

GAS COMBUSTION REPORTING  
DETAILED RUN SUMMARY SHEET

1513019006

Date 7-15-67

Purpose: *To measure combustibility and yield with shale using hot dilution gas.*

GENERAL		SPENT SHALE PROPERTIES	
Run No.	C1051-3	Fischer Assay, Gal/ton	0.5
Length, hours	12	Mineral CO <sub>2</sub> , Wt %	14.8
Retort Type Number	RC-VII	Ash, Wt %	83.3
Oil Recovery System Number	C-2	Carbon (total), Wt %	6.23
Tons Total Raw Shale Charged, lbs.	97.76	Organic Carbon, Wt %	2.19
Bed Height above Dist., ft	5 1/2'	Hydrogen (total), Wt %	0.22
Type Air Dist.	AD-VII	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6'	Oil, Wt %	99.2
RATES AND QUANTITIES		Density, lb/gal	7.778
Raw Shale, lbs/(hr)(ft <sup>2</sup> )	2.95	Gravity, API	20.0
Spent Shale, % of RS	81.5	Ash, Wt %	-
Liquid Product, lbs/hr	1649.4	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	24.1	Water Vapor, lbs/MSCF (dry)	14.3
Air, SCF/ton RS (dry)	5270	Oil, lbs/MSCF (dry)**	0.603
Total Recycle*, SCF/ton RS (wet)	12900	Analysis (dry)	
Dilution, SCF/ton RS (wet)	1610	CO <sub>2</sub> , Vol %	27.8
Calc. Vent Gas SCF/ton RS (dry)	6770	O <sub>2</sub> , Vol %	0.2
Gas Losses, SCF/ton RS (wet)	1800	N <sub>2</sub> + Argon, Vol %	61.6
Propane, SCF/ton RS	18.5	CH <sub>4</sub> , Vol %	1.7
TEMPERATURES AND HEAT BALANCE		CO, Vol %	2.4
Retort Offgas, °F	147	H <sub>2</sub> , Vol %	4.2
Spent Shale, F	556	Other, Vol %	2.1
Raw Shale, °F	88	Gross Heating Value (calc), Btu/SCF	94.1
Recycle Gas Inlet, °F	265	Carbon (Total), lbs/MSCF (dry)	11.6
Dilution Gas Inlet, °F	203	Hydrogen (Total), lbs/MSCF (dry)	0.76
Air Inlet, °F	160	YIELDS AND BALANCES	
Retort Air Inlet, F	160	Oil Collected, Vol % RSFA	88.3
Heat of Comb. MBtu/ton RS	484	Oil in Gas**, Vol % RSFA	1.9
Heat Lost, MBtu/ton RS	11	Oil in Spent Shale, Vol % RSFA	1.6
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	91.8
Fischer Assay, gal/ton RS	27.3	Carbonate Decomposition, %	29.9
Oil, Wt %	10.4	Water Recovered, lb/ton RS	141.5
Water, Wt %	1.3	Ash Balance, % - As Measured	-
Gas, Wt %	2.2	Ash Balance, % - Assumed	RS-100
Mineral CO <sub>2</sub> , Wt %	17.2	Overall Balance, %	103.4
Ash, Wt %	67.9	Carbon Balance, % - Organic	100.6
Moisture, Wt % (Uncrushed)	1.32	Carbon Balance, % - Total	101.4
Carbon (Total), Wt %	15.9	Hydrogen Balance, % - Organic	89.1
Hydrogen (Total), Wt %	1.80	Hydrogen Balance, % - Total	116.1
Nominal Size Range, inches	1/4" - 1"	Water Balance, %	228.2
5 % passing thru	0.263	MISCELLANEOUS	
98 % passing thru	1.05	Avg. Retort ΔP, in H <sub>2</sub> O/ft	0.36
D <sub>a</sub>	0.628	ΔP Above Air Dist., in H <sub>2</sub> O/ft	0.53
D <sub>v</sub>	0.715	NaCl Soln., Wt %	-
Line Burner °F	840	NaCl Rate, gal/ton RS	-

Comments: *Off gas temperatures still right and good combustibility balance and distribution. Shale has some substandard.*

\*Measured Recycle + Dilution Gas  
 \*\* Oil Mist + Condensibles to 77 °F  
 \*\*\* Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed *Earl J. Johnson* DATE *July 28, 1967*

A. YIELDS

FAY	8.825E 01	DRYGAS	6.768E 03	MISTFA	1.920E 00
H2	2.842E 02	OTHER	1.421E 02	UNRETO	1.568E 00
CH4	1.151E 02	O2	1.354E 01	SSY	8.151E 01
CO	1.624E 02	CO2DEC	2.986E 01	MH2O	1.415E 02
CO2	1.881E 03	GILCOL	2.409E 01		

B. METERED GAS RATES

RECG	1.130E 04	DIL	1.607E 03	WVENTG	7.002E 03
AIR	5.269E 03	TRECG	1.290E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.840E 01	HVGT	6.367E 02	MWDG	3.152E 01
GBTU	9.408E 01				

D. COMBUSTION PRODUCTS

CO2C	9.351E 02	COC	1.440E 02	H2OC	8.524E 00
CHR	3.576E 01	COMBCP	1.391E 01		

E. MATERIAL IN

ORGCIN	2.458E 02	RSR	2.951E 02	ORH2IN	8.348E 01
MATIN	2.433E 03				

F. MATERIAL OUT

ORGCVG	5.392E 01	COKEC	3.181E 01	UNRETH	4.160E-01
ORGCOL	1.576E 02	ORH2VG	6.552E 00	COKEH	2.075E 00
UNRETC	3.883E 00	ORH2OL	2.080E 01	ORCOLP	6.410E 01
ORCVGP	2.193E 01	ORCSSP	1.452E 01	HCCVGP	8.018E 00

G. MATERIAL BALANCES

OVALL	1.034E 02	ORH2	8.913E 01	O2BAL	1.182E 02
ASH	0.0	TC	1.014E 02	WATER	2.282E 02
ORGC	1.006E 02	TH2	1.161E 02	GASL	1.799E 03
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.843E 05	QH2OC	1.262E 04	QAIR	7.000E 03
QPROP	6.385E 01	QOILC	1.312E 04	QRCYL	4.648E 04
QSUMIN	5.636E 05				

I. HEAT OUT

QMC02D	1.664E 05	QKEROD	9.819E 04	QH2OV	5.950E 04
QLIQO	4.123E 03	QOFGAS	2.645E 04	QSS	1.800E 05
QGASL	1.217E 04	LBLOSS	0.0	HETLOS	1.081E 04
QSUMOT	5.636E 05				

J. MISCELLANEOUS

ORCSS	2.190E 00	VPOIL	6.025E-01	TGL	2.937E 03
VPM	1.428E 01	WCG	2.310E 01	PROP	1.849E 01

END MESSAGE

END OUTPUT

0 2080, C10 1-3 7-5-67

1	WRS 1.3	OLRS 10.4	TRS 88	B -1	MRS 16293.8	← RAW SHALE	
2	FA 27.3	GRS 2.2	CORS 17.2	XA 55.22			
3	ASRS 67.9	CRS 16.9	HRS 1.80	BP 24.47	TOG 147		
4	CRA 714.9	MFA 1.0	TA 160	PA 144	WA 0.14	LBHL 0	← AIR
5	CRRG 1516.1	MFRG 1.0	TRG 265	PRG 102	CRTG 0.0	MFTG 0.0	← RECYCLE / TOTAL GAS
6	CRDG 5.9	MFDG 42.5	TDG 203	PDG 99			← DILUTION
7	P 2.89	TP 0.4	PP 127.2	W 218.0	N 0.0		← PREPARE / NUCLEATING AGENT
8	VSS 0.6	OLSS 0.2	GSS 0.2	SS 0.0			← SPENT SHALE
9	COSS 14.8	ASSS 83.3	CSS 6.23	HSS 0.22	TSS 556		
10	OILLP 1526.6	COL 84.1	HOL 11.1	DOL 7.778	WLP 122.9		← LIQUID PRODUCT
11	CRVG 1273.3	MFIG 1.0	TVG 271	WG 0.0	OILM 0.0	M 0	← VENT GAS
12	CG 11.6	H 0	COOG 27.8	OG 0.2	NG 61.6		
13	MEG 1.7	COG 2.4	HHG 4.2	OTG 2.1	HG 0.76		
14	CRVP 4.63	VPMF 0.59	TVP 74	PVP 4.0			← VENT PURGE
15	TVPC 77	VPOIL 68.9	VPW 3.0	GL 103.4			

9.4

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 7-15-67

Run No. C1051-3

Sample Time: RS 18:15; SS 23:45

ES FISCHER ASSAY  
 RAW SHALE BKM  SPENT SHALE

RETORT SHALE MOISTURE  
1.32 wt %  
BKM  RAW SHALE FISCHER ASSAY MOISTURE  
0.89 wt %

<u>27.1</u>	<u>0.5</u>	Gal/Ton
<u>0.911</u>	<u>—</u>	S.G., g/ml
<u>10.3</u>	<u>0.2</u>	Oil, wt %
<u>2.2</u>	<u>0.6</u>	Water, wt %
<u>85.3</u>	<u>99.0</u>	Sp. Shale, wt %
<u>2.2</u>	<u>0.2</u>	Gas & Loss, wt %
<u>slight</u>	<u>None</u>	COKING TENDENCY

ES MINERAL CO<sub>2</sub> ES  
 17.1  14.8 wt %

BKM ASH (SHALE) ES  
 67.6  83.3 wt %

BKM MOISTURE ES  
 0.37  0.13 wt %

ES CARBON ES  
 16.8  6.23 wt %

ES HYDROGEN ES  
 0.79  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 CO<sub>2</sub>", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS

DATE COMPLETED JUL 17 1967

CHECKED BY Rep

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 7-15-67

Run No. C1051-3

*RES*

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>
WATER, wt %	<u>0.8</u>					
GRAVITY, °API	<u>20.0</u>					
<input type="radio"/> OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

*RES*

VENT PURGE PRODUCT

OIL WT, g 827.0  
 WATER VOL, ml 54.0  
 GRAVITY OIL, °API 32.3

*E6B*

VENT GAS

MAJOR COMPONENTS

CO<sub>2</sub> 27.8 vol %  
 O<sub>2</sub> 0.2 "  
 N<sub>2</sub> 60.9 "  
 CH<sub>4</sub> 1.7 "  
 CO 2.4 "  
 H<sub>2</sub> 4.2 "  
 Ar 0.7 "  
 Others 2.1 "

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> \_\_\_\_\_ "

CARBON, 11.6 lbs/MSCFDG

HYDROGEN, 0.76 lbs/MSCFDG

COMMENTS \_\_\_\_\_

DATE COMPLETED JUL 17 1967

CHECKED BY RES

# SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C-1051-3 SAMPLE NO. \_\_\_\_\_ DATE 7-15-67

UNIT Retort #3 DESCRIPTION Top Soil

APPROX. SHALE SIZE 1/2" - 1" SHAKING TIME 10 min ANALYSIS BY S. R. ...

TOTAL SAMPLE WT. GROSS 90.1 - TARE 6.6 = NET 83.5

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		21.2	19.2	2.0
	0.742		59.2	20.5	38.7
	0.525		41.0	18.5	22.5
	0.371		29.6	19.2	10.4
	0.263	3	25.3	18.5	6.8
	0.185	4	20.1	19.4	.7
	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		22.6	21.0	1.6
TOTAL ON SCREENS AND PAN					83.1
LOSS (BY DIFFERENCE)					<u>4</u>
TOTAL SAMPLE WEIGHT					<u>83.5</u>

SCREEN SIZE	D <sub>i</sub> *	1/D <sub>i</sub>	% RETAINED	CUM. % RETAINED	% PASSING
4.25					
3.00	(3.125)	(0.3200)			
2.50	(2.625)	(0.3809)			
	2.750	0.3636			
2.00	2.250	0.4444			
1.50	1.750	0.5714			
1.05	(1.087)	(0.9199)	2.41		97.59
	1.275	0.7843			
0.742	0.896	1.116	46.57		51.02
0.525	0.634	1.577	27.09		23.94
0.371	0.448	2.232	12.51		11.43
0.263	0.317	3.154	8.18		3.25
0.185	0.224	4.464	0.84		2.41
0.131	0.158	6.329	0.24		2.17
0.093	0.112	8.928	0.00	97.83	2.17
0.065			0.24		1.93
PAN			1.93		0.00
LOSS			-	-	-
TOTAL			100.00	-	-

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

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

$\sum_{+8m}^m D_i$	0.69939	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	1.55985	$\sum_{+8m}^m X_i / D_i$	
D <sub>a</sub>	0.62757	$\sum_{+8m}^m X_i D_i$	
D <sub>v</sub>	0.71490		