GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513023005

Date 4-9-67

Purpose: To determine operability and well with 1-2" rock shale, 55 liner, 36 degree slot A/D and 3" over 3 cm. steady state location.

GENERAL		**SPENT SHALE PROPERTIES**	
Run No.	C-1027-4	Fischer Assay, Gal/ton	0.0
Length, hours	12	Mineral CO_2, Wt %	13.2
Retort Type Number	RC-V	Ash, Wt %	85.1
Oil Recovery System Number	C-1	Carbon (total), Wt %	5.77
Tons Total Raw Shale Charged, lbs.	133.02	Organic Carbon, Wt %	2.17
Bed Height above Dist., ft	12½'	Hydrogen (total), Wt %	0.12
Type Air Dist.	AD-VIII	**LIQUID PRODUCT PROPERTIES**	
Bed Below Air Dist., ft	7'	Oil, Wt %	99.3
RATES AND QUANTITIES		Density, lb/gal	7.773
Raw Shale, lbs/(hr)(ft²)	402	Gravity, API	20.1
Spent Shale, % of RS	80.4	Ash, Wt %	
Liquid Product, lbs/hr	2169.5	**PRODUCT GAS PROPERTIES**	
Oil Collected, gal/ton RS	72.3	Water Vapor, lbs/MSCF(dry)	7.8
Air, SCF/ton RS (dry)	4620	Oil, lbs/MSCF(dry)**	0.055
Total Recycle*, SCF/ton RS(wet)	14400	Analysis (dry)	
Dilution, SCF/ton RS (wet)	—	CO_2, Vol %	28.4
Calc.Vent Gas SCF/ton RS(dry)	6110	O_2, Vol %	0.2
Gas Losses, SCF/ton RS(wet)	52	N_2 + Argon, Vol %	59.9
Propane, SCF/ton RS	—	CH_4, Vol %	1.8
TEMPERATURES AND HEAT BALANCE		CO, Vol %	3.2
Retort Offgas, °F	142	H_2, Vol %	5.1
Spent Shale, F	378	Other, Vol %	1.4
Raw Shale, °F	64	Gross Heating Value(calc),Btu/SCF	85.4
Recycle Gas Inlet, °F	250	Carbon (Total), lbs/MSCF (dry)	12.4
Dilution Gas Inlet, °F	—	Hydrogen (Total), lbs/MSCF (dry)	0.71
Air Inlet, °F	128	**YIELDS AND BALANCES**	
Retort Air Inlet, F	128	Oil Collected, Vol % RSFA	85.2
Heat of Comb. MBtu/ton RS	449	Oil in Gas**, Vol % RSFA	0.2
Heat Lost, MBtu/ton RS	15	Oil in Spent Shale, Vol % RSFA	0.0
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	85.4
Fischer Assay, gal/ton RS	26.2	Carbonate Decomposition, %	29.7
Oil, Wt %	10.0	Water Recovered, lb/ton RS	25.8
Water, Wt %	1.1	Ash Balance, % - As Measured	—
Gas, Wt %	2.1	Ash Balance, % - Assumed	RS-100
Mineral CO_2, Wt %	17.3	Overall Balance, %	99.1
Ash, Wt %	68.4	Carbon Balance, % - Organic	95.2
Moisture, Wt % (Uncrushed)	1.05st	Carbon Balance, % - Total	96.6
Carbon (Total), Wt %	16.3	Hydrogen Balance, % - Organic	88.9
Hydrogen (Total), Wt %	1.73	Hydrogen Balance, % - Total	92.2
Nominal Size Range, inches	1"-2½"	Water Balance, %	99.9
5 % passing thru	0.742	**MISCELLANEOUS**	
98 % passing thru	2.50	Avg. Retort ΔP, in H_2O/ft	0.42
Da	1.470	ΔP Above Air Dist., in H_2O/ft	0.26
D_V	1.653	NaCl Soln., Wt %	
		NaCl Rate, gal/ton RS	

Comments: Operations good. Some bowls much #3 screw Condenser bowls Spent shale building up and forcing retort Leaked out cover.

*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 Jenner DATE April 14, 1967

OSRC-10
Revised 7/19/66

921, RUN NO. C-1027-A

YIELDS

FAY	8.524 01	DRYGAS	6.105 03	MISTFA	1.654-01		
H2	3.113 02	OTHER	3.543 01	UNREIC	0.000 00	CH4	1.029 02
O2	1.201 01	SOY	8.037 01	CO	1.953 02	CO2REC	3.967 01
H2O	7.379 01	CO2	1.734 03	OILCOL	2.933 01		

WETTED GAS RATES

RECG	1.443 04	OIL	0.000 00	WVENTG	7.049 03	AIR	4.692 03
TRECG	1.443 04	TGF	0.000 00				

MOL WT & HEATING VALUE OF VENT GAS

MWG	2.939 01	HVGT	5.309 02	MWDG	3.124 01	GBTU	6.242 01

COMBUSTION PRODUCTS

CO2G	5.236 02	COG	1.780 02				
H2OG	3.329 01	O2R	5.963 00	OCMBGP	9.606 00		

MATERIAL IN

ORGCIN	2.315 02	RSR	4.015 02	CRH2IN	3.913 01	MATIN	2.374 03

MATERIAL OUT

ORGCVG	3.959 01	COKSC	3.472 01	UNREIM	0.000 00		
ORGCCL	1.469 02	CRH2VG	8.095 00	COKSH	1.000 00	UNREIC	0.000 00
ORH2OL	1.927 01	CRCCLP	6.305 01	CRCVGP	1.706 01	CRCSSP	1.504 01
MCCVGP	7.454 00						

MATERIAL BALANCES

CVALL	9.913 01	ORCMP	9.991 01				
O2BAL	1.002 02	ASH	0.000 00	TC	9.555 01	WATER	9.965 01
ORGC	9.516 01	TN2	9.994 01	CASL	5.186 01	ASHB	-1.000 00

HEAT IN

CCCMB	4.473 05	CH2CC	8.994 03	CAIR	5.433 03		
CPROP	0.000 00	COILC	1.915 04	CRCYL	5.611 04	CSUMIN	5.998 05

HEAT OUT

CHCCRD	2.167 05	CKERCD	9.690 04	CH2CV	4.797 04		
CLIQC	4.927 03	COFGAS	3.537 04	CSS	1.127 05	CGASL	3.471 02
LSLOSS	0.000 00	RETLOS	1.469 04	CSUMOT	5.998 05		

MISCELLANEOUS

CPCSS	2.166 00	VPOIL	5.517-02	TGL	4.314 03	VPW	7.752 00
MCG	1.401 01	PROP	0.000 00				

MATERIAL AND HEAT BALANCE INPUT SHEET

RIF 92	, RUN NO.	C- 27-4	STARTED	4-9-6	CALC. ON	4-12-6

RAW SHALE, BAROMETRIC PRESSURE, AND OFFGAS TEMPERATURE

101	1000	64	-1	221793
H_2O, wt%	Oil, wt%	°F	(1)	Rate, lbs/Hr

26.2	20.1	17.3	55022
Oil, gal/T	Gas+L, wt%	CO_2, wt%	Retort XS, ft²

68.4	16.3	10.73	24038	142
Ash, wt%	Carbon, wt%	H_2, wt%	Bar. Press, " Hg	Offgas Temp, °F

AIR

85503	1.00	128	133	0.014	0
Chart Reading	Meter Factor	Temp, °F	Press, "H_2O gauge	Moisture, lbs/MSCF	Heat Loss, Btu/Hr

RECYCLE AND TOTAL GAS

268705	1.00	250	72	0.00	0.00
Recycle Ch Reading	Meter Factor	Temp, °F	Press, "H_2O gauge	Total Gas Ch Reading	Meter Factor

DILUTION GAS

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

PROPANE, WATER & NUCLEATING AGENT

0.00	0	0	1224.0	0.00
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

13.2	85.1	5.77	0.12	378
CO_2, wt%	Ash, wt%	Carbon, wt%	H_2, wt%	Temp, °F

LIQUID PRODUCT

1925.3	84.1	11.1	70.773	2440.3
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

134803	1.00	250	0.00	0.00	0	12.4
Vent+Dil Gas Chart Reading	Meter Factor	Temp, °F	Moist, lbs/MSCF	Mist, lbs/MSCF	(2)	Carbon, lbs/MSCF

0	28.4	0.2	59.9	1.8	3.2	5.1
(3)	CO_2, vol%	O_2, vol%	N_2, vol%	CH_4, vol%	CO_2, vol%	H_2, vol%

1.4	0.71	2302
Others, vol%	H_2S, lbs/MSCF	Vi Purge Ch. Reading

1.083	185	167	75	4808	1205	6206
Meter Factor	Temp, °F	Press "H_2O gauge	Cond. Gas Out Temp, °F	Dry Oil, gm/Hr	Water lbs/Hr	Top Seal Gas Rate, SCFH

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 SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-16-67 Run No. C 1027-4

Sample Time: RS 0615 ; SS 1115

FISCHER ASSAY

	RAW SHALE	SPENT SHALE	
EST	25.9	0.0	Gal/Ton
	0.912	—	S.G., g/ml
	9.9	0.0	Oil, wt %
	2.0	0.1	Water, wt %
	86.0	99.5	Sp. Shale, ~~wt~~ %
	2.1	0.1	Gas & Loss, wt %
	Slight	none	COKING TENDENCY

RETORT SHALE MOISTURE

1.0 Est. wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.88 wt %

MINERAL CO_2	17.3	13.2 (EST)	wt %
ASH (SHALE)	68.2	85.1 (EST)	wt %
MOISTURE	0.22	0.10 (EST)	wt %
CARBON	16.3	5.77	wt %
HYDROGEN	1.73	0.12	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 12 1967 CHECKED BY RFP

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-10-67 Run No. C-16274

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
(X) WATER, wt %	0.70					
GRAVITY, °API	20.1					
( ) OIL ASH, wt %						

( ) DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

(X)

OIL WT, g 585.0

WATER VOL, ml 5.0

GRAVITY OIL, °API 42.2

VENT GAS

(X) MAJOR COMPONENTS

CO_2	25.4	vol %	
O_2	0.2	"	
N_2	57.3	"	
CH_4	1.5	"	
CO	3.2	"	
H_2	5.1	"	
Ar	0.7	"	
Others	1.4	"	

( ) 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}	.	"	
ϕC_3H_6	.	"	
n C_5H_{12}	.	"	

(X) CARBON, 12.4 lbs/MSCFDG HYDROGEN, 0.71 lbs/MSCFDG

COMMENTS

DATE COMPLETED CHECKED BY

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 1027-4 SAMPLE NO. 1 DATE 4-1-67

UNIT Retort DESCRIPTION Tyler

APPROX. SHALE SIZE 1-3/4 SHAKING TIME 1 min ANALYSIS BY [illegible]

TOTAL SAMPLE WT. GROSS 91.2 - TARE 5.9 = NET 85.3

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50		19.2	16.7	2.5
	2.00		37.5	20.2	17.3
	1.50		62.0	23.4	38.6
	1.05		37.7	19.1	18.6
	0.742		26.6	20.5	6.1
	0.525		19.9	18.4	1.5
	0.371		19.4	19.4	.0
	0.263	3	18.5	18.3	.2
	0.185	4	19.4	19.4	.0
	0.131	6	19.4	19.3	.1
	0.093	8	20.4	20.4	.0
	0.065	10	19.3	19.2	.1
	PAN		21.5	21.0	.5
TOTAL ON SCREENS AND PAN					85.5
LOSS (BY DIFFERENCE)					-.2
TOTAL SAMPLE WEIGHT					85.3

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			
2.00	2.250	0.4444			
1.50	1.750	0.5714			
1.05	(1.087) 1.275	(0.9199) 0.7843			
0.742	0.896	1.116			
0.525	0.634	1.577			
0.371	0.448	2.232			
0.263	0.317	3.154			
0.185	0.224	4.464			
0.131	0.158	6.329			
0.093	0.112	8.928			
0.065					
PAN					
LOSS					
TOTAL					

003854

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

$\sum_{+8m}^{m} Di$		$\sum_{+8m}^{m} Xi$	
$1/\sum_{+8m}^{m} Di$		$\sum_{+8m}^{m} Xi / Di$	
Da		$\sum_{+8m}^{m} Xi\ Di$	
Dv			

REMARKS: _____

OSRC-4

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C-1027-4 SAMPLE NO. 2 DATE 4-10-67

UNIT Retort "B" DESCRIPTION TY Lab

APPROX. SHALE SIZE 1-2½ SHAKING TIME 10 min ANALYSIS BY [illegible]

TOTAL SAMPLE WT. GROSS 27.3 − TARE 2.6 = NET 24.7

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50		17.3	16.7	.6
	2.00		22.0	20.2	1.8
	1.50		35.1	23.4	11.7
	1.05		26.2	19.1	7.1
	0.742		23.5	20.5	3.0
	0.525		19.2	18.4	.8
	0.371		19.4	19.3	.1
	0.263	3	19.5	19.3	.2
	0.185	4	19.2	19.1	.1
	0.131	6	19.4	19.3	.1
	0.093	8	20.4	20.4	.0
	0.065	10	19.3	19.2	.1
	PAN		21.2	21.0	.2
TOTAL ON SCREENS AND PAN					24.8
LOSS (BY DIFFERENCE)					−.1
TOTAL SAMPLE WEIGHT					24.7

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			
2.00	2.250	0.4444			
1.50	1.750	0.5714			
1.05	(1.087) 1.275	(0.9199) 0.7843			
0.742	0.896	1.116			
0.525	0.634	1.577			
0.371	0.448	2.232			
0.263	0.317	3.154			
0.185	0.224	4.464			
0.131	0.158	6.329			
0.093	0.112	8.928			
0.065					
PAN					
LOSS			—		
TOTAL					

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

$\sum_{+8m}^{m} Di$		$\sum_{+8m}^{m} Xi$	
$1/\sum_{+8m}^{m} Di$		$\sum_{+8m}^{m} Xi / Di$	
Da		$\sum_{+8m}^{m} Xi\ Di$	
Dv			

REMARKS: _____

OSRC-4

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C-1027-4 SAMPLE NO. _____ DATE 4-10-67

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				3.1
	2.00				19.1
	1.50				50.3
	1.05				25.7
	0.742				8.1
	0.525				2.3
	0.371				0.1
	0.263	3			0.4
	0.185	4			0.1
	0.131	6			0.2
	0.093	8			0.0
	0.065	10			0.2
	PAN				0.7
TOTAL ON SCREENS AND PAN					110.3
LOSS (BY DIFFERENCE)					—
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	2.81		97.18
2.00	2.250	0.4444	17.32		79.86
1.50	1.750	0.5714	45.60		34.26
1.05	(1.087) 1.275	(0.9199) 0.7843	23.30		10.96
0.742	0.896	1.116	7.34		3.62
0.525	0.634	1.577	2.09		1.53
0.371	0.448	2.232	0.09		1.44
0.263	0.317	3.154	0.36		1.08
0.185	0.224	4.464	0.09		6.99
0.131	0.158	6.329	0.18		0.81
0.093	0.112	8.928	0.00	99.18	0.81
0.065			0.18		0.63
PAN			0.63		0.00
LOSS			—	—	—
TOTAL			99.99	—	—

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

$\Sigma^{m}_{+8m} Di$	1.63958	$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$	0.67462	$\Sigma^{m}_{+8m} Xi / Di$	
Da	1.47016	$\Sigma^{m}_{+8m} Xi\ Di$	
Dv	1.65314		

REMARKS: _____

OSRC-4