

GAS COMBUSTION REPORTING  
DETAILED RUN SUMMARY SHEET

1513018012

Date

6-23-67

Purpose: To determine calorific value and yield with  $\frac{1}{2}$  inch mesh shale without dilution and with hot air.

GENERAL	
Run No.	PTC1047
Length, hours	12
Retort Type Number	RC VII
Oil Recovery System Number	C-1
Total Raw Shale Charged, lbs.	98.97
Bed Height above Dist., ft	9 1/2
Type Air Dist.	ADXT
Bed Below Air Dist., ft	6
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft <sup>2</sup> )	299
Spent Shale, % of RS	80.2
Liquid Product, lbs/hr	1757.7
Oil Collected, gal/ton RS	24.4
Air, SCF/ton RS (dry)	647.0
Total Recycle*, SCF/ton RS (wet)	1420.0
Dilution, SCF/ton RS (wet)	590
Calc. Vent Gas SCF/ton RS (dry)	5702
Gas Losses, SCF/ton RS (wet)	500
Propane, SCF/ton RS	16.9
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	139
Spent Shale, F	492
Raw Shale, °F	88
Recycle Gas Inlet, °F	281
Dilution Gas Inlet, °F	266
Air Inlet, °F	136
Retort Air Inlet, F	136
Heat of Comb. MBtu/ton RS	428
Heat Lost, MBtu/ton RS	17
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	29.3
Oil, Wt %	11.2
Water, Wt %	0.9
Gas, Wt %	1.8
Mineral CO <sub>2</sub> , Wt %	17.9
Ash, Wt %	61.0
Moisture, Wt % (Uncrushed)	
Carbon (Total), Wt %	18.1
Hydrogen (Total), Wt %	1.80
Nominal Size Range, inches	1/4" - 2 1/2"
5 % passing thru	0.371
98 % passing thru	250
D <sub>a</sub>	1.073
D <sub>v</sub>	1.406
Line Burner °F	830

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO <sub>2</sub> , Wt %	16.0
Ash, Wt %	82.3
Carbon (total), Wt %	6.56
Organic Carbon, Wt %	2.19
Hydrogen (total), Wt %	0.15
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	99.2
Density, lb/gal	7.762
Gravity, API	20.3
Ash, Wt %	-
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF (dry)	4.7
Oil, lbs/MSCF (dry)**	0.074
Analysis (dry)	
CO <sub>2</sub> , Vol %	25.4
O <sub>2</sub> , Vol %	0.0
N <sub>2</sub> + Argon, Vol %	61.3
CH <sub>4</sub> , Vol %	2.2
CO, Vol %	3.6
H <sub>2</sub> , Vol %	6.2
Other, Vol %	1.3
Gross Heating Value (calc), Btu/SCF	124
Carbon (Total), lbs/MSCF (dry)	12.9
Hydrogen (Total), lbs/MSCF (dry)	0.96
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	83.2
Oil in Gas**, Vol % RSFA	6.2
Oil in Spent Shale, Vol % RSFA	6.0
Total Oil Meas., Vol % RSFA	83.4
Carbonate Decomposition, %	28.3
Water Recovered, lb/ton RS	58.7
Ash Balance, % - As Measured	-
Ash Balance, % - Assumed	RS 100
Overall Balance, %	97.4
Carbon Balance, % - Organic	90.5
Carbon Balance, % - Total	93.9
Hydrogen Balance, % - Organic	91.7
Hydrogen Balance, % - Total	90.7
Water Balance, %	81.4
MISCELLANEOUS	
Avg. Retort ΔP, in H <sub>2</sub> O/ft	0.36
ΔP Above Air Dist., in H <sub>2</sub> O/ft	0.35
NaCl Soln., Wt %	-
NaCl Rate, gal/ton RS	-

Comments: Temperature control in which the dilution gas was replaced with recycle gas. But line burner on to ensure even air distribution in the air headers.

\*Measured Recycle + Dilution Gas  
 \*\* Oil Mist + Condensibles to 80 °F  
 \*\*\* Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. Turner

DATE July 17, 1967

//A100

2080, C1047-PT 6-23-67

A. YIELDS

FAY	8.317E 01	DRYGAS	5.702E 03	MISTFA	1.861E-01
H2	3.535E 02	OTHER	7.413E 01	UNRETO	0.0
CH4	1.255E 02	O2	0.0	SSY	8.019E 01
CO	2.053E 02	CO2DEC	2.832E 01	MH2O	5.874E 01
CO2	1.448E 03	OILCOL	2.437E 01		

B. METERED GAS RATES

RECG	1.365E 04	DIL	5.919E 02	WVENTG	5.764E 03
AIR	4.418E 03	TRECG	1.424E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.930E 01	HVGT	7.070E 02	MWDG	3.041E 01
GBTU-	1.240E 02				

D. COMBUSTION PRODUCTS

CO2C	5.281E 02	COC	1.912E 02	H2OC	2.921E 01
CHR	6.955E 00	COMBCP	8.577E 00		

E. MATERIAL IN

ORGCIN	2.659E 02	RSR	2.987E 02	ORH2IN	3.435E 01
MATIN	2.365E 03				

F. MATERIAL OUT

ORCVG	4.627E 01	COKEC	3.516E 01	UNRETH	0.0
ORGCOL	1.591E 02	ORH2VG	8.796E 00	COKEH	1.687E 00
UNRETC	0.0	ORH2OL	2.100E 01	ORCOLP	5.983E 01
ORCVGP	1.740E 01	ORCSSP	1.322E 01	HCCVGP	8.825E 00

G. MATERIAL BALANCES

OVALL	9.739E 01	ORM2	9.165E 01	O2BAL	9.714E 01
ASH	0.0	TC	9.385E 01	WATER	8.144E 01
ORGC	9.046E 01	TH2	9.069E 01	GASL	5.001E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.284E 05	QH2OC	8.276E 03	QAIR	3.907E 03
QPROP	3.838E 01	QOILC	1.324E 04	QRCYL	5.721E 04
QSUMIN	5.111E 05				

I. HEAT OUT

QMC02D	1.642E 05	QKEROD	1.040E 05	QH2OV	4.678E 04
QLI00	3.574E 03	QOFGAS	2.176E 04	QSS	1.498E 05
QGASL	4.332E 03	LBLOSS	0.0	HETLOS	1.663E 04
QSUMOT	5.111E 05				

J. MISCELLANEOUS

ORCSS	2.192E 00	VPOIL	7.422E-02	TGL	2.988E 03
VPM	4.684E 00	WCG	8.968E 00	PROP	1.694E 01

END MESSAGE

END OUTPUT

# HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	← USER IDENTIFICATION →					
0	2080,	C1047-PT		6-23-67			
1	WRS	OLRS	TRS	B	MRS	← RAW SHALE	
	0.9	11.2	88	-1	16494.3		
2	FA	GRS	CORS	XA			
	29.3	1.8	17.9	55.22			
3	ASRS	CRS	HRS	BP	TOG		
	66.0	18.1	1.80	24.43	139		
4	CRA	MFA	TA	PA	WA	LBHL	← AIR
	607.3	1.0	136	137	0.14	0	
5	CRRG	MFRG	TRG	PRG	CRTG	MFTG	← RECYCLE A TOTAL GAS
	1885.1	1.0	281	80	0.0	0.0	
6	CRDG	MFDG	TDG	PDG			← DILUTION G
	1.86	56.4	266	30			
7	P	TP	PP	W	N		← PROPANE A NUCLEATING AGENT
	2.68	0.4	127.8	200.3	0.0		
8	WSS	OLSS	GSS	SS			← SPENT SHALE
	0.4	0.0	0.0	0.0			
9	COSS	ASSS	CSS	HSS	TSS		
	16.0	82.3	6.56	0.15	492		
10	OILLP	COL	HOL	DOL	WLP		← LIQUID PRODUCT
	1560.0	84.1	11.1	7762	197.6		
11	CRVG	MFVG	TVG	WG	OILM	M	← VENT GAS
	930.9	1.0	266	0.0	0.0	0	
12	CG	H	COOG	OG	NG		
	12.9	0	25.4	0.0	61.3		
13	MEG	COG	HHG	OTG	HG		
	2.2	3.6	6.2	1.3	0.96		
14	CRVP	VPMF	TVP	PVP			← VENT PURGE
	3.2	2.18	165	46			
15	TVPC	VPOIL	VPW	GL			
	80	26.0	2.1	91.3			

**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 with Measured Moisture and Mist,  
Or "0" to Calculate from Vent Purge Data.
3. H Enter "1" to Calculate using Retort #2,  
Or "0" to Calculate using Retort #3.

C 1097-PT	6-24-67	EA
R.S. Mesh	WTS grams	WTS %
8	198.0	28.8
14	206.4	30.0
28	105.6	15.4
35	39.2	5.0
48	19.2	2.8
65	18.8	2.7
100	18.0	2.6
150	18.0	2.6
PAN	68.2	10.1
TOTAL	<u>687.4</u>	<u>100.0%</u>

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-24-67

Run No. C1047-PT

Sample Time: RS 2:45; SS 1115

<u>FISCHER ASSAY</u>		<input type="radio"/>	<u>RETORT SHALE MOISTURE</u>
<input checked="" type="radio"/> RAW SHALE	<input checked="" type="radio"/> SPENT SHALE		<u>1.2</u> wt %
<u>29.00</u> <del>46.1</del>	<u>0.0</u>	Gal/Ton	
<u>91.3</u> <del>11.1</del>	<u>0.0</u>	S.G., g/ml	
<u>11.1</u> <del>11.1</del>	<u>0.0</u>	Oil, wt %	
<u>7.9</u> <u>1.9</u>	<u>0.4</u>	Water, wt %	
<del>85.2</del> <u>85.2</u>	<u>99.4</u>	Sp. Shale, wt %	
<u>1.8</u>	<u>0.3</u>	Gas & Loss, wt %	
<u>Slight</u>	<u>None</u>	COKING TENDENCY	
			<input checked="" type="radio"/> RAW SHALE FISCHER ASSAY MOISTURE
			<u>1.02</u> wt %

<u>MINERAL CO<sub>2</sub></u>		
<input checked="" type="radio"/> <u>17.8</u>	<input checked="" type="radio"/> <u>16.0</u>	wt %

<u>ASH (SHALE)</u>		
<input checked="" type="radio"/> <u>65.8</u>	<input checked="" type="radio"/> <u>82.3</u>	wt %

<u>MOISTURE</u>		
<input checked="" type="radio"/> <u>0.36</u>	<input checked="" type="radio"/> <u>0.09</u>	wt %

<u>CARBON</u>		
<input checked="" type="radio"/> <u>18.0</u>	<input checked="" type="radio"/> <u>6.56</u>	wt %

<u>HYDROGEN</u>		
<input checked="" type="radio"/> <u>1.79</u>	<input checked="" type="radio"/> <u>0.15</u>	wt %

<u>BENZENE EXTRACTABLES</u>		
<input type="radio"/> <u>.</u>	<input type="radio"/> <u>.</u>	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<sub>2</sub>", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS \_\_\_\_\_

DATE COMPLETED

JUN 27 1967

CHECKED BY

REP

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-24-67

Run No. C1047 PT

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>1</u>	<u>2</u>
<input checked="" type="checkbox"/> WATER, wt %	<u>0.8090</u>					
<input checked="" type="checkbox"/> GRAVITY, °API	<u>20.3</u>					
<input type="checkbox"/> OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

*EA*

OIL WT, g 311.5

WATER VOL, ml 88.0

GRAVITY OIL, °API 40.5

VENT GAS

MAJOR COMPONENTS

CO<sub>2</sub> 25.4 vol %

O<sub>2</sub> 0.0 "

N<sub>2</sub> 60.6 "

CH<sub>4</sub> 2.2 "

CO 3.6 "

H<sub>2</sub> 6.2 "

Ar 0.8 "

Others 1.3 "

C<sub>1</sub> thru C<sub>4</sub>, plus n-Pentane

CH<sub>4</sub> \_\_\_\_\_ vol %

C<sub>2</sub>H<sub>4</sub>-C<sub>2</sub>H<sub>6</sub> \_\_\_\_\_ "

C<sub>3</sub>H<sub>8</sub> \_\_\_\_\_ "

C<sub>3</sub>H<sub>6</sub> \_\_\_\_\_ "

i C<sub>4</sub>H<sub>10</sub> \_\_\_\_\_ "

n C<sub>4</sub>H<sub>10</sub> \_\_\_\_\_ "

∅C<sub>3</sub>H<sub>6</sub> \_\_\_\_\_ "

n C<sub>5</sub>H<sub>12</sub> \_\_\_\_\_ "

*PH*  CARBON, 13.9 lbs/MSCFDG

HYDROGEN, 0.96 lbs/MSCFDG

COMMENTS \_\_\_\_\_

# SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1047 PY SAMPLE NO. \_\_\_\_\_ DATE 6-24-67  
 UNIT # 3 DESCRIPTION R.S.  
 APPROX. SHALE SIZE 1/4" - 2 1/2" SHAKING TIME 10 MIN ANALYSIS BY Walden - Standard  
 TOTAL SAMPLE WT. GROSS 81.4 - TARE 14.9 = NET 66.5

SCREEN SIZE			WEIGHTS								
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED	SCREEN SIZE	D <sub>i</sub> *	1/D <sub>i</sub>	% RETAINED	CUM. % RETAINED	% PASSING
	4.25					4.25					
	3.00					3.00	(3.125)	(0.3200)			
	2.50		17.2	16.7	.5	2.50	(2.625) 2.750	(0.3809) 0.3636	0.76		99.23
	2.00		29.7	20.2	9.5	2.00	2.250	0.4444	13.62		85.61
	1.50		46.0	23.4	22.6	1.50	1.750	0.5714	34.19		51.42
	1.05		32.3	19.2	13.1	1.05	(1.087) 1.275	(0.9199) 0.7843	19.82		31.60
	0.742		29.2	20.5	8.7	0.742	0.896	1.116	13.16		18.44
	0.525		21.7	18.5	3.2	0.525	0.634	1.577	9.38		9.06
	0.371		21.9	19.2	2.7	0.371	0.448	2.232	4.08		4.98
	0.263	3	20.4	18.5	1.9	0.263	0.317	3.154	2.87		2.11
	0.185	4	19.5	19.4	.1	0.185	0.224	4.464	0.15		1.96
	0.131	6	19.5	19.3	.2	0.131	0.158	6.329	0.30		1.66
	0.093	8	20.4	20.4	0	0.093	0.112	8.928	0.00	98.33	1.66
	0.065	10	19.3	19.2	.1	0.065			0.15		1.51
	PAN		22.0	21.0	1.0	PAN			1.51		0.00
TOTAL ON SCREENS AND PAN					66.5	LOSS			—	—	—
LOSS (BY DIFFERENCE)					—	TOTAL			99.99	—	—
TOTAL SAMPLE WEIGHT					66.5				—	—	—

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

REMARKS: \_\_\_\_\_

$\sum_{+8m}^m D_i$	1.38300	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	0.91629	$\sum_{+8m}^m X_i / D_i$	
D <sub>a</sub>	1.07313	$\sum_{+8m}^m X_i D_i$	
D <sub>v</sub>	1.40648		