

GAS COMBUSTION RETORTING  
DETAILED RUN SUMMARY SHEET

151301802B

Date 6-26-67

Purpose: To determine gas solubility and yield with a wet shale with hot air addition (without dilution gas)

GENERAL	
Run No.	C1047-6
Length, hours	12
Retort Type Number	RC VII
Oil Recovery System Number	C-1
TONS Total Raw Shale Charged, lbs.	99.75
Bed Height above Dist., ft	9 1/2
Type Air Dist.	AD XI
Bed Below Air Dist., ft	6
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft <sup>2</sup> )	301
Spent Shale, % of RS	80.9
Liquid Product, lbs/hr	1869.6
Oil Collected, gal/ton RS	26.2
Air, SCF/ton RS (dry)	4240
Total Recycle*, SCF/ton RS (wet)	1420
Dilution, SCF/ton RS (wet)	-
Calc. Vent Gas SCF/ton RS (dry)	5790
Gas Losses, SCF/ton RS (wet)	777
Propane, SCF/ton RS	-
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	140
Spent Shale, F	475
Raw Shale, °F	88
Recycle Gas Inlet, °F	276
Dilution Gas Inlet, °F	-
Air Inlet, °F	145
Retort Air Inlet, F	145
Heat of Comb. MBtu/ton RS	386
Heat Lost, MBtu/ton RS	6
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	30.2
Oil, Wt %	11.5
Water, Wt %	0.8
Gas, Wt %	2.1
Mineral CO <sub>2</sub> , Wt %	18.2
Ash, Wt %	65.4
Moisture, Wt % (Uncrushed)	1.14
Carbon (Total), Wt %	18.7
Hydrogen (Total), Wt %	1.90
Nominal Size Range, inches	1/4" - 2 1/2"
5 % passing thru	0.371
98 % passing thru	2.50
D <sub>a</sub>	1.055
D <sub>v</sub>	1.449
Line Burner °F	870

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.1
Mineral CO <sub>2</sub> , Wt %	17.3
Ash, Wt %	80.8
Carbon (total), Wt %	7.34
Organic Carbon, Wt %	2.62
Hydrogen (total), Wt %	0.20
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	96.6
Density, lb/gal	7.752
Gravity, API	20.5
Ash, Wt %	-
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF (dry)	5.2
Oil, lbs/MSCF (dry)**	0.069
Analysis (dry)	
CO <sub>2</sub> , Vol %	25.2
O <sub>2</sub> , Vol %	0.0
N <sub>2</sub> + Argon, Vol %	58.7
CH <sub>4</sub> , Vol %	2.6
CO, Vol %	4.3
H <sub>2</sub> , Vol %	6.3
Other, Vol %	2.9
Gross Heating Value (calc), Btu/SCF	154.3
Carbon (Total), lbs/MSCF (dry)	13.8
Hydrogen (Total), lbs/MSCF (dry)	1.25
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	86.8
Oil in Gas**, Vol % RSFA	0.2
Oil in Spent Shale, Vol % RSFA	0.4
Total Oil Meas., Vol % RSFA	87.4
Carbonate Decomposition, %	23.1
Water Recovered, lb/ton RS	58.4
Ash Balance, % - As Measured	-
Ash Balance, % - Assumed	125.100
Overall Balance, %	99.5
Carbon Balance, % - Organic	97.8
Carbon Balance, % - Total	99.5
Hydrogen Balance, % - Organic	91.1
Hydrogen Balance, % - Total	96.3
Water Balance, %	118.6
MISCELLANEOUS	
Avg. Retort ΔP, in H <sub>2</sub> O/ft	0.39
ΔP Above Air Dist., in H <sub>2</sub> O/ft	0.43
NaCl Soln., Wt %	-
NaCl Rate, gal/ton RS	-

Comments: operations journal

\*Measured Recycle + Dilution Gas  
 \*\* Oil Mist + Condensibles to 78 °F  
 \*\*\* Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Paul E. Turner DATE July 17, 1967  
 OSRC-10  
 Revised 7/19/66

//A100

2080, C1047-6 6-26-67

A. YIELDS

FAY	8.684E 01	DRYGAS	5.785E 03	MISTFA	1.712E-01
H2	3.645E 02	OTHER	1.678E 02	UNRETO	3.519E-01
CH4	1.504E 02	O2	0.0	SSY	8.094E 01
CO	2.488E 02	CO2DEC	2.306E 01	MH2O	5.844E 01
CO2	1.458E 03	OILCOL	2.623E 01		

B. METERED GAS RATES

RECG	1.421E 04	DIL	0.0	WVENTG	5.646E 03
AIR	4.241E 03	TRECG	1.421E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.915E 01	HVGT	8.927E 02	MWDG	3.038E 01
GBTU	1.543E 02				

D. COMBUSTION PRODUCTS

CO2C	6.769E 02	CO	2.314E 02	H2OC	9.607E 00
CHR	2.671E 01	COMBCP	1.040E 01		

E. MATERIAL IN

ORGCIN	2.763E 02	RSR	3.011E 02	ORH2IN	3.670E 01
MATIN	2.351E 03				

F. MATERIAL OUT

ORGCVG	5.728E 01	COKEC	4.112E 01	UNRETH	1.167E-01
ORGCOL	1.710E 02	ORH2VG	8.353E 00	COKEH	2.396E 00
UNRETC	1.247E 00	ORH2OL	2.257E 01	ORCOLP	6.177E 01
ORCVGP	2.069E 01	ORCSSP	1.531E 01	HCCVGP	1.029E 01

G. MATERIAL BALANCES

OVALL	9.946E 01	ORN2	9.110E 01	O2BAL	1.024E 02
ASH	0.0	TC	9.950E 01	WATER	1.186E 02
ORCC	9.777E 01	TH2	9.633E 01	GASL	7.773E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	3.863E 05	QH2OC	8.353E 03	QAIR	4.456E 03
QPROP	6.195E 01	QOILC	1.423E 04	QRCYL	5.676E 04
QSUMIN	4.702E 05				

I. HEAT OUT

QMC02D	1.360E 05	QKEROD	1.078E 05	QH2OV	4.301E 04
QLIQO	3.920E 03	QOFGAS	2.230E 04	QSS	1.446E 05
QGASL	6.593E 03	LBLOSS	0.0	HETLOS	5.938E 03
QSUMOT	4.702E 05				

J. MISCELLANEOUS

ORCSS	2.617E 00	VPOIL	6.928E-02	TGL	2.989E 03
VPM	5.245E 00	WCG	9.934E 00	PROP	2.288E 01

END MESSAGE

END OUTPUT

-GOODBYE

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080,	C 1047-6		6-26-67			
1	WRS	OLRS	TRS	B	MRS	RAW SHALE	
	0.8	11.5	88	-1	16624.9		
2	FA	GRS	CORS	XA			
	30.2	2.1	18.2	55.22			
3	ASRS	CRS	HRS	BP	TOG	AIR	
	65.4	18.7	1.90	24.41	140		
4	CRA	MFA	TA	VPA	WA		LBHL
	587.8	1.0	145	121	0.14	0	
5	CRRG	MFRG	TRG	PRG	CRTG	MFTG	RECYCLE A TOTAL GAS
	1973.7	1.0	276	73	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
	3.65	0.4	128.0	191.7	0.0		
8	WSS	OLSS	GSS	SS			SPENT SHALE
	0.4	0.05	0.1	0.0			
9	COSS	ASSS	CSS	HSS	TSS		
	17.3	80.8	7.34	0.20	475		
10	OILLP	COL	HOL	DOL	WLP		LIQUID PRODUCT
	1689.9	84.1	11.1	7.752	179.7		
11	CRVG	MVVG	.TVG	WG	OILM	M	VENT GAS
	832.8	1.0	266	0.0	0.0	0	
12	CG	H	COOG	OG	NG		
	13.8	0	25.2	0.0	58.0		
13	MEG	COG	HHG	OTG	HG		VENT PURGE
	2.6	4.3	6.3	2.9	1.25		
14	CRVP	VPMF	TVP	PVP			
	2.7	2.17	159	46			
15	TVPC	VPOIL	VPW	GL			
	78	22.3	2.4	90.5			

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 1047-6

Sample Time: RS 0615; SS \_\_\_\_\_

FISCHER ASSAY

RETORT SHALE MOISTURE

RAW SHALE       SPENT SHALE

1.14 wt %

<u>29.82</u>	<u>0.18</u>	Gal/Ton
<u>0.915</u>	<u>.901</u>	S.G., g/ml
<u>11.4</u>	<u>0.05</u>	Oil, wt %
<u>1.7</u>	<u>0.4</u>	Water, wt %
<u>84.8</u>	<u>99.5</u>	Sp. Shale, wt %
<u>2.1</u>	<u>0.1</u>	Gas & Loss, wt %
<u>SA 767</u>	<u>none</u>	COKING TENDENCY

RAW SHALE FISCHER ASSAY MOISTURE

0.90 wt %

MINERAL CO<sub>2</sub>

18.1       17.3      wt %

ASH (SHALE)

6.52       80.8      wt %

MOISTURE

0.35       0.06      wt %

CARBON

18.6       7.34      wt %

HYDROGEN

1.89       0.20      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

*RCR*

OSRC-12A

Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-27-67

Run No. C-1047-6

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

EA

WATER, wt %

1 3.4

~~2~~

~~3~~

~~4~~

~~1~~

~~2~~

GRAVITY, °API

20.5

~~ASH, wt %~~

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

EA

OIL WT, g

267.0

WATER VOL, ml

23.0

GRAVITY OIL, °API

42.0

VENT GAS

ET

MAJOR COMPONENTS

CO<sub>2</sub> 25.2 vol %

O<sub>2</sub> 0.0 "

N<sub>2</sub> 58.0 "

CH<sub>4</sub> 2.6 "

CO 4.3 "

H<sub>2</sub> 6.3 "

Ar 0.7 "

Others 2.9 "

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

ELB

CARBON, 13.8 lbs/MSCFDG

ELB

HYDROGEN, 1.25 lbs/MSCFDG

COMMENTS \_\_\_\_\_

DATE COMPLETED JUN 28 1967

CHECKED BY REP

# SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 01047-6      SAMPLE NO. 1      DATE 6/27/61  
 UNIT RET. T #3      DESCRIPTION TYLAR  
 APPROX. SHALE SIZE 1/2 to 2 1/2      SHAKING TIME 10 min.      ANALYSIS BY RA  
 TOTAL SAMPLE WT. GROSS 77.2      - TARE 6.2      = NET 71.2

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		19.6	16.7	2.9	2.50	(2.625) 2.750	(0.3809) 0.3636	4.06		95.93
	2.00		31.2	20.2	11.0	2.00	2.250	0.4444	15.41		80.53
	1.50		45.3	23.4	21.9	1.50	1.750	0.5714	30.67		49.86
	1.05		33.4	19.2	14.2	1.05	(1.087) 1.275	(0.9199) 0.7843	19.89		29.97
	0.742		23.5	20.5	8.0	0.742	0.896	1.116	11.20		18.77
	0.525		25.2	18.5	6.7	0.525	0.634	1.577	9.38		9.39
	0.371		22.2	19.2	3.0	0.371	0.448	2.232	4.20		5.19
	0.263	3	20.7	19.4	2.3	0.263	0.317	3.154	3.22		1.97
	0.185	4	19.3	19.1	.4	0.185	0.224	4.464	0.56		1.41
	0.131	6	19.5	19.3	.2	0.131	0.158	6.329	0.28		1.13
	0.093	8	20.5	20.4	.1	0.093	0.112	8.928	0.14	99.01	0.99
	0.065	10	19.3	19.2	.1	0.065			0.14		0.84
	PAN		21.6	21.0	.6	PAN			0.84		0.00
TOTAL ON SCREENS AND PAN					71.2	LCBS					
LOSS (BY DIFFERENCE)					0.2	TOTAL					
TOTAL SAMPLE WEIGHT					71.2						

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

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

$\sum_{+8m}^m D_i$	1.43432	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	0.93862	$\sum_{+8m}^m X_i / D_i$	
D <sub>a</sub>	1.0548	$\sum_{+8m}^m X_i D_i$	
D <sub>v</sub>	1.4486		