

GAS COMBUSTION REPORTING
DETAILED RUN SUMMARY SHEET

1513018004

Date 6-19-67

Purpose: *To determine operability and yield with 1/2 - 2 1/2 inch shale using hot dilution gas.*

GENERAL	
Run No.	R-2 C1046-2
Length, hours	12
Retort Type Number	RC VII
Oil Recovery System Number	C-1
Total Raw Shale Charged, lbs.	98.57
Bed Height above Dist., ft	9 1/2
Type Air Dist.	AD 81
Bed Below Air Dist., ft	6
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft ²)	29.8
Spent Shale, % of RS	81.0
Liquid Product, lbs/hr	1632.1
Oil Collected, gal/ton RS	21.8
Air, SCF/ton RS (dry)	5250
Total Recycle*, SCF/ton RS (wet)	12700
Dilution, SCF/ton RS (wet)	2230
Calc. Vent Gas SCF/ton RS (dry)	6700
Gas Losses, SCF/ton RS (wet)	744
Propane, SCF/ton RS	16.7
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	140
Spent Shale, F	669
Raw Shale, °F	88
Recycle Gas Inlet, °F	278
Dilution Gas Inlet, °F	286
Air Inlet, °F	146
Retort Air Inlet, F	146
Heat of Comb. MBtu/ton RS	496
Heat Lost, MBtu/ton RS	-5
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	26.4
Oil, Wt %	10.1
Water, Wt %	1.0
Gas, Wt %	2.4
Mineral CO ₂ , Wt %	16.9
Ash, Wt %	62.1
Moisture, Wt % (Uncrushed)	1.13
Carbon (Total), Wt %	16.6
Hydrogen (Total), Wt %	1.73
Nominal Size Range, inches	1/4" - 2 1/2"
5 % passing thru	0.371
98 % passing thru	2.50
D _a	1.081
D _v	1.426
Line Burner °F	700

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO ₂ , Wt %	14.2
Ash, Wt %	84.1
Carbon (total), Wt %	5.92
Organic Carbon, Wt %	2.05
Hydrogen (total), Wt %	0.18
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	98.5
Density, lb/gal	7.778
Gravity, API	20.0
Ash, Wt %	—
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF (dry)	5.4
Oil, lbs/MSCF (dry)**	0.109
Analysis (dry)	
CO ₂ , Vol %	26.2
O ₂ , Vol %	0.2
N ₂ + Argon, Vol %	62.0
CH ₄ , Vol %	1.7
CO, Vol %	2.9
H ₂ , Vol %	5.3
Other, Vol %	1.7
Gross Heating Value (calc), Btu/SCF	71.8
Carbon (Total), lbs/MSCF (dry)	10.9
Hydrogen (Total), lbs/MSCF (dry)	2.60
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	82.6
Oil in Gas**, Vol % RSFA	0.4
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	83.0
Carbonate Decomposition, %	32.0
Water Recovered, lb/ton RS	84.0
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	RS100
Overall Balance, %	99.2
Carbon Balance, % - Organic	91.2
Carbon Balance, % - Total	64.5
Hydrogen Balance, % - Organic	83.2
Hydrogen Balance, % - Total	93.8
Water Balance, %	124.7
MISCELLANEOUS	
Avg. Retort ΔP, in H ₂ O/ft	0.34
ΔP Above Air Dist., in H ₂ O/ft	0.37
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: *Line burner temperature fluctuations probably due to dilution gas burning in the subject system. Line burner checked. Reduced dilution in shell to get 1.8 lbs/hr. Dilution levels on*

*Measured Recycle + Dilution Gas
 ** Oil Mist + Condensibles to 85 °F
 *** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. Turner DATE July 17, 1967
 OSRC-10 Revised 7/19/66

//A100

2080, C1046-2 R-2 6-19-67

A. YIELDS

FAY	8.258E 01	DRYGAS	6.699E 03	MISTFA	3.565E-01
H2	3.550E 02	OTHER	1.139E 02	UNRETO	0.0
CH4	1.139E 02	O2	1.340E 01	SSY	8.097E 01
CO	1.943E 02	CO2DEC	3.196E 01	MH2O	8.399E 01
CO2	1.755E 03	OILCOL	2.180E 01		

B. METERED GAS RATES

RECG	1.050E 04	DIL	2.228E 03	WVENTG	6.719E 03
AIR	5.249E 03	TRECG	1.273E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWWG	2.959E 01	HVGT	4.808E 02	MWDG	3.091E 01
GBTU	7.177E 01				

D. COMBUSTION PRODUCTS

CO2C	7.558E 02	COC	1.737E 02	H2OC	2.378E 01
CHR	1.104E 01	COMBCP	1.221E 01		

E. MATERIAL IN

ORGCIN	2.413E 02	RSR	2.975E 02	ORH2IN	3.272E 01
MATIN	2.427E 03				

F. MATERIAL OUT

ORGCVG	4.417E 01	COKEC	3.325E 01	UNRETH	0.0
ORGCOL	1.426E 02	ORH2VG	6.766E 00	COKEH	1.645E 00
UNRETC	0.0	ORH2OL	1.882E 01	ORCOLP	5.910E 01
ORCVGP	1.830E 01	ORCSSP	1.378E 01	HCCVGP	6.093E 00

G. MATERIAL BALANCES

OVALL	9.923E 01	ORH2	8.324E 01	O2BAL	1.042E 02
ASH	0.0	TC	9.451E 01	WATER	1.247E 02
ORGC	9.118E 01	TH2	9.376E 01	GASL	7.443E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.963E 05	QH2OC	1.462E 04	QAIR	5.613E 03
QPROP	4.600E 01	QOILC	1.187E 04	QRCYL	5.125E 04
QSUMIN	5.797E 05				

I. HEAT OUT

QMC02D	1.750E 05	QKEROD	1.000E 05	QH2OV	4.798E 04
QLIQO	3.269E 03	QOFGAS	2.200E 04	QSS	2.273E 05
QGASL	9.464E 03	LBLOSS	0.0	HETLOS	-5.330E 03
QSUMOT	5.797E 05				

J. MISCELLANEOUS

ORCSS	2.053E 00	VPOIL	1.093E-01	TGL	2.893E 03
VPM	5.431E 00	WCG	1.025E 01	PROP	1.669E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080,	C-1046-2 R-2 6-19-67					
1	WRS 1.0	QLRS 10.1	TRS 88	B -1	MRS 16429.0	← RAW SHALE	
2	FA 26.4	GRS 2.4	CORS 16.9	XA 55.22			
3	ASRS 68.1	CRS 16.6	HRS 1.73	BP 24.20	TOG 140		
4	CRA 722.1	MFA 1.0	TA 146	PA 132	WA 0.14	LBHL 0	← AIR
5	CRRG 1458.4	MFRG 1.0	TRG 278	PRG 78	CRTG 0.0	MFTG 0.0	← RECYCLE A TOTAL GAS
6	CRDG 6.4	MFDG 56.4	TDG 286	PDG 120			← DILUTION G
7	P 2.63	TP 0.4	PP 1317	W 187.8	N 0.0		← PROPANE A NUCLEATING AGENT
8	WSS 0.7	OLSS 0.0	GSS 0.0	SS 0.0			← SPENT SHALE
9	COSS 14.2	ASSS 84.1	CSS 5.93	HSS 0.18	TSS 669		
10	OILLP 1392.9	COL 84.1	HOL 11.1	DOL 7.778	WLP 239.2		← LIQUID PRODUCT
11	CRVG 1309.5	MFVG 1.0	TVG 286	WG 0.0	OILM 0.0	M 0	← VENT GAS
12	CG 10.9	H 0	COOG 26.2	OG 0.2	NG 62.0		
13	MEG 1.7	COG 2.9	HHG 5.3	OTG 1.7	HG 0.60		
14	CRVP 4.1	VPMF 2.16	TVP 155	PVP 52			← VENT PURGE
15	TVPC 85	VPOIL 43.1	VPW 2.7	GL 86.4			

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 Moist,
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 6-20-67

Run No. 11-1096-2

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

OK REA

WATER, wt %

1.5 ~~2~~ ~~3~~ ~~4~~

GRAVITY, °API

20.0°

OIL ASH, wt %

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 517.0

WATER VOL, ml 146.0

GRAVITY OIL, °API 38.9

VENT GAS

REA

MAJOR COMPONENTS

CO₂ 26.2 vol %

O₂ 0.2 "

N₂ 61.3 "

CH₄ 1.7 "

CO 2.9 "

H₂ 5.3 "

Ar 0.7 "

Others 1.7 "

C₁ thru C₄, plus n-Pentane

CH₄ _____ vol %

C₂H₄-C₂H₆ _____ "

C₃H₈ _____ "

C₃H₆ _____ "

i C₄H₁₀ _____ "

n C₄H₁₀ _____ "

∅C₃H₆ _____ "

n C₅H₁₂ _____ "

REA CARBON, 10.9 lbs/MSCFDG

HYDROGEN, 0.60 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUN 21 1967

CHECKED BY REA

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1046-2 SAMPLE NO. 1 DATE 6-20-67

UNIT REPORT #3 DESCRIPTION TYLAB

APPROX. SHALE SIZE 2 1/4 - 1/2 SHAKING TIME 10 MIN ANALYSIS BY JAS - B.2.

TOTAL SAMPLE WT. GROSS 69.0 - TARE 6.7 = NET 62.3

SCREEN SIZE			WEIGHTS								
SCREENS REQD.	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.	NET WT. RETAINED	SCREEN SIZE	D _i *	1/D _i	% RETAINED	CUM. % RETAINED	% PASSING
	4.25					4.25					
	3.00					3.00	(3.125)	(0.3200)			
	2.50		19.7	16.7	3.0	2.50	(2.625) 2.750	(0.3809) 0.3636	4.82		95.18
	2.00		27.0	20.2	6.8	2.00	2.250	0.4444	10.91		84.27
	1.50		42.6	23.4	19.2	1.50	1.750	0.5714	30.82		53.45
	1.05		33.2	19.2	14.0	1.05	(1.087) 1.275	(0.9199) 0.7843	22.47		30.98
	0.742		28.2	20.5	7.7	0.742	0.896	1.116	12.36		18.62
	0.525		24.3	18.5	5.8	0.525	0.634	1.577	9.31		9.31
	0.371		21.5	19.2	2.3	0.371	0.448	2.232	3.69		5.62
	0.263	3	20.2	18.5	1.7	0.263	0.317	3.154	2.73		2.89
	0.185	4	19.7	19.4	.3	0.185	0.224	4.464	0.48		2.41
	0.131	6	19.5	19.4	.1	0.131	0.158	6.329	0.16		2.25
	0.093	8	20.4	20.4	.0	0.093	0.112	8.928	0.00	97.75	2.25
	0.065	10	19.3	19.2	.1	0.065			0.16		2.09
	PAN		22.1	21.0	1.1	PAN			1.77		0.32
TOTAL ON SCREENS AND PAN					62.1	LOSS			0.32		0.00
LOSS (BY DIFFERENCE)					.2	TOTAL			100.00	-	-
TOTAL SAMPLE WEIGHT					62.3				-	-	-

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

REMARKS: _____

$\sum_{+8m}^m D_i$	1.39413	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	0.90396	$\sum_{+8m}^m X_i / D_i$	
D _a	1.08135	$\sum_{+8m}^m X_i D_i$	
D _v	1.42621		

MESH	WT GRAMS	WT %
8	74.0	20.4
14	100.0	27.5
28	64.0	17.6
35	27.5	7.6
48	20.3	5.6
65	19.0	5.2
100	15.9	4.4
150	10.2	2.8
PAN	32.5	8.9
TOTAL	363.4	100.0%

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 6-20-67

Run No. C. 1646-2

Sample Time: RS 0615; SS 1115

FISCHER ASSAY

RAW SHALE

SPENT SHALE

26.2

0.0

Gal/Ton

.920

—

S.G., g/ml

10.0

0.0

Oil, wt %

1.9

0.7

Water, wt %

85.7

98.9

Sp. Shale, wt %

2.4

0.4

Gas & Loss, wt %

Slight

none

COKING TENDENCY

MINERAL CO₂

16.5

14.2

wt %

ASH (SHALE)

67.8

84.1

wt %

MOISTURE

0.38

0.22

wt %

CARBON

16.5

5.93

wt %

HYDROGEN

1.72

0.18

wt %

BENZENE EXTRACTABLES

.

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wt %

RETORT SHALE MOISTURE

1.13 wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.87 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 CO₂", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS

DATE COMPLETED JUN 21 1967

CHECKED BY [Signature]

OSRC-12A