1513021001

Mobil Oil Corporation

RESEARCH DEPARTMENT
RIFLE, COLORADO 81650

R. H. CRAMER
PROGRAM MANAGER
OIL SHALE RESEARCH CENTER

September 5, 1967

File 102.05

C. A. Blaine - Sinclair Research, Inc.
R. T. Ellington - Sinclair Oil and Gas Company
K. M. Elliott - Mobil Research and Development Corporation
Att: W. W. Hamilton
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E. J. Moll - Mobil Research and Development Corporation
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D. C. Smith - Phillips Petroleum Company
J. K. Smith - Continental Oil Company
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 the C1055 operating attempt. This operation, balance periods C1055 Startup, Pretest, and C1055-1, made as a part of the continuing program to test the hypothesis of liquid removal to improve yield and extend the range of operability.

Prior to the start of C1055, the following modifications were made to the retort:

1. Installation of an improved liquid disengagement grid made of rods instread of strap. (See Drawings RC146, RC158 and RC161)

2. The shale chutes were modified to reduce shale pile sizes. (See Drawing RC162)

3. Modification of the liquid system to allow independent circulation and measurement of oil for the cyclones and liquid disengagement deck. (RC156 Revision 5)

4. Revised thermocouple layout. (See Drawing R192 Revision 1)

Mobil

C1055-PT and C1055-1 were made at nominal conditions of 500 lbs/(hr)(ft^2) shale rate, 4,500 SCF/T air and 15,000 SCF/T recycle gas rates using 1/4 to 1 inch shale. See OSRC 10's for a detailed summary of test period data. Table 1 presents a log of operations.

C1055 startup and operation was very similar to C1054. No oil was collected in either the cyclones or liquid disengagement deck. During the first 24 hours of operation the spent shale contained almost five gallons per ton of oil indicating inefficient retorting. The severity was increased in an attempt to clean up the spent shale. However, the operation deteriorated quickly and the unit was shut down with clinkers about 36 hours after startup. The grid was found to be 20 to 30% plugged - a substantial improvement over the previous design. The modified grid did pass considerable shale chips on to the deck and into the liquid flush system. When shut down, three clinkers were found in the air distributor in the northwest, southwest and southeast corners. (See Internal Retort Condition Report of August 16, 1967 for a complete description of retort internals after shutdown.)

Further modifications are in progress to improve mechanical operability and allow a more significant test of the principle.

Yours truly,

RH Cramer

R. H. Cramer
Program Manager

RLMcGalliard:rl
Attachments

cc: S. L. Meisel w/o attach

TABLE 1

LOG OF OPERATIONS C1055

8-10-67	0445	Fired line burner at 400 F.
	0500	Raised line burner to 700 F.
	0700	Raised line burner to 900 F.
	1000	O_2 = 1.5 Vol % in vent gas; CO_2, 24.5 Vol %.
	1125	Offgas split 6 F.
	1635	Started transition to 500 mass rate conditions.
	1910	Line burner phased out of system.
	1920	Deck wash surge drum blow back into retort; turned steam coil off.
	2100	Started C1055-PT.
	2330	On 500 mass rate conditions.
8-11-67	0630	West filter plugged; switched both wash systems to east filter.
	0900	Ended C1055-PT; started C1055-1.
	1100	South roll found to have moved back about 1/2 inch.
	1430	Gas sample compressor out.
	1640	Made special temperature probe under air headers.
	1645	Raised air 25 SCFM.
	1745	Raised air 25 SCFM.
	1830	Cut air 50 SCFM.
	2010	Bottom pressure went off chart (maximum chart reading 20 inches H_2O).
	2015	Pulled all samples.
	2110	Start shutdown.

RLMcGalliard
8/31/67

CO-273
(2-51)

INTEROFFICE CORRESPONDENCE
MOBIL RESEARCH AND DEVELOPMENT CORPORATION

RESEARCH DEPARTMENT
Anvil Points Oil Shale Research Center
Rifle, Colorado

August 16, 1967

File 526

R. H. Cramer
Program Manager
Anvil Points

INTERNAL RETORT CONDITION - RETORT NO. 3 TURNAROUND
AUGUST 12 - 16, 1967

Retort No. 3 was inspected carefully as pieces of equipment were dismantled. These notes should help in analyzing terminal conditions of Run C1055.

1. Surge Drum - West and East

No leak in the steam coils. Reported blow of oil may have resulted from water if oil was pumped from product tanks into surge drums.

2. Grids and Screens

Screens on west wall heavily to totally blinded with a hard coke like deposit. Other screens generally open. Back of all screens had a hard coke deposit. Sand blasting was required to clean the screens.

3. Cyclones Nos. 1 through 6 West to East

West Cyclone No. 1 - heavy and hard coke deposit on walls with cone full of deposit.

Cyclone No. 2 - cone one-half full of deposit with light wall deposits.

Cyclones Nos. 3, 4 and 5 - drains open, light wall deposit.

Cyclone No. 6 - filled with oil.

4. Deck Drains

East and west wall drains plugged with very hard coke deposits. Center drains open.

5. Deck - Deposits of Oil, Coke, Dust and Chips

West end - very hard deposit - 3 to 4 inches deep
East end - very hard deposit - 1 to 2 inches deep
Center - hard thin coke-like deposit

6. Flush Oil Piping - Inlet

Many ports plugged, all required cleaning. Generally plugged on perimeter.

7. Surge Drum Deposits

Both drums had approximately 12 inches of deposit which would not wash clear. The vessel had to be opened and the deposit scooped out.

8. General

The nature of the deposits make their removal most difficult and time consuming. The cyclone deposits had to be air hammered loose. The drain line deposits had to be hammered and rodded. Deck deposits were similar.

W. S. Bergen /ms

W. S. Bergen
Mechanical Engineering Group

cc: R. E. Smith
J. J. McAleer
J. E. Lawson
T. C. Lyons

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

Date 8-10-67

Purpose: DEMONSTRATE PRINCIPLE OF LIQUID REMOVAL TO IMPROVE YIELD AND OPERABILITY.

GENERAL	
Run No.	SUC1055
Length, hours	12
Retort Type Number	RC-X
Oil Recovery System Number	C-5
Tons Total Raw Shale Charged, ~~lbs.~~	101,76
Bed Height above Dist., ft	6½'
Type Air Dist.	XIII
Bed Below Air Dist., ft	6'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft^2)	307
Spent Shale, % of RS	80.4
Liquid Product, lbs/hr	1606.8
Oil Collected, gal/ton RS	19.1
Air, SCF/ton RS (dry)	5760
Total Recycle*, SCF/ton RS(wet)	17200
Dilution, SCF/ton RS (wet)	—
Calc.Vent Gas SCF/ton RS(dry)	8460
Gas Losses, SCF/ton RS(wet)	2450
Propane, SCF/ton RS	28.3
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	147
Spent Shale, F	362
Raw Shale, °F	72
Recycle Gas Inlet, °F	251
Dilution Gas Inlet, °F	—
Air Inlet, °F	155
Retort Air Inlet, F	155
Heat of Comb. MBtu/ton RS	468
Heat Lost, MBtu/ton RS	39
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	29.1
Oil, Wt %	11.1
Water, Wt %	0.8
Gas, Wt %	2.4
Mineral CO_2, Wt %	19.2
Ash, Wt %	65.6
Moisture, Wt % (Uncrushed)	0.88
Carbon (Total), Wt %	17.9
Hydrogen (Total), Wt %	1.77
Nominal Size Range, inches	¼"-1"
5 % passing thru	0.263
98 % passing thru	1.05
Da	0.611
D_V	0.707

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	4.38
Mineral CO_2, Wt %	15.0
Ash, Wt %	81.6
Carbon (total), Wt %	7.81
Organic Carbon, Wt %	3.72
Hydrogen (total), Wt %	0.40
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	76.8
Density, lb/gal	7.597
Gravity, API	23.6
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	13.3
Oil, lbs/MSCF(dry)**	0.084
Analysis (dry)	
CO_2, Vol %	26.0
O_2, Vol %	1.2
N_2 + Argon, Vol %	53.9
CH_4, Vol %	1.2
CO, Vol %	4.2
H_2, Vol %	4.3
Other, Vol %	9.2
Gross Heating Value(calc),Btu/SCF	90.2
Carbon (Total), lbs/MSCF (dry)	11.9
Hydrogen (Total), lbs/MSCF (dry)	0.69
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	65.6
Oil in Gas**, Vol % RSFA	0.3
Oil in Spent Shale, Vol % RSFA	12.3
Total Oil Meas., Vol % RSFA	78.2
Carbonate Decomposition, %	37.2
Water Recovered, lb/ton RS	166.9
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	RS 100
Overall Balance, %	107.0
Carbon Balance, % - Organic	95.4
Carbon Balance, % - Total	96.7
Hydrogen Balance, % - Organic	81.4
Hydrogen Balance, % - Total	123.8
Water Balance, %	428.8
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.61
ΔP Above Air Dist., in H_2O/ft	0.92
Pressure Above Deck - PI8 - "H_2O	1.2
Pressure Below Deck - PI10 - "H_2O	3.8

Comments: NON-EQUILIBRATED OPERATION.

*Measured Recycle + Dilution Gas

** Oil Mist + Condensibles to 84 °F

*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed W. M. Sullivan DATE August 22, 1967

OSRC-10

Revised 7/19/66

//A100
2080, SUC1055 8-10-67

A. YIELDS

FAY	6.563E 01	DRYGAS	8.455E 03	MISTFA	3.200E-01
H2	3.636E 02	OTHER	7.778E 02	UNRETO	1.231E 01
CH4	1.015E 02	O2	1.015E 02	SSY	8.039E 01
CO	3.551E 02	CO2DEC	3.719E 01	MH2O	1.669E 02
CO2	2.198E 03	OILCOL	1.910E 01		

B. METERED GAS RATES

RECG	1.722E 04	DIL	0.0	WVENTG	8.380E 03
AIR	5.759E 03	TRECG	1.722E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.934E 01	HVGT	7.622E 02	MWDG	3.251E 01
GBTU	9.015E 01				

D. COMBUSTION PRODUCTS

CO2C	8.993E 02	COC	3.345E 02	H2OC	4.345E 00
CHR	8.021E 01	COMBCP	1.529E 01		

E. MATERIAL IN

ORGCIN	2.559E 02	RSR	3.071E 02	ORH2IN	3.421E 01
MATIN	2.463E 03				

F. MATERIAL OUT

ORGCVG	6.225E 01	COKEC	3.393E 01	UNRETH	3.167E 00
ORGCOL	1.220E 02	ORH2VG	6.399E 00	COKEH	2.183E 00
UNRETC	2.580E 01	ORH2OL	1.610E 01	ORCOLP	4.769E 01
ORCVGP	2.433E 01	ORCSSP	2.335E 01	HCCVGP	9.046E 00

G. MATERIAL BALANCES

OVALL	1.070E 02	ORH2	8.141E 01	O2BAL	1.276E 02
ASH	0.0	TC	9.670E 01	WATER	4.288E 02
ORGC	9.537E 01	TH2	1.238E 02	GASL	2.447E 03
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.680E 05	QH2OC	1.244E 04	QAIR	8.809E 03
QPROP	1.112E 02	QOILC	1.016E 04	QRCYL	7.018E 04
QSUMIN	5.697E 05				

I. HEAT OUT

QMCO2D	2.314E 05	QKEROD	9.385E 04	QH2OV	3.787E 04
QLIQO	4.004E 03	QOFGAS	4.111E 04	QSS	1.063E 05
QGASL	1.654E 04	LBLOSS	0.0	HETLOS	3.864E 04
QSUMOT	5.697E 05				

J. MISCELLANEOUS

ORCSS	3.715E 00	VPOIL	8.367E-02	TGL	3.932E 03
VPM	1.334E 01	WCG	2.191E 01	PROP	2.832E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS – DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION						
0	2080,	S.U.C1055			8-10-67			

1	WRS: 0,8 (H2O, WT %)	OLRS: 11.1 (OIL, WT%)	TRS: 72 (TEMP., °F)	B: -1	MRS: 16959,3 (RATE, lb/HR)		RAW SHALE
2	FA: 29.1 (OIL, GAL/TON)	GRS: 2,4 (GAS&LOSS, WT%)	CORS: 19,2 (CO2, WT%)	XA: 55,22 (RETORT XS, FT²)			
3	ASRS: 65,6 (ASH, WT%)	CRS: 17,9 (CARBON, WT%)	HRS: 1,77 (H2, WT%)	BP: 24,52 (BARO. PRESS., IN Hg)	TOG: 147 (OFFGAS TEMP., °F)		
4	CRA: 814,6 (CHART READING, SCFM)	MFA: 1,0 (METER FACTOR)	TA: 155 (TEMP., °F)	PA: 125 (PRESS., IN H2O)	WA: 0,14 (H2O, lb/MSCF)	LBHL: 0 (HEAT LOSS, BTU/HR)	AIR
5	CRRG: 2442,6 (RECYCLE CHART READING, SCFM)	MFRG: 1,0 (METER FACTOR)	TRG: 251 (TEMP., °F)	PRG: 67 (PRESS., IN H2O)	CRTG: 0,0 (TOTAL GAS CHART READING)	MFTG: 0,0 (METER FACTOR)	RECYCLE AND TOTAL GAS
6	CRDG: 0,0 (CHART READING)	MFDG: 0,0 (METER FACTOR)	TDG: 0 (TEMP., °F)	PDG: 0 (PRESS., IN H2O)			DILUTION GAS
7	P: 4,0 (SCFM)	TP: 0,4 (TEMP., °F)	PP: ,127 (PRESS., IN H2O)	W: 150,6 (H2O ADDED, lb/HR)	N: 0,0 (NUCL. AGENT, lb/HR)		PROPANE AND NUCLEATING AGENT
8	WSS: 0,6 (H2O, WT %)	OLSS: 1,7 (OIL, WT %)	GSS: 0,5 (GAS, WT%)	SS: 0,0 (RATE, lb/HR)			SPENT SHALE
9	COSS: 15,0 (CO2, WT %)	ASSS: 81,6 (ASH, WT %)	CSS: 7,81 (CARBON, WT%)	HSS: 0,40 (H2, WT%)	TSS: 362 (TEMP., °F)		
10	OILLP: 1230,3 (DRY OIL, lb/HR)	COL: 84,1 (CARBON, WT %)	HOL: 11,1 (H2, WT %)	DOL: 7,597 (DENSITY, lb/GAL)	WLP: 376,5 (H2O, lb/HR)		LIQUID PRODUCT
11	CRVG: 1230,6 (CHT. RDG. VENT GAS, SCFM)	MFVG: 1,0 (METER FACTOR)	TVG: 244 (TEMP., °F)	WG: 0,0 (H2O, lb/MSCF)	OILM: 0,0 (OIL MIST, lb/MSCF)	M: 0	VENT GAS
12	CG: 11,9 (CARBON, lb/MSCF)	H: 0	COOG: 26,0 (CO2, VOL %)	OG: 1,2 (O2, VOL %)	NG: 53,9 (N2, VOL %)		
13	MEG: 1,2 (CH4, VOL %)	COG: 4,2 (CO, VOL %)	HHG: 4,3 (H2, VOL %)	OTG: 9,2 (OTHERS, VOL%)	HG: 0,69 (H2, lb/MSCF)		
14	CRVP: 15,77 (CHART READING)	VPMF: 1,83 (METER FACTOR)	TVP: 79 (TEMP., °F)	PVP: 291 (PRESS., IN H2O)	PVPC: 27 (CONDENSER PRESS. IN H2O)		VENT PURGE
15	TVPC: 84 (CONDENSER GAS EFFLUENT TEMP., °F)	VPOIL: 73,1 (DRY OIL, GM/HR)	VPW: 20,4 (H2O, lb/HR)	CL: 77,8 (TOP SEAL GAS RATE, SCFM)			

OPTIONS:

1. B *Enter "1" to Calculate with Spent Shale Rate and Ash Analyses,*
   Or "0" to Calculate with Measured Rates,
   Or "-1" to Calculate with Raw Shale Rate and Ash Analyses.
2. M *Enter "1" to Calculate Moisture and Mist, Externally,*
   Or "0" to Calculate from Vent Purge Raw Data.
3. H *Enter "1" to Calculate using Retort #2,*
   Or "0" to Calculate using Retort #3.

OSRC-9
Revised

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 8-10-67 Run No. C 1055 STARTUP

Sample Time: RS 1845; SS ?

FISCHER ASSAY

EA ⊗ RAW SHALE	EA ⊗ SPENT SHALE	
28.9	4.38	Gal/Ton
.912	—	S.G., g/ml
4.0	1.7	Oil, wt %
1.6	0.6	Water, wt %
95.0	97.2	Sp. Shale, ~~wt~~ %
2.4	0.5	Gas & Loss, wt %
Slight	None	COKING TENDENCY

○ RETORT SHALE MOISTURE

0.88 wt %

⊗ RAW SHALE FISCHER ASSAY MOISTURE

R/A 0.83 wt %

MINERAL CO_2

EA ⊗	EA ⊗	
19.1	15.0	wt %

ASH (SHALE)

⊗	⊗	
65.4	81.6	wt %

MOISTURE

⊗	⊗	
0.35	0.06	wt %

CARBON

⊗	⊗	
17.8	7.81	wt %

HYDROGEN

⊗	⊗	
1.76	0.40	wt %

BENZENE EXTRACTABLES

○	○	
.	.	wt %

○ SHALE RICHNESS DISTRIBUTION (See attached graph)

○ SCREEN ANALYSIS (See back of this sheet)

All results are "as received" unless noted. "Moisture" designates the moisture content of the -48 mesh material used for "Ash", "Mineral CO_2", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS

DATE COMPLETED AUG 14 CHECKED BY RA

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 8-10-67 Run No. C1055-SU

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
⊗ WATER, wt %	23.2					
⊗ GRAVITY, °API	23.6					
○ OIL ASH, wt %						

○ DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

⊗ OIL WT, g 377

⊗ WATER VOL, ml 550

⊗ GRAVITY OIL, °API 37.7

VENT GAS

⊗ MAJOR COMPONENTS

CO_2	26.0	vol %
O_2	1.2	"
N_2	53.3	"
CH_4	1.2	"
CO	4.2	"
H_2	4.3	"
Ar	0.6	"
Others	9.2	"

⊗ CARBON, 11.9 lbs/MSCFDG

○ C_1 thru C_4, plus n-Pentane

CH_4	.	vol %
C_2H_4-C_2H_6	.	"
C_3H_8	.	"
C_3H_6	.	"
i C_4H_{10}	.	"
n C_4H_{10}	.	"
$\emptyset C_3H_6$	.	"
n C_5H_{12}	.	"

⊗ HYDROGEN, 0.69 lbs/MSCFDG

COMMENTS

DATE COMPLETED AUG 14 1967 CHECKED BY

OSRC-12B
(Revised 5/3/66)

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. _____ SAMPLE NO. _____ DATE _____

UNIT _____ DESCRIPTION _____

APPROX. SHALE SIZE _____ SHAKING TIME _____ ANALYSIS BY _____

TOTAL SAMPLE WT. GROSS _____ − TARE _____ = NET _____

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50				
	2.00				
	1.50				
	1.05				2.8
	0.742				50.6
	0.525				33.7
	0.371				8.4
	0.263	3			13.7
	0.185	4			1.1
	0.131	6			0.3
	0.093	8			0.0
	0.065	10			0.3
	PAN				2.9
TOTAL ON SCREENS AND PAN					113.7
LOSS (BY DIFFERENCE)					0.0
TOTAL SAMPLE WEIGHT					113.7

SCREEN SIZE	Di *	1/Di	% RETAINED	CUM. % RETAINED	% PASSING
4.25					
3.00	(3.125)	(0.3200)			
2.50	(2.625) 2.750	(0.3809) 0.3636			
2.00	2.250	0.4444			
1.50	1.750	0.5714			
1.05	(1.087) 1.275	(0.9199) 0.7843	2.46		97.53
0.742	0.896	1.116	44.50		53.03
0.525	0.634	1.577	29.64		23.39
0.371	0.448	2.232	7.39		16.00
0.263	0.317	3.154	12.05		3.95
0.185	0.224	4.464	0.97		2.98
0.131	0.158	6.329	0.26		2.72
0.093	0.112	8.928	0.00	97.27	2.72
0.065			0.26		2.46
PAN			2.46		0.00
LOSS			0.01	—	—
TOTAL			99.99	—	—
			—	—	—

* NUMBERS IN PARENTHESES SHOULD BE USED WHEN THESE SCREEN SIZES REPRESENT THE TOP OF THE SHALE SIZE RANGE.

$\Sigma^{m}_{+8m} Di$	0.68727	$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$	1.59143	$\Sigma^{m}_{+8m} Xi / Di$	
Da	0.61121	$\Sigma^{m}_{+8m} Xi\ Di$	
Dv	0.70655		

REMARKS: _____

OSRC-4
REV 9/66

004484

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C-1055-S.U. SAMPLE NO. 2 DATE 8-10-67

UNIT B&T 3 DESCRIPTION T. Lab

APPROX. SHALE SIZE ½-1" SHAKING TIME 10 min ANALYSIS BY [illegible]

TOTAL SAMPLE WT. GROSS 62.2 – TARE 6.8 = NET 55.4

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50				
	2.00				
	1.50				
	1.05		20.3	19.2	1.1
	0.742		43.7	20.5	23.2
	0.525		35.8	18.5	17.3
	0.371		23.3	18.7	4.6
	0.263	3	26.0	18.4	7.6
	0.185	4	19.9	19.4	.5
	0.131	6	19.5	19.4	.1
	0.093	8	20.8	20.8	0
	0.065	10	19.3	19.2	.1
	PAN		21.8	21.0	.8
TOTAL ON SCREENS AND PAN					55.3
LOSS (BY DIFFERENCE)					.1
TOTAL SAMPLE WEIGHT					55.4

SCREEN SIZE	Di *	1/Di	% RETAINED	CUM. % RETAINED	% PASSING
4.25					
3.00	(3.125)	(0.3200)			
2.50	(2.625) 2.750	(0.3809) 0.3636			
2.00	2.250	0.4444			
1.50	1.750	0.5714			
1.05	(1.087) 1.275	(0.9199) 0.7843	1.99		98.01
0.742	0.896	1.116	41.88		56.13
0.525	0.634	1.577	31.23		24.90
0.371	0.448	2.232	8.30		16.60
0.263	0.317	3.154	13.72		2.88
0.185	0.224	4.464	0.90		1.98
0.131	0.158	6.329	0.18		1.80
0.093	0.112	8.928	0.00	98.2	1.80
0.065			0.18		1.62
PAN			1.44		0.18
LOSS			0.18		0.00
TOTAL			100.00	—	—
			—	—	—

* NUMBERS IN PARENTHESES SHOULD BE USED WHEN THESE SCREEN SIZES REPRESENT THE TOP OF THE SHALE SIZE RANGE.

$\Sigma^{m}_{+8m} Di$	0.67785	$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$	1.64774	$\Sigma^{m}_{+8m} Xi / Di$	
Da	0.59596	$\Sigma^{m}_{+8m} Xi\ Di$	
Dv	0.69027		

REMARKS: _____

OSRC-4
REV 9/66

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C-1055-59 SAMPLE NO. 1 DATE 8-10-67

UNIT R.L.F. #3 DESCRIPTION T.Y. Lab

APPROX. SHALE SIZE ½" - 1" SHAKING TIME 10 min. ANALYSIS BY S. Smith

TOTAL SAMPLE WT. GROSS 64.4 - TARE 6.0 = NET 58.4

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50				
	2.00				
	1.50				
	1.05		20.9	19.2	1.7
	0.742		47.9	20.5	27.4
	0.525		34.9	18.5	16.4
	0.371		22.5	18.7	3.8
	0.263	3	24.5	19.4	5.1
	0.185	4	20.0	19.4	.6
	0.131	6	19.6	19.4	.2
	0.093	8	20.8	20.8	.0
	0.065	10	19.4	19.2	.2
	PAN		23.0	21.0	2.0
TOTAL ON SCREENS AND PAN					58.4
LOSS (BY DIFFERENCE)					0
TOTAL SAMPLE WEIGHT					

SCREEN SIZE	Di *	1/Di	% RETAINED	CUM. % RETAINED	% PASSING
4.25					
3.00	(3.125)	(0.3200)			
2.50	(2.625) 2.750	(0.3809) 0.3636			
2.00	2.250	0.4444			
1.50	1.750	0.5714			
1.05	(1.087) 1.275	(0.9199) 0.7843			
0.742	0.896	1.116			
0.525	0.634	1.577			
0.371	0.448	2.232			
0.263	0.317	3.154			
0.185	0.224	4.464			
0.131	0.158	6.329			
0.093	0.112	8.928			
0.065					
PAN					
LOSS					
TOTAL					

* NUMBERS IN PARENTHESES SHOULD BE USED WHEN THESE SCREEN SIZES REPRESENT THE TOP OF THE SHALE SIZE RANGE.

$\Sigma^{m}_{+8m} Di$		$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$		$\Sigma^{m}_{+8m} Xi / Di$	
Da		$\Sigma^{m}_{+8m} Xi\ Di$	
Dv			

REMARKS: _____

OSRC-4
REV 9/66

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

Date 8-10-67

Purpose: DEMONSTRATE PRINCIPLE OF LIQUID REMOVAL TO IMPROVE YIELD AND OPERABILITY.

GENERAL	
Run No.	PTC1055
Length, hours	12
Retort Type Number	RC-X
Oil Recovery System Number	C-5
Tons Total Raw Shale Charged, ~~lbs.~~	150.13
Bed Height above Dist., ft	6½'
Type Air Dist.	XIII
Bed Below Air Dist., ft	6'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft²)	468
Spent Shale, % of RS	81.2
Liquid Product, lbs/hr	2286.3
Oil Collected, gal/ton RS	22.4
Air, SCF/ton RS (dry)	4800
Total Recycle*, SCF/ton RS(wet)	15800
Dilution, SCF/ton RS (wet)	—
Calc. Vent Gas SCF/ton RS(dry)	6940
Gas Losses, SCF/ton RS(wet)	1570
Propane, SCF/ton RS	—
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	158
Spent Shale, F	326
Raw Shale, °F	70
Recycle Gas Inlet, °F	236
Dilution Gas Inlet, °F	—
Air Inlet, °F	150
Retort Air Inlet, F	150
Heat of Comb. MBtu/ton RS	387
Heat Lost, MBtu/ton RS	14
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	29.5
Oil, Wt %	11.2
Water, Wt %	0.9
Gas, Wt %	2.6
Mineral CO_2, Wt %	18.1
Ash, Wt %	65.7
Moisture, Wt % (Uncrushed)	Est. 10
Carbon (Total), Wt %	18.5
Hydrogen (Total), Wt %	1.91
Nominal Size Range, inches	¼"-1"
5 % passing thru	0.263
98 % passing thru	1.05
Da	0.638
D_v	0.736

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	4.57
Mineral CO_2, Wt %	15.8
Ash, Wt %	80.9
Carbon (total), Wt %	8.00
Organic Carbon, Wt %	3.69
Hydrogen (total), Wt %	0.40
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	98.1
Density, lb/gal	7.778
Gravity, API	20.0
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	12.1
Oil, lbs/MSCF(dry)**	0.213
Analysis (dry)	
CO_2, Vol %	25.0
O_2, Vol %	1.2
N_2 + Argon, Vol %	54.7
CH_4, Vol %	1.6
CO, Vol %	4.7
H_2, Vol %	4.9
Other, Vol %	7.9
Gross Heating Value(calc),Btu/SCF	104.5
Carbon (Total), lbs/MSCF (dry)	12.0
Hydrogen (Total), lbs/MSCF (dry)	0.80
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	75.9
Oil in Gas**, Vol % RSFA	0.6
Oil in Spent Shale, Vol % RSFA	11.6
Total Oil Meas., Vol % RSFA	88.1
Carbonate Decomposition, %	29.1
Water Recovered, lb/ton RS	96.4
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	RS100
Overall Balance, %	103.5
Carbon Balance, % - Organic	96.7
Carbon Balance, % - Total	97.5
Hydrogen Balance, % - Organic	84.9
Hydrogen Balance, % - Total	104.4
Water Balance, %	234.0
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	1.22
ΔP Above Air Dist., in H_2O/ft	1.88
Pressure Above Deck - PI8 - "H_2O	2.0
Pressure Below Deck - PI10 - "H_2O	8.0

Comments: OIL WASH SYSTEM PROBLEMS THROUGHOUT LAST HALF OF THIS PERIOD.

*Measured Recycle + Dilution Gas
** Oil Mist + Condensibles to 81 °F
*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed W. R. Hallmark DATE August 22, 1967

OSRC-10
Revised 7/19/66

8/17/67

//A100
2080, PTC1055 R-1 8-10-67

A. YIELDS

FAY	7.586E 01	DRYGAS	6.943E 03	MISTFA	6.447E-01
H2	3.402E 02	OTHER	5.485E 02	UNRETO	1.160E 01
CH4	1.111E 02	O2	8.332E 01	SSY	8.121E 01
CO	3.263E 02	CO2DEC	2.911E 01	MH2O	9.636E 01
CO2	1.736E 03	OILCOL	2.238E 01		

B. METERED GAS RATES

RECG	1.577E 04	DIL	0.0	WVENTG	7.137E 03
AIR	4.800E 03	TRECG	1.577E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.911E 01	HVGT	7.257E 02	MWDG	3.193E 01
GBTU	1.045E 02				

D. COMBUSTION PRODUCTS

CO2C	7.521E 02	COC	3.036E 02	H2OC	2.303E 00
CHR	1.295E 02	COMBCP	1.234E 01		

E. MATERIAL IN

ORGCIN	2.712E 02	RSR	4.682E 02	ORH2IN	3.618E 01
MATIN	2.388E 03				

F. MATERIAL OUT

ORGCVG	5.582E 01	COKEC	3.632E 01	UNRETH	2.966E 00
ORGCOL	1.464E 02	ORH2VG	5.977E 00	COKEH	2.440E 00
UNRETC	2.356E 01	ORH2OL	1.932E 01	ORCOLP	5.398E 01
ORCVGP	2.059E 01	ORCSSP	2.208E 01	HCCVGP	8.244E 00

G. MATERIAL BALANCES

OVALL	1.035E 02	ORH2	8.485E 01	O2BAL	1.130E 02
ASH	0.0	TC	9.754E 01	WATER	2.340E 02
ORGC	9.665E 01	TH2	1.044E 02	GASL	1.569E 03
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	3.867E 05	QH2OC	1.257E 04	QAIR	7.073E 03
QPROP	0.0	QOILC	1.218E 04	QRCYL	5.861E 04
QSUMIN	4.771E 05				

I. HEAT OUT

QMCO2D	1.707E 05	QKEROD	9.806E 04	QH2OV	4.282E 04
QLIQO	5.678E 03	QOFGAS	4.301E 04	QSS	9.379E 04
QGASL	9.160E 03	LBLOSS	0.0	HETLOS	1.388E 04
QSUMOT	4.771E 05				

J. MISCELLANEOUS

ORCSS	3.687E 00	VPOIL	2.131E-01	TGL	5.363E 03
VPM	1.207E 01	WCG	2.025E 01	PROP	0.0

END MESSAGE

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS – DATA SHEET

LINE # , PROGRAM ID ← – USER IDENTIFICATION →

0 | 2080, | PT C1055 R-1 8-10-67

1	WRS: 0.9 (H2O, WT %)	OLRS: 11.2 (OIL, WT%)	TRS: 70 (TEMP., °F)	B: -1	MRS: 258558 (RATE, lb/HR)		RAW SHALE
2	FA: 29.5 (OIL, GAL/TON)	GRS: 2.6 (GAS & LOSS, WT%)	CORS: 18.1 (CO2, WT %)	XA: 55.22 (RETORT XS, FT²)			
3	ASRS: 65.7 (ASH, WT %)	CRS: 18.5 (CARBON, WT %)	HRS: 1.91 (H2, WT %)	BP: 24.49 (BARO. PRESS., INHg)	TOG: 158 (OFFGAS TEMP., °F)		
4	CRA: 1035.0 (CHART READING, SCFM)	MFA: 1.0 (METER FACTOR)	TA: 150 (TEMP., °F)	PA: 126 (PRESS., IN H2O)	WA: 0.14 (H2O, lb/MSCF)	LBHL: 0 (HEAT LOSS, BTU/HR)	AIR
5	CRRG: 3405.2 (RECYCLE CHART READING, SCFM)	MFRG: 1.0 (METER FACTOR)	TRG: 236 (TEMP., °F)	PRG: 70 (PRESS., IN H2O)	CRTG: 0.0 (TOTAL GAS CHART READING)	MFTG: 0.0 (METER FACTOR)	RECYCLE AND TOTAL GAS
6	CRDG: 0.0 (CHART READING)	MFDG: 0.0 (METER FACTOR)	TDG: 0 (TEMP., °F)	PDG: 0 (PRESS., IN H2O)			DILUTION GAS
7	P: 0.0 (SCFM)	TP: 0 (TEMP., °F)	PP: 0 (PRESS., IN H2O)	W: 261.2 (H2O ADDED, lb/HR)	N: 0.0 (NUCL. AGENT, lb/HR)		PROPANE AND NUCLEATING AGENT
8	WSS: 0.6 (H2O, WT %)	OLSS: 1.6 (OIL, WT %)	GSS: 0.3 (GAS, WT %)	SS: 0.0 (RATE, lb/HR)			SPENT SHALE
9	COSS: 15.8 (CO2, WT %)	ASSS: 80.9 (ASH, WT %)	CSS: 8.0 (CARBON, WT %)	HSS: 0.40 (H2, WT %)	TSS: 326 (TEMP., °F)		
10	OILLP: 2250.3 (DRY OIL, lb/HR)	COL: 84.1 (CARBON, WT %)	HOL: 11.1 (H2, WT %)	DOL: 7.778 (DENSITY, lb/GAL)	WLP: 36.0 (H2O, lb/HR)		LIQUID PRODUCT
11	CRVG: 1556.2 (CHT. RDNG VENT, SCFM)	MFVG: 1.0 (METER FACTOR)	TVG: 229 (TEMP., °F)	WG: 0.0 (H2O, lb/MSCF)	OILM: 0.0 (OIL MIST, lb/MSCF)	M: 0	VENT GAS
12	CG: 12.0 (CARBON, lb/MSCF)	H: 0	COOG: 25.0 (CO2, VOL %)	OG: 1.2 (O2, VOL %)	NG: 54.7 (N2, VOL %)		
13	MEG: 1.6 (CH4, VOL %)	COG: 4.7 (CO, VOL %)	HHG: 4.9 (H2, VOL %)	OTG: 7.9 (OTHERS, VOL %)	HG: 0.80 (H2, lb/MSCF)		
14	CRVP: 18.3 (CHART READING)	VPMF: 1.83 (METER FACTOR)	TVP: 72 (TEMP., °F)	PVP: 274 (PRESS., IN H2O)	PVPC: 20 (CONDENSER PRESS. IN H2O)		VENT PURGE
15	TVPC: 81 (CONDENSER GAS EFFLUENT TEMP., °F)	VPOIL: 200.8 (DRY OIL, GM/HR)	VPW: 19.9 (H2O, lb/HR)	CL: 30.2 (TOP SEAL GAS RATE, SCFM)			

OPTIONS:

1. B *Enter "1" to Calculate with Spent Shale Rate and Ash Analyses,*
   Or "0" to Calculate with Measured Rates,
   Or "-1" to Calculate with Raw Shale Rate and Ash Analyses.
2. M *Enter "1" to Calculate Moisture and Mist, Externally,*
   Or "0" to Calculate from Vent Purge Raw Data.
3. H *Enter "1" to Calculate using Retort #2,*
   Or "0" to Calculate using Retort #3.

OSRC-9
Revised

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 8-11-67 Run No. C1055 PT

Sample Time: RS 0745; SS 10:45

	FISCHER ASSAY RAW SHALE	FISCHER ASSAY SPENT SHALE	
	29.2	4.3	Gal/Ton
	.914	.—	S.G., g/ml
	11.1	1.6	Oil, wt %
	1.8	0.6	Water, wt %
	84.5	97.3	Sp. Shale, ~~wt~~ %
	2.6	0.3	Gas & Loss, wt %
	Slight	None	COKING TENDENCY
	MINERAL CO_2		
FA	18.1	15.5	wt %
	ASH (SHALE)		
	65.6	50.9	wt %
	MOISTURE		
	0.18	0.08	wt %
	CARBON		
	18.5	8.00	wt %
	HYDROGEN		
	1.91	0.40	wt %
	BENZENE EXTRACTABLES		
	.	.	wt %

○ RETORT SHALE MOISTURE
EST. 1.00 wt %

⊗ RAW SHALE FISCHER ASSAY MOISTURE
0.93 wt %

○ SHALE RICHNESS DISTRIBUTION (See attached graph)

○ SCREEN ANALYSIS (See back of this sheet)

All results are "as received" unless noted. "Moisture" designates the moisture content of the -48 mesh material used for "Ash", "Mineral CO_2", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS

DATE COMPLETED AUG 14 1967 CHECKED BY

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 8-10-67 Run No. C1055 PT

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
⊗ WATER, wt %	1.9					
⊗ GRAVITY, °API	20.0					
○ OIL ASH, wt %						

○ DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

⊗ OIL WT, g 2409.0

⊗ WATER VOL, ml 1075.0

⊗ GRAVITY OIL, °API 41.4

VENT GAS

⊗ MAJOR COMPONENTS

CO_2	25.0	vol %
O_2	1.2	"
N_2	54.0	"
CH_4	1.6	"
CO	4.7	"
H_2	4.9	"
Ar	.7	"
Others	7.9	"

⊗ CARBON, 12.0 lbs/MSCFDG

○ C_1 thru C_4, plus n-Pentane

CH_4	.	vol %
C_2H_4-C_2H_6	.	"
C_3H_8	.	"
C_3H_6	.	"
i C_4H_{10}	.	"
n C_4H_{10}	.	"
ϕC_3H_6	.	"
n C_5H_{12}	.	"

⊗ HYDROGEN, 0.80 lbs/MSCFDG

COMMENTS

DATE COMPLETED _____ CHECKED BY _____

OSRC-12B
(Revised 5/3/66)

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 1055 P.T. SAMPLE NO. _____ DATE 8-11-67

UNIT _____ DESCRIPTION _____

APPROX. SHALE SIZE _____ SHAKING TIME 10 min. ANALYSIS BY _____

TOTAL SAMPLE WT. GROSS 94.4 – TARE 6.7 = NET 87.7

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50				
	2.00				
	1.50				
	1.05		23.8	19.2	4.6
	0.742		63.7	20.5	43.2
	0.525		39.6	18.5	21.1
	0.371		24.7	18.7	6.0
	0.263	3	28.7	18.5	10.2
	0.185	4	20.0	19.4	.6
	0.131	6	19.5	19.4	.1
	0.093	8	20.8	20.8	.0
	0.065	10	19.4	19.3	.1
	PAN		22.1	21.0	1.1
TOTAL ON SCREENS AND PAN					87.0
LOSS (BY DIFFERENCE)					—
TOTAL SAMPLE WEIGHT					87.7

SCREEN SIZE	Di *	1/Di	% RETAINED	CUM. % RETAINED	% PASSING
4.25					
3.00	(3.125)	(0.3200)			
2.50	(2.625) 2.750	(0.3809) 0.3636			
2.00	2.250	0.4444			
1.50	1.750	0.5714			
1.05	(1.087) 1.275	(0.9199) 0.7843	5.29		94.69
0.742	0.896	1.116	49.65		45.04
0.525	0.634	1.577	24.25		20.79
0.371	0.448	2.232	6.90		13.89
0.263	0.317	3.154	11.72		2.17
0.185	0.224	4.464	0.69		1.48
0.131	0.158	6.329	0.11		1.37
0.093	0.112	8.928	0.00	98.61	1.37
0.065			0.11		1.26
PAN			1.26		0.00
LOSS			—	—	—
TOTAL			99.98	—	—

* NUMBERS IN PARENTHESES SHOULD BE USED WHEN THESE SCREEN SIZES REPRESENT THE TOP OF THE SHALE SIZE RANGE.

$\sum_{+8m}^{m} Di$	0.72590	$\sum_{+8m}^{m} Xi$	
$1/\sum_{+8m}^{m} Di$	1.54660	$\sum_{+8m}^{m} Xi/Di$	
Da	0.63759	$\sum_{+8m}^{m} Xi\ Di$	
Dv	0.73612		

REMARKS: _____

OSRC-4
REV 9/66

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

Date 8-11-67

Purpose: DEMONSTRATE PRINCIPLE OF LIQUID REMOVAL TO IMPROVE YIELD AND OPERABILITY.

GENERAL	
Run No.	C1055-1
Length, hours	12
Retort Type Number	RC-X
Oil Recovery System Number	C-5
Total Raw Shale Charged, ~~lbs.~~ TONS	160.51
Bed Height above Dist., ft	6 1/2
Type Air Dist.	XIII
Bed Below Air Dist., ft	6'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft²)	485
Spent Shale, % of RS	81.3
Liquid Product, lbs/hr	2315.34
Oil Collected, gal/ton RS	21.9
Air, SCF/ton RS (dry)	4750
Total Recycle*, SCF/ton RS(wet)	15700
Dilution, SCF/ton RS (wet)	—
Calc. Vent Gas SCF/ton RS(dry)	6270
Gas Losses, SCF/ton RS(wet)	1271
Propane, SCF/ton RS	—
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	156
Spent Shale, F	284
Raw Shale, °F	73
Recycle Gas Inlet, °F	228
Dilution Gas Inlet, °F	—
Air Inlet, °F	162
Retort Air Inlet, F	162
Heat of Comb. MBtu/ton RS	423
Heat Lost, MBtu/ton RS	59
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	28.2
Oil, Wt %	10.7
Water, Wt %	0.9
Gas, Wt %	2.4
Mineral CO_2, Wt %	18.2
Ash, Wt %	66.4
Moisture, Wt % (Uncrushed)	Est. 1.0
Carbon (Total), Wt %	17.6
Hydrogen (Total), Wt %	1.82
Nominal Size Range, inches	1/4"-1"
5 % passing thru	0.263
98 % passing thru	1.05
Da	0.610
D_V	0.711

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	2.45
Mineral CO_2, Wt %	15.5
Ash, Wt %	81.7
Carbon (total), Wt %	7.45
Organic Carbon, Wt %	3.22
Hydrogen (total), Wt %	0.32
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	97.0
Density, lb/gal	7.778
Gravity, API	20.0
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	12.5
Oil, lbs/MSCF(dry)**	0.082
Analysis (dry)	
CO_2, Vol %	25.4
O_2, Vol %	0.8
N_2 + Argon, Vol %	59.9
CH_4, Vol %	1.7
CO, Vol %	4.8
H_2, Vol %	5.2
Other, Vol %	2.2
Gross Heating Value(calc), Btu/SCF	110.3
Carbon (Total), lbs/MSCF (dry)	12.5
Hydrogen (Total), lbs/MSCF (dry)	0.85
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	77.7
Oil in Gas**, Vol % RSFA	0.2
Oil in Spent Shale, Vol % RSFA	6.8
Total Oil Meas., Vol % RSFA	84.7
Carbonate Decomposition, %	30.8
Water Recovered, lb/ton RS	90.6
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	RS100
Overall Balance, %	100.2
Carbon Balance, % - Organic	96.6
Carbon Balance, % - Total	97.5
Hydrogen Balance, % - Organic	90.4
Hydrogen Balance, % - Total	102.4
Water Balance, %	144.5
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	1.30
ΔP Above Air Dist., in H_2O/ft	1.89
Pressure Above Deck-PI-8 "H_2O	1.7
Pressure Below Deck-PI10 - "H_2O	8.5

Comments: OPERATION DETERIORATED RAPIDLY NEAR END OF TEST.

*Measured Recycle + Dilution Gas

** Oil Mist + Condensibles to 83 °F

*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed [signature] DATE August 22, 1967

OSRC-10

//A100
2080. C1055-1 8-11-67

A. YIELDS

FAY	7.772E 01	DRYGAS	6.274E 03	MISTFA	2.332E-01
H2	3.263E 02	OTHER	1.380E 02	UNRETO	6.836E 00
CH4	1.067E 02	O2	5.019E 01	SSY	8.127E 01
CO	3.012E 02	CO2DEC	3.078E 01	MH2O	9.063E 01
CO2	1.594E 03	OILCOL	2.192E 01		

B. METERED GAS RATES

RECG	1.567E 04	DIL	0.0	WVENTG	6.649E 03
AIR	4.750E 03	TRECG	1.567E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.824E 01	HVGT	6.918E 02	MWDG	3.092E 01
GBTU	1.103E 02				

D. COMBUSTION PRODUCTS

CO2C	5.597E 02	COC	2.806E 02	H2OC	2.384E 01
CHR	9.955E 00	COMBCP	1.054E 01		

E. MATERIAL IN

ORGCIN	2.526E 02	RSR	4.845E 02	ORH2IN	3.438E 01
MATIN	2.385E 03				

F. MATERIAL OUT

ORGCVG	4.830E 01	COKEC	3.831E 01	UNRETH	1.705E 00
ORGCOL	1.434E 02	ORH2VG	8.062E 00	COKEH	2.404E 00
UNRETC	1.401E 01	ORH2OL	1.892E 01	ORCOLP	5.675E 01
ORCVGP	1.912E 01	ORCSSP	2.071E 01	HCCVGP	8.574E 00

G. MATERIAL BALANCES

OVALL	1.002E 02	ORH2	9.043E 01	O2BAL	1.067E 02
ASH	0.0	TC	9.753E 01	WATER	1.445E 02
ORGC	9.657E 01	TH2	1.024E 02	GASL	1.271E 03
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.226E 05	QH2OC	1.258E 04	QAIR	7.794E 03
QPROP	0.0	QOILC	1.193E 04	QRCYL	5.082E 04
QSUMIN	5.057E 05				

I. HEAT OUT

QMCO2D	1.815E 05	QKEROD	9.700E 04	QH2OV	4.281E 04
QLIQO	5.249E 03	QOFGAS	3.805E 04	QSS	7.623E 04
QGASL	5.661E 03	LBLOSS	0.0	HETLOS	5.915E 04
QSUMOT	5.057E 05				

J. MISCELLANEOUS

ORCSS	3.219E 00	VPOIL	8.154E-02	TGL	5.406E 03
VPM	1.247E 01	WCG	2.078E 01	PROP	0.0

END MESSAGE

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS – DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION	
0	2080,	C1055-1	8-11-67

1	WRS: 0.9 (H2O, WT %)	OLRS: 10.7 (OIL, WT%)	TRS: 73 (TEMP., °F)	B: -1	MRS: 267516 (RATE, lb/HR)		RAW SHALE
2	FA: 28.2 (OIL, GAL/TON)	GRS: 2.4 (GAS & LOSS, WT%)	CORS: 18.2 (CO_2, WT%)	XA: 55.22 (RETORT XS, FT^2)			
3	ASRS: 66.4 (ASH, WT %)	CRS: 17.6 (CARBON, WT %)	HRS: 1.82 (H_2, WT%)	BP: 24.53 (BARO. PRESS., INH_g)	TOG: 156 (OFFGAS TEMP., °F)		
4	CRA: 1059.7 (CHART READING, SCFM)	MFA: 1.0 (METER FACTOR)	TA: 162 (TEMP., °F)	PA: 121 (PRESS., IN H_2O)	WA: 0.14 (H_2O, lb/MSCF)	LBHL: 0 (HEAT LOSS, BTU/HR)	AIR
5	CRRG: 3447.1 (RECYCLE CHART READING, SCFM)	MFRG: 1.0 (METER FACTOR)	TRG: 228 (TEMP., °F)	PRG: 78 (PRESS., IN H_2O)	CRTG: 0.0 (TOTAL GAS CHART READING)	MFTG: 0.0 (METER FACTOR)	RECYCLE AND TOTAL GAS
6	CRDG: 0.0 (CHART READING)	MFDG: 0.0 (METER FACTOR)	TDG: 0 (TEMP., °F)	PDG: 0 (PRESS., IN H_2O)			DILUTION GAS
7	P: 0.0 (SCFM)	TP: 0 (TEMP., °F)	PP: 0 (PRESS., IN H_2O)	W: 270.2 (H_2O ADDED, lb/HR)	N: 0.0 (NUCL. AGENT, lb/HR)		PROPANE AND NUCLEATING AGENT
8	WSS: 0.6 (H_2O, WT %)	OLSS: 0.9 (OIL, WT %)	GSS: 0.3 (GAS, WT %)	SS: 0.0 (RATE, lb/HR)			SPENT SHALE
9	COSS: 15.5 (CO_2, WT %)	ASSS: 81.7 (ASH, WT %)	CSS: 7.45 (CARBON, WT%)	HSS: 0.32 (H_2, WT %)	TSS: 284 (TEMP., °F)		
10	OILLP: 2280.1 (DRY OIL, lb/HR)	COL: 84.1 (CARBON, WT %)	HOL: 11.1 (H_2, WT %)	DOL: 7.778 (DENSITY, lb/GAL)	WLP: 35.3 (H_2O, lb/HR)		LIQUID PRODUCT
11	CRVG: 1501.2 (CHT. READING VENT, SCFM)	MFVG: 1.0 (METER FACTOR)	TVG: 219 (TEMP., °F)	WG: 0.0 (H_2O, lb/MSCF)	OILM: 0.0 (OIL MIST, lb/MSCF)	M: 0	VENT GAS
12	CG: 12.5 (CARBON, lb/MSCF)	H: 0	COOG: 25.4 (CO_2, VOL%)	OG: 0.8 (O_2, VOL%)	NG: 59.9 (N_2, VOL%)		
13	MEG: 1.7 (CH_4, VOL%)	COG: 4.8 (CO, VOL %)	HHG: 5.2 (H_2, VOL %)	OTG: 2.2 (OTHERS, VOL%)	HG: 0.85 (H_2, lb/MSCF)		
14	CRVP: 8.88 (CHART READING)	VPMF: 1.83 (METER FACTOR)	TVP: 79 (TEMP., °F)	PVP: 186 (PRESS., IN H_2O)	PVPC: 26 (CONDENSER PRESS. IN H_2O)		VENT PURGE
15	TVPC: 83 (CONDENSER GAS EFFLUENT TEMP., °F)	VPOIL: 50.0 (DRY OIL, GM/HR)	VPW: 13.3 (H_2O, lb/HR)	GL: 77.6 (TOTAL VPG GAS RATE, SCFM)			

OPTIONS:

1. D Enter "1" to Calculate with Spent Shale Rate and Ash Analyses,
   Or "0" to Calculate with Measured Rates,
   Or "-1" to Calculate with Raw Shale Rate and Ash Analyses.
2. M Enter "1" to Calculate Moisture and Mist, Externally,
   Or "0" to Calculate from Vent Purge Raw Data.
3. H Enter "1" to Calculate using Retort #2,
   Or "0" to Calculate using Retort #3.

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 8-11-67 Run No. C 1055-1

Sample Time: RS 1945; SS 2015

FISCHER ASSAY

(X) RAW SHALE	(+) SPENT SHALE	
28.0	2.4	Gal/Ton
.916	.—	S.G., g/ml
10.6	0.9	Oil, wt %
1.7	0.6	Water, wt %
85.3	98.2	Sp. Shale, ~~wt~~ %
2.4	0.3	Gas & Loss, wt %
Slight	None	COKING TENDENCY

( ) RETORT SHALE MOISTURE

Est. 1.00 wt %

(X) RAW SHALE FISCHER ASSAY MOISTURE

0.80 wt %

MINERAL CO_2

(X)	(+)	
18.2	15.5	wt %

ASH (SHALE)

(X)	(+)	
66.3	81.7	wt %

MOISTURE

(X)	(+)	
0.19	0.07	wt %

CARBON

(X)	(+)	
17.6	7.45	wt %

HYDROGEN

(X)	(+)	
1.82	0.32	wt %

BENZENE EXTRACTABLES

( )	( )	
.	.	wt %

( ) SHALE RICHNESS DISTRIBUTION (See attached graph)

( ) SCREEN ANALYSIS (See back of this sheet)

All results are "as received" unless noted. "Moisture" designates the moisture content of the -48 mesh material used for "Ash", "Mineral CO_2", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS

DATE COMPLETED AUG 14 1967 CHECKED BY

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 8-11-67 Run No. C1055-1 (133 hr)

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	3.0					
GRAVITY, °API	17.6					
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

SAMPLE LOST

OIL WT, g 600 EST.

WATER VOL, ml

GRAVITY OIL, °API

VENT GAS

MAJOR COMPONENTS

CO_2	15.4	vol %
O_2	1.8	"
N_2	59.2	"
CH_4	1.7	"
CO	4.8	"
H_2	5.2	"
Ar	1.7	"
Others	2.2	"

CARBON, 12.5 lbs/MSCFDG

C_1 thru C_4, plus n-Pentane

CH_4	.	vol %
C_2H_4-C_2H_6	.	"
C_3H_8	.	"
C_3H_6	.	"
i C_4H_{10}	.	"
n C_4H_{10}	.	"
ϕC_3H_6	.	"
n C_5H_{12}	.	"

HYDROGEN, 0.85 lbs/MSCFDG

COMMENTS

DATE COMPLETED [illegible] 14 1967 CHECKED BY

OSRC-12B
(Revised 5/3/66)

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 8-11-67 Run No. C1C5S-1 (201.5 hr)

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
✓ WATER, wt %	3.0					
✓ GRAVITY, °API	20.0					
○ OIL ASH, wt %						

○ DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g _____

WATER VOL, ml _____

GRAVITY OIL, °API _____

VENT GAS

○ MAJOR COMPONENTS

CO_2	___ . ___	vol %
O_2	___ . ___	"
N_2	___ . ___	"
CH_4	___ . ___	"
CO	___ . ___	"
H_2	___ . ___	"
Ar	___ . ___	"
Others	___ . ___	"

○ C_1 thru C_4, plus n-Pentane

CH_4	___ . ___	vol %
C_2H_4-C_2H_6	___ . ___	"
C_3H_8	___ . ___	"
C_3H_6	___ . ___	"
i C_4H_{10}	___ . ___	"
n C_4H_{10}	___ . ___	"
$\emptyset C_3H_6$	___ . ___	"
n C_5H_{12}	___ . ___	"

○ CARBON, ___ . ___ lbs/MSCFDG

HYDROGEN, ___ . ___ lbs/MSCFDG

COMMENTS _____

DATE COMPLETED AUG 14 1967 CHECKED BY _____

OSRC-12B
(Revised 5/3/66)

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C-1155-1 SAMPLE NO. _____ DATE 8-11-67

UNIT Point "3 DESCRIPTION Ty Lab

APPROX. SHALE SIZE ¼-1" SHAKING TIME 10 min. ANALYSIS BY Schaffer Sons

TOTAL SAMPLE WT. GROSS 94.7 – TARE 6.6 = NET 88.1

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50				
	2.00				
	1.50				
	1.05		21.8	19.2	2.6
	0.742		61.8	20.5	41.3
	0.525		42.1	18.5	23.6
	0.371		25.2	18.7	6.5
	0.263	3	30.0	18.4	11.6
	0.185	4	20.3	19.4	.9
	0.131	6	19.6	19.4	.2
	0.093	8	20.8	20.8	.0
	0.065	10	19.4	19.2	.2
	PAN		21.8	21.0	.8
TOTAL ON SCREENS AND PAN					87.7
LOSS (BY DIFFERENCE)					.4
TOTAL SAMPLE WEIGHT					88.1

SCREEN SIZE	Di *	1/Di	% RETAINED	CUM. % RETAINED	% PASSING
4.25					
3.00	(3.125)	(0.3200)			
2.50	(2.625) 2.750	(0.3809) 0.3636			
2.00	2.250	0.4444			
1.50	1.750	0.5714			
1.05	(1.087) 1.275	(0.9199) 0.7843	2.96		97.04
0.742	0.896	1.116	47.09		49.95
0.525	0.634	1.577	26.91		23.04
0.371	0.448	2.232	7.41		15.63
0.263	0.317	3.154	13.23		2.40
0.185	0.224	4.464	1.03		1.37
0.131	0.158	6.329	0.23		1.14
0.093	0.112	8.928	0.00	98.86	1.14
0.065			0.23		0.91
PAN			0.91		0.00
LOSS			—	—	—
TOTAL			100.00	—	—
			—	—	—

004498

* NUMBERS IN PARENTHESES SHOULD BE USED WHEN THESE SCREEN SIZES REPRESENT THE TOP OF THE SHALE SIZE RANGE.

$\sum_{+8m}^{m} Di$	0.70252	$\sum_{+8m}^{m} Xi$	
$1/\sum_{+8m}^{m} Di$	1.62033	$\sum_{+8m}^{m} Xi / Di$	
Da	0.61012	$\sum_{+8m}^{m} Xi\ Di$	
Dv	0.71061		

REMARKS: _____

2.8

OSRC-4
REV 9/66