

GAS COMBUSTION REPORTING  
DETAILED RUN SUMMARY SHEET

1513013002

Date 4-8-67

Purpose: To determine availability and yield with 1-2 1/2 inch shale with SS liner, 36 bayonet A/D and 3 over 3 and out of 300 lbs. header

| GENERAL                               |           |
|---------------------------------------|-----------|
| Run No.                               | C-1027-1  |
| Length, hours                         | 12        |
| Retort Type Number                    | RC-VI     |
| Oil Recovery System Number            | C-1       |
| Tons Total Raw Shale Charged, lbs.    | 130.34    |
| Bed Height above Dist., ft            | 12 1/2    |
| Type Air Dist.                        | AD-VIII   |
| Bed Below Air Dist., ft               | 7'        |
| RATES AND QUANTITIES                  |           |
| Raw Shale, lbs/(hr)(ft <sup>2</sup> ) | 393       |
| Spent Shale, % of RS                  | 81.4      |
| Liquid Product, lbs/hr                | 2175.1    |
| Oil Collected, gal/ton RS             | 21.6      |
| Air, SCF/ton RS (dry)                 | 4600      |
| Total Recycle*, SCF/ton RS (wet)      | 14500     |
| Dilution, SCF/ton RS (wet)            | -         |
| Calc. Vent Gas SCF/ton RS (dry)       | 5950      |
| Gas Losses, SCF/ton RS (wet)          | -379      |
| Propane, SCF/ton RS                   | -         |
| TEMPERATURES AND HEAT BALANCE         |           |
| Retort Offgas, °F                     | 139       |
| Spent Shale, F                        | 369       |
| Raw Shale, °F                         | 62        |
| Recycle Gas Inlet, °F                 | 250       |
| Dilution Gas Inlet, °F                | -         |
| Air Inlet, °F                         | 131       |
| Retort Air Inlet, F                   | 131       |
| Heat of Comb. MBtu/ton RS             | 452       |
| Heat Lost, MBtu/ton RS                | 31        |
| RAW SHALE PROPERTIES                  |           |
| Fischer Assay, gal/ton RS             | 25.1      |
| Oil, Wt %                             | 9.6       |
| Water, Wt %                           | 1.1       |
| Gas, Wt %                             | 1.9       |
| Mineral CO <sub>2</sub> , Wt %        | 17.6      |
| Ash, Wt %                             | 68.9      |
| Moisture, Wt % (Uncrushed)            | 1.0 Est.  |
| Carbon (Total), Wt %                  | 15.5      |
| Hydrogen (Total), Wt %                | 1.53      |
| Nominal Size Range, inches            | 1"-2 1/2" |
| 5 % passing thru                      | 0.742     |
| 98 % passing thru                     | 2.00      |
| D <sub>a</sub>                        | 1.440     |
| D <sub>v</sub>                        | 1.607     |

| SPENT SHALE PROPERTIES                     |        |
|--|--------|
| Fischer Assay, Gal/ton                     | 0.3    |
| Mineral CO <sub>2</sub> , Wt %             | 13.4   |
| Ash, Wt %                                  | 84.6   |
| Carbon (total), Wt %                       | 6.02   |
| Organic Carbon, Wt %                       | 2.36   |
| Hydrogen (total), Wt %                     | 0.18   |
| LIQUID PRODUCT PROPERTIES                  |        |
| Oil, Wt %                                  | 99.76  |
| Density, lb/gal                            | 7.778  |
| Gravity, API                               | 20.0   |
| Ash, Wt %                                  |        |
| PRODUCT GAS PROPERTIES                     |        |
| Water Vapor, lbs/MSCF (dry)                | 6.6    |
| Oil, lbs/MSCF (dry)**                      | 0.006  |
| Analysis (dry)                             |        |
| CO <sub>2</sub> , Vol %                    | 27.5   |
| O <sub>2</sub> , Vol %                     | 0.3    |
| N <sub>2</sub> + Argon, Vol %              | 61.2   |
| CH <sub>4</sub> , Vol %                    | 1.6    |
| CO, Vol %                                  | 3.2    |
| H <sub>2</sub> , Vol %                     | 4.6    |
| Other, Vol %                               | 1.6    |
| Gross Heating Value (calc), Btu/SCF        | 85.2   |
| Carbon (Total), lbs/MSCF (dry)             | 17.3   |
| Hydrogen (Total), lbs/MSCF (dry)           | 0.63   |
| YIELDS AND BALANCES                        |        |
| Oil Collected, Vol % RSFA                  | 86.0   |
| Oil in Gas**, Vol % RSFA                   | 0.02   |
| Oil in Spent Shale, Vol % RSFA             | 0.9    |
| Total Oil Meas., Vol % RSFA                | 86.9   |
| Carbonate Decomposition, %                 | 38.0   |
| Water Recovered, lb/ton RS                 | 77.9   |
| Ash Balance, % - As Measured               | -      |
| Ash Balance, % - Assumed                   | RS 100 |
| Overall Balance, %                         | 99.4   |
| Carbon Balance, % - Organic                | 101.1  |
| Carbon Balance, % - Total                  | 100.8  |
| Hydrogen Balance, % - Organic              | 103.5  |
| Hydrogen Balance, % - Total                | 103.4  |
| Water Balance, %                           | 93.4   |
| MISCELLANEOUS                              |        |
| Avg. Retort ΔP, in H <sub>2</sub> O/ft     | 0.40   |
| ΔP Above Air Dist., in H <sub>2</sub> O/ft | 0.42   |
| NaCl Soln., Wt %                           | -      |
| NaCl Rate, gal/ton RS                      | -      |

Comments: *Operational General, NO 2 star header stopped during latter part of run because for very short time. Bayonet found on spent shale, shale shatterly character. There may be only*

\*Measured Recycle + Dilution Gas  
 \*\* Oil Mist + Condensibles to 75 OF 35 bayonets left on A/D.  
 \*\*\* Rates are for moisture-free raw shale. All shale analyses are on a moisture-free basis.

Signed Earl F. Turner

DATE April 14, 1967

YIELDS

|      |          |        |          |        |          |        |          |
|------|----------|--------|----------|--------|----------|--------|----------|
| FAY  | 8.604 01 | DRYGAS | 5.948 03 | MISTFA | 1.935-02 |        |          |
| H2   | 2.736 02 | OTHER  | 9.517 01 | UNRETO | 8.483-01 | CH4    | 9.517 01 |
| O2   | 1.784 01 | SSY    | 8.144 01 | CO     | 1.903 02 | CO2DEC | 3.799 01 |
| MH2O | 7.792 01 | CO2    | 1.635 03 | OILCOL | 2.159 01 |        |          |

METERED GAS RATES

|       |          |     |          |        |          |     |          |
|-------|----------|-----|----------|--------|----------|-----|----------|
| RECG  | 1.446 04 | DIL | 0.000 00 | WVENTC | 7.150 03 | AIR | 4.600 03 |
| TRECG | 1.446 04 | TGF | 0.000 00 |        |          |     |          |

MOL WT & HEATING VALUE OF VENT GAS

|      |          |      |          |      |          |      |          |
|------|----------|------|----------|------|----------|------|----------|
| MWVG | 2.968 01 | NVGT | 5.070 02 | MWDG | 3.129 01 | GBTU | 8.523 01 |
|------|----------|------|----------|------|----------|------|----------|

COMBUSTION PRODUCTS

|      |          |     |          |        |          |  |  |
|------|----------|-----|----------|--------|----------|--|--|
| CO2C | 4.368 02 | COC | 1.752 02 |        |          |  |  |
| H2OC | 4.057 01 | CHR | 4.268 00 | COMBCP | 9.086 00 |  |  |

MATERIAL IN

|        |          |     |          |        |          |       |          |
|--------|----------|-----|----------|--------|----------|-------|----------|
| ORGCIN | 2.139 02 | RSR | 3.934 02 | ORH2IN | 2.313 01 | MATIN | 2.373 03 |
|--------|----------|-----|----------|--------|----------|-------|----------|

MATERIAL OUT

|        |          |        |          |        |          |        |          |
|--------|----------|--------|----------|--------|----------|--------|----------|
| ORGCVG | 3.672 01 | COKEC  | 3.595 01 | UNRETH | 2.348-01 |        |          |
| ORGCOL | 1.412 02 | CRH2VC | 8.300 00 | COKEH  | 1.967 00 | UNRETC | 2.510 00 |
| ORH2OL | 1.864 01 | ORCOLP | 6.604 01 | ORCVGP | 1.716 01 | ORCSSP | 1.798 01 |
| HCCVGP | 3.082 00 |        |          |        |          |        |          |

MATERIAL BALANCES

|       |          |       |          |      |           |       |           |
|-------|----------|-------|----------|------|-----------|-------|-----------|
| OVALL | 9.942 01 | ORGH2 | 1.035 02 |      |           |       |           |
| O2BAL | 9.892 01 | ASH   | 0.000 00 | TC   | 1.008 02  | WATER | 9.341 01  |
| ORGC  | 1.011 02 | TH2   | 1.034 02 | GASL | -3.791 02 | ASHS  | -1.000 00 |

HEAT IN

|       |          |       |          |       |          |        |          |
|-------|----------|-------|----------|-------|----------|--------|----------|
| QCOMB | 4.515 05 | QH2OC | 3.404 03 | QAIP  | 5.237 03 |        |          |
| QPROP | 0.000 00 | QOILC | 1.175 04 | QRCYL | 5.671 04 | QSUYIN | 5.342 05 |

HEAT OUT

|        |          |        |          |        |          |       |           |
|--------|----------|--------|----------|--------|----------|-------|-----------|
| QMCOD  | 2.166 05 | QKERC  | 8.924 04 | QH2OV  | 4.797 04 |       |           |
| QLIQ   | 4.687 03 | QOPGAS | 3.518 04 | QSS    | 1.117 05 | QGASL | -2.473 03 |
| LBLOSS | 0.000 00 | HETLOS | 3.126 04 | QSUMCT | 5.342 05 |       |           |

MISCELLANEOUS

|       |          |       |          |     |          |     |          |
|-------|----------|-------|----------|-----|----------|-----|----------|
| ORCSS | 2.361 00 | VPOIL | 6.353-03 | TCL | 4.251 03 | VPY | 6.580 00 |
| WCG   | 1.215 01 | PROP  | 0.000 00 |     |          |     |          |

RIF 92 | RUN NO. | C-27-1 | STARTED | 4-8-67 | CALC. ON | 4-11-67

101 | 906 | 62 | -1 | 21723 09  
 H<sub>2</sub>O, wt% | Oil, wt% | °F | (1) | Rate, lbs/Hr

RAW SHALE  
BAROMETR  
PRESSU  
AND  
OFFG  
TEMPERATU

2501 | 108 | 1706 | 55022  
 Oil, gal/T | Gas+L, wt% | CO<sub>2</sub>, wt% | Retort XS, ft<sup>2</sup>

6809 | 1505 | 1053 | 24010 | 139  
 Ash, wt% | Carbon, wt% | H<sub>2</sub>, wt% | Bar. Press, " Hg | Offgas Temp, °F

838.7 | 100 | 131 | 123 | 0014 | 0  
 Chart Reading | Meter Factor | Temp, °F | Press, "H<sub>2</sub>O gauge | Moist, lbs/Mscf | Heat Loss, Btu/Hr

AIR

266505 | 100 | 250 | 72 | 000 | 000  
 Recycle Ch. Read | Meter Factor | Temp, °F | Press, "H<sub>2</sub>O gauge | Tot Gas Ch. Read | Meter Factor

RECYCLE A  
TOTAL GAS

000 | 000 | 0 | 0  
 Dil Gas Ch. Read | Meter Factor | Temp, °F | Press, "H<sub>2</sub>O gauge

DILUTIO  
GAS

000 | 0 | 0 | 21904 | 000  
 C<sub>3</sub> Rotometer R. | Temp, °F | Press, "H<sub>2</sub>O gauge | Water added, lbs/Hr | Nucl. Agent, lb/Hr

PROPANE, WM  
& NUCLEATI  
AGENT

004 | 001 | 002 | 000  
 H<sub>2</sub>O, wt% | Oil, wt% | Gas, wt% | Rate, lbs/Hr

SPENT  
SHALE

1304 | 8406 | 6002 | 0018 | 369  
 CO<sub>2</sub>, wt% | Ash, wt% | Carbon, wt% | H<sub>2</sub>, wt% | Temp, °F

182406 | 8401 | 1101 | 70778 | 35005  
 Dry Oil, lbs/Hr | Carbon, wt% | H<sub>2</sub>, wt% | Den, lbs/gal | Water, lbs/Hr

LIQUID  
PRODUCT

133804 | 100 | 257 | 000 | 000 | 0 | 1203  
 Vent + Dil Gas Chart Reading | Meter Factor | Temp, °F | Moist, lbs/Mscf | Mist, lbs/Mscf (2) | Carbon, lbs/Mscf

VENT +  
DILUTIO  
GAS,  
VENT PU  
GAS, AN  
TOP SEA  
GAS

0 | 2705 | 003 | 6102 | 106 | 302 | 406  
 (3) CO<sub>2</sub>, vol% | O<sub>2</sub>, vol% | N<sub>2</sub>, vol% | CH<sub>4</sub>, vol% | CO, vol% | H<sub>2</sub>, vol%

106 | 0063 | 2000  
 Others, vol% | H<sub>2</sub>, lbs/Mscf | V. Purge Ch. Reading

1083 | 167 | 175 | 75 | 503 | 907 | 3600  
 Meter Factor | Temp, °F | Press, "H<sub>2</sub>O gauge | Cond. Gas Exit Temp, °F | Dry Oil, gal/Hr | Water, lbs/Hr | Top Seal Gas Rate, SCFH

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).

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-8-67

Run No. C-1027-1

Sample Time: RS 1815; SS 2315

FISCHER ASSAY

RAW SHALE       SPENT SHALE

|               |             |                  |
|---------------|-------------|------------------|
| <u>24.9</u>   | <u>0.3</u>  | Gal/Ton          |
| <u>.910</u>   | <u>.901</u> | S.G., g/ml       |
| <u>9.5</u>    | <u>0.1</u>  | Oil, wt %        |
| <u>1.8</u>    | <u>0.4</u>  | Water, wt %      |
| <u>86.9</u>   | <u>99.3</u> | Sp. Shale, wt %  |
| <u>1.8</u>    | <u>0.2</u>  | Gas & Loss, wt % |
| <u>Slight</u> | <u>none</u> | COKING TENDENCY  |

RETORT SHALE MOISTURE

1.0 <sup>Est.</sup> wt %

RAW SHALE FISCHER ASSAY MOISTURE

0.73 wt %

MINERAL CO<sub>2</sub>

17.5       13.4      wt %

ASH (SHALE)

88.7       84.6      wt %

MOISTURE

0.31       0.11      wt %

CARBON

15.5       6.02      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<sub>2</sub>", "Carbon", and "Hydrogen". The "FA Moisture" is for the sample used for the Fischer Assay.

COMMENTS

DATE COMPLETED APR 11 1967

CHECKED BY PCP

LABORATORY ANALYSIS SHEET

ANVIL POINTS OIL SHALE RESEARCH CENTER

Date Sampled 4-2-67

Run No. C-107-1  
(210)

LIQUID PRODUCTS

D3 PUMPOUT

T3 PUMPOUT

|               | <u>1</u>    | <u>2</u> | <u>3</u> | <u>4</u> | <u>1</u> | <u>2</u> |
|---------------|-------------|----------|----------|----------|----------|----------|
| WATER, wt %   | <u>0.24</u> |          |          |          |          |          |
| GRAVITY, °API | <u>23.5</u> |          |          |          |          |          |

OIL ASH, wt %

DISTILLATION (See attached sheet - OSRC-24)

VENT PURGE PRODUCT

*Handwritten initials*

OIL WT, g 14.0

WATER VOL, ml 86.0

GRAVITY OIL, °API insufficient sample

VENT GAS

MAJOR COMPONENTS

C<sub>1</sub> thru C<sub>4</sub>, plus n-Pentane

|                 |             |       |
|-----------------|-------------|-------|
| CO <sub>2</sub> | <u>27.5</u> | vol % |
| O <sub>2</sub>  | <u>0.5</u>  | "     |
| N <sub>2</sub>  | <u>10.5</u> | "     |
| CH <sub>4</sub> | <u>1.3</u>  | "     |
| CO              | <u>3.2</u>  | "     |
| H <sub>2</sub>  | <u>4.1</u>  | "     |
| Ar              | <u>0.9</u>  | "     |
| Others          | <u>1.1</u>  | "     |

|  |               |       |
|--|---------------|-------|
| CH <sub>4</sub>  | <u>      </u> | vol % |
| C <sub>2</sub> H <sub>4</sub> -C <sub>2</sub> H <sub>6</sub> | <u>      </u> | "     |
| C <sub>3</sub> H <sub>8</sub>                                | <u>      </u> | "     |
| C <sub>3</sub> H <sub>6</sub>                                | <u>      </u> | "     |
| i C <sub>4</sub> H <sub>10</sub>                             | <u>      </u> | "     |
| n C <sub>4</sub> H <sub>10</sub>                             | <u>      </u> | "     |
| ∅C <sub>3</sub> H <sub>6</sub>                               | <u>      </u> | "     |
| n C <sub>5</sub> H <sub>12</sub>                             | <u>      </u> | "     |

CARBON, 12.5 lbs/MSCFDG

HYDROGEN, 1.1 lbs/MSCFDG

COMMENTS \_\_\_\_\_

DATE COMPLETED APR 11 1967

CHECKED BY [Signature]

OSRC-12B

(Revised 5/2/66)

# SCREEN ANALYSIS DATA SHEET (TY-LAB)

RUN NO. C 1027-1 SAMPLE NO. ONE DATE 7-8-67  
 UNIT # 3 Retort DESCRIPTION 74 10h  
 APPROX. SHALE SIZE \_\_\_\_\_ SHAKING TIME 10 min ANALYSIS BY S. M. N. Adams, L.L.P.  
 TOTAL SAMPLE WT. GROSS 61.7 - TARE 5.2 = NET 56.5

| SCREEN SIZE              |              |      | WEIGHTS    |           |                  |             |                  |                    |            |                 |           |
|--------------------------|--------------|------|------------|-----------|------------------|-------------|------------------|--------------------|------------|-----------------|-----------|
| SCREENS REQD.            | OPENING SIZE | MESH | GROSS LBS. | TARE LBS. | NET WT. RETAINED | SCREEN SIZE | D <sub>i</sub> * | 1/D <sub>i</sub>   | % RETAINED | CUM. % RETAINED | % PASSING |
|                          | 4.25         |      |            |           |                  | 4.25        |                  |                    |            |                 |           |
|                          | 3.00         |      |            |           |                  | 3.00        | (3.125)          | (0.3200)           |            |                 |           |
|                          | 2.50         |      |            |           |                  | 2.50        | (2.625)<br>2.750 | (0.3809)<br>0.3636 |            |                 |           |
|                          | 2.00         |      | 30.4       | 20.2      | 10.2             | 2.00        | 2.250            | 0.4444             | 18.05      |                 | 81.94     |
|                          | 1.50         |      | 48.0       | 23.5      | 24.5             | 1.50        | 1.750            | 0.5714             | 43.36      |                 | 38.58     |
|                          | 1.05         |      | 33.5       | 19.2      | 14.3             | 1.05        | (1.087)<br>1.275 | (0.9199)<br>0.7843 | 25.31      |                 | 13.27     |
|                          | 0.742        |      | 25.5       | 20.5      | 5.0              | 0.742       | 0.896            | 1.116              | 8.85       |                 | 4.42      |
|                          | 0.525        |      | 17.8       | 18.5      | 1.3              | 0.525       | 0.634            | 1.577              | 2.30       |                 | 2.12      |
|                          | 0.371        |      | 19.4       | 19.3      | .1               | 0.371       | 0.448            | 2.232              | 0.18       |                 | 1.94      |
|                          | 0.263        | 3    | 18.5       | 18.3      | .2               | 0.263       | 0.317            | 3.154              | 0.35       |                 | 1.59      |
|                          | 0.185        | 4    | 19.5       | 19.4      | .1               | 0.185       | 0.224            | 4.464              | 0.18       |                 | 1.41      |
|                          | 0.131        | 6    | 19.4       | 19.4      | 0                | 0.131       | 0.158            | 6.329              | 0.00       |                 | 1.41      |
|                          | 0.093        | 8    | 20.5       | 20.5      | 0                | 0.093       | 0.112            | 8.928              | 0.00       | 98.58           | 1.41      |
|                          | 0.065        | 10   | 19.2       | 19.3      | 0                | 0.065       |                  |                    | 0.00       |                 | 1.41      |
|                          | PAN          |      | 21.5       | 21.4      | .1               | PAN         |                  |                    | 1.06       |                 | 0.35      |
| TOTAL ON SCREENS AND PAN |              |      |            |           | 56.3             | LOSS        |                  |                    | 10.35      |                 | 0.00      |
| LOSS (BY DIFFERENCE)     |              |      |            |           | 1.2              | TOTAL       |                  |                    | 99.99      |                 |           |
| TOTAL SAMPLE WEIGHT      |              |      |            |           | 56.5             |             |                  |                    |            |                 |           |

JU3836

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

REMARKS: \_\_\_\_\_

|                      |         |                          |  |
|----------------------|---------|--------------------------|--|
| $\sum_{+8m}^m D_i$   | 1.58382 | $\sum_{+8m}^m X_i$       |  |
| $1/\sum_{+8m}^m D_i$ | 0.68461 | $\sum_{+8m}^m X_i / D_i$ |  |
| D <sub>a</sub>       | 1.43994 | $\sum_{+8m}^m X_i D_i$   |  |
| D <sub>v</sub>       | 1.60663 |                          |  |