

GAS COMBUSTION REPORTING
DETAILED RUN SUMMARY SHEET

1513014002

Exploratory runs

Date 4-19-67

Purpose: *To start up with 1-2 1/2 inch shale and make 2 balances before changing to 3/4 - 2 1/2 inch shale.*

GENERAL	
Run No.	C-1029-1
Length, hours	12
Retort Type Number	RC-VI
Oil Recovery System Number	C-2
Tons Total Raw Shale Charged, lbs.	163.0
Bed Height above Dist., ft	12 1/2'
Type Air Dist.	AD-IX
Bed Below Air Dist., ft	7'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft ²)	492
Spent Shale, % of RS	81.1
Liquid Product, lbs/hr	2716.2
Oil Collected, gal/ton RS	23.6
Air, SCF/ton RS (dry)	4680
Total Recycle*, SCF/ton RS (wet)	12700
Dilution, SCF/ton RS (wet)	-
Calc. Vent Gas SCF/ton RS (dry)	6020
Gas Losses, SCF/ton RS (wet)	-366
Propane, SCF/ton RS	-
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	139
Spent Shale, F	357
Raw Shale, °F	69
Recycle Gas Inlet, °F	215
Dilution Gas Inlet, °F	-
Air Inlet, °F	143
Retort Air Inlet, F	143
Heat of Comb. MBtu/ton RS	449
Heat Lost, MBtu/ton RS	40
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	26.7
Oil, Wt %	10.2
Water, Wt %	1.0
Gas, Wt %	2.1
Mineral CO ₂ , Wt %	17.3
Ash, Wt %	68.5
Moisture, Wt % (Uncrushed)	1.0 Est
Carbon (Total), Wt %	16.3
Hydrogen (Total), Wt %	1.65
Nominal Size Range, inches	1"-2 1/2"
5 % passing thru	1.05
98 % passing thru	3.00
D ₅₀	1.626
D ₉₀	1.880

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.16
Mineral CO ₂ , Wt %	13.9
Ash, Wt %	84.5
Carbon (total), Wt %	5.77
Organic Carbon, Wt %	1.98
Hydrogen (total), Wt %	0.14
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	95.2
Density, lb/gal	7.809
Gravity, API	19.4
Ash, Wt %	-
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF (dry)	6.8
Oil, lbs/MSCF (dry)**	0.030
Analysis (dry)	
CO ₂ , Vol %	24.0
O ₂ , Vol %	0.5
N ₂ + Argon, Vol %	61.5
CH ₄ , Vol %	2.0
CO, Vol %	4.7
H ₂ , Vol %	6.0
Other, Vol %	1.3
Gross Heating Value (calc), Btu/SCF	109.6
Carbon (Total), lbs/MSCF (dry)	12.2
Hydrogen (Total), lbs/MSCF (dry)	0.92
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	88.4
Oil in Gas**, Vol % RSFA	0.1
Oil in Spent Shale, Vol % RSFA	0.8
Total Oil Meas., Vol % RSFA	89.3
Carbonate Decomposition, %	34.9
Water Recovered, lb/ton RS	61.6
Ash Balance, % - As Measured	-
Ash Balance, % - Assumed	RS 100
Overall Balance, %	98.5
Carbon Balance, % - Organic	98.3
Carbon Balance, % - Total	98.8
Hydrogen Balance, % - Organic	104.6
Hydrogen Balance, % - Total	97.9
Water Balance, %	71.5
MISCELLANEOUS	
Avg. Retort ΔP, in H ₂ O/ft	0.57
ΔP Above Air Dist., in H ₂ O/ft	0.65
NaCl Soln., Wt %	-
NaCl Rate, gal/ton RS	-

Comments: *NO 8 Conveyor failed + RS off about 20 minutes. Shift never finished about mid way balance. Some fines may have been fed to next during last part of balance due to secondary conveyor failure. Feeding RS*

*Measured Recycle + Dilution Gas *direct from Run NO. 4.*
 ** Oil Mist + Condensibles to 75 °F
 *** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Carl E. Jones DATE May 17, 1967

921, RUN NO C1029-1

Started

4/19/69

4/26/69
etc

YIELDS

FAY	5.837 01	DRYGAS	6.015 03	MISTFA	8.579-02		
H2	3.609 02	OTHER	7.820 01	UNRETC	7.947-01	CH4	1.203 02
O2	3.007 01	SSY	8.106 01	CO	2.327 02	CC2DEC	3.436 01
MH2O	5.159 01	CO2	1.443 03	OILCOL	2.359 01		

METERED GAS RATES

REGG	1.270 04	DIL	0.000 00	WVENTG	7.245 03	AIR	4.675 03
TREGG	1.270 04	TGF	0.000 00				

MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.274 01	HVGT	5.594 02	NWDG	3.023 01	GGTU	1.095 02
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COMBUSTION PRODUCTS

CO2C	3.458 02	COC	2.654 02				
H2OC	4.524 01	CHR	3.822 00	COYBCP	3.332 00		

MATERIAL IN

ORGCIN	2.315 02	RSR	4.921 02	ORH2IN	3.076 01	MATIN	2.378 03
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MATERIAL OUT

ORCVG	4.064 01	COXEC	3.009 01	UNRETH	2.068-01		
ORCCOL	1.549 02	ORH2VG	1.002 01	COXEN	1.513 00	UNRETC	1.930 00
ORH2OL	2.045 01	ORCOLP	6.692 01	ORCVSP	1.755 01	ORCSSP	1.353 01
HOCVGP	9.172 00						

MATERIAL BALANCES

OVALL	9.849 01	ORGH2	1.046 02				
ORBAL	9.451 01	ASH	0.000 00	TC	9.379 01	WATER	7.153 01
ORRC	9.831 01	TH2	9.735 01	GASL	-3.656 02	ASHB	-1.000 00

HEAT IN

QCOMB	4.494 05	QH2OC	6.274 03	QAIR	6.370 03		
QPROP	0.000 00	QOILC	1.239 04	QRCYL	3.804 04	QSUMIN	5.130 05

HEAT OUT

QXCO2D	1.954 05	QKEROD	9.710 04	QH2OV	4.539 04		
QLI2O	4.702 03	QCFGAS	2.274 04	QSS	1.035 05	QGASL	-2.205 03
LBLOSS	0.000 00	HETLOS	4.033 04	QSUMCT	5.130 05		

MISCELLANEOUS

ORCSS	1.975 00	VPOIL	3.007-02	TGL	4.909 03	VPM	6.227 00
WCG	1.255 01	PROP	0.000 00				

MATERIAL AND HEAT BALANCE INPUT SHEET

RIF 92 | RUN NO. | C, 9-1 | STARTED | 4-19- | CALC. ON |

100 | 10.2 | 69 | -1 | 27173.08
 H₂O, wt% | Oil, wt% | °F | (1) | Rate, lbs/Hr

26.7 | 2.1 | 17.3 | 55.22
 Oil, gal/T | Gas+L, wt% | CO₂, wt% | Retort XS, ft²

68.5 | 16.3 | 1.65 | 24.01 | 139
 Ash, wt% | Carbon, wt% | H₂, wt% | Bar. Press, " Hg | Offgas Temp, °F

RAW SHALE
 BAROMETRIC
 PRESSURE
 AND
 OFFGAS
 TEMPERATURE

1068.2 | 1.0 | 143 | 121 | 0.14 | 0
 Chart Reading | Meter Factor | Temp, °F | Press, "H₂O gauge | Moist, lbs/Mscf | Heat Loss, Btu/Hr

AIR

2888.1 | 1.0 | 215 | 75 | 0.0 | 0.0
 Recycle Ch. Read | Meter Factor | Temp, °F | Press, "H₂O gauge | Tot Gas Ch. Read | Meter Factor

RECYCLE AIR
 TOTAL GAS

0.0 | 0.0 | 0 | 0
 Dil Gas Ch. Read | Meter Factor | Temp, °F | Press, "H₂O gauge

DILUTION
 GAS

0.0 | 0 | 0 | 274.5 | 0.0
 C₃ Rotometer R. | Temp, °F | Press, "H₂O gauge | Water added, lbs/Hr | Nucl. Agent, lb/Hr

PROPANE, WATER
 & NUCLEATING
 AGENT

0.3 | 0.1 | 0.1 | 0.0
 H₂O, wt% | Oil, wt% | Gas, wt% | Rate, lbs/Hr

SPENT
 SHALE

13.9 | 84.5 | 5.77 | 0.14 | 357
 CO₂, wt% | Ash, wt% | Carbon, wt% | H₂, wt% | Temp, °F

2503.5 | 84.1 | 11.1 | 7.809 | 212.7
 Dry Oil, lbs/Hr | Carbon, wt% | H₂, wt% | Den, lbs/gal | Water, lbs/Hr

LIQUID
 PRODUCT

1657.5 | 1.0 | 218 | 0.0 | 0.0 | 0 | 12.2
 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 | 24.0 | 0.5 | 61.5 | 2.0 | 4.7 | 6.0
 (3) CO₂, vol% | O₂, vol% | N₂, vol% | CH₄, vol% | CO, vol% | H₂, vol%

1.3 | 0.82 | 12.9
 Others, vol% | H₂, lbs/Mscf | V. Purge Ch. Reading

1.83 | 140 | 132 | 75 | 20.0 | 2.9 | 19.0
 Meter Factor | Temp, °F | Press, "H₂O gauge | Cond. Gas Cpt. 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).

IB Gilmore
 1/17/67

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-19-67

Run No. C 1039-1

Sample Time: RS 1815; SS 2:15

FISCHER ASSAY

<input checked="" type="checkbox"/> RAW SHALE	<input checked="" type="checkbox"/> SPENT SHALE	0.16	
<u>26.5</u>	<u>40.92</u>	0.156	Gal/Ton
<u>0.910</u>	<u>0.5</u>		S.G., g/ml
<u>10.1</u>	<u>0.21</u>		Oil, wt %
<u>1.8</u>	<u>0.3</u>		Water, wt %
<u>26.0</u>	<u>95.5</u>		Sp. Shale, wt %
<u>2.1</u>	<u>0.1</u>		Gas & Loss, wt %
<u>Slight</u>	<u>None</u>		COKING TENDENCY

RETORT SHALE MOISTURE

1.0 wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.83 wt %

MINERAL CO₂

17.2 13.9 wt %

ASH (SHALE) 84.5 wt %

MOISTURE 0.01 wt %

CARBON 5.77 wt %

HYDROGEN 0.14 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 21 1967

CHECKED BY [Signature]

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-19-67

Run No. C 1029-1

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

P.H.C.

WATER, wt %

	1	2	3	4	1	2
WATER, wt %	4.8	/	/	/	/	/
GRAVITY, °API	19.4	/	/	/	/	/
OIL ASH, wt %						

GRAVITY, °API

OIL ASH, wt %

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

P.H.C.

OIL WT, g 240.0

WATER VOL, ml 1.0

GRAVITY OIL, °API 40.9

VENT GAS

JJ

MAJOR COMPONENTS

C₁ thru C₁₁, plus n-Pentane

CO₂ 24.0 vol %

O₂ 0.5 "

N₂ 60.8 "

CH₄ 2.0 "

CO 4.7 "

H₂ 6.0 "

Ar 0.7 "

Others 1.3 "

CH₄ _____ vol %

C₂H₄-C₂H₆ _____ "

C₃H₈ _____ "

C₃H₆ _____ "

i C₄H₁₀ _____ "

n C₄H₁₀ _____ "

∅C₃H₆ _____ "

n C₅H₁₂ _____ "

B.V.M.

CARBON, 12.2 lbs/MSCFDG

HYDROGEN, 0.22 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED 4/24/67

CHECKED BY [Signature]

OSRC-12B

(Revised 5/2/66)

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C-1028-1 SAMPLE NO. Pulled 1315 DATE 4-19-67
 UNIT Refert P3 DESCRIPTION 79.4 ANALYSIS BY 73.2
 APPROX. SHALE SIZE 1.25 SHAKING TIME 10
 TOTAL SAMPLE W.T. GROSS 78.4 - TARE 5.2 = NET 73.2

SCREENS REQD.	SCREEN OPENING SIZE	MESH	WEIGHTS			NET WT. RETAINED	SCREEN SIZE	Di *	1/di	% RETAINED	CUM. % RETAINED	% PASSING
			GROSS LBS.	TARE LBS.								
	4.25					4.25						
	3.00		18.9	18.2	0.7	3.00	(3.125)	(0.3200)	0.95		99.05	
	2.50		23.8	16.7	7.1	2.50	(2.625) 2.750	(0.3809) 0.3636	9.71		89.34	
	2.00		44.5	20.2	24.3	2.00	2.250	0.4444	33.24		56.10	
	1.50		46.3	23.4	22.9	1.50	1.750	0.5714	31.32		24.78	
	1.05		31.8	19.2	12.6	1.05	(1.067) 1.275	(0.9193) 0.7843	17.23		7.55	
	0.742		23.7	20.5	3.2	0.742	0.896	1.116	4.37		3.18	
	0.525		19.6	18.5	1.1	0.525	0.634	1.577	1.50		1.68	
	0.371		19.4	19.3	0.1	0.371	0.448	2.232	0.27		1.41	
	0.263	3	18.4	18.3	0.1	0.263	0.317	3.154	0.13		1.28	
	0.185	4	19.5	19.4	0.1	0.185	0.224	4.464	0.14		1.14	
	0.131	6	19.5	19.4	0.1	0.131	0.158	6.329	0.13		1.01	
	0.093	8	21.0	20.9	0.1	0.093	0.112	8.928	0.14	99.13	0.97	
	0.065	10	20.0	19.9	0.1	0.065			0.13		0.74	
	PAN		21.5	21.0	0.5	PAN			0.68		0	
TOTAL ON SCREENS AND PAN					73.1	LOSS (BY DIFFERENCE)			99.94			
TOTAL SAMPLE WEIGHT					73.2							

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

REMARKS: The 0.7# piece of the 3" screen must be subtracted.

$\sum_{+8m}^m D_i$	1.86336	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	0.60969	$\sum_{+8m}^m X_i / D_i$	
D_a	1.62596	$\sum_{+8m}^m X_i D_i$	
D_v	1.87971		

RS

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-19-67

Run No. C1029-START

Sample Time: RS 06:15; SS _____

FISCHER ASSAY

*RJ
P.H.*

RAW SHALE SPENT SHALE

<u>26.5</u>	_____	Gal/Ton
<u>.914</u>	_____	S.G., g/ml
<u>10.1</u>	_____	Oil, wt %
<u>1.6</u>	_____	Water, wt %
<u>86.5</u>	_____	Sp. Shale, wt %
<u>1.8</u>	_____	Gas & Loss, wt %
<u>Slight</u>	_____	COKING TENDENCY

RETORT SHALE MOISTURE
_____ wt %

RAW SHALE FISCHER ASSAY MOISTURE
_____ wt %

MINERAL CO₂

_____ _____ wt %

ASH (SHALE)

_____ _____ wt %

MOISTURE

_____ _____ wt %

CARBON

_____ _____ wt %

HYDROGEN

_____ _____ 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 20 1967

CHECKED BY

REP

OSRC-12A

Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-19-67

Run No. C1029 startup

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

WATER, wt %

GRAVITY, °API

OIL ASH, wt %

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>1</u>	<u>2</u>
WATER, wt %	<u>17.2</u>	 	 	 	 	
GRAVITY, °API	<u>20.0</u>	 	 	 	 	
<input type="radio"/> OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g

WATER VOL, ml

GRAVITY OIL, °API

143.8
146.0
38.4

VENT GAS

MAJOR COMPONENTS

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

C₁ thru C₄, plus n-Pentane

CH₄ . vol %
C₂H₄-C₂H₆ . "
C₃H₈ . "
C₃H₆ . "
i C₄H₁₀ . "
n C₄H₁₀ . "
∅C₃H₆ . "
n C₅H₁₂ . "

CARBON, . lbs/MSCFDG

HYDROGEN, . lbs/MSCFDG

COMMENTS _____

DATE COMPLETED

CHECKED BY

OSRC-12B
(Revised 5/3/66)