

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

0513018030

Date 7-2-67

Purpose: *To determine operability and record with 4-2" mesh shale at 500 mass rate and with hot air. (W/O dilution Gas)*

7015

GENERAL		SPENT SHALE PROPERTIES	
Run No.	R-3 C1099-5	Fischer Assay, Gal/ton	0.2
Length, hours	12	Mineral CO ₂ , Wt %	15.9
Retort Type Number	RCVII	Ash, Wt %	82.4
Oil Recovery System Number	C-2	Carbon (total), Wt %	6.47
Total Raw Shale Charged, lbs.	16473	Organic Carbon, Wt %	2.13
Bed Height above Dist., ft	9 1/2	Hydrogen (total), Wt %	0.19
Type Air Dist.	ADXT	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6	Oil, Wt %	94.3
RATES AND QUANTITIES		Density, lb/gal	7.788
Raw Shale, lbs/(hr)(ft ²)	497	Gravity, API	19.8
Spent Shale, % of RS	82.0	Ash, Wt %	—
Liquid Product, lbs/hr	2621.85	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	22.7	Water Vapor, lbs/MSCF (dry)	6.2
Air, SCF/ton RS (dry)	4720	Oil, lbs/MSCF (dry)**	0.110
Total Recycle%, SCF/ton RS (wet)	12310	Analysis (dry)	
Dilution, SCF/ton RS (wet)	—	CO ₂ , Vol %	24.5
Calc. Vent Gas SCF/ton RS (dry)	6303	O ₂ , Vol %	0.2
Gas Losses, SCF/ton RS (wet)	431	N ₂ + Argon, Vol %	59.2
Propane, SCF/ton RS	27.3	CH ₄ , Vol %	2.5
TEMPERATURES AND HEAT BALANCE		CO, Vol %	4.2
Retort Offgas, °F	143	H ₂ , Vol %	6.5
Spent Shale, F	584	Other, Vol %	3.2
Raw Shale, °F	92	Gross Heating Value (calc), Btu/SCF	148
Recycle Gas Inlet, °F	263	Carbon (Total), lbs/MSCF (dry)	13.4
Dilution Gas Inlet, °F	—	Hydrogen (Total), lbs/MSCF (dry)	1.18
Air Inlet, °F	116	YIELDS AND BALANCES	
Retort Air Inlet, F	116	Oil Collected, Vol % RSFA	85.9
Heat of Comb. MBtu/ton RS	437	Oil in Gas**, Vol % RSFA	0.3
Heat Lost, MBtu/ton RS	-9	Oil in Spent Shale, Vol % RSFA	1.6
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	87.8
Fischer Assay, gal/ton RS	26.4	Carbonate Decomposition, %	27.5
Oil, Wt %	10.1	Water Recovered, lb/ton RS	58.5
Water, Wt %	0.7	Ash Balance, % - As Measured	—
Gas, Wt %	2.2	Ash Balance, % - Assumed	25.100
Mineral CO ₂ , Wt %	18.0	Overall Balance, %	99.9
Ash, Wt %	67.6	Carbon Balance, % - Organic	103.1
Moisture, Wt % (Uncrushed)	0.93	Carbon Balance, % - Total	103.8
Carbon (Total), Wt %	16.5	Hydrogen Balance, % - Organic	101.6
Hydrogen (Total), Wt %	1.63	Hydrogen Balance, % - Total	104.1
Nominal Size Range, inches	1/4" - 2 1/2"	Water Balance, %	105.9
5 % passing thru	0.371	MISCELLANEOUS	
98 % passing thru	7.50	Avg. Retort ΔP, in H ₂ O/ft	0.77
D _a	1.028	ΔP Above Air Dist., in H ₂ O/ft	0.91
D _v	1.368	NaCl Soln., Wt %	—
Line Burner °F	850	NaCl Rate, gal/ton RS	—

Comments: *Spent shale found except for gas adjustments*

To give temperatures at reasonable level.

*Measured Recycle + Dilution Gas
 ** Oil Mist + Condensibles to 89 °F
 *** Rates are for moisture-free raw shale. free basis.

All shale analyses are on a moisture-free basis.

Signed *Earl E. Turner*

DATE *July 18, 1967*

//A100

2080, C1049-5 R-3 7-2-67

J.
7/12/67

A. YIELDS

FAY	8.594E 01	DRYGAS	6.303E 03	MISTFA	3.366E-01
H2	4.097E 02	OTHER	2.017E 02	UNRETO	8.123E-01
CH4	1.576E 02	O2	1.261E 01	SSY	8.204E 01
CO	2.647E 02	CO2DEC	2.753E 01	MH2O	5.846E 01
CO2	1.544E 03	OILCOL	2.269E 01		

B. METERED GAS RATES

RECG	1.231E 04	DIL	0.0	WVENTG	6.697E 03
AIR	4.716E 03	TRECG	1.231E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.911E 01	HVGT	9.354E 02	MWDG	3.057E 01
GBTU	1.484E 02				

D. COMBUSTION PRODUCTS

CO2C	6.291E 02	COC	2.463E 02	H2OC	2.177E 01
CHR	1.135E 01	COMBCP	1.184E 01		

E. MATERIAL IN

ORGCIN	2.343E 02	RSR	4.972E 02	ORH2IN	3.162E 01
MATIN	2.384E 03				

F. MATERIAL OUT

ORGCVG	5.801E 01	COKEC	3.298E 01	UNRETH	2.094E-01
ORGCOL	1.486E 02	ORH2VG	9.956E 00	COKEH	2.357E 00
UNRETC	1.954E 00	ORH2OL	1.961E 01	ORCOLP	6.342E 01
ORCVGP	2.476E 01	ORCSSP	1.491E 01	HCCVGP	1.292E 01

G. MATERIAL BALANCES

OVALL	9.985E 01	ORH2	1.016E 02	O2BAL	1.011E 02
ASH	0.0	TC	1.038E 02	WATER	1.059E 02
ORGC	1.031E 02	TH2	1.041E 02	GASL	4.309E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.373E 05	QH2OC	6.350E 03	QAIR	2.083E 03
QPROP	3.060E 01	QOILC	1.237E 04	QRCYL	4.511E 04
QSUMIN	5.032E 05				

I. HEAT OUT

QMCO2D	1.606E 05	QKEROD	9.709E 04	QH2OV	3.627E 04
QLIQO	3.361E 03	QOFGAS	2.084E 04	QSS	1.902E 05
QGASL	4.768E 03	LBLOSS	0.0	HETLOS	-9.919E 03
QSUMOT	5.032E 05				

J. MISCELLANEOUS

ORCSS	2.129E 00	VPOIL	1.098E-01	TGL	4.725E 03
VPM	6.224E 00	WCG	1.157E 01	PROP	2.730E 01

END MESSAGE

END OUTPUT

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080,	C1049-5 R-3. 7-2-67					
1	WRS	OLRS	TRS	B	MRS		
	0.7	10.1	92	-1	27454.2		
2	FA	GRS	CORS	XA			
	26.4	2.2	18.0	55.22			
3	ASRS	CRS	HRS	BP	TOG		
	67.6	16.5	1.63	24.47	143		
4	CRA	MFA	TA	VPA	WA	LBHL	
	1078.2	1.0	116	116	0.14	0	
5	CRRG	MFRG	TRG	PRG	CRTG	MFTG	
	2818.3	1.0	263	65	0.0	0.0	
6	CRDG	MFDG	TDG	PDG			
	0.0	0.0	0	0			
7	P	TP	PP	W	N		
	7.19	0.4	127.2	257.7	0.0		
8	WSS	OLSS	GSS	SS			
	0.3	0.1	0.1	0.0			
9	COSS	ASSS	CSS	HSS	TSS		
	15.9	82.4	6.47	0.19	584		
10	OILLP	COL	HOL	DOL	WLP		
	2425.56	84.1	11.1	7.788	196.3		
11	CRVG	MFVG	TVG	WG	OILM	M	
	1570.6	1.0	259	0.0	0.0	0	
12	CG	H	COOG	OG	NG		
	13.4	0	24.5	0.2	59.2		
13	MEG	COG	HHG	OTG	HG		
	2.5	4.2	6.5	3.2	1.18		
14	CRVP	VPMF	TVP	PVP			
	5.5	2.21	172	22			
15	TVPC	VPOIL	VPW	GL			
	89	49.1	3.3	69.5			

← RAW SHALE

← AIR

← RECYCLE AND TOTAL GAS

← DILUTION GAS

← PROPANE AND NUCLEATING AGENT

← SPENT SHALE

← LIQUID PRODUCT

← VENT GAS

← VENT PURGE

2 used Ave of Test 4, 6, 7, 8, 9 for gas analysis.

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 7-3-67

Run No. C1049-5

Sample Time: RS 07:15; SS 10:45

FISCHER ASSAY

RAW SHALE SPENT SHALE

<u>26.2</u>	<u>0.2</u> 0.10	Gal/Ton
<u>0.912</u>	<u>—</u>	S.G., g/ml
<u>10.0</u>	<u>0.1</u>	Oil, wt %
<u>1.6</u>	<u>0.3</u>	Water, wt %
<u>86.2</u>	<u>99.5</u>	Sp. Shale, wt %
<u>2.2</u>	<u>0.1</u>	Gas & Loss, wt %
<u>slight</u>	<u>none</u>	COKING TENDENCY

RETORT SHALE MOISTURE
0.93 wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.57 wt %

MINERAL CO₂

17.9 15.9 wt %

67.2 82.4 wt %

0.28 0.02 wt %

16.4 6.47 wt %

1.62 0.19 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 10 1967

CHECKED BY

Rep

OSRC-12A

Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 7-3-67

Run No. C 1049-5

ET

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>5.7</u>	_____	_____	_____	_____	_____
GRAVITY, °API	<u>19.8</u>	_____	_____	_____	_____	_____

OIL ASH, wt %

DISTILLATION (See attached sheet - OSRC-24)

ET

VENT PURGE PRODUCT

OIL WT, g 589.2
 WATER VOL, ml 10.0
 GRAVITY OIL, °API 41.5

ELB

VENT GAS

MAJOR COMPONENTS

CO₂ 25.3 vol % - 24.5
 O₂ 0.0 " - 0.2
 N₂ 55.0 " - 58.5
 CH₄ 3.4 " - 2.5
 CO 4.4 " - 4.2
 H₂ 6.4 " - 6.5
 Ar 0.7 " - 0.7
 others 6.1 " - 3.2

C₁ thru C₄, plus n-Pentane

CH₄ _____ vol %
 C₂H₄-C₂H₆ _____ "
 C₃H₈ _____ "
 C₃H₆ _____ "
 i C₄H₁₀ _____ "
 n C₄H₁₀ _____ "
 C₃H₆ _____ "
 n C₅H₁₂ _____ "

ELB

CARBON, 13.2 lbs/MSCFDG - 13.4

ELB

HYDROGEN, 1.09 lbs/MSCFDG - 1.18

COMMENTS _____

DATE COMPLETED JUL 4 1967

CHECKED BY REP

OSRC-12B

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1049-5 SAMPLE NO. _____ DATE 7-3-67

UNIT Net 3 DESCRIPTION TY Lab

APPROX. SHALE SIZE 1-2 1/2 SHAKING TIME 10 min ANALYSIS BY Sears & Smith

TOTAL SAMPLE WT. GROSS 64.1 - TARE 5.8 = NET 58.3

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		18.0	16.7	1.3	2.50	(2.625) 2.750	(0.3809) 0.3636	2.23		97.77
	2.00		26.2	20.2	6.0	2.00	2.250	0.4444	10.29		87.48
	1.50		42.0	23.5	18.5	1.50	1.750	0.5714	31.73		55.75
	1.05		42.3	19.2	23.1	1.05	(1.087) 1.275	(0.9199) 0.7843	22.47		33.28
	0.742		28.7	20.5	7.5	0.742	0.896	1.116	12.86		20.42
	0.525		24.4	18.6	5.8	0.525	0.634	1.577	9.95		10.47
	0.371		21.9	19.2	2.7	0.371	0.448	2.232	4.63		5.84
	0.263	3	20.3	18.5	1.8	0.263	0.317	3.154	3.09		2.75
	0.185	4	19.8	18.4	.4	0.185	0.224	4.464	0.69		2.06
	0.131	6	19.5	19.4	.1	0.131	0.158	6.329	0.17		1.89
	0.093	8	20.5	20.5	0	0.093	0.112	8.928	0	98.11	1.89
	0.065	10	19.4	18.2	.2	0.065			0.34		1.55
	PAN		21.9	21.0	.9	PAN			1.54		0
TOTAL ON SCREENS AND PAN					58.3	LOSS					
LOSS (BY DIFFERENCE)					0.0	TOTAL					
TOTAL SAMPLE WEIGHT					58.3						

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

REMARKS: _____

$\sum_{+8m}^m D_i$		$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$		$\sum_{+8m}^m X_i / D_i$	0.954165
D _a	1.0282	$\sum_{+8m}^m X_i D_i$	1.322441
D _v	1.3684		