GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513018007

Date 6-21-67

Purpose: To determine operability and yield with 1/4 - 2 1/2 inch actual using hot dilution gas.

GENERAL	
Run No.	R-1 C1046-5
Length, hours	12
Retort Type Number	RC VII
Oil Recovery System Number	C-1
Tons Total Raw Shale Charged, ~~lbs.~~	98.51
Bed Height above Dist., ft	9 1/2
Type Air Dist.	AD XI
Bed Below Air Dist., ft	6
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft^2)	297
Spent Shale, % of RS	81.0
Liquid Product, lbs/hr	1704.7
Oil Collected, gal/ton RS	23.9
Air, SCF/ton RS (dry)	5190
Total Recycle*, SCF/ton RS(wet)	12800
Dilution, SCF/ton RS (wet)	1780
Calc. Vent Gas SCF/ton RS(dry)	6540
Gas Losses, SCF/ton RS(wet)	637
Propane, SCF/ton RS	18.1
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	141
Spent Shale, F	597
Raw Shale, °F	87
Recycle Gas Inlet, °F	272
Dilution Gas Inlet, °F	278
Air Inlet, °F	150
Retort Air Inlet, F	150
Heat of Comb. MBtu/ton RS	486
Heat Lost, MBtu/ton RS	20
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	28.7
Oil, Wt %	10.9
Water, Wt %	1.0
Gas, Wt %	1.5
Mineral CO_2, Wt %	17.9
Ash, Wt %	66.7
Moisture, Wt % (Uncrushed)	1.35
Carbon (Total), Wt %	17.6
Hydrogen (Total), Wt %	1.94
Nominal Size Range, inches	1/4-2 1/2
5 % passing thru	0.371
98 % passing thru	2.50
Da	1.104
Dv	1.508
Line Burner °F	705

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO_2, Wt %	15.9
Ash, Wt %	82.3
Carbon (total), Wt %	6.78
Organic Carbon, Wt %	2.44
Hydrogen (total), Wt %	0.21
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	99.0
Density, lb/gal	7.752
Gravity, API	20.7
Ash, Wt %	–
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	5.5
Oil, lbs/MSCF(dry)**	0.123
Analysis (dry)	
CO_2, Vol %	23.8
O_2, Vol %	0.5
N_2 + Argon, Vol %	62.8
CH_4, Vol %	2.1
CO, Vol %	3.2
H_2, Vol %	5.5
Other, Vol %	2.1
Gross Heating Value(calc), Btu/SCF	99.6
Carbon (Total), lbs/MSCF (dry)	11.6
Hydrogen (Total), lbs/MSCF (dry)	0.72
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	83.1
Oil in Gas**, Vol % RSFA	0.4
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	83.5
Carbonate Decomposition, %	28.0
Water Recovered, lb/ton RS	70.7
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	R.S. 100
Overall Balance, %	98.7
Carbon Balance, % - Organic	95.4
Carbon Balance, % - Total	97.6
Hydrogen Balance, % - Organic	86.0
Hydrogen Balance, % - Total	90.8
Water Balance, %	91.7
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.34
ΔP Above Air Dist., in H_2O/ft	0.33
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: Increased dilution - Dilution burning in header and causing pressure fluctuations.

*Measured Recycle + Dilution Gas
** Oil Mist + Condensibles to 98 °F
*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. [illegible] DATE July 17 1967

OSRC-10
Revised 7/19/66

//A100
2080, C1046-5 R-1 6-21-67

A. YIELDS

FAY	8.313E 01	DRYGAS	6.543E 03	MISTFA	3.620E-01
H2	3.598E 02	OTHER	1.374E 02	UNRETO	0.0
CH4	1.374E 02	02	3.271E 01	SSY	8.104E 01
CO	2.094E 02	CO2DEC	2.801E 01	MH2O	7.067E 01
CO2	1.557E 03	OILCOL	2.386E 01		

B. METERED GAS RATES

RECG	1.102E 04	DIL	1.775E 03	WVENTG	6.662E 03
AIR	5.193E 03	TRECG	1.279E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.921E 01	HVGT	6.513E 02	MWDG	3.050E 01
GBTU	9.955E 01				

D. COMBUSTION PRODUCTS

CO2C	6.572E 02	COC	1.985E 02	H2OC	2.901E 01
CHR	8.331E 00	COMBCP	1.060E 01		

E. MATERIAL IN

ORGCIN	2.560E 02	RSR	2.973E 02	ORH2IN	3.495E 01
MATIN	2.428E 03				

F. MATERIAL OUT

ORGCVG	4.922E 01	COKEC	3.954E 01	UNRETH	0.0
ORGCOL	1.553E 02	ORH2VG	8.052E 00	COKEH	2.678E 00
UNRETC	0.0	ORH2OL	2.050E 01	ORCOLP	6.068E 01
ORCVGP	1.923E 01	ORCSSP	1.545E 01	HCCVGP	8.631E 00

G. MATERIAL BALANCES

OVALL	9.874E 01	ORH2	8.937E 01	O2BAL	9.880E 01
ASH	0.0	TC	9.758E 01	WATER	9.165E 01
ORGC	9.536E 01	TH2	9.081E 01	GASL	6.371E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.857E 05	QH2OC	8.364E 03	QAIR	6.032E 03
QPROP	5.429E 01	QOILC	1.293E 04	QRCYL	4.992E 04
QSUMIN	5.630E 05				

I. HEAT OUT

QMCO2D	1.624E 05	QKEROD	9.920E 04	QH2OV	5.235E 04
QLIQO	3.698E 03	QOFGAS	2.263E 04	QSS	1.958E 05
QGASL	7.073E 03	LBLOSS	0.0	HETLOS	1.984E 04
QSUMOT	5.630E 05				

J. MISCELLANEOUS

ORCSS	2.439E 00	VPOIL	1.229E-01	TGL	2.892E 03
VPM	5.497E 00	WCG	1.036E 01	PROP	1.809E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS – DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080,	C-1046-5	R-1	6-21-67			
	WRS	OLRS	TRS	B	MRS		RAW SHALE
1	1.0	10.9	87	-1	16418.6		
	FA	GRS	CORS	XA			
2	28.7	1.5	17.9	55.22			
	ASRS	CRS	HRS	BP	TOG		
3	68.7	17.6	1.84	24.29	141		
	CRA	MFA	TA	PA	WA	LBHL	AIR
4	712.6	1.0	150	126	0.14	0	
	CRRG	MFRG	TRG	PRG	CRTG	MFTG	RECYCLE A TOTAL GAS
5	1516.3	1.0	272	75	0.0	0.0	
	CRDG	MFDG	TDG	PDG			DILUTION G
6	5.3	56.4	278	75			
	P	TP	PP	W	N		PROPANE A NUCLEATIN AGENT
7	2.85	0.4	129.7	224.7	0.0		
	WSS	OLSS	GSS	SS			SPENT SHALE
8	0.4	0.0	0.0	0.0			
	COSS	ASSS	CSS	HSS	TSS		
9	15.9	82.3	6.78	0.21	597		
	OILLP	COL	HOL	DOL	WLP		LIQUID PRODUCT
10	1516.3	84.1	11.1	7.742	188.4		
	CRVG	MFVG	TVG	WG	OILM	M	VENT GAS
11	1220.1	1.0	278	0.0	0.0	0	
	CG	H	COOG	OG	NG		
12	11.6	0	23.8	0.5	62.8		
	MEG	COG	HHG	OTG	HG		
13	2.1	3.2	5.5	2.1	0.72		
	CRVP	VPMF	TVP	PVP			VENT PURGE
14	4.3	2.09	199	44			
	TVPC	VPOIL	VPW	GL			
15	88	46.3	2.4	82.3			

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.

Mesh	Wt. Grams	Wt. %
8	127.7	24.3
14	157.8	30.2
28	91.4	17.4
35	36.4	6.9
48	21.9	4.2
65	20.0	3.8
100	19.6	3.7
150	15.2	2.9
Pan	34.5	6.6
Total	524.5	100.0 %

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-21-67 C1046-5 Run No. C1046-5

Sample Time: RS 15:15; SS _____

FISCHER ASSAY

RAW SHALE	SPENT SHALE	
28.4	0.0	Gal/Ton
0.910	—	S.G., g/ml
10.8	0.0	Oil, wt %
2.0	0.4	Water, wt %
85.7	99.6	Sp. Shale, ~~wt~~ %
1.5	0.0	Gas & Loss, wt %
slight	None	COKING TENDENCY

RETORT SHALE MOISTURE

1.35 wt %

RAW SHALE FISCHER ASSAY MOISTURE

1.01 wt %

MINERAL CO_2	17.8	15.9 wt %
ASH (SHALE)	66.5	82.3 wt %
MOISTURE	0.37	0.10 wt %
CARBON	17.5	6.78 wt %
HYDROGEN	1.83	0.21 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 CO_2", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS _____

DATE COMPLETED JUN 26 1967 CHECKED BY RPP

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-21-67 Run No. C1046-S

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	1.0					
GRAVITY, °API	20.7					
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 556.0

WATER VOL, ml 32.0

GRAVITY OIL, °API 40.4

VENT GAS

MAJOR COMPONENTS

CO_2	23.8	vol %
O_2	~~0.4~~ 0.5	"
N_2	62.0	"
CH_4	2.1	"
CO	3.2	"
H_2	5.5	"
Ar	0.8	"
Others	~~2.2~~ 2.1	"

C_1 thru C_4, plus n-Pentane

CH_4	.	vol %
C_2H_4-C_2H_6	.	"
C_3H_8	.	"
C_3H_6	.	"
i C_4H_{10}	.	"
n C_4H_{10}	.	"
$\not\alpha C_3H_6$	.	"
n C_5H_{12}	.	"

CARBON, 11.6 lbs/MSCFDG HYDROGEN, 0.72 lbs/MSCFDG

COMMENTS

DATE COMPLETED JUN 23 1967 CHECKED BY RCP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1046-5 SAMPLE NO. 5 DATE 6-21-67

UNIT retort 3 DESCRIPTION TY LAB

APPROX. SHALE SIZE [illegible] SHAKING TIME [illegible] ANALYSIS BY Lowery & Smith

TOTAL SAMPLE WT. GROSS 81.2 − TARE 6.6 = NET 74.6

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50		19.7	16.7	3.0
	2.00		33.95	20.2	13.75
	1.50		46.8	23.45	23.35
	1.05		31.75	19.25	12.50
	0.742		27.8	20.5	7.3
	0.525		24.2	18.5	5.7
	0.371		22.2	19.2	3.0
	0.263	3	20.8	18.4	2.4
	0.185	4	19.8	19.4	.4
	0.131	6	19.5	19.3	.2
	0.093	8	20.4	20.4	.0
	0.065	10	19.3	19.2	.1
	PAN		22.5	20.9	2.6
TOTAL ON SCREENS AND PAN					~~94~~.3
LOSS (BY DIFFERENCE)					.3
TOTAL SAMPLE WEIGHT					74.6

SCREEN SIZE	Di *	1/Di	% RETAINED	CUM. % RETAINED	% PASSING
4.25					
3.00	(3.125)	(0.3200)			
2.50	(2.625) 2.750	(0.3809) 0.3636	4.02		95.98
2.00	2.250	0.4444	18.43		77.55
1.50	1.750	0.5714	31.29		46.26
1.05	(1.087) 1.275	(0.9199) 0.7843	16.75		29.51
0.742	0.896	1.116	9.78		19.73
0.525	0.634	1.577	7.64		12.09
0.371	0.448	2.232	4.02		8.07
0.263	0.317	3.154	3.22		4.85
0.185	0.224	4.464	0.54		4.31
0.131	0.158	6.329	0.27		4.04
0.093	0.112	8.928	0	95.96	4.04
0.065			0.13		3.91
PAN			3.48		0.43
LOSS			0.40		0.03
TOTAL			99.97		

Recalculated with new tares

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

$\Sigma^{m}_{+8m} D_i$	1.447259	$\Sigma^{m}_{+8m} X_i$	
$1/\Sigma^{m}_{+8m} D_i$	0.86948	$\Sigma^{m}_{+8m} X_i / D_i$	
Da	1.10365	$\Sigma^{m}_{+8m} X_i D_i$	
Dv	1.50818		

REMARKS: