Total
V_2 bal.
1513017

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

Date 6-1-67

Purpose: To determine operability and yield with hot dilution gas using 1/4" to 1" shale. - Mobil Task Force recommendations.

GENERAL	
Run No.	C1040-3
Length, hours	12
Retort Type Number	RC-VII
Oil Recovery System Number	C-1
Total Raw Shale Charged, ~~lbs.~~ Tons	97.61
Bed Height above Dist., ft	5 1/2'
Type Air Dist.	AD-X
Bed Below Air Dist., ft	6'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft^2)	295
Spent Shale, % of RS	80.5
Liquid Product, lbs/hr	1484.6
Oil Collected, gal/ton RS	20.7
Air, SCF/ton RS (dry)	5200
Total Recycle*, SCF/ton RS(wet)	14500
Dilution, SCF/ton RS (wet)	2650
Calc. Vent Gas SCF/ton RS(dry)	6340
Gas Losses, SCF/ton RS(wet)	166
Propane, SCF/ton RS	24.4
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	138
Spent Shale, F	653
Raw Shale, °F	72
Recycle Gas Inlet, °F	250
Dilution Gas Inlet, °F	250
Air Inlet, °F	148
Retort Air Inlet, F	148
Heat of Comb. MBtu/ton RS	509
Heat Lost, MBtu/ton RS	-11
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	26.7
Oil, Wt %	10.2
Water, Wt %	1.0
Gas, Wt %	2.0
Mineral CO_2, Wt %	17.3
Ash, Wt %	68.3
Moisture, Wt % (Uncrushed)	0.72
Carbon (Total), Wt %	16.2
Hydrogen (Total), Wt %	1.71
Nominal Size Range, inches	1/4"-1"
5 % passing thru	0.263
98 % passing thru	1.05
Da	0.641
Dv	0.753
Line Burner °F	800

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO_2, Wt %	13.6
Ash, Wt %	84.8
Carbon (total), Wt %	5.47
Organic Carbon, Wt %	1.76
Hydrogen (total), Wt %	0.19
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	99.6
Density, lb/gal	7.778
Gravity, API	20.0
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	6.2
Oil, lbs/MSCF(dry)**	0.102
Analysis (dry)	
CO_2, Vol %	25.7
O_2, Vol %	0.7
N_2 + Argon, Vol %	64.8
CH_4, Vol %	1.5
CO, Vol %	2.2
H_2, Vol %	4.5
Other, Vol %	0.6
Gross Heating Value(calc),Btu/SCF	74.7
Carbon (Total), lbs/MSCF (dry)	10.9
Hydrogen (Total), lbs/MSCF (dry)	0.60
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	77.3
Oil in Gas**, Vol % RSFA	0.3
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	77.6
Carbonate Decomposition, %	36.7
Water Recovered, lb/ton RS	82.2
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	RS 100
Overall Balance, %	97.8
Carbon Balance, % - Organic	85.6
Carbon Balance, % - Total	91.0
Hydrogen Balance, % - Organic	90.1
Hydrogen Balance, % - Total	93.3
Water Balance, %	98.6
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.43
ΔP Above Air Dist., in H_2O/ft	0.38
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: Increased recycle to 11,500 and decreased air to 5100 SCF, Operation looked good.

*Measured Recycle + Dilution Gas
** Oil Mist + Condensibles to 80 °F
*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. Jones DATE June 20, 1967

OSRC-10
Revised 7/19/66

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//A100
2030, C1040-3 6-1-67

A. YIELDS
FAY      7.733E 01    DRYGAS   6.344E 03    MISTFA   3.112E-01
H2       2.855E 02    OTHER    3.806E 01    UNRETO   0.0
CH4      9.516E 01    02       4.441E 01    SSY      8.054E 01
CO       1.395E 02    CO2DEC   3.568E 01    MH2O     8.219E 01
CO2      1.630E 03    OILCOL   2.065E 01

B. METERED GAS RATES
RECG     1.183E 04    DIL      2.651E 03    WVENTG   7.005E 03
AIR      5.195E 03    TRECG    1.448E 04    TGF      0.0

C. MOL WT & HEATING VALUE OF VENT GAS
MWVG     2.941E 01    HVGT     4.741E 02    MWDG     3.039E 01
GBTU     7.473E 01

D. COMBUSTION PRODUCTS
CO2C     4.828E 02    COC      1.233E 02    H2OC     4.811E 01
CHR      3.559E 00    COMBCP   8.288E 00

E. MATERIAL IN
ORGCIN   2.319E 02    RSR      2.946E 02    ORH2IN   3.248E 01
MATIN    2.415E 03

F. MATERIAL OUT
ORGCVG   3.508E 01    COKEC    2.831E 01    UNRETH   0.0
ORGCOL   1.351E 02    ORH2VG   9.271E 00    COKEH    2.159E 00
UNRETC   0.0          ORH2OL   1.733E 01    ORCOLP   5.925E 01
ORCVGP   1.513E 01    ORCSSP   1.221E 01    HCCVGP   6.841E 00

G. MATERIAL BALANCES
CVALL    9.783E 01    ORH2     9.007E 01    O2BAL    1.000E 02
ASH      0.0          TC       9.104E 01    WATER    9.992E 01
ORGC     8.559E 01    TH2      9.323E 01    GASL     1.660E 02
ASHB    -1.000E 00

H. HEAT IN
QCOMB    5.090E 05    QH2OC    1.039E 04    QAIR     7.273E 03
QPROP    8.712E 01    QOILC    1.124E 04    QRCYL    5.285E 04
QSUMIN   5.909E 05

I. HEAT OUT
QMCO2D   2.056E 05    QKEROD   9.760E 04    QH2OV    3.987E 04
QLIQO    3.871E 03    QOFGAS   2.998E 04    QSS      2.233E 05
QGASL    2.041E 03    LBLOSS   0.0          METLOS  -1.143E 04
QSUMOT   5.909E 05

J. MISCELLANEOUS
ORCSS    1.757E 00    VPOIL    1.019E-01    TGL      3.165E 03
VPW      6.222E 00    VCG      1.154E 01    PSOP     2.435E 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,	C1040-3	6-1-67					
	WRS	QLRS	TRS	B	MRS			
1	1.0	10.2	72	-1	16268.7			RAW SHALE
	FA	GRS	CORS	XA				
2	26.7	2.0	17.3	55.22				
	ASRS	CRS	HRS	BP	TOG			
3	68.3	16.2	1.71	24.28	138			
	CRA	MFA	TA	PA	WA	LBHL		AIR
4	706.6	1.0	148	113	0.14	0		
	CRRG	MFRG	TRG	PRG	CRTG	MFTG		RECYCLE A TOTAL GAS
5	1618.8	1.0	250	72	0.0	0.0		
	CRDG	MFDG	TDG	PDG				DILUTION G
6	3.45	129.5	250	57				
	P	TP	PP	W	N			PROPANE A NUCLEATIN AGENT
7	3.8	0.4	129.8	118	0.0			
	WSS	OLSS	GSS	SS				SPENT SHALE
8	0.5	0.0	0.0	0.0				
	COSS	ASSS	CSS	HSS	TSS			
9	13.6	84.8	5.47	0.19	653			
	OILLP	COL	HOL	DOL	WLP			LIQUID PRODUCT
10	1306.3	84.1	11.1	7.778	178.3			
	CRVG	MFVG	TVG	WG	OILM	M		VENT GAS
11	1403.8	1.0	250	0.0	0.0	0		
	CG	H	COOG	OG	NG			
12	10.9	0	25.7	0.7	64.8			
	MEG	COG	HHG	OTG	HG			
13	1.5	2.2	4.5	0.6	0.60			
	CRVP	VPMF	TVP	PVP				VENT PURGE
14	6.4	1.83	130	179				
	TVPC	VPOIL	VPW	GL				
15	80	50.2	5.1	83.2				

5 1/CF

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 6-1-67 Run No. C 1040-3

Sample Time: RS 1815 ; SS 2315

FISCHER ASSAY & HA

(X) RAW SHALE	(X) SPENT SHALE	
26.5	0.00	Gal/Ton
0.914	-	S.G., g/ml
10.1	0.00	Oil, wt %
1.7	0.5	Water, wt %
86.2	99.4	Sp. Shale, ~~wt~~ %
2.0	0.1	Gas & Loss, wt %
Slight	NONE	COKING TENDENCY

( ) RETORT SHALE MOISTURE

0.72 wt %

BKM (X) RAW SHALE FISCHER ASSAY MOISTURE

0.62 wt %

BKM (X) MINERAL CO_2 17.2	BKM (X) 13.6	wt %
BKM (X) ASH (SHALE) 68.1	BKM (X) 84.2	wt %
BKM (X) MOISTURE 0.31	BKM (X) 0.09	wt %
BKM (X) CARBON 16.1	EA (X) 5.47	wt %
BKM (X) HYDROGEN 1.70	EA (X) 0.19	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 6 1967 CHECKED BY REP

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 5-1-67 Run No. C 1040-3

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	0.4					
GRAVITY, °API	20.0					
ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 602

WATER VOL, ml 140

GRAVITY OIL, °API 42.8

VENT GAS

MAJOR COMPONENTS

CO_2	25.7	vol %	CH_4	.	vol %
O_2	0.7	"	C_2H_4-C_2H_6	.	"
N_2	64.0	"	C_3H_8	.	"
CH_4	1.5	"	C_3H_6	.	"
CO	2.2	"	i C_4H_{10}	.	"
H_2	4.5	"	n C_4H_{10}	.	"
Ar	0.8	"	$\emptyset C_3H_6$	.	"
Others	0.6	"	n C_5H_{12}	.	"

C_1 thru C_4, plus n-Pentane

CARBON, 10.9 lbs/MSCFDG HYDROGEN, 0.60 lbs/MSCFDG

COMMENTS

DATE COMPLETED JUN 5 1967 CHECKED BY REP

OSRC-12B
(Revised 5/3/66)

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C 70 40-3 SAMPLE NO. 3 DATE 6-1-67

UNIT Pilot #2 DESCRIPTION TY Lab

APPROX. SHALE SIZE ½ = 1" SHAKING TIME 10 min ANALYSIS BY Smith & Stratton

TOTAL SAMPLE WT. GROSS 101 − TARE 7.1 = NET 93.9

SCREEN SIZE			WEIGHTS		
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED
	4.25				
	3.00				
	2.50				
	2.00				
	1.50				
	1.05		30.1	19.2	10.9
	0.742		62.5	20.5	41.0
	0.525		38.9	18.5	20.4
	0.371		28.1	19.3	8.8
	0.263	3	25.8	18.3	7.5
	0.185	4	21.5	19.4	2.1
	0.131	6	19.6	19.3	.3
	0.093	8	20.5	20.5	0
	0.065	10	19.3	19.3	0
	PAN		20.8	20.9	0.9
TOTAL ON SCREENS AND PAN					93.9
LOSS (BY DIFFERENCE)					+1.0
TOTAL SAMPLE WEIGHT					93.9

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	11.73		88.26
0.742	0.896	1.116	45.21		43.05
0.525	0.634	1.577	21.96		21.09
0.371	0.448	2.232	9.47		11.62
0.263	0.317	3.154	8.07		3.55
0.185	0.224	4.464	2.26		1.29
0.131	0.158	6.329	0.32		0.97
0.093	0.112	8.928	0.00	99.02	0.97
0.065			0.00		0.97
PAN			0.97		0.00
LOSS			—	—	—
TOTAL			99.99	—	—
			—	—	—

00111

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

$\sum_{+8m}^{m} Di$	0.74539	$\sum_{+8m}^{m} Xi$	
$1/\sum_{+8m}^{m} Di$	1.54579	$\sum_{+8m}^{m} Xi / Di$	
Da	0.64057	$\sum_{+8m}^{m} Xi\ Di$	
Dv	0.75276		

REMARKS: _____

OSRC-4