

GAS COMBUSTION REPORTING  
DETAILED RUN SUMMARY SHEET

1513018.018

Date 6-27-67

Purpose: To determine compatibility and yield with ~~to~~ *dry* raw shale with hot gas circulation (retort distillation gas)

7015

GENERAL		SPENT SHALE PROPERTIES	
Run No.	C1047-7	Fischer Assay, Gal/ton	0.0
Length, hours	12	Mineral CO <sub>2</sub> , Wt %	17.2
Retort Type Number	RC-VII	Ash, Wt %	81.0
Oil Recovery System Number	C-1	Carbon (total), Wt %	7.20
Total Raw Shale Charged, lbs.	100.94	Organic Carbon, Wt %	2.50
Bed Height above Dist., ft	9 1/2	Hydrogen (total), Wt %	0.17
Type Air Dist.	AD-XI	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6	Oil, Wt %	98.4
RATES AND QUANTITIES		Density, lb/gal	7.737
Raw Shale, lbs/(hr)(ft <sup>2</sup> )	30.5	Gravity, API	20.8
Spent Shale, % of RS	82.0	Ash, Wt %	-
Liquid Product, lbs/hr	1780.9	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	26.0	Water Vapor, lbs/MSCF (dry)	5.9
Air, SCF/ton RS (dry)	3730	Oil, lbs/MSCF (dry)**	0.217
Total Recycle*, SCF/ton RS (wet)	13810	Analysis (dry)	
Dilution, SCF/ton RS (wet)	-	CO <sub>2</sub> , Vol %	24.5
Calc. Vent Gas SCF/ton RS (dry)	4991	O <sub>2</sub> , Vol %	0.0
Gas Losses, SCF/ton RS (wet)	96	N <sub>2</sub> + Argon, Vol %	59.2
Propane, SCF/ton RS	20.9	CH <sub>4</sub> , Vol %	2.6
TEMPERATURES AND HEAT BALANCE		CO, Vol %	4.1
Retort Offgas, °F	140	H <sub>2</sub> , Vol %	6.2
Spent Shale, F	481	Other, Vol %	2.3
Raw Shale, °F	100	Gross Heating Value (calc), Btu/SCF	114
Recycle Gas Inlet, °F	277	Carbon (Total), lbs/MSCF (dry)	11.2
Dilution Gas Inlet, °F	-	Hydrogen (Total), lbs/MSCF (dry)	1.09
Air Inlet, °F	156	YIELDS AND BALANCES	
Retort Air Inlet, F	156	Oil Collected, Vol % RSFA	85.5
Heat of Comb. MBtu/ton RS	364	Oil in Gas**, Vol % RSFA	0.5
Heat Lost, MBtu/ton RS	-9	Oil in Spent Shale, Vol % RSFA	0.0
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	86.0
Fischer Assay, gal/ton RS	30.4	Carbonate Decomposition, %	23.8
Oil, Wt %	11.5	Water Recovered, lb/ton RS	48.6
Water, Wt %	0.6	Ash Balance, % - As Measured	-
Gas, Wt %	2.4	Ash Balance, % - Assumed	85.100
Mineral CO <sub>2</sub> , Wt %	18.5	Overall Balance, %	98.9
Ash, Wt %	66.4	Carbon Balance, % - Organic	91.7
Moisture, Wt % (Uncrushed)	1.0 Est.	Carbon Balance, % - Total	95.0
Carbon (Total), Wt %	18.2	Hydrogen Balance, % - Organic	96.0
Hydrogen (Total), Wt %	1.76	Hydrogen Balance, % - Total	95.1
Nominal Size Range, inches	4" - 2 1/2"	Water Balance, %	79.4
5 % passing thru	0.371	MISCELLANEOUS	
98 % passing thru	2.50	Avg. Retort ΔP, in H <sub>2</sub> O/ft	0.39
D <sub>a</sub>	1.078	ΔP Above Air Dist., in H <sub>2</sub> O/ft	0.42
D <sub>v</sub>	1.460	NaCl Soln., Wt %	-
Line Burner °F	880	NaCl Rate, gal/ton RS	-

Comments: *Operations Good*

\*Measured Recycle + Dilution Gas  
 \*\* Oil Mist + Condensibles to 81 OF  
 \*\*\* Rates are for moisture-free raw shale.  
 free basis.

All shale analyses are on a moisture-free basis.

Signed *Earl P. Jones*

DATE *July 17, 1967*

8/27/5/67

//A100

2080, C1047-7 6-27-67

A. YIELDS

FAY	8.546E 01	DRYGAS	4.991E 03	MISTFA	4.595E-01
H2	3.144E 02	OTHER	1.647E 02	UNRETO	0.0
CH4	1.298E 02	02	0.0	SSY	8.198E 01
CO	2.046E 02	CO2DEC	2.379E 01	MH2O	4.856E 01
CO2	1.223E 03	OILCOL	2.598E 01		

B. METERED GAS RATES

RECG	1.381E 04	DIL	0.0	WVENTG	5.518E 03
AIR	3.734E 03	TRECG	1.381E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MHWG	2.914E 01	HVGT	5.691E 02	MWDG	3.053E 01
GBTU	1.140E 02				

D. COMBUSTION PRODUCTS

CO2C	3.960E 02	COC	1.841E 02	H2OC	2.842E 01
CHR	5.765E 00	COMBCP	6.939E 00		

E. MATERIAL IN

ORGCIN	2.650E 02	RSR	3.047E 02	ORH2IN	3.430E 01
MATIN	2.309E 03				

F. MATERIAL OUT

ORGCVG	3.281E 01	COKEC	4.106E 01	UNRETH	0.0
ORGCOL	1.691E 02	ORH2VG	8.746E 00	COKEH	1.869E 00
UNRETC	0.0	ORH2OL	2.231E 01	ORCOLP	6.380E 01
ORCVGP	1.238E 01	ORCSSP	1.550E 01	HCCVGP	5.442E 00

G. MATERIAL BALANCES

OVALL	9.892E 01	ORH2	9.599E 01	O2BAL	9.731E 01
ASH	0.0	TC	9.500E 01	WATER	7.941E 01
ORGC	9.168E 01	TH2	9.509E 01	GASL	9.667E 01
ASNB	-1.000E 00				

H. HEAT IN

QCOMB	3.640E 05	QH2OC	1.057E 04	QAIR	3.861E 03
QPROP	5.639E 01	QOILC	1.407E 04	QRCYL	5.266E 04
QSUMIN	4.452E 05				

I. HEAT OUT

QMC02D	1.426E 05	QKEROD	1.112E 05	QH2OV	3.507E 04
QLIGO	3.011E 03	QOFGAS	1.669E 04	QSS	1.450E 05
QGASL	8.192E 02	LBLOSS	0.0	HETLOS	-9.156E 03
QSUMOT	4.452E 05				

J. MISCELLANEOUS

ORCSS	2.504E 00	VPOIL	2.166E-01	TGL	2.945E 03
VPM	5.948E 00	WCG	1.111E 01	PROP	2.088E 01

END MESSAGE

END OUTPUT

# HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	← USER IDENTIFICATION →					
0	2080,	C1097-7		6/27/67			
1	WRS	OLRS	TRS	B	MRS	← RAW SHALE	
	0.6	11.5	100	-1	16823.8		
2	FA	GRS	CORS	XA			
	30.4	2.4	18.5	55.22			
3	ASRS	CRS	HRS	BP	TOG	← AIR	
	66.9	18.2	1.76	29.4	190		
4	CRA	MFA	TA	VPA	WA	LBHL	
	523.9	1.0	156	113	0.14	0	
5	CRRG	MFRG	TRG	PRG	CRTG	MFTG	← RECYCLE A TOTAL GAS
	1991.4	1.0	277	69	0.0	0.0	
6	CRDG	MFDG	TDG	PDG			← DILUTION G
	0.0	0.0	0	0			
7	P	TP	PP	W	N		← PROPANE A NUCLEATING AGENT
	3.37	0.4	128.2	169.9	0.0		
8	WSS	OLSS	GSS	SS			← SPENT SHALE
	0.5	0.0	0.0	0.0			
9	COSS	ASSS	CSS	HSS	TSS		
	17.2	81.0	2.20	0.17	981		
10	OILLP	COL	HOL	DOL	WLP		← LIQUID PRODUCT
	1690.9	84.1	11.1	7.737	90.0		
11	CRVG	MVVG	TVG	WG	OILM	M	← VENT GAS
	825.0	1.0	266	0.0	0.0	0	
12	CG	H	COOG	OG	NG		
	11.2	0	24.5	0.0	59.2		
13	MEG	COG	HHG	OTG	HG		← VENT PURGE
	2.6	4.1	6.3	3.3	1.09		
14	CRVP	VPMF	TVP	PVP			
	1.9	2.2	161	43			
15	TVPC	VPOIL	VPW	GL			
	81	58.8	2.3	91.1			

**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 6-27-67

Run No. C-1047-7

Sample Time: RS 1815; SS 2315

FISCHER ASSAY

RETORT SHALE MOISTURE

RAW SHALE  SPENT SHALE

Est. 1.0 wt %

<u>30.1</u>	<u>0.0</u>	Gal/Ton
<u>.913</u>	<u>-</u>	S.G., g/ml
<u>11.4</u>	<u>0.0</u>	Oil, wt %
<u>1.6</u>	<u>0.5</u>	Water, wt %
<u>84.6</u>	<u>99.1</u>	Sp. Shale, wt %
<u>2.4</u>	<u>0.4</u>	Gas & Loss, wt %
<u>Slight</u>	<u>none</u>	COKING TENDENCY

RAW SHALE FISCHER ASSAY MOISTURE 0.76 wt %

MINERAL CO<sub>2</sub>

18.4  17.2 wt %

ASH (SHALE)

65.9  81.0 wt %

MOISTURE

0.31  0.02 wt %

CARBON

18.1  7.20 wt %

HYDROGEN

1.75  0.17 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<sub>2</sub>", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS

DATE COMPLETED JUN 30 1967

CHECKED BY [Signature]

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-27-67

Run No. C1047-7

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>1</u>	<u>2</u>
<i>pfl</i> WATER, wt %	<u>1.6</u>	<u>/</u>	<u>/</u>	<u>/</u>		
GRAVITY, °API	<u>20.8</u>	<u>/</u>	<u>/</u>	<u>/</u>		
<input type="radio"/> OTI. ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

*pfl*  
 OIL WT, g 706.0  
 WATER VOL, ml 6.0  
 GRAVITY OIL, °API 42.6

VENT GAS

MAJOR COMPONENTS

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

CO <sub>2</sub> <u>24.5</u> vol %	CH <sub>4</sub> _____ vol %
O <sub>2</sub> <u>0.0</u> "	C <sub>2</sub> H <sub>4</sub> -C <sub>2</sub> H <sub>6</sub> _____ "
N <sub>2</sub> <u>58.5</u> "	C <sub>3</sub> H <sub>8</sub> _____ "
CH <sub>4</sub> <u>2.6</u> "	C <sub>3</sub> H <sub>6</sub> _____ "
CO <u>4.1</u> "	i C <sub>4</sub> H <sub>10</sub> _____ "
H <sub>2</sub> <u>6.3</u> "	n C <sub>4</sub> H <sub>10</sub> _____ "
Ar <u>0.7</u> "	∅C <sub>3</sub> H <sub>6</sub> _____ "
Others <u>3.3</u> "	n C <sub>5</sub> H <sub>12</sub> _____ "

CARBON, 11.2 lbs/MSCFDG

HYDROGEN, 1.09 lbs/MSCFDG

COMMENTS \_\_\_\_\_

DATE COMPLETED

JUN 29 1967

CHECKED BY

*KER*

# SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1047-6 SAMPLE NO.                      DATE 6-22-52  
 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	SCREEN SIZE	$D_i^*$	$\%D_i$	% RETAINED	CUM. % RETAINED	% PASSING
	4.25					4.25					
	3.00					3.00	(3.125)	(0.3200)			
	2.50		20.1	16.7	3.4	2.50	(2.625) 2.750	(0.3809) 0.3636	4.94		95.06
	2.00		28.1	20.2	7.9	2.00	2.250	0.4444	11.48		83.58
	1.50		48.0	32.5	15.5	1.50	1.750	0.5714	35.61		47.97
	1.05		32.2	19.5	12.7	1.05	(1.087) 1.275	(0.9199) 0.7843	18.89		29.08
	0.742		27.7	23.5	4.2	0.742	0.896	1.116	10.46		18.62
	0.525		24.6	18.5	6.1	0.525	0.634	1.577	8.87		9.75
	0.371		21.7	19.2	2.5	0.371	0.448	2.232	3.63		6.12
	0.263	3	20.6	18.4	2.2	0.263	0.317	3.154	3.20		2.92
	0.185	4	19.7	19.4	.3	0.185	0.224	4.464	0.58		2.34
	0.131	6	19.5	19.4	.1	0.131	0.158	6.329	0.15		2.19
	0.093	8	20.5	20.4	.1	0.093	0.112	8.928	0.15	97.96	2.04
	0.065	10	19.3	19.2	.1	0.065			0.15		1.89
	PAN		22.3	21.0	1.3	PAN			1.89		0
TOTAL ON SCREENS AND PAN					68.9	LOSS					
LOSS (BY DIFFERENCE)					-1.3	TOTAL					
TOTAL SAMPLE WEIGHT					69.1						

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

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

$\sum_{+8m}^m D_i$	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	$\sum_{+8m}^m X_i / D_i$	0.90880
$D_a$	1.07790	$\sum_{+8m}^m X_i D_i$
$D_v$	1.45985	1.43007