GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513014007

Exploratory Runs

Date 4-23-67

Purpose: To start-up with 3/4 - 2 1/2 in shale and determine operability before changing to 1/2 - 2 1/2 inch shale.

GENERAL	
Run No.	C-103-Z
Length, hours	12
Retort Type Number	AC-III
Oil Recovery System Number	C-2
Tons Total Raw Shale Charged, ~~lbs.~~	16403
Bed Height above Dist., ft	10½'
Type Air Dist.	AD-IX
Bed Below Air Dist., ft	7'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft²)	495
Spent Shale, % of RS	81.9
Liquid Product, lbs/hr	2608.1
Oil Collected, gal/ton RS	21.9
Air, SCF/ton RS (dry)	4690
Total Recycle*, SCF/ton RS(wet)	12700
Dilution, SCF/ton RS (wet)	—
Calc. Vent Gas SCF/ton RS(dry)	5990
Gas Losses, SCF/ton RS(wet)	-436
Propane, SCF/ton RS	—
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	139
Spent Shale, F	383
Raw Shale, °F	60
Recycle Gas Inlet, °F	219
Dilution Gas Inlet, °F	—
Air Inlet, °F	135
Retort Air Inlet, F	135
Heat of Comb. MBtu/ton RS	438
Heat Lost, MBtu/ton RS	34
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	26.0
Oil, Wt %	9.9
Water, Wt %	1.1
Gas, Wt %	1.8
Mineral CO_2, Wt %	17.1
Ash, Wt %	68.9
Moisture, Wt % (Uncrushed)	1.0 Est.
Carbon (Total), Wt %	16.0
Hydrogen (Total), Wt %	1.67
Nominal Size Range, inches	3/4"-2½
5 % passing thru	0.742
98 % passing thru	2.50
Da	1.236
D_v	1.469

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.4
Mineral CO_2, Wt %	14.2
Ash, Wt %	84.1
Carbon (total), Wt %	6.00
Organic Carbon, Wt %	2.12
Hydrogen (total), Wt %	0.13
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	94.2
Density, lb/gal	7.799
Gravity, API	19.6
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	6.9
Oil, lbs/MSCF(dry)**	0.035
Analysis (dry)	
CO_2, Vol %	25.5
O_2, Vol %	0.5
N_2 + Argon, Vol %	61.9
CH_4, Vol %	1.9
CO, Vol %	3.9
H_2, Vol %	5.5
Other, Vol %	0.8
Gross Heating Value(calc), Btu/SCF	114.3
Carbon (Total), lbs/MSCF (dry)	12.8
Hydrogen (Total), lbs/MSCF (dry)	0.85
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	84.4
Oil in Gas**, Vol % RSFA	0.1
Oil in Spent Shale, Vol % RSFA	0.8
Total Oil Meas., Vol % RSFA	95.3
Carbonate Decomposition, %	32.0
Water Recovered, lb/ton RS	65.9
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	RS-100
Overall Balance, %	98.9
Carbon Balance, % - Organic	99.6
Carbon Balance, % - Total	99.7
Hydrogen Balance, % - Organic	93.7
Hydrogen Balance, % - Total	94.1
Water Balance, %	91.3
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.58
ΔP Above Air Dist., in H_2O/ft	0.61
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: Operations Good.

*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 May 17, 1967

OSRC-10
Revised 7/19/66

921, RUN NO. C1031-2 Started 11/23/6· 11/28/67

YIELDS

FAY	8.439 01	DRYGAS	5.992 03	MISTFA	1.033-01		
H2	3.295 02	OTHER	4.794 01	UNRETO	8.275-01	CH4	1.132 02
O2	2.996 01	SSY	3.192 01	CO	2.337 02	CO2DEC	3.196 01
MH2O	6.591 01	CO2	1.528 03	OILCOL	2.194 01		

METERED GAS RATES

RECG	1.265 04	DIL	0.000 00	WVENTG	7.297 03	AIR	4.687 03
TRECG	1.265 04	TGF	0.000 00				

MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.898 01	HVGT	6.849 02	MWDG	3.057 01	GBTU	1.143 02

COMBUSTION PRODUCTS

CO2C	5.393 02	COC	2.196 02				
H2OC	2.936 01	CHR	7.300 00	CCMBCP	1.051 01		

MATERIAL IN

ORGCIN	2.266 02	RSR	4.950 02	ORH2IN	3.093 01	MATIN	2.379 03

MATERIAL OUT

ORGCVG	4.706 01	COKEC	3.284 01	UNRETH	2.090-01		
ORGCOL	1.439 02	ORH2VG	3.408 00	COKEH	1.370 00	UNRETC	1.951 00
ORH2OL	1.899 01	ORCOLP	6.350 01	ORCVGP	2.076 01	ORCSSP	1.535 01
HCCVGP	1.015 01						

MATERIAL BALANCES

OVALL	9.893 01	ORGH2	9.368 01				
O2BAL	9.877 01	ASH	0.000 00	TC	9.972 01	WATER	9.126 01
ORGC	9.962 01	TH2	9.410 01	BASL	-4.358 02	ASHB	-1.000 00

HEAT IN

QCOMB	4.377 05	QH2OC	6.341 03	QAIR	6.465 03		
QPROP	0.000 00	QCILC	1.197 04	QRCYL	4.112 04	QSUMIN	5.037 05

HEAT OUT

QWCO2D	1.771 05	QKEROD	9.223 04	QH2OV	4.797 04		
QLIQC	4.890 03	QOFGAS	3.243 04	QSS	1.179 05	QGASL	-2.946 03
LBLOSS	0.000 00	HEILOS	3.397 04	QSUMOT	5.037 05		

MISCELLANEOUS

CRCSS	2.123 00	VPOIL	3.498-02	TGL	4.938 03	VPX	6.894 00
WCG	1.266 01	PROP	0.000 00				

MATERIAL AND HEAT BALANCE INPUT SHEET

RIF92	, RUN NO.	C-1-2	STARTED	4-23-	CALC. ON	4-28-6

RAW SHA BAROMETR PRESSU AND OFFG TEMPERATU

1.0	9.9	60	-1	27337.7
H_2O, wt%	Oil, wt%	°F	(1)	Rate, lbs/Hr

26.0	1.8	17.1	55.22
Oil, gal/T	Gas+L, wt%	CO_2, wt%	Retort XS, ft^2

68.9	16.0	1.67	24.10	139
Ash, wt%	Carbon, wt%	H_2, wt%	Bar. Press, " Hg	Offgas Temp, °F

AIR

1075.4	1.0	135	107	0.014	0
Chart Reading	Meter Factor	Temp, °F	Press, "H_2O gauge	Moist, lbs/MSCF	Heat Loss, Btu/Hr

RECYCLE A TOTAL GAS

2900.7	1.0	219	72	0.0	0.0
Recycle Ch Read	Meter Factor	Temp, °F	Press, "H_2O gauge	Tot Gas Ch Read	Meter Factor

DILUTIO GAS

0.0	0.0	0	0
Dil Gas Ch. Read	Meter Factor	Temp, °F	Press, "H_2O gauge

PROPANE, WA & NUCLEATI AGENT

0.0	0	0	2761	0.0
C_3 Rotameter R.	Temp, °F	Press, "H_2O gauge	Water added, lbs/Hr	Nucl. Agent, lb/Hr.

SPENT SHALE

0.3	0.1	0.1	0.0
H_2O, wt%	Oil, wt%	Gas, wt%	Purge, lbs/Hr

14.2	84.1	6.00	0.13	383
CO_2, wt%	Ash, wt%	Carbon, wt%	H_2, wt%	Temp, °F

LIQUID PRODUCT

2339.1	84.1	11.1	70.799	269.0
Dry Oil, lbs/Hr	Carbon, wt%	H_2, wt%	Den, lbs/gal	Water, lbs/Hr

VENT + DILUTIO GAS, VENT PU GAS, AN TOP SEA GAS

1684.0	1.00	250	0.00	0.0	0	12.8
Vent + Dil Gas Chart Reading	Meter Factor	Temp, °F	Moist, lbs/MSCF	Mist, lbs/MSCF	(2)	Carbon, lbs/MSCF

0	25.5	0.5	61.9	1.9	3.9	5.5
(3)	CO_2, vol%	O_2, vol%	N_2, vol%	CH_4, vol%	CO_2, vol%	H_2, vol%

0.8	0.85	3.4
Others, vol%	H_2, lbs/MSCF	V. Purge Ch. Reading

1.83	144	135	75	11.9	4.1	20.2
Meter Factor	Temp, °F	Press "H_2O gauge	Cond. Gas Out Temp, °F	Dry Oil, gm/Hr	Water lbs/Hr	Top Seal Gas Rate, SCFH

OPTIONS:

(1) Insert "0" to calc. with measured rates; "1" to calc. with spent shale rate and ash analyses; "-1" to calc. with raw shale rate and ash analyses.

(2) Insert "1" to calc. with measured moisture and mist; "0" to calc. from vent purge data.

(3) Insert "0" for Retort No.3 (pressure and temperature have no effect on gas rates); "1" for Retort No. 1&2 (pressure and temperature have effect on gas rates).

LBGilmore
1/17/67

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-24-67 Run No. C1031-2

Sample Time: RS 0615; SS 1115

FISCHER ASSAY

(X) RAW SHALE (X) SPENT SHALE

25.8	0.4	Gal/Ton
.912	.901	S.G., g/ml
9.8	0.1	Oil, wt %
1.8	0.3	Water, wt %
86.6	99.5	Sp. Shale, wt %
1.8	0.1	Gas & Loss, wt %
Slight	None	COKING TENDENCY

( ) RETORT SHALE MOISTURE

1.0 Est. wt %

(X) RAW SHALE FISCHER ASSAY MOISTURE

0.73 wt %

MINERAL CO_2

(X) 17.0 (X) 14.2 wt %

ASH (SHALE)

(X) 68.6 (X) 54.1 wt %

MOISTURE

(X) 0.41 (X) 0.11 wt %

( ) SHALE RICHNESS DISTRIBUTION (See attached graph)

CARBON

(X) 15.9 (X) 6.0 wt %

( ) SCREEN ANALYSIS (See back of this sheet)

HYDROGEN

(X) 1.66 (X) 0.13 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 APR 27 1967 CHECKED BY REP

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-24-67 Run No. C 1031-2

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
PVA ⊗ WATER, wt %	5.8					
PVA ⊗ GRAVITY, °API	19.6					
◯ OIL ASH, wt %						

◯ DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

PVA ⊗ OIL WT, g 142.5

PVA ⊗ WATER VOL, ml 186.0

PVA ⊗ GRAVITY OIL, °API 41.0

VENT GAS

RK ⊗ MAJOR COMPONENTS

CO_2	25.5	vol %
O_2	0.5	"
N_2	61.2	"
CH_4	1.9	"
CO	3.9	"
H_2	5.5	"
Ar	0.7	"
Others	0.3	"

◯ 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}	.	"
$\emptyset C_3H_6$	.	"
n C_5H_{12}	.	"

JA ⊗ CARBON, 12.8 lbs/MSCFDG

⊗ HYDROGEN, 0.85 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED _____ CHECKED BY _____

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 1031-2 SAMPLE NO. ______ DATE 4-24-67

UNIT Retort DESCRIPTION Ty Lab

APPROX. SHALE SIZE 3/4"-2½" SHAKING TIME 10 min ANALYSIS BY Antonelli & Smith

TOTAL SAMPLE WT. GROSS 71.3 − TARE 5.3 = NET 66.0

SCREEN SIZE			WEIGHTS								
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED	SCREEN SIZE	Di *	1/Di	% 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			100
	2.00		30.7	20.2	10.5	2.00	2.250	0.4444	15.71		84.29
	1.50		44.4	23.4	21.4	1.50	1.750	0.5714	32.03		52.26
	1.05		35.7	19.2	16.5	1.05	(1.087) 1.275	(0.9193) 0.7843	24.70		27.56
	0.742		32.1	20.5	11.6	0.742	0.896	1.116	17.36		10.20
	0.525		22.6	18.5	4.1	0.525	0.634	1.577	6.14		4.06
	0.371		19.6	19.3	.3	0.371	0.448	2.232	0.45		3.61
	0.263	3	18.5	18.3	.2	0.263	0.317	3.154	0.30		3.31
	0.185	4	19.5	19.4	.1	0.185	0.224	4.464	0.15		3.16
	0.131	6	19.5	19.4	.1	0.131	0.158	6.329	.15		3.01
	0.093	8	20.8	20.7	.1	0.093	0.112	8.928	.15	97.14	2.86
	0.065	10	19.3	19.2	.1	0.065			.15		2.71
	PAN		22.8	21.0	1.8	PAN			2.69		0
TOTAL ON SCREENS AND PAN					66.8	LOSS					
LOSS (BY DIFFERENCE)					.2	TOTAL			99.98		
TOTAL SAMPLE WEIGHT					[illegible]						

003961

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

$\Sigma^m_{+8m} D_i$	1.427106	$\Sigma^m_{+8m} X_i$	
$1/\Sigma^m_{+8m} D_i$	0.78621	$\Sigma^m_{+8m} X_i / D_i$	
Da	1.23554	$\Sigma^m_{+8m} X_i D_i$	
Dv	1.46912		

REMARKS: There is a 1 pound difference between Bucket wts & sum of screens. Bad workmanship.

OSRC-4