GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513018008

Date 6-21-67

Purpose: To determine operability and yield with ¼-2½ in. shale using hot dilution gas.

GENERAL		SPENT SHALE PROPERTIES	
Run No.	R-1 C1046-6	Fischer Assay, Gal/ton	0.0
Length, hours	12	Mineral CO_2, Wt %	14.5
Retort Type Number	RC VII	Ash, Wt %	83.9
Oil Recovery System Number	C-1	Carbon (total), Wt %	6.18
Tons Total Raw Shale Charged, lbs.	98.99	Organic Carbon, Wt %	2.22
Bed Height above Dist., ft	9½	Hydrogen (total), Wt %	0.14
Type Air Dist.	AD XII	**LIQUID PRODUCT PROPERTIES**	
Bed Below Air Dist., ft	6	Oil, Wt %	99.0
RATES AND QUANTITIES		Density, lb/gal	7.762
Raw Shale, lbs/(hr)(ft^2)	299	Gravity, API	20.3
Spent Shale, % of RS	79.7	Ash, Wt %	—
Liquid Product, lbs/hr	1674.6	**PRODUCT GAS PROPERTIES**	
Oil Collected, gal/ton RS	23.5	Water Vapor, lbs/MSCF(dry)	5.2
Air, SCF/ton RS (dry)	5220	Oil, lbs/MSCF(dry)**	0.043
Total Recycle*, SCF/ton RS(wet)	12300	Analysis (dry)	
Dilution, SCF/ton RS (wet)	1820	CO_2, Vol %	25.6
Calc. Vent Gas SCF/ton RS(dry)	4790	O_2, Vol %	0.3
Gas Losses, SCF/ton RS(wet)	1299	N_2 + Argon, Vol %	60.9
Propane, SCF/ton RS	20.9	CH_4, Vol %	2.0
TEMPERATURES AND HEAT BALANCE		CO, Vol %	3.5
Retort Offgas, °F	139	H_2, Vol %	5.8
Spent Shale, F	529	Other, Vol %	1.9
Raw Shale, °F	87	Gross Heating Value(calc),Btu/SCF	109.0
Recycle Gas Inlet, °F	229	Carbon (Total), lbs/MSCF (dry)	12.4
Dilution Gas Inlet, °F	286	Hydrogen (Total), lbs/MSCF (dry)	0.77
Air Inlet, °F	151	**YIELDS AND BALANCES**	
Retort Air Inlet, F	151	Oil Collected, Vol % RSFA	82.2
Heat of Comb. MBtu/ton RS	501	Oil in Gas**, Vol % RSFA	0.1
Heat Lost, MBtu/ton RS	-1	Oil in Spent Shale, Vol % RSFA	0.0
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	82.3
Fischer Assay, gal/ton RS	28.6	Carbonate Decomposition, %	33.4
Oil, Wt %	10.9	Water Recovered, lb/ton RS	68.4
Water, Wt %	0.8	Ash Balance, % - As Measured	—
Gas, Wt %	2.3	Ash Balance, % - Assumed	R.S. 100
Mineral CO_2, Wt %	17.9	Overall Balance, %	98.3
Ash, Wt %	66.9	Carbon Balance, % - Organic	93.2
Moisture, Wt % (Uncrushed)	1.30	Carbon Balance, % - Total	96.1
Carbon (Total), Wt %	17.6	Hydrogen Balance, % - Organic	92.2
Hydrogen (Total), Wt %	1.76	Hydrogen Balance, % - Total	91.6
Nominal Size Range, inches	¼"-2½"	Water Balance, %	85.2
5 % passing thru	0.371	**MISCELLANEOUS**	
98 % passing thru	2.50	Avg. Retort ΔP, in H_2O/ft	0.34
Da	1.051	ΔP Above Air Dist., in H_2O/ft	0.37
Dv	1.419	NaCl Soln., Wt %	—
Line Burner °F	700	NaCl Rate, gal/ton RS	—

Comments: Operation good except for excessive [illegible] in vent gas due to pressure fluctuations due to dilution gas burning in headers.

*Measured Recycle + Dilution Gas
** Oil Mist + Condensibles to 79 °F
*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. [illegible] DATE July 17, 1967

OSRC-10
Revised 7/19/66

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//A100
2080, C1046-6 R-1 6-21-67

A. YIELDS
FAY      8.222E 01    DRYGAS   6.787E 03    MISTFA   1.316E-01
H2       3.937E 02    OTHER    1.290E 02    UNRETO   0.0
CH4      1.357E 02    02       2.036E 01    SSY      7.974E 01
CO       2.376E 02    CO2DEC   3.541E 01    MH2O     6.836E 01
CO2      1.738E 03    OILCOL   2.351E 01

B. METERED GAS RATES
RECG     1.052E 04    DIL      1.822E 03    WVENTG   6.233E 03
AIR      5.224E 03    TRECG    1.234E 04    TGF      0.0

C. MOL WT & HEATING VALUE OF VENT GAS
MWWG     2.943E 01    HVGT     7.058E 02    MWDG     3.068E 01
GBTU     1.040E 02

D. COMBUSTION PRODUCTS
CO2C     5.806E 02    COC      2.181E 02    H2OC     3.717E 01
CHR      6.069E 00    COMBCP   9.880E 00

E. MATERIAL IN
ORGCIN   2.562E 02    RSR      2.988E 02    ORH2IN   3.386E 01
MATIN    2.429E 03

F. MATERIAL OUT
ORGCVG   4.984E 01    COKEC    3.543E 01    UNRETH   0.0
ORGCOL   1.535E 02    ORH2VG   9.425E 00    COKEH    1.518E 00
UNRETC   0.0          ORH2OL   2.026E 01    ORCOLP   5.990E 01
ORCVGP   1.945E 01    ORCSSP   1.383E 01    HCCVGP   9.569E 00

G. MATERIAL BALANCES
OVALL    9.834E 01    ORH2     9.217E 01    O2BAL    9.767E 01
ASH      0.0          TC       9.613E 01    WATER    8.519E 01
ORGC     9.318E 01    TH2      9.156E 01    GASL     1.299E 03
ASHB    -1.000E 00

H. HEAT IN
QCOMB    5.012E 05    QH2OC    8.229E 03    QAIR     6.166E 03
QPROP    6.378E 01    QOILC    1.278E 04    QRCYL    5.014E 04
QSUMIN   5.785E 05

I. HEAT OUT
QMCO2D   2.054E 05    QKEROD   1.056E 05    QH2OV    4.619E 04
QLIQO    3.513E 03    QOFGAS   2.089E 04    QSS      1.845E 05
QGASL    1.387E 04    LBLOSS   0.0          HETLOS  -1.426E 03
QSUMOT   5.785E 05

J. MISCELLANEOUS
ORCSS    2.222E 00    VPOIL    4.305E-02    TGL      2.774E 03
VPM      5.213E 00    WCG      9.880E 00    PROP     2.091E 01

END MESSAGE


END OUTPUT
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HEAT AND MATERIAL BALANCE FOR PILOT RETORTS – DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION						
0	2080,	C1046-6	R-1	6-21-67				
	WRS	OLRS	TRS	B	MRS			
1	0.8	10.9	87	-1	16498.3			
	FA	GRS	CORS	XA				RAW SHALE
2	28.6	2.3	17.9	55.22				
	ASRS	CRS	HRS	BP	TOG			
3	66.9	17.6	1.76	24.35	139			
	CRA	MFA	TA	PA	WA	LBHL		
4	719.5	1.0	151	133	0.14	0		AIR
	CRRG	MFRG	TRG	PRG	CRTG	MFTG		
5	1458.4	1.0	279	75	0.0	0.0		RECYCLE A TOTAL GAS
	CRDG	MFDG	TDG	PDG				
6	5.5	56.4	286	76				DILUTION G
	P	TP	PP	W	N			
7	3.31	0.4	128.8	217.3	0.0			PROPANE A NUCLEATIN AGENT
	WSS	OLSS	GSS	SS				
8	0.4	0.0	0.0	0.0				SPENT SHALE
	COSS	ASSS	CSS	HSS	TSS			
9	14.5	83.9	6.18	0.14	579			
	OILLP	COL	HOL	DOL	WLP			
10	15056.	84.1	11.1	7.762	169.0			LIQUID PRODUCT
	CRVG	MFVG	TVG	WG	OILM	M		
11	1179.3	1.0	286	0.0	0.0	0		
	CG	H	COOG	OG	NG			VENT GAS
12	12.4	0	25.6	0.3	60.9			
	MEG	COG	HHG	OTG	HG			
13	2.0	3.5	5.8	1.9	0.77			
	CRVP	VPMF	TVP	PVP				
14	4.1	2.16	156	40				VENT PURGE
	TVPC	VPOIL	VPW	GL				
15	79	16.8	28	83.5				

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.

MESH	WT. GRAMS	WT %
8	330.9	23.8
14	365.4	26.3
28	267.9	19.3
35	94.0	6.8
48	57.2	4.1
65	54.8	3.9
100	45.4	3.3
150	40.4	2.9
PAN	133.2	9.6
TOTAL	1389.2	100.0

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-22-67 Run No. C1046-6

Sample Time: RS 0615; SS _____

FISCHER ASSAY RAW SHALE	FISCHER ASSAY SPENT SHALE	
28.3	0.0	Gal/Ton
.914	. —	S.G., g/ml
10.8	. —	Oil, wt %
1.8	0.4	Water, wt %
85.1	99.5	Sp. Shale, wt %
2.3	0.1	Gas & Loss, wt %
SLIGHT	None	COKING TENDENCY

RETORT SHALE MOISTURE

1.30 wt %

RAW SHALE FISCHER ASSAY MOISTURE

1.00 wt %

	RAW SHALE	SPENT SHALE	
MINERAL CO_2	17.8	14.5	wt %
ASH (SHALE)	~~66.7~~ ~~67.~~	83.9	wt %
MOISTURE	0.37	0.10	wt %
CARBON	17.5	6.18	wt %
HYDROGEN	1.75	0.14	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 JUN 26 1967 CHECKED BY _____

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-22-67 Run No. C1046-6

BKH

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	4.0	X	X	X	X	X
GRAVITY, °API	20.3	X	X	X	X	X
○ OIL ASH, wt %						

○ DISTILLATION (See attached sheet - OSRC-24)

BKH

VENT PURGE PRODUCT

OIL WT, g 202.0

WATER VOL, ml 94.0

GRAVITY OIL, °API 40.3

VENT GAS

RX ⊗ MAJOR COMPONENTS

CO_2	25.6	vol %
O_2	0.3	"
N_2	60.2	"
CH_4	2.0	"
CO	3.5	"
H_2	5.8	"
Ar	0.7	"
Others	~~2.0~~ 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}	.	"
$\emptyset C_3H_6$	.	"
n C_5H_{12}	.	"

6/14 ⊗ CARBON, 12.4 lbs/MSCFDG

⊗ HYDROGEN, 0.77 lbs/MSCFDG

COMMENTS

DATE COMPLETED JUN 23 1967 CHECKED BY REV

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C 1046-6 SAMPLE NO. 6 DATE 6-22-67

UNIT Reactor #3 DESCRIPTION TYLAB.

APPROX. SHALE SIZE 2½" - ¼" SHAKING TIME 10 MIN. ANALYSIS BY STRATTON & Gabbey

TOTAL SAMPLE WT. GROSS 68.1 - TARE 6.5 = NET 61.6

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		31.6	20.2	11.4
	1.50		40.9	23.4	17.5
	1.05		30.3	19.2	11.1
	0.742		29.0	20.3	8.7
	0.525		24.5	18.7	5.8
	0.371		22.0	19.3	2.7
	0.263	3	20.4	18.5	1.9
	0.185	4	19.8	19.4	.4
	0.131	6	19.5	19.4	.1
	0.093	8	20.4	20.4	.0
	0.065	10	19.2	19.2	.0
	PAN		22.1	21.0	1.1
TOTAL ON SCREENS AND PAN					61.3
LOSS (BY DIFFERENCE)					.3
TOTAL SAMPLE WEIGHT					61.6

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	0.97		99.03
2.00	2.250	0.4444	18.51		80.52
1.50	1.750	0.5714	28.41		52.11
1.05	(1.087) 1.275	(0.9199) 0.7843	18.02		34.09
0.742	0.896	1.116	14.12		19.97
0.525	0.634	1.577	9.42		10.55
0.371	0.448	2.232	4.38		6.17
0.263	0.317	3.154	3.08		3.09
0.185	0.224	4.464	0.65		2.44
0.131	0.158	6.329	0.16		2.28
0.093	0.112	8.928	0.00	97.72	2.28
0.065			0.00		2.28
PAN			1.79		0.49
LOSS			0.49	—	0.00
TOTAL			100.00	—	—
			—	—	—

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

$\Sigma^{m}_{+8m} Di$	1.38620	$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$	0.92980	$\Sigma^{m}_{+8m} Xi / Di$	
Da	1.05097	$\Sigma^{m}_{+8m} Xi\ Di$	
Dv	1.41854		

REMARKS: _____

OSRC-4