

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513017010

Date 6-3-67

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

GENERAL		SPENT SHALE PROPERTIES	
Run No.	C1040-7	Fischer Assay, Gal/ton	0.4
Length, hours	12	Mineral CO ₂ , Wt %	13.4
Retort Type Number	RC-VII	Ash, Wt %	84.9
Oil Recovery System Number	C-1	Carbon (total), Wt %	5.00
70ns Total Raw Shale Charged, lbs.	95.61	Organic Carbon, Wt %	1.34
Bed Height above Dist., ft	5 1/2'	Hydrogen (total), Wt %	0.22
Type Air Dist.	A0-X	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	8'	Oil, Wt %	99.7
RATES AND QUANTITIES		Density, lb/gal	7.788
Raw Shale, lbs/(hr)(ft ²)	289	Gravity, API	19.8
Spent Shale, % of RS	80.1	Ash, Wt %	-
Liquid Product, lbs/hr	1814.7	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	23.8	Water Vapor, lbs/MSCF (dry)	1.3
Air, SCF/ton RS (dry)	5020	Oil, lbs/MSCF (dry)**	0.059
Total Recycle*, SCF/ton RS (wet)	14700	Analysis (dry)	
Dilution, SCF/ton RS (wet)	1340	CO ₂ , Vol %	27.4
Calc. Vent Gas SCF/ton RS (dry)	6650	O ₂ , Vol %	0.2
Gas Losses, SCF/ton RS (wet)	428	N ₂ + Argon, Vol %	59.8
Propane, SCF/ton RS	19.0	CH ₄ , Vol %	1.6
TEMPERATURES AND HEAT BALANCE		CO, Vol %	3.2
Retort Offgas, °F	136	H ₂ , Vol %	4.6
Spent Shale, F	623	Other, Vol %	3.2
Raw Shale, °F	83	Gross Heating Value (calc), Btu/SCF	49.9
Recycle Gas Inlet, °F	250	Carbon (Total), lbs/MSCF (dry)	10.3
Dilution Gas Inlet, °F	250	Hydrogen (Total), lbs/MSCF (dry)	0.49
Air Inlet, °F	148	YIELDS AND BALANCES	
Retort Air Inlet, F	148	Oil Collected, Vol % RSFA	88.4
Heat of Comb. MBtu/ton RS	482	Oil in Gas**, Vol % RSFA	0.2
Heat Lost, MBtu/ton RS	-39	Oil in Spent Shale, Vol % RSFA	1.6
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	90.2
Fischer Assay, gal/ton RS	26.9	Carbonate Decomposition, %	38.3
Oil, Wt %	10.3	Water Recovered, lb/ton RS	98.9
Water, Wt %	1.1	Ash Balance, % - As Measured	-
Gas, Wt %	2.1	Ash Balance, % - Assumed	RS-100
Mineral CO ₂ , Wt %	17.4	Overall Balance, %	101.0
Ash, Wt %	68.0	Carbon Balance, % - Organic	89.3
Moisture, Wt % (Uncrushed)	1.03	Carbon Balance, % - Total	93.4
Carbon (Total), Wt %	16.4	Hydrogen Balance, % - Organic	94.0
Hydrogen (Total), Wt %	1.70	Hydrogen Balance, % - Total	104.5
Nominal Size Range, inches	1/4"-1"	Water Balance, %	131.6
5 % passing thru	0.263	MISCELLANEOUS	
98 % passing thru	1.05	Avg. Retort ΔP, in H ₂ O/ft	0.43
Da	0.593	ΔP Above Air Dist., in H ₂ O/ft	0.42
Dv	0.708	NaCl Soln., Wt %	-
Line Burner °F	800	NaCl Rate, gal/ton RS	-

Comments: Difficulties in maintaining a low and constant temperature in retort. Fluctuations in pressures due to dilution burning in low burner level air headers.

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

Oil
Dec/97

//4100

2080, C1040-7 6-3-67

A. YIELDS

FAY	8.837E 01	DRYGAS	6.848E 03	MISTFA	1.889E-01
H2	3.053E 02	OTHER	2.127E 02	UNRETO	1.553E 00
CH4	1.064E 02	O2	1.330E 01	SSY	8.009E 01
CO	2.127E 02	CO2DEC	3.232E 01	WH2O	9.889E 01
CO2	1.821E 03	OILCOL	9.877E 01		

B. METERED GAS RATES

RECG	1.336E 04	DIL	1.839E 03	VENTG	7.527E 03
AIR	5.024E 03	TRECG	1.479E 04	ICF	0.0

C. VOL WT & HEATING VALUE OF VENT GAS

MMWG	2.932E 01	MMGT	3.390E 02	MMWG	3.155E 01
GBIU	4.994E 01				

D. COMBUSTION PRODUCTS

CO2C	6.150E 02	COO	1.954E 02	H2OC	3.154E 01
CHR	7.233E 00	COMBCP	1.024E 01		

E. MATERIAL IN

ORGCIN	2.348E 02	PSR	2.836E 02	GRH2IN	3.194E 01
MATIN	2.403E 03				

F. MATERIAL OUT

ORCOVC	3.243E 01	COYEC	1.824E 01	UNRETE	3.829E-01
ORCOOL	1.557E 02	ORH2VG	6.845E 00	COYEH	2.245E 00
UNRETC	3.255E 00	ORNGOL	2.055E 01	ORCOLP	6.632E 01
ORCVCP	1.371E 01	ORCSSP	9.154E 00	HCCVCP	2.873E 00

G. MATERIAL BALANCES

OVALL	1.010E 02	ORH2	9.409E 01	ORBAL	1.053E 02
ASH	0.0	TC	9.333E 01	WATER	1.316E 02
ORGC	8.929E 01	THP	1.045E 02	CASL	4.283E 02
ASHB	-1.000E 00				

H. HEAT IN

QCCMB	4.817E 05	QH2OC	1.033E 04	QAIR	6.019E 03
QPROP	5.843E 01	QOILC	1.296E 04	QCYL	5.254E 04
QSUMIN	5.636E 05				

I. HEAT OUT

QWCC2D	2.160E 05	QKEROD	9.726E 04	QH2OV	4.856E 04
QLICO	3.611E 03	QOF046	2.569E 04	QSS	2.058E 05
QGASL	5.155E 03	LBLOSS	0.0	NETLOS	-3.752E 04
QSUMOT	5.636E 05				

J. MISCELLANEOUS

ORCSS	1.349E 00	VPOIL	5.932E-02	TCL	3.207E 03
VPC	9.356E 00	ICF	1.644E 01	RECP	1.897E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080,	C 1040-7		6-3-67			
1	WRS	OLRS	TRS	B	MRS	← RAW SHALE	
	1.1	10.3	83	-1	15935.4		
2	FA	GRS	CORS	XA			
	26.9	2.1	17.4	55.22			
3	ASRS	CRS	HRS	BP	TOG		
	68.0	16.4	1.70	24.10	136		
4	CRA	MFA	TA	PA	WA	LBHL	← AIR
	671.8	1.0	148	117	0.14	0	
5	CRRG	MFRG	TRG	PRG	CRTG	MFTG	← RECYCLE A TOTAL GAS
	1795.5	1.0	250	73	0.0	0.0	
6	CRDG	MFDG	TDG	PDG			← DILUTION C
	1.7	129.5	250	71			
7	P	TP	PP	W	N		← PROPANE A NUCLEATING AGENT
	2.9	0.4	132.2	165.8	0.0		
8	WSS	OLSS	GSS	SS			← SPENT SHALE
	0.5	0.2	0.1	0.0			
9	COSS	ASSS	CSS	HSS	TSS		
	13.4	84.9	5.00	0.22	623		
10	OILLP	COL	HOL	DOL	WLP		← LIQUID PRODUCT
	1475.2	84.1	11.1	7.722	139.5		
11	CRVG	MFIG	TVG	WG	OILM	M	← VENT GAS
	1262.9	1.0	250	0.0	0.0	0	
12	CG	H	COOG	OG	NG		
	10.3	0	27.4	0.2	59.8		
13	MEG	COG	HHG	OTG	HG		
	1.6	3.2	4.6	3.2	0.49		
14	CRVP	VPMF	TVP	PVP			← VENT PURGE
	5.8	1.83	135	177			
15	TVPC	VPOIL	VPW	GL			
	75	27.3	8.1	69.5			

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 6-2-67

Run No. E1040-7

Sample Time: RS 1815; SS 2315

FISCHER ASSAY

<input checked="" type="checkbox"/> RAW SHALE	<input checked="" type="checkbox"/> SPENT SHALE	
<u>26.7</u>	<u>0.4</u>	Gal/Ton
<u>.912</u>	<u>—</u>	S.G., g/ml
<u>11.2</u>	<u>0.2</u>	Oil, wt %
<u>1.7</u>	<u>0.5</u>	Water, wt %
<u>86.0</u>	<u>99.2</u>	Sp. Shale, wt %
<u>2.1</u>	<u>0.1</u>	Gas & Loss, wt %
<u>SLIGHT</u>	<u>none</u>	COKING TENDENCY

RETORT SHALE MOISTURE
1.03 wt %

RAW SHALE FISCHER ASSAY MOISTURE
0.63 wt %

MINERAL CO₂

<input checked="" type="checkbox"/> <u>17.3</u>	<input checked="" type="checkbox"/> <u>13.4</u>	wt %
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ASH (SHALE)

<input checked="" type="checkbox"/> <u>67.8</u>	<input checked="" type="checkbox"/> <u>84.9</u>	wt %
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MOISTURE

<input checked="" type="checkbox"/> <u>0.29</u>	<input checked="" type="checkbox"/> <u>0.08</u>	wt %
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CARBON

<input checked="" type="checkbox"/> <u>16.4</u>	<input checked="" type="checkbox"/> <u>5.00</u>	wt %
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HYDROGEN

<input checked="" type="checkbox"/> <u>1.70</u>	<input checked="" type="checkbox"/> <u>0.22</u>	wt %
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BENZENE EXTRACTABLES

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

CHECKED BY RIP

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-3-67

Run No. C1040-7

BKM
⊕

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>1</u>	<u>2</u>
WATER, wt %	<u>0.30</u>	 	 	 	 	
GRAVITY, °API	<u>19.8</u>	 	 	 	 	
<input type="radio"/> CHL. ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

BKM
⊕

VENT PURGE PRODUCT

OIL WT, g 327.0
 WATER VOL, ml 40.0
 GRAVITY OIL, °API 41.6

ET
⊕

VENT GAS

MAJOR COMPONENTS

CO₂ 27.4 vol %
 O₂ 0.2 "
 N₂ 59.1 "
 CH₄ 1.6 "
 CO 3.2 "
 H₂ 4.6 "
 Ar 0.7 "
 Others 3.2 "

C₁ thru C₄, plus n-Pentane

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

BKM
⊕

CARBON, 10.3 lbs/MSCFDG

BKM

HYDROGEN, 0.49 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUN 5 1967

CHECKED BY RET

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1000-7 SAMPLE NO. 7 DATE 6-3-67

UNIT Retent 3 DESCRIPTION TY Lab

APPROX. SHALE SIZE 1-1 SHAKING TIME 10 min ANALYSIS BY Smith & Stratton

TOTAL SAMPLE WT. GROSS 90.8 - TARE 6.0 = NET 84.8

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					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	77.36		92.65
	0.742		55.4	20.8	34.6	0.742	0.896	1.116	41.09		51.56
	0.525		39.8	18.5	21.3	0.525	0.634	1.577	25.30		26.26
	0.371		20.2	19.3	0.9	0.371	0.448	2.232	10.57		15.69
	0.263	3	27.3	18.4	8.9	0.263	0.317	3.154	10.57		5.12
	0.185	4	22.1	19.4	2.7	0.185	0.224	4.464	3.21		1.91
	0.131	6	19.7	19.4	0.3	0.131	0.158	6.329	0.36		1.55
	0.093	8	20.5	20.5	0.0	0.093	0.112	8.928	0.00	98.46	1.55
	0.065	10	19.4	19.2	0.2	0.065			0.24		1.31
	PAN		22.0	20.9	1.1	PAN			1.31	100.01	0.00
TOTAL ON SCREENS AND PAN					84.2	LOSS					
LOSS (BY DIFFERENCE)					0.6	TOTAL		100.01			
TOTAL SAMPLE WEIGHT					84.8						

004135

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

REMARKS: _____

$\sum_{+8m}^m D_i$	6.69719	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	1.66063	$\sum_{+8m}^m X_i / D_i$	
D_a	0.5929	$\sum_{+8m}^m X_i D_i$	
D_v	0.70809		