GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513018029

Date 7-2-67

Purpose: To determine operability and yield with ¼ - 2½ inch shale at 500 mass rate and with hot air. (w/o dilution gas)

GENERAL		SPENT SHALE PROPERTIES	
Run No.	C1044-4	Fischer Assay, Gal/ton	0.0
Length, hours	12	Mineral CO_2, Wt %	16.1
Retort Type Number	RC VII	Ash, Wt %	81.6
Oil Recovery System Number	C-2	Carbon (total), Wt %	6.75
Tons Total Raw Shale Charged, ~~lbs.~~	163.73	Organic Carbon, Wt %	2.36
Bed Height above Dist., ft	9½	Hydrogen (total), Wt %	0.22
Type Air Dist.	AD XI	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6	Oil, Wt %	93.6
RATES AND QUANTITIES		Density, lb/gal	7.804
Raw Shale, lbs/(hr)(ft²)	994	Gravity, API	19.5
Spent Shale, % of RS	83.0	Ash, Wt %	—
Liquid Product, lbs/hr	2475.51	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	21.6	Water Vapor, lbs/MSCF(dry)	6.2
Air, SCF/ton RS (dry)	4700	Oil, lbs/MSCF(dry)**	0.166
Total Recycle*, SCF/ton RS(wet)	11900	Analysis (dry)	
Dilution, SCF/ton RS (wet)	—	CO_2, Vol %	26.0
Calc. Vent Gas SCF/ton RS(dry)	6275	O_2, Vol %	0.0
Gas Losses, SCF/ton RS(wet)	428	N_2 + Argon, Vol %	59.2
Propane, SCF/ton RS	50.8	CH_4, Vol %	2.9
TEMPERATURES AND HEAT BALANCE		CO, Vol %	4.4
Retort Offgas, °F	143	H_2, Vol %	6.4
Spent Shale, F	555	Other, Vol %	1.9
Raw Shale, °F	102	Gross Heating Value(calc),Btu/SCF	141
Recycle Gas Inlet, °F	263	Carbon (Total), lbs/MSCF (dry)	13.3
Dilution Gas Inlet, °F	—	Hydrogen (Total), lbs/MSCF (dry)	1.18
Air Inlet, °F	130	YIELDS AND BALANCES	
Retort Air Inlet, F	130	Oil Collected, Vol % RSFA	77.0
Heat of Comb. MBtu/ton RS	416	Oil in Gas**, Vol % RSFA	0.5
Heat Lost, MBtu/ton RS	6	Oil in Spent Shale, Vol % RSFA	0.0
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	77.5
Fischer Assay, gal/ton RS	28.1	Carbonate Decomposition, %	73.2
Oil, Wt %	10.7	Water Recovered, lb/ton RS	58.2
Water, Wt %	0.7	Ash Balance, % - As Measured	—
Gas, Wt %	2.5	Ash Balance, % - Assumed	17.5.100
Mineral CO_2, Wt %	17.4	Overall Balance, %	100.1
Ash, Wt %	67.7	Carbon Balance, % - Organic	99.0
Moisture, Wt % (Uncrushed)	1.0 Est	Carbon Balance, % - Total	102.2
Carbon (Total), Wt %	16.8	Hydrogen Balance, % - Organic	85.8
Hydrogen (Total), Wt %	1.72	Hydrogen Balance, % - Total	96.3
Nominal Size Range, inches	¼" - 2½"	Water Balance, %	167.3
5 % passing thru	0.371	MISCELLANEOUS	
98 % passing thru	2.50	Avg. Retort ΔP, in H_2O/ft	0.78
Da	1.080	ΔP Above Air Dist., in H_2O/ft	0.74
D_V	1.427	NaCl Soln., Wt %	—
Line Burner °F	850	NaCl Rate, gal/ton RS	—

Comments: Increased air rate.

*Measured Recycle + Dilution Gas
** Oil Mist + Condensibles to 84 °F
*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. Jones DATE July 18, 1967

OSRC-10
Revised 7/19/66

//A100
2080, C1049-4 7-2-67

A. YIELDS

FAY	7.699E 01	DRYGAS	6.275E 03	MISTFA	4.754E-01
H2	4.016E 02	OTHER	1.192E 02	UNRETO	0.0
CH4	1.820E 02	02	0.0	SSY	8.297E 01
CO	2.761E 02	CO2DEC	2.323E 01	MH2O	5.822E 01
CO2	1.632E 03	OILCOL	2.163E 01		

B. METERED GAS RATES

RECG	1.190E 04	DIL	0.0	WVENTG	6.667E 03
AIR	4.695E 03	TRECG	1.190E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.923E 01	HVGT	8.854E 02	MWDG	3.070E 01
GBTU	1.411E 02				

D. COMBUSTION PRODUCTS

CO2C	8.628E 02	COC	2.544E 02	H2OC	-5.877E-02
CHR	-5.370E 03	COMBCP	1.441E 01		

E. MATERIAL IN

ORGCIN	2.456E 02	RSR	4.942E 02	ORH2IN	3.392E 01
MATIN	2.386E 03				

F. MATERIAL OUT

ORGCVG	6.229E 01	COKEC	3.907E 01	UNRETH	0.0
ORGCOL	1.420E 02	ORH2VG	7.514E 00	COKEH	2.907E 00
UNRETC	0.0	ORH2OL	1.874E 01	ORCOLP	5.776E 01
ORCVGP	2.534E 01	ORCSSP	1.589E 01	HCCVGP	1.093E 01

G. MATERIAL BALANCES

OVALL	1.001E 02	ORH2	8.597E 01	O2BAL	1.059E 02
ASH	0.0	TC	1.022E 02	WATER	1.673E 02
ORGC	9.899E 01	TH2	9.633E 01	GASL	4.280E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.162E 05	QH2OC	8.562E 03	QAIR	2.423E 03
QPROP	6.751E 01	QOILC	1.182E 04	QRCYL	4.136E 04
QSUMIN	4.804E 05				

I. HEAT OUT

QMCO2D	1.310E 05	QKEROD	1.048E 05	QH2OV	3.765E 04
QLIQO	2.603E 03	QOFGAS	1.629E 04	QSS	1.780E 05
QGASL	4.306E 03	LBLOSS	0.0	HETLOS	5.824E 03
QSUMOT	4.804E 05				

J. MISCELLANEOUS

ORCSS	2.355E 00	VPOIL	1.661E-01	TGL	4.589E 03
VPM	6.209E 00	WCG	1.155E 01	PROP	5.080E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR FIRST RETORT - OSRC RUNS

LINE #	PROGRAM ID ←	USER IDENTIFICATION →						
0	2080,	C1049-4	7-2-67					
	WRS	OLRS	TRS	B	MRS			
1	0.7	10.6	102	-1	27287.7			RAW SHALE
	FA	GRS	CORS	XA				
2	28.1	2.5	17.4	55.22				
	ASRS	CRS	HRS	BP	TOG			
3	67.7	16.8	1.72	74.40	143			
	CRA	MFA	TA	PA	WA	LBHL		AIR
4	1068.4	1.0	730	111	0.14	0		
	CRRG	MFRG	TRG	PRG	CRTG	MFTG		RECYCLE AN TOTAL GAS
5	2718.3	1.0	265	64	0.0	0.0		
	CRDG	MFDG	TDG	PDG				DILUTION GA
6	0.0	0.0	0	0				
	P	TP	PP	W	N			PROPANE AN NUCLEATING AGENT
7	7.10	0.4	1282	275.6	0.0			
	WSS	OLSS	GSS	SS				SPENT SHALE
8	0.4	0.0	0.0	0.0				
	COSS	ASSS	CSS	HSS	TSS			
9	16.1	81.6	6.75	0.22	555			
	OILLP	COL	HOL	DOL	WLP			LIQUID PRODUCT
10	2303.4	84.1	11.1	7.804	172.1			
	CRVG	MFVG	TVG	WG	OILM	M		VENT GAS
11	1562.2	1.0	261	0.0	0.0	0		
	CG	H	COOG	OG	NG			
12	13.3	0	26.0	0.0	59.2			
	MEG	COG	HHG	OTG	HG			
13	2.9	4.4	6.4	1.9	1.18			
	CRVP	VPMF	TVP	PVP				VENT PURGE
14	5.8	2.21	178	25				
	TVPC	VPOIL	VPW	GL				
15	84	76.0	3.8	73.7				

OPTIONS:

1. *B Enter "1" to Calculate with Spent Shale Rate and Ash Analyses,*
   Or "0" to Calculate with Measured Rates,
   Or "-1" to Calculate with Raw Shale Rate and Ash Analyses.
2. *M Enter "1" to Calculate with Measured Moisture and Mist,*
   Or "0" to Calculate from Vent Purge Data.
3. *H Enter "1" to Calculate using Retort #2,*
   Or "0" to Calculate using Retort #3.

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 7-2-67 Run No. C 1049-4

Sample Time: RS 19:15 ; SS 22:45

FISCHER ASSAY

(X) RAW SHALE	(X) SPENT SHALE	
27.8	0.0	Gal/Ton
0.914	—	S.G., g/ml
10.6	0.0	Oil, wt %
1.7	0.4	Water, wt %
85.2	99.4	Sp. Shale, wt %
2.5	0.2	Gas & Loss, wt %
Slight	None	COKING TENDENCY

( ) RETORT SHALE MOISTURE

_____ wt %

(X) RAW SHALE FISCHER ASSAY MOISTURE

0.62 wt %

	(X)	(X)	
MINERAL CO_2	17.3	16.1	wt %
ASH (SHALE)	67.3	81.6	wt %
MOISTURE	0.33	0.03	wt %
CARBON	16.7	6.75	wt %
HYDROGEN	1.71	0.22	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 JUL 5 1967 CHECKED BY

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 7-2-67 Run No. C1049-41

EET

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	6.4					
GRAVITY, °API	19.5					
◯ OIL ASH, wt %						

◯ DISTILLATION (See attached sheet - OSRC-24)

EET

VENT PURGE PRODUCT

OIL WT, g 911.8

WATER VOL, ml 70.0

GRAVITY OIL, °API 41.7

E6B

VENT GAS

⊗ MAJOR COMPONENTS

CO_2	26.6	vol %
O_2	0.0	"
N_2	58.5	"
CH_4	2.9	"
CO	4.4	"
H_2	6.4	"
Ar	0.7	"
Others	1.9	"

◯ 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}	.	"

⊗ CARBON, 13.3 lbs/MSCFDG

HYDROGEN, 1.18 lbs/MSCFDG

COMMENTS

DATE COMPLETED JUL 4 1967 CHECKED BY TEP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1049-4 SAMPLE NO. TY-06 DATE 9-2-67

UNIT #3 DESCRIPTION R.S

APPROX. SHALE SIZE 4"x4" SHAKING TIME 10 ANALYSIS BY TY-LAB

TOTAL SAMPLE WT. GROSS 68.7 - TARE 6.6 = NET 62.1

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50		17.6	16.7	4.9
	2.00		30.5	20.2	10.3
	1.50		41.7	23.4	18.3
	1.05		32.3	19.2	13.1
	0.742		29.0	20.5	8.5
	0.525		23.7	18.5	5.2
	0.371		21.5	19.2	2.3
	0.263	3	20.3	19.4	1.9
	0.185	4	19.7	19.4	.3
	0.131	6	19.5	19.4	.1
	0.093	8	20.4	20.4	.0
	0.065	10	19.3	19.2	.1
	PAN		22.1	21.0	1.1
TOTAL ON SCREENS AND PAN					62.1
LOSS (BY DIFFERENCE)					-
TOTAL SAMPLE WEIGHT					62.1

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	1.45		98.55
2.00	2.250	0.4444	16.59		81.96
1.50	1.750	0.5714	29.47		52.49
1.05	(1.087) 1.275	(0.9199) 0.7843	21.09		31.40
0.742	0.896	1.116	13.69		17.71
0.525	0.634	1.577	8.37		9.34
0.371	0.448	2.232	3.70		5.64
0.263	0.317	3.154	3.06		2.58
0.185	0.224	4.464	0.48		2.10
0.131	0.158	6.329	0.16		1.94
0.093	0.112	8.928	0	98.06	1.94
0.065			0.16		1.78
PAN			1.77		0
LOSS					
TOTAL					

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

$\Sigma^{m}_{+8m} Di$		$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$		$\Sigma^{m}_{+8m} Xi / Di$	0.908224
Da	1.0997	$\Sigma^{m}_{+8m} Xi\ Di$	1.39929
Dv	1.4280		

REMARKS: _____

OSRC-4