GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513014010

Exploratory Runs

Date 4-25-67

Purpose: To determine operability and yield with ½ - 2½ mm shale after transition from ¾ x ½ mm shale.

GENERAL	
Run No.	C1032-3
Length, hours	12
Retort Type Number	RC-VI
Oil Recovery System Number	C-2
Tons Total Raw Shale Charged, lbs.	166.38
Bed Height above Dist., ft	9½'
Type Air Dist.	AD-IX
Bed Below Air Dist., ft	7'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft²)	502
Spent Shale, % of RS	82.2
Liquid Product, lbs/hr	2570.7
Oil Collected, gal/ton RS	19.8
Air, SCF/ton RS (dry)	4590
Total Recycle*, SCF/ton RS(wet)	12600
Dilution, SCF/ton RS (wet)	—
Calc. Vent Gas SCF/ton RS(dry)	5980
Gas Losses, SCF/ton RS(wet)	-66
Propane, SCF/ton RS	—
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	140
Spent Shale, °F	371
Raw Shale, °F	64
Recycle Gas Inlet, °F	140
Dilution Gas Inlet, °F	—
Air Inlet, °F	136
Retort Air Inlet, °F	136
Heat of Comb. MBtu/ton RS	426
Heat Lost, MBtu/ton RS	27
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	24.7
Oil, Wt %	9.4
Water, Wt %	1.2
Gas, Wt %	1.8
Mineral CO_2, Wt %	17.8
Ash, Wt %	68.6
Moisture, Wt % (Uncrushed)	1.0 est
Carbon (Total), Wt %	15.9
Hydrogen (Total), Wt %	1.69
Nominal Size Range, inches	½"-2½"
5 % passing thru	0.525
98 % passing thru	2.50
Da	1.168
Dv	1.449

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.2
Mineral CO_2, Wt %	15.0
Ash, Wt %	83.5
Carbon (total), Wt %	6.16
Organic Carbon, Wt %	2.07
Hydrogen (total), Wt %	0.18
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	91.4
Density, lb/gal	7.820
Gravity, API	19.2
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	9.3
Oil, lbs/MSCF(dry)**	0.008
Analysis (dry)	
CO_2, Vol %	25.9
O_2, Vol %	0.5
N_2 + Argon, Vol %	60.8
CH_4, Vol %	1.8
CO, Vol %	3.9
H_2, Vol %	5.3
Other, Vol %	1.9
Gross Heating Value(calc), Btu/SCF	120.6
Carbon (Total), lbs/MSCF (dry)	13.1
Hydrogen (Total), lbs/MSCF (dry)	0.92
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	80.3
Oil in Gas**, Vol % RSFA	0.0
Oil in Spent Shale, Vol % RSFA	0.9
Total Oil Meas., Vol % RSFA	81.2
Carbonate Decomposition, %	30.8
Water Recovered, lb/ton RS	89.0
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	RS-100
Overall Balance, %	99.8
Carbon Balance, % - Organic	96.4
Carbon Balance, % - Total	97.5
Hydrogen Balance, % - Organic	89.5
Hydrogen Balance, % - Total	98.7
Water Balance, %	125.5
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.62
ΔP Above Air Dist., in H_2O/ft	0.71
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: Operations during the period became erratic. May have been due to the injection of the liquid system into the bed. Off gas temperatures split and strong tar encrusted uneven shale flow. Unit had to be shut down shortly after this balance was completed.

*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. Farmer DATE May 17, 1967

OSRC-10

921, RUN NO. C1032-3

YIELDS

FAY	8.028 01	DRYGAS	5.975 03	MISFA	2.346-02		
H2	3.167 02	OTHGR	1.135 02	UNRETO	3.739-01	CH4	1.075 02
C2	2.987 01	SSY	8.215 01	CO	2.270 02	C02DSC	3.070 01
MH2O	8.903 01	C02	1.547 03	OILCOL	1.983 01		

METERED GAS RATES

RECG	1.261 04	OIL	0.000 00	WVENTG	7.214 03	AIR	4.591 03
TRECG	1.261 04	TGF	0.000 00				

MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.878 01	HVGT	7.203 02	MWDG	3.089 01	GBTU	1.206 02

COMBUSTION PRODUCTS

C02C	5.571 02	COC	2.129 02				
H2OC	2.605 01	CHR	8.347 00	COMBCP	1.105 01		

MATERIAL IN

ORGCIN	2.208 02	RSR	5.021 02	ORH2IN	3.111 01	MATIN	2.379 03

MATERIAL OUT

ORGCVG	4.844 01	COKEC	3.254 01	UNRETH	1.823-01		
ORGCOL	1.304 02	ORH2VG	6.423 00	COKEH	2.030 00	UNRETO	1.381 00
ORH2OL	1.721 01	ORGOLP	5.906 01	ORGVGP	2.194 01	ORGSGP	1.536 01
HCCVGP	1.048 01						

MATERIAL BALANCES

OVALL	9.980 01	ORGH2	3.954 01				
O2BAL	1.044 02	ASH	0.000 00	TC	9.747 01	WATER	1.255 02
ORGC	9.637 01	TH2	9.867 01	GASL	-6.629 01	ASHR	-1.000 00

HEAT IN

QCOMB	4.258 05	QH2OC	8.478 03	QAIR	6.031 03		
QPROP	0.000 00	QOILC	1.035 04	QRCYL	4.088 04	QSUMIN	4.921 05

HEAT OUT

QXC02D	1.774 05	QKEROD	8.894 04	QH2OV	5.055 04		
QLIQC	4.282 03	QOFGAS	3.181 04	QSS	1.123 05	QGASL	-4.329 02
LBLOSS	0.000 00	HETLOS	2.718 04	QSUMOT	4.921 05		

MISCELLANEOUS

ORCSS	2.065 00	VPOIL	7.585-03	TGL	4.978 03	VPX	9.328 00
WCG	1.639 01	PROP	0.000 00				

MATERIAL AND HEAT BALANCE INPUT SHEET

RIF 921 , RUN NO. C 32-3 STARTED 4-25- CALC. ON 4-28-6

RAW SHA / BAROMETR / PRESSU / AND / OFFG / TEMPERATU

1.02	9.04	64	-1	27729.2
H_2O, wt%	Oil, wt%	°F	(1)	Rate, lbs/Hr

24.7	1.8	17.8	55.22
Oil, gal/T	Gas+L, wt%	CO_2, wt%	Retort XS, ft²

68.6	15.9	1.69	24.15	140
Ash, wt%	Carbon, wt%	H_2, wt%	Bar. Pres., " Hg	Offgas Temp, °F

AIR

1067.3	1.0	136	109	0.014	0
Chart Reading	Meter Factor	Temp, °F	Press, "H_2O gauge	Moist, lbs/MSCF	Heat Loss, Btu/Hr

RECYCLE A / TOTAL GAS

2919.5	1.0	220	75	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	280.1	0.0
C_3 Rotameter R.	Temp, °F	Press, "H_2O gauge	Water added, lbs/Hr	Nucl. Agent, lb/Hr.

SPENT SHALE

0.4	0.1	0.0	0.0
H_2O, wt%	Oil, wt%	Gas, wt%	Rate, lbs/Hr

15.0	83.5	6.16	0.18	371
CO_2, wt%	Ash, wt%	Carbon, wt%	H_2, wt%	Temp, °F

LIQUID PRODUCT

2150.1	84.1	11.1	7.820	370.5
Dry Oil, lbs/Hr	Carbon, wt%	H_2, wt%	Den, lbs/gal	Water, lbs/Hr

VENT + / DILUTION / GAS, / VENT PU / GAS, AN / TOP SEA / GAS

16820.7	1.0	242	0.0	0.0	0	1301
Vent+Dil Gas Chart Reading	Meter Factor	Temp, °F	Moist, lbs/MSCF	Mist, lbs/MSCF	(2)	Carbon, lbs/MSCF

0	25.9	0.5	60.8	1.8	3.8	5.3
(3)	CO_2, vol%	O_2, vol%	N_2, vol%	CH_4, vol%	CO, vol%	H_2, vol%

1.9	0.92	3.2
Others, vol%	H_2, lbs/MSCF	V. Purge Ch. Reading

1.083	144	138	75	2.5	5.7	22.4
Meter Factor	Temp, °F	Press "H_2O gauge	Cond. Gas Out Temp, °F	Dry Oil, gal/Hr	Water lbs/Hr	Top Seal Gas Rate, SCFM

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).

LRGilmore
1/17/67

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-25-67 Run No. C1032-3

Sample Time: RS 1815; SS 2315

FISCHER ASSAY

RAW SHALE	SPENT SHALE	
24.5	0.2	Gal/Ton
0.911	—	S.G., g/ml
9.3	0.1	Oil, wt %
2.2	0.4	Water, wt %
86.7	99.5	Sp. Shale, wt %
1.8	0.0	Gas & Loss, wt %
slight	—	COKING TENDENCY

MINERAL CO_2

17.7	15.0	wt %

ASH (SHALE)

68.4	83.5	wt %

MOISTURE

0.34	0.11	wt %

CARBON

15.3	0.16 +0.63	wt %

HYDROGEN

1.68 ~~6.16~~	0.18	wt %

BENZENE EXTRACTABLES

.	.	wt %

RETORT SHALE MOISTURE

1.0 Est wt %

RAW SHALE FISCHER ASSAY MOISTURE

1.0 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 APR 27 1967 CHECKED BY RSP

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-25-67 Run No. C1032-3

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	8.6					
GRAVITY, °API	19.2					
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 3009

WATER VOL, ml 0.09

GRAVITY OIL, °API 42.1

VENT GAS

MAJOR COMPONENTS

CO_2	25.9	vol %
O_2	0.5	"
N_2	60.1	"
CH_4	1.3	"
CO	3.3	"
H_2	5.3	"
Ar	0.7	"
Others	1.9	"

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}	.	"

CARBON, 13.1 lbs/MSCFDG

HYDROGEN, 0.92 lbs/MSCFDG

COMMENTS

DATE COMPLETED APR 27 1967 CHECKED BY REP

OSRC-12B

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C-1033-3 SAMPLE NO. _____ DATE 4-25-67

UNIT Retort "3" DESCRIPTION Fr. Sh.

APPROX. SHALE SIZE ½ - 2½ SHAKING TIME 10 min ANALYSIS BY Schaft & Hirsch

TOTAL SAMPLE WT. GROSS 70.2 - TARE 6.6 = NET 68.6 "

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50		18.2	16.6	1.6
	2.00		27.1	20.2	6.9
	1.50		49.4	23.4	26.0
	1.05		34.8	19.2	15.6
	0.742		29.5	20.5	9.0
	0.525		24.5	18.5	6.0
	0.371		20.9	19.3	1.6
	0.263	3	18.8	18.3	.5
	0.185	4	19.5	19.3	.2
	0.131	6	19.4	19.3	.1
	0.093	8	20.7	20.6	.1
	0.065	10	19.2	19.2	.0
	PAN		21.7	20.9	.8
TOTAL ON SCREENS AND PAN					68.4
LOSS (BY DIFFERENCE)					"
TOTAL SAMPLE WEIGHT					68.6

SCREEN SIZE	Di *	1/Di	% RETAINED	CUM. % RETAINED	% PASSING
4.25					
3.00	(3.125)	(0.3200)			100
2.50	(2.625) 2.750	(0.3609) 0.3636	2.34		97.66
2.00	2.250	0.4444	10.09		87.57
1.50	1.750	0.5714	38.01		49.56
1.05	(1.087) 1.275	(0.9199) 0.7843	22.81		26.75
0.742	0.896	1.116	13.16		13.59
0.525	0.634	1.577	8.77		4.82
0.371	0.448	2.232	2.34		2.48
0.263	0.317	3.154	0.73		1.75
0.185	0.224	4.464	0.29		1.46
0.131	0.158	6.329	0.15		1.31
0.093	0.112	8.928	0.15	98.84	1.16
0.065			0		1.16
PAN			1.17		0
LOSS					
TOTAL			100.01		

75.1

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

$\Sigma_{+8m}^{m} Di$	1.43182	$\Sigma_{+8m}^{m} Xi$	
$1/\Sigma_{+8m}^{m} Di$	0.84609	$\Sigma_{+8m}^{m} Xi / Di$	
Da	1.16819	$\Sigma_{+8m}^{m} Xi\ Di$	
Dv	1.44862		

REMARKS: _____

OSRC-4

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-28-67 Run No. C 1033 START UP

Sample Time: RS 0615; SS _____

FISCHER ASSAY

Rx (X) RAW SHALE ( ) SPENT SHALE

26.2	.	Gal/Ton
.914	.	S.G., g/ml
10.0	.	Oil, wt %
1.8	.	Water, wt %
86.2	.	Sp. Shale, wt %
2.0	.	Gas & Loss, wt %
Slight		COKING TENDENCY

MINERAL CO_2

ptd (X) 17.6 ( ) . wt %

ASH (SHALE)

ptd (X) 67.9 ( ) . wt %

MOISTURE

ptd (X) 0.30 ( ) . wt %

CARBON

ptd (X) 6.3 ( ) . wt %

HYDROGEN

ptd (X) 1.67 ( ) . wt %

BENZENE EXTRACTABLES

( ) . ( ) . wt %

( ) RETORT SHALE MOISTURE

_____ wt %

ptd (X) RAW SHALE FISCHER ASSAY MOISTURE

0.65 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 MAY 1 1967 CHECKED BY RCP

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-28-67 Run No. C1033 Transition start up

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	27.3					
GRAVITY, °API	19.8					

OIL ASH, wt % _____

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g _____

WATER VOL, ml _____

GRAVITY OIL, °API _____

VENT GAS

MAJOR COMPONENTS

CO_2	.	vol %
O_2	.	"
N_2	.	"
CH_4	.	"
CO	.	"
H_2	.	"
Ar	.	"
Others	.	"

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}	.	"

CARBON, . lbs/MSCFDG HYDROGEN, . lbs/MSCFDG

COMMENTS _____

DATE COMPLETED MAY 1 1967 CHECKED BY _____