

1513017018

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

Date 6-5-67

Purpose: *To determine operability and yield without delubrication from using ty-1 rock shale.*

GENERAL		SPENT SHALE PROPERTIES	
Run No.	C1041-2	Fischer Assay, Gal/ton	2.2
Length, hours	12	Mineral CO ₂ , Wt %	15.1
Retort Type Number	RC-144	Ash, Wt %	80.3
Oil Recovery System Number	C-1	Carbon (total), Wt %	8.41
Total Raw Shale Charged, lbs.	97.43	Organic Carbon, Wt %	4.29
Bed Height above Dist., ft	5 1/2'	Hydrogen (total), Wt %	0.55
Type Air Dist.	A0-X	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6'	Oil, Wt %	93.2
RATES AND QUANTITIES		Density, lb/gal	7.788
Raw Shale, lbs/(hr)(ft ²)	294	Gravity, API	17.8
Spent Shale, % of RS	82.3	Ash, Wt %	-
Liquid Product, lbs/hr	1615.6	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	22.1	Water Vapor, lbs/MSCF (dry)	8.5
Air, SCF/ton RS (dry)	4170	Oil, lbs/MSCF (dry)**	0.084
Total Recycle*, SCF/ton RS (wet)	12900	Analysis (dry)	
Dilution, SCF/ton RS (wet)	-	CO ₂ , Vol %	24.1
Calc. Vent Gas SCF/ton RS (dry)	5480	O ₂ , Vol %	0.5
Gas Losses, SCF/ton RS (wet)	153	N ₂ + Argon, Vol %	60.2
Propane, SCF/ton RS	-	CH ₄ , Vol %	2.2
TEMPERATURES AND HEAT BALANCE		CO, Vol %	4.0
Retort Offgas, °F	135	H ₂ , Vol %	5.5
Spent Shale, F	594	Other, Vol %	3.5
Raw Shale, °F	85	Gross Heating Value (calc), Btu/SCF	90.9
Recycle Gas Inlet, °F	250	Carbon (Total), lbs/MSCF (dry)	10.9
Dilution Gas Inlet, °F	-	Hydrogen (Total), lbs/MSCF (dry)	0.79
Air Inlet, °F	141	YIELDS AND BALANCES	
Retort Air Inlet, F	141	Oil Collected, Vol % RSFA	70.0
Heat of Comb. MBtu/ton RS	394	Oil in Gas**, Vol % RSFA	0.2
Heat Lost, MBtu/ton RS	-66	Oil in Spent Shale, Vol % RSFA	5.5
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	75.7
Fischer Assay, gal/ton RS	31.6	Carbonate Decomposition, %	27.7
Oil, Wt %	12.0	Water Recovered, lb/ton RS	91.7
Water, Wt %	0.8	Ash Balance, % - As Measured	-
Gas, Wt %	2.5	Ash Balance, % - Assumed	RS/100
Mineral CO ₂ , Wt %	17.2	Overall Balance, %	99.6
Ash, Wt %	66.1	Carbon Balance, % - Organic	89.1
Moisture, Wt % (Uncrushed)	1.38	Carbon Balance, % - Total	91.8
Carbon (Total), Wt %	18.7	Hydrogen Balance, % - Organic	91.9
Hydrogen (Total), Wt %	2.0	Hydrogen Balance, % - Total	96.5
Nominal Size Range, inches	1/4" - 1"	Water Balance, %	108.1
5 % passing thru	0.263	MISCELLANEOUS	
98 % passing thru	1.05	Avg. Retort ΔP, in H ₂ O/ft	0.31
Da	0.633	ΔP Above Air Dist., in H ₂ O/ft	0.22
Dv	0.745	NaCl Soln., Wt %	-
		NaCl Rate, gal/ton RS	-

Comments: *Necessary to adjust air and recycle to keep temperature distribution under control. FA = 31.6 gal/T. Operations were unstable probably due to large organic in bag.*

*Measured Recycle + Dilution Gas

** Oil Mist + Condensibles to 75 °F *which gave low pressure drop result in poor air distribution and unit was shut down - NO clinker*

*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed

Earl E. Jumper

DATE

June 20, 1967

Oil
10/10/67

//A100
2080, C1041-2 5-5-67

A. YIELDS

FAY	6.997E 01	DRYGAS	5.430E 03	NISTFA	1.559E-01
H2	3.014E 00	OTHER	1.918E 02	UNRETC	5.433E 00
CH4	1.205E 02	C2	2.743E 01	SSY	8.232E 01
CO	2.192E 02	CO2DEC	2.773E 01	MH2O	5.157E 01
CO2	1.321E 03	CILCCL	2.211E 01		

B. MEASURED GAS RATES

FEED	1.230E 04	DIL	0.0	VENTG	6.302E 03
AIR	4.150E 03	TRCG	1.239E 04	IGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.284E 01	HVGI	4.981E 02	MWDC	3.075E 01
GSTU	9.090E 01				

D. COMBUSTION PRODUCTS

CO2C	4.265E 02	CO	1.975E 02	H2OC	3.099E 01
CHR	5.687E 00	COMBOP	7.062E 00		

E. MATERIAL IN

ORCOIN	2.301E 02	PSR	2.941E 02	ORH2 IN	3.521E 01
MATIN	2.342E 03				

F. MATERIAL OUT

ORCOVB	3.410E 01	COXEC	4.372E 01	UNRETH	1.927E 00
ORCCOL	1.442E 02	ORH2VB	7.854E 00	COMEH	6.206E 00
UNRETC	2.027E 01	ORH2CL	1.911E 01	ORCCLP	5.171E 01
ORCVSP	1.217E 01	ORCSSP	2.520E 01	HCCVSP	5.111E 00

G. MATERIAL BALANCES

OVALL	9.956E 01	ORH2	9.197E 01	ORRAL	1.018E 02
ASH	0.0	TC	9.152E 01	WATER	1.021E 02
ORGO	8.202E 01	TH2	9.554E 01	GASL	1.532E 02
ASNB	-1.000E 00				

H. HEAT IN

QCOMB	3.941E 05	QR2CC	1.052E 04	QAIR	4.302E 03
QPROP	0.0	QOILC	1.205E 04	QRCYL	4.532E 04
QSUMIN	4.655E 05				

I. HEAT OUT

QR2CO2D	1.546E 05	QR2ROD	9.954E 04	QR2CV	4.778E 04
QLIRO	3.171E 03	QCPGAS	2.100E 04	QSS	2.049E 05
QASL	1.753E 03	LBLOSS	0.0	HEILO5	-6.621E 04
QSUMGT	4.665E 05				

J. MISCELLANEOUS

ORCOVB	4.222E 00	MR2IL	7.304E-02	TRL	2.201E 03
UNRETC	5.515E 00	MR2C	1.519E 01	PROP	0.0

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	← USER IDENTIFICATION →					
0	2080,	C 1041-2		6-5-67			
1	WRS	QLRS	TRS	B	MRS	← RAW SHALE	
	0.8	12.0	85	-1	16239.1		
2	FA	GRS	CORS	XA			
	31.6	2.5	17.2	55.22			
3	ASRS	CRS	HRS	BP	TOG		
	66.1	18.7	2.0	24.10	135		
4	CRA	MFA	TA	IPA	WA	LBHL	← AIR
	568.1	1.0	141	105	0.14	0	
5	CRRG	MFRG	TRG	PRG	CRTG	MFTG	← RECYCLE A TOTAL GAS
	175.1	1.0	250	75	0.0	0.0	
6	CRDG	MFDG	TDG	PDG			← DILUTION G
	0.0	0.0	0	0			
7	P	TP	PP	W	N		← PROPANE A NUCLEATING AGENT
	0.0	0	0	227.2	0.0		
8	WSS	OLSS	GSS	SS			← SPENT SHALE
	0.5	0.8	1.7	0.0			
9	COSS	ASSS	CSS	HSS	TSS		
	15.1	80.3	8.41	0.55	594		
10	OILLP	COL	HOL	DOL	WLP		← LIQUID PRODUCT
	1398.2	84.1	11.1	7.788	217.4		
11	CRVG	MFVG	TVG	WG	OILM	M	← VENT GAS
	908.6	1.0	250	0.0	0.0	0	
12	CG	H	COOG	OG	NG		
	10.9	0	24.1	0.5	60.2		
13	MEG	COG	HHG	OTG	HG		
	2.2	4.0	5.5	3.5	0.79		
14	CRVP	VPMF	TVP	PVP			← VENT PURGE
	6.0	1.83	152	179			
15	TVPC	VPOIL	VPW	GL			
	75	39.3	7.4	89.9			

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 6-5-67

Run No. C1091-2

Sample Time: RS 18:15; SS 21:00

FISCHER ASSAY

<input checked="" type="checkbox"/> RAW SHALE	<input checked="" type="checkbox"/> SPENT SHALE	
<u>31.3</u>	<u>2.2</u>	Gal/Ton
<u>.912</u>	<u>—</u>	S.G., g/ml
<u>11.9</u>	<u>0.8</u>	Oil, wt %
<u>1.7</u>	<u>0.5</u>	Water, wt %
<u>83.9</u>	<u>97.0</u>	Sp. Shale, wt %
<u>2.5</u>	<u>1.7</u>	Gas & Loss, wt %
<u>Slight</u>	<u>None</u>	COKING TENDENCY

RETORT SHALE MOISTURE
1.38 wt %

RAW SHALE FISCHER ASSAY MOISTURE
0.90 wt %

MINERAL CO₂

<input checked="" type="checkbox"/> <u>17.1</u>	<input checked="" type="checkbox"/> <u>15.1</u>	wt %
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ASH (SHALE)

<input checked="" type="checkbox"/> <u>65.3</u>	<input checked="" type="checkbox"/> <u>80.3</u>	wt %
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MOISTURE

<input checked="" type="checkbox"/> <u>0.119</u>	<input checked="" type="checkbox"/> <u>0.09</u>	wt %
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CARBON

<input checked="" type="checkbox"/> <u>18.6</u>	<input checked="" type="checkbox"/> <u>8.41</u>	wt %
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HYDROGEN

<input checked="" type="checkbox"/> <u>2.00</u>	<input checked="" type="checkbox"/> <u>0.55</u>	wt %
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BENZENE EXTRACTABLES

<input type="checkbox"/> <u>.</u>	<input 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 RS SAMPLE REC'D IN LAB
 @ 22:15 - SS SAMPLE REC'D @ 22:1

DATE COMPLETED JUN 9 1967

CHECKED BY REP

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-5-67

Run No. C-1041-2

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>1</u>	<u>2</u>
<input checked="" type="checkbox"/> WATER, wt %	<u>6.8</u>					
<input checked="" type="checkbox"/> GRAVITY, °API	<u>19.8</u>					
<input type="checkbox"/> OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

BMM
 OIL WT, g 471.8
 WATER VOL, ml 78.0
 GRAVITY OIL, °API 41.4

VENT GAS

MAJOR COMPONENTS

C₁ thru C₁₁, plus n-Pentane

EA
 CO₂ 24.1 vol %
 O₂ 0.5 "
 N₂ 59.5 "
 CH₄ 2.2 "
 CO 4.0 "
 H₂ 5.5 "
 Ar 0.7 "
 Others 3.5 "

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

EA CARBON, 10.9 lbs/MSCFDG

EA HYDROGEN, 0.79 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUN 8 1967

CHECKED BY PPD

OSRC-12B

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C7041-2 SAMPLE NO. #2 DATE 6-5-67
 UNIT Retort 3 DESCRIPTION Hydro
 APPROX. SHALE SIZE _____ SHAKING TIME 10 ANALYSIS BY Smith et al
 TOTAL SAMPLE WT. GROSS 67.5 - TARE 6.6 = NET 61.4

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		24.3	19.2	5.1	1.05	(1.087) 1.275	(0.9199) 0.7843			
	0.742		44.0	20.5	23.5	0.742	0.896	1.116			
	0.525		32.4	18.5	13.9	0.525	0.634	1.577			
	0.371		24.5	19.2	5.3	0.371	0.448	2.232			
	0.263	3	26.1	18.4	7.7	0.263	0.317	3.154			
	0.185	4	22.3	19.3	3.0	0.185	0.224	4.464			
	0.131	6	19.9	19.3	.6	0.131	0.158	6.329			
	0.093	8	20.5	20.5	0	0.093	0.112	8.928			
	0.065	10	19.5	19.2	.3	0.065					
	PAN		23.4	20.9	2.5	PAN					
TOTAL ON SCREENS AND PAN					61.4	LOSS					
LOSS (BY DIFFERENCE)					0	TOTAL					
TOTAL SAMPLE WEIGHT					61.4						

004159

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

REMARKS: _____

$\sum_{+8m}^m D_i$	$\sum_{+8m}^m X_i$
$1/\sum_{+8m}^m D_i$	$\sum_{+8m}^m X_i / D_i$
D_a	$\sum_{+8m}^m X_i D_i$
D_v	

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1041-2 SAMPLE NO. 2 DATE 6-5-67

UNIT Net wt 3 DESCRIPTION TY Lab

APPROX. SHALE SIZE _____ SHAKING TIME _____ ANALYSIS BY Stratton / Smith

TOTAL SAMPLE WT. GROSS 67.5 - TARE 5.6 = NET 61.9

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	(1.067) 1.275	(0.9199) 0.7843	10.13		89.87
	0.742		47.2	20.5	26.7	0.742	0.896	1.116	43.63		46.24
	0.525		34.4	18.5	15.9	0.525	0.634	1.577	26.63		19.61
	0.371		24.1	13.2	10.9	0.371	0.448	2.232	8.82		10.79
	0.263	3	22.4	19.4	3.0	0.263	0.317	3.154	6.54		4.25
	0.185	4	20.2	19.3	0.9	0.185	0.224	4.464	2.45		1.80
	0.131	6	19.0	19.3	0.2	0.131	0.158	6.329	0.33		1.47
	0.093	8	19.5	19.3	0.2	0.093	0.112	8.928	0.33	98.86	1.14
	0.065	10	19.3	19.3	0.0	0.065			0.00		1.14
	PAN		21.6	20.9	0.7	PAN			1.14		0.00
TOTAL ON SCREENS AND PAN					61.2	LOSS			—	—	—
LOSS (BY DIFFERENCE)					0.7	TOTAL			100.00	—	—
TOTAL SAMPLE WEIGHT					61.9				—	—	—

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

REMARKS: _____

$\sum_{+8m}^m Di$	0.73650	$\sum_{+8m}^m Xi$	
$1/\sum_{+8m}^m Di$	1.56290	$\sum_{+8m}^m Xi / Di$	
Da	0.63254	$\sum_{+8m}^m Xi Di$	
Dv	0.74499		