GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513018031

Date 7-3-67

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.	C1049-6	Fischer Assay, Gal/ton	0.0
Length, hours	12	Mineral CO_2, Wt %	15.5
Retort Type Number	RC VII	Ash, Wt %	82.9
Oil Recovery System Number	C-2	Carbon (total), Wt %	6.40
Total Raw Shale Charged, ~~lbs.~~ Tons	166.81	Organic Carbon, Wt %	2.17
Bed Height above Dist., ft	9½	Hydrogen (total), Wt %	0.21
Type Air Dist.	ADXI	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6	Oil, Wt %	95.2
RATES AND QUANTITIES		Density, lb/gal	7.788
Raw Shale, lbs/(hr)(ft^2)	504	Gravity, API	19.8
Spent Shale, % of RS	82.2	Ash, Wt %	—
Liquid Product, lbs/hr	25040	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	21.8	Water Vapor, lbs/MSCF(dry)	5.8
Air, SCF/ton RS (dry)	4690	Oil, lbs/MSCF(dry)**	0.231
Total Recycle*, SCF/ton RS(wet)	17080	Analysis (dry)	
Dilution, SCF/ton RS (wet)	—	CO_2, Vol %	25.6
Calc. Vent Gas SCF/ton RS(dry)	6113	O_2, Vol %	0.1
Gas Losses, SCF/ton RS(wet)	111	N_2 + Argon, Vol %	60.7
Propane, SCF/ton RS	27.0	CH_4, Vol %	2.3
TEMPERATURES AND HEAT BALANCE		CO, Vol %	4.1
Retort Offgas, °F	143	H_2, Vol %	6.1
Spent Shale, F	565	Other, Vol %	1.1
Raw Shale, °F	96	Gross Heating Value(calc),Btu/SCF	144
Recycle Gas Inlet, °F	261	Carbon (Total), lbs/MSCF (dry)	13.4
Dilution Gas Inlet, °F	—	Hydrogen (Total), lbs/MSCF (dry)	1.15
Air Inlet, °F	130	YIELDS AND BALANCES	
Retort Air Inlet, F	130	Oil Collected, Vol % RSFA	81.8
Heat of Comb. MBtu/ton RS	444	Oil in Gas**, Vol % RSFA	0.7
Heat Lost, MBtu/ton RS	-4	Oil in Spent Shale, Vol % RSFA	0.0
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	82.5
Fischer Assay, gal/ton RS	26.6	Carbonate Decomposition, %	29.3
Oil, Wt %	10.2	Water Recovered, lb/ton RS	52.8
Water, Wt %	0.7	Ash Balance, % - As Measured	—
Gas, Wt %	2.4	Ash Balance, % - Assumed	R.S. 100
Mineral CO_2, Wt %	18.0	Overall Balance, %	98.6
Ash, Wt %	68.1	Carbon Balance, % - Organic	96.8
Moisture, Wt % (Uncrushed)	1.0 Est.	Carbon Balance, % - Total	99.2
Carbon (Total), Wt %	16.8	Hydrogen Balance, % - Organic	94.2
Hydrogen (Total), Wt %	1.73	Hydrogen Balance, % - Total	94.3
Nominal Size Range, inches	¼" - 2½"	Water Balance, %	86.0
5 % passing thru	0.371	MISCELLANEOUS	
98 % passing thru	2.50	Avg. Retort ΔP, in H_2O/ft	0.79
Da	1.060	ΔP Above Air Dist., in H_2O/ft	0.94
Dv	1.625	NaCl Soln., Wt %	—
Line Burner °F	860	NaCl Rate, gal/ton RS	—

Comments: Operations good except for high temperature excursions adjusted recycle to control.

*Measured Recycle + Dilution Gas
** Oil Mist + Condensibles to 82 °F
*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. Turner DATE July 18 1967

OSRC-10
Revised 7/19/66

//A100
2080. C1049-6 7-3-67

A. YIELDS

FAY	8.178E 01	DRYGAS	6.113E 03	MISTFA	6.810E-01
H2	3.729E 02	OTHER	6.724E 01	UNRETO	0.0
CH4	1.406E 02	02	6.113E 00	SSY	8.215E 01
CO	2.506E 02	CO2DEC	2.926E 01	MH2O	5.275E 01
CO2	1.565E 03	OILCOL	2.175E 01		

B. METERED GAS RATES

RECG	1.208E 04	DIL	0.0	WVENTG	6.747E 03
AIR	4.689E 03	TRECG	1.208E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.908E 01	HVGT	8.804E 02	MWDG	3.043E 01
GBTU	1.440E 02				

D. COMBUSTION PRODUCTS

CO2C	5.887E 02	COC	2.300E 02	H2OC	2.647E 01
CHR	8.737E 00	COMBCP	1.080E 01		

E. MATERIAL IN

ORGCIN	2.403E 02	RSR	5.035E 02	ORH2IN	3.361E 01
MATIN	2.383E 03				

F. MATERIAL OUT

ORGCVG	5.436E 01	COKEC	3.563E 01	UNRETH	0.0
ORGCOL	1.425E 02	ORH2VG	1.015E 01	COKEH	2.714E 00
UNRETC	0.0	ORH2OL	1.881E 01	ORCOLP	5.930E 01
ORCVGP	2.263E 01	ORCSSP	1.483E 01	HCCVGP	1.182E 01

G. MATERIAL BALANCES

OVALL	9.864E 01	ORH2	9.424E 01	O2BAL	9.835E 01
ASH	0.0	TC	9.918E 01	WATER	8.602E 01
ORGC	9.675E 01	TH2	9.425E 01	GASL	1.112E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.444E 05	QH2OC	8.478E 03	QAIR	2.938E 03
QPROP	4.333E 01	QOILC	1.186E 04	QRCYL	4.160E 04
QSUMIN	5.093E 05				

I. HEAT OUT

QMCO2D	1.707E 05	QKEROD	1.008E 05	QH2OV	3.765E 04
QLIQO	2.979E 03	QOFGAS	1.849E 04	QSS	1.811E 05
QGASL	1.133E 03	LBLOSS	0.0	HETLOS	-3.556E 03
QSUMOT	5.093E 05				

J. MISCELLANEOUS

ORCSS	2.169E 00	VPOIL	2.308E-01	TGL	4.739E 03
VPM	5.802E 00	WCG	1.087E 01	PROP	2.696E 01

END MESSAGE

END OUTPUT

LINE #	PROGRAM ID	USER IDENTIFICATION						
0	2080,	C1049-6			7-3-67			
	WRS	OLRS	TRS	B	MRS			RAW SHALE
1	0.7	10.2	96	-1	2780.2			
	FA	GRS	CORS	XA				
2	26.6	2.4	18.0	55.22				
	ASRS	CRS	HRS	BP	TOG			
3	68.1	16.8	1.73	24.43	143			
	CRA	MFA	TA	PA	WA	LBHL		AIR
4	1086.5	1.0	130	110	0.14	6		
	CRRG	MFRG	TRG	PRG	CRTG	MFTG		RECYCLE AI TOTAL GAS
5	2800.6	1.0	26.1	67	0.0	0.0		
	CRDG	MFDG	TDG	PDG				DILUTION G
6	0.0	0.0	0	0				
	P	TP	PP	W	N			PROPANE AI NUCLEATIN AGENT
7	7.19	0.4	127.8	280.8	0.0			
	WSS	OLSS	GSS	SS				SPENT SHALE
8	0.4	0.0	0.0	0.0				
	COSS	ASSS	CSS	HSS	TSS			
9	15.5	82.9	6.40	0.21	565			
	OILLP	COL	HOL	DOL	WLP			LIQUID PRODUCT
10	2355.0	84.1	11.1	7.788	199.0			
	CRVG	MFVG	TVG	WG	OILM	M		VENT GAS
11	1603.7	1.0	257	0.0	0.0	0		
	CG	H	COOG	OG	NG			
12	13.4	0	25.6	0.1	60.7			
	MEG	COG	HHG	OTG	HG			
13	2.3	4.1	6.1	1.1	1.15			
	CRVP	VPMF	TVP	PVP				VENT PURGE
14	5.6	2.05	180	29				
	TVPC	VPOIL	VPW	GL				
15	82	97.1	3.3	72.8				

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 7-3-67 Run No. C 1049-6

Sample Time: RS 1915; SS _____

FISCHER ASSAY

RAW SHALE	SPENT SHALE	
26.3	0.0	Gal/Ton
.916	—	S.G., g/ml
10.1	0.0	Oil, wt %
1.6	0.4	Water, wt %
85.9	99.5	Sp. Shale, wt %
2.4	0.1	Gas & Loss, wt %
Slight	none	COKING TENDENCY

RETORT SHALE MOISTURE _____ wt %

RAW SHALE FISCHER ASSAY MOISTURE 0.63 wt %

	RAW SHALE	SPENT SHALE	
MINERAL CO_2	17.9	15.5	wt %
ASH (SHALE)	67.7	82.9	wt %
MOISTURE	0.18 ~~0.63~~	0.07	wt %
CARBON	16.7 ~~15.8~~	6.40	wt %
HYDROGEN	1.72 ~~1.59~~	0.21	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 7 1967 CHECKED BY _____

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 7-3-67 Run No. C 1049-6

PJH

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	4.8	/	/			
GRAVITY, °API	19.8	/	/			
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

PJH

VENT PURGE PRODUCT

OIL WT, g 1165.0

WATER VOL, ml 68.0

GRAVITY OIL, °API 47.6

EGB

VENT GAS

MAJOR COMPONENTS

CO_2	25.6	vol %
O_2	0.1	"
N_2	60.0	"
CH_4	2.3	"
CO	4.1	"
H_2	6.1	"
Ar	0.7	"
Others	1.1	"

PJH CARBON, 13.4 lbs/MSCFDG

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}	.	"

HYDROGEN, 1.15 lbs/MSCFDG

COMMENTS Small A Holder 13.4 #/MSCF C 1.16 #/MSCF H

DATE COMPLETED JUL 4 1967 CHECKED BY REP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1049-6 SAMPLE NO. _____ DATE 2-3-67

UNIT #3 DESCRIPTION 12.5

APPROX. SHALE SIZE ¼-2" SHAKING TIME 10 ANALYSIS BY Valley + Stratton

TOTAL SAMPLE WT. GROSS 79.8 – TARE 6.5 = NET 73.3

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50		18.7	16.7	2.0
	2.00		33.0	20.2	12.8
	1.50		45.5	23.5	22.0
	1.05		33.0	19.4	13.6
	0.742		29.5	20.5	9.0
	0.525		25.2	18.6	6.6
	0.371		22.4	19.2	3.2
	0.263	3	20.6	18.4	2.2
	0.185	4	20.0	19.4	.6
	0.131	6	19.6	19.4	.2
	0.093	8	20.6	20.6	.0
	0.065	10	19.3	19.3	.0
	PAN		22.1	21.0	1.1
TOTAL ON SCREENS AND PAN					73.3
LOSS (BY DIFFERENCE)					0
TOTAL SAMPLE WEIGHT					73.3

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	2.73		97.27
2.00	2.250	0.4444	17.46		79.81
1.50	1.750	0.5714	30.02		49.79
1.05	(1.067) 1.275	(0.9199) 0.7843	18.55		31.24
0.742	0.896	1.116	12.28		18.96
0.525	0.634	1.577	9.00		9.96
0.371	0.448	2.232	4.37		5.59
0.263	0.317	3.154	3.00		2.59
0.185	0.224	4.464	6.82		1.77
0.131	0.158	6.329	0.27		1.50
0.093	0.112	8.928	0	98.50	1.50
0.065			0		1.50
PAN			1.50		0
LOSS					
TOTAL					

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

$\Sigma_{+8m}^{m} Di$		$\Sigma_{+8m}^{m} Xi$	
$1/\Sigma_{+8m}^{m} Di$		$\Sigma_{+8m}^{m} Xi / Di$	0.929367
Da	1.0599	$\Sigma_{+8m}^{m} Xi\ Di$	1.601013
Dv	1.6254		

REMARKS: _____

OSRC-4