

GAS COMBUSTION REPORTING  
DETAILED RUN SUMMARY SHEET

1513013008

Date 4-12-67

Purpose: *To determine operability and yield with 1-2" in retort with SS liner, 36 bagmet APD and 3 air release hangers.*

GENERAL	
Run No.	C-1078-2
Length, hours	12
Retort Type Number	RC-IX
Oil Recovery System Number	C-2
Total Raw Shale Charged, lbs.	165.25
Bed Height above Dist., ft	12 1/4
Type Air Dist.	AD-VII
Bed Below Air Dist., ft	7'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft <sup>2</sup> )	499
Spent Shale, % of RS	81.7
Liquid Product, lbs/hr	2536.6
Oil Collected, gal/ton RS	344
Air, SCF/ton RS (dry)	4670
Total Recycle*, SCF/ton RS (wet)	12200
Dilution, SCF/ton RS (wet)	-
Calc. Vent Gas SCF/ton RS (dry)	6070
Gas Losses, SCF/ton RS (wet)	-65
Propane, SCF/ton RS	-
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	136
Spent Shale, F	384
Raw Shale, °F	58
Recycle Gas Inlet, °F	247
Dilution Gas Inlet, °F	-
Air Inlet, °F	124
Retort Air Inlet, F	124
Heat of Comb. MBtu/ton RS	1148
Heat Lost, MBtu/ton RS	36
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	25.7
Oil, Wt %	9.7
Water, Wt %	1.1
Gas, Wt %	1.8
Mineral CO <sub>2</sub> , Wt %	17.6
Ash, Wt %	68.9
Moisture, Wt % (Uncrushed)	1.0 Est.
Carbon (Total), Wt %	15.7
Hydrogen (Total), Wt %	1.59
Nominal Size Range, inches	1" - 2 1/2"
5 % passing thru	0.742
98 % passing thru	2.50
D <sub>80</sub>	1.418
D <sub>90</sub>	1.607

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO <sub>2</sub> , Wt %	14.3
Ash, Wt %	84.3
Carbon (total), Wt %	6.00
Organic Carbon, Wt %	2.10
Hydrogen (total), Wt %	0.12
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	94.8
Density, lb/gal	7.809
Gravity, API	19.4
Ash, Wt %	-
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF (dry)	7.4
Oil, lbs/MSCF (dry)**	0.015
Analysis (dry)	
CO <sub>2</sub> , Vol %	25.6
O <sub>2</sub> , Vol %	0.3
N <sub>2</sub> + Argon, Vol %	60.9
CH <sub>4</sub> , Vol %	1.8
CO, Vol %	3.8
H <sub>2</sub> , Vol %	4.9
Other, Vol %	2.7
Gross Heating Value (calc), Btu/SCF	1070
Carbon (Total), lbs/MSCF (dry)	12.6
Hydrogen (Total), lbs/MSCF (dry)	0.74
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	85.0
Oil in Gas**, Vol % RSFA	0.04
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	85.0
Carbonate Decomposition, %	33.6
Water Recovered, lb/ton RS	64.3
Ash Balance, % - As Measured	-
Ash Balance, % - Assumed	15.100
Overall Balance, %	99.7
Carbon Balance, % - Organic	100.6
Carbon Balance, % - Total	100.4
Hydrogen Balance, % - Organic	94.3
Hydrogen Balance, % - Total	95.8
Water Balance, %	97.6
MISCELLANEOUS	
Avg. Retort ΔP, in H <sub>2</sub> O/ft	0.50
ΔP Above Air Dist., in H <sub>2</sub> O/ft	0.54
NaCl Soln., Wt %	-
NaCl Rate, gal/ton RS	-

Comments: *Operation good. Bottom pressure gradually built up to 1.5" after 4 hours. Due to gas from bin no. 4. Crusher broke down and had to be replaced from bin no. 4 for short time before recovery.*

\*Measured Recycle + Dilution Gas  
 \*\* Oil Mist + Condensibles to 75 °F  
 \*\*\* Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. Jumper

DATE April 24, 1967

Started 4/11/50

4/20/50  
230

YIELDS

FAY	8.503 01	DEYGAS	6.057 03	MISTFA	4.472-02		
IR	2.973 02	OTHER	1.532 02	UNRETC	0.000 00	CHA	1.032 02
C2	1.829 01	SBY	8.175 01	CO	2.305 02	CO2DEC	3.359 01
WRC	6.234 01	CO2	1.553 03	OILCCL	2.142 01		

METERED GAS RATES

FRCG	1.217 04	DIL	0.000 00	VVENTG	7.073 03	AIR	4.670 03
TREC	1.217 04	ISF	0.000 00				

VOL WT & HEATING VALUE OF VENT GAS

WVWG	2.951 01	HVHT	6.314 02	WVDC	3.107 01	CVTU	1.040 02
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COMBUSTION PRODUCTS

CO2C	4.777 02	CO	2.154 02				
H2OC	3.517 01	CHR	5.655 03	COVFCP	1.024 01		

MATERIAL IN

ORGCM	2.179 02	RR	4.937 02	ORHCH	2.333 01	MATIN	2.373 03
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MATERIAL OUT

ORCOVC	4.427 01	COXEC	3.436 01	UNREIN	0.000 00		
ORCOCL	1.407 02	ORHCVS	2.443 03	COXEH	1.229 00	UNRETC	0.000 00
ORH2OL	1.357 01	ORCOLP	6.453 01	ORCVGP	2.339 01	ORCSSP	1.572 01
HCCVGP	1.007 01						

MATERIAL BALANCES

OVALL	2.922 01	CRFMR	9.629 01	TC	1.004 02	WATER	9.752 01
OBAL	2.301 01	ASH	0.000 00	GASE	-6.577 01	ACNB	-1.000 00
ORCC	1.000 02	TRG	2.572 01				

HEAT IN

ORCOVB	4.420 05	ORHCC	3.434 03	CAIP	5.653 05		
ORROP	0.000 00	OOILC	1.171 04	ORCYL	4.842 04	ORHCH	5.222 05

HEAT OUT

ORCO2D	1.915 05	ORHROD	9.200 04	ORH2OV	4.797 04		
ORL2O	4.702 03	ORFCAS	3.157 04	ORSS	1.137 05	ORGASL	-4.619 02
ORLOSS	0.000 00	ORH2LOS	3.618 04	ORCVCT	5.222 05		

MISCELLANEOUS

ORCSS	2.095 00	VPCIL	1.450-02	TOL	4.302 03	VPY	7.437 00
WCG	1.347 01	PROP	0.000 00				

MATERIAL- AND HEAT BALANCE INPUT SHEET

4-20-6

RIF92	, RUN NO.	C-1028-2	STARTED	4-12-67	CALC. ON	5/17/67
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R#2

101	907	58	-1	27541.08
H <sub>2</sub> O, wt%	Oil, wt%	°F	(1)	Rate, lbs/hr

2502	108	1706	55022
Oil, gal/T	Gas, L, wt%	CO <sub>2</sub> , wt%	Retort XS, ft <sup>2</sup>

6809	1507	1059	23083	136
Ash, wt%	Carbon, wt%	H <sub>2</sub> , wt%	Bar. Press, " Hg	Off-gas Temp, °F

RAW SHALE  
BAROMETRIC  
PRESSURE  
AND  
OFF-GAS  
TEMPERATURE

1085.4	100	124	121	0014	0
Chart Reading	Meter Factor	Temp, °F	Press, " H <sub>2</sub> O gauge	Moist, lb/MSCF	Heat Loss, Btu/hr

AIR

2874.3	100	247	74	000	000
Recycle Ch. Read	Meter Factor	Temp, °F	Press, " H <sub>2</sub> O gauge	Total Gas Ch. Read	Meter Factor

RECYCLE AIR  
TOTAL GAS

000	000	0	0
Dil Gas Ch. Read	Meter Factor	Temp, °F	Press, " H <sub>2</sub> O gauge

DILUTION  
GAS

000	0	0	278.2	000
C <sub>3</sub> Reometer R#	Temp, °F	Press, " H <sub>2</sub> O gauge	Water added, lbs/hr	Nucl. Agent, lb/hr

PROPANE, WATER  
& NUCLEATING  
AGENT

004	000	000	000
H <sub>2</sub> O, wt%	Oil, wt%	Gas, wt%	Rate, lbs/hr

SPENT  
SHALE

1403	8403	6000	0012	384
CO <sub>2</sub> , wt%	Ash, wt%	Carbon, wt%	H <sub>2</sub> , wt%	Temp, °F

230405	8401	1101	70809	23202
Dry Oil, lbs/hr	Carbon, wt%	H <sub>2</sub> , wt%	Dens, lbs/gal	Water, lbs/hr

LITQUID  
PRODUCT

166508	100	238	000	000	0	1206
Vent + Dil Gas Chart Reading	Meter Factor	Temp, °F	Moist, lb/MSCF	Mist, lb/MSCF	(2)	Carbon, lbs/MSCF

VENT +  
DILUTION  
GAS,  
VENT PURGE  
GAS, AND  
TOP SEAL  
GAS

0	2506	003	6009	108	308	409
(3)	CO <sub>2</sub> , vol%	O <sub>2</sub> , vol%	N <sub>2</sub> , vol%	CH <sub>4</sub> , vol%	CO, vol%	H <sub>2</sub> , vol%

207	0074	1606
Others, vol%	H <sub>2</sub> , lb/MSCF	V. Purge Ch. Reading

1083	156	139	75	1007	907	2109
Meter Factor	Temp, °F	Press, " H <sub>2</sub> O gauge	Cond. Gas Cond. Temp, °F	Dry Oil, gm/hr	Water, lbs/hr	Top Seal Gas Rate, SCFH

OPTIONS:

- (1) Insert "0" to calc. with measured rates; "1" to calc. with spent shale rate and ash analyses; "-1" to calc. with raw shale rate and ash analyses.
- (2) Insert "1" to calc. with measured moisture and mist; "0" to calc. from vent purge data.
- (3) Insert "0" for Retort No. 3 (pressure and temperature have no effect on gas rates); "1" for Retort No. 1&2 (pressure and temperature have effect on gas rates).

IB Gilmore

1/17/67

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-12-67

Run No. C 1028-2  
12H

Sample Time: RS 1815; SS 2315

FISCHER ASSAY

RAW SHALE  SPENT SHALE

RETORT SHALE MOISTURE

1.0 ES wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.80 wt %

6+12 Hr  
Avg  
ES

25.0 25.0 0.0 Gal/Ton

Gal/Ton

0.909 .908 --- S.G., g/ml

S.G., g/ml

9.6 9.5 0.0 Oil, wt %

Oil, wt %

1.9 1.9 0.4 Water, wt %

Water, wt %

86.8 86.7 99.5 Sp. Shale, wt %

Sp. Shale, wt %

1.8 2.0 0.1 Gas & Loss, wt %

Gas & Loss, wt %

51.945 None COKING TENDENCY

COKING TENDENCY

MINERAL CO<sub>2</sub>

17.5  17.3  14.3 wt % CO<sub>2</sub> ×  $\frac{12}{44}$

wt % CO<sub>2</sub> ×  $\frac{12}{44}$

ASH (SHALE)

68.7  68.7  84.3 wt %

wt %

MOISTURE

0.30  0.32  0.12 wt %

wt %

CARBON

15.6  15.5  6.00 wt %

wt %

HYDROGEN

1.58  1.57  0.12 wt %

wt %

BENZENE EXTRACTABLES

.  . wt %

wt %

~~14.3~~  
~~17.3~~  
~~68.7~~  
~~84.3~~  
37.6

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

APR 17 1967

CHECKED BY

PPP

OSRC-12A

Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-12-67

Run No. C1028-2  
6 Hr.

Sample Time: RS 1215; SS \_\_\_\_\_

FISCHER ASSAY

*AK*  RAW SHALE     SPENT SHALE

25.0 \_\_\_\_\_ Gal/Ton  
0.909 \_\_\_\_\_ S.G., g/ml  
8.6 \_\_\_\_\_ Oil, wt %  
1.9 \_\_\_\_\_ Water, wt %  
86.9 \_\_\_\_\_ Sp. Shale, wt %  
1.4 \_\_\_\_\_ Gas & Loss, wt %  
Slight \_\_\_\_\_ COKING TENDENCY

RETORT SHALE MOISTURE  
\_\_\_\_\_ wt %

*BKM*  RAW SHALE FISCHER ASSAY MOISTURE  
0.77 wt %

MINERAL CO<sub>2</sub>

*BKM*  17.7 \_\_\_\_\_  \_\_\_\_\_ wt %

ASH (SHALE)

*EJ*  68.6 \_\_\_\_\_  \_\_\_\_\_ wt %

MOISTURE

*AK*  0.27 \_\_\_\_\_  \_\_\_\_\_ wt %

SHALE RICHNESS DISTRIBUTION  
(See attached graph)

CARBON

*BKM*  15.6 \_\_\_\_\_  \_\_\_\_\_ wt %

SCREEN ANALYSIS  
(See back of this sheet)

HYDROGEN

*BKM*  1.59 \_\_\_\_\_  \_\_\_\_\_ wt %

BENZENE EXTRACTABLES

\_\_\_\_\_  \_\_\_\_\_ wt %

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 APR 14 1967

CHECKED BY [Signature]

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-12-67

Run No. C 1028-2  
12 hr.

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>5.2</u>	/	/	/	/	/
GRAVITY, °API	<u>19.4</u>	/	/	/	/	/

OIL ASH, wt %

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

111

OIL WT, g 128.0  
 WATER VOL, ml 265.0  
 GRAVITY OIL, °API 41.5

VENT GAS

R

MAJOR COMPONENTS

CO<sub>2</sub> 25.6 vol %  
 O<sub>2</sub> 0.3 "  
 N<sub>2</sub> 60.2 "  
 CH<sub>4</sub> 1.8 "  
 CO 3.3 "  
 H<sub>2</sub> 4.9 "  
 Ar 0.7 "  
 Others 2.7 "

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

R

CARBON, 12.6 lbs/MSCFDG

R

HYDROGEN, 0.74 lbs/MSCFDG

COMMENTS \_\_\_\_\_

DATE COMPLETED APR 14 1967

CHECKED BY [Signature]

# SCREEN ANALYSIS DATA SHEET (TY-LAB)

 RUN NO. C1028-2

 SAMPLE NO. 1

 DATE 4/12/57

 UNIT RETORT #3

 DESCRIPTION TY LAB

 APPROX. SHALE SIZE 17-25

 SHAKING TIME 10 min

 ANALYSIS BY St. J.

 TOTAL SAMPLE W/T. GROSS 21.9

 - TARE 5.3

 = NET 16.6

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		18.2	16.6	1.6	2.50	(2.625) 2.750	(0.3809) 0.3636	2.40		97.59
	2.00		29.4	20.2	9.2	2.00	2.250	0.4444	12.31		85.28
	1.50		56.00	29.2	27.2	1.50	1.750	0.5714	48.95		36.33
	1.05		34.00	19.1	14.9	1.05	(1.087) 1.275	(0.9199) 0.7843	22.37		13.96
	0.742		27.00	20.4	6.6	0.742	0.896	1.116	9.91		4.05
	0.525		19.6	18.4	1.2	0.525	0.634	1.577	1.80		2.25
	0.371		19.5	19.2	.3	0.371	0.448	2.232	0.45		1.80
	0.263	3	18.4	18.3	.1	0.263	0.317	3.154	0.15		1.65
	0.185	4	18.5	18.5	.0	0.185	0.224	4.464	0.00		1.65
	0.131	6	19.45	19.35	.1	0.131	0.158	6.329	0.15		1.50
	0.093	8	20.8	20.7	.1	0.093	0.112	8.928	0.15	98.64	1.35
	0.065	10	20.25	20.15	.1	0.065			0.15		1.20
	PAN		21.7	20.9	.8	PAN			1.20		0.00
TOTAL ON SCREENS AND PAN					16.6	LOSS			-		5
LOSS (BY DIFFERENCE)						TOTAL		99.99			
TOTAL SAMPLE WEIGHT											

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

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

$\sum_{+8m}^m D_i$	1.58492	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	0.69564	$\sum_{+8m}^m X_i / D_i$	
$D_a$	1.41797	$\sum_{+8m}^m X_i D_i$	
$D_v$	1.60677		