GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513014609

Exploratory Runs

Date 4-24-67

Purpose: To determine operability and yield with +- 2½ inch shale after bromination from ¾ - 2½ inch shale.

GENERAL	
Run No.	C1032-2
Length, hours	12
Retort Type Number	RC-VII
Oil Recovery System Number	C-2
Tons Total Raw Shale Charged, ~~lbs.~~	166.95
Bed Height above Dist., ft	9½'
Type Air Dist.	AD-TX
Bed Below Air Dist., ft	7'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft²)	504
Spent Shale, % of RS	81.2
Liquid Product, lbs/hr	2798.2
Oil Collected, gal/ton RS	22.8
Air, SCF/ton RS (dry)	4580
Total Recycle*, SCF/ton RS(wet)	12600
Dilution, SCF/ton RS (wet)	—
Calc.Vent Gas SCF/ton RS(dry)	5890
Gas Losses, SCF/ton RS(wet)	-94
Propane, SCF/ton RS	—
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	139
Spent Shale, F	364
Raw Shale, °F	58
Recycle Gas Inlet, °F	220
Dilution Gas Inlet, °F	—
Air Inlet, °F	136
Retort Air Inlet, F	136
Heat of Comb. MBtu/ton RS	421
Heat Lost, MBtu/ton RS	20
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	26.7
Oil, Wt %	10.2
Water, Wt %	1.1
Gas, Wt %	1.8
Mineral CO_2, Wt %	17.4
Ash, Wt %	68.2
Moisture, Wt % (Uncrushed)	1.0 Est.
Carbon (Total), Wt %	16.5
Hydrogen (Total), Wt %	1.70
Nominal Size Range, inches	½"-2½"
5 % passing thru	0.525
98 % passing thru	2.50
Da	1.118
D_V	1.362

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO_2, Wt %	14.6
Ash, Wt %	84.0
Carbon (total), Wt %	6.05
Organic Carbon, Wt %	2.06
Hydrogen (total), Wt %	0.17
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	93.2
Density, lb/gal	7.809
Gravity, API	19.4
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	10.6
Oil, lbs/MSCF(dry)**	0.044
Analysis (dry)	
CO_2, Vol %	26.0
O_2, Vol %	0.6
N_2 + Argon, Vol %	61.5
CH_4, Vol %	1.8
CO, Vol %	4.2
H_2, Vol %	5.6
Other, Vol %	0.3
Gross Heating Value(calc),Btu/SCF	120.5
Carbon (Total), lbs/MSCF (dry)	13.2
Hydrogen (Total), lbs/MSCF (dry)	0.90
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	85.4
Oil in Gas**, Vol % RSFA	0.1
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	85.5
Carbonate Decomposition, %	31.9
Water Recovered, lb/ton RS	93.3
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	85.00
Overall Balance, %	99.6
Carbon Balance, % - Organic	98.3
Carbon Balance, % - Total	98.8
Hydrogen Balance, % - Organic	95.1
Hydrogen Balance, % - Total	105.4
Water Balance, %	133.5
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.67
ΔP Above Air Dist., in H_2O/ft	0.24
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: No apparent change in operations from previous tests during this shale range also.

*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 Jones DATE May 17, 1967

OSRC-10
Revised 7/19/66

92i, RUN NO. C1032-2 Started 1/24/60 1/28/60

YIELDS							
FAY	8.542 01	DRYGAS	9.886 03	CISTFA	1.240-01		
H2	3.896 02	OTHER	1.766 01	UNRETC	0.000 00	CH4	1.089 02
C2	3.532 01	SSY	8.119 01	CO	2.472 02	COMBC	5.187 01
MH2O	9.329 01	CO2	1.530 03	CILOOL	2.980 01		
METERED GAS RATES							
RECG	1.259 04	DIL	0.000 00	WATER	7.287 03	AIR	4.575 03
TRECG	1.259 04	TGF	0.000 00				
MOL WT & HEATING VALUE OF VENT GAS							
MWVG	2.828 01	HVGT	7.096 02	MWDG	3.056 01	GBTU	1.205 02
COMBUSTION PRODUCTS							
CO2C	5.231 02	COC	2.331 02				
H2OC	2.702 01	CHR	7.956 00	COMRCP	1.026 01		
MATERIAL IN							
ORGCIN	2.349 02	RSR	5.038 02	ORH2IN	3.153 01	MATIN	2.371 03
MATERIAL OUT							
ORGCVG	4.767 01	COKEC	3.351 01	UNRETM	0.000 00		
ORGCOL	1.497 02	ORH2VG	8.356 00	COKEM	1.851 00	UNRETC	0.000 00
OPH2OL	1.977 01	OPCOLP	6.374 01	ORCVCP	9.028 01	ORCPSP	1.426-01
HCCVGP	1.001 01						
MATERIAL BALANCES							
CVALL	9.961 01	ORGH2	9.506 01				
O2BAL	1.051 02	ASH	0.000 00	TC	9.877 01	WATER	1.335 02
ORGC	9.829 01	TH2	1.084 02	GASL	-9.366 01	ASHB	-1.000 00
HEAT IN							
QCOMB	4.209 05	QH2OC	1.047 04	QAIR	6.582 03		
QPROP	0.000 00	QOILC	1.246 04	QRCYL	4.159 04	QSUMIN	4.920 05
HEAT OUT							
QMCO2D	1.796 05	QKEROD	9.600 04	QH2OV	4.797 04		
QLIQD	5.210 03	QOFGAS	3.324 04	QSS	1.104 05	QGASL	-5.959 02
LBLOSS	0.000 00	HETLOS	2.005 04	QSUMOT	4.920 05		
MISCELLANEOUS							
ORCSS	2.064 00	VPOIL	4.393-02	TGL	5.010 03	VPW	1.055 01
WCG	1.816 01	PROP	0.000 00				

MATERIAL AND HEAT BALANCE INPUT SHEET

RIF 921 , RUN NO. C[illegible] 2-2 STARTED 4-24- [illegible] CALC. ON 4-28-67

Transition

RAW SHALE, BAROMETRIC PRESSURE, AND OFFGAS TEMPERATURE

1.1	10.2	58	-1	27824.3
H_2O, wt %	Oil, wt %	°F	(1)	Rate, lbs/Hr

26.7	1.8	17.4	55.22
Oil, gal/T	Gas+L, wt%	CO_2, wt%	Retort X-S, ft²

68.2	16.5	1.70	24.20	139
Ash, wt%	Carbon, wt%	H_2, wt%	Bar. Pres., " Hg	Offgas Temp, °F

AIR

1066.1	1.0	136	90	0.14	0
Chart Reading	Meter Factor	Temp, °F	Press, "H_2O gauge	Moist, lbs/MSCF	Heat Loss, Btu/Hr

RECYCLE AND TOTAL GAS

28970.4	1.0	220	76	0.0	0.0
Recycle Ch Read	Meter Factor	Temp, °F	Press, "H_2O gauge	Tot Gas Ch Read	Meter Factor

DILUTION GAS

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

PROPANE, WATER & NUCLEATING AGENT

0.0	0	0	2810.1	0.0
C_3 Rotameter R.	Temp, °F	Press, "H_2O gauge	Water added, lbs/Hr.	Nucl. Agent, lb/Hr.

SPENT SHALE

0.5	0.0	0.0	0.0
H_2O, wt%	Oil, wt%	Gas, wt%	Rate, lbs/Hr

14.6	84.0	6.05	0.17	364
CO_2, wt%	Ash, wt%	Carbon, wt%	H_2, wt%	Temp, °F

LIQUID PRODUCT

2478.0	84.1	11.1	7.809	320.2
Dry Oil, lbs/Hr	Carbon, wt%	H_2, wt%	Den, lbs/gal	Water, lbs/Hr

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

1687.9	1.0	247	0.0	0.0	0	13.2
Vent+Dil Gas Chart Reading	Meter Factor	Temp, °F	Moist, lbs/MSCF	Mist, lbs/MSCF	(2)	Carbons, lbs/MSCF

0	26.0	6.6	61.5	1.8	4.2	5.6
(3)	CO_2, vol%	O_2, vol%	N_2, vol%	CH_4, vol%	CO, vol%	H_2, vol %

0.3	0.90	3.5
Others, vol%	H_2, lbs/MSCF	V. Purge Ch. Reading

1.83	150	110	75	14.7	6.6	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, 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. C 1032-2

Sample Time: RS 0615 ; SS _____

FISCHER ASSAY (X) RAW SHALE	(Y) SPENT SHALE	
26.4	0.0	Gal/Ton
.913	—	S.G., g/ml
10.1	0.0	Oil, wt %
2.1	0.5	Water, wt %
86.0	99.5	Sp. Shale, ~~wt~~ %
1.8	0.0	Gas & Loss, wt %
slight	none	COKING TENDENCY

( ) RETORT SHALE MOISTURE
1.0 Est. wt %

Rx (X) RAW SHALE FISCHER ASSAY MOISTURE
1.00 wt %

	(X)	(Y)	
MINERAL CO_2	17.3	14.6	wt %
ASH (SHALE)	65.0	84.0	wt %
MOISTURE	0.35	0.12	wt %
CARBON	16.4	6.05	wt %
HYDROGEN	1.69	0.17	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 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 _____

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-25-67 Run No. C1032-2 (C900)

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	6.8					
GRAVITY, °API	19.4					
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 176.0

WATER VOL, ml 640

GRAVITY OIL, °API 42.1

VENT GAS

MAJOR COMPONENTS

CO_2	26.0	vol %
O_2	0.6	"
N_2	20.8	"
CH_4	1.8	"
CO	4.2	"
H_2	5.6	"
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}	.	"

CARBON, 13.2 lbs/MSCFDG

HYDROGEN, 0.90 lbs/MSCFDG

COMMENTS

DATE COMPLETED APR 28 1967 CHECKED BY REP

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

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 1037-2 SAMPLE NO. _____ DATE 4-25-67

UNIT #2 DESCRIPTION _____

APPROX. SHALE SIZE _____ SHAKING TIME 11 min ANALYSIS BY [illegible]

TOTAL SAMPLE WT. GROSS 66.5 – TARE 3.3 = NET 63.2

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50				
	2.00		32.6	30.2	7.4
	1.50		41.0	23.4	13.6
	1.05		37.8	19.1	18.7
	0.742		25.8	20.5	9.3
	0.525		25.7	18.5	7.2
	0.371		21.0	19.3	1.7
	0.263	3	18.7	18.3	.4
	0.185	4	19.5	19.4	.1
	0.131	6	19.4	19.3	.1
	0.093	8	[illegible]	[illegible]	.0
	0.065	10	19.2	19.2	.0
	PAN		21.6	20.9	.6
TOTAL ON SCREENS AND PAN					63.2
LOSS (BY DIFFERENCE)					.1
TOTAL SAMPLE WEIGHT					63.2

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			100.00
2.00	2.250	0.4444	11.73		88.27
1.50	1.750	0.5714	27.89		60.38
1.05	(1.087) 1.275	(0.9199) 0.7843	29.64		30.74
0.742	0.896	1.116	14.74		16.00
0.525	0.634	1.577	11.41		4.59
0.371	0.448	2.232	2.69		1.90
0.263	0.317	3.154	0.63		1.27
0.185	0.224	4.464	0.16		1.11
0.131	0.158	6.329	0.16		0.95
0.093	0.112	8.928	0	99.05	0.95
0.065			0		0.95
PAN			0.95		0
LOSS			—		
TOTAL			100.00		

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

$\Sigma_{+8m}^{m} Di$	1.34898	$\Sigma_{+8m}^{m} Xi$	
$1/\Sigma_{+8m}^{m} Di$	0.88557	$\Sigma_{+8m}^{m} Xi / Di$	
Da	1.11848	$\Sigma_{+8m}^{m} Xi\ Di$	
Dv	1.36191		

REMARKS: _____

OSRC-4

1003973