GAS COMBUSTION RETORTING
DETAILED RUN SUMMARY SHEET

15/3015N7

Date 5-23-67

Purpose: To study operability and yield with +-1 inch shale, using Gas A/D to recycle heater, w/o dolomite and with 6 of 11 mm SS drawn off bottom.

GENERAL	
Run No.	C1038-3
Length, hours	12
Retort Type Number	RC-VII
Oil Recovery System Number	C-1
Tons Total Raw Shale Charged, lbs.	95.0
Bed Height above Dist., ft	5½'
Type Air Dist.	AD-X
Bed Below Air Dist., ft	6'
RATES AND QUANTITIES	
Raw Shale, lbs/(hr)(ft²)	287
Spent Shale, % of RS	80.1
Liquid Product, lbs/hr	1452.7
Oil Collected, gal/ton RS	21.1
Air, SCF/ton RS (dry)	5170
Total Recycle*, SCF/ton RS(wet)	13700
Dilution, SCF/ton RS (wet)	—
Calc. Vent Gas SCF/ton RS(dry)	707
Gas Losses, SCF/ton RS(wet)	157
Propane, SCF/ton RS	—
TEMPERATURES AND HEAT BALANCE	
Retort Offgas, °F	138
Spent Shale, F	559
Raw Shale, °F	78
Recycle Gas Inlet, °F	250
Dilution Gas Inlet, °F	—
Air Inlet, °F	152
Retort Air Inlet, F	152
Heat of Comb. MBtu/ton RS	461
Heat Lost, MBtu/ton RS	~55
RAW SHALE PROPERTIES	
Fischer Assay, gal/ton RS	24.1
Oil, Wt %	9.1
Water, Wt %	1.1
Gas, Wt %	1.8
Mineral CO_2, Wt %	17.4
Ash, Wt %	69.5
Moisture, Wt % (Uncrushed)	1.0 Est+
Carbon (Total), Wt %	14.7
Hydrogen (Total), Wt %	1.53
Nominal Size Range, inches	¼" - 1"
5 % passing thru	0.263
98 % passing thru	1.05
Da	0.550
D_V	0.704

SPENT SHALE PROPERTIES	
Fischer Assay, Gal/ton	0.0
Mineral CO_2, Wt %	12.1
Ash, Wt %	86.8
Carbon (total), Wt %	5.15
Organic Carbon, Wt %	1.85
Hydrogen (total), Wt %	0.18
LIQUID PRODUCT PROPERTIES	
Oil, Wt %	99.0
Density, lb/gal	7.788
Gravity, API	19.8
Ash, Wt %	
PRODUCT GAS PROPERTIES	
Water Vapor, lbs/MSCF(dry)	6.2
Oil, lbs/MSCF(dry)**	0.121
Analysis (dry)	
CO_2, Vol %	31.0
O_2, Vol %	0.5
N_2 + Argon, Vol %	57.9
CH_4, Vol %	1.4
CO, Vol %	3.4
H_2, Vol %	4.6
Other, Vol %	1.2
Gross Heating Value(calc),Btu/SCF	78.1
Carbon (Total), lbs/MSCF (dry)	12.9
Hydrogen (Total), lbs/MSCF (dry)	0.60
YIELDS AND BALANCES	
Oil Collected, Vol % RSFA	87.7
Oil in Gas**, Vol % RSFA	0.5
Oil in Spent Shale, Vol % RSFA	0.0
Total Oil Meas., Vol % RSFA	88.2
Carbonate Decomposition, %	44.3
Water Recovered, lb/ton RS	70.5
Ash Balance, % - As Measured	—
Ash Balance, % - Assumed	KS100
Overall Balance, %	100.2
Carbon Balance, % - Organic	109.5
Carbon Balance, % - Total	106.4
Hydrogen Balance, % - Organic	92.2
Hydrogen Balance, % - Total	101.4
Water Balance, %	128.3
MISCELLANEOUS	
Avg. Retort ΔP, in H_2O/ft	0.43
ΔP Above Air Dist., in H_2O/ft	0.44
NaCl Soln., Wt %	—
NaCl Rate, gal/ton RS	—

Comments: Cooler on retort somewhat colder than usual. Temperatures were increasing at about hour 10 but dropped during the latter part of the balance. Est. heat to heater from gas balance compared to cooler load.

*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. Jones DATE June 8, 1967.

OSRC-10
Revised 7/19/66

//A100
0050, C1058-3 3-1 5-03-67

A. YIELDS

FAY	9.7736 01	DRYGAS	7.0662 03	TARIFA	4.3587-01
H2	3.0317 02	OINTR	2.4315 01	WASTIC	0.0
CH4	0.8958 01	O2	5.5341 01	SOY	3.0076 01
CO	2.4036 02	COMBTC	4.4362 01	CHAR	7.1477 01
CO2	2.1911 03	OILCOL	3.1143 01		

B. METERED GAS RATES

RECY	1.3657 04	OIL	0.0	WATERG	7.8395 03
AIR	5.1792 03	TARCY	1.5058 02	TAR	0.0

C. MOL WT & METABOLIC VALUE OF WASTE GAS

MWAG	3.0286 01	HVGT	5.5296 02	HVDG	5.1792 01
GBTU	7.8154 01				

D. COMBUSTION PRODUCTS

COPC	9.1556 02	CPC	9.2825 02	NPC	1.1961 01
CH2	2.4578 01	CMTPCP	1.6328 01		

E. MATERIAL IN

ORGCIN	1.9905 02	PCT	2.3602 00	CTNCTN	1.7146 01
MATIN	2.4176 03				

F. MATERIAL OUT

ORGCMG	4.9235 01	CCMSC	2.0275 01	MCHETH	0.0
ORGCOL	1.3259 02	ORHCMG	5.6725 00	CCMLR	1.1869 00
UNRLTC	0.0	ORMPCL	1.3957 01	CTRCLL	5.0521 01
ORCMCP	2.5041 01	ORGSCP	1.4868 01	RCMVCP	1.4478 00

G. MATERIAL BALANCES

CVALL	1.0025 02	CBMP	9.0207 01	CRCIL	1.0301 02
ACM	0.0	TC	1.0918 02	WATER	1.0352 02
CRCL	1.0255 02	TMP	1.0143 02	SOIL	1.0502 02
ACHO	-1.0000 00				

H. HEAT IN

CCOTB	4.5128 05	SUPCC	1.0335 04	CAIF	7.0547 03
CFTCP	0.0	CCILC	1.1531 04	CRCYL	4.9458 04
CCMTDT	5.3968 05				

I. HEAT OUT

CTCCRB	2.4032 05	CMTRCP	1.7902 04	CHRCV	4.7420 04
CLITH	5.6262 03	CCTCAS	2.7342 04	CEE	1.7391 05
CRACL	1.8012 03	LTLCRS	0.0	MCRLCT	-3.7502 04
CCUTCT	5.3968 05				

J. [illegible]

CRCRS	1.7472 00	VRCIL	1.2102-01	TCL	3.0412 03
VRT	6.1552 [illegible]	VCC	1.1512 01	RCCH	0.0

END RESEARCH

END CUTS

HEAT AND MATERIAL BALANCE FOR PILOT RETORTS – DATA SHEET

LINE #	PROGRAM ID	USER IDENTIFICATION
0	2080,	C 1038-3 R-1 5-23-67

1	WRS: 1.1	OLRS: 9.1	TRS: 78	B: -1	MRS: 1584 0.4		RAW SHALE
2	FA: 24.1	GRS: 1.8	CORS: 17.4	XA: 55.22			
3	ASRS: 69.5	CRS: 14.7	HRS: 1.53	BP: 24.40	TOG: 138		
4	CRA: 683.2	MFA: 1.0	TA: 152	PA: 137	WA: 0.14	LBHL: 0	AIR
5	CRRG: 1839.8	MFRG: 1.0	TRG: 250	PRG: 73	CRTG: 0.0	MFTG: 0.0	RECYCLE A TOTAL GAS
6	CRDG: 0.0	MFDG: 0.0	TDG: 0	PDG: 0			DILUTION G
7	P: 0.0	TP: 0	PP: 0	W: 160.0	N: 0.0		PROPANE A NUCLEATIN AGENT
8	WSS: 0.5	OLSS: 0.0	GSS: 0.0	SS: 0.0			SPENT SHALE
9	COSS: 12.1	ASSS: 86.8	CSS: 5.15	HSS: 0.18	TSS: 559		
10	OILLP: 1304.1	COL: 84.1	HOL: 11.1	DOL: 7.788	WLP: 148.5		LIQUID PRODUCT
11	CRVG: 1085.8	MFVG: 1.0	TVG: 250	WG: 0.0	OILM: 0.0	M: 0	VENT GAS
12	CG: 12.9	H: 0	COOG: 31.0	OG: 0.5	NG: 57.9		
13	MEG: 1.4	COG: 3.4	HHG: 4.6	OTG: 1.2	HG: 0.60		
14	CRVP: 1.4	VPMF: 1.83	TVP: 140	PVP: 73			VENT PURGE
15	TVPC: 80	VPOIL: 24.3	VPW: 1.9	GL: 54.4			

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 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 5-24-67 Run No. C-1038-3

Sample Time: RS 0015 ; SS 09.00

FISCHER ASSAY

RAW SHALE	SPENT SHALE	
24.5	2.5	Gal/Ton
0.914	—	S.G., g/ml
9.1	0.0	Oil, wt %
1.6	0.5	Water, wt %
87.4	99.2	Sp. Shale, wt %
1.8	0.3	Gas & Loss, wt %
SLIGHT	NONE	COKING TENDENCY

RETORT SHALE MOISTURE

Est. 0.0 wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.53 wt %

	RAW SHALE	SPENT SHALE	
MINERAL CO_2	17.4	12.1	wt %
ASH (SHALE)	89.3	86.8	wt %
MOISTURE	0.27	0.05	wt %
CARBON	14.7	5.15	wt %
HYDROGEN	1.53	0.18	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 MAY 26 1967 CHECKED BY PEP

OSRC-12A
Revised 6/20/66

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 5-24-67 Run No. C1028-3

LIQUID PRODUCTS

	D3 PUMPOUT				T3 PUMPOUT	
	1	2	3	4	1	2
WATER, wt %	4.0%					
GRAVITY, °API	19.8					
OIL ASH, wt %	0.04					

○ DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 29.9

WATER VOL, ml 34.0

GRAVITY OIL, °API 41.2

VENT GAS

⊗ MAJOR COMPONENTS

CO_2	31.0	vol %
O_2	0.5	"
N_2	57.2	"
CH_4	1.1	"
CO	3.1	"
H_2	4.6	"
Ar	0.7	"
Others	1.2	"

○ 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}	.	"

⊗ CARBON, 12.9 lbs/MSCFDG HYDROGEN, 0.60 lbs/MSCFDG

COMMENTS

DATE COMPLETED MAY 25 1967 CHECKED BY

OSRC-12B

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C/0 2-3 mins 1.0# SAMPLE NO. _____ DATE _____

UNIT _____ DESCRIPTION _____

APPROX. SHALE SIZE _____ SHAKING TIME _____ ANALYSIS BY _____

TOTAL SAMPLE WT. GROSS _____ – TARE _____ = NET _____

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				3.3
	0.742				20.6
	0.525				11.4
	0.371				4.6
	0.263	3			4.7
	0.185	4			1.5
	0.131	6			0.2
	0.093	8			1.0
	0.065	10			0.1
	PAN				0.6
TOTAL ON SCREENS AND PAN					48.0
LOSS (BY DIFFERENCE)					
TOTAL SAMPLE WEIGHT					

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	6.87		93.12
0.742	0.896	1.116	42.92		50.20
0.525	0.634	1.577	23.75		26.45
0.371	0.448	2.232	9.58		16.87
0.263	0.317	3.154	9.79		7.08
0.185	0.224	4.464	3.12		3.96
0.131	0.158	6.329	0.42		3.54
0.093	0.112	8.928	2.08	98.53	1.46
0.065			0.21		1.25
PAN			1.25		0.00
LOSS			—	—	—
TOTAL			99.99	—	—
			—	—	—

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

$\sum_{+8m}^{m} Di$	0.69375	$\sum_{+8m}^{m} Xi$	
$1/\sum_{+8m}^{m} Di$	1.79029	$\sum_{+8m}^{m} Xi / Di$	
Da	0.55017	$\sum_{+8m}^{m} Xi\ Di$	
Dv	0.70410		

REMARKS: _____

OSRC-4

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C1038-3 SAMPLE NO. _____ DATE 5-24-67

UNIT TF3 DESCRIPTION TY-LAB

APPROX. SHALE SIZE _____ SHAKING TIME 10 MIN ANALYSIS BY Smith + Stanton

TOTAL SAMPLE WT. GROSS 51.7 − TARE 2.5 = NET 49.2

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		22.4	19.1	3.3
	0.742		41.1	20.5	20.6
	0.525		33.9	18.5	15.4
	0.371		23.9	19.3	4.6
	0.263	3	23.0	18.3	4.7
	0.185	4	20.9	19.4	1.5
	0.131	6	19.6	19.4	.2
	0.093	8	21.6	20.6	1.0
	0.065	10	19.5	19.4	.1
	PAN		22.5	20.9	1.6
TOTAL ON SCREENS AND PAN					49.0
LOSS (BY DIFFERENCE)					+.2
TOTAL SAMPLE WEIGHT					49.2

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	6.73		93.27
0.742	0.896	1.116	42.04		51.23
0.525	0.634	1.577	23.27		27.96
0.371	0.448	2.232	9.39		18.57
0.263	0.317	3.154	9.59		8.98
0.185	0.224	4.464	3.06		5.92
0.131	0.158	6.329	0.41		5.51
0.093	0.112	8.928	2.04	96.53	3.47
0.065			0.20		3.27
PAN			3.27		0.00
LOSS			—		—
TOTAL			100.00	—	—
			—	—	—

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

$\Sigma^{m}_{+8m} Di$	0.67962	$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$	1.75478	$\Sigma^{m}_{+8m} Xi / Di$	
Da	0.55509	$\Sigma^{m}_{+8m} Xi\ Di$	
Dv	0.70405		

REMARKS: _____

OSRC-4

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. 1038-3 SAMPLE NO. 3 DATE 5-24-[illegible]

UNIT #3 [illegible] DESCRIPTION [illegible]

APPROX. SHALE SIZE [illegible] SHAKING TIME [illegible] ANALYSIS BY [illegible]

TOTAL SAMPLE WT. GROSS 453 – TARE 3.3 = NET 449.7

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		209	19.2	1.7
	0.742		38.8	23.5	15.3
	0.525		30.9	18.5	12.4
	0.371		24.8	19.3	5.5
	0.263	3	23.2	18.4	4.8
	0.185	4	21.0	19.4	1.6
	0.131	6	19.5	19.4	.1
	0.093	8	20.7	20.6	.1
	0.065	10	19.4	19.3	.1
	PAN		21.2	[illegible]	.3
TOTAL ON SCREENS AND PAN					41.9
LOSS (BY DIFFERENCE)					
TOTAL SAMPLE WEIGHT					41.9

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	4.06		95.96
0.742	0.896	1.116	36.52		59.44
0.525	0.634	1.577	29.59		29.85
0.371	0.448	2.232	13.13		16.72
0.263	0.317	3.154	11.46		5.26
0.185	0.224	4.464	3.82		1.44
0.131	0.158	6.329	0.24		1.20
0.093	0.112	8.928	0.24	99.06	0.96
0.065			0.24	[illegible]	0.72
PAN			0.72		0.00
LOSS			—	—	—
TOTAL			100.05	—	—
				—	—

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

$\Sigma^{m}_{+8m} Di$	6.6331	$\Sigma^{m}_{+8m} Xi$	
$1/\Sigma^{m}_{+8m} Di$	1.77320	$\Sigma^{m}_{+8m} Xi / Di$	
Da	0.55865	$\Sigma^{m}_{+8m} Xi\ Di$	
Dv	2.66760		

REMARKS: _____

OSRC-4