

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

151307008

Date 6-2-67

Purpose: To determine operability and yield with less dilution gas using 4-1 inch shale -

GENERAL		SPENT SHALE PROPERTIES	
Run No.	TR- C1040-5	Fischer Assay, Gal/ton	0.2
Length, hours	12	Mineral CO ₂ , Wt %	13.7
Retort Type Number	RC-VII	Ash, Wt %	84.9
Oil Recovery System Number	C-1	Carbon (total), Wt %	5.68
Total Raw Shale Charged, lbs.	99.50	Organic Carbon, Wt %	1.94
Bed Height above Dist., ft	5 1/2'	Hydrogen (total), Wt %	0.20
Type Air Dist.	AD-X	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6'	Oil, Wt %	97.0
RATES AND QUANTITIES		Density, lb/gal	7.768
Raw Shale, lbs/(hr)(ft ²)	300	Gravity, API	20.2
Spent Shale, % of RS	8/10	Ash, Wt %	-
Liquid Product, lbs/hr	1489.7	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	19.8	Water Vapor, lbs/MSCF(dry)	9.2
Air, SCF/ton RS (dry)	4880	Oil, lbs/MSCF(dry)**	0.077
Total Recycle*, SCF/ton RS(wet)	14100	Analysis (dry)	
Dilution, SCF/ton RS (wet)	1580	CO ₂ , Vol %	28.0
Calc. Vent Gas SCF/ton RS(dry)	6260	O ₂ , Vol %	0.4
Gas Losses, SCF/ton RS(wet)	~45	N ₂ + Argon, Vol %	61.7
Propane, SCF/ton RS	15.1	CH ₄ , Vol %	1.8
TEMPERATURES AND HEAT BALANCE		CO, Vol %	2.8
Retort Offgas, °F	138	H ₂ , Vol %	4.5
Spent Shale, F	685	Other, Vol %	1.8
Raw Shale, °F	81	Gross Heating Value(calc), Btu/SCF	73.9
Recycle Gas Inlet, °F	250	Carbon (Total), lbs/MSCF (dry)	11.7
Dilution Gas Inlet, °F	250	Hydrogen (Total), lbs/MSCF (dry)	0.59
Air Inlet, °F	150	YIELDS AND BALANCES	
Retort Air Inlet, F	150	Oil Collected, Vol % RSFA	77.2
Heat of Comb. MBtu/ton RS	460	Oil in Gas**, Vol % RSFA	0.2
Heat Lost, MBtu/ton RS	-63	Oil in Spent Shale, Vol % RSFA	0.8
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	78.2
Fischer Assay, gal/ton RS	25.7	Carbonate Decomposition, %	35.5
Oil, Wt %	9.8	Water Recovered, lb/ton RS	102.8
Water, Wt %	1.1	Ash Balance, % - As Measured	-
Gas, Wt %	1.8	Ash Balance, % - Assumed	AS-100
Mineral CO ₂ , Wt %	17.2	Overall Balance, %	100.2
Ash, Wt %	68.8	Carbon Balance, % - Organic	88.5
Moisture, Wt % (Uncrushed)	0.70	Carbon Balance, % - Total	92.7
Carbon (Total), Wt %	16.0	Hydrogen Balance, % - Organic	81.3
Hydrogen (Total), Wt %	1.72	Hydrogen Balance, % - Total	97.9
Nominal Size Range, inches	1/4" - 1"	Water Balance, %	165.1
5 % passing thru	0.263	MISCELLANEOUS	
98 % passing thru	1.05	Avg. Retort ΔP, in H ₂ O/ft	0.47
D _a	0.610	ΔP Above Air Dist., in H ₂ O/ft	0.42
D _v	0.727	NaCl Soln., Wt %	-
Line Burner °F	800	NaCl Rate, gal/ton RS	-

Comments: Transition to 4 dilution rate (1250 SCF/T). Started using the small original reactor. Large reactor was unsatisfactory.

*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. Jones DATE June 20, 1967 OSRC-10 Revised 7/19/66

//A100

2080, C1040-5 6-2-67

A. YIELDS

FAY	7.715E 01	DRYGAS	6.257E 03	MISTFA	2.421E-01
H2	2.816E 02	OTHER	1.126E 02	UNRETC	8.269E-01
CH4	1.126E 02	OP	2.503E 01	SSY	8.104E 01
CO	1.752E 02	CO2DTC	3.545E 01	NH2O	1.023E 02
CO2	1.752E 03	OILCOOL	1.933E 01		

B. METERED GAS RATES

REGR	1.252E 04	DIL	1.576E 03	WVENTG	7.127E 03
AIR	4.379E 03	TREGR	1.410E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.947E 01	HWBT	4.626E 02	XWDG	3.170E 01
GBTU	7.393E 01				

D. COMBUSTION PRODUCTS

CO2C	5.544E 02	COG	1.011E 02	H2OOC	2.550E 01
CHR	9.033E 00	COMBOP	1.136E 01		

E. MATERIAL IN

ORGIN	2.275E 02	RSR	3.003E 02	ORH2IN	3.226E 01
MATIN	2.390E 03				

F. MATERIAL OUT

ORCOVG	4.035E 01	COKEC	2.333E 01	UNRETH	2.606E-01
ORCOOL	1.295E 02	ORH2VG	6.604E 00	COKEH	2.255E 00
UNRETC	3.065E 00	ORH2OL	1.710E 01	ORCOLP	5.693E 01
ORCVGP	1.774E 01	ORCSSP	1.332E 01	HCCVGP	5.373E 00

G. MATERIAL BALANCES

OVALL	1.002E 02	ORH2	8.126E 01	ORBAL	1.099E 02
ASH	0.0	TC	9.266E 01	WATER	1.651E 02
ORGC	3.343E 01	TM2	9.789E 01	GASL	3.449E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOKB	4.595E 05	QH2OC	8.363E 03	QAIR	6.205E 03
QPROP	4.937E 01	QOILC	1.079E 04	QRCYL	5.055E 04
QSUMIN	5.354E 05				

I. HEAT OUT

QMCOD	1.976E 05	QKEPOD	9.021E 04	QH2OV	4.206E 04
QLIHO	3.231E 03	QOPGAS	2.654E 04	QSS	2.346E 05
QGASL	4.601E 03	LELOSS	0.0	NETLOS	-6.340E 04
QSUMCT	5.354E 05				

J. MISCELLANEOUS

ORCSS	1.940E 00	VPCIL	7.723E-02	TGL	3.137E 05
VPM	2.204E 00	WCP	1.636E 01	PROP	1.539E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080,	C/040-5		6-2-67			
1	WRS 1.1	OLRS 9.8	TRS 81	B -1	MRS 16582.9	← RAW SHALE	
2	FA 25.7	GRS 1.9	CORS 17.2	XA 55.22			
3	ASRS 68.8	CRS 16.0	HRS 1.72	BP 24.23	TOG 138		
4	CRA 677.1	MFA 1.0	TA 150	PA 110	WA 0.14	LBHL 0	← AIR
5	CRRG 1751.1	MFRG 1.0	TRG 250	PRG 73	CRTG 0.0	MFTG 0.0	← RECYCLE A TOTAL GAS
6	CRDG 2.1	MFDG 129.5	TDG 250	PDG 64			← DILUTION G
7	P 2.4	TP 0.4	PP 130.5	W 116.9	N 0.0	← PROPANE A NUCLEATING AGENT	
8	WSS 0.4	OLSS 0.1	GSS 0.3	SS 0.0			← SPENT SHALE
9	COSS 13.7	ASSS 84.9	CSS 5.68	HSS 0.20	TSS 685		
10	OILLP 1277.0	COL 84.1	HOL 11.1	DOL 7.768	WLP 212.7	← LIQUID PRODUCT	
11	CRVG 1303.5	MFIG 1.0	TVG 250	WG 0.0	OILM 0.0	M 0	← VENT GAS
12	CG 11.7	H 0	COOG 28.0	OG 0.4	NG 61.7		
13	MEG 1.8	COG 2.8	HHG 4.5	OTG 1.8	HG 0.59		
14	CRVP 7.0	VPMF 1.83	TVP 132	PVP 161			← VENT PURGE
15	TVPC 75	VPOIL 38.5	VPW 8.6	GL 85.4			

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 Moist,
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 6-2-67

Run No. C1040-5

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

FISCHER ASSAY

<u>ET</u> <input checked="" type="checkbox"/> RAW SHALE	<u>ET</u> <input checked="" type="checkbox"/> SPENT SHALE	
<u>25.5</u>	<u>0.76</u> ^{0.2}	Gal/Ton
<u>.909</u>	<u>—</u>	S.G., g/ml
<u>9.7</u>	<u>0.1</u>	Oil, wt %
<u>1.8</u>	<u>0.4</u>	Water, wt %
<u>86.7</u>	<u>99.2</u>	Sp. Shale, wt %
<u>1.8</u>	<u>0.3</u>	Gas & Loss, wt %
<u>Slight</u>	<u>none</u>	COKING TENDENCY

RETORT SHALE MOISTURE

0.70 wt %

R RAW SHALE FISCHER ASSAY MOISTURE

0.69 wt %

MINERAL CO₂

<u>R</u> <input checked="" type="checkbox"/> <u>17.1</u>	<u>R</u> <input checked="" type="checkbox"/> <u>13.7</u>	wt %
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ASH (SHALE)

<u>ET</u> <input checked="" type="checkbox"/> <u>68.6</u>	<u>ET</u> <input checked="" type="checkbox"/> <u>84.9</u>	wt %
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MOISTURE

<u>R</u> <input checked="" type="checkbox"/> <u>0.34</u>	<u>ET</u> <input checked="" type="checkbox"/> <u>0.11</u>	wt %
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SHALE RICHNESS DISTRIBUTION
(See attached graph)

CARBON

<u>R</u> <input checked="" type="checkbox"/> <u>15.9</u>	<u>R</u> <input checked="" type="checkbox"/> <u>5.68</u>	wt %
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SCREEN ANALYSIS
(See back of this sheet)

HYDROGEN

<u>R</u> <input checked="" type="checkbox"/> <u>1.71</u>	<u>R</u> <input checked="" type="checkbox"/> <u>0.20</u>	wt %
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BENZENE EXTRACTABLES

<input type="checkbox"/> <u>—</u>	<input type="checkbox"/> <u>—</u>	wt %
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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 JUN 8 1967

CHECKED BY PCP

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-2-67

Run No. C1040-5

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

WATER, wt %

GRAVITY, °API

OIL ASH, wt %

	1	2	3	4	1	2
WATER, wt %	3.0	 	 	 		
GRAVITY, °API	20.2	 	 	 		
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g

WATER VOL, ml

GRAVITY OIL, °API

2161.5
524.4

0.0

42.6

VENT GAS

MAJOR COMPONENTS

C₁ thru C₄, plus n-Pentane

CO₂ 28.0 vol %

O₂ 0.4 "

N₂ 61.0 "

CH₄ 1.8 "

CO 2.8 "

H₂ 4.5 "

Ar 0.7 "

Others 1.8 "

CH₄ vol %

C₂H₄-C₂H₆ "

C₃H₈ "

C₃H₆ "

i C₄H₁₀ "

n C₄H₁₀ "

∅C₃H₆ "

n C₅H₁₂ "

CARBON, 11.7 lbs/MSCFDG

HYDROGEN, 0.59 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUN 5 1967

CHECKED BY REP

OSRC-12B

SCREEN ANALYSIS DATA SHEET (TY-LAB)

81.9

RUN NO. C1040 SAMPLE NO. # 5 DATE 6-2-69
 UNIT RETORT #3 DESCRIPTION TYLAB
 APPROX. SHALE SIZE 1/4" TO 1" SHAKING TIME 10 MIN. ANALYSIS BY STRATTON & SMITH
 TOTAL SAMPLE WT. GROSS 88.2 - TARE -6.6 = NET 82.1

004123

SCREEN SIZE			WEIGHTS								
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED	SCREEN SIZE	Di *	1/Di	% RETAINED	CUM. % RETAINED	% PASSING
	4.25					4.25					
	3.00					3.00	(3.125)	(0.3200)			
	2.50					2.50	(2.625) 2.750	(0.3809) 0.3636			
	2.00					2.00	2.250	0.4444			
	1.50					1.50	1.750	0.5714			
	1.05		25.4	19.2	6.2	1.05	(1.087) 1.275	(0.9199) 0.7843	7.55		92.44
	0.742		57.8	20.5	37.3	0.742	0.896	1.116	45.43		47.01
	0.525		37.7	18.5	19.2	0.525	0.634	1.577	23.39		23.62
	0.371		27.2	19.3	7.9	0.371	0.448	2.232	9.62		14.00
	0.263	3	25.9	18.4	7.5	0.263	0.317	3.154	9.14		4.86
	0.185	4	21.7	19.4	2.3	0.185	0.224	4.464	2.80		2.06
	0.131	6	19.7	19.3	.4	0.131	0.158	6.329	0.49		1.57
	0.093	8	20.6	20.5	.1	0.093	0.112	8.928	0.12	98.54	1.45
	0.065	10	19.4	19.2	.2	0.065			0.24		1.21
	PAN		21.8	21.0	.8	PAN			0.97		0.24
TOTAL ON SCREENS AND PAN					81.9	LOSS			0.24		0.00
LOSS (BY DIFFERENCE)					.2	TOTAL			99.99	-	-
TOTAL SAMPLE WEIGHT					82.1				-	-	-

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

REMARKS: _____

$\sum_{+8m}^m Di$	0.71667	$\sum_{+8m}^m Xi$	
$1/\sum_{+8m}^m Di$	1.61502	$\sum_{+8m}^m Xi / Di$	
D_a	0.61014	$\sum_{+8m}^m Xi Di$	
D_v	0.72728		