

GAS COMBUSTION REPORTING
DETAILED RUN SUMMARY SHEET

1513019010

Date 7-17-67

Purpose: *To improve operability and yield with 1/2" - 1" mesh shale with hot air operations.*

GENERAL	
Run No.	C1052-3
Length, hours	12
Retort Type Number	RC-VTL
Oil Recovery System Number	C-2
Total Raw Shale Charged, lbs.	98,28
Bed Height above Dist., ft	5'6"
Type Air Dist.	AD-XII
Bed Below Air Dist., ft	6'

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	4.4
Mineral CO ₂ , Wt %	13.6
Ash, Wt %	82.6
Carbon (total), Wt %	7.30
Organic Carbon, Wt %	3.59
Hydrogen (total), Wt %	0.47

RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft ²)	297
Spent Shale, % of RS	80.9
Liquid Product, lbs/hr	1302.4
Oil Collected, gal/ton RS	22.4
Air, SCF/ton RS (dry)	4930
Total Recycle*, SCF/ton RS (wet)	12900
Dilution, SCF/ton RS (wet)	—
Calc. Vent Gas SCF/ton RS (dry)	6340
Gas Losses, SCF/ton RS (wet)	558
Propane, SCF/ton RS	42.7

LIQUID PRODUCT PROPERTIES	
Oil, Wt %	98.6
Density, lb/gal	7.788
Gravity, API	19.8
Ash, Wt %	—

TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	142
Spent Shale, F	400
Raw Shale, °F	82
Recycle Gas Inlet, °F	764
Dilution Gas Inlet, °F	—
Air Inlet, °F	158
Retort Air Inlet, F	158
Heat of Comb. MBtu/ton RS	479
Heat Lost, MBtu/ton RS	42

PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF (dry)	10.0
Oil, lbs/MSCF (dry)**	0.213

RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	27.7
Oil, Wt %	10.6
Water, Wt %	1.3
Gas, Wt %	2.2
Mineral CO ₂ , Wt %	17.4
Ash, Wt %	67.6
Moisture, Wt % (Uncrushed)	2.05%
Carbon (Total), Wt %	17.1
Hydrogen (Total), Wt %	1.83
Nominal Size Range, inches	1/4" - 1"
5 % passing thru	0.263
98 % passing thru	1.05
D ₅₀	0.637
D ₉₀	0.718
Line Burner °F	840

ANALYSIS (dry)	
CO ₂ , Vol %	26.0
O ₂ , Vol %	0.3
N ₂ + Argon, Vol %	61.5
CH ₄ , Vol %	1.8
CO, Vol %	3.6
H ₂ , Vol %	6.6
Other, Vol %	0.2

Gross Heating Value (calc), Btu/SCF	120.1
Carbon (Total), lbs/MSCF (dry)	12.5
Hydrogen (Total), lbs/MSCF (dry)	0.99

YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	80.9
Oil in Gas**, Vol % RSFA	0.6
Oil in Spent Shale, Vol % RSFA	13.0
Total Oil Meas., Vol % RSFA	94.5
Carbonate Decomposition, %	76.8
Water Recovered, lb/ton RS	94.4
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	15-160
Overall Balance, %	98.4
Carbon Balance, % - Organic	94.7
Carbon Balance, % - Total	97.7
Hydrogen Balance, % - Organic	106.6
Hydrogen Balance, % - Total	104.3
Water Balance, %	87.0

MISCELLANEOUS	
Avg. Retort ΔP, in H ₂ O/ft	0.30
ΔP Above Air Dist., in H ₂ O/ft	0.40
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: *Temperature basis with hot air and small burner used. Cold inert shales. Additional gas rate did not help. Overall balance - 3 shales found in pile.*

*Measured Recycle + Dilution Gas
 ** Oil Mist + Condensibles to 77 °F
 *** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed *Earl E. Turner* DATE *July 28, 1967*
 OSRC-10
 Revised 7/19/66

//A100

3030. C1052-3 R-1 7-17-67

A. YIELDS

FAY	8.086E 01	DRYGAS	6.341E 03	MISTFA	6.267E-01
H2	4.185E 02	OTHER	1.268E 01	UNRETO	1.297E 01
CH4	1.141E 02	O2	1.902E 01	SSY	8.036E 01
CO	2.283E 02	CO2DEC	3.660E 01	MH2O	9.438E 01
CO2	1.649E 03	OILCOL	2.240E 01		

B. METERED GAS RATES

RECG	1.288E 04	DIL	0.0	WVENTG	7.117E 03
AIR	4.929E 03	TRECG	1.288E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.815E 01	HVGT	7.615E 02	MWDG	3.028E 01
GBTU	1.201E 02				

D. COMBUSTION PRODUCTS

CO2C	4.841E 02	COG	2.099E 02	H2OC	4.094E 01
CHR	4.788E 00	COMBCP	8.764E 00		

E. MATERIAL IN

ORGCIN	2.510E 02	RSR	2.966E 02	ORH2IN	3.460E 01
MATIN	2.424E 03				

F. MATERIAL OUT

ORCVG	4.548E 01	COKEC	2.923E 01	UNRETH	3.320E 00
ORCOL	1.467E 02	ORH2VG	1.102E 01	COKEH	3.194E 00
UNRETC	2.878E 01	ORH2OL	1.936E 01	ORCOLP	5.844E 01
ORCVSP	1.811E 01	ORCSSP	2.311E 01	HCCVSP	9.351E 00

G. MATERIAL BALANCES

OVALL	9.837E 01	ORH2	1.066E 02	O2BAL	9.723E 01
ASH	0.0	TC	9.974E 01	WATER	8.703E 01
ORGC	9.966E 01	TH2	1.043E 02	GASL	5.530E 02
ASHB	-1.000E 00				

H. HEAT IN

QCOMB	4.789E 05	QH2OC	1.252E 04	QAIR	6.908E 03
QPROP	1.547E 02	QOILC	1.221E 04	QRCYL	4.833E 04
QSUMIN	5.590E 05				

I. HEAT OUT

QMC02D	2.075E 05	QKEROD	8.493E 04	QH2OV	7.313E 04
QLIGO	3.868E 03	QOFGAS	2.563E 04	QSS	1.179E 05
QGASL	3.724E 03	LELOSS	0.0	HETLOS	4.241E 04
QSUMOT	5.590E 05				

J. MISCELLANEOUS

ORCSS	3.587E 00	VPOIL	2.132E-01	TGL	2.966E 03
VBI	1.000E 01	WCS	1.780E 01	PROP	4.266E 01

END MESSAGE

END OUTPUT

0	2080, 3080	C 1052-3 R-1 7-17-67					
1	WRS 1.3	OLRS 10.6	TRS 82	B -1	MRS 16380.3	← RAW SHALE	
2	FA 27.7	GRS 2.2	CORS 17.4	XA 55.22			
3	ASRS 67.6	CRS 17.1	HRS 1.83	BP 24.38	TOG 142		
4	CRA 673.3	MFA 1.0	TA 158	VPA 139	VA 0.14	LBHL 0	← AIR
5	CRRG 1732.7	MFRG 1.0	TRG 264	PRG 74	CRTG 0.0	MFTG 0.0	← RECYCLE TOTAL GA
6	CRDG 0.0	MFDG 0.0	TDG 0	PDG 0			← DILUTION
7	P 5.82	TP 0.4	PP 128.4	W 334.3	N 0.0		← PROPANE NUCLEATING AGENT
8	WSS 0.6	OLSS 1.7	GSS 1.0	SS 0.0			← SPENT SHALE
9	COSS 13.6	ASSS 83.6	CSS 7.30	HSS 0.47	TSS 400		
10	OILLP 1428.7	COL 84.1	HOL 11.1	DOL 7.788	WLP 174.1		← LIQUID PRODUCT
11	CRVG 998.4	MFIG 1.0	TVG 263	WG 0.0	OILM 0.0	M 0	← VENT GAS
12	CG 12.5	H 0	COOG 26.0	OG 0.3	NG 61.5		
13	MEG 1.8	COG 3.6	HHG 6.6	OTG 0.2	HG 0.99		
14	CRVP 3.84	VPMF 1.83	TVP 73	PVP 166	PVPG 7.83		← VENT PURGE
15	TVPC 77	VPOIL 22.3	VPW 1.8	GL 83.5			

5.6

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 S. ET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 7-17-67

Run No. E 1052-3

Sample Time: RS 1815; SS 2315

FISCHER ASSAY

RAW SHALE SPENT SHALE

<u>27.2</u>	<u>4.4</u>	Gal/Ton
<u>0.914</u>	<u>7.1</u>	S.G., g/ml
<u>10.4</u>	<u>1.7</u>	Oil, wt %
<u>3.2</u>	<u>.6</u>	Water, wt %
<u>84.2</u>	<u>96.7</u>	Sp. Shale, wt %
<u>2.2</u>	<u>1.0</u>	Gas & Loss, wt %
<u>Slight</u>	<u>N.C. N.C.</u>	COKING TENDENCY

RETORT SHALE MOISTURE

Est. 2.0 wt %

RAW SHALE FISCHER ASSAY MOISTURE

1.76 wt %

MINERAL CO₂

27.3 13.6 wt %

ASH (SHALE)

67.3 83.6 wt %

MOISTURE

0.43 0.06 wt %

CARBON

17.0 7.30 wt %

HYDROGEN

1.82 0.47 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 CO₂", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS _____

DATE COMPLETED JUL 19 1967

CHECKED BY REP

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 7-17-67

Run No. 61052-3

Time Received 2215

EA ⊕

LIQUID PRODUCTS

	<u>D3 PUMPOUT</u>				<u>T3 PUMPOUT</u>	
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>1</u>	<u>2</u>
WATER, wt %	<u>1.4</u>					
GRAVITY, °API	<u>19.8</u>					

OIL ASH, wt %

DISTILLATION (See attached sheet - OSRC-24)

EA ⊕

VENT PURGE PRODUCT

OIL WT, g 268.0
 WATER VOL, ml 65.0
 GRAVITY OIL, °API 35.7

VENT GAS

EA ⊕

MAJOR COMPONENTS

CO₂ 26.0 vol %
 O₂ 0.3 "
 N₂ 60.8 "
 CH₄ 1.8 "
 CO 3.6 "
 H₂ 6.6 "
 Ar 0.7 "
 Others 0.2 "

C₁ thru C₄, plus n-Pentane

CH₄ _____ vol %
 C₂H₄-C₂H₆ _____ "
 C₃H₈ _____ "
 C₃H₆ _____ "
 i C₄H₁₀ _____ "
 n C₄H₁₀ _____ "
 C₃H₆ _____ "
 n C₅H₁₂ _____ "

BVM ⊕

CARBON, 12.5 lbs/MSCFDG

HYDROGEN, 0.99 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUL 19 1967

CHECKED BY REP

SCREEN ANALYSIS [ATA] SHEET (TY-LAB)

RUN NO. C-1050-3 SAMPLE NO. _____ DATE 7-17-67

UNIT 0.57-3 DESCRIPTION Ty Lab

APPROX. SHALE SIZE 10-11 SHAKING TIME 10 min ANALYSIS BY Schiffman

TOTAL SAMPLE WT. GROSS 72.4 - TARE 6.0 = NET 66.4

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					2.50	(2.625) 2.750	(0.3809) 0.3636			
	2.00					2.00	2.250	0.4444			
	1.50					1.50	1.750	0.5714			
	1.05		20.7	19.2	1.5	1.05	(1.037) 1.275	(0.9199) 0.7843	2.07		97.93
	0.742		54.7	20.5	34.2	0.742	0.896	1.116	47.24		50.69
	0.525		39.0	18.5	20.5	0.525	0.634	1.577	28.31		22.38
	0.371		28.4	19.2	9.2	0.371	0.448	2.232	12.71		9.67
	0.263	3	23.9	18.5	5.3	0.263	0.317	3.154	7.32		2.35
	0.185	4	20.0	19.5	.5	0.185	0.224	4.464	0.69		1.66
	0.131	6	19.5	19.4	.1	0.131	0.158	6.329	0.14		1.52
	0.093	8	20.8	20.8	.0	0.093	0.112	8.928	0.00	98.48	1.52
	0.065	10	19.3	19.2	.1	0.065			0.14		1.38
	PAN		21.9	21.0	.9	PAN			1.24		0.14
TOTAL ON SCREENS AND PAN					72.3	LOSS			0.14	-	0.00
LOSS (BY DIFFERENCE)					.1	TOTAL			100.00	-	-
TOTAL SAMPLE WEIGHT					72.4				-	-	-

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

REMARKS: _____

$\sum_{+8m}^m D_i$	0.70717	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	1.54691	$\sum_{+8m}^m X_i / D_i$	
D _a	0.6366	$\sum_{+8m}^m X_i D_i$	
D _v	0.71808		