

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

151302007

Date 8-3-67

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

GENERAL		SPENT SHALE PROPERTIES	
Run No.	C-1054-3	Fischer Assay, Gal/ton	6.7
Length, hours	12	Mineral CO ₂ , Wt %	17.4
Retort Type Number	RC-IX	Ash, Wt %	78.5
Oil Recovery System Number	C-5	Carbon (total), Wt %	9.0
<i>TONS</i> Total Raw Shale Charged, lbs.	152.88	Organic Carbon, Wt %	4.25
Bed Height above Dist., ft	6 1/2'	Hydrogen (total), Wt %	0.46
Type Air Dist.	XIII	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6'	Oil, Wt %	97.2
RATES AND QUANTITIES		Density, lb/gal	7.788
Raw Shale, lbs/(hr)(ft ²)	475	Gravity, API	19.8
Spent Shale, % of RS	83.1	Ash, Wt %	-
Liquid Product, lbs/hr	2042.6	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	19.5	Water Vapor, lbs/MSCF (dry)	10.8
Air, SCF/ton RS (dry)	4670	Oil, lbs/MSCF (dry)**	0.440
Total Recycle*, SCF/ton RS (wet)	15900	Analysis (dry)	
Dilution, SCF/ton RS (wet)	-	CO ₂ , Vol %	24.5
Calc. Vent Gas SCF/ton RS (dry)	6260	O ₂ , Vol %	0.2
Gas Losses, SCF/ton RS (wet)	916	N ₂ + Argon, Vol %	59.7
Propane, SCF/ton RS	-	CH ₄ , Vol %	4.6
TEMPERATURES AND HEAT BALANCE		CO, Vol %	3.0
Retort Offgas, °F	161	H ₂ , Vol %	3.8
Spent Shale, F	554	Other, Vol %	4.2
Raw Shale, °F	75	Gross Heating Value (calc), Btu/SCF	111.7
Recycle Gas Inlet, °F	222	Carbon (Total), lbs/MSCF (dry)	11.9
Dilution Gas Inlet, °F	-	Hydrogen (Total), lbs/MSCF (dry)	0.20
Air Inlet, °F	159	YIELDS AND BALANCES	
Retort Air Inlet, F	159	Oil Collected, Vol % RSFA	65.7
Heat of Comb. MBtu/ton RS	44.5	Oil in Gas**, Vol % RSFA	1.2
Heat Lost, MBtu/ton RS	-14	Oil in Spent Shale, Vol % RSFA	18.5
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	85.4
Fischer Assay, gal/ton RS	29.6	Carbonate Decomposition, %	25.5
Oil, Wt %	11.2	Water Recovered, lb/ton RS	80.5
Water, Wt %	0.7	Ash Balance, % - As Measured	-
Gas, Wt %	2.2	Ash Balance, % - Assumed	RS-100
Mineral CO ₂ , Wt %	19.4	Overall Balance, %	100.8
Ash, Wt %	65.2	Carbon Balance, % - Organic	94.6
Moisture, Wt % (Uncrushed)	Est. 1.0	Carbon Balance, % - Total	96.1
Carbon (Total), Wt %	18.4	Hydrogen Balance, % - Organic	92.0
Hydrogen (Total), Wt %	1.80	Hydrogen Balance, % - Total	100.8
Nominal Size Range, inches	1/4" - 1"	Water Balance, %	130.8
5 % passing thru	0.263	MISCELLANEOUS	
98 % passing thru	1.05	Avg. Retort ΔP, in H ₂ O/ft	1.17
D _a	0.609	ΔP Above Air Dist., in H ₂ O/ft	1.74
D _v	0.709	Pressure Above Deck - PI 8 - "H ₂ O	1.7
		Pressure Below Deck - PI 10 - "H ₂ O	8.5

Comments: *Estimated 2 to 5% of liquid present with drawn from barrel removed sample*

*Measured Recycle + Dilution Gas
 ** Oil Mist + Condensibles to 81 °F
 *** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed *Earl E. Jones* DATE *Aug. 10, 1967*

//A100

3080, C1054-3 R-1 8-3-67

A. YIELDS

FAY	6.573E 01	DRYGAS	6.264E 03	MISTFA	1.195E 00
H2	2.380E 02	OTHER	2.631E 02	UNRETO	1.854E 01
CH4	2.881E 02	O2	1.253E 01	SSY	8.306E 01
CO	1.879E 02	CO2DEC	2.551E 01	MH2O	8.054E 01
CO2	1.535E 03	OILCOL	1.945E 01		

B. METERED GAS RATES

RECG	1.588E 04	DIL	0.0	WVENTG	6.775E 03
AIR	4.671E 03	TRECG	1.588E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.852E 01	HVGT	6.996E 02	MWDG	3.091E 01
GBTU	1.117E 02				

D. COMBUSTION PRODUCTS

CO2C	6.208E 02	COC	1.695E 02	H2OC	2.532E 01
CHR	8.817E 00	COMBCP	9.559E 00		

E. MATERIAL IN

ORGCIN	2.621E 02	RSR	4.746E 02	ORH2IN	3.443E 01
MATIN	2.380E 03				

F. MATERIAL OUT

ORGCVG	4.987E 01	COKEC	3.567E 01	UNRETH	4.610E 00
ORGCOL	1.274E 02	ORH2VG	8.155E 00	COKEH	2.101E 00
UNRETC	3.493E 01	ORH2OL	1.682E 01	ORCOLP	4.862E 01
ORCVGP	1.903E 01	ORCSSP	2.694E 01	HCCVGP	9.470E 00

G. MATERIAL BALANCES

OVALL	1.008E 02	ORH2	9.202E 01	O2BAL	1.045E 02
ASH	0.0	TC	9.614E 01	WATER	1.308E 02
ORGC	9.459E 01	TH2	1.008E 02	GASL	9.160E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.445E 05	QH2OC	1.071E 04	QAIR	7.233E 03
QPROP	0.0	QOILC	1.061E 04	QRCYL	5.020E 04
QSUMIN	5.232E 05				

I. HEAT OUT

QMCO2D	1.603E 05	QKEROD	9.059E 04	QH2OV	3.903E 04
QLIQO	4.862E 03	QOFGAS	4.140E 04	QSS	1.914E 05
QGASL	9.988E 03	LBLOSS	0.0	HETLOS	-1.434E 04
QSUMOT	5.232E 05				

J. MISCELLANEOUS

ORCSS	4.250E 00	VPOIL	4.398E-01	TGL	5.377E 03
VPM	1.083E 01	WCG	1.856E 01	PROP	0.0

END MESSAGE

END OUTPUT

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080, 3080	C1054-3	R-1	8-3-67			
1	WRS 0.7 H ₂ O, WT% FA	OLRS 11.2 OIL, WT% GRS	TRS 75 TEMP., °F CRS	B -1 XA	MRS 26207.7 RATE, lb/HR	RAW SHAPE	
2	29.6 OIL, GAL/TON ASRS	2.2 GAS & LOSS, WT% CRS	19.4 CO ₂ , WT% HRS	55.22 RETORT XS, FT ² BP	TOG		
3	65.2 ASH, WT%	18.4 CARBON, WT%	1.80 H ₂ , WT%	24.55 BARO. PRESS., IN H ₂ O	161 OFFGAS TEMP., °F		
4	CRA 1020.9 CHART READING, SCFM	MFA 1.0 METER FACTOR	TA 159 TEMP., °F	PA 116 PRESG., IN H ₂ O	WA 0.14 H ₂ O, lb/MSCF	LBHL 0 HEAT LOSS, BTU/HR	AIR
5	CRRG 3440.6 RECYCLE CHART READING, SCFM	MFRG 1.0 METER FACTOR	TRG 222 TEMP., °F	PRG 80 PRESG., IN H ₂ O	CRTG 0.0 TOTAL GAS CHART READING	MFTG 0.0 METER FACTOR	RECYCLE TOTAL GAS
6	CRDG 0.0 CHART READING	MFDG 0.0 METER FACTOR	TDG 0 TEMP., °F	PDG 0 PRESG., IN H ₂ O			DILUTION
7	P 0.0 SCFM	TP 0 TEMP., °F	PP 0 PRESG., IN H ₂ O	W 283.3 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 2.5 OIL, WT% ASSS	GSS 0.0 GAS, WT% CSS	SS 0.0 RATE, lb/HR HSS	TSS 554 TEMP., °F		SPENT SHAPE
9	17.4 CO ₂ , WT%	78.5 ASH, WT%	9.0 CARBON, WT%	0.46 H ₂ , WT%			
10	OILLP 1985.4 DRY OIL, lb/HR	COL 84.1 CARBON, WT%	HOL 11.1 H ₂ , WT%	DOL 7.788 DENSITY, lb/GAL	WLP 57.2 H ₂ O, lb/HR		LIQUID PRODUCT
11	CRVG 1508.1 CHART READING, SCFM CC	MFCG 1.0 METER FACTOR H	TVC 214 TEMP., °F COOG	WG 0.0 H ₂ O, lb/MSCF OG	OILM 0.0 OIL MIL, lb/MSCF NG	M 0	VENT GAS
12	11.9 CARBON, lb/MSCF MEG	0 COG	24.5 CO ₂ , VOL% HIG	0.2 O ₂ , VOL% OTG	59.0 N ₂ , VOL% HG		
13	7.6 CH ₄ , VOL%	3.0 CO, VOL%	3.8 H ₂ , VOL%	4.2 OTHERS, VOL%	0.80 H ₂ , lb/MSCF		
14	CRVP 18.4 CHART READING TVPC	VPMF 1.83 METER FACTOR VPOIL	TVP 74 TEMP., °F VPW	PVP 276 PRESG., IN H ₂ O CL	PVPC 35 CONDENSER PRESS. IN H ₂ O		VENT PURGE
15	81 CONDENSER GAS EFFLUENT TEMP., °F	422.6 DRY OIL, GPM/HR	18.0 H ₂ O, lb/HR C	81.6 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 E-3-67

Run No. C1054-3

Sample Time: RS 1945; SS 2100

EA+P/6 FISCHER ASSAY *EH+P/6*
 RAW SHALE SPENT SHALE

RETORT SHALE MOISTURE
ES Est. 1.16 wt %
 RAW SHALE FISCHER ASSAY MOISTURE

<u>29.3</u>	<u>6.7</u>	Gal/Ton
<u>.912</u>	<u>-</u>	S.G., g/ml
<u>11.1</u>	<u>2.5</u>	Oil, wt %
<u>1.8</u>	<u>0.5</u>	Water, wt %
<u>84.9</u>	<u>97.0</u>	Sp. Shale, wt %
<u>2.2</u>	<u>0.0</u>	Gas & Loss, wt %
<u>Slight</u>	<u>none</u>	COKING TENDENCY

1.06 wt %

MINERAL CO₂

R 19.3 *R* 17.4 wt %

ES ASH (SHALE)
 65.0 78.5 wt %

ES MOISTURE
 0.35 0.14 wt %

EA CARBON
 18.3 9.0 wt %

EA HYDROGEN
 1.79 1.46 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 _____

CHECKED BY _____

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 8-3-67

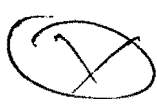
Run No. C1054-3 LP

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
<input checked="" type="checkbox"/> WATER, wt %	<u>2.3</u>					
<input checked="" type="checkbox"/> GRAVITY, °API	<u>19.3</u>					
<input type="checkbox"/> CIL. ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

PJA



VENT PURGE PRODUCT

OIL WT, g 5070.6
 WATER VOL, ml 315.0
 GRAVITY OIL, °API 43.0

DK.

VENT GAS

MAJOR COMPONENTS

CO₂ 24.5 vol %
 O₂ 0.2 "
 N₂ 59.0 "
 CH₄ 4.6 "
 CO 3.0 "
 H₂ 3.8 "
 Ar 0.7 "
 Others 4.2 "

C₁ thru C₄, plus n-Pentane

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

PJA

CARBON, 11.4 lbs/MSCFDG

PJA

HYDROGEN, 0.80 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED _____

CHECKED BY _____

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1054-3 SAMPLE NO. 1 DATE 8/3/67
 UNIT RETORT #3 DESCRIPTION TY-LAB
 APPROX. SHALE SIZE #1 SHAKING TIME 10 min ANALYSIS BY R.A. Steele
 TOTAL SAMPLE WT. GROSS 96.3 - TARE 14.9 = NET 81.4

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		21.10	19.15	1.95	1.05	(1.087) 1.275	(0.9199) 0.7843	2.40		97.60
	0.742	x	59.90	20.50	39.40	0.742	0.896	1.116	45.70		51.90
	0.525		41.65	18.50	23.15	0.525	0.634	1.577	28.44		23.46
	0.371		24.45	18.70	5.75	0.371	0.448	2.232	7.06		16.40
	0.263	3	28.35	12.95	15.40	0.263	0.317	3.154	12.16		4.24
	0.185	4	22.10	14.40	7.70	0.185	0.224	4.464	0.86		3.38
	0.131	6	19.65	19.35	.30	0.131	0.158	6.329	0.37		3.01
	0.093	8	20.25	20.75	.10	0.093	0.112	8.928	0.12	97.11	2.89
	0.065	10	19.50	19.25	.25	0.065			0.31		2.58
	PAN		22.95	21.00	1.95	PAN			2.40		0.18
TOTAL ON SCREENS AND PAN					21.25	LOSS			0.18		0.00
LOSS (BY DIFFERENCE)					-.15	TOTAL			100.00	-	-
TOTAL SAMPLE WEIGHT					81.4				-	-	-

U4476

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

REMARKS: lots of dust coming out around the top cover on the TY-LAB. How about getting the lid fixed

$\sum_{+8m}^m Di$	0.62869	$\sum_{+8m}^m Xi$	
$1/\sum_{+8m}^m Di$	1.59422	$\sum_{+8m}^m Xi / Di$	
Da	0.60913	$\sum_{+8m}^m Xi Di$	
Dv	0.70918		