1513013004

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

Date 4-9-67

Purpose: To determine operability and yield with 1-2½ inch shale with SS liner, 36 bayonet A/B and 3 over 3 air-recycle headers.

GENERAL	
Run No.	C-1027-3
Length, hours	12
Retort Type Number	RC-IV
Oil Recovery System Number	C-1
Total Raw Shale Charged, ~~lbs.~~ Tons	122.05
Bed Height above Dist., ft	12½'
Type Air Dist.	A/-III
Bed Below Air Dist., ft	7'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft^2)	399
Spent Shale, % of RS	80.7
Liquid Product, lbs/hr	2146.5
Oil Collected, gal/ton RS	22.1
Air, SCF/ton RS (dry)	4630
Total Recycle*, SCF/ton RS(wet)	14400
Dilution, SCF/ton RS (wet)	—
Calc. Vent Gas SCF/ton RS(dry)	6120
Gas Losses, SCF/ton RS(wet)	-113
Propane, SCF/ton RS	—
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	141
Spent Shale, F	378
Raw Shale, °F	65
Recycle Gas Inlet, °F	250
Dilution Gas Inlet, °F	—
Air Inlet, °F	132
Retort Air Inlet, F	132
Heat of Comb. MBtu/ton RS	458
Heat Lost, MBtu/ton RS	32
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	25.3
Oil, Wt %	9.7
Water, Wt %	1.1
Gas, Wt %	1.6
Mineral CO_2, Wt %	17.5
Ash, Wt %	68.6
Moisture, Wt % (Uncrushed)	1.0 Est
Carbon (Total), Wt %	15.9
Hydrogen (Total), Wt %	1.61
Nominal Size Range, inches	1"-2½"
5 % passing thru	0.742
98 % passing thru	2.50
D_a	1.417
D_v	1.603

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO_2, Wt %	13.4
Ash, Wt %	85.0
Carbon (total), Wt %	5.69
Organic Carbon, Wt %	2.03
Hydrogen (total), Wt %	0.14
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	99.9
Density, lb/gal	7.778
Gravity, API	20.0
Ash, Wt %	[illegible]
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	6.5
Oil, lbs/MSCF(dry)**	0.004
Analysis (dry)	
CO_2, Vol %	27.2
O_2, Vol %	0.1
N_2 + Argon, Vol %	59.9
CH_4, Vol %	1.7
CO, Vol %	3.1
H_2, Vol %	5.0
Other, Vol %	3.0
Gross Heating Value(calc), Btu/SCF	84.0
Carbon (Total), lbs/MSCF (dry)	12.2
Hydrogen (Total), lbs/MSCF (dry)	0.61
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	87.5
Oil in Gas**, Vol % RSFA	0.01
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	87.5
Carbonate Decomposition, %	38.2
Water Recovered, lb/ton RS	67.5
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	85-100
Overall Balance, %	99.2
Carbon Balance, % - Organic	97.0
Carbon Balance, % - Total	97.9
Hydrogen Balance, % - Organic	97.2
Hydrogen Balance, % - Total	94.6
Water Balance, %	82.6
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.42
ΔP Above Air Dist., in H_2O/ft	0.46
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. [signature] DATE April 14, 1967

921, RUN NO. C-1087-3 Start 4/4/69 4/12/69

YIELDS

FAY	8.749 01	DRYGAS	6.118 03	MISTFA	1.332-02		
H2	3.059 02	OTHER	1.835 02	UNREIO	0.000 00	CH4	1.040 02
C2	6.113 00	SOY	8.070 01	CO	1.896 02	COPDEC	3.820 01
MH2O	6.748 01	CO2	1.664 03	OILCOL	2.213 01		

METERED GAS RATES

RECG	1.442 04	OIL	0.000 00	WVENTG	7.067 03	AIR	4.632 03
TRECG	1.442 04	TOP	0.000 00				

MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.975 01	HVGT	5.141 02	MWDG	3.136 01	GBTU	8.402 01

COMBUSTION PRODUCTS

CO2C	4.727 02	COC	1.777 02				
H2OC	3.882 01	CHR	4.732 00	COMBCP	9.870 00		

MATERIAL IN

ORGCIN	2.224 02	RSR	3.985 02	CRH2IN	8.973 01	MATIN	2.375 03

MATERIAL OUT

ORGCVG	3.820 01	COKEC	3.279 01	UNREIM	0.000 00		
ORGCOL	1.448 02	ORH2VG	8.087 00	COKSH	1.717 00	UNREIC	0.000 00
ORH2OL	1.911 01	ORGOLP	6.500 01	OPCVGP	1.717 01	ORGSSP	1.474 01
HCCVGP	7.903 00						

MATERIAL BALANCES

OVALL	9.915 01	OPCHP	9.794 01				
ORBAL	9.691 01	ASH	0.000 00	TC	9.739 01	WATER	9.952 01
ORGC	9.701 01	THP	9.460 01	GASL	-1.129 02	ASHB	-1.000 00

HEAT IN

BCOMB	4.576 05	BHPOC	6.246 03	SAIR	5.707 03		
OPROP	0.000 00	OOILC	1.205 04	OPOYL	5.670 04	OSUMIN	5.353 05

HEAT OUT

BMCOOD	2.166 05	CHEROD	9.040 04	CHPOV	4.797 04		
QLIQO	4.762 03	BOPGAS	3.486 04	OBS	1.124 05	OGASL	-7.672 02
LBLOSS	0.000 00	HETLOS	3.201 04	OSUMOT	5.333 05		

MISCELLANEOUS

ORCSS	2.031 00	VPOIL	4.283-03	TGL	4.282 03	VPW	6.498 00
WCG	1.202 01	PROP	0.000 00				

MATERIAL AND HEAT BALANCE INPUT SHEET

RIF92	, RUN NO.	C-, 7-3	STARTED	4-9-6	CALC. ON	4-12-6

RAW SHA
BAROMETR
PRESSU
AND
OFFG
TEMPERATU

101	907	65	-1	22007.7
H_2O, wt%	Oil, wt%	°F	(1)	Rate, lbs/Hr

25.3	106	1705	55022
Oil, gal/T	Gas+L, wt%	CO_2, wt%	Retort XS, ft²

68.06	1509	1061	24027	141
Ash, wt%	Carbon, wt%	H_2, wt%	Bar. Press, " Hg	Offgas Temp, °F

AIR

852.4	1.0	132	126	0.014	0
Chart Reading	Meter Factor	Temp, °F	Press, "H_2O gauge	Moist, lbs/MSCF	Heat Loss, Btu/Hr

RECYCLE A
TOTAL GAS

268705	1.0	250	73	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	222.3	0.0
C_3 Rotameter R.	Temp, °F	Press, "H_2O gauge	Water added, lbs/Hr	Nucl. Agent, lb/Hr

SPENT
SHALE

0.3	0.0	0.0	0.0
H_2O, wt%	Oil, wt%	Gas, wt%	Rate, lbs/Hr

13.4	85.0	5.69	0.14	378
CO_2, wt%	Ash, wt%	Carbon, wt%	H_2, wt%	Temp, °F

LIQUID
PRODUCT

1894.7	84.1	11.1	7.778	2518
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

133701	1.0	250	0.0	0.0	0	12 oz
Vent+Dil Gas Chart Reading	Meter Factor	Temp, °F	Moist, lbs/MSCF	Mist, lbs/MSCF	(2)	Carbon, lbs/MSCF

0	27.2	0.1	59.9	1.7	3.1	5.0
(3)	CO_2, vol%	O_2, vol%	N_2 vol%	CH_4, vol%	CO, vol%	H_2, vol%

3.0	0.61	229
Others, vol%	H_2, lbs/MSCF	V. Purge Ch. Reading

1.083	184	181	75	308	10 oz	3600
Meter Factor	Temp, °F	Press "H_2O gauge	Cond. Gas Out Temp, °F	Dry Oil, gm/Hr	Water lbs/Hr	Top Seal Purge 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).

LBGilmore
1/17/67

LABORATORY ANALYSIS SHEE

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-9-67 Run No. C 1027-3

Sample Time: RS 18:45; SS 23:15

	FISCHER ASSAY RAW SHALE (EJ)	FISCHER ASSAY SPENT SHALE (EJ)	
	25.1%	0.0	Gal/Ton
	0.910	.	S.G., g/ml
	9.6	0.0	Oil, wt %
	1.8	0.3	Water, wt %
	87.0	99.7	Sp. Shale, wt %
	1.6	0.0	Gas & Loss, wt %
	Slight	None	COKING TENDENCY
BKM	MINERAL CO_2 17.4	BKM 13.4	wt %
BKM	ASH (SHALE) 68.4	BKM 85.0	wt %
BKM	MOISTURE 0.29	BKM FA 0.09	wt %
BKM	CARBON 15.9	PJH 5.69	wt %
BKM	HYDROGEN 1.61	PJH 0.14	wt %
	BENZENE EXTRACTABLES .	.	wt %

RETORT SHALE MOISTURE 1.0 Est wt %

EJ RAW SHALE FISCHER ASSAY MOISTURE 0.71 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 12 1967 CHECKED BY

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEE

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-9-67 Run No. C-1027-3

Sample Time: RS 12:15 ; SS _____

E.T FISCHER ASSAY

(X) RAW SHALE ( ) SPENT SHALE

24.6+	.	Gal/Ton
0.911	.	S.G., g/ml
9.4	.	Oil, wt %
1.7	.	Water, wt %
87.1	.	Sp. Shale, wt %
1.8	.	Gas & Loss, wt %
Slight		COKING TENDENCY

( ) RETORT SHALE MOISTURE

_____ wt %

(X) RAW SHALE FISCHER ASSAY MOISTURE

0.68 wt %

MINERAL CO_2

(X) 17.4 ( ) . wt %

PJH ASH (SHALE)

(X) 68.6 ( ) . wt %

MOISTURE

(X) 0.24 ( ) . wt %

( ) SHALE RICHNESS DISTRIBUTION (See attached graph)

PJH CARBON

(X) 15.6 ( ) . wt %

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

PJH HYDROGEN

(X) 1.59 ( ) . 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 12 1967 CHECKED BY _____

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4.2.67 Run No. C1602-3 (Gas)

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	0.10					
GRAVITY, °API	50.0					
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 45.4

WATER VOL, ml 114.0

GRAVITY OIL, °API INSUFFICIENT SAMPLE

VENT GAS

MAJOR COMPONENTS

CO_2	27.3	vol %	CH_4	. vol %
O_2	6.1	"	C_2H_4-C_2H_6	. "
N_2	59.2	"	C_3H_8	. "
CH_4	1.7	"	C_3H_6	. "
CO	3.1	"	i C_4H_{10}	. "
H_2	5.6	"	n C_4H_{10}	. "
Ar	0.7	"	ϕC_3H_6	. "
Others	2.0	"	n C_5H_{12}	. "

C_1 thru C_4, plus n-Pentane

CARBON, 12.2 lbs/MSCFDG HYDROGEN, 0.61 lbs/MSCFDG

COMMENTS

DATE COMPLETED CHECKED BY

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1027-3 SAMPLE NO. _____ DATE 4-9-61

UNIT #3 DESCRIPTION _____

APPROX. SHALE SIZE ¼" + 2½" SHAKING TIME 10 min ANALYSIS BY Smith Rothdell

TOTAL SAMPLE WT. GROSS 67.6 − TARE 5.2 = NET 62.4

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50		18.8	16.7	2.1
	2.00		30.6	26.2	4.4
	1.50		40.0	23.4	3.6
	1.05		35.3	19.2	16.1
	0.742		27.8	20.5	7.3
	0.525		19.8	18.5	1.3
	0.371		19.5	19.3	.2
	0.263	3	18.5	18.3	.2
	0.185	4	19.5	19.4	.1
	0.131	6	19.4	19.2	.2
	0.093	8	19.5	19.5	.0
	0.065	10	19.4	19.3	.1
	PAN		21.6	21.0	.6
	TOTAL ON SCREENS AND PAN				62.0
	LOSS (BY DIFFERENCE)				.4
	TOTAL SAMPLE WEIGHT				62.4

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	3.37		96.63
2.00	2.250	0.4444	16.67		79.96
1.50	1.750	0.5714	37.82		42.14
1.05	(1.087) 1.275	(0.9199) 0.7843	25.80		16.34
0.742	0.896	1.116	11.70		4.64
0.525	0.634	1.577	2.08		2.56
0.371	0.448	2.232	0.32		2.24
0.263	0.317	3.154	0.32		1.92
0.185	0.224	4.464	0.16		1.76
0.131	0.158	6.329	0.00		1.76
0.093	0.112	8.928	0.00	98.24	1.76
0.065			0.16		1.60
PAN			0.96		0.64
LOSS			0.64		0.00
TOTAL			100.00	—	—

UU3040

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

$\sum_{+8m}^{m} Di$	1.57516	$\sum_{+8m}^{m} Xi$	
$1/\sum_{+8m}^{m} Di$	0.69312	$\sum_{+8m}^{m} Xi/Di$	
Da	1.41735	$\sum_{+8m}^{m} Xi\ Di$	
Dv	1.60338		

REMARKS: _____

OSRC-4