end of C1051-3, transition to hot air operations, without dilution, was made. The dilution gas was phased out of the system in five equal steps with a corresponding increase in recycle gas and a slight decrease in the air rate. The unit looked fair at the end of the transition except for the continued split in the offgas temperature. (about 9 F). The yield for the 12-hour transition period (PTC1052) was 87.8% at 297 lbs/(hr) (ft²), 4,930 SCF/T air, 13,070 SCF/T recycle and 330 SCF/T dilution. The west side of the retort began to cool off during the latter part of PTC1052. However, the vertical couples in the west side were questionable since the offgas temperature split narrowed to 2 F. Three 12-hour material balances were made after the transition period. The average yield for these periods (C1052-1 through C1052-3) was 81.3% at averaged conditions of 295 lbs/(hr) (ft²) shale rate, 4,840 SCF/T air and 13,000 SCF/T recycle gas rates. The temperature on the west side was colder than the center and east sides. The high oil (3.1 gallons per ton) in the spent shale and the skewed temperatures in the retort and offgases indicated adverse conditions in the retort. The retort was shut down after C1052-3. Three clinkers were found in the retort. They were located in the northeast, south and northwest corner of the retort.

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- 3 -

August 1, 1967

An extensive turnaround in the retort is essentially complete. Modifications were made during the turnaround to test the hypothesis of liquid removed from the bed to improve yields and extend the range of operations in the Gas Combustion process.

The computer program has been revised to make corrections to better fit the operations on Retort No. 3. The new program has not been completely debugged. Some of the balances may be rerun although the corrections will not affect yields. There will be some changes in material balances.

Yours truly,



R. H. Cramer
Program Manager

EETurner:gw
Attachments

cc: S. L. Meisel w/o attach

RESULTS FROM RETORT NO. 3 WITH AND WITHOUT DILUTION GAS - 1/4 TO 1 INCH SHALE

July 6, 1967 to July 18, 1967

Run No.	PTC1050	PTC1051	C1051-1 through C1051-3	PTC1052	C1052-1 through C1052-3
Date	7/11/67	7/13/67	7/14/67	7/15/67	7/16/67
Shale size, inches	¼ to 1	¼ to 1	¼ to 1	¼ to 1	¼ to 1
Da	--	0.634	0.646	0.635	0.634
Dv	--	0.707	0.728	0.719	0.717
Fischer Assay, gal/ton	28.5	29.1	27.4	27.9	27.7
Shale rate, lbs/(hr)(ft ²)	304	294	295	297	295
Air, SCF/T	5,220	5,420	5,240	4,930	4,840
Recycle, SCF/T	11,800	10,870	11,340	13,070	13,000
Dilution, SCF/T	2,600	2,430	1,630	330	--
Gas Loss, SCF/T	2,980	2,370	1,563	1,980	720
Line burner temperature, F	720	830	843	838	--
Offgas Temperature, F	141	142	145	143	140
Retort Pressures, in/ft					
Overall	0.43	0.39	0.36	0.37	0.30
Above air distributor	0.62	0.42	0.50	0.49	0.38
Yield, % Fischer Assay	78.7	89.4	88.6	87.8	81.3
Yield, calculated from No. 2 regression analysis					
CO ₃ Decomposition, Wt %	34.1	32.8	31.4	38.8	35.7
Spent shale					
gallons per ton	0.0	0.45	0.40	0.50	3.1
Temperature, F	520	582	540	465	396
Material Balance, Wt %					
Overall	102.6	103.9	102.0	103.7	99.7
Organic Carbon	89.3	100.8	98.8	102.1	99.5
Water	272.3	203.5	184.3	279.0	119.0

TABLE 2

LOG OF OPERATIONS

PTC1050 through C1052-3

July 6, 1967 to July 18, 1967

7/6/67 -
7/10/67

Turnaround items in addition to normal maintenance:

1. Installed 36 bayonet air distributor with yokes on 2 air headers. (See Drawings RB-133, RB-271 and RB-272.)
2. Cut off bottom section of vertical thermowells which eliminated the first couple in each well. Rearranged couples on headers also (See Drawing RE 75 for thermocouple layout) vertical couples start 18 inches above air ports.

7/10/67

- 0500 Started feeding 1/4 to 1 inch shale to retort.
- 1015 Started 4-hour shale circulation.
- 1410 Tried to fire line burner but would not light. Mechanics working on it.
- 1825 Line burner fired at 400 F.
- 1845 Increased line burner temperature to 700 F for startup of C1050 with air equivalent constant O₂ consumption with the addition of dilution gas at O₂ concentration of approximately 4%.
- 2045 Increased line burner temperature to 900 F.
- 2045 - Bringing on conditions. Electrostatic Precipitator turned on.
2233
- 2240 Started adding dilution to unit. 30 SCFM dilution gas with decrease in recycle to 2,110 SCFM.
- 2315 Increased dilution to 90 SCFM.
Decreased recycle to 1,990 SCFM.
- 2350 Increased dilution to 140 SCFM.
Decreased recycle to 1,870 SCFM.

7/11/67

- 2401 - Increased dilution and reduced recycle in 4 increments to:
0120
Dilution = 290 SCFM
Recycle = 1,570 SCFM
Retort is slow heating up. O₂ = 2.8%; CO₂ = 19.5%

- 0207 Line burner failed. Reduced air - when refired line burner, temperature control stuck and allowed air valve to open and give excessive air and give excessive temperatures for approximately 2 minutes. Line burner off.
- 0220 Line burner refired. Pressure and flame in line burner is surging badly.
- 0505 Air blower temperature is running about 100 F. Water apparently leaking into air blower causing cooling effect.
- 0530 East and center of retort still cold but heating up.
- 0900 End SUC1050
Start PTC1050
- 0915 Reduced line burner temperature 100 F to try and reduce dilution burning in headers.
- 0950 Reduced line burner temperature 50 F.
- 1100 Started transition to following conditions:
Air = 720 SCFM (5,200 SCF/T)
Recycle = 1,620 SCFM (11,700 SCF/T)
Dilution = 2,600 SCFM (2,600 SCF/T)
- 1330 Recycle on conditions.
Reduced air 30 SCFM to cool unit.
- 1400 Retort doesn't look good. Offgas temperatures are split.
On following conditions:
Air = 5,000 SCF/T
Recycle = 11,700 SCF/T
Dilution = 2,300 SCF/T
Line burner temperature = 700 F
Shale rate = 300 lbs/(hr) (ft²)
- 1515 Retort looks better. Offgas temperatures are back together.
O₂ = 0.2%; CO₂ = 28%
- 1615 Cut decanter into system.
- 1830 Dilution gas rate and line burner pressures fluctuating more frequently. Dilution dropping off.
- 1925 Dilution now = 260 SCFM.
- 2100 End PTC1050
Start C1050-1
- 2230 Gas rate checks.
Air = 702 SCFM
Recycle = 1,595 SCFM
Dilution = 265 SCFM

2400 Line burner temperature stuck at 400 F. Unit got hotter while line burner temperature was stuck at lower temperature. Line burner back up to 700 F finally.

7/12/67

0130 - Line burner failed again. Line burner temperature dropped
0200 to 200 F. Turned off line burner and restarted - still would not work.

0200 Started reducing air to cool retort. Getting high levels on LR-3.

0250 Offgas temperatures split 15 F. Temperatures are getting more skewed.

0305 Offgas temperatures split 28 F.

0315 Line burner temperature up to 450 F.

0320 Line burner temperature = 300 F.

0600 Retort in bad shape. West side is hot, east and center sides are cool. Approximately 50 F offgas temperature split.

0700 Offgas temperature split = 70 F. Started shutting down.

1100 Retort empty except for clinker on west end. Clinker extended over first 4 yokes on north header across retort over first 3 yokes on south header. The clinker extended from north to south walls on west side.

1100 - Normal turnaround items plus following items:
2400 1. Repair line burner.
2. Repair or replace west vertical therowell.

7/13/67

0045 Started filling retort.

0345 Retort full.

0400 Started 3-hour shale circulation.

0645 Fired line burner. Took 35 minutes to get to 400 F.

0735 Increased line burner temperature to 700 F for C1051 startup using same method as used in C1050.

0940 Increased line burner temperature to 900 F.

1100 Added 30 SCFM dilution gas and reduced recycle to 2,110 SCFM
Electrostatic Precipitator turned on.

Sequence of dilution addition

	<u>Dilution, SCFM</u>	<u>Recycle, SCFM</u>	<u>Air, SCFM</u>
1100	30	2,110	810
1110	60	2,050	810
1120	90	1,990	810
1130	120	1,930	810
1140	150	1,870	810
1150	180	1,810	810
1200	210	1,750	775
1210	240	1,690	775
1220	270	1,630	775
1230	280	1,570	775
1240	280	1,500	775
1315	286	1,525	770 (gas rate checks)

1400 Offgas temperatures split 4 F (west side high).

1520 Offgas temperature split 7 F.

1530 Cut decanter into system.

1540 Air reduced to 740 SCFM. CO₂ is 28% and rising.

1600 Raw shale sample cutter jumped the tracks; raw shale sample crusher plugged.

1635 Air reduced to 720 SCFM.

O₂ = 725 SCFM

CO₂ = 28.5%

TR1-2 = 650 F; TR1-14 = 910 F; TR2-1 = 880 F

TR1-3 = 495 F; TR1-15 = 540 F; TR2-2 = 515 F

Offgas temperature split 8 F.

1730 Gas rate checks.

Air = 725 SCFM

Recycle = 1,536 SCFM

Dilution 323 SCFM

1900 Recycle reduced to 1,500 SCFM - Bottom pressure = 5.0 inches H₂O.

1940 Offgas temperature split 8 F.

2055 Line burner temperature reduced to 845 F to try and increase dilution gas.

2100 End SUC1051
Start PTC1051

2200 Gas checks.
Air = 738 SCFM
Recycle = 1,460 SCFM
Vent = 1,083 SCFM
Dilution = 361 SCFM

2230 Offgas temperature split 12 F.

7/14/67

0200 Unit running hot. CO₂ = 28 to 29%.

0310 Retort running smoothly except for split in offgas temperature.

0430 Offgas temperature split = 16 F.

0700 Unit looks good other than offgas temperature split. Dilution control does not operate very well over sustained periods.

0900 End PTC1051
Start C1051-1

1030 - Offgas split has varied from 6 to 10 F.
1550 Split 10 F at 1550.

1630 Gas rate checks.
Air = 724 SCFM
Recycle = 1,488 SCFM
Dilution = 347 SCFM

2100 End C1051-1
Start C1051-2
Unit looks good except for offgas split of 11 F (west side high).

7/15/67

0200 Retort appears to be cooling off. Raised recycle gas rate 75 SCFM at 0215. (1,570 SCFM)

0410 Retort heating back up.

0700 Recycle reduced about 30 SCFM.

0800 Offgas temperature split 19 F.

0900 End C1051-2
Start C1051-3

1120 Raw shale feed system off approximately 8 minutes so mechanics could repair Feeder No. 6.

2130 Started transition to hot air operation without dilution although there were indications of adverse conditions in retort. (Offgas temperature split, grid temperatures)

Sequence of the transition to hot air operations

	<u>Dilution, SCFM</u>	<u>Recycle, SCFM</u>	<u>Air, SCFM</u>
2100	350	1,470	720
2130	280	1,540	700
2200	210	1,610	700
2230	140	1,680	700
2300	0	1,750	700
2330	--	1,800	700

Unit looking satisfactory - except for 12 F offgas split.

7/16/67

0130 Retort warming up. CO₂ = 28%; O₂ = 0.18%.
Reduced air approximately 20 SCFM to lower CO₂.
Offgas split = 11 F.

0300 Offgas split = 9 F. Unit running fair.
Gas rate check.
Air = 650 SCFM
Recycle = 1,803 SCFM
TR1-2 = 900 F; TR1-14 = 850 F; TR2-1 = 800 F
TR1-3 = 600 F; TR1-15 = 520 F; TR2-2 = 450 F

0630 Lost level in feed inlet system.
Increased raw shale rate to bring level back.

0810 West temperatures down. TR2-1 = 530 F, TR2-2 = 390 F.
East and center couples satisfactory, about 900 F.

0900 End PTC1052
Start C1052-1
Offgas split 6 F.

1025 West side still cold - CO₂ = 29.2%.

1045 East side heating up - Reduced air.

1215 Gas rate checks.
Air = 661 SCFM
Recycle = 1,800 SCFM
O₂ = 0.2
CO₂ = 29.8 %
TR1-2 = 1,000 F; TR1-14 = 945 F; TR2-1 = 510 F
TR1-3 = 720 F; TR1-15 = 680 F; TR2-2 = 375 F

1330 TR2-1 = 380 F. Lowered recycle to 1,720 SCFM.

1615 TR2-1 = 295 F; O₂ = 0.3%; CO₂ = 29%

2100 End C1052-1
Start C1052-2

7/17/67

0800 All TR2-1 couples are running cold.

0900 End C1052-2
Start C1052-3
Increased air to 690 SCFM.

1015 Gas rate checks.
Air = 681 SCFM
Recycle = 1,731 SCFM

1510 Retort running hot in east and center of retort. Couples in west thermocouple well running cold.

1510 - High levels on LR-3. High temperatures in east and center
2000 of retort. Adjusted gas rates did not help.

2100 End C1052-3
Start C1052-4

2130 Offgas temperature split 27 F.

2350 Started shutdown. Grid temperatures spread 350 F - offgas split about 25 F - combustion zone temperatures split. East temperatures TR1-2, 3 and 4 together.

7/18/67

0430 Retort empty except for clinker. Three clinkers found. One in northeast corner covering first 3 yokes on north header; one on south side covering 3 1/2 yokes on south header (2, 3, 4 and 5 yokes from east wall); small clinker in northwest corner covering 2 north bayonets on 2 yokes from west wall on north header. The clinkers extended to the feed inlet chutes.

An extensive turnaround is underway to install the internal hardware for exploratory experiment to remove liquid from the bed above the air distributor.