

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

15130
017 003

Date 5-30-67

Purpose: To determine operability and yield with best dilution gas using 1 inch shale. - Mobil Tech Force - recommendation

GENERAL		SPENT SHALE PROPERTIES	
Run No.	PTC 1040	Fischer Assay, Gal/ton	1.85
Length, hours	12	Mineral CO ₂ , Wt %	14.0
Retort Type Number	RC VII	Ash, Wt %	83.1
Oil Recovery System Number	C-1	Carbon (total), Wt %	6.65
Total Raw Shale Charged, lbs.	98.20	Organic Carbon, Wt %	2.81
Bed Height above Dist., ft	5 1/2'	Hydrogen (total), Wt %	0.31
Type Air Dist.	AU-X	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6'	Oil, Wt %	99.16
RATES AND QUANTITIES		Density, lb/gal	7.793
Raw Shale, lbs/(hr)(ft ²)	296	Gravity, API	19.7
Spent Shale, % of RS	82.6	Ash, Wt %	-
Liquid Product, lbs/hr	1610.3	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	22.4	Water Vapor, lbs/MSCF (dry)	15.1
Air, SCF/ton RS (dry)	5340	Oil, lbs/MSCF (dry)**	0.131
Total Recycle*, SCF/ton RS (wet)	14500	Analysis (dry)	
Dilution, SCF/ton RS (wet)	2750	CO ₂ , Vol %	26.4
Calc. Vent Gas SCF/ton RS (dry)	6570	O ₂ , Vol %	0.9
Gas Losses, SCF/ton RS (wet)	1554	N ₂ + Argon, Vol %	64.3
Propane, SCF/ton RS	22.3	CH ₄ , Vol %	1.3
TEMPERATURES AND HEAT BALANCE		CO, Vol %	2.3
Retort Offgas, °F	137	H ₂ , Vol %	4.7
Spent Shale, F	765	Other, Vol %	0.1
Raw Shale, °F	68	Gross Heating Value (calc), Btu/SCF	64.9
Recycle Gas Inlet, °F	250	Carbon (Total), lbs/MSCF (dry)	10.7
Dilution Gas Inlet, °F	250	Hydrogen (Total), lbs/MSCF (dry)	0.53
Air Inlet, °F	134	YIELDS AND BALANCES	
Retort Air Inlet, F	134	Oil Collected, Vol % RSFA	84.3
Heat of Comb. MBtu/ton RS	490	Oil in Gas**, Vol % RSFA	0.4
Heat Lost, MBtu/ton RS	-36	Oil in Spent Shale, Vol % RSFA	5.7
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	90.4
Fischer Assay, gal/ton RS	26.5	Carbonate Decomposition, %	32.4
Oil, Wt %	10.1	Water Recovered, lb/ton RS	167.8
Water, Wt %	1.3	Ash Balance, % - As Measured	-
Gas, Wt %	1.9	Ash Balance, % - Assumed	RS100
Mineral CO ₂ , Wt %	17.1	Overall Balance, %	103.5
Ash, Wt %	68.6	Carbon Balance, % - Organic	101.2
Moisture, Wt % (Uncrushed)	1.10	Carbon Balance, % - Total	102.2
Carbon (Total), Wt %	16.1	Hydrogen Balance, % - Organic	93.2
Hydrogen (Total), Wt %	1.72	Hydrogen Balance, % - Total	125.1
Nominal Size Range, inches	1/4" - 1"	Water Balance, %	225.0
5 % passing thru	0.263	MISCELLANEOUS	
98 % passing thru	1.05	Avg. Retort ΔP, in H ₂ O/ft	0.46
D _a	0.612	ΔP Above Air Dist., in H ₂ O/ft	0.40
D _v	0.736	NaCl Soln., Wt %	-
Line Burner °F	800	NaCl Rate, gal/ton RS	-

Comments: RS sample continues to plug, otherwise operation looks good. 1 1/2" in surface on bricks.

*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. Turner DATE June 20, 1967

//A100
2080, PTC1040 A 5-30-67

A. YIELDS

FAY	8.433E 01	DRYGAS	6.569E 03	YISIFA	4.153E-01
H2	3.087E 02	OTHER	6.569E 00	UNRETO	5.721E 00
CH4	2.539E 01	O2	5.912E 01	SSY	8.255E 01
CO	1.511E 02	CO2DEC	3.241E 01	NH2O	1.678E 02
CO2	1.734E 03	OILCOL	2.235E 01		

B. METERED GAS RATES

RECG	1.179E 04	DIL	2.751E 03	JVENTG	7.094E 03
AIR	5.338E 03	TRECG	1.454E 04	IGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

<u>YMWG</u>	2.730E 01	HWGT	4.265E 02	YWDG	3.090E 01
GBTU	6.493E 01				

D. COMBUSTION PRODUCTS

CO2C	7.236E 02	COG	1.359E 02	H2OC	2.560E 01
CHR	9.539E 00	COMBOP	1.183E 01		

E. MATERIAL IN

ORGCIN	2.307E 02	RSR	2.964E 02	GRH2IN	3.195E 01
MATIN	2.434E 03				

F. MATERIAL OUT

ORGCVG	4.077E 01	COKEC	3.375E 01	UNRETH	1.420E 00
ORGCOL	1.465E 02	ORH2VG	6.445E 00	COKEH	2.559E 00
UNRETC	1.261E 01	ORH2CL	1.935E 01	CRCOLP	6.342E 01
ORCVGP	1.767E 01	ORCSSP	2.009E 01	HCCVGP	5.793E 00

G. MATERIAL BALANCES

OVALL	1.035E 02	GRH2	9.319E 01	COBAL	1.215E 02
ASH	0.0	TC	1.022E 02	WATER	2.250E 02
ORGC	1.012E 02	TH2	1.251E 02	GASL	1.554E 03
ASHE	-1.000E 00				

H. HEAT IN

QCOMB	4.900E 05	QH2OC	7.195E 04	QAIR	6.481E 03
QPROP	6.843E 01	QOILC	1.219E 04	QRCYL	5.422E 04
QSUMIN	6.349E 05				

I. HEAT OUT

QCO2D	1.796E 05	QKEROD	3.808E 04	QH2OV	5.511E 04
QLIQC	8.396E 03	QCFEAS	3.092E 04	QSS	2.859E 05
QGASL	2.235E 04	LELOSS	0.0	HETLOS	-3.555E 04
QSUMOT	6.349E 05				

J. MISCELLANEOUS

ORCSS	2.808E 00	VPOIL	1.306E-01	TGL	3.206E 03
VPR	1.505E 01	HCG	2.404E 01	PROP	2.222E 01

END MESSAGE

END OUTPUT

1.3 10.1 68 -1 16366.3
//A002

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	← USER IDENTIFICATION →				
0	2080,	PT-C1040	A	5-30-67		
1	WRS	QLRS	TRS	B	MRS	
	1.3	10.1	68	-1	16366.3	
2	FA	GRS	CORS	XA		
	26.5	1.9	17.1	55.22		
3	ASRS	CRS	HRS	BP	TOG	
	68.6	16.1	1.72	24.35	137	
4	CRA	MFA	TA	PA	WA	LBHL
	729.3	1.0	134	116	0.14	0
5	CRRG	MFRG	TRG	PRG	CRTG	MFTG
	1576.5	1.0	250	72	0.0	0.0
6	CRDG	MFDG	TDG	PDG		
	3.65	129.5	250	46		
7	P	TP	PP	W	N	
	3.5	0.4	128.8	182.0	0.0	
8	WSS	OLSS	GSS	SS		
	0.6	0.7	0.5	0.0		
9	COSS	ASSS	CSS	HSS	TSS	
	14.0	83.1	6.63	0.31	765	
10	OILLP	COL	HOL	DOL	WLP	
	1425.2	84.1	11.1	7.793	185.1	
11	CRVG	MVVG	TVG	WG	OILM	M
	1463.8	1.0	250	0.0	0.0	0
12	CG	H	COOG	OG	NG	
	10.7	0	26.4	0.9	64.3	
13	MEG	COG	HHG	OTG	HG	
	1.3	2.3	4.7	0.1	0.53	
14	CRVP	VPMF	TVP	PVP		
	3.7	1.83	120	72		
15	TVPC	VPOIL	VPW	GL		
	80	43.9	9.5	77.4		

← RAW SHALE

← AIR

← RECYCLE A TOTAL GAS

← DILUTION G

← PROPANE A NUCLEATING AGENT

← SPENT SHALE

← LIQUID PRODUCT

← VENT GAS

← VENT PURGE

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.

9.5¹⁶

SCFM

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 5-31-67

Run No. C1040 PT

Sample Time: RS 0615; SS

FISCHER ASSAY

RAW SHALE ^{8x} SPENT SHALE ^{REP}

<u>26.2</u>	<u>1.8</u>	Gal/Ton
<u>7.14</u>	<u>0.901</u>	S.G., g/ml
<u>10.0</u>	<u>0.7</u>	Oil, wt %
<u>2.2</u>	<u>0.6</u>	Water, wt %
<u>85.9</u>	<u>98.2</u>	Sp. Shale, wt %
<u>1.9</u>	<u>0.5</u>	Gas & Loss, wt %
<u>Flight</u>	<u>none</u>	COKING TENDENCY

RETORT SHALE MOISTURE

1.10 wt %

FISCHER ASSAY MOISTURE

0.96 wt %

MINERAL CO₂

17.1 ^{BKM} 14.0 wt %

ASH (SHALE)

68.4 ^{BKM} 23.1 wt %

MOISTURE

0.22 ^{BKM} 0.20 wt %

CARBON

16.1 ^{BKM} 6.63 wt %

HYDROGEN

1.22 ^{BKM} 0.31 wt %

BENZENE EXTRACTABLES

 wt %

SHALE RICHNESS DISTRIBUTION
(See attached graph)

SCREEN ANALYSIS
(See back of this sheet)

12.4

* 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 5 1967

CHECKED BY REP

OSRC-12A
(Initiated 4/29/66)

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 5-31-67

Run No. C1040 PT

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

WATER, wt %
 GRAVITY, °API
 OIL ASH, wt %

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
WATER, wt %	<u>0.84</u>	_____	_____	_____
GRAVITY, °API	<u>19.7</u>	_____	_____	_____

	<u>1</u>	<u>2</u>
WATER, wt %	_____	_____
GRAVITY, °API	_____	_____

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

Jd

OIL WT, g 527
 WATER VOL, ml 60
 GRAVITY OIL, °API 46.4

VENT GAS

BKM

MAJOR COMPONENTS

C₁ thru C₄, plus n-Pentane

CO₂ 26.4 vol %
 O₂ 0.9 "
 N₂ 63.5 "
 CH₄ 1.3 "
 CO 2.3 "
 H₂ 4.7 "
 Ar 0.8 "
 Others 0.1 "

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

BKM

CARBON, 10.7 lbs/MSCFDG

BKM

HYDROGEN, 0.53 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUN 1 1967

CHECKED BY RCP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 01040 PRE TEST SAMPLE NO. 1 DATE 5/31/67
 UNIT REPORT # 3 DESCRIPTION TY LAB
 APPROX. SHALE SIZE 1/2" - 1" SHAKING TIME 10 MIN. ANALYSIS BY M.A. R.D.L.
 TOTAL SAMPLE WT. GROSS 114.0 - TARE 18.2 = NET 93.8

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)	(0.3809)			
	2.00					2.00	2.250	0.4444			
	1.50					1.50	1.750	0.5714			
	1.05		29.1	19.1	10.0	1.05	(1.087)	(0.9199)	10.72		89.30
	0.742		61.2	20.3	40.9	0.742	0.896	1.116	43.84		45.46
	0.525		89.0	18.5	20.50	0.525	0.634	1.577	21.97		23.49
	0.371		78.1	19.2	8.9	0.371	0.448	2.232	9.54		13.95
	0.263	3	26.6	18.3	8.3	0.263	0.317	3.154	8.90		5.05
	0.185	4	22.4	19.4	3.0	0.185	0.224	4.464	3.22		1.83
	0.131	6	19.9	19.4	.5	0.131	0.158	6.329	0.54		1.29
	0.093	8	20.5	20.4	.1	0.093	0.112	8.928	0.11	98.84	1.18
	0.065	10	19.4	18.3	.1	0.065			0.11		1.07
	PAN		21.9	20.9	1.0	PAN			1.07		0.00
TOTAL ON SCREENS AND PAN					93.3	LOSS					
LOSS (BY DIFFERENCE)					.5	TOTAL		100.02			
TOTAL SAMPLE WEIGHT					93.8						

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

REMARKS: _____

$\sum_{+8m}^m D_i$	0.72776	$\sum_{+8m}^m X_i$	
$1/\sum_{+8m}^m D_i$	1.61571	$\sum_{+8m}^m X_i / D_i$	
D_a	0.61174	$\sum_{+8m}^m X_i D_i$	
D_v	0.73630		

004093

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 5-30-67

Run No. C1040 START up

Sample Time: RS 18:15; SS _____
Rec 2095

FISCHER ASSAY

RETORT SHALE MOISTURE

RAW SHALE SPENT SHALE

RAW SHALE FISCHER ASSAY MOISTURE

27.3 _____ Gal/Ton

.914 _____ S.G., g/ml

10.4 _____ Oil, wt %

2.0 _____ Water, wt %

85.6 _____ Sp. Shale, wt %

2.0 _____ Gas & Loss, wt %

None _____ COKING TENDENCY

MINERAL CO₂

16.8 _____ wt %

ASH (SHALE) _____ wt %

MOISTURE _____ wt %

CARBON _____ wt %

HYDROGEN _____ 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 JUN 8 1967

CHECKED BY REC

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 5-30-67

Run No. C1040 STARTUP

LIQUID PRODUCTS

~~R~~

~~R~~

D3 PUMPOUT

T3 PUMPOUT

	1	2	3	4	1	2
WATER, wt %	1.7	/	/	/	/	/
GRAVITY, °API	19.6	/	/	/	/	/
OIL ASH, wt %						

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

~~R~~

OIL WT, g 340
 WATER VOL, ml 70
 GRAVITY OIL, °API 39.3

VENT GAS

~~R~~

MAJOR COMPONENTS

C₁ thru C₄, plus n-Pentane

CO₂ _____ vol %
 O₂ _____ "
 N₂ _____ "
 CH₄ _____ "
 C₂H₆ _____ "
 H₂ _____ "
 Ar _____ "
 Others _____ "

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

CARBON, _____ lbs/MSCFDG

HYDROGEN, _____ lbs/MSCFDG

COMMENTS _____

DATE COMPLETED JUN 1 1967

CHECKED BY RCP

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1040 START UP SAMPLE NO. 2 DATE 5/30/67

UNIT RETRY #3 DESCRIPTION TYLAR

APPROX. SHALE SIZE #1 SHAKING TIME 12 min ANALYSIS BY STONE & MORTIMER

TOTAL SAMPLE WT. GROSS 81.2 - TARE 14.9 = 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		27.2	19.1	8.1	1.05	(1.087) 1.275	(0.9199) 0.7843			
	0.742		47.6	22.5	25.1	0.742	0.896	1.116			
	0.525		34.8	18.5	16.3	0.525	0.634	1.577			
	0.371		20.7	12.2	7.5	0.371	0.448	2.232			
	0.263	3	22.0	9.4	12.6	0.263	0.317	3.154			
	0.185	4	20.0	8.4	11.6	0.185	0.224	4.464			
	0.131	6	20.0	8.4	11.6	0.131	0.158	6.329			
	0.093	8	20.0	20.5	1.1	0.093	0.112	8.928			
	0.065	10	19.4	19.2	0.2	0.065					
	PAN		27.1	21.0	6.1	PAN					
TOTAL ON SCREENS AND PAN					66.4	LOSS					
LOSS (BY DIFFERENCE)						TOTAL					
TOTAL SAMPLE WEIGHT											

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

REMARKS: _____

$\sum_{+8m}^m D_i$	$\sum_{+8m}^m X_i$
$1/\sum_{+8m}^m D_i$	$\sum_{+8m}^m X_i / D_i$
D_a	$\sum_{+8m}^m X_i D_i$
D_v	

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 01240 Station SAMPLE NO. 1 DATE 5/30/61
 UNIT RETORT #3 DESCRIPTION TY LAB
 APPROX. SHALE SIZE 1/4" x 1/4" SHAKING TIME 10 min ANALYSIS BY KIELEY-STOOD
 TOTAL SAMPLE WT. GROSS 87 - TARE 14.8 = NET 72.2

01240
14.8
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		25.4	19.1	6.3	1.05	(1.087) 1.275	(0.9199) 0.7843			
	0.742		44.8	20.5	34.3	0.742	0.896	1.116			
	0.525		36.8	18.5	18.3	0.525	0.634	1.577			
	0.371		25.7	19.2	6.5	0.371	0.448	2.232			
	0.263	3	22.8	18.4	4.4	0.263	0.317	3.154			
	0.185	4	20.8	19.4	1.4	0.185	0.224	4.464			
	0.131	6	19.6	19.4	.2	0.131	0.158	6.329			
	0.093	8	20.6	20.5	.1	0.093	0.112	8.928			
	0.065	10	19.2	19.2	.0	0.065					
	PAN		21.6	21.0	.6	PAN					
TOTAL ON SCREENS AND PAN						LOSS					
LOSS (BY DIFFERENCE)						TOTAL					
TOTAL SAMPLE WEIGHT											

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

REMARKS: _____

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