

GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

1513015003

Date 5-15-67

Purpose: To study operability and yield with 1" shale using open type A/D
to top recycle header, dilution gas and Barton of Hanes type 55 down off Barton.

GENERAL		SPENT SHALE PROPERTIES	
Run No.	TRC-1036	Fischer Assay, Gal/ton	0.4
Length, hours	12	Mineral CO ₂ , Wt %	12.4
Retort Type Number	RC-VII	Ash, Wt %	86.7
Oil Recovery System Number	C-2	Carbon (total), Wt %	5.09
Tons Total Raw Shale Charged, lbs.	131.07	Organic Carbon, Wt %	1.71
Bed Height above Dist., ft	5 1/2	Hydrogen (total), Wt %	0.20
Type Air Dist.	AD-X	LIQUID PRODUCT PROPERTIES	
Bed Below Air Dist., ft	6'	Oil, Wt %	99.22
RATES AND QUANTITIES		Density, lb/gal	7.793
Raw Shale, lbs/(hr)(ft ²)	396	Gravity, API	19.7
Spent Shale, % of RS	79.2	Ash, Wt %	-
Liquid Product, lbs/hr	2065.5	PRODUCT GAS PROPERTIES	
Oil Collected, gal/ton RS	22.0	Water Vapor, lbs/MSCF(dry)	8.2
Air, SCF/ton RS (dry)	6000	Oil, lbs/MSCF(dry)**	0.032
Total Recycle*, SCF/ton RS(wet)	13700	Analysis (dry)	
Dilution, SCF/ton RS (wet)	2560	CO ₂ , Vol %	28.8
Calc. Vent Gas SCF/ton RS(dry)	7720	O ₂ , Vol %	0.3
Gas Losses, SCF/ton RS(wet)	781	N ₂ + Argon, Vol %	61.5
Propane, SCF/ton RS	15.6	CH ₄ , Vol %	1.2
TEMPERATURES AND HEAT BALANCE		CO, Vol %	2.8
Retort Offgas, °F	143	H ₂ , Vol %	4.5
Spent Shale, F	336	Other, Vol %	0.9
Raw Shale, °F	66	Gross Heating Value(calc), Btu/SCF	63.7
Recycle Gas Inlet, °F	250	Carbon (Total), lbs/MSCF (dry)	11.5
Dilution Gas Inlet, °F	250	Hydrogen (Total), lbs/MSCF (dry)	0.54
Air Inlet, °F	140	YIELDS AND BALANCES	
Retort Air Inlet, F	140	Oil Collected, Vol % RSFA	85.1
Heat of Comb. MBtu/ton RS	563	Oil in Gas**, Vol % RSFA	0.1
Heat Lost, MBtu/ton RS	88	Oil in Spent Shale, Vol % RSFA	1.6
RAW SHALE PROPERTIES		Total Oil Meas., Vol % RSFA	86.8
Fischer Assay, gal/ton RS	25.9	Carbonate Decomposition, %	43.5
Oil, Wt %	9.9	Water Recovered, lb/ton RS	104.5
Water, Wt %	1.1	Ash Balance, % - As Measured	-
Gas, Wt %	2.1	Ash Balance, % - Assumed	RS 100
Mineral CO ₂ , Wt %	17.4	Overall Balance, %	100.7
Ash, Wt %	68.7	Carbon Balance, % - Organic	95.1
Moisture, Wt % (Uncrushed)	1.0 Est.	Carbon Balance, % - Total	97.4
Carbon (Total), Wt %	16.2	Hydrogen Balance, % - Organic	89.6
Hydrogen (Total), Wt %	1.73	Hydrogen Balance, % - Total	102.3
Nominal Size Range, inches	1/4"-1"	Water Balance, %	149.6
5 % passing thru	0.263	MISCELLANEOUS	
98 % passing thru	1.05	Avg. Retort ΔP, in H ₂ O/ft	0.76
D _a	0.608	ΔP Above Air Dist., in H ₂ O/ft	0.87
D _v	0.712	NaCl Soln., Wt %	-
		NaCl Rate, gal/ton RS	-

Comments: Transition period from 300 to 500 MR. Oil Gas temperature had 12°F split with wet sack experiment (151°F)

*Measured Recycle + Dilution Gas

** Oil Mist + Condensibles to 75 °F

*** Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl E. Jones

DATE May 25, 1967

OSRC-10

Revised 7/19/66

//A100

2080, TRC-1036 5-15-67 R-2

A. YIELDS

FAY	8.510E 01	DRYGAS	7.717E 03	MISTFA	1.237E-01
H2	3.473E 02	OTHER	6.945E 01	UNRETC	1.501E 00
CH4	9.260E 01	O2	2.315E 01	SSY	7.924E 01
CO	2.161E 02	CO2DEC	4.353E 01	MH2O	1.022E 02
CO2	2.222E 03	OILCOL	2.204E 01		

B. METERED GAS RATES

RECC	1.111E 04	DIL	2.563E 03	WVENTG	8.266E 03
AIR	5.998E 03	TRCCG	1.368E 04	TGF	0.0

C. MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.948E 01	HVGT	4.912E 02	YWDG	3.146E 01
GBTU	6.365E 01				

D. COMBUSTION PRODUCTS

CO2C	8.597E 02	COC	1.937E 02	H2OC	2.679E 01
CHR	1.116E 01	COMBCP	1.456E 01		

E. MATERIAL IN

ORGCIN	2.305E 02	RSP	3.956E 02	ORH2IN	3.247E 01
MATIN	2.482E 03				

F. MATERIAL OUT

ORCOVG	4.764E 01	COKEC	2.269E 01	UNRETH	4.307E-01
ORCOL	1.445E 02	ORH2VG	7.198E 00	COKEH	2.384E 00
UNRETC	4.330E 00	ORH2OL	1.907E 01	ORCOLP	6.263E 01
ORCVGP	2.057E 01	ORCSSP	1.172E 01	HCCVGP	6.112E 00

G. MATERIAL BALANCES

OVALL	1.005E 02	ORH2	2.956E 01	O2BAL	1.075E 02
ASH	0.0	TC	9.738E 01	WATER	1.453E 02
ORGC	9.507E 01	TH2	1.016E 02	GASL	7.808E 02
ASHB	-1.000E 00				

H. HEAT IN

QCCMB	5.632E 05	QH2OC	4.089E 03	QAIR	8.168E 03
QPROP	5.385E 01	QOILC	1.202E 04	QRCYL	4.381E 04
QSUMIN	6.313E 05				

I. HEAT OUT

QMCQ2D	2.454E 05	QKEPCD	9.283E 04	QH2OV	4.798E 04
QLIQO	4.826E 03	QOFGAS	3.593E 04	QSS	9.340E 04
QGASL	4.314E 03	LBLOSS	0.0	HETLOS	1.057E 05
QSUMOT	6.313E 05				

J. MISCELLANEOUS

ORCSS	1.705E 00	VPCIL	3.236E-02	TCL	4.340E 03
VPX	8.192E 00	WCG	1.470E 01	PROP	1.560E 01

END MESSAGE

END OUTPUT

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS - DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION					
0	2080,	TRC-1036 5-15-67 R-2					
1	WRS	OLRS	TRS	B	MRS		
	1.1	9.9	66	-1	21844.4		
2	FA	GRS	CORS	XA		RAW SHALE	
	25.9	2.1	17.4	55.22			
3	ASRS	CRS	HRS	BP	TOG		
	68.7	16.2	1.73	24.51	143		
4	CRA	MFA	TA	PA	WA	LBHL	AIR
	1090.2	1.0	140	143	0.14	0	
5	CRRG	MFRG	TRG	PRG	CRTG	MFTG	RECYCLE AND TOTAL GAS
	2035.6	1.0	250	73	0.0	0.0	
6	CRDG	MFDG	TDG	PDG			DILUTION GAS
	485.2	1.0	100	111			
7	P	TP	PP	W	N		PROPANE AND NUCLEATING AGENT
	30	0.4	126.7	220.7	0.0		
8	WSS	OLSS	GSS	SS			SPENT SHALE
	0.2	0.2	0.3	0.0			
9	COSS	ASSS	CSS	HSS	TSS		
	12.4	86.7	5.09	0.20	336		
10	OILLP	COL	HOL	DOL	WLP		LIQUID PRODUCT
	1876.1	84.1	11.1	7.793	189.4		
11	CRVG	MFBG	TVG	WG	OILM	M	VENT GAS
	2071.9	1.0	250	0	0.0	0	
12	CG	H	COOG	OG	NG		
	11.5	0	28.8	0.3	61.5		
13	MEG	COG	HHG	OTG	HG		
	1.2	2.8	4.5	0.9	0.54		
14	CRVP	VPMF	TVP	PVP			VENT PURGE
	17.6	1.83	194	193			
15	TVPC	VPOIL	VPW	GL			
	75	25.3	11.9	35.0			

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 5-16-67

Run No. Q. 1036 TRANS

Sample Time: RS 0615; SS 1115

400 grams TOTAL SAMPLE

FISCHER ASSAY

RAW SHALE SPENT SHALE

<u>25.8</u>	<u>0.4</u>	Gal/Ton
<u>.913</u>	<u>—</u>	S.G., g/ml
<u>9.8</u>	<u>0.2</u>	Oil, wt %
<u>1.6</u>	<u>0.2</u>	Water, wt %
<u>86.5</u>	<u>99.3</u>	Sp. Shale, wt %
<u>2.1</u>	<u>0.3</u>	Gas & Loss, wt %
<u>Slight</u>	<u>None</u>	COKING TENDENCY

RETORT SHALE MOISTURE

1.0 Est wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.52 wt %

MINERAL CO₂

17.4 12.4 wt %

ASH (SHALE)

68.5 86.7 wt %

MOISTURE

0.26 0.03 wt %

CARBON

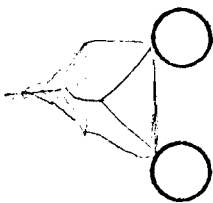
16.2 5.09 wt %

HYDROGEN

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

COMMENTS _____

DATE COMPLETED MAY 18 1967

CHECKED BY REP

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 5-16-67

Run No. C-1036 T

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>0.78</u>	_____	_____	_____	_____	_____
GRAVITY, °API	<u>19.7</u>	_____	_____	_____	_____	_____
<input type="radio"/> OIL ASH, wt %	_____	_____	_____	_____	_____	_____

DISTILLATION (See attached sheet - OSRC-24)

WP

VENT PURGE PRODUCT

OIL WT, g 304.0
 WATER VOL, ml 0.0
 GRAVITY OIL, °API 42.6

ET

VENT GAS

MAJOR COMPONENTS

CO₂ 28.8 vol %
 O₂ 0.3 "
 N₂ 60.8 "
 CH₄ 1.2 "
 CO 2.8 "
 H₂ 4.5 "
 Ar 0.7 "
 Others 0.9 "

C₁ thru C₄, plus n-Pentane

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

R CARBON, 11.5 lbs/MSCFDG

R HYDROGEN, 0.54 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED MAY 18 1967

CHECKED BY REP
 OSRC-12B
 (Revised 5/3/66)

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 1036 SAMPLE NO. _____ DATE 5-17-67
 UNIT # 3 DESCRIPTION TY Lab
 APPROX. SHALE SIZE 1/4 - 1 SHAKING TIME 5 min ANALYSIS BY Robert J. Sipe
 TOTAL SAMPLE WT. GROSS 45.3 - TARE 3.3 = NET 42.0

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		22.0	19.2	2.8	1.05	(1.087) 1.275	(0.9199) 0.7843			
	0.742		38.2	20.5	17.7	0.742	0.896	1.116			
	0.525		30.0	18.5	11.5	0.525	0.634	1.577			
	0.371		24.3	19.2	5.1	0.371	0.448	2.232			
	0.263	3	25.0	18.3	3.7	0.263	0.317	3.154			
	0.185	4	20.2	18.4	.8	0.185	0.224	4.464			
	0.131	6	19.4	18.3	.1	0.131	0.158	6.329			
	0.093	8	20.5	20.5	.0	0.093	0.112	8.928			
	0.065	10	19.2	19.2	.0	0.065					
	PAN		21.2	21.0	.2	PAN					
TOTAL ON SCREENS AND PAN					41.9	LOSS					
LOSS (BY DIFFERENCE)					+1	TOTAL					
TOTAL SAMPLE WEIGHT					42.0						

* 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 D. TA SHEET (TY-LAB)

RUN NO. ⁷¹² ~~1036~~ - ~~714~~ SAMPLE NO. _____ DATE 5-17-67
 UNIT #3 DESCRIPTION 71746
 APPROX. SHALE SIZE 1/1 SHAKING TIME 5 min. ANALYSIS BY Fe. Baker - 3041
 TOTAL SAMPLE WT. GROSS 49.0 - TARE 3.3 = NET 45.7

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		22.1	19.2	3.2	1.05	(1.087) 1.275	(0.9199) 0.7843			
	0.742		41.4	20.5	20.9	0.742	0.896	1.116			
	0.525		31.0	18.5	12.5	0.525	0.634	1.577			
	0.371		24.3	19.2	5.1	0.371	0.448	2.232			
	0.263	3	21.3	18.3	3.0	0.263	0.317	3.154			
	0.185	4	20.5	19.4	.6	0.185	0.224	4.464			
	0.131	6	19.4	19.3	.1	0.131	0.158	6.329			
	0.093	8	20.5	20.5	.0	0.093	0.112	8.928			
	0.065	10	19.2	19.2	.0	0.065					
	PAN		21.2	21.0	.2	PAN					
TOTAL ON SCREENS AND PAN					45.6	LOSS					
LOSS (BY DIFFERENCE)					+ .1	TOTAL					
TOTAL SAMPLE WEIGHT					45.7						

* 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. 712 4-1036-7741 SAMPLE NO. _____ DATE 5-17-67

UNIT A 3 DESCRIPTION 97 Lab.

APPROX. SHALE SIZE 1/4 - 1 SHAKING TIME 5 min ANALYSIS BY R. E. H. Boyce

TOTAL SAMPLE WT. GROSS 30.5 - TARE 3.4 = NET 27.1

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		20.2	19.2	1.0	1.05	(1.087) 1.275	(0.9199) 0.7843			
	0.742		30.2	20.5	9.7	0.742	0.896	1.116			
	0.525		25.6	18.5	7.1	0.525	0.634	1.577			
	0.371		20.5	17.2	3.3	0.371	0.448	2.232			
	0.263	3	21.8	18.4	3.4	0.263	0.317	3.154			
	0.185	4	20.5	19.5	1.1	0.185	0.224	4.464			
	0.131	6	19.5	18.5	1.0	0.131	0.158	6.329			
	0.093	8	20.6	19.5	1.1	0.093	0.112	8.928			
	0.065	10	19.2	19.2	0.0	0.065					
	PAN		21.8	21.0	0.8	PAN					
TOTAL ON SCREENS AND PAN					26.7	LOSS					
LOSS (BY DIFFERENCE)					0.4	TOTAL					
TOTAL SAMPLE WEIGHT					27.1						

* 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		