

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

151301800

Date 6-18-67

Purpose: To determine operability and yield with $\frac{1}{4}$ - $2\frac{1}{2}$ " shale using hot dilution gas.

GENERAL		SPENT SHALE PROPERTIES	
Run No.	R-2 DTC1046	Fischer Assay, Gal/ton	0.2
Length, hours	12	Mineral CO ₂ , Wt %	14.0
Retort Type Number	RC-VII	Ash, Wt %	84.4
Oil Recovery System Number	C-1	Carbon (total), Wt %	5.99
Tons Total Raw Shale Charged, lbs.	100.64	Organic Carbon, Wt %	2.17
Bed Height above Dist., ft	9 1/2	Hydrogen (total), Wt %	0.18
Type Air Dist.	ADXL	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6	Oil, Wt %	95.2
RATES AND QUANTITIES		Density, lb/gal	7.762
Raw Shale, lbs/(hr)(ft ²)	304	Gravity, API	20.5
Spent Shale, % of RS	80.3	Ash, Wt %	-
Liquid Product, lbs/hr	1675.0	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	22.7	Water Vapor, lbs/MSCF (dry)	5.5
Air, SCF/ton RS (dry)	5400	Oil, lbs/MSCF (dry)**	0.043
Total Recycle*, SCF/ton RS (wet)	12500	Analysis (dry)	
Dilution, SCF/ton RS (wet)	2040	CO ₂ , Vol %	76.4
Calc. Vent Gas SCF/ton RS (dry)	6930	O ₂ , Vol %	0.3
Gas Losses, SCF/ton RS (wet)	334	N ₂ + Argon, Vol %	61.6
Propane, SCF/ton RS	15.6	CH ₄ , Vol %	1.8
TEMPERATURES AND HEAT BALANCE		CO, Vol %	3.1
Retort Offgas, °F	140	H ₂ , Vol %	5.3
Spent Shale, F	170	Other, Vol %	1.5
Raw Shale, °F	90	Gross Heating Value (calc), Btu/SCF	88.4
Recycle Gas Inlet, °F	250	Carbon (Total), lbs/MSCF (dry)	11.9
Dilution Gas Inlet, °F	287	Hydrogen (Total), lbs/MSCF (dry)	0.68
Air Inlet, °F	151	YIELDS AND BALANCES	
Retort Air Inlet, F	151	Oil Collected, Vol % RSFA	82.1
Heat of Comb. MBtu/ton RS	500	Oil in Gas**, Vol % RSFA	0.1
Heat Lost, MBtu/ton RS	24	Oil in Spent Shale, Vol % RSFA	0.8
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	83.0
Fischer Assay, gal/ton RS	27.7	Carbonate Decomposition, %	33.1
Oil, Wt %	10.6	Water Recovered, lb/ton RS	73.9
Water, Wt %	1.1	Ash Balance, % - As Measured	-
Gas, Wt %	2.2	Ash Balance, % - Assumed	R.S. 100
Mineral CO ₂ , Wt %	16.8	Overall Balance, %	94.1
Ash, Wt %	67.8	Carbon Balance, % - Organic	92.1
Moisture, Wt % (Uncrushed)	1.05	Carbon Balance, % - Total	95.0
Carbon (Total), Wt %	17.3	Hydrogen Balance, % - Organic	87.3
Hydrogen (Total), Wt %	1.75	Hydrogen Balance, % - Total	93.9
Nominal Size Range, inches	1/4" - 2 1/2"	Water Balance, %	116.1
5 % passing thru	0.371	MISCELLANEOUS	
98 % passing thru	2.50	Avg. Retort ΔP, in H ₂ O/ft	0.32
D _a	1.074	ΔP Above Air Dist., in H ₂ O/ft	0.36
D _v	1.466	NaCl Soln., Wt %	-
Line Burner °F	700	NaCl Rate, gal/ton RS	-

Comments: Rolls energy - Vent runs well but hot.

*Measured Recycle + Dilution Gas
 ** Oil Mist + Condensibles to 87 °F
 *** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. June DATE July 17, 1967
 OSRC-10
 Revised 7/19/66

//A100

2080, PTC1046 R-2 6-18-67

A. YIELDS

FAY	8.205E 01	DRYGAS	6.931E 03	MISTFA	1.393E-01
H2	3.674E 02	OTHER	1.040E 02	UNRETO	7.578E-01
CH4	1.248E 02	O2	2.079E 01	SSY	8.033E 01
CO	2.149E 02	CO2DEC	3.306E 01	MH2O	7.386E 01
CO2	1.830E 03	OILCOL	2.273E 01		

B. METERED GAS RATES

RECG	1.048E 04	DIL	2.040E 03	WVENTG	7.393E 03
AIR	5.396E 03	TRECG	1.252E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.957E 01	HVGT	6.125E 02	MWDG	3.090E 01
GBTU	8.837E 01				

D. COMBUSTION PRODUCTS

CO2C	8.116E 02	COC	1.965E 02	H2OC	1.963E 01
CHR	1.450E PVP	COMBCP	1.249E 01		

P

E. MATEKIAL IN

ORGCIN	2.558E 02	RSR	3.038E 02	ORH2IN	3.287E 01
MATIN	2.437E 03				

F. MATERIAL OUT

ORGCVG	5.244E 01	COKEC	3.348E 01	UNRETH	1.783E-01
ORGCOL	1.484E 02	ORH2VG	6.947E 00	COKEH	1.994E 00
UNRETC	1.351E 00	ORH2OL	1.958E 01	ORCOLP	5.801E 01
ORCVGP	2.050E 01	ORCSSP	1.362E 01	HCCVGP	8.010E 00

G. MATERIAL BALANCES

OVALL	9.914E 01	ORH2	8.732E 01	O2BAL	1.027E 02
ASH	0.0	TC	9.501E 01	WATER	1.161E 02
ORGC	9.214E 01	TH2	9.393E 01	GASL	3.339E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	5.001E 05	QH2OC	8.290E 03	QAIR	6.071E 03
QPROP	4.543E 01	QOILC	1.235E 04	QRCYL	4.977E 04
QSUMIN	5.766E 05				

I. HEAT OUT

QMC02D	1.799E 05	QKEROD	1.018E 05	QH2OV	4.897E 04
OLIQQ	3.276E 03	QOFGAS	2.137E 04	QSS	2.411E 05
QGASL	4.542E 03	LBLOSS	0.0	HETLOS	-2.436E 04
QSUMOT	5.766E 05				

J. MISCELLANEOUS

ORCSS	2.168E 00	VPOIL	4.320E-02	TGL	3.024E 03
VPM	5.458E 00	WCG	1.030E 01	PROP	1.560E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	← USER IDENTIFICATION →					
0	2080,	PTC 1046 R-2 6-18-67					
1	WRS	OLRS	TRS	B	MRS	← RAW SHALE	
	1.1	10.6	90	-1	16773.2		
2	FA	GRS	CORS	XA			
	27.7	2.2	16.8	55.22			
3	ASRS	CRS	HRS	BP	TOG	← AIR	
	67.8	17.3	1.75	24.38	140		
4	CRA	MFA	TA	PA	WA		LBHL
	755.1	1.0	151	135	0.14	0	
5	CRRG	MFRG	TRG	PRG	CRTG	MFTG	← RECYCLE A TOTAL GAS
	1480.0	1.0	278	79	0.0	0.0	
6	CRDG	MFDG	TDG	PDG			
	6.2	56.4	287	87			← DILUTION G
7	P	TP	PP	W	N	← PROPANE A NUCLEATING AGENT	
	2.51	0.4	128.4	178.0	0.0		
8	WSS	OLSS	GSS	SS			
	0.4	0.1	0.0	0.0			← SPENT SHALE
9	COSS	ASSS	CSS	HSS	TSS		
	14.0	84.4	5.99	0.18	710		
10	OILLP	COL	HOL	DOL	WLP	← LIQUID PRODUCT	
	1479.6	84.1	11.1	7.762	195.5		
11	CRVG	MVFG	TVG	WG	OILM		M
	1395.5	1.0	287	0.0	0.0	0	← VENT GAS
12	CG	H	COOG	OG	NG		
	11.9	0	26.4	0.3	61.6		
13	MEG	COG	HHG	OTG	HG	← VENT PURGE	
	1.8	3.1	5.3	1.5	0.68		
14	CRVP	VPMF	TVP	PVP			
	2.7	2.17	164	50			
15	TVPC	VPOIL	VPW	GL			
	87	13.8	2.1	84.3			

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 6-18-67

Run No. C 1046 PT

Sample Time: RS 0615; SS 1115

FISCHER ASSAY

RAW SHALE SPENT SHALE

<u>27.5</u> <u>27.8</u>	<u>0.2X</u>	Gal/Ton
<u>.914</u>	<u>.901</u>	S.G., g/ml
<u>10.5</u>	<u>0.1</u> <u>0.08</u>	Oil, wt %
<u>1.8</u>	<u>0.4</u>	Water, wt %
<u>85.5</u>	<u>99.5</u> <u>99.3</u>	Sp. Shale, wt %
<u>2.2</u>	<u>0.0</u>	Gas & Loss, wt %
<u>Slight</u>	<u>NONE</u>	COKING TENDENCY

RETORT SHALE MOISTURE
1.05 wt %

RAW SHALE FISCHER ASSAY MOISTURE
0.22 wt %

MINERAL CO₂

17.2 14.0 wt %

ASH (SHALE)

67.6 84.4 wt %

MOISTURE

0.30 0.12 wt %

CARBON

17.2 5.99
6.0 wt %

HYDROGEN

1.74 0.18 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 JUN 20 1967

CHECKED BY REP

MESH	WT. GRAMS	WT %
8	173.2	18.9
14	276.8	30.2
28	182.1	19.7
35	70.7	7.7
48	45.0	4.9
65	37.7	4.1
100	30.4	3.3
150	23.8	2.6
PAN	76.8	8.6
TOTAL	916.5	100.0

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-19-67

Run No. C 1046 PT
(0900)

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	<u>4.8</u>	/	/	/		
GRAVITY, °API	<u>20.3</u>	/	/	/		
<input type="radio"/> OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 165.0
 WATER VOL, ml 56.0
 GRAVITY OIL, °API 34.6

VENT GAS

<input checked="" type="radio"/> MAJOR COMPONENTS	<input type="radio"/> C ₁ thru C ₄ , plus n-Pentane
CO ₂ <u>26.4</u> vol %	CH ₄ _____ vol %
O ₂ <u>0.3</u> "	C ₂ H ₄ -C ₂ H ₆ _____ "
N ₂ <u>60.9</u> "	C ₃ H ₈ _____ "
CH ₄ <u>1.8</u> "	C ₃ H ₆ _____ "
CO <u>3.1</u> "	i C ₄ H ₁₀ _____ "
H ₂ <u>5.3</u> "	n C ₄ H ₁₀ _____ "
Ar <u>0.7</u> "	∅C ₃ H ₆ _____ "
Others <u>1.5</u> "	n C ₅ H ₁₂ _____ "
<input checked="" type="radio"/> CARBON, <u>11.9</u> lbs/MSCFDG	HYDROGEN, <u>0.68</u> lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUN 20 1967

CHECKED BY REP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1046 PT SAMPLE NO. 1 DATE 6-18-67

UNIT _____ DESCRIPTION TYLAB.

APPROX. SHALE SIZE 2 1/2 TO 1/4 SHAKING TIME 10 MIN ANALYSIS BY JRS. + B. VALDEZ.

TOTAL SAMPLE WT. GROSS 86.7 - TARE 6.0 = NET 80.7

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)			100.00
	2.50		18.2	16.7	1.5	2.50	(2.625) 2.750	(0.3809) 0.3636	1.84		98.14
	2.00		34.0	20.2	13.8	2.00	2.250	0.4444	16.95		81.19
	1.50		51.6	23.4	28.2	1.50	1.750	0.5714	34.64		46.55
	1.05		34.0	19.2	14.8	1.05	(1.087) 1.275	(0.9199) 0.7843	18.18		28.37
	0.742		29.4	20.5	8.9	0.742	0.896	1.116	10.93		17.44
	0.525		25.5	18.5	7.0	0.525	0.634	1.577	8.60		8.84
	0.371		22.0	19.2	2.8	0.371	0.448	2.232	3.44		5.40
	0.263	3	20.2	18.5	1.7	0.263	0.317	3.154	2.09		3.31
	0.185	4	19.8	19.4	1.4	0.185	6.224	4.464	1.72		1.59
	0.131	6	19.5	19.4	.1	0.131	0.158	6.329	0.12		1.47
	0.093	8	20.5	20.4	.1	0.093	0.112	8.928	0.12	98.63	1.35
	0.065	10	19.3	19.2	.1	0.065			0.12		1.23
	PAN		21.9	20.9	1.0	PAN			1.23		0.00
TOTAL ON SCREENS AND PAN					86.4	LOSS			-		-
LOSS (BY DIFFERENCE)					- .3	TOTAL			99.98		-
TOTAL SAMPLE WEIGHT					86.7				-		-

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

REMARKS: _____

$\sum_{+8m}^m D_i$	1.44634	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	0.91824	$\sum_{+8m}^m X_i / D_i$	
D _a	1.07412	$\sum_{+8m}^m X_i D_i$	
D _v	1.46643		