GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

15/3013016

Date 4-15-67

Purpose:

GENERAL	
Run No.	C-1028-9
Length, hours	12
Retort Type Number	RC-2
Oil Recovery System Number	C-2
Tons Total Raw Shale Charged, lbs.	16498
Bed Height above Dist., ft	12½
Type Air Dist.	AP-MRL
Bed Below Air Dist., ft	1'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft²)	498
Spent Shale, % of RS	82.4
Liquid Product, lbs/hr	2551.6
Oil Collected, gal/ton RS	70.4
Air, SCF/ton RS (dry)	4600
Total Recycle*, SCF/ton RS(wet)	13900
Dilution, SCF/ton RS (wet)	—
Calc. Vent Gas SCF/ton RS(dry)	5970
Gas Losses, SCF/ton RS(wet)	-172
Propane, SCF/ton RS	—
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	138
Spent Shale, °F	377
Raw Shale, °F	61
Recycle Gas Inlet, °F	231
Dilution Gas Inlet, °F	—
Air Inlet, °F	144
Retort Air Inlet, °F	148
Heat of Comb. MBtu/ton RS	432
Heat Lost, MBtu/ton RS	43
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	24.6
Oil, Wt %	9.4
Water, Wt %	0.8
Gas, Wt %	1.8
Mineral CO_2, Wt %	17.7
Ash, Wt %	69.3
Moisture, Wt % (Uncrushed)	0.78
Carbon (Total), Wt %	15.5
Hydrogen (Total), Wt %	1.58
Nominal Size Range, inches	1"-2½"
5 % passing thru	0.78"
98 % passing thru	2.50"
Da	1.529
D_v	1.723

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO_2, Wt %	14.6
Ash, Wt %	84.1
Carbon (total), Wt %	5.97
Organic Carbon, Wt %	1.98
Hydrogen (total), Wt %	0.16
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	91.1
Density, lb/gal	7.488
Gravity, API	19.8
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	6.8
Oil, lbs/MSCF(dry)**	0.025
Analysis (dry)	
CO_2, Vol %	26.6
O_2, Vol %	0.4
N_2 + Argon, Vol %	61.0
CH_4, Vol %	1.6
CO, Vol %	3.6
H_2, Vol %	6.3
Other, Vol %	0.5
Gross Heating Value(calc),Btu/SCF	114.2
Carbon (Total), lbs/MSCF (dry)	13.0
Hydrogen (Total), lbs/MSCF (dry)	3.45
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	82.7
Oil in Gas**, Vol % RSFA	0.1
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	82.8
Carbonate Decomposition, %	32.0
Water Recovered, lb/ton RS	74.2
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	95.100
Overall Balance, %	99.4
Carbon Balance, % - Organic	99.8
Carbon Balance, % - Total	99.8
Hydrogen Balance, % - Organic	93.1
Hydrogen Balance, % - Total	101.1
Water Balance, %	125.5
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.52
ΔP Above Air Dist., in H_2O/ft	0.53
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: Operation Good. Retort pressure and temperature

profile looking good. H₂O Tr. 9.5 inches water

*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. Turner DATE April 21, 1967

OSRC-10
Revised 7/19/66

YIELDS

CAY	1.074 01	DRYGAS	5.071 03	LIQUEA	7.709-02		
H2	3.769 02	CH4	2.979 01	UNREIC	0.000 00	C2H4	9.551 01
CO	2.332 01	C2Y	2.240 01	C2	2.143 02	C2H2D10	3.203 01
H2O	7.421 01	CO2	1.518 36	OILCCL	2.068 01		

WATER AND RATES

RCO	1.290 04	OIL	0.000 00	WVPIP	5.006 03	AIR	4.603 05
TRCO	1.290 04	TOT	0.000 00				

MOL WT & HEATING VALUE OF VENT GAS

MWG	2.696 01	HHST	6.721 02	HHDC	3.059 01	CBTU	1.142 02

COMBUSTION PRODUCTS

CO2G	2.547 02	CDC	0.000 00				
H2OG	2.672 01	CBA	5.731 00	CO2BOP	1.157 01		

MATERIAL IN

ORIGIN	2.133 02	PCP	4.079 02	CRYSTF	2.049 01	MAIN	2.504 03

MATERIAL OUT

CRSOVB	4.673 01	COLDC	3.970 01	UNB TH	0.000 00		
CRSOOL	1.335 02	OILOVC	5.007 00	SCRUB	1.007 02	UNBLDS	0.000 00
CRSPOL	1.750 01	CRSOLP	6.040 01	CRSVST	2.195 01	CRSBSP	1.582 01
HSOVTP	1.057 01						

MATERIAL BALANCING

OVAIL	2.543 01	CRSUP	2.515 01				
OPAL	1.080 02	ASH	0.000 00	FC	2.409 01	VOLT	1.299 02
OBCO	9.976 01	TMO	1.011 02	OASL	-1.715 02	ATAB	-1.000 00

HEAT IN

CRCIN	4.715 05	CRHOC	5.503 03	OATP	7.371 03		
CRHOP	0.000 00	HOIL	1.109 04	CRCYL	4.414 04	CRHTJ	2.134 03

HEAT OUT

CRCOOL	1.035 05	CRCOOL	8.050 04	CH2OV	5.572 04		
CLOSS	4.415 03	CRFGAS	3.170 04	CRH	1.136 05	CRCOL	-1.130 05
LOSSES	0.000 00	HEILOS	4.958 04	CRU CT	5.000 03		

MISCELLANEOUS

CROSS	1.074 00	VPOIL	2.407-03	TOL	4.994 03	VPI	6.792 00
WOS	1.249 01	PROP	0.000 00				

MATERIAL AND HEAT BALANCE INPUT SHEET

RIF92	, RUN NO.	C-1 8-9	STARTED	4-15-(	CALC. ON	4-20-6

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

0.8	9.4	61	-1	27497.2
H_2O, wt %	Oil, wt %	°F	(1)	Rate, lbs/Hr

24.6	1.8	17.7	55022
Oil, gal/T	Gas+L, wt%	CO_2, wt%	Retort XS, ft³

69.3	15.5	1.58	23.97	138
Ash, wt%	Carbon, wt%	H_2, wt%	Bar. Press, " Hg	Offgas Temp, °F

AIR

1065.1	1.0	148	12.8	0.14	0
Chart Reading	Meter Factor	Temp, °F	Press, "H_2O gauge	Moist, lbs/mscf	Heat Loss, Btu/Hr

RECYCLE A / TOTAL GAS

298.06	1.0	231	73	0.0	0.0
Recycle Ch Read	Meter Factor	Temp, °F	Press, "H_2O gauge	Tot Gas Ch Read	Meter Factor

DILUTIO / GAS

0.00	0.0	0	0
Dil Gas Ch. Read	Meter Factor	Temp, °F	Press, "H_2O gauge

PROPANE, WA / & NUCLEATI / AGENT

0.0	0	0	216.2	0.0
C_3 Rotameter R.	Temp, °F	Press, "H_2O gauge	Water added, lbs/Hr	Nucl. Agent, lb/Hr.

SPENT SHALE

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

14.06	84.01	5.97	0.16	379
CO_2, wt%	Ash, wt%	Carbon, wt%	H_2, wt%	Temp, °F

LIQUID PRODUCT

2179.05	84.01	11.01	7.0788	37200
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

16230.7	1.0	227	0.0	0.0	0	13.0
Vent+Dil Gas Chart Reading	Meter Factor	Temp, °F	Moist, lbs/mscf	Mist, lbs/mscf	(2)	Carbon, lbs/mscf

0	26.6	0.4	61.0	1.06	3.06	6.03
(3)	CO_2, vol%	O_2, vol%	N_2, vol%	CH_4, vol%	CO_2, vol%	H_2, vol %

0.05	0.088	15.07
Others, vol%	H_2, lbs/mscf	Vent Purge Ch. Reading

1.083	153	166	75	18.07	9.00	12.04
Meter Factor	Temp, °F	Press, "H_2O gauge	Cond. Gas Out Temp, °F	Dry Oil, gal/Hr	Water lbs/Hr	Top Heat Loss 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. M-2 (pressure and temperature have effect on gas rates).

LBGilmore
1/17/67

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-11-67 Run No. C 1028-9 0615

Sample Time: RS 0615 ; SS _____

FISCHER ASSAY

RAW SHALE	SPENT SHALE	
~~25.9~~ 24.5	0.0	Gal/Ton
~~0.916~~ 0.915	—	S.G., g/ml
~~4.8~~ 3.3	0.0	Oil, wt %
~~1.4~~ 1.6	0.4	Water, wt %
~~57.2~~ 57.3	99.4	Sp. Shale, wt %
~~1.6~~ 1.8	0.2	Gas & Loss, wt %
Slight	None	COKING TENDENCY

RETORT SHALE MOISTURE

0.78 wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.76 wt %

MINERAL CO_2	ASH (SHALE)	MOISTURE	CARBON	HYDROGEN	BENZENE EXTRACTABLES	
17.7	69.1	0.22	15.5	1.58	.	wt %
14.6	84.1	0.10	5.97	0.16	.	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 20 1967 CHECKED BY _____

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-16-67 Run No. C 1028-9

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	3.9					
GRAVITY, °API	19.8					
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 224.0

WATER VOL, ml 6.0

GRAVITY OIL, °API 41.8

VENT GAS

MAJOR COMPONENTS

CO_2	26.6	vol %
O_2	0.4	"
N_2	60.3	"
CH_4	1.6	"
CO	3.6	"
H_2	6.3	"
Ar	0.7	"
Others	0.5	"

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, 13.0 lbs/MSCFDG

HYDROGEN, 0.33 lbs/MSCFDG

COMMENTS

DATE COMPLETED [illegible] CHECKED BY RPP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1029 1 SAMPLE NO. _____ DATE 2-16-69

UNIT _____ DESCRIPTION _____

APPROX. SHALE SIZE _____ SHAKING TIME _____ ANALYSIS BY _____

TOTAL SAMPLE WT. GROSS _____ – TARE _____ = NET _____

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50		17.1	16.7	.4
	2.00				
	1.50				
	1.05				
	0.742				
	0.525				
	0.371				
	0.263	3			
	0.185	4			
	0.131	6			
	0.093	8			
	0.065	10			
	PAN				
TOTAL ON SCREENS AND PAN					
LOSS (BY DIFFERENCE)					0
TOTAL SAMPLE WEIGHT					

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	0.78		99.21
2.00	2.250	0.4444	31.52		67.6
1.50	1.750	0.5714	36.38		31.31
1.05	(1.087) 1.275	(0.9199) 0.7843	21.01		10.30
0.742	0.896	1.116	7.20		3.10
0.525	0.634	1.577	1.75		1.35
0.371	0.448	2.232	0.39		0.96
0.263	0.317	3.154	0.19		0.77
0.185	0.224	4.464	0.00		0.77
0.131	0.158	6.329	0.19		0.58
0.093	0.112	8.928	0.00	99.41	0.58
0.065			0.19		0.39
PAN			0.39		0.0
LOSS			—	—	—
TOTAL			99.99	—	—

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

$\Sigma^{m}_{+8m} Di$	1.71246	$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$	0.65037	$\Sigma^{m}_{+8m} Xi / Di$	
Da	1.52857	$\Sigma^{m}_{+8m} Xi\ Di$	
Dv	1.72262		

REMARKS: _____