

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513018028

Date 7-1-67

Purpose: To determine operability and yield with $\frac{1}{2}$ inch shale at 500 r/min rate and with hot air. (w/o dilution gas)

GENERAL		SPENT SHALE PROPERTIES	
Run No.	C1049-3	Fischer Assay, Gal/ton	0.0
Length, hours	12	Mineral CO ₂ , Wt %	15.9
Retort Type Number	RC VII	Ash, Wt %	82.2
Oil Recovery System Number	C-2	Carbon (total), Wt %	6.52
Tons Total Raw Shale Charged, lbs.	163.55	Organic Carbon, Wt %	2.18
Bed Height above Dist., ft	9 1/2	Hydrogen (total), Wt %	0.19
Type Air Dist.	AD XI	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6	Oil, Wt %	93.6
RATES AND QUANTITIES		Density, lb/gal	7.804
Raw Shale, lbs/(hr)(ft ²)	499	Gravity, API	19.5
Spent Shale, % of RS	83.0	Ash, Wt %	—
Liquid Product, lbs/hr	2471.4	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	71.5	Water Vapor, lbs/MSCF (dry)	6.3
Air, SCF/ton RS (dry)	4596	Oil, lbs/MSCF (dry)**	0.200
Total Recycle*, SCF/ton RS (wet)	11970	Analysis (dry)	
Dilution, SCF/ton RS (wet)	—	CO ₂ , Vol %	24.0
Calc. Vent Gas SCF/ton RS (dry)	6076	O ₂ , Vol %	0.0
Gas Losses, SCF/ton RS (wet)	441	N ₂ + Argon, Vol %	59.7
Propane, SCF/ton RS	26.1	CH ₄ , Vol %	2.3
TEMPERATURES AND HEAT BALANCE		CO, Vol %	4.0
Retort Offgas, °F	145	H ₂ , Vol %	6.1
Spent Shale, °F	606	Other, Vol %	3.9
Raw Shale, °F	93	Gross Heating Value (calc), Btu/SCF	125
Recycle Gas Inlet, °F	265	Carbon (Total), lbs/MSCF (dry)	12.2
Dilution Gas Inlet, °F	—	Hydrogen (Total), lbs/MSCF (dry)	1.01
Air Inlet, °F	118	YIELDS AND BALANCES	
Retort Air Inlet, °F	118	Oil Collected, Vol % RSFA	81.9
Heat of Comb. MBtu/ton RS	432	Oil in Gas**, Vol % RSFA	0.6
Heat Lost, MBtu/ton RS	100	Oil in Spent Shale, Vol % RSFA	0.0
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	82.5
Fischer Assay, gal/ton RS	26.2	Carbonate Decomposition, %	25.1
Oil, Wt %	10.0	Water Recovered, lb/ton RS	60.4
Water, Wt %	0.7	Ash Balance, % - As Measured	—
Gas, Wt %	2.3	Ash Balance, % - Assumed	RS.100
Mineral CO ₂ , Wt %	17.6	Overall Balance, %	99.9
Ash, Wt %	68.2	Carbon Balance, % - Organic	96.5
Moisture, Wt % (Uncrushed)	1.0 Est.	Carbon Balance, % - Total	99.0
Carbon (Total), Wt %	16.5	Hydrogen Balance, % - Organic	90.9
Hydrogen (Total), Wt %	1.67	Hydrogen Balance, % - Total	95.8
Nominal Size Range, inches	1/4" - 2 1/2"	Water Balance, %	108.3
5 % passing thru	0.371	MISCELLANEOUS	
98 % passing thru	2.50	Avg. Retort ΔP, in H ₂ O/ft	0.74
D _a	1.071	ΔP Above Air Dist., in H ₂ O/ft	0.77
D _v	1.578	NaCl Soln., Wt %	—
Line Burner °F	850	NaCl Rate, gal/ton RS	—

Comments: _____

*Measured Recycle + Dilution Gas
 ** Oil Mist + Condensibles to 82 °F
 *** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. Turner DATE July 18, 1967
 OSRC-10
 Revised 7/19/66

//A100

2080, C1049-2 7-1-67

A. YIELDS

FAY	8.186E 01	DRYGAS	6.076E 03	MISTFA	5.949E-01
H2	3.707E 02	OTHER	2.370E 02	UNRETO	0.0
CH4	1.398E 02	O2	0.0	SSY	8.297E 01
CO	2.431E 02	CO2DEC	2.505E 01	MH2O	6.043E 01
CO2	1.458E 03	OILCOL	2.145E 01		

B. METERED GAS RATES

RECG	1.197E 04	DIL	0.0	WVENTG	6.438E 03
AIR	4.585E 03	TRECG	1.197E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.917E 01	HVGT	7.612E 02	MWDG	3.064E 01
GBTU	1.253E 02				

D. COMBUSTION PRODUCTS

CO2C	6.338E 02	COC	2.236E 02	H2OC	2.097E 01
CHR	1.155E 01	COMBCP	1.150E 01		

E. MATERIAL IN

ORGCIN	2.364E 02	RSR	4.936E 02	ORH2IN	3.239E 01
MATIN	2.375E 03				

F. MATERIAL OUT

ORGCVG	5.111E 01	COKEC	3.616E 01	UNRETH	0.0
ORGCOL	1.408E 02	ORH2VG	8.623E 00	COKEH	2.224E 00
UNRETC	0.0	ORH2OL	1.858E 01	ORCOLP	5.955E 01
ORCVGP	2.162E 01	ORCSSP	1.530E 01	HCCVGP	1.012E 01

G. MATERIAL BALANCES

OVALL	9.985E 01	ORH2	9.085E 01	O2BAL	1.014E 02
ASH	0.0	TC	9.896E 01	WATER	1.083E 02
ORGC	9.647E 01	TH2	9.583E 01	GASL	4.414E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.319E 05	QH2OC	1.070E 04	QAIR	2.110E 03
QPROP	3.056E 01	QOILC	1.172E 04	QRCYL	4.444E 04
QSUMIN	5.009E 05				

I. HEAT OUT

QMC02D	1.428E 05	QKEROD	9.840E 04	QH2OV	3.765E 04
QLIQO	3.254E 03	QOFGAS	2.073E 04	QSS	2.029E 05
QGASL	5.154E 03	LBLOSS	0.0	HETLOS	-1.005E 04
QSUMOT	5.009E 05				

J. MISCELLANEOUS

ORCSS	2.179E 00	VPOIL	2.002E-01	TGL	4.543E 03
VPM	6.284E 00	WCG	1.167E 01	PROP	2.612E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080,	01049-3		7-1-67			
1	WRS 0.7	OLRS 10.0	TRS 93	B -1	MRS 27258.6	← RAW SHALE	
2	FA 26.2	GRS 2.3	CORS 17.6	XA 55.22			
3	ASRS 68.2	CRS 16.5	HRS 1.67	BP 24.45	TOG 145		
4	CRA 1041.1	MFA 1.0	TA 118	VPA 119	WA 0.14	LBHL 0	← AIR
5	CRRG 2724.6	MFRG 1.0	TRG 265	PRG 67	CRTG 0.0	MFTG 0.0	← RECYCLE AIR TOTAL GAS
6	CRDG 0.0	MFDG 0.0	TDG 0	PDG 0			← DILUTION GAS
7	P 6.83	TP 0.4	PP 127.5	W 275.3	N 0.0		← PROPANE AIR NUCLEATING AGENT
8	WSS 0.5	OLSS 0.0	GSS 0.0	SS 0.0			← SPENT SHALE
9	COSS 15.9	ASSS 82.2	CSS 6.52	HSS 0.19	TSS 606		
10	OILLP 2281.3	COL 84.1	HOL 11.1	DOL 7.804	WLP 190.1		← LIQUID PRODUCT
11	CRVG 1504.3	MFBG 1.0	TVG 263	WG 0.0	OILM 0.0	M 0	← VENT GAS
12	CG 12.2	H 0	COOG 24.0	OG 0.0	NG 59.7		
13	MEG 2.3	COG 4.0	HHG 6.1	OTG 3.9	HG 1.01		
14	CRVP 5.7	VPMF 2.2	TVP 173	PVP 25			← VENT PURGE
15	TVPC 82	VPOIL 90.9	VPW 4.0	GL 71.6			

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 7/2/67

Run No. C 1049-3

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

ES FISCHER ASSAY
 RAW SHALE SPENT SHALE

RETORT SHALE MOISTURE
Est 1.0 wt %

<u>25.9</u>	<u>0.0</u>	Gal/Ton
<u>0.913</u>	<u>—</u>	S.G., g/ml
<u>9.9</u>	<u>0.0</u>	Oil, wt %
<u>1.7</u>	<u>0.5</u>	Water, wt %
<u>86.1</u>	<u>99.3</u>	Sp. Shale, wt %
<u>2.3</u>	<u>0.2</u>	Gas & Loss, wt %
<u>slight</u>	<u>slight</u>	COKING TENDENCY

RAW SHALE FISCHER ASSAY MOISTURE
0.53 wt %

MINERAL CO₂

DK 17.5 *ES* 15.9 wt %

ASH (SHALE)

DK 67.8 *DK* 82.2 wt %

MOISTURE

DK 0.20 *DK* 0.03 wt %

CARBON

ES 16.4 *ES* 6.52 wt %

HYDROGEN

ES 1.66 *ES* 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 5 1967

CHECKED BY RCR

OSRC-12A
 Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 7-2-67

Run No. C1049-3

EF

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>6.4</u>	_____	_____	_____	_____	_____
GRAVITY, °API	<u>19.5</u>	_____	_____	_____	_____	_____
<input type="checkbox"/> OIL ASH, wt %	_____	_____	_____	_____	_____	_____

DISTILLATION (See attached sheet - OSRC-24)

EF

VENT PURGE PRODUCT

OIL WT, g 1090.5
 WATER VOL, ml 56.0
 GRAVITY OIL, °API 41.8

EF

VENT GAS

MAJOR COMPONENTS

CO₂ 24.0 vol %
 O₂ 0.0 "
 N₂ 59.0 "
 CH₄ 2.3 "
 CO 4.0 "
 H₂ 6.1 "
 Ar 0.7 "
 others 3.9 "

C₁ thru C₄, plus n-Pentane

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

CARBON, 12.2 lbs/MSCFDG

HYDROGEN, 1.01 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUL 3 1967

CHECKED BY NOF

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 10015-3 SAMPLE NO. 7. V. 1 DATE 7-2-57
 UNIT 10015-3 DESCRIPTION 1
 APPROX. SHALE SIZE 1/2-2 1/4 SHAKING TIME 10 ANALYSIS BY CH + JS
 TOTAL SAMPLE WT. GROSS 69.3 - TARE 6.5 = NET 62.8

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		19.2	16.7	2.5	2.50	(2.625) 2.750	(0.3802) 0.3636	3.98		96.02
	2.00		32.8	20.2	12.6	2.00	2.250	0.4444	20.06		75.96
	1.50		40.7	23.5	16.5	1.50	1.750	0.5714	26.27		49.69
	1.05		30.6	19.2	11.4	1.05	(1.087) 1.275	(0.9199) 0.7843	18.15		31.54
	0.742		28.2	20.5	7.7	0.742	0.896	1.116	12.26		19.28
	0.525		24.2	18.5	5.7	0.525	0.634	1.577	9.08		10.20
	0.371		21.9	19.3	2.6	0.371	0.448	2.232	4.14		6.06
	0.263	3	20.7	18.5	2.2	0.263	0.317	3.154	3.50		2.56
	0.185	4	19.8	19.0	.8	0.185	0.224	4.464	0.64		1.92
	0.131	6	18.5	9.4	.1	0.131	0.158	6.329	0.16		1.76
	0.093	8	22.5	20.5	.0	0.093	0.112	8.928	0	98.24	1.76
	0.065	10	19.4	19.3	.1	0.065			0.16		1.60
	PAN		22.0	21.0	1.0	PAN			0.60		0
TOTAL ON SCREENS AND PAN					62.8	LOSS					
LOSS (BY DIFFERENCE)					.0	TOTAL					
TOTAL SAMPLE WEIGHT					62.8						

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

REMARKS: _____

$\sum_{+8m}^m D_i$		$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$		$\sum_{+8m}^m X_i / D_i$	0.91758
D _a	1.07064	$\sum_{+8m}^m X_i D_i$	1.55054
D _v	1.5783		