

Exploratory Run

Date 4-23-67

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

GENERAL	
Run No.	C-1031-1
Length, hours	12
Retort Type Number	RC-VI
Oil Recovery System Number	C-2
Total Raw Shale Charged, lbs.	163.8
Bed Height above Dist., ft	10 1/2'
Type Air Dist.	AD-IX
Bed Below Air Dist., ft	7'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft ²)	494
Spent Shale, % of RS	81.8
Liquid Product, lbs/hr	2655.2
Oil Collected, gal/ton RS	21.7
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)	6090
Gas Losses, SCF/ton RS(wet)	-251
Propane, SCF/ton RS	-
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, OF	137
Spent Shale, F	369
Raw Shale, OF	57
Recycle Gas Inlet, OF	218
Dilution Gas Inlet, OF	-
Air Inlet, OF	135
Retort Air Inlet, F	135
Heat of Comb. MBtu/ton RS	437
Heat Lost, MBtu/ton RS	33
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	25.9
Oil, Wt %	9.9
Water, Wt %	1.2
Gas, Wt %	2.0
Mineral CO ₂ , Wt %	17.5
Ash, Wt %	68.5
Moisture, Wt % (Uncrushed)	1.0 Est.
Carbon (Total), Wt %	15.8
Hydrogen (Total), Wt %	1.58
Nominal Size Range, inches	3/4" - 2 1/2"
5 % passing thru	0.742
98 % passing thru	2.50
D _a	1.335
D _v	1.555

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO ₂ , Wt %	14.7
Ash, Wt %	83.7
Carbon (total), Wt %	6.23
Organic Carbon, Wt %	2.22
Hydrogen (total), Wt %	0.16
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	90.0
Density, lb/gal	7.804
Gravity, API	19.5
Ash, Wt %	-
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	7.3
Oil, lbs/MSCF(dry)**	0.006
Analysis (dry)	
CO ₂ , Vol %	25.2
O ₂ , Vol %	0.5
N ₂ + Argon, Vol %	61.7
CH ₄ , Vol %	1.9
CO, Vol %	4.0
H ₂ , Vol %	5.5
Other, Vol %	1.2
Gross Heating Value(calc), Btu/SCF	113.7
Carbon (Total), lbs/MSCF (dry)	12.8
Hydrogen (Total), lbs/MSCF (dry)	6.83
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	83.8
Oil in Gas**, Vol % RSFA	0.0
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	83.8
Carbonate Decomposition, %	31.3
Water Recovered, lb/ton RS	76.1
Ash Balance, % - As Measured	-
Ash Balance, % - Assumed	15-100
Overall Balance, %	99.3
Carbon Balance, % - Organic	102.9
Carbon Balance, % - Total	102.0
Hydrogen Balance, % - Organic	100.3
Hydrogen Balance, % - Total	103.1
Water Balance, %	102.6
MISCELLANEOUS	
Avg. Retort ΔP, in H ₂ O/ft	0.56
ΔP Above Air Dist., in H ₂ O/ft	0.62
NaCl Soln., Wt %	-
NaCl Rate, gal/ton RS	-

Comments: operations good

*Measured Recycle + Dilution Gas
 ** Oil Mist + Condensibles to 75 OF
 *** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl S. Jumper DATE May 17, 1967

921, RUN NO. C1031-1

Started 4/25/69

4/26/69
etc

YIELDS

FAY	8.379 01	DRYGAS	6.089 03	MISTFA	1.853-02		
H2	3.349 02	OTHER	7.307 01	UNRETC	0.000 00	CH4	1.157 02
O2	3.044 01	SSY	8.183 01	CO	2.435 02	CO2DEC	3.125 01
MH2O	7.606 01	CO2	1.534 03	OILCOL	2.170 01		

METERED GAS RATES

RECG	1.273 04	DIL	0.000 00	WVENTG	7.273 03	AIR	4.694 03
TRECG	1.273 04	TGF	0.000 00				

MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.375 01	HVGT	6.927 02	MWDG	3.040 01	GBTU	1.137 02
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COMBUSTION PRODUCTS

CO2C	5.380 02	COC	2.273 02				
H2OC	2.920 01	CHR	7.402 00	COMBCP	1.100 01		

MATERIAL IN

ORGCIN	2.204 02	RSR	4.943 02	ORH2IN	2.891 01	MATIN	2.380 03
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MATERIAL OUT

ORGCVG	4.814 01	COKEC	3.628 01	UNRETH	0.000 00		
ORGCOL	1.424 02	ORH2VG	8.332 00	COKEH	1.885 00	UNRETC	0.000 00
ORH2OL	1.880 01	ORCOLP	6.461 01	ORCVGP	2.183 01	ORCSSP	1.646 01
HCCVGP	1.033 01						

MATERIAL BALANCES

OVALL	9.932 01	ORGH2	1.003 02				
O2BAL	1.007 02	ASH	0.000 00	TC	1.020 02	WATER	1.026 02
ORGC	1.029 02	TH2	1.031 02	GASL	-2.508 02	ASHE	-1.000 00

HEAT IN

QCOMB	4.372 05	QH2OC	8.445 03	QAIR	6.732 03		
QPROP	0.000 00	QOILC	1.185 04	QRCYL	4.182 04	QSUMIN	5.061 05

HEAT OUT

QMC02D	1.772 05	QKEROD	9.520 04	QH2OV	5.055 04		
QLIQO	4.881 03	QOFGAS	3.308 04	QSS	1.135 05	QGASL	-1.633 03
LBLOSS	0.000 00	HETLOS	3.327 04	QSUMOT	5.061 05		

MISCELLANEOUS

ORCSS	2.216 00	VPOIL	6.151-03	TGL	4.946 03	VPY	7.283 00
WCG	1.328 01	PROP	0.000 00				

MATERIAL AND HEAT BALANCE INPUT SHEET

RIF 921, RUN NO. C- 1-1 STARTED 4-23- CALC. ON

102 909 57 -1 27298.08
 H₂O, wt% Oil, wt% °F (1) Rate, lbs/hr

2509 200 1705 55022
 Oil, gal/T Gas+L, wt% CO₂, wt% Retort XS, ft²

6805 1508 1058 24010 137
 Ash, wt% Carbon, wt% H₂, wt% Bar. Press, " Hg Offgas Temp, °F

RAW SHALE
 BAROMETRIC
 PRESSURE
 AND
 OFFGAS
 TEMPERATURE

1075.4 1.00 135 114 0.14 0
 Chart Reading Meter Factor Temp, °F Press, "H₂O gauge Moist, lbs/MSCF Heat Loss, Btu/hr

AIR

2904.0 1.00 218 72 0.00 0.00
 Recycle Ch. Read Meter Factor Temp, °F Press, "H₂O gauge Tot Gas Ch. Read Meter Factor

RECYCLE AIR
 TOTAL GAS

0.00 0.00 0 0
 Dil Gas Ch. Read Meter Factor Temp, °F Press, "H₂O gauge

DILUTION
 GAS

0.00 0 0 275.7 0.00
 C₃ Retometer R. Temp, °F Press, "H₂O gauge Water added, lbs/hr Nucl. Agent, lb/hr

PROPANE, WATER
 & NUCLEATING
 AGENT

0.04 0.00 0.00 0.00
 H₂O, wt% Oil, wt% Gas, wt% Rate, lbs/hr

SPENT
 SHALE

14.07 83.07 6.023 0.16 369
 CO₂, wt% Ash, wt% Carbon, wt% H₂, wt% Temp, °F

2311.08 84.01 11.01 7.804 3430.4
 Dry Oil, lbs/hr Carbon, wt% H₂, wt% Den, lbs/gal Water, lbs/hr

LIQUID
 PRODUCT

1669.06 1.00 244 0.00 0.00 0 12.08
 Vent + Dil Gas Chart Reading Meter Factor Temp, °F Moist, lbs/MSCF Mist, lbs/MSCF (2) Carbon, lbs/MSCF

VENT +
 DILUTION
 GAS,
 VENT PURGE
 GAS, AND
 TOP SEAL
 GAS

0 25.2 0.5 61.00 1.9 4.00 5.05
 (3) CO₂, vol% O₂, vol% N₂, vol% CH₄, vol% CO, vol% H₂, vol%

1.02 0.83 3.04
 Others, vol% H₂, lbs/MSCF V. Purge Ch. Reading

1.83 143 135 75 2.01 4.04 20.03
 Meter Factor Temp, °F Press, "H₂O gauge Cond. Gas Curt Temp, °F Dry Oil, gm/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).

LB Gilmore
 1/17/67

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-23-67

Run No. C 1031-1

Sample Time: RS 18.15; SS 2315

FISCHER ASSAY

RAW SHALE SPENT SHALE

<u>25.7</u>	<u>—</u>	Gal/Ton
<u>0.907</u>	<u>—</u>	S.G., g/ml
<u>9.8</u>	<u>—</u>	Oil, wt %
<u>1.9</u>	<u>0.4</u>	Water, wt %
<u>86.3</u>	<u>99.6</u>	Sp. Shale, wt %
<u>2.0</u>	<u>0.0</u>	Gas & Loss, wt %
<u>slight</u>	<u>none</u>	COKING TENDENCY

RETORT SHALE MOISTURE

1.0 Est wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.75 wt %

MINERAL CO₂

17.5 14.7 wt %

ASH (SHALE)

68.3 83.7 wt %

MOISTURE

0.23 0.15 wt %

CARBON

15.8 6.23 wt %

HYDROGEN

1.58 0.16 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 CO₂", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS _____

DATE COMPLETED

APR 25 1967

CHECKED BY

Rep

OSRC-12A

Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-23-67

Run No. C1031-1
(2100)

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

	1	2	3	4	1	2
<input checked="" type="checkbox"/> WATER, wt %	10.0	/	/	/	/	/
<input checked="" type="checkbox"/> GRAVITY, °API	19.5	/	/	/	/	/

OIL ASH, wt %

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 25.5

WATER VOL, ml 72.0

GRAVITY OIL, °API INSUFFICIENT SAMPLE FOR GRAVITY

VENT GAS

MAJOR COMPONENTS

C₁ thru C₄, plus n-Pentane

CO₂ 25.2 vol %

O₂ 0.5 "

N₂ 61.0 "

CH₄ 1.9 "

CO 4.0 "

H₂ 5.5 "

Ar 0.7 "

Others 1.2 "

CH₄ _____ vol %

C₂H₄-C₂H₆ _____ "

C₃H₈ _____ "

C₃H₆ _____ "

i C₄H₁₀ _____ "

n C₄H₁₀ _____ "

∅C₃H₆ _____ "

n C₅H₁₂ _____ "

CARBON, 2.8 lbs/MSCFDG

HYDROGEN, 0.83 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED _____

CHECKED BY _____

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-23-67

Run No. C1031-START UP

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

~~R~~
~~R~~

~~⊗~~
~~⊗~~
○

WATER, wt %
GRAVITY, °API
OIL ASH, wt %

1	2	3	4
<u>23.9</u>	/	/	/
<u>20.2</u>	/	/	/

1	2
/	/
/	/

○ DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

~~R~~ ~~⊗~~ OIL WT, g 130.0
~~R~~ ~~⊗~~ WATER VOL, ml 5.0
~~R~~ ~~⊗~~ GRAVITY OIL, °API 39.6

VENT GAS

~~⊗~~

MAJOR COMPONENTS

○

C₁ thru C₄, plus n-Pentane

CO₂ _____ vol %
 O₂ _____ "
 N₂ _____ "
 CH₄ _____ "
 CO _____ "
 H₂ _____ "
 Ar _____ "
 Others _____ "

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

~~⊗~~

CARBON, _____ lbs/MSCFDG

~~⊗~~

HYDROGEN, _____ lbs/MSCFDG

COMMENTS _____

DATE COMPLETED 4-24-67

CHECKED BY (Signature)

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-23-67

Run No. C1031 START UP

Sample Time: RS _____; SS 11:15

FISCHER ASSAY

RAW SHALE ^{RES} SPENT SHALE

_____	<u>0.6</u>	Gal/Ton
_____	<u>—</u>	S.G., g/ml
_____	<u>0.2</u>	Oil, wt %
_____	<u>0.4</u>	Water, wt %
_____	<u>98.4</u>	Sp. Shale, wt %
_____	<u>1.0</u>	Gas & Loss, wt %
_____	<u>None</u>	COKING TENDENCY

RETORT SHALE MOISTURE
_____ wt %

RAW SHALE FISCHER ASSAY MOISTURE
_____ wt %

MINERAL CO₂

_____ ^{RES} 13.9 wt %

ASH (SHALE)

_____ ^{RES} 84.2 wt %

MOISTURE

_____ ^{RES} 0.13 wt %

CARBON

_____ ^{RES} 6.17 wt %

HYDROGEN

_____ ^{RES} 0.19 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 CO₂", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS _____

DATE COMPLETED

APR 24 1967

CHECKED BY

REP

OSRC-12A

Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-23-67

Run No. C1031-TRANS

Sample Time: RS 0675; SS _____

FISCHER ASSAY

RETORT SHALE MOISTURE

RAW SHALE SPENT SHALE

25.6 _____ Gal/Ton

9.14 _____ S.G., g/ml

9.8 _____ Oil, wt %

1.9 _____ Water, wt %

86.6 _____ Sp. Shale, wt %

1.7 _____ Gas & Loss, wt %

Slight _____ COKING TENDENCY

MINERAL CO₂

17.3 _____ wt %

ASH (SHALE)

68.6 _____ wt %

MOISTURE

0.35 _____ wt %

CARBON

15.7 _____ wt %

HYDROGEN

1.59 _____ wt %

BENZENE EXTRACTABLES

_____ _____ wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.94 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 APR 24 1967

CHECKED BY REP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1031-("P") SAMPLE NO. _____ DATE 4-23-67

UNIT #3 DESCRIPTION _____

APPROX. SHALE SIZE 1" to 1/2" SHAKING TIME 10 min ANALYSIS BY STANTON VAN DORNE

TOTAL SAMPLE WT. GROSS 94.4 - TARE 6.3 = NET 88.1

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		21.4	16.6	4.8	2.50	(2.625) 2.750	(0.3809) 0.3636			
	2.00		46.5	20.2	26.3	2.00	2.250	0.4444			
	1.50		51.5	23.4	28.1	1.50	1.750	0.5714			
	1.05		36.2	19.2	17.0	1.05	(1.087) 1.275	(0.9193) 0.7843			
	0.742		30.4	20.5	9.9	0.742	0.896	1.116			
	0.525		20.3	18.5	1.8	0.525	0.634	1.577			
	0.371		19.3	19.2	.1	0.371	0.448	2.232			
	0.263	3	18.4	18.3	.1	0.263	0.317	3.154			
	0.185	4	19.5	19.4	.1	0.185	0.224	4.464			
	0.131	6	19.5	19.4	.1	0.131	0.158	6.329			
	0.093	8	20.9	20.8	.1	0.093	0.112	8.928			
	0.065	10	19.4	19.3	.1	0.065					
	PAN		21.5	21.0	.5	PAN					
TOTAL ON SCREENS AND PAN					89.0	LOSS					
LOSS (BY DIFFERENCE)					.1	TOTAL					
TOTAL SAMPLE WEIGHT					89.1						

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

$\sum_{+8m}^m D_i$	$\sum_{+8m}^m X_i$
$1/\sum_{+8m}^m D_i$	$\sum_{+8m}^m X_i / D_i$