

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513018022

Date 6-29-67

Purpose: To determine operability and yield with $\pm 2\%$ ash shale at 400 mesh with that air dilution. (W/O dilution gas)

GENERAL		SPENT SHALE PROPERTIES	
Run No.	01098-2	Fischer Assay, Gal/ton	0.0
Length, hours	12	Mineral CO ₂ , Wt %	16.8
Retort Type Number	RC-VII	Ash, Wt %	81.2
Oil Recovery System Number	C-2	Carbon (total), Wt %	6.71
Tons Total Raw Shale Charged, lbs.	130.70	Organic Carbon, Wt %	2.12
Bed Height above Dist., ft	9 1/2	Hydrogen (total), Wt %	0.22
Type Air Dist.	AD XI	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6	Oil, Wt %	94.4
RATES AND QUANTITIES		Density, lb/gal	7.778
Raw Shale, lbs/(hr)(ft ²)	395	Gravity, API	20.0
Spent Shale, % of RS	82.1	Ash, Wt %	—
Liquid Product, lbs/hr	2225.8	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	24.4	Water Vapor, lbs/MSCF (dry)	5.7
Air, SCF/ton RS (dry)	456.0	Oil, lbs/MSCF (dry)**	0.153
Total Recycle*, SCF/ton RS (wet)	12610	Analysis (dry)	
Dilution, SCF/ton RS (wet)	—	CO ₂ , Vol %	23.6
Calc. Vent Gas SCF/ton RS (dry)	6034	O ₂ , Vol %	0.0
Gas Losses, SCF/ton RS (wet)	189	N ₂ + Argon, Vol %	59.8
Propane, SCF/ton RS	21.7	CH ₄ , Vol %	2.6
TEMPERATURES AND HEAT BALANCE		CO, Vol %	4.3
Retort Offgas, °F	140	H ₂ , Vol %	6.9
Spent Shale, F	517	Other, Vol %	2.8
Raw Shale, °F	90	Gross Heating Value (calc), Btu/SCF	156
Recycle Gas Inlet, °F	269	Carbon (Total), lbs/MSCF (dry)	13.4
Dilution Gas Inlet, °F	—	Hydrogen (Total), lbs/MSCF (dry)	1.22
Air Inlet, °F	126	YIELDS AND BALANCES	
Retort Air Inlet, F	126	Oil Collected, Vol % RSFA	80.3
Heat of Comb. MBtu/ton RS	434	Oil in Gas**, Vol % RSFA	6.3
Heat Lost, MBtu/ton RS	25	Oil in Spent Shale, Vol % RSFA	0.0
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	80.6
Fischer Assay, gal/ton RS	30.4	Carbonate Decomposition, %	25.8
Oil, Wt %	11.5	Water Recovered, lb/ton RS	58.4
Water, Wt %	0.7	Ash Balance, % - As Measured	—
Gas, Wt %	2.4	Ash Balance, % - Assumed	RS 100
Mineral CO ₂ , Wt %	18.4	Overall Balance, %	99.6
Ash, Wt %	66.7	Carbon Balance, % - Organic	96.0
Moisture, Wt % (Uncrushed)	1.0 Est.	Carbon Balance, % - Total	98.2
Carbon (Total), Wt %	18.0	Hydrogen Balance, % - Organic	98.1
Hydrogen (Total), Wt %	1.79	Hydrogen Balance, % - Total	100.3
Nominal Size Range, inches	1/4" - 2 1/2"	Water Balance, %	95.2
5 % passing thru	0.371	MISCELLANEOUS	
98 % passing thru	2.50	Avg. Retort ΔP, in H ₂ O/ft	0.59
D _a	1.012	ΔP Above Air Dist., in H ₂ O/ft	0.57
D _v	1.403	NaCl Soln., Wt %	—
Line Burner °F	870	NaCl Rate, gal/ton RS	—

Comments: operations good except inlet 7 vertical thermocouple appears to have leaked in air. Winter limit for carbon about 2 hours.

*Measured Recycle + Dilution Gas
 ** Oil Mist + Condensibles to 83 °F
 *** Rates are for moisture-free raw shale. free basis.

All shale analyses are on a moisture-free basis.

Signed E. J. Turner

DATE July 17, 1967

//A100

2080, C1048-2 6-29-67

A. YIELDS

FAY	8.034E 01	DRYGAS	6.034E 03	MISTFA	3.892E-01
H2	4.163E 02	OTHER	1.689E 02	UNRETO	0.0
CH4	1.569E 02	O2	0.0	SSY	8.214E 01
CO	2.594E 02	CO2DEC	2.500E 01	MH2O	5.837E 01
CO2	1.424E 03	OILCOL	2.442E 01		

B. METERED GAS RATES

RECG	1.261E 04	DIL	0.0	WVENTG	6.563E 03
AIR	4.560E 03	TRECG	1.261E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.866E 01	HVGT	9.384E 02	MWDG	3.015E 01
GBTU	1.555E 02				

D. COMBUSTION PRODUCTS

CO2C	5.627E 02	COC	2.389E 02	H2OC	2.651E 01
CHR	8.542E 00	COMBCP	9.714E 00		

E. MATERIAL IN

ORGCIN	2.616E 02	RSR	3.945E 02	ORH2IN	3.470E 01
MATIN	2.372E 03				

F. MATERIAL OUT

ORGCVG	5.653E 01	COKEC	3.489E 01	UNRETH	0.0
ORGCOL	1.598E 02	ORH2VG	1.043E 01	COKEH	2.510E 00
UNRETC	0.0	ORH2OL	2.109E 01	ORCOLP	6.107E 01
ORCVGP	2.161E 01	ORCSSP	1.334E 01	HCCVGP	1.190E 01

G. MATERIAL BALANCES

OVALL	9.957E 01	ORH2	9.808E 01	O2BAL	9.965E 01
ASH	0.0	TC	9.823E 01	WATER	9.515E 01
ORGC	9.602E 01	TH2	1.003E 02	GASL	1.885E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.341E 05	QH2OC	1.272E 04	QAIR	5.131E 03
QPROP	6.327E 01	QOILC	1.330E 04	QRCYL	4.793E 04
QSUMIN	5.133E 05				

I. HEAT OUT

QMC02D	1.490E 05	QKEROD	1.112E 05	QH2OV	3.765E 04
QLIQ	3.527E 03	QOFGAS	2.037E 04	QSS	1.645E 05
QGASL	1.774E 03	LBLOSS	0.0	HETLOS	2.525E 04
QSUMOT	5.133E 05				

J. MISCELLANEOUS

ORCSS	2.124E 00	VPOIL	1.525E-01	TGL	3.781E 03
VPM	5.654E 00	WCG	1.063E 01	PROP	2.172E 01

END MESSAGE

END OUTPUT

7/5/67

0 2080, 1048-2 6/29, 7

1	WRS 0.7	OLRS 11.5	TRS 90	B -1	MRS 21783.2	← RAW SHALE	
2	FA 30.4	GRS 2.4	CORS 18.4	XA 55.22			
3	ASRS 66.7	CRS 18.0	HRS 1.79	BP 24.91	TOG 140		
4	CRA 828.2	MFA 1.0	TA 151	VPA 126	WA 0.19	LBHL 0	← AIR
5	CRRG 2282.9	MFRG 1.0	TRG 269	PRG 69	CRTG 0.0	MFTG 0.0	← RECYCLE AND TOTAL GAS
6	CRDG 0.0	MFDG 0.0	TDG 0	PDG 0			← DILUTION GAS
7	P 4.54	TP 0.4	PP 128.0	W 220.0	N 0.0		← PROPANE AND NUCLEATING AGENT
8	WSS 0.6	OLSS 0.0	GSS 0.0	SS 0.0			← SPENT SHALE
9	COSS 16.8	ASSS 81.2	CSS 6.71	HSS 0.22	TSS 517		
10	OILLP 2068.97	COL 84.1	HOL 11.1	DOL 7.778	WLP 156.8		← LIQUID PRODUCT
11	CRVG 1215.9	MFRG 1.0	TVG 266	WG 0.0	OILM 0.0	M 0	← VENT GAS
12	CG 13.4	H 0	COOG 23.6	OG 0.0	NG 59.8		
13	MEG 2.6	COG 4.3	HHG 6.9	OTG 2.8	HG 1.22		
14	CRVP 2.5	VPMF 2.19	TVP 165	PVP 36			← VENT PURGE
15	TVPC 83	VPOIL 47.0	VPW 2.3	GL 51.6			

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.

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-29-67

Run No. C1048-2

Sample Time: RS 1815; SS _____

FISCHER ASSAY

pkk

RAW SHALE SPENT SHALE

<u>30.1</u> <u>50.4</u>	<u>0.0</u>	Gal/Ton
<u>.913</u>	<u>0.0</u>	S.G., g/ml
<u>11.4</u>	<u>0.0</u>	Oil, wt %
<u>1.7</u>	<u>0.4</u>	Water, wt %
<u>84.5</u>	<u>98.5</u>	Sp. Shale, wt %
<u>2.4</u>	<u>0.9</u>	Gas & Loss, wt %
<u>slight</u>	<u>none</u>	COKING TENDENCY

RETORT SHALE MOISTURE
Est 1.0 wt %

RAW SHALE FISCHER ASSAY MOISTURE
0.76 wt %

MINERAL CO₂

FA 18.3 *FA* 16.8 wt %

ASH (SHALE)

DK 66.2 *DK* 81.2 wt %

MOISTURE

DK 0.27 *DK* 0.04 wt %

CARBON

pkk 17.9 *pkk* 6.71 wt %

HYDROGEN

pkk 1.78 *pkk* 0.22 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 CO₂", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS _____

DATE COMPLETED JUL 3 1967

CHECKED BY BEP

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-29-67

Run No. C 1048-2

LIQUID PRODUCTS

	<u>D3 PUMPOUT</u>				<u>T3 PUMPOUT</u>	
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>1</u>	<u>2</u>
<i>P.A.</i> WATER, wt %	<u>5.6</u>	<u>/</u>	<u>/</u>	<u>/</u>		
GRAVITY, °API	<u>20.0</u>	<u>/</u>	<u>/</u>	<u>/</u>		
<input type="radio"/> OIL ASH, wt %						
<input type="radio"/> DISTILLATION (See attached sheet - OSRC-24)						

VENT PURGE PRODUCT

2A
 OIL WT, g 564.4
 WATER VOL, ml 98.0
 GRAVITY OIL, °API 41.5

VENT GAS

<input checked="" type="radio"/> MAJOR COMPONENTS	<input type="radio"/> C ₁ thru C ₄ , plus n-Pentane
CO ₂ <u>23.6</u> vol %	CH ₄ _____ vol %
O ₂ <u>0.0</u> "	C ₂ H ₄ -C ₂ H ₆ _____ "
N ₂ <u>59.1</u> "	C ₃ H ₈ _____ "
CH ₄ <u>2.6</u> "	C ₃ H ₆ _____ "
CO <u>4.3</u> "	i C ₄ H ₁₀ _____ "
H ₂ <u>6.9</u> "	n C ₄ H ₁₀ _____ "
Ar <u>0.7</u> "	∅C ₃ H ₆ _____ "
Others <u>2.8</u> "	n C ₅ H ₁₂ _____ "
<i>P.A.</i> <input checked="" type="radio"/> CARBON, <u>13.4</u> lbs/MSCFDG	HYDROGEN, <u>1.22</u> lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUL 3 1967

CHECKED BY REP
 OSRC-12R

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C 1048-2 SAMPLE NO. # DATE 6-29-67

UNIT Retort #3 DESCRIPTION TYLAB

APPROX. SHALE SIZE 2 1/2 SHAKING TIME 10 MIN. ANALYSIS BY Shallon's Valley

TOTAL SAMPLE WT. GROSS 76.1 - TARE 6.7 = NET 69.4

SCREEN SIZE			WEIGHTS								
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED	SCREEN SIZE	D _i *	1/D _i	% RETAINED	CUM. % RETAINED	% PASSING
	4.25					4.25					
	3.00					3.00	(3.125)	(0.3200)			
	2.50		18.1	16.7	1.4	2.50	(2.625) 2.750	(0.3809) 0.3636	2.0		
	2.00		31.6	20.2	11.4	2.00	2.250	0.4444	16.4		
	1.50		42.0	23.4	18.6	1.50	1.750	0.5714	26.8		
	1.05		33.2	18.2	15.0	1.05	(1.087) 1.275	(0.9199) 0.7843	21.6		
	0.742		29.0	20.5	8.5	0.742	0.896	1.116	12.2		
	0.525		25.4	18.5	6.9	0.525	0.634	1.577	9.9		
	0.371		22.3	19.2	3.1	0.371	0.448	2.232	4.5		
	0.263	3	20.9	18.4	2.5	0.263	0.317	3.154	3.6		
	0.185	4	20.0	19.4	.6	0.185	0.224	4.464	0.9		
	0.131	6	19.6	19.4	.2	0.131	0.158	6.329	0.3		
	0.093	8	20.4	20.4	.0	0.093	0.112	8.928	0	99.0	
	0.065	10	19.4	19.2	.2	0.065			0.3		
	PAN		22.0	21.0	1.0	PAN			1.4		
TOTAL ON SCREENS AND PAN					69.4	LOSS					
LOSS (BY DIFFERENCE)						TOTAL					
TOTAL SAMPLE WEIGHT											

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

REMARKS: _____

$\sum_{+8m}^m D_i$	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	$\sum_{+8m}^m X_i / D_i$	0.96847
D _a	1.0146	$\sum_{+8m}^m X_i D_i$ 1.37454
D _v	1.4026	