GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

check balances
1513017005

Date 5-31-67

Purpose: To determine operability and yield with hot dilution gas using ¼"-1" shale. - Mobil Task Force recommendations

GENERAL	
Run No.	C1040-2
Length, hours	12
Retort Type Number	RC-VII
Oil Recovery System Number	C-1
Tons Total Raw Shale Charged, ~~lbs.~~	9901
Bed Height above Dist., ft	5½'
Type Air Dist.	A 0-X
Bed Below Air Dist., ft	6'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft²)	299
Spent Shale, % of RS	83.0
Liquid Product, lbs/hr	1861.5
Oil Collected, gal/ton RS	26.2
Air, SCF/ton RS (dry)	5280
Total Recycle*, SCF/ton RS(wet)	14200
Dilution, SCF/ton RS (wet)	2620
Calc. Vent Gas SCF/ton RS(dry)	6540
Gas Losses, SCF/ton RS(wet)	1973
Propane, SCF/ton RS	27.8
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	137
Spent Shale, F	593
Raw Shale, °F	66
Recycle Gas Inlet, °F	250
Dilution Gas Inlet, °F	250
Air Inlet, °F	135
Retort Air Inlet, F	135
Heat of Comb. MBtu/ton RS	485
Heat Lost, MBtu/ton RS	24
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	24.6
Oil, Wt %	9.5
Water, Wt %	0.94
Gas, Wt %	1.8
Mineral CO_2, Wt %	17.5
Ash, Wt %	69.1
Moisture, Wt % (Uncrushed)	1.11
Carbon (Total), Wt %	15.6
Hydrogen (Total), Wt %	1.61
Nominal Size Range, inches	¼"-1"
5 % passing thru	0.263
98 % passing thru	1.05
Da	0.641
D_v	0.756
Line Burner °F	800

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.8
Mineral CO_2, Wt %	14.4
Ash, Wt %	83.3
Carbon (total), Wt %	6.39
Organic Carbon, Wt %	2.46
Hydrogen (total), Wt %	0.20
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	99.4
Density, lb/gal	7.762
Gravity, API	20.3
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	1.3
Oil, lbs/MSCF(dry)**	0.112
Analysis (dry)	
CO_2, Vol %	27.0
O_2, Vol %	0.7
N_2 + Argon, Vol %	63.8
CH_4, Vol %	1.5
CO, Vol %	2.5
H_2, Vol %	3.9
Other, Vol %	0.6
Gross Heating Value(calc),Btu/SCF	58.7
Carbon (Total), lbs/MSCF (dry)	10.44
Hydrogen (Total), lbs/MSCF (dry)	0.554
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	106.5
Oil in Gas**, Vol % RSFA	0.4
Oil in Spent Shale, Vol % RSFA	2.6
Total Oil Meas., Vol % RSFA	109.5
Carbonate Decomposition, %	31.7
Water Recovered, lb/ton RS	147.9
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	RS-100
Overall Balance, %	104.6
Carbon Balance, % - Organic	114.2
Carbon Balance, % - Total	111.8
Hydrogen Balance, % - Organic	101.3
Hydrogen Balance, % - Total	130.4
Water Balance, %	232.1
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.40
ΔP Above Air Dist., in H_2O/ft	0.35
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: Trouble with oil-water separator - Taking RS grab samples while sampler being repaired and modified

*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 Carl E Joerns DATE June 29, 1967

OSRC-10
Revised 7/19/66

//A100
2030, C1040-2 5-31-67

A. YIELDS

10 — FAY	1.055E 02	DRYGAS	6.543E 03	MISTFA	3.339E-01
H2	2.552E 02	OTHER	3.926E 01	UNREIO	2.620E 00
CH4	9.914E 01	O2	4.550E 01	SSY	8.295E 01
CO	1.636E 02	CO2DEC	3.174E 01	MH2O	1.479E 02
CO2	1.755E 03	OILCOL	2.621E 01		

B. METERED GAS RATES

RECG	1.155E 04	OIL	2.615E 03	VENTG	6.402E 03
AIR	5.275E 03	TRECG	1.415E 04	TCF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.836E 01	HVGI	3.337E 02	MWDG	3.129E 01
GBTU	5.859E 01				

D. COMBUSTION PRODUCTS

CO2C	7.625E 02	COC	1.495E 02	H2CC	2.174E 01
CHR	1.135E 01	COMBCP	1.320E 01		

E. MATERIAL IN

1 — ORGCIN	2.191E 02	RSR	2.935E 02	ORH2IN	3.069E 01
MAIN	2.430E 03				

F. MATERIAL OUT

ORGCVG	3.836E 01	COKEC	3.370E 01	UNRETH	6.902E-01
ORGCOL	1.711E 02	ORH2VG	6.117E 00	COKEH	1.699E 00
7 — UNREIC	7.039E 00	ORH2OL	2.259E 01	5 — ORCOLP	7.309E 01
2 — ORCVGP	1.751E 01	ORCSSP	1.862E 01	HCCVGP	4.313E 00

16 13

G. MATERIAL BALANCES

OVALL	1.046E 02	ORH2	1.013E 02	O2BAL	1.105E 02
ASH	0.0	TC	1.113E 02	WATER	2.521E 02
ORGC	1.142E 02	TH2	1.304E 02	GASL	1.973E 03
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.845E 05	QH2OC	4.360E 04	QAIR	6.696E 03
QPROP	8.914E 01	QOILC	1.424E 04	QRCYL	5.376E 04
QSUMIN	6.029E 05				

I. HEAT OUT

QMCO2D	1.300E 05	QKERCD	8.509E 04	QH2OV	4.803E 04
QLICO	7.547E 03	QOFGAS	3.110E 04	QSS	2.073E 05
QGASL	2.146E 04	LBLOSS	0.0	HETLOS	2.437E 04
QSUMOT	6.029E 05				

J. MISCELLANEOUS

CROSS	2.452E 00	VPOIL	1.190E-01	TCL	3.070E 03
VPC	1.331E 01	MCB	2.137E 01	PROP	2.779E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS – DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION						
0	2080,	C-1040-2	5-31-67					
	WRS	OLRS	TRS	B	MRS			
1	0.94	9.5	66	-1	16501.4			
	FA	GRS	CORS	XA				RAW SHALE
2	24.6	1.8	17.5	55.22				
	ASRS	CRS	HRS	BP	TOG			
3	69.1	15.6	1.61	24.21	137			
	CRA	MFA	TA	PA	WA	LBHL		
4	728.8	1.0	135	114	0.14	0		AIR
	CRRG	MFRG	TRG	PRG	CRTG	MFTG		RECYCLE A TOTAL GAS
5	1576.5	1.0	250	75	0.0	0.0		
	CRDG	MFDG	TDG	PDG				DILUTION G
6	3.5	129.5	250	52				
	P	TP	PP	W	N			PROPANE A NUCLEATIN AGENT
7	4.4	0.4	130.7	185.2	0.0			
	WSS	OLSS	GSS	SS				SPENT SHALE
8	0.5	0.3	0.5	0.0				
	COSS	ASSS	CSS	HSS	TSS			
9	14.4	83.3	6.39	0.20	593			
	OILLP	COL	HOL	DOL	WLP			LIQUID PRODUCT
10	1678.4	84.1	11.1	7.762	183.1			
	CRVG	MFVG	TVG	WG	OILM	M		VENT GAS
11	1349.3	1.0	250	0.0	0.0	0		
	CG	H	COOG	OG	NG			
12	10.4	0	27.0	0.7	63.8			
	MEG	COG	HHG	OTG	HG			
13	1.5	2.5	3.9	0.6	0.55			
	CRVP	VPMF	TVP	PVP				VENT PURGE
14	2.4	1.83	121	73				
	TVPC	VPOIL	VPW	GL				
15	80	30.1	6.6	55.8				

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 6-1-67 Run No. C1011O-2

Sample Time: RS 7:15 ; SS 11:15

FISCHER ASSAY

RAW SHALE	SPENT SHALE	
24.4	0.81	Gal/Ton
0.914	0.901	S.G., g/ml
9.4	0.3	Oil, wt %
1.7	0.5	Water, wt %
87.1	98.7	Sp. Shale, ~~wt~~ %
1.8	0.5	Gas & Loss, wt %
Slight	none	COKING TENDENCY

RETORT SHALE MOISTURE 1.11 wt %

RAW SHALE FISCHER ASSAY MOISTURE 0.77 wt %

	RAW SHALE	SPENT SHALE	
MINERAL CO_2	17.4	14.4	wt %
ASH (SHALE)	68.9	23.3	wt %
MOISTURE	0.29	0.12	wt %
CARBON	15.6	6.39	wt %
HYDROGEN	1.61	0.20	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

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-1-67 Run No. C1040-2

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
⊗ WATER, wt %	0.6					
⊗ GRAVITY, °API	20.3					
○ ASH, wt %						

○ DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

⊗ OIL WT, g 361

⊗ WATER VOL, ml 22

⊗ GRAVITY OIL, °API 39.6

VENT GAS

⊗ MAJOR COMPONENTS

CO_2	27.0	vol %
O_2	0.7	"
N_2	63.0	"
CH_4	1.5	"
CO	2.5	"
H_2	3.9	"
Ar	0.8	"
Others	0.6	"

○ 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}	.	"

Avg from C1040-1 & 2

⊗ CARBON, 10.4 lbs/MSCFDG ⊗ HYDROGEN, 0.55 lbs/MSCFDG

COMMENTS Sample of Gas Dumped from holder before C-H could be checked

DATE COMPLETED JUN 5 1967 CHECKED BY REP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 10420 -2 SAMPLE NO. 1 DATE 6/1/67

UNIT RETORT #3 DESCRIPTION TY LAB

APPROX. SHALE SIZE 1/4 to 1 SHAKING TIME 10 min ANALYSIS BY Stark & Anderson

TOTAL SAMPLE WT. GROSS 120.5 - TARE 3.4 = NET 97.1

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		29.3	19.1	10.2
	0.742		63.2	20.5	42.7
	0.525		38.8	18.4	20.4
	0.371		26.6	19.2	7.4
	0.263	3	25.6	18.4	7.2
	0.185	4	21.6	19.2	~~1.3~~ 2.3
	0.131	6	19.7	19.3	~~.4~~
	0.093	8	20.5	20.5	0
	0.065	10	19.3	19.2	.1
	PAN		21.6	20.4	1.2
TOTAL ON SCREENS AND PAN					91.4
LOSS (BY DIFFERENCE)					1.3
TOTAL SAMPLE WEIGHT					~~92.7~~

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	11.16		88.86
0.742	0.896	1.116	46.72		42.14
0.525	0.634	1.577	22.32		19.82
0.371	0.448	2.232	8.10		11.72
0.263	0.317	3.154	7.88		3.84
0.185	0.224	4.464	2.52		1.32
0.131	0.158	6.329	0.44		0.88
0.093	0.112	8.928	0.00	99.14	0.88
0.065			0.11		0.77
PAN			0.77		0.00
LOSS			—	—	—
TOTAL			100.02	—	—
			—	—	—

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

$\Sigma^{m}_{+8m} Di$	0.74904	$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$	1.54571	$\Sigma^{m}_{+8m} Xi / Di$	
Da	0.64138	$\Sigma^{m}_{+8m} Xi\ Di$	
Dv	0.75553		

REMARKS: _____

OSRC-4

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