

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513020006

Date 8-2-67

Purpose: To test the hypothesis of removing liquid as a sidestream from the shale bed.

GENERAL		SPENT SHALE PROPERTIES	
Run No.	R-1 C1054-2	Fischer Assay, Gal/ton	4.7
Length, hours	12	Mineral CO ₂ , Wt %	17.4
Retort Type Number	RC IX	Ash, Wt %	78.4
Oil Recovery System Number	C-5	Carbon (total), Wt %	8.95
Tons Total Raw Shale Charged, lbs.	163.1	Organic Carbon, Wt %	4.20
Bed Height above Dist., ft	6 1/2'	Hydrogen (total), Wt %	0.44
Type Air Dist.	XIII	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6'	Oil, Wt %	96.0
RATES AND QUANTITIES		Density, lb/gal	7.288
Raw Shale, lbs/(hr)(ft ²)	4.92	Gravity, API	19.8
Spent Shale, % of RS	82.9	Ash, Wt %	-
Liquid Product, lbs/hr	2373.2	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	21.5	Water Vapor, lbs/MSCF (dry)	11.6
Air, SCF/ton RS (dry)	4360	Oil, lbs/MSCF (dry)**	
Total Recycle*, SCF/ton RS (wet)	15300	Analysis (dry)	
Dilution, SCF/ton RS (wet)	-	CO ₂ , Vol %	25.3
Calc. Vent Gas SCF/ton RS (dry)	5690	O ₂ , Vol %	0.4
Gas Losses, SCF/ton RS (wet)	727	N ₂ + Argon, Vol %	60.7
Propane, SCF/ton RS	-	CH ₄ , Vol %	1.7
TEMPERATURES AND HEAT BALANCE		CO, Vol %	2.9
Retort Offgas, °F	160	H ₂ , Vol %	4.4
Spent Shale, °F	469	Other, Vol %	4.6
Raw Shale, °F	74	Gross Heating Value (calc), Btu/SCF	128.9
Recycle Gas Inlet, °F	225	Carbon (Total), lbs/MSCF (dry)	12.8
Dilution Gas Inlet, °F	-	Hydrogen (Total), lbs/MSCF (dry)	0.92
Air Inlet, °F	154	YIELDS AND BALANCES	
Retort Air Inlet, °F	154	Oil Collected, Vol % RSFA	74.5
Heat of Comb. MBtu/ton RS	420	Oil in Gas**, Vol % RSFA	1.2
Heat Lost, MBtu/ton RS	0.3	Oil in Spent Shale, Vol % RSFA	13.6
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	89.3
Fischer Assay, gal/ton RS	28.9	Carbonate Decomposition, %	26.0
Oil, Wt %	11.0	Water Recovered, lb/ton RS	81.1
Water, Wt %	0.6	Ash Balance, % - As Measured	-
Gas, Wt %	2.4	Ash Balance, % - Assumed	85/100
Mineral CO ₂ , Wt %	19.5	Overall Balance, %	100.7
Ash, Wt %	65.0	Carbon Balance, % - Organic	99.4
Moisture, Wt % (Uncrushed)	Est. 1.10	Carbon Balance, % - Total	99.5
Carbon (Total), Wt %	18.3	Hydrogen Balance, % - Organic	95.4
Hydrogen (Total), Wt %	1.85	Hydrogen Balance, % - Total	102.4
Nominal Size Range, inches	1/4" - 1"	Water Balance, %	122.7
5 % passing thru	0.263	MISCELLANEOUS	
98 % passing thru	1.05	Avg. Retort ΔP, in H ₂ O/ft	1.11
D _a	0.629	ΔP Above Air Dist., in H ₂ O/ft	1.65
D _v	0.723	Pressure Above Deck - PI-8 - "H ₂ O	2.0
		Pressure Below Deck - PI-10 - "H ₂ O	7.5

Comments: Estimated 2 to 5% of liquid product withdrawn from liquid removal system.

*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 Carl E. Jones

DATE Aug. 9 1967

//A100

3080, C1054-2 R-1 8-2-67

A. YIELDS

FAY	7.447E 01	DRYGAS	5.686E 03	MISTFA	1.197E 00
H2	2.502E 02	OTHER	2.616E 02	UNRETO	1.357E 01
CH4	9.666E 01	O2	2.274E 01	SSY	8.291E 01
CO	1.649E 02	CO2DEC	2.602E 01	MH2O	8.109E 01
CO2	1.439E 03	OILCOL	2.152E 01		

B. METERED GAS RATES

RECG	1.528E 04	DIL	0.0	WVENTG	6.343E 03
AIR	4.362E 03	TRECG	1.528E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.886E 01	HVGT	7.329E 02	MWDG	3.150E 01
GBTU	1.289E 02				

D. COMBUSTION PRODUCTS

CO2C	4.957E 02	COC	1.443E 02	H2OC	3.125E 01
CHR	5.785E 00	COMBCP	7.817E 00		

E. MATERIAL IN

ORGCIN	2.595E 02	RSR	4.923E 02	ORH2IN	3.566E 01
MATIN	2.357E 03				

F. MATERIAL OUT

ORGCVG	4.737E 01	COKEC	4.048E 01	UNRETH	3.506E 00
ORGCOL	1.410E 02	ORH2VG	9.033E 00	COKEH	2.862E 00
UNRETC	2.916E 01	ORH2OL	1.860E 01	ORCOLP	5.431E 01
ORCVGP	1.825E 01	ORCSSP	2.683E 01	HCCVGP	1.043E 01

G. MATERIAL BALANCES

OVALL	1.007E 02	ORH2	9.537E 01	O2BAL	1.037E 02
ASH	0.0	TC	9.956E 01	WATER	1.227E 02
ORGC	9.940E 01	TH2	1.024E 02	GASL	7.266E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.198E 05	QH2OC	1.070E 04	QAIR	6.431E 03
QPROP	0.0	QOILC	1.173E 04	QRCYL	4.992E 04
QSUMIN	4.986E 05				

I. HEAT OUT

QMC02D	1.644E 05	QKEROD	9.062E 04	QH2OV	3.706E 04
QLIQO	5.370E 03	QOFGAS	3.992E 04	QSS	1.544E 05
QGASL	6.475E 03	LBLOSS	0.0	HETLOS	3.355E 02
QSUMOT	4.986E 05				

J. MISCELLANEOUS

ORCSS	4.200E 00	VPOIL	4.739E-01	TGL	5.324E 03
VPM	1.157E 01	WCG	1.958E 01	PROP	0.0

END MESSAGE

END OUTPUT

-GOODBYE
-GOODBYE

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION				
0	2080, 3080,	C1054-2	R-1	8-2-67		
1	WRS 0.6 H ₂ O, WT % FA	OLRS 11.0 OIL, WT % GRS	TRS 74 TEMP., °F CRS	B -1 XA	MRS 27187.1 RATE, lb/HR	← RAW SHALE
2	28.9 OIL, GAL/TON ASRS	2.4 GAS & LOSS, WT % CRS	19.5 CO ₂ , WT % HRS	55.22 RETORT XS, FT ² BP	TOG 160 OFFGAS TEMP., °F	
3	65.0 ASH, WT %	18.3 CARBON, WT %	1.85 H ₂ , WT %	24.39 BARO. PRESS., IN H ₂ O		
4	CRA 989.0 CHART READING, SCFM	MFA 1.0 METER FACTOR	TA 154 TEMP., °F	PA 116 PRESS., IN H ₂ O	WA 0.14 H ₂ O, lb/MSCF	← AIR
5	CRRG 3455.0 RECYCLE CHART READING, SCFM	MFRG 1.0 METER FACTOR	TRG 225 TEMP., °F	PRG 78 PRESS., IN H ₂ O	'CRTG 0.0 TOTAL GAS CHART READING	← RECYCLE TOTAL GAS
6	CRDG 0.0 CHART READING	MFDG 0.0 METER FACTOR	TDG 0 TEMP., °F	PDG 0 PRESS., IN H ₂ O		← DILUTION
7	P 0.0 SCFM	TP 0 TEMP., °F	PP 0 PRESS., IN H ₂ O	W 302.4 H ₂ O ADDED, lb/HR	N 0.0 NUCL. AGENT, lb/HR	← PROPANE / NUCLEATING AGENT
8	WSS 0.5 H ₂ O, WT % COSS	OLSS 1.8 OIL, WT % ASSS	GSS 0.7 GAS, WT % CSS	SS 0.0 RATE, lb/HR HSS	TSS 469 TEMP., °F	← SPENT SHALE
9	17.4 CO ₂ , WT %	78.4 ASH, WT %	8.95 CARBON, WT %	0.44 H ₂ , WT %		
10	OILLP 2278.3 DRY OIL, lb/HR	COL 84.1 CARBON, WT %	HOL 11.1 H ₂ , WT %	DOL 7.788 DENSITY, lb/GAL	WLP 94.9 H ₂ O, lb/HR	← LIQUID PRODUCT
11	CRVG 1472.3 CHART READING CG	MFIG 1.0 METER FACTOR H	TVG 215 TEMP., °F COOG	WG 0.0 H ₂ O, lb/MSCF OG	OILM 0.0 OIL MIST, lb/MSCF NG	← VENT GAS
12	12.8 CARBON, lb/MSCF MEG	0 COG	25.3 CO ₂ , VOL % HHG	0.4 O ₂ , VOL % OTG	60.7 N ₂ , Vol % HG	
13	1.7 CH ₄ , VOL %	2.9 CO, VOL %	4.4 H ₂ , VOL %	4.6 OTHERS, VOL %	0.92 H ₂ , lb/MSCF	
14	CRVP 16.7 CHART READING TVPC	VPMF 1.83 METER FACTOR VPOIL	TVP 76 TEMP., °F VPW	PVP 260 PRESS., IN H ₂ O GL	PVPC 34 CONDENSER PRESS. IN H ₂ O	← VENT PURGE
15	82 CONDENSER GAS EFFLUENT TEMP., °F	422.5 DRY OIL, GPH/HR	17.9 H ₂ O, lb/HR M	76.8 TOP SEAL GAS RATE, SCFM		

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 Moisture and Mist, Externally,
Or "0" to Calculate from Vent Purge Raw Data.
3. H Enter "1" to Calculate using Retort #2,
Or "0" to Calculate using Retort #3.

LABORATORY ANALYSIS REPORT

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 8-3-67

Run No. C1054-2

Sample Time: RS 0745; SS _____

FISCHER ASSAY ^{EA}

FA

<input checked="" type="radio"/> RAW SHALE	<input checked="" type="radio"/> SPENT SHALE	
<u>28.6</u>	<u>4.7</u>	Gal/Ton
<u>.912</u>	<u>.901</u>	S.G., g/ml
<u>10.9</u>	<u>1.8</u>	Oil, wt %
<u>1.6</u>	<u>0.5</u>	Water, wt %
<u>85.1</u>	<u>97.0</u>	Sp. Shale, wt %
<u>2.4</u>	<u>0.7</u>	Gas & Loss, wt %
<u>Slight</u>	<u>none</u>	COKING TENDENCY

RETORT SHALE MOISTURE
EF EST. 1.10 wt %
 RAW SHALE FISCHER ASSAY MOISTURE
1.02 wt %

MINERAL CO₂

EF 17.4 *EF* 17.4 wt %

ASH (SHALE)

EF 64.8 *EF* 78.4 wt %

MOISTURE

EF 0.34 *EF* 0.14 wt %

CARBON

EA 18.2 *EA* ~~7.8~~ 8.95 wt %

HYDROGEN

EA 1.84 *EA* ~~0.11~~ 0.44 wt %

BENZENE EXTRACTABLES

. 0.42 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 _____

CHECKED BY _____

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 3-3-67

Run No. C1054-2

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

1 2 3 4 1 2

WATER, wt % 4.0 _____ _____ _____ _____

GRAVITY, °API 19.3 _____ _____ _____ _____

OIL ASH, wt % _____ _____ _____ _____ _____

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 5070

WATER VOL, ml 315

GRAVITY OIL, °API 42.0

VENT GAS

MAJOR COMPONENTS

C₁ thru C₄, plus n-Pentane

CO₂ 25.3 vol %

O₂ 0.4 "

N₂ 60.0 "

CH₄ 1.7 "

CO 2.9 "

H₂ 4.4 "

Ar 0.7 "

Others 4.6 "

CH₄ _____ vol %

C₂H₄-C₂H₆ _____ "

C₃H₈ _____ "

C₃H₆ _____ "

i C₄H₁₀ _____ "

n C₄H₁₀ _____ "

∅C₃H₆ _____ "

n C₅H₁₂ _____ "

CARBON, 12.3 lbs/MSCFDG

HYDROGEN, 5.92 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED _____

CHECKED BY _____

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C 1054-2 SAMPLE NO. _____ DATE 8-3-69

UNIT REPORT #3 DESCRIPTION TYLAB

APPROX. SHALE SIZE _____ SHAKING TIME 10 MIN ANALYSIS BY Yalin & Strutton

TOTAL SAMPLE WT. GROSS 62.8 - TARE 6.6 = NET 61.2

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	(0.3800) 0.3636			
	2.00					2.00	2.250	0.4444			
	1.50					1.50	1.750	0.5714			
	1.05		20.5	19.2	1.3	1.05	(1.087) 1.275	(0.9199) 0.7843	2.12		97.87
	0.742		50.2	20.5	29.7	0.742	0.896	1.116	48.53		49.34
	0.525		36.3	18.5	17.8	0.525	0.634	1.577	29.08		20.26
	0.371		23.0	18.7	4.3	0.371	0.448	2.232	7.03		13.23
	0.263	3	24.5	18.4	6.1	0.263	0.317	3.154	9.97		3.26
	0.185	4	19.8	17.4	.4	0.185	0.224	4.464	0.65		2.61
	0.131	6	19.6	19.4	.2	0.131	0.158	6.329	0.33		2.28
	0.093	8	21.0	20.9	.1	0.093	0.112	8.928	0.16	97.87	2.12
	0.065	10	19.3	19.2	.1	0.065			0.16		1.96
	PAN		22.2	21.0	1.2	PAN			1.96		0.00
TOTAL ON SCREENS AND PAN					61.2	LOSS			-	-	-
LOSS (BY DIFFERENCE)					0.0	TOTAL			99.99	-	-
TOTAL SAMPLE WEIGHT					61.2				-	-	-

00469

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

REMARKS: _____

$\sum_{+8m} D_i$	0.70750	$\sum_{+8m} X_i$	
$1/\sum_{+8m} D_i$	1.55524	$\sum_{+8m} X_i / D_i$	
D _a	0.62929	$\sum_{+8m} X_i D_i$	
D _v	0.72289		