

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513018034

Date 7-4-67

Purpose: *To determine operability and yield with 4-2 1/2 inch shale at 500 mass rate and with hot air (W/O dilution gas)*

GENERAL		SPENT SHALE PROPERTIES	
Run No.	R-1 C1049-9	Fischer Assay, Gal/ton	0.3
Length, hours	12	Mineral CO ₂ , Wt %	16.8
Retort Type Number	RC VII	Ash, Wt %	81.5
Oil Recovery System Number	C-2	Carbon (total), Wt %	6.90
70MS Total Raw Shale Charged, lbs.	165.70	Organic Carbon, Wt %	2.31
Bed Height above Dist., ft	9 1/2	Hydrogen (total), Wt %	0.18
Type Air Dist.	AD XI	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6	Oil, Wt %	95.0
RATES AND QUANTITIES		Density, lb/gal	7.788
Raw Shale, lbs/(hr)(ft ²)	500	Gravity, API	19.8
Spent Shale, % of RS	82.5	Ash, Wt %	—
Liquid Product, lbs/hr	2759.5	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	23.9	Water Vapor, lbs/MSCF(dry)	5.6
Air, SCF/ton RS (dry)	4670	Oil, lbs/MSCF(dry)**	0.229
Total Recycle*, SCF/ton RS(wet)	11940	Analysis (dry)	
Dilution, SCF/ton RS (wet)	—	CO ₂ , Vol %	24.2
Calc. Vent Gas SCF/ton RS(dry)	6345	O ₂ , Vol %	0.3
Gas Losses, SCF/ton RS(wet)	615	N ₂ + Argon, Vol %	58.2
Propane, SCF/ton RS	27.1	CH ₄ , Vol %	2.4
TEMPERATURES AND HEAT BALANCE		CO, Vol %	4.1
Retort Offgas, °F	141	H ₂ , Vol %	6.7
Spent Shale, F	543	Other, Vol %	4.1
Raw Shale, °F	90	Gross Heating Value(calc), Btu/SCF	155
Recycle Gas Inlet, °F	261	Carbon (Total), lbs/MSCF (dry)	13.5
Dilution Gas Inlet, °F	—	Hydrogen (Total), lbs/MSCF (dry)	1.20
Air Inlet, °F	121	YIELDS AND BALANCES	
Retort Air Inlet, F	121	Oil Collected, Vol % RSFA	82.3
Heat of Comb. MBtu/ton RS	408	Oil in Gas**, Vol % RSFA	0.6
Heat Lost, MBtu/ton RS	13	Oil in Spent Shale, Vol % RSFA	2.2
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	85.1
Fischer Assay, gal/ton RS	29.0	Carbonate Decomposition, %	20.4
Oil, Wt %	11.2	Water Recovered, lb/ton RS	56.1
Water, Wt %	0.6	Ash Balance, % - As Measured	—
Gas, Wt %	7.8	Ash Balance, % - Assumed	128.100
Mineral CO ₂ , Wt %	17.4	Overall Balance, %	100.7
Ash, Wt %	67.2	Carbon Balance, % - Organic	102.5
Moisture, Wt % (Uncrushed)	1.05	Carbon Balance, % - Total	103.3
Carbon (Total), Wt %	17.4	Hydrogen Balance, % - Organic	84.7
Hydrogen (Total), Wt %	1.85	Hydrogen Balance, % - Total	94.3
Nominal Size Range, inches	1/4" - 2 1/2"	Water Balance, %	167.9
5 % passing thru	0.371	MISCELLANEOUS	
98 % passing thru	2.50	Avg. Retort ΔP, in H ₂ O/ft	0.82
Da	1.30	ΔP Above Air Dist., in H ₂ O/ft	0.93
Dy	1.362	NaCl Soln., Wt %	—
Line Burner OF	850	NaCl Rate, gal/ton RS	—

Comments: *Observed gas leak at vertical down-comer junction box indicating a leak in one or more OTC wells.*

*Measured Recycle + Dilution Gas
 ** Oil Mist + Condensibles to 82 OF
 *** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl J. Jones DATE July 18, 1967

//A100

2080, C1049-9 R-1 7-4-67

A. YIELDS

FAY	8.228E 01	DRYGAS	6.345E 03	MISTFA	6.425E-01
H2	4.251E 02	OTHER	2.601E 02	UNRETO	7.362E-01
CH4	1.523E 02	O2	1.903E 01	SSY	8.245E 01
CO	2.601E 02	CO2DEC	2.039E 01	MH2O	5.608E 01
CO2	1.535E 03	OILCOL	2.386E 01		

B. METERED GAS RATES

RECG	1.194E 04	DIL	0.0	WVENTG	6.475E 03
AIR	4.667E 03	TRECG	1.194E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.923E 01	HVGT	9.815E 02	MWDG	3.055E 01
GBTU	1.547E 02				

D. COMBUSTION PRODUCTS

CO2C	8.410E 02	COC	2.352E 02	H2OC	5.491E-01
CHR	5.536E 02	COMBCP	1.335E 01		

E. MATERIAL IN

ORGCIN	2.556E 02	RSR	5.001E 02	ORH2IN	3.624E 01
MATIN	2.381E 03				

F. MATERIAL OUT

ORGCVG	6.752E 01	COKEC	3.503E 01	UNRETH	2.652E-01
ORGCOL	1.563E 02	ORH2VG	7.836E 00	COKEH	1.964E 00
UNRETC	3.118E 00	ORH2OL	2.063E 01	ORCOLP	6.115E 01
ORCVGP	2.642E 01	ORCSSP	1.493E 01	HCCVGP	1.307E 01

G. MATERIAL BALANCES

OVALL	1.007E 02	ORH2	8.470E 01	O2BAL	1.058E 02
ASH	0.0	TC	1.033E 02	WATER	1.679E 02
ORGC	1.025E 02	TH2	9.434E 01	GASL	6.154E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.076E 05	QH2OC	8.509E 03	QAIR	2.663E 03
QPROP	3.937E 01	QOILC	1.301E 04	QRCYL	4.419E 04
QSUMIN	4.760E 05				

I. HEAT OUT

QMCO2D	1.149E 05	QKEROD	1.094E 05	QH2OV	3.508E 04
QLIQO	3.523E 03	QOFGAS	2.040E 04	QSS	1.748E 05
QGASL	6.320E 03	LBLOSS	0.0	HETLOS	1.162E 04
QSUMOT	4.760E 05				

J. MISCELLANEOUS

ORCSS	2.314E 00	VPOIL	2.287E-01	TGL	4.604E 03
VPM	5.591E 00	WCG	1.052E 01	PROP	2.714E 01

END MESSAGE

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080,	C1049-9 R-1 '7-4-67					
1	WRS	OLRS	TRS	B	MRS		
	0.6	11.2	90	-1	27616.1		
2	FA	GRS	CORS	XA		RAW SHALE	
	29.0	2.8	17.4	55.22			
3	ASRS	CRS	HRS	BP	TOG		
	67.2	17.4	1.85	24.38	191		
4	CRA	MFA	TA	SPA	WA	LBHL	AIR
	1075.2	1.0	121	115	0.14	0	
5	CRRG	MFRG	TRG	PRG	CRTG	MFTG	RECYCLE A TOTAL GAS
	2759.7	1.0	261	69	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
	7.19	0.4	128.4	279.0	0.0		
8	VSS	OLSS	GSS	SS			SPENT SHALE
	0.4	0.1	0.3	0.0			
9	COSS	ASSS	CSS	HSS	TSS		
	16.8	81.5	6.9	0.18	54.3		
10	OILLR	COL	HOL	DOL	WLP		LIQUID PRODUCT
	2565.9	84.1	11.1	7.788	193.5		
11	CRVG	MVFG	TVG	WG	OILM	M	VENT GAS
	1535.3	1.0	256	0.0	0.0	0	
12	CG	H	COOG	OG	NG		
	13.5	0	24.2	0.3	58.2		
13	MEG	COG	HIG	OTG	HG		
	2.4	4.1	6.7	4.1	1.20		
14	CRVP	VPMF	TVP	PVP			VENT PURGE
	5.2	2.2	174	27			
15	TYPC	VPOIL	VPW	GL			
	82	99.4	3.2	71.2			

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 Mst,
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 7-5-67

Run No. C1049-9

Sample Time: RS 0615; SS _____

<u>66B</u> FISCHER ASSAY		<input type="radio"/> RETORT SHALE MOISTURE
<input checked="" type="radio"/> RAW SHALE	<input checked="" type="radio"/> SPENT SHALE	<u>ET</u> <u>Est</u> <u>1.0</u> wt %
<u>28.8</u>	<u>0.3</u>	<input checked="" type="radio"/> RAW SHALE FISCHER ASSAY MOISTURE
<u>0.912</u>	<u>—</u>	<u>0.28</u> wt %
<u>11.1</u>	<u>0.1</u>	
<u>1.6</u>	<u>0.4</u>	
<u>84.5</u>	<u>99.2</u>	
<u>2.8</u>	<u>0.3</u>	
<u>slight</u>	<u>None</u>	

MINERAL CO₂

DK
 17.3 16.8 wt %

ET ASH (SHALE)
 66.7 81.5 wt %

ET MOISTURE
 0.37 0.06 wt %

DK CARBON
 17.3 6.90 wt %
 17.6

DK HYDROGEN
 1.84 0.18 wt %
 1.88

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 JUL 11 1967

CHECKED BY Rep

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 7/5/67

Run No. C1049-9

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
<i>EGB</i> WATER, wt %	<u>5.0</u>					
GRAVITY, °API	<u>19.8</u>					
<input type="radio"/> OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

W.C.

OIL WT, g 1193.0
 WATER VOL, ml 10.0
 GRAVITY OIL, °API 41.7

VENT GAS

W.C.

MAJOR COMPONENTS

CO₂ 24.2 vol %
 O₂ 0.3 "
 N₂ 57.5 "
 CH₄ 2.4 "
 CO 4.1 "
 H₂ 6.7 "
 Ar 0.7 "
 Others 4.1 "

C₁ thru C₄, plus n-Pentane

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

W.C.

CARBON, 13.5 lbs/MSCFDG

HYDROGEN, 1.20 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUL 6 1967

CHECKED BY PCP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1049-9 SAMPLE NO. I DATE 7-5-67
 UNIT #3 DESCRIPTION R.S. TY-LAB SAMPLE
 APPROX. SHALE SIZE 1/4 x 2 1/2 SHAKING TIME 10 ANALYSIS BY Smith & Lowery
 TOTAL SAMPLE WT. GROSS 83.1 - TARE 3.3 = NET 76.7

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	0		100.0
	2.00		29.1	20.2	8.9	2.00	2.250	0.4444	11.10		88.90
	1.50		29.3	23.5	5.8	1.50	1.750	0.5714	33.64		54.76
	1.05		34.6	19.1	15.5	1.05	(1.087) 1.275	(0.9199) 0.7843	20.21		34.55
	0.742		32.0	20.5	11.5	0.742	0.896	1.116	14.99		19.56
	0.525		25.3	18.6	6.7	0.525	0.634	1.577	8.74		10.82
	0.371		22.9	10.3	12.6	0.371	0.448	2.232	4.69		6.13
	0.263	3	21.0	14.5	6.5	0.263	0.317	3.154	3.26		2.87
	0.185	4	19.0	19.4	-0.4	0.185	0.224	4.464	0.52		2.35
	0.131	6	19.5	19.4	0	0.131	0.158	6.329	0		2.35
	0.093	8	20.5	20.5	0	0.093	0.112	8.928	0	97.65	2.35
	0.065	10	19.3	19.2	0.1	0.065			0.13		2.22
	PAN		22.7	21.0	1.7	PAN			2.22		0
TOTAL ON SCREENS AND PAN					76.7	LOSS					
LOSS (BY DIFFERENCE)						TOTAL					
TOTAL SAMPLE WEIGHT					76.7						

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

REMARKS: _____

$\sum_{+8m}^m D_i$		$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$		$\sum_{+8m}^m X_i / D_i$	0.93811
D _a	1.0300	$\sum_{+8m}^m X_i D_i$	1.32961
D _v	1.3616		