

GAS COMBUSTION REPORTING
DETAILED RUN SUMMARY SHEET

Date 4-19-67
1513014003

Date 4-19-67

with 1-2" sand at bottom of retort before charging to Spent Shale.		Date <u>4-19-67</u>	
		<u>SPENT SHALE PROPERTIES</u>	
Fischer Assay, Gal/ton	0-10:9.2	Fischer Assay, Gal/ton	0.16
Retort Hours	12	Mineral CO ₂ , Wt %	12.9
Spent Shale Number	KC-17	Ash, Wt %	28.5
Recirculation System Number	0-7	Carbon (total), Wt %	5.70
Spent Shale Charged, lbs.	161,96	Organic Carbon, Wt %	1.98
Bed Height above Dist., ft	17 1/2	Hydrogen (total), Wt %	0.14
Above Air Dist.	11-78	<u>LIQUID PRODUCT PROPERTIES</u>	
Bed Below Air Dist., ft	71	Oil, Wt %	93.4
<u>RATES AND QUANTITIES</u>		Density, lb/gal	7.793
Raw Shale, lbs/(hr)/(ft ²)	489	Gravity, API	19.7
Spent Shale, % of RS	80.7	Ash, Wt %	-
Liquid Product, lbs/hr	2693.0	<u>PRODUCT GAS PROPERTIES</u>	
Oil Collected, gal/ton RS	22.8	Water Vapor, lbs/MSCF (dry)	6.6
Air, SCF/ton RS (dry)	4650	Oil, lbs/MSCF (dry)**	0.041
Total Recycle*, SCF/ton RS (wet)	12700	<u>Analysis (dry)</u>	
Dilution, SCF/ton RS (wet)	--	CO ₂ , Vol %	24.2
Calc. Vent Gas SCF/ton RS (dry)	6030	O ₂ , Vol %	0.5
Gas Losses, SCF/ton RS (wet)	-325	N ₂ + Argon, Vol %	61.0
Propane, SCF/ton RS	-	CH ₄ , Vol %	2.0
<u>TEMPERATURES AND HEAT BALANCE</u>		CO, Vol %	4.4
Retort Offgas, °F	138	H ₂ , Vol %	5.9
Spent Shale, F	364	Other, Vol %	1.4
Raw Shale, °F	67	Gross Heating Value (calc), Btu/SCF	125.7
Recycle Gas Inlet, °F	215	Carbon (Total), lbs/MSCF (dry)	12.9
Dilution Gas Inlet, °F	-	Hydrogen (Total), lbs/MSCF (dry)	0.96
Air Inlet, °F	143	<u>YIELDS AND BALANCES</u>	
Retort Air Inlet, F	143	Oil Collected, Vol % RSFA	84.2
Heat of Comb. MBtu/ton RS	447	Oil in Gas**, Vol % RSFA	0.3
Heat Lost, MBtu/ton RS	26	Oil in Spent Shale, Vol % RSFA	0.8
<u>RAW SHALE PROPERTIES</u>		Total Oil Meas., Vol % RSFA	85.9
Fischer Assay, gal/ton RS	26.9	Carbonate Decomposition, %	11.9
Oil, Wt %	10.2	Water Recovered, lb/ton RS	66.3
Water, Wt %	1.1	Ash Balance, % - As Measured	-
Gas, Wt %	1.9	Ash Balance, % - Assumed	25.100
Mineral CO ₂ , Wt %	17.5	Overall Balance, %	78.4
Ash, Wt %	68.2	Carbon Balance, % - Organic	96.9
Moisture, Wt % (Uncrushed)	1.05	Carbon Balance, % - Total	97.2
Carbon (Total), Wt %	16.4	Hydrogen Balance, % - Organic	101.5
Hydrogen (Total), Wt %	1.71	Hydrogen Balance, % - Total	96.5
Nominal Size Range, inches	1/2-2 1/2"	Water Balance, %	76.4
5 % passing thru	0.742	<u>MISCELLANEOUS</u>	
98 % passing thru	3.00	Avg. Retort ΔP, in H ₂ O/ft	0.52
D _a	1.485	ΔP Above Air Dist., in H ₂ O/ft	0.63
D _v	1.737	NaCl Soln., Wt %	-
		NaCl Rate, gal/ton RS	-

Comments: Potassium measured to 0.0004, 12 in due to thin film on surface.
Several RS shales used due to presence of residual NaCl.

*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 J. Jones DATE May 17, 1967

921, RUN NO. 01029-2

Started 4/19/67

4/26/67
230

YIELDS

FAY	8.477	01	DRYGAS	6.031	03	MISTFA	2.628	-01			
H2	3.558	02	OTHER	8.443	01	UNPETO	7.912	-01	CH4	1.206	02
O2	3.015	01	SSY	8.071	01	CO	2.653	02	CO2DEC	3.589	01
NH2O	6.630	01	CCR	1.495	03	OILCOL	2.280	01			

METERED GAS RATES

RECG	1.274	04	DIL	0.000	00	WVENTG	7.190	03	AIR	4.649	03
TRECG	1.274	04	TGF	0.000	00						

MOL WT & HEATING VALUE OF VENT GAS

MWVG	2.894	01	HVGT	7.598	02	MWDG	3.045	01	GBTU	1.259	02
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COMBUSTION PRODUCTS

CO2C	3.630	02	COO	2.502	02						
H2OC	4.382	01	CHR	3.946	00	COMBOP	8.363	00			

MATERIAL IN

OROCIN	2.324	02	PSR	4.828	02	ORW2IN	3.173	01	MATIN	2.276	03
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MATERIAL OUT

OROCVG	4.400	01	COKEC	2.996	01	UNRETH	2.059	-01			
OROCOL	1.494	02	ORH2VG	1.077	01	COKEH	1.511	00	UNRETC	1.922	00
ORH2OL	1.972	01	ORCOLP	6.429	01	ORCVCP	1.393	01	ORCSSP	1.371	01
HCCVCP	1.056	01									

MATERIAL BALANCES

OVALL	9.833	01	ORGM2	1.015	02						
CBAL	9.549	01	ASH	0.000	00	TC	9.732	01	WATER	7.644	01
ORGC	9.694	01	THE	9.653	01	GASL	-3.254	02	ASHB	-1.000	00

HEAT IN

QCOMB	4.470	05	QH2OC	6.246	03	QAIR	6.504	03			
QPROP	0.000	00	QOILC	1.243	04	QRCYL	3.324	04	QSUMIN	5.110	05

HEAT OUT

QXCO2D	2.035	05	QKEROD	9.550	04	QH2OV	4.797	04			
QLIQ	4.533	05	QOFGAS	2.943	04	QSS	1.064	05	QGASL	-2.036	03
LBLOSS	0.000	00	QHTLOS	2.559	04	QSUMOT	5.110	05			

MISCELLANEOUS

ORCSS	1.975	00	VPCIL	9.135	-02	TGL	4.372	03	VPX	6.573	00
WCG	1.214	01	PROP	0.000	00						

MATERIAL AND HEAT BALANCE INPUT SHEET

RIF 92 | RUN NO. | C-1 7-2 | STARTED | 4-19- | CALC. ON

101 | 1002 | 67 | -1 | 26994.00
 H₂O, wt% | Oil, wt% | °F | (1) | Rate, lbs/Hr

RAW SHALE
 BAROMETRIC PRESSURE AND OFFGAS TEMPERATURE

2609 | 109 | 1705 | 55022
 Oil, gal/T | Gas+L, wt% | CO₂, wt% | Retort XS, ft²

6802 | 1604 | 1071 | 24001 | 138
 Ash, wt% | Carbon, wt% | H₂, wt% | Bar. Press, " Hg | Offgas Temp, °F

1055.2 | 100 | 143 | 129 | 0074 | 0
 Chart Reading | Meter Factor | Temp, °F | Press, "H₂O gauge | Moist, lbs/MSCF | Mist, lbs/MSCF

AIR

28870.8 | 100 | 215 | 71 | 000 | 000
 Recycle Ch. Read | Meter Factor | Temp, °F | Press, "H₂O gauge | Tot. Gas Ch. Read | Meter Factor

RECYCLE AIR TOTAL GAS

000 | 000 | 0 | 0
 Dil Gas Ch. Read | Meter Factor | Temp, °F | Press, "H₂O gauge

DILUTION GAS

000 | 0 | 0 | 27207 | 000
 C₂ Rotameter R. | Temp, °F | Press, "H₂O gauge | Water added, lbs/Hr. | Nucl. Agent, lb/Hr.

PROPANE, WATER & NUCLEATING AGENT

003 | 001 | 001 | 000
 H₂O, wt% | Oil, wt% | Gas, wt% | Rate, lbs/Hr

used S.S. analysis from C1029-1 due to bad sample for C1029-2

SPENT SHALE

1309 | 8405 | 5077 | 0014 | 364
 CO₂, wt% | Ash, wt% | Carbon, wt% | H₂, wt% | Temp, °F

239805 | 8401 | 1101 | 70793 | 29405
 Dry Oil, lbs/Hr | Carbon, wt% | H₂, wt% | Den, lbs/gal | Water, lbs/Hr

LIQUID PRODUCT

16400.6 | 100 | 231 | 000 | 000 | 0 | 1209
 Vent + Dil Gas Chart Reading | Meter Factor | Temp, °F | Moist, lbs/MSCF | Mist, lbs/MSCF (2) | Carbon, lbs/MSCF

VENT + DILUTION GAS, VENT PURGE GAS, AND TOP SEAS GAS

0 | 2408 | 005 | 6100 | 200 | 404 | 509
 (3) CO₂, vol% | O₂, vol% | N₂, vol% | CH₄, vol% | CO, vol% | H₂, vol%

104 | 0096 | 1608
 Others, vol% | H₂, lbs/MSCF | V. Purge Ch. Reading

1083 | 170 | 193 | 75 | 7108 | 902 | 2002
 Meter Factor | Temp, °F | Press, "H₂O gauge | Cond. Gas Cut Temp, °F | Dry Oil, gal/Hr | Water, lbs/Hr | Top Seal Loss Rate, %CAM

OPTIONS:

- (1) Insert "0" to calc. with measured rates; "1" to calc. with spent shale rate and ash analyses; "-1" to calc. with raw shale rate and ash analyses.
- (2) Insert "1" to calc. with measured moisture and mist; "0" to calc. from vent purge data.
- (3) Insert "0" for Retort No.3 (pressure and temperature have no effect on gas rates); "1" for Retort No. 1&2 (pressure and temperature have effect on gas rates).

IB Gilmore
 1/17/67

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4/20-67

Run No. C-1029-2

Sample Type: RS Oil; SS _____

FISCHER ASSAY

RAW SHALE SPENT SHALE

26.7 _____ Gal/Ton 0.16
0.911 _____ S.G., g/ml 0.0
14. _____ Oil, wt % 0.1
2.5 _____ Water, wt % 0.3
85.0 _____ Sp. Shale, wt % 95.5
1.9 _____ Gas & Loss, wt % 0.1
Sample _____ COKING TENDENCY None

RETORT SHALE MOISTURE
1.0 est wt %
 RAW SHALE FISCHER ASSAY MOISTURE
0.891 wt %

*0.952
 5.5. 2 room
 C-1029-1
 because of
 bad sample*

MINERAL CO₂

17.4 _____ wt % 13.9

ASH (SHALE)

68.0 _____ wt % 54.5

MOISTURE

0.30 _____ wt % 0.01

CARBON

16.4 _____ wt % 5.77

HYDROGEN

1.70 _____ wt % 0.17

BENZENE EXTRACTABLES

_____ _____ wt %

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 APR 21 1967

CHECKED BY [Signature]

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-20-67

Run No. C. 1029-2

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>6.6</u>	_____	_____	_____	_____	_____
GRAVITY, °API	<u>19.7</u>	_____	_____	_____	_____	_____

OIL ASH, wt %

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

OIL WT, g 862.0
 WATER VOL, ml 40.0
 GRAVITY OIL, °API 41.8

VENT GAS

MAJOR COMPONENTS

CO₂ 24.8 vol %
 O₂ 0.5 "
 N₂ 60.3 "
 CH₄ 2.0 "
 CO 4.4 "
 H₂ 5.9 "
 Ar 0.7 "
 Others 1.4 "

C₁ thru C₄, plus n-Pentane

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

CARBON, 12.9 lbs/MSCFDG

HYDROGEN, 0.96 lbs/MSCFDG

COMMENTS _____

DATE COMPLETED 4-24-67

CHECKED BY _____

OSRC-12B
 (Revised 5/3/66)

SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. CU 20-2 SAMPLE NO. 70-146 DATE 7/20/11
 UNIT #3 DESCRIPTION 70-146
 APPROX. SHALE SIZE / - 3/8 SHAKING TIME 10 ANALYSIS BY RE...
 TOTAL SAMPLE WT. GROSS 78.1 - TARE 5.3 = NET 72.8

SCREENS REQD.	SCREEN SIZE		WEIGHTS		NET WT. RETAINED	Di *	1/di	% RETAINED	CUM. % RETAINED	% PASSING
	OPENING SIZE	MESH	GROSS LBS.	TARE LBS.						
	4.25					(3.125)	(0.3200)	0.96		99.02
	3.00		18.9	18.2	0.7	(2.625)	(0.3809)			
	2.50		21.6	16.7	4.9	2.750	0.3636	6.70	53	92.37
	2.00		36.0	20.2	15.8	2.250	0.4444	21.61	53	70.71
	1.50		50.9	23.4	27.5	1.750	0.5714	37.62	53	33.09
	1.05		34.6	19.2	15.4	(1.087)	(0.9193)	21.07	53	12.02
	0.742		25.7	20.5	5.2	0.896	1.116	7.11		4.91
	0.525		20.0	18.5	1.5	0.634	1.577	2.05		2.86
	0.371		19.6	19.3	.3	0.448	2.232	0.41		2.45
	0.263	3	18.6	18.4	.2	0.317	3.154	0.27		2.18
	0.185	4	19.6	19.4	.2	0.224	4.464	0.27		1.91
	0.131	6	19.6	19.4	.2	0.158	6.329	0.27		1.64
	0.093	8	20.7	20.7	.0	0.112	8.928	0.00	98.34	1.64
	0.065	10	20.2	19.9	.3			0.41		1.22
	PAN		21.9	21.0	.9			1.23		0.00
TOTAL ON SCREENS AND PAN					73.1					
LOSS (BY DIFFERENCE)					(4.5)					
TOTAL SAMPLE WEIGHT					78.1			99.99		

$\sum_{i=1}^m X_i D_i$	170129	$\sum_{i=1}^m X_i$	
$\frac{1}{\sum_{i=1}^m D_i}$	6.6617	$\sum_{i=1}^m X_i D_i$	
Da	1.48511	$\sum_{i=1}^m X_i D_i$	
Dv	1.7367	$\sum_{i=1}^m X_i D_i$	

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

REMARKS:

15/13/11