

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513017009

Date 6-2-67

Purpose: To determine operability and yield with less dilution gas
Using 1/2" - 1" shale.

GENERAL		SPENT SHALE PROPERTIES	
Run No.	C1040-6	Fischer Assay, Gal/ton	1.1
Length, hours	12	Mineral CO ₂ , Wt %	14.7
Retort Type Number	RC-VII	Ash, Wt %	83.2
Oil Recovery System Number	C-1	Carbon (total), Wt %	5.31
Total Raw Shale Charged, lbs.	101.41	Organic Carbon, Wt %	1.30
Bed Height above Dist., ft	5 1/2'	Hydrogen (total), Wt %	0.22
Type Air Dist.	A-D-X	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6'	Oil, Wt %	99.41
RATES AND QUANTITIES		Density, lb/gal	7.733
Raw Shale, lbs/(hr)(ft ²)	306	Gravity, API	20.1
Spent Shale, % of RS	83.2	Ash, Wt %	-
Liquid Product, lbs/hr	1485.0	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	19.7	Water Vapor, lbs/MSCF (dry)	10.2
Air, SCF/ton RS (dry)	4820	Oil, lbs/MSCF (dry)**	0.089
Total Recycle*, SCF/ton RS (wet)	13900	Analysis (dry)	
Dilution, SCF/ton RS (wet)	1190	CO ₂ , Vol %	27.0
Calc. Vent Gas SCF/ton RS (dry)	6020	O ₂ , Vol %	0.7
Gas Losses, SCF/ton RS (wet)	987	N ₂ + Argon, Vol %	63.3
Propane, SCF/ton RS	36.4	CH ₄ , Vol %	1.7
TEMPERATURES AND HEAT BALANCE		CO, Vol %	2.4
Retort Offgas, °F	136	H ₂ , Vol %	4.0
Spent Shale, F	688	Other, Vol %	0.9
Raw Shale, °F	76	Gross Heating Value (calc), Btu/SCF	70.7
Recycle Gas Inlet, °F	250	Carbon (Total), lbs/MSCF (dry)	10.8
Dilution Gas Inlet, °F	250	Hydrogen (Total), lbs/MSCF (dry)	0.66
Air Inlet, °F	144	YIELDS AND BALANCES	
Retort Air Inlet, F	144	Oil Collected, Vol % RSFA	77.4
Heat of Comb. MBtu/ton RS	444	Oil in Gas**, Vol % RSFA	0.5
Heat Lost, MBtu/ton RS	-67	Oil in Spent Shale, Vol % RSFA	3.4
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	81.1
Fischer Assay, gal/ton RS	25.4	Carbonate Decomposition, %	29.7
Oil, Wt %	9.7	Water Recovered, lb/ton RS	102.8
Water, Wt %	1.0	Ash Balance, % - As Measured	-
Gas, Wt %	1.8	Ash Balance, % - Assumed	RS-100
Mineral CO ₂ , Wt %	17.4	Overall Balance, %	100.7
Ash, Wt %	69.2	Carbon Balance, % - Organic	84.7
Moisture, Wt % (Uncrushed)	0.92	Carbon Balance, % - Total	91.3
Carbon (Total), Wt %	15.6	Hydrogen Balance, % - Organic	82.5
Hydrogen (Total), Wt %	1.66	Hydrogen Balance, % - Total	99.9
Nominal Size Range, inches	1/4" - 1"	Water Balance, %	170.9
5 % passing thru	0.263	MISCELLANEOUS	
98 % passing thru	1.05	Avg. Retort ΔP, in H ₂ O/ft	0.41
D _a	0.629	ΔP Above Air Dist., in H ₂ O/ft	0.29
D _v	0.740	NaCl Soln., Wt %	-
Line Burner °F	800	NaCl Rate, gal/ton RS	-

Comments: Line burner failed but repaired - Temperatures in retort went high - Reduced wt of Carbon Contribution at end of run.

*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. Turner DATE June 20, 1967

36/9/6

//A100

2030, C1040-6 6-2-67

A. YIELDS

FAY	7.742E 01	DRYGAS	6.024E 03	MISTFA	2.735E-01
H2	2.410E 02	OTHER	5.422E 01	UNPETO	3.430E 00
CH4	1.024E 02	O2	4.217E 01	SSY	7.317E 01
CO	1.446E 02	CO2DEC	2.273E 01	WMO	1.022E 02
CO2	1.527E 03	OILCOL	1.267E 01		

B. METERED GAS RATES

RECO	1.274E 04	DIL	1.102E 03	WVENTG	6.332E 03
AIR	4.319E 03	TRECO	1.304E 04	IGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.291E 01	HVGT	4.250E 02	MWDG	3.125E 01
GBTU	7.071E 01				

D. COMBUSTION PRODUCTS

CO2C	6.233E 02	CO	1.305E 02	H2OC	2.021E 01
CHR	1.106E 01	CONCOP	1.177E 01		

E. MATERIAL IN

ORGIN	2.204E 02	SSS	3.061E 02	ORH2IN	3.174E 01
NATIN	2.392E 03				

F. MATERIAL OUT

ORGVG	3.729E 01	COKEC	1.365E 01	UNRETH	8.490E-01
ORCOL	1.279E 02	ORHPVG	6.320E 00	COKEH	2.063E 00
UNRETC	7.925E 00	ORH2CL	1.538E 01	ORCOLP	5.801E 01
ORCVSP	1.692E 01	ORCSSP	9.735E 00	HCCVSP	5.144E 00

G. MATERIAL BALANCES

OVALL	1.007E 02	ORH2	8.247E 01	O2BAL	1.103E 02
ASH	0.0	IC	9.131E 01	WATER	1.709E 02
ORGC	8.472E 01	TH2	9.991E 01	GASL	9.873E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.442E 05	QH2OC	2.533E 03	QAIR	6.036E 03
QPROP	1.165E 02	QOILC	1.064E 04	QCYL	5.029E 04
QSUMIN	5.199E 05				

I. HEAT OUT

QWCO2D	1.576E 05	QKEROD	2.693E 04	QH2OV	4.321E 04
QLI2O	3.333E 03	QOFGAS	2.623E 04	QSS	2.460E 05
QGASL	1.303E 04	LBLOSS	0.0	HETLOS	-5.682E 04
QSUMOT	5.199E 05				

J. MISCELLANEOUS

ORCSS	1.297E 00	VPCIL	2.917E-02	TGL	3.102E 03
VPM	1.022E 01	QCS	1.770E 01	ETCP	3.639E 01

END MESSAGE

END INPUT

12345

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	← USER IDENTIFICATION →					
0	2080,	C 1040-6		6-2-67			
1	WRS	OLRS	TRS	B	MRS	← RAW SHALE	
	1.0	9.7	76	-1	16901.4		
2	FA	GRS	CORS	XA			
	25.4	1.8	17.4	55.22			
3	ASRS	CRS	HRS	BP	TOG		
	69.2	15.6	1.66	24.32	136		
4	CRA	MFA	TA	PA	WA	LBHL	← AIR
	680.4	1.0	144	107	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 G
	1.6	129.5	250	67			
7	P	TP	PP	W	N		← PROPANE A NUCLEATING AGENT
	5.9	0.4	129.3	156.9	0.0		
8	WSS	OLSS	GSS	SS			← SPENT SHALE
	0.4	0.4	0.4	0.0			
9	COSS	ASSS	CSS	HSS	TSS		
	14.7	83.2	5.31	0.22	688		
10	OILLP	COL	HOL	DOL	WLP		← LIQUID PRODUCT
	1285.1	84.1	11.1	7.733	199.9		
11	CRVG	MVFG	TVG	WG	OILM	M	← VENT GAS
	1141.8	1.0	250	0.0	0.0	0	
12	CG	H	COOG	OG	NG		
	10.8	0	27.0	0.7	63.3		
13	MEG	COG	HHG	OTG	HG		
	1.7	2.4	4.0	0.9	0.66		
14	CRVP	VPMF	TVP	PVP			← VENT PURGE
	6.7	1.83	136	161			
15	TVPC	VPOIL	VPW	GL			
	75	43.7	9.5	85.2			

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 6-3-67

Run No. C 1040-6

Sample Time: RS 06:15; SS 11:15

FISCHER ASSAY

RETORT SHALE MOISTURE

ET RAW SHALE *ET* SPENT SHALE

0.92 wt %

25.2 1.18 Gal/Ton

RAW SHALE FISCHER ASSAY MOISTURE

1.709 — S.G., g/ml

0.67 wt %

9.6 0.41 Oil, wt %

1.7 0.4 Water, wt %

86.9 98.8 Sp. Shale, wt %

1.8 0.4 Gas & Loss, wt %

slight none COKING TENDENCY

MINERAL CO₂

PKM 17.3 *PKM* 14.7 wt %

ASH (SHALE)

ET 69.0 *ET* 83.2 wt %

MOISTURE

ET 0.31 *ET* 0.08 wt %

SHALE RICHNESS DISTRIBUTION
(See attached graph)

CARBON

PKM 15.6 *PKM* 5.31
~~3.43~~ wt %

SCREEN ANALYSIS
(See back of this sheet)

HYDROGEN

PKM 1.65 *PKM* 0.22 wt %

BENZENE EXTRACTABLES

— — wt %

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 9 1967

CHECKED BY

RCF

OSRC-12A

Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-3-67

Run No. C1040-6

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

	1	2	3	4	1	2
<input checked="" type="checkbox"/> WATER, wt %	0.59	X				
<input checked="" type="checkbox"/> GRAVITY, °API	20.1	X				
<input type="checkbox"/> OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 524.4
 WATER VOL, ml 10.0
 GRAVITY OIL, °API 42.6

VENT GAS

MAJOR COMPONENTS

CO₂ 27.0 vol %
 O₂ 0.7 "
 N₂ 62.5 "
 CH₄ 1.7 "
 CO 2.4 "
 H₂ 4.0 "
 Ar 0.8 "
 Others 0.9 "

C₁ thru C₄, plus n-Pentane

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

CARBON, 10.8 lbs/MSCFDG

HYDROGEN, 0.16 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUN 5 1967

CHECKED BY REP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C-1040-6 SAMPLE NO. _____ DATE 6-3-67
 UNIT P₂ bit #5 DESCRIPTION Top Soil
 APPROX. SHALE SIZE 1/2-1" SHAKING TIME 14 min ANALYSIS BY S.L.T.
 TOTAL SAMPLE WT. GROSS 94.2 - TARE 6.5 = NET 87.7

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)			
	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		26.5	19.2	7.3	1.05	(1.087) 1.275	(0.9199) 0.7843	8.37		91.63
	0.742		61.3	20.5	40.8	0.742	0.896	1.116	46.79		44.84
	0.525		38.1	18.5	19.6	0.525	0.634	1.577	22.48		22.36
	0.371		27.3	19.2	8.1	0.371	0.448	2.232	9.29		13.07
	0.263	3	26.0	18.4	7.6	0.263	0.317	3.154	8.72		4.35
	0.185	4	21.5	19.4	2.1	0.185	0.224	4.464	2.41		1.94
	0.131	6	19.6	19.3	.3	0.131	0.158	6.329	0.34		1.60
	0.093	8	20.5	20.5	.0	0.093	0.112	8.928	0.0	98.40	1.60
	0.065	10	19.3	19.2	.1	0.065			0.11		1.49
	PAN		22.3	21.0	1.3	PAN			1.49		0.00
TOTAL ON SCREENS AND PAN					87.2	LOSS			-	-	0.00
LOSS (BY DIFFERENCE)					5	TOTAL			100.00	-	-
TOTAL SAMPLE WEIGHT					87.7						

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

REMARKS: _____

$\sum_{+8m}^m D_i$	0.72794	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	1.56516	$\sum_{+8m}^m X_i / D_i$	
D _a	0.62868	$\sum_{+8m}^m X_i D_i$	
D _v	0.73977		

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