GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513018015

Date 6-25-67

Purpose: To determine operability and yield with 1/4 - 2 1/2 inch shale with hot air addition. (without dilution gas)

GENERAL	
Run No.	01047-3
Length, hours	12
Retort Type Number	RC VII
Oil Recovery System Number	C-1
Total Raw Shale Charged, lbs.	99.77
Bed Height above Dist., ft	9 1/2
Type Air Dist.	10 XI
Bed Below Air Dist., ft	6
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft^2)	301
Spent Shale, % of RS	81.4
Liquid Product, lbs/hr	1662.5
Oil Collected, gal/ton RS	23.4
Air, SCF/ton RS (dry)	4360
Total Recycle*, SCF/ton RS(wet)	13500
Dilution, SCF/ton RS (wet)	—
Calc. Vent Gas SCF/ton RS(dry)	5830
Gas Losses, SCF/ton RS(wet)	538
Propane, SCF/ton RS	20.7
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	140
Spent Shale, F	503
Raw Shale, °F	92
Recycle Gas Inlet, °F	250
Dilution Gas Inlet, °F	—
Air Inlet, °F	149
Retort Air Inlet, F	149
Heat of Comb. MBtu/ton RS	413
Heat Lost, MBtu/ton RS	3
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	28.8
Oil, Wt %	11.1
Water, Wt %	1.0
Gas, Wt %	2.4
Mineral CO_2, Wt %	17.9
Ash, Wt %	66.4
Moisture, Wt % (Uncrushed)	1.0
Carbon (Total), Wt %	17.7
Hydrogen (Total), Wt %	1.78
Nominal Size Range, inches	1/4" - 2 1/2"
5 % passing thru	0.371
98 % passing thru	2.50
D_a	1.023
D_v	1.417
Line Burner °F	910

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO_2, Wt %	16.5
Ash, Wt %	81.6
Carbon (total), Wt %	0.73
Organic Carbon, Wt %	2.23
Hydrogen (total), Wt %	0.26
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	97.2
Density, lb/gal	7.752
Gravity, API	20.5
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	5.1
Oil, lbs/MSCF(dry)**	0.171
Analysis (dry)	
CO_2, Vol %	24.5
O_2, Vol %	0.0
N_2 + Argon, Vol %	59.2
CH_4, Vol %	2.3
CO, Vol %	3.9
H_2, Vol %	6.4
Other, Vol %	3.7
Gross Heating Value(calc), Btu/SCF	134
Carbon (Total), lbs/MSCF (dry)	13.0
Hydrogen (Total), lbs/MSCF (dry)	1.01
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	81.4
Oil in Gas**, Vol % RSFA	0.4
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	81.8
Carbonate Decomposition, %	25.0
Water Recovered, lb/ton RS	54.7
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	R.S. 100
Overall Balance, %	98.8
Carbon Balance, % - Organic	93.4
Carbon Balance, % - Total	96.3
Hydrogen Balance, % - Organic	94.9
Hydrogen Balance, % - Total	95.2
Water Balance, %	87.6
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.35
ΔP Above Air Dist., in H_2O/ft	0.36
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: [illegible] pump gave trouble. [illegible] for about 1 hour.

*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 [illegible] DATE [illegible]

OSRC-10

C1047-3 6-25 -67

A. YIELDS

[illegible]	6.136E 01	DRYGAS	5.830E 03	MISTFA	4.471E-01
[illegible]	3.731E 02	OTHER	2.157E 02	UNRETO	0.0
[illegible]	1.341E 02	02	0.0	SSY	8.137E 01
[illegible]	2.274E 02	CO2DEC	2.499E 01	MH20	5.467E 01
[illegible]	1.426E 03	OILCOL	2.343E 01		

B. METERED GAS RATES

[illegible]	1.354E 04	DIL	0.0	WVENTG	5.919E 03
AIR	4.362E 03	TRECG	1.354E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

[illegible]	2.939E 01	HVGT	7.806E 02	MWDG	3.061E 01
GBTU	1.339E 02				

D. COMBUSTION PRODUCTS

CO2C	5.889E 02	COC	2.068E 02	H20C	2.157E 01
CHR	1.042E 01	COMBCP	9.767E 00		

E. MATERIAL IN

ORGCIN	2.562E 02	RSR	3.011E 02	ORH2IN	3.380E 01
MATIN	2.357E 03				

F. MATERIAL OUT

ORGCVG	5.223E 01	COKEC	3.622E 01	UNRETH	0.0
ORGCOL	1.526E 02	ORH2VG	8.417E 00	COKEH	3.502E 00
UNRETC	0.0	ORH2OL	2.016E 01	ORCOLP	5.916E 01
ORCVGP	2.022E 01	ORCSSP	1.403E 01	HCCVGP	1.046E 01

G. MATERIAL BALANCES

OVALL	9.631E 01	ORH2	9.491E 01	O2BAL	9.853E 01
ASH	0.0	TC	9.628E 01	WATER	8.763E 01
ORGC	9.341E 01	TH2	9.517E 01	GASL	5.384E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.132E 05	QH20C	8.398E 03	QAIR	4.586E 03
QPROP	5.646E 01	QOILC	1.272E 04	QRCYL	4.598E 04
QSUMIN	4.850E 05				

I. HEAT OUT

QHCO2D	1.449E 05	QKEROD	1.080E 05	QH20V	4.540E 04
QLIQC	3.244E 03	QOFGAS	2.028E 04	QSS	1.555E 05
QGASL	4.955E 03	LBLOSS	0.0	HETLOS	2.662E 03
QSUMOT	4.850E 05				

J. MISCELLANEOUS

ORCSS	2.226E 00	VPOIL	1.712E-01	TGL	2.930E 03
VPM	5.122E 00	WCG	9.723E 00	PROP	2.074E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS – DATA SHEET

PROGRAM ID	USER IDENTIFICATION
2080,	C 1047-3 6/25/67

	WRS	OLRS	TRS	B	MRS		
1	.0	11.1	92	-1	16628.6		← RAW SHALE
	FA	GRS	CORS	XA			
2	[illegible]	3.4	17.9	55.22			
	ASRS	CRS	HRS	BP	TOG		
3	[illegible]	17.7	1.78	24.38	190		
	CRA	MFA	TA	PA	WA	LBHL	
4	605.1	1.0	149	118	0.14	0	← AIR
	CRRG	MFRG	TRG	PRG	CRTG	MFTG	
5	1890.0	1.0	250	67	0.0	0.0	← RECYCLE A TOTAL GAS
	CRDG	MFDG	TDG	PDG			
6	0.0	0.0	0	0			← DILUTION G
	P	TP	PP	W	N		
7	3.31	6.4	128.3	168.0	0.0		← PROPANE A NUCLEATIN AGENT
	WSS	OLSS	GSS	SS			
8	0.4	0.0	0.0	0.0			← SPENT SHALE
	COSS	ASSS	CSS	HSS	TSS		
9	16.5	81.6	6.73	0.26	503		
	OILLP	COL	HOL	DOL	WLP		
10	1510.29	84.1	11.1	7.752	152.2		← LIQUID PRODUCT
	CRVG	MFVG	TVG	WG	OILM	M	
11	855.2	1.0	250	0.0	0.0	0	← VENT GAS
	CG	H	COOG	OG	NG		
12	13.0	0	29.5	0.0	59.2		
	MEG	COG	HHG	OTG	HG		
13	2.3	3.9	6.4	3.7	1.01		
	CRVP	VPMF	TVP	PVP			
14	2.6	2.19	160	39			← VENT PURGE
	TVPC	VPOIL	VPW	GL			
15	81	53.8	2.1	54.2			

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.

C1047-3 6-26-67 EA

Mesh	Wt grams	wt %
8	343.0	29.6
14	314.4	27.1
28	185.7	16.0
35	78.9	6.8
48	47.6	4.1
65	42.3	3.6
100	42.3	3.6
150	30.8	2.7
PAN	75.2	6.5
TOTAL	1160.2	100.0

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-25-67 Run No. C1047-3

Sample Time: RS 15:15; SS 23:15

FISCHER ASSAY

(X) RAW SHALE	(X) SPENT SHALE	
28.6	3.0	Gal/Ton
0.914	—	S.G., g/ml
11.0	3.0	Oil, wt %
1.6	0.4	Water, wt %
85.0	99.4	Sp. Shale, wt %
2.4	0.2	Gas & Loss, wt %
slight	NONE	COKING TENDENCY

( ) RETORT SHALE MOISTURE

____ wt %

(X) RAW SHALE FISCHER ASSAY MOISTURE

0.64 wt %

MINERAL CO_2

(X)	(X)	
17.9	16.5	wt %

ASH (SHALE)

(X)	(X)	
66.2	81.6	wt %

MOISTURE

(X)	(X)	
0.28	0.07	wt %

( ) SHALE RICHNESS DISTRIBUTION (See attached graph)

CARBON

(X)	(X)	
17.7	6.73	wt %

(X) SCREEN ANALYSIS (See back of this sheet)

HYDROGEN

(X)	(X)	
1.78	0.26	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 CO_2", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS

DATE COMPLETED JUN 27 1967 CHECKED BY KEP

OSRC-12A

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-25-67 Run No. C1047-3

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	2.8					
GRAVITY, °API	20.5					
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 714.2

WATER VOL, ml 30.0

GRAVITY OIL, °API 43.0

VENT GAS

MAJOR COMPONENTS

CO_2	24.5	vol %
O_2	0.0	"
N_2	59.5	"
CH_4	2.3	"
CO	3.9	"
H_2	6.4	"
Ar	0.7	"
Others	3.7	"

CARBON, 13.04 lbs/MSCFDG

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}	.	"
ϕC_3H_6	.	"
n C_5H_{12}	.	"

HYDROGEN, 1.01 lbs/MSCFDG

COMMENTS

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 01047-3 SAMPLE NO. _____ DATE 6-25-67

UNIT [illegible] DESCRIPTION [illegible]

APPROX. SHALE SIZE ¼-½ SHAKING TIME 15 min ANALYSIS BY [illegible]

TOTAL SAMPLE WT. GROSS 110.9 - TARE 6.5 = NET 73.4 ?

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50		18.6	16.7	1.9
	2.00		31.5	20.2	11.3
	1.50		46.5	23.4	23.1
	1.05		31.1	19.2	11.9
	0.742		23.1	20.5	2.6
	0.525		21.2	18.5	1.8
	0.371		22.4	19.2	3.2
	0.263	3	21.2	18.4	2.9
	0.185	4	20.0	19.4	.6
	0.131	6	19.5	19.4	.1
	0.093	8	20.4	20.4	0
	0.065	10	19.2	19.2	.1
	PAN		22.2	20.8	1.4
TOTAL ON SCREENS AND PAN					72.9
LOSS (BY DIFFERENCE)					.5
TOTAL SAMPLE WEIGHT					73.4

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	2.61		97.40
2.00	2.250	0.4444	15.50		81.90
1.50	1.750	0.5714	31.69		50.21
1.05	(1.087) 1.275	(0.9199) 0.7843	16.32		33.89
0.742	0.896	1.116	11.80		22.09
0.525	0.634	1.577	10.70		11.39
0.371	0.448	2.232	4.39		7.00
0.263	0.317	3.154	3.98		3.02
0.185	0.224	4.464	0.82		2.20
0.131	0.158	6.329	0.14		2.06
0.093	0.112	8.928	0.00	97.95	2.06
0.065			0.14		1.92
PAN			1.92		0.00
LOSS			—	—	—
TOTAL			100.01	—	—
			—	—	—

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

$\sum_{+8m}^{m} Di$	1.38783	$\sum_{+8m}^{m} Xi$	
$1/\sum_{+8m}^{m} Di$	0.95730	$\sum_{+8m}^{m} Xi/Di$	
Da	1.02319	$\sum_{+8m}^{m} Xi\ Di$	
Dv	1.41687		

REMARKS: _____

OSRC-4