

Fig. 135

2- 5-025 0.29

100-443887-100



TEMP = 17.5°C 32.1°F 17.5°C L.H.T = 40.5°C

54: oven temp=276°C SETPT=276°C LIMIT=405°C

27: 0VLY -TEMP=350°C SETPT=350°C LIMIT=405°C

4: 5-02 RUN

6372-2:2:1723-4-146

Fig. 136

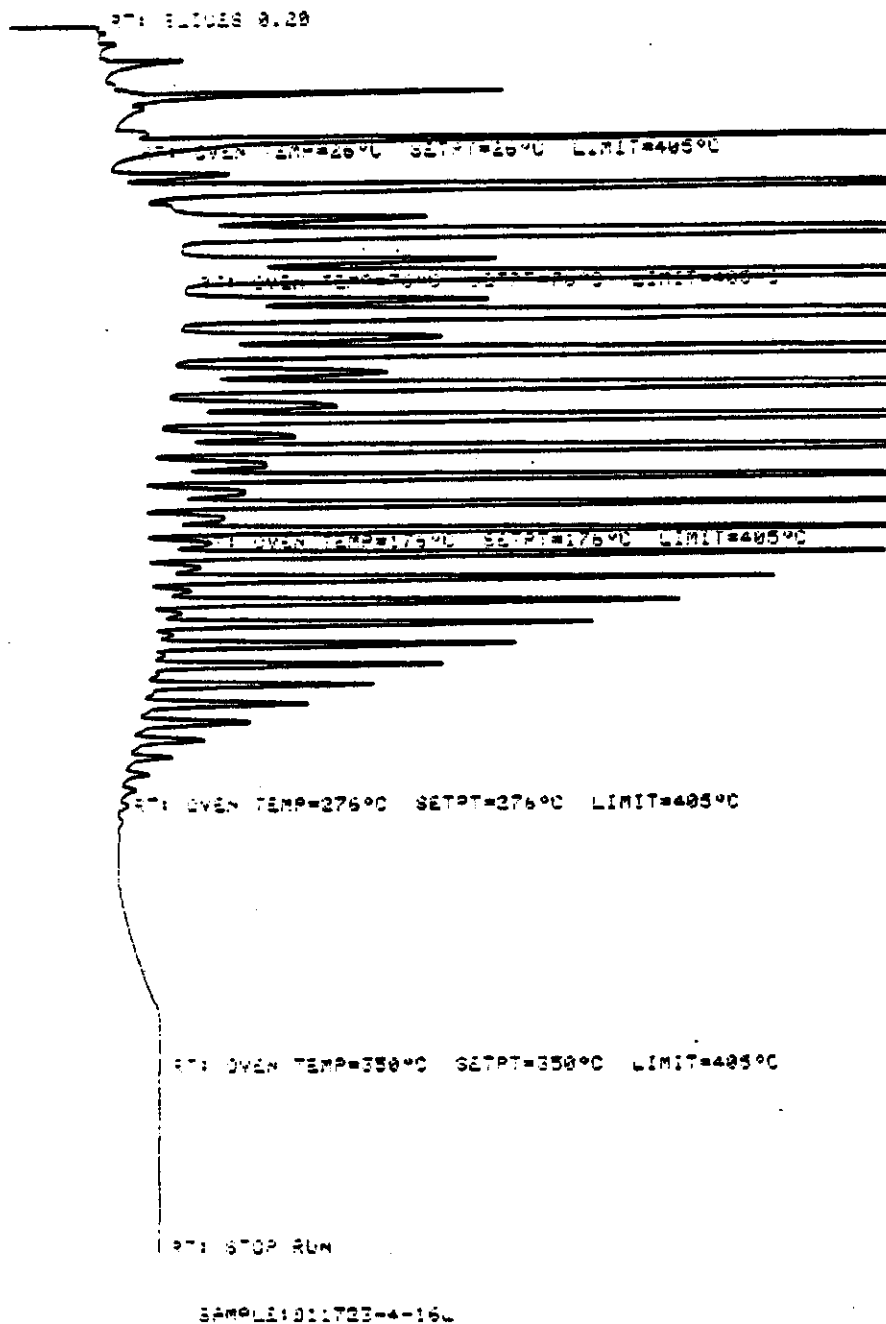


Fig. 137

4-: 6-1135 0.20

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14-00000

1/24 1250=276°C 6277=276°C LIMIT=405°C

11: 2424 1210=350° 32-27=350° LIMIT=405°

**SECRET**

9402-2: 21:723-4-18L

TABLE 22

## RESULT OF SYNGAS OPERATION

RUN NO. 11723-04

CATALYST CO/TH/X6+UCC-103 #11684-41C 80 CC 38.87 GM

FEED H2:CO:ARGON OF 50:50: 0 @ 400 CC/MN OR 300 GHSV

|                        | 11723-04-01 | 723-04-02 | 723-04-03 | 723-04-04 | 723-04-05 |
|------------------------|-------------|-----------|-----------|-----------|-----------|
|                        | =====       | =====     | =====     | =====     | =====     |
| FEED H2:CO:AR          | 50:50: 0    | 50:50: 0  | 50:50: 0  | 50:50: 0  | 50:50: 0  |
| HRS ON STREAM          | 18.8        | 25.9      | 43.7      | 49.7      | 67.0      |
| PRESSURE, PSIG         | 296         | 306       | 295       | 305       | 302       |
| TEMP. C                | 273         | 273       | 273       | 273       | 273       |
| FEED CC/MIN            | 400         | 400       | 400       | 400       | 400       |
| HOURS FEEDING          | 18.75       | 7.17      | 24.92     | 6.00      | 23.33     |
| EFFLNT GAS LITER       | 179.37      | 74.35     | 270.66    | 67.86     | 265.97    |
| GM AQUEOUS LAYER       | 40.19       | 17.45     | 60.66     | 14.55     | 56.60     |
| GM OIL                 | 12.82       | 4.29      | 14.90     | 2.83      | 11.01     |
| MATERIAL BALANCE       |             |           |           |           |           |
| GM ATOM CARBON %       | 90.28       | 92.24     | 90.63     | 93.28     | 92.63     |
| GM ATOM HYDROGEN %     | 95.67       | 99.72     | 98.62     | 100.80    | 99.98     |
| GM ATOM OXYGEN %       | 87.39       | 93.69     | 93.39     | 95.05     | 95.45     |
| RATIO CHX/(H2O+CO2)    | 1.0735      | 0.9652    | 0.9299    | 0.9548    | 0.9276    |
| RATIO X IN CHX         | 2.5017      | 2.5412    | 2.5816    | 2.5983    | 2.6274    |
| USAGE H2/CO PRODT      | 1.4365      | 1.4951    | 1.5824    | 1.6075    | 1.6140    |
| RATIO CO2/(H2O+CO2)    | 0.3503      | 0.3035    | 0.2608    | 0.2567    | 0.2537    |
| K SHIFT IN EFFLNT      | 0.27        | 0.22      | 0.18      | 0.17      | 0.17      |
| CONVERSION             |             |           |           |           |           |
| ON CO %                | 62.16       | 57.29     | 51.69     | 50.77     | 49.68     |
| ON H2 %                | 82.10       | 80.32     | 77.39     | 76.94     | 76.56     |
| ON CO+H2 %             | 72.42       | 69.26     | 65.08     | 64.36     | 63.63     |
| PRDT SELECTIVITY, WT % |             |           |           |           |           |
| CH4                    | 17.23       | 18.83     | 21.12     | 21.31     | 22.96     |
| C2 HC'S                | 5.17        | 4.68      | 5.02      | 5.23      | 5.51      |
| C3H8                   | 8.78        | 9.26      | 9.12      | 9.90      | 9.45      |
| C3H6=                  | 1.87        | 2.28      | 1.62      | 2.01      | 1.79      |
| C4H10                  | 7.48        | 7.68      | 7.26      | 7.88      | 7.52      |
| C4H8=                  | 4.22        | 4.31      | 3.53      | 4.13      | 3.41      |
| C5H12                  | 7.65        | 7.73      | 7.22      | 7.71      | 7.54      |
| C5H10=                 | 3.23        | 3.29      | 2.69      | 3.11      | 2.84      |
| C6H14                  | 6.77        | 6.76      | 6.34      | 6.72      | 6.59      |
| C6H12= & CYCLO'S       | 2.01        | 1.51      | 1.36      | 1.24      | 1.69      |
| C7+ IN GAS             | 13.08       | 13.01     | 12.06     | 13.26     | 12.66     |
| LIQ HC'S               | 22.52       | 20.67     | 22.65     | 17.50     | 18.04     |
| TOTAL                  | 100.00      | 100.00    | 100.00    | 100.00    | 100.00    |

|                       |        |        |        |        |           |
|-----------------------|--------|--------|--------|--------|-----------|
| SUB-GROUPING          |        |        |        |        |           |
| C1 -C4                | 44.75  | 47.04  | 47.68  | 50.46  | 50.64     |
| C5 -420 F             | 47.71  | 45.97  | 44.66  | 43.62  | 43.26     |
| 420-700 F             | 6.66   | 6.62   | 7.25   | 5.39   | 5.55      |
| 700-END PT            | 0.88   | 0.38   | 0.41   | 0.53   | 0.55      |
| C5+-END PT            | 55.25  | 52.96  | 52.32  | 49.54  | 49.36     |
| ISO/NORMAL MOLE RATIO |        |        |        |        |           |
| C4                    | 0.0617 | 0.0522 | 0.0387 | 0.0438 | 0.0392    |
| C5                    | 0.1139 | 0.1067 | 0.0869 | 0.0946 | 0.0845    |
| C6                    | 0.1259 | 0.1148 | 0.0995 | 0.1009 | 0.0965    |
| C4=                   | 0.2208 | 0.2117 | 0.1969 | 0.1928 | 0.1955    |
| PARAFFIN/OLEFIN RATIO |        |        |        |        |           |
| C3                    | 4.4919 | 3.8766 | 5.3726 | 4.7003 | 5.0395    |
| C4                    | 1.7103 | 1.7211 | 1.9830 | 1.8436 | 2.1287    |
| C5                    | 2.3029 | 2.2849 | 2.6080 | 2.4098 | 2.5828    |
| SCHULZ-FLORY DISTRBTN |        |        |        |        |           |
| ALPHA (EXP(SLOPE))    | 0.7627 |        | 0.7427 |        | 0.7411    |
| RATIO CH4/(1-A)**2    | 3.0595 |        | 3.1901 |        | 3.4257    |
| LIQ HC COLLECTION     |        |        |        |        |           |
| PHYS. APPEARANCE      | CLDY   |        | CLDY   |        | CLDY      |
| DENSITY               | 0.736  |        | 0.726  |        | .747 .746 |
| N, REFRACTIVE INDEX   | 1.4152 |        | 1.4156 |        | 1.4156    |
| SIMULT'D DISTILATN    |        |        |        |        |           |
| 10 WT % @ DEG F       | 254    |        | 256    |        | 256       |
| 16                    | 259    |        | 264    |        | 283       |
| 50                    | 378    |        | 383    |        | 383       |
| 84                    | 528    |        | 528    |        | 533       |
| 90                    | 583    |        | 575    |        | 593       |
| RANGE(16-84 %)        | 269    |        | 264    |        | 250       |
| WT % @ 420 F          | 66.50  | 66.15  | 66.15  | 66.17  | 66.17     |
| WT % @ 700 F          | 96.08  | 98.18  | 98.18  | 96.95  | 96.95     |

TABLE 23

## RESULT OF SYNGAS OPERATION

RUN NO. 11723-04  
 CATALYST CO/TH/X6+UCC-103 #11684-41C 80 CC 38.9 GM  
 FEED H2:CO:ARGON OF 50:50: 0 @ 400 CC/MN OR 300 GHSV

|                        | 11723-04-06 | 723-04-07 | 723-04-08 | 723-04-09 | 723-04-10 |
|------------------------|-------------|-----------|-----------|-----------|-----------|
|                        | =====       | =====     | =====     | =====     | =====     |
| FEED H2:CO:AR          | 50:50: 0    | 50:50: 0  | 50:50: 0  | 50:50: 0  | 50:50: 0  |
| HRS ON STREAM          | 74.5        | 91.0      | 98.5      | 115.0     | 139.0     |
| PRESSURE, PSIG         | 295         | 296       | 300       | 298       | 300       |
| TEMP. C                | 273         | 273       | 273       | 273       | 260       |
| FEED CC/MIN            | 400         | 400       | 400       | 400       | 400       |
| HOURS FEEDING          | 7.50        | 24.00     | 7.50      | 24.00     | 24.00     |
| EFFLNT GAS LITER       | 85.85       | 275.60    | 86.75     | 277.45    | 301.55    |
| GM AQUEOUS LAYER       | 17.99       | 57.56     | 18.03     | 57.68     | 57.90     |
| GM OIL                 | 3.23        | 10.34     | 3.10      | 9.92      | 9.90      |
| MATERIAL BALANCE       |             |           |           |           |           |
| GM ATOM CARBON %       | 92.10       | 93.21     | 94.31     | 94.16     | 90.44     |
| GM ATOM HYDROGEN %     | 98.95       | 99.41     | 99.01     | 99.35     | 96.26     |
| GM ATOM OXYGEN %       | 95.32       | 95.72     | 97.29     | 97.18     | 95.18     |
| RATIO CHX/(H2O+CO2)    | 0.9164      | 0.9347    | 0.9232    | 0.9226    | 0.8564    |
| RATIO X IN CHX         | 2.6402      | 2.6393    | 2.6647    | 2.6675    | 2.5724    |
| USAGE H2/CO PRODT      | 1.6155      | 1.6254    | 1.6181    | 1.6122    | 1.8919    |
| RATIO CO2/(H2O+CO2)    | 0.2530      | 0.2518    | 0.2574    | 0.2606    | 0.1194    |
| K SHIFT IN EFFLNT      | 0.17        | 0.16      | 0.16      | 0.17      | 0.07      |
| CONVERSION             |             |           |           |           |           |
| ON CO %                | 48.91       | 48.96     | 48.64     | 49.02     | 35.67     |
| ON H2 %                | 76.17       | 76.67     | 77.40     | 77.36     | 68.07     |
| ON CO+H2 %             | 63.03       | 63.26     | 63.37     | 63.57     | 52.37     |
| PRDT SELECTIVITY, WT % |             |           |           |           |           |
| CH4                    | 23.52       | 23.48     | 24.32     | 24.54     | 20.96     |
| C2 HC'S                | 5.58        | 5.64      | 5.74      | 5.75      | 5.10      |
| C3H8                   | 9.51        | 9.40      | 10.26     | 10.01     | 8.51      |
| C3H6=                  | 1.62        | 1.79      | 1.63      | 1.63      | 2.49      |
| C4H10                  | 7.59        | 7.58      | 8.01      | 7.99      | 7.07      |
| C4H8=                  | 3.47        | 3.38      | 3.41      | 3.34      | 4.55      |
| C5H12                  | 7.49        | 7.57      | 7.48      | 7.63      | 6.83      |
| C5H10=                 | 2.64        | 2.76      | 2.75      | 2.87      | 3.44      |
| C6H14                  | 6.84        | 6.72      | 6.85      | 6.94      | 6.32      |
| C6H12= & CYCLO'S       | 1.21        | 1.46      | 1.13      | 1.27      | 1.61      |
| C7+ IN GAS             | 13.69       | 13.67     | 12.54     | 12.20     | 12.92     |
| LIQ HC'S               | 16.85       | 16.54     | 15.88     | 15.82     | 20.21     |
| TOTAL                  | 100.00      | 100.00    | 100.00    | 100.00    | 100.00    |

|                       |        |        |        |        |        |
|-----------------------|--------|--------|--------|--------|--------|
| SUB-GROUPING          |        |        |        |        |        |
| C1 -C4                | 51.28  | 51.28  | 53.37  | 53.26  | 48.68  |
| C5 -420 F             | 42.17  | 42.30  | 41.12  | 41.24  | 43.58  |
| 420-700 F             | 5.95   | 5.84   | 4.99   | 4.97   | 7.11   |
| 700-END PT            | 0.59   | 0.58   | 0.53   | 0.53   | 0.63   |
| C5+-END PT            | 48.72  | 48.72  | 46.63  | 46.74  | 51.32  |
| ISO/NORMAL MOLE RATIO |        |        |        |        |        |
| C4                    | 0.0397 | 0.0373 | 0.0420 | 0.0403 | 0.0273 |
| C5                    | 0.0848 | 0.0816 | 0.0690 | 0.0678 | 0.0618 |
| C6                    | 0.0951 | 0.1014 | 0.0965 | 0.1010 | 0.0707 |
| C4=                   | 0.1949 | 0.2009 | 0.1994 | 0.1989 | 0.1422 |
| PARAFFIN/OLEFIN RATIO |        |        |        |        |        |
| C3                    | 5.6087 | 5.0086 | 6.0110 | 5.8555 | 3.2614 |
| C4                    | 2.1102 | 2.1606 | 2.2705 | 2.3094 | 1.4998 |
| C5                    | 2.7564 | 2.6636 | 2.6489 | 2.5847 | 1.9325 |
| SCHULZ-FLORY DISTRBTN |        |        |        |        |        |
| ALPHA (EXP(SLOPE))    |        | 0.7439 |        | 0.7373 | 0.7458 |
| RATIO CH4/(1- )**2    |        | 3.5799 |        | 3.5577 | 3.2440 |
| LIQ HC COLLECTION     |        |        |        |        |        |
| PHYS. APPEARANCE      |        | CLDY   |        | CLDY   | CLDY   |
| DENSITY               |        | 0.747  |        | 0.720  | 0.747  |
| N, REFRACTIVE INDEX   |        | 1.4163 |        | 1.4161 | 1.4179 |
| SIMULT'D DISTILATN    |        |        |        |        |        |
| 10 WT % @ DEG F       |        | 258    |        | 257    | 263    |
| 16                    |        | 299    |        | 298    | 302    |
| 50                    |        | 388    |        | 385    | 388    |
| 84                    |        | 545    |        | 526    | 540    |
| 90                    |        | 602    |        | 583    | 595    |
| RANGE(16-84 %)        |        | 246    |        | 228    | 238    |
| WT % @ 420 F          | 61.15  | 61.15  | 65.25  | 65.25  | 61.67  |
| WT % @ 700 F          | 96.48  | 96.48  | 96.68  | 96.68  | 96.88  |

TABLE 24

## RESULT OF SYNGAS OPERATION

RUN NO. 11723-04  
 CATALYST CO/TH/X6+UCC-103 #11684-41C 80 CC 38.87 GM ,41.7G AFTER RUN  
 FEED H2:CO:ARGON OF 50:50: 0 @ 400 CC/MN OR 300 GHSV

|                        | 11723-04-11 | 723-04-12 | 723-04-13 | 723-04-14 | 723-04-15 |
|------------------------|-------------|-----------|-----------|-----------|-----------|
|                        | =====       | =====     | =====     | =====     | =====     |
| FEED H2:CO:AR          | 50:50: 0    | 50:50: 0  | 50:50: 0  | 50:50: 0  | 50:50: 0  |
| HRS ON STREAM          | 146.5       | 163.0     | 170.5     | 186.0     | 192.0     |
| PRESSURE, PSIG         | 296         | 304       | 301       | 294       | 304       |
| TEMP. C                | 260         | 261       | 261       | 260       | 261       |
| FEED CC/MIN            | 400         | 400       | 400       | 400       | 400       |
| HOURS FEEDING          | 7.50        | 24.00     | 7.50      | 23.00     | 6.00      |
| EFFLNT GAS LITER       | 96.85       | 309.15    | 94.60     | 291.70    | 76.05     |
| GM AQUEOUS LAYER       | 18.16       | 58.11     | 18.23     | 55.90     | 14.86     |
| GM OIL                 | 3.28        | 10.49     | 3.30      | 10.12     | 2.72      |
| MATERIAL BALANCE       |             |           |           |           |           |
| GM ATOM CARBON %       | 92.15       | 92.96     | 92.41     | 92.11     | 93.59     |
| GM ATOM HYDROGEN %     | 98.02       | 97.54     | 97.64     | 97.26     | 99.11     |
| GM ATOM OXYGEN %       | 96.90       | 97.56     | 96.13     | 96.61     | 97.02     |
| RATIO CHX/(H2O+CO2)    | 0.8571      | 0.8623    | 0.8889    | 0.8659    | 0.8989    |
| RATIO X IN CHX         | 2.5745      | 2.5719    | 2.5682    | 2.5834    | 2.5586    |
| USAGE H2/CO PRODT      | 1.8888      | 1.8774    | 1.8895    | 1.8839    | 1.8947    |
| RATIO CO2/(H2O+CO2)    | 0.1210      | 0.1254    | 0.1235    | 0.1251    | 0.1213    |
| K SHIFT IN EFFLNT      | 0.07        | 0.07      | 0.07      | 0.07      | 0.07      |
| CONVERSION             |             |           |           |           |           |
| ON CO %                | 35.34       | 35.54     | 36.64     | 36.07     | 37.03     |
| ON H2 %                | 67.32       | 68.02     | 69.13     | 68.71     | 69.53     |
| ON CO+H2 %             | 51.82       | 52.18     | 53.33     | 52.83     | 53.74     |
| PRDT SELECTIVITY, WT % |             |           |           |           |           |
| CH4                    | 21.28       | 21.04     | 20.70     | 21.41     | 19.88     |
| C2 HC'S                | 5.17        | 5.29      | 5.34      | 5.42      | 5.00      |
| C3H8                   | 8.40        | 8.40      | 8.45      | 8.61      | 9.30      |
| C3H6=                  | 2.34        | 2.34      | 2.83      | 2.43      | 2.52      |
| C4H10                  | 6.74        | 6.72      | 7.16      | 6.77      | 7.30      |
| C4H8=                  | 4.09        | 4.17      | 4.52      | 4.03      | 4.43      |
| C5H12                  | 6.61        | 6.59      | 6.62      | 6.51      | 6.81      |
| C5H10=                 | 3.42        | 3.31      | 2.29      | 2.58      | 3.46      |
| C6H14                  | 6.20        | 6.19      | 7.05      | 7.00      | 6.73      |
| C6H12= & CYCLO'S       | 1.61        | 2.02      | 1.98      | 1.62      | 0.04      |
| C7+ IN GAS             | 12.91       | 12.90     | 12.54     | 12.62     | 13.90     |
| LIQ HC'S               | 21.24       | 21.01     | 20.53     | 21.00     | 20.63     |
| TOTAL                  | 100.00      | 100.00    | 100.00    | 100.00    | 100.00    |



|                       |        |        |        |           |        |
|-----------------------|--------|--------|--------|-----------|--------|
| SUB-GROUPING          |        |        |        |           |        |
| C1 -C4                | 48.01  | 47.98  | 49.00  | 48.67     | 48.43  |
| C5 -420 F             | 43.10  | 43.23  | 42.24  | 42.36     | 42.70  |
| 420-700 F             | 7.88   | 7.80   | 7.63   | 7.80      | 7.69   |
| 700-END PT            | 1.01   | 1.00   | 1.14   | 1.17      | 1.18   |
| C5+-END PT            | 51.99  | 52.02  | 51.00  | 51.33     | 51.57  |
| ISO/NORMAL MOLE RATIO |        |        |        |           |        |
| C4                    | 0.0314 | 0.0307 | 0.0466 | 0.0409    | 0.0312 |
| C5                    | 0.0577 | 0.0560 | 0.0642 | 0.0565    | 0.0595 |
| C6                    | 0.0742 | 0.0696 | 0.2299 | 0.2223    | 0.0743 |
| C4=                   | 0.1389 | 0.1411 | 0.1593 | 0.1436    | 0.1469 |
| PARAFFIN/OLEFIN RATIO |        |        |        |           |        |
| C3                    | 3.4262 | 3.4227 | 2.8507 | 3.3747    | 3.5230 |
| C4                    | 1.5920 | 1.5565 | 1.5309 | 1.6201    | 1.5894 |
| C5                    | 1.8773 | 1.9341 | 2.8079 | 2.4483    | 1.9110 |
| SCHULZ-FLORY DISTRBTN |        |        |        |           |        |
| ALPHA (EXP(SLOPE))    |        | 0.7656 |        | 0.7680    |        |
| RATIO CH4/(1-A)**2    |        | 3.8293 |        | 3.9789    |        |
| LIQ HC COLLECTION     |        |        |        |           |        |
| PHYS. APPEARANCE      |        | CLDY   |        | CLDY      |        |
| DENSITY               |        | 0.737  |        | .753 .755 |        |
| N, REFRACTIVE INDEX   |        | 1.4191 |        | 1.4202    |        |
| SIMULT'D DISTILATN    |        |        |        |           |        |
| 10 WT % @ DEG F       |        | 272    |        | 270       |        |
| 16                    |        | 302    |        | 302       |        |
| 50                    |        | 410    |        | 410       |        |
| 84                    |        | 569    |        | 573       |        |
| 90                    |        | 627    |        | 643       |        |
| RANGE(16-84 %)        |        | 267    |        | 271       |        |
| WT % @ 420 F          | 58.15  | 58.15  | 57.29  | 57.29     | 57.00  |
| WT % @ 700 F          | 95.26  | 95.26  | 94.44  | 94.44     | 94.28  |

TABLE 25

## RESULT OF SYNGAS OPERATION

RUN NO. 11723-04  
 CATALYST CO/TH/X6+UCC-103 #11684-41C 80 CC 38.9 GM  
 FEED H2:CO:ARGON OF 50:50: 0 @ 400 CC/MN OR 300 GHSV

11723-04-16 723-04-17 723-04-18

=====

|                        |          |          |          |
|------------------------|----------|----------|----------|
| FEED H2:CO:AR          | 50:50: 0 | 50:50: 0 | 50:50: 0 |
| HRS ON STREAM          | 210.5    | 216.5    | 235.0    |
| PRESSURE, PSIG         | 295      | 301      | 288      |
| TEMP. C                | 260      | 261      | 261      |
| FEED CC/MIN            | 400      | 400      | 400      |
| HOURS FEEDING          | 24.50    | 6.00     | 24.50    |
| EFFLNT GAS LITER       | 310.15   | 74.35    | 308.35   |
| GM AQUEOUS LAYER       | 60.68    | 14.66    | 59.87    |
| GM OIL                 | 11.12    | 2.72     | 11.11    |
| MATERIAL BALANCE       |          |          |          |
| GM ATOM CARBON %       | 95.37    | 93.49    | 93.46    |
| GM ATOM HYDROGEN %     | 100.05   | 98.29    | 97.82    |
| GM ATOM OXYGEN %       | 97.49    | 95.65    | 96.90    |
| RATIO CHX/(H2O+CO2)    | 0.9379   | 0.9358   | 0.8982   |
| RATIO X IN CHX         | 2.5511   | 2.5487   | 2.5716   |
| USAGE H2/CO PRODT      | 1.8906   | 1.8912   | 1.8781   |
| RATIO CO2/(H2O+CO2)    | 0.1261   | 0.1252   | 0.1294   |
| K SHIFT IN EFFLNT      | 0.07     | 0.07     | 0.07     |
| CONVERSION             |          |          |          |
| ON CO %                | 38.10    | 38.19    | 37.21    |
| ON H2 %                | 70.67    | 70.77    | 70.08    |
| ON CO+H2 %             | 54.77    | 54.89    | 54.02    |
| PRDT SELECTIVITY, WT % |          |          |          |
| CH4                    | 19.66    | 19.58    | 21.16    |
| C2 HC'S                | 4.74     | 4.72     | 5.18     |
| C3H8                   | 8.95     | 8.91     | 8.25     |
| C3H6=                  | 2.50     | 2.49     | 2.43     |
| C4H10                  | 7.22     | 7.19     | 6.87     |
| C4H8=                  | 4.55     | 4.54     | 4.26     |
| C5H12                  | 6.70     | 6.67     | 6.48     |
| C5H10=                 | 2.71     | 2.70     | 3.24     |
| C6H14                  | 7.34     | 7.31     | 6.20     |
| C6H12= & CYCLO'S       | 1.66     | 1.65     | 1.49     |
| C7+ IN GAS             | 14.28    | 14.22    | 13.75    |
| LIQ HC'S               | 19.68    | 20.00    | 20.69    |
| TOTAL                  | 100.00   | 100.00   | 100.00   |

|                       |        |        |        |
|-----------------------|--------|--------|--------|
| SUB-GROUPING          |        |        |        |
| C1 -C4                | 47.63  | 47.44  | 48.16  |
| C5 -420 F             | 43.91  | 43.56  | 42.53  |
| 420-700 F             | 7.34   | 7.86   | 8.13   |
| 700-END PT            | 1.13   | 1.14   | 1.18   |
| C5+-END PT            | 52.37  | 52.56  | 51.84  |
| ISO/NORMAL MOLE RATIO |        |        |        |
| C4                    | 0.0296 | 0.0296 | 0.0331 |
| C5                    | 0.0638 | 0.0638 | 0.0627 |
| C6                    | 0.2252 | 0.2252 | 0.0814 |
| C4=                   | 0.1528 | 0.1528 | 0.1529 |
| PARAFFIN/OLEFIN RATIO |        |        |        |
| C3                    | 3.4116 | 3.4116 | 3.2385 |
| C4                    | 1.5306 | 1.5306 | 1.5553 |
| C5                    | 2.4002 | 2.4002 | 1.9474 |
| SCHULZ-FLORY DISTRBTN |        |        |        |
| ALPHA (EXP(SLOPE))    | 0.7670 |        | 0.7706 |
| RATIO CH4/(1- )**2    | 3.6202 |        | 4.0214 |
| LIQ HC COLLECTION     |        |        |        |
| PHYS. APPEARANCE      | CLDY   |        | CLDY   |
| DENSITY               | 0.729  |        | 0.741  |
| N, REFRACTIVE INDEX   | 1.4196 |        | 1.4197 |
| SIMULT'D DISTILATN    |        |        |        |
| 10 WT % @ DEG F       | 263    |        | 263    |
| 16                    | 303    |        | 305    |
| 50                    | 408    |        | 406    |
| 84                    | 577    |        | 577    |
| 90                    | 646    |        | 642    |
| RANGE(16-84 %)        | 274    |        | 272    |
| WT % @ 420 F          | 57.00  | 55.00  | 55.00  |
| WT % @ 700 F          | 94.28  | 94.28  | 94.28  |

TABLE 26

## RESULT OF SYNGAS OPERATION

RUN NO. 11677-03  
 CATALYST CO/TH/X6 +UCC-101 11684-3C 80CC 35.8GM (38.6 AFTER RUN +2.6G)  
 FEED H2:CO:ARGON OF 50:50: 0 @ 400 CC/MN OR 300 GHSV

| RUN & SAMPLE NO.       | 11677-03-01 | 677-03-05 | 677-03-07 | 677-03-09 | 677-03-11 |
|------------------------|-------------|-----------|-----------|-----------|-----------|
| FEED H2:CO:AR          | 50:50: 0    | 50:50: 0  | 50:50: 0  | 50:50: 0  | 50:50: 0  |
| HRS ON STREAM          | 23.0        | 70.9      | 94.9      | 118.9     | 143.4     |
| PRESSURE, PSIG         | 295         | 297       | 297       | 293       | 301       |
| TEMP. C                | 272         | 271       | 270       | 270       | 270       |
| FEED CC/MIN            | 400         | 400       | 400       | 400       | 400       |
| HOURS FEEDING          | 23.00       | 23.00     | 24.00     | 24.00     | 24.50     |
| EFFLNT GAS LITER       | 209.30      | 249.70    | 275.00    | 284.95    | 296.20    |
| GM AQUEOUS LAYER       | 59.13       | 65.52     | 69.17     | 58.07     | 59.23     |
| GM OIL                 | 23.83       | 26.40     | 26.50     | 22.83     | 24.36     |
| MATERIAL BALANCE       |             |           |           |           |           |
| GM ATOM CARBON %       | 82.63       | 94.04     | 94.89     | 95.73     | 96.51     |
| GM ATOM HYDROGEN %     | 78.23       | 95.23     | 97.80     | 92.48     | 93.04     |
| GM ATOM OXYGEN %       | 87.17       | 95.79     | 97.92     | 94.93     | 96.12     |
| RATIO CHX/(H2O+CO2)    | 0.8643      | 0.9514    | 0.9165    | 1.0259    | 1.0123    |
| RATIO X IN CHX         | 2.3018      | 2.3503    | 2.3853    | 2.4191    | 2.4342    |
| USAGE H2/CO PRODT      | 1.8562      | 1.9844    | 2.0136    | 2.0225    | 2.0185    |
| RATIO CO2/(H2O+CO2)    | 0.0926      | 0.0609    | 0.0543    | 0.0636    | 0.0667    |
| K SHIFT IN EFFLNT      | 0.03        | 0.02      | 0.02      | 0.03      | 0.03      |
| CONVERSION             |             |           |           |           |           |
| ON CO %                | 38.72       | 38.68     | 37.01     | 35.34     | 34.85     |
| ON H2 %                | 81.30       | 77.62     | 75.41     | 73.11     | 72.54     |
| ON CO+H2 %             | 59.43       | 58.27     | 56.50     | 53.90     | 53.35     |
| PROT SELECTIVITY, WT % |             |           |           |           |           |
| CH4                    | 13.56       | 14.14     | 16.03     | 17.70     | 18.58     |
| C2 HC'S                | 2.12        | 2.35      | 2.49      | 2.62      | 2.62      |
| C3H8                   | 1.85        | 1.99      | 1.99      | 2.20      | 2.20      |
| C3H6=                  | 2.74        | 2.87      | 2.76      | 3.03      | 3.11      |
| C4H10                  | 1.59        | 1.70      | 1.66      | 1.79      | 1.78      |
| C4H8=                  | 3.94        | 3.90      | 3.88      | 4.21      | 4.24      |
| C5H12                  | 2.07        | 2.05      | 2.02      | 2.20      | 2.06      |
| C5H10=                 | 3.22        | 3.28      | 4.10      | 3.56      | 3.38      |
| C6H14                  | 3.69        | 3.63      | 3.36      | 3.99      | 3.50      |
| C6H12= & CYCLO'S       | 3.34        | 4.85      | 3.46      | 3.92      | 3.65      |
| C7+ IN GAS             | 11.23       | 11.97     | 11.46     | 12.93     | 10.76     |
| LIQ HC'S               | 50.65       | 47.29     | 46.79     | 41.85     | 44.12     |
| TOTAL                  | 100.00      | 100.00    | 100.00    | 100.00    | 100.00    |

|                       |         |          |         |          |          |
|-----------------------|---------|----------|---------|----------|----------|
| SUB-GROUPING          |         |          |         |          |          |
| C1 -C4                | 29.80   | 26.94    | 28.81   | 31.55    | 32.53    |
| C5 -420 F             | 46.14   | 46.86    | 46.07   | 44.95    | 43.03    |
| 420-700 F             | 23.25   | 21.70    | 21.13   | 19.01    | 18.82    |
| 700-END PT            | 4.81    | 4.49     | 3.98    | 4.50     | 5.63     |
| C5+END PT             | 74.20   | 73.06    | 71.19   | 68.45    | 67.47    |
| ISO/NORMAL MOLE RATIO |         |          |         |          |          |
| C4                    | 0.2716  | 0.1913   | 0.1453  | 0.1272   | 0.1092   |
| C5                    | 0.4937  | 0.3226   | 0.2364  | 0.2085   | 0.1966   |
| C6                    | 1.7074  | 1.2078   | 1.0986  | 1.0447   | 0.9495   |
| C4+                   | 0.0533  | 0.0631   | 0.0634  | 0.0625   | 0.0616   |
| PARAFFIN/OLEFIN RATIO |         |          |         |          |          |
| C3                    | 0.6435  | 0.6638   | 0.6895  | 0.6912   | 0.6770   |
| C4                    | 0.3908  | 0.4198   | 0.4125  | 0.4097   | 0.4061   |
| C5                    | 0.6249  | 0.6082   | 0.4788  | 0.6016   | 0.5933   |
| SCHULZ-FLORY DISTRBTN |         |          |         |          |          |
| ALPHA (EXP(SLOPE))    |         | 0.8188   | 0.8180  | 0.8208   | 0.8314   |
| RATIO CH4/(1-A)**2    |         | 4.3060   | 4.8372  | 5.5158   | 6.5387   |
| LIQ HC COLLECTION     |         |          |         |          |          |
| PHYS. APPEARANCE      | GRN OIL | CLOY OIL | GRN OIL | CLOY OIL | CLOY OIL |
| DENSITY               |         | 0.765    | 0.765   | 0.765    | 0.768    |
| N, REFRACTIVE INDEX   |         | 1.4300   | 1.4294  | 1.4306   | 1.4311   |
| SIMULT'D DISTILATN    |         |          |         |          |          |
| 10 WT % @ DEG F       |         | 282      | 285     | 287      | 285      |
| 16                    |         | 304      | 306     | 308      | 305      |
| 50                    |         | 444      | 434     | 444      | 443      |
| 84                    |         | 645      | 633     | 654      | 671      |
| 90                    |         | 695      | 685     | 709      | 730      |
| RANGE(16-34 %)        |         | 341      | 327     | 346      | 366      |
| WT % @ 420 F          | 44.60   | 44.60    | 46.33   | 43.83    | 44.60    |
| WT % @ 700 F          | 90.50   | 90.50    | 91.50   | 89.25    | 87.25    |

TABLE 27 RESULT OF SYNGAS OPERATION

RUN NO. 11677-03  
 CATALYST CO/TH/X6 +UCC-101 11684-3C 80CC 35.8GM (38.6 AFTER RUN +2.8G)  
 FEED H2:CO:ARGON OF 50:50: 0 @ 400 CC/MN OR 300 GHSV

RUN & SAMPLE NO. 11677-03-13 677-03-17  
 =====

|                |          |          |
|----------------|----------|----------|
| FEED H2:CO:AR  | 50:50: 0 | 50:50: 0 |
| HRS ON STREAM  | 168.8    | 214.1    |
| PRESSURE, PSIG | 304      | 303      |
| TEMP. C        | 270      | 270      |

|                  |        |        |
|------------------|--------|--------|
| FEED CC/MIN      | 400    | 400    |
| HOURS FEEDING    | 25.42  | 22.25  |
| EFFLNT GAS LITER | 295.41 | 269.76 |
| GM AQUEOUS LAYER | 58.80  | 53.55  |
| GM OIL           | 21.81  | 25.07  |

|                     |        |        |
|---------------------|--------|--------|
| MATERIAL BALANCE    |        |        |
| GM ATOM CARBON %    | 91.57  | 97.09  |
| GM ATOM HYDROGEN %  | 89.64  | 96.58  |
| GM ATOM OXYGEN %    | 91.15  | 94.29  |
| RATIO CHX/(H2O+CO2) | 1.0142 | 1.0914 |
| RATIO X IN CHX      | 2.4274 | 2.4189 |
| *USAGE H2/CO PRODT  | 2.0369 | 2.0560 |
| RATIO CO2/(H2O+CO2) | 0.0592 | 0.0556 |
| K SHIFT IN EFFLNT   | 0.03   | 0.03   |

|            |       |       |
|------------|-------|-------|
| CONVERSION |       |       |
| ON CO %    | 34.69 | 36.25 |
| ON H2 %    | 71.71 | 71.93 |
| ON CO+H2 % | 53.00 | 54.04 |

|                        |       |       |
|------------------------|-------|-------|
| PRDT SELECTIVITY, WT % |       |       |
| CH4                    | 18.17 | 17.78 |
| C2 HC'S                | 2.75  | 2.54  |
| C3H8                   | 2.51  | 2.20  |
| C3H6=                  | 3.51  | 2.91  |
| C4H10                  | 2.10  | 1.75  |
| C4H8=                  | 4.10  | 3.69  |
| C5H12                  | 1.93  | 1.78  |
| C5H10=                 | 4.38  | 3.09  |
| C6H14                  | 3.61  | 3.24  |
| C6H12= & CYCLO'S       | 3.46  | 3.13  |
| C7+ IN GAS             | 13.43 | 10.74 |
| LIQ HC'S               | 40.04 | 47.16 |

|       |        |        |
|-------|--------|--------|
| TOTAL | 100.00 | 100.00 |
|-------|--------|--------|

|                       |         |         |
|-----------------------|---------|---------|
| SUB-GROUPING          |         |         |
| C1 -C4                | 33.14   | 30.86   |
| C5 -420 F             | 42.76   | 42.07   |
| 420-700 F             | 16.18   | 20.85   |
| 700-END PT            | 7.92    | 6.23    |
| C5+END PT             | 66.86   | 69.14   |
| ISO/NORMAL MOLE RATIO |         |         |
| C4                    | 0.1471  | 0.1122  |
| C5                    | 0.1678  | 0.1561  |
| C6                    | 1.0217  | 1.0011  |
| C4=                   | 0.0687  | 0.0706  |
| PARAFFIN/OLEFIN RATIO |         |         |
| C3                    | 0.6824  | 0.7207  |
| C4                    | 0.4937  | 0.4593  |
| C5                    | 0.4282  | 0.5622  |
| SCHULZ-FLORY DISTRBTN |         |         |
| ALPHA (EXP(SLOPE))    | 0.8457  | 0.8361  |
| RATIO CH4/(1-A)**2    | 7.6346  | 6.6188  |
| LIQ HC COLLECTION     |         |         |
| PHYS. APPEARANCE      | OIL SLD | OIL SLD |
| DENSITY               | 0.761   | 0.763   |
| N, REFRACTIVE INDEX   | 1.4338  | 1.4311  |
| SIMULT'D DISTILATN    |         |         |
| 10 WT % @ DEG F       | 296     | 295     |
| 16                    | 326     | 321     |
| 50                    | 474     | 457     |
| 84                    | 737     | 672     |
| 90                    | 809     | 734     |
| RANGE(16-84 %)        | 411     | 351     |
| WT % @ 420 F          | 39.83   | 42.60   |
| WT % @ 700 F          | 80.23   | 86.80   |

VII. Run 6 (11677-11) with Catalyst 6 (Co/Th/X<sub>4</sub>+UCC-103+UCC-101)

The additive X<sub>4</sub> was first used in Tenth Quarter Catalyst 9 (Run 10225-08), containing UCC-101, which was remarkably stable over the course of a 480-hour test; both the rate of deactivation and the rate of change in selectivity were one-quarter as great as those of previous catalysts with similar formulations but without the additive. X<sub>4</sub> was also tested with UCC-108 in Eleventh Quarter Catalyst 6 (Run 10112-22), which had some desirable properties but was not nearly as stable as Tenth Quarter Catalyst 9.

This catalyst was prepared in the same way as Catalyst 5 except with X<sub>4</sub> in place of X<sub>6</sub>, and contained 4.5 percent cobalt and 0.9 percent X<sub>4</sub>. It is to be compared with Catalyst 2, which had a similar formulation but without the additive, as well as with Tenth Quarter Catalyst 9 and Eleventh Quarter Catalyst 6.

Conversion, product selectivity, isomerization of the pentane, and percent olefins of the C<sub>4</sub>'s are plotted against time on stream in Figs. 138-141 for this run and in Figs. 142-145 and Figs. 146-149 for Runs 10225-08 and 10112-22 respectively. Simulated distillations of the C<sub>5</sub><sup>+</sup> product are plotted in Figs. 150-153. Carbon number product distributions are plotted in Figs. 154-164. Detailed material balances appear in Tables 28-32 for this catalyst and in Tables 33-40 and Tables 41-43 for Runs



10225-08 and 10112-22 respectively.

Because of difficulties with data from the early samples it is impossible to determine whether the conversion of this catalyst deactivated initially. After 100 hours on stream, however, it was exceptionally stable. If Samples 4 and 5 are disregarded, the syngas conversion declined only about two percentage points during the entire 12 days on stream, and during the last 8 days the conversion was 55 percent with no measurable deactivation. Catalyst 2 was almost as stable at 52 percent conversion. The initial conversion of the present catalyst was 70 percent as high as that of Catalyst 1, which contained 90 percent more cobalt and was tested at a higher temperature. The conversion of syngas by the Tenth Quarter Catalyst 9 (Run 10225-08), which contained almost 2.5 times as much cobalt, was only 75 percent initially and dropped to 55 percent by 480 hours on stream. The conversion of Eleventh Quarter Catalyst 6 (Run 10112-22), with the same cobalt content as Tenth Quarter Catalyst 9, dropped from an initial 73 percent to less than 55 percent by 120 hours on stream.

As with the other catalysts previously reported in this Quarter, the water gas shift activity was very low, with only 9 percent of the oxygen rejected as  $\text{CO}_2$  and a  $\text{H}_2:\text{CO}$  ratio of 1.9:1 --lower than that of any other cobalt catalyst tested to date except Catalysts 1 and 2.

The most notable property of this catalyst is its extraordinary stability. Tenth Quarter Catalyst 9 (Run 10225-08), which was the first test of the  $\text{X}_4$  additive, after an initial deactiva-

tion lost one percent syngas conversion every 35 hours during the last 15 days on stream. This deactivation rate, which was about one-fourth that of the reference catalyst (Tenth Quarter Catalyst 3, Run 10112-15, without  $X_4$ ), was remarkable enough. During the 12-day test of the present catalyst, the data indicate that the deactivation, if any, was immeasurably slow. From a least squares fit of data taken after 100 hours on stream, the conversion should increase by one percent every 666 hours on stream. If the 99.6 hour sample is included, the deactivation rate is one percentage point every 1100 hours. Catalyst 2 may not have been quite as stable. If the two data points after 120 hours on stream are used, that catalyst lost one percent conversion every 94 hours. However, all of these values are well within the error of measurement.

The product selectivity was extremely stable as well. Methane production was constant at about 13 percent; by a least squares analysis of all the data, it dropped from 14 to 13.2 percent; and during the last 7.5 days it increased from 13.17 percent at 99.6 hours on stream to 13.22 percent at 284.5 hours--these values also within the error of measurement. Prior to the data in this report, the best methane stability was with Tenth Quarter Catalyst 9 (Run 10225-08); its methane production, initially 15 percent, rose to 18 percent by 115 hours on stream and to 24 percent by 480 hours, a rate of increase of one percentage point every 55 hours. The methane production of Eleventh Quarter Catalyst 6 (Run 10112-22) increased by one percentage point every

23 hours. That of Catalyst 2 was fairly stable but at a higher level (17.8 percent).

As in the earlier test in Run 10225-08, the X<sub>4</sub> additive seems to increase the selectivity to C<sub>2</sub>-C<sub>4</sub> hydrocarbons; this is one of the few cobalt catalysts which produce more C<sub>2</sub>-C<sub>4</sub>'s than methane.

Also exceptionally stable was the yield of C<sub>5</sub><sup>+</sup> hydrocarbons, which was 69.7 percent initially and dropped only about one percentage point over the entire course of the test. The heavies product was constant as well, at about 2.7 percent of total hydrocarbons. Motor fuels, initially 67 percent, also dropped about one percentage point during the test. The selectivity of Tenth Quarter Catalyst 9 (Run 10225-08) was almost as high initially (C<sub>5</sub><sup>+</sup>'s 67 percent, motor fuels 65 percent), but dropped by one percentage point every 32 hours on stream. And as compared with Catalyst 2, the present catalyst has about the same stability and better selectivity.

The pentane product contained very little isopentane, less than with Tenth Quarter Catalyst 9 but typical of catalysts with close physical contact between the cobalt and the shape selective component.

Tenth Quarter Catalyst 9 also had a high and stable selectivity for butenes, which made up a constant 66 percent of the C<sub>4</sub> hydrocarbons. Catalysts with close contact between cobalt and SSC generally produce low C<sub>4</sub> olefins. The C<sub>4</sub> product of the present catalyst was higher in olefins than that of other similar

catalysts, such as Catalyst 2, but lower than that of Tenth Quarter Catalyst 9.

Aside from the usual excess of methane, the Schulz-Flory plots show a straight line distribution. No chromatograms are available from the simulated distillation; if available, they would probably show little isomerization of the liquid. Some samples of the liquid product contained wax, others did not.

This is an important catalyst primarily by reason of its exceptional stability; through the entire 12 day test there was no measurable deactivation. In addition, its selectivity to liquid products is well above average. Unlike the additive X<sub>6</sub> as tested in Catalyst 5, the X<sub>4</sub> in this catalyst seems to have had the same effect as in Tenth Quarter Catalyst 9 (Run 10225-08). These catalysts constitute a long step forward in stability, so much so that longer tests will be needed to obtain reliable data on deactivation rates.

# RUN 11677-11

1:1 H<sub>2</sub>:CO  
300 PSIG  
260°C

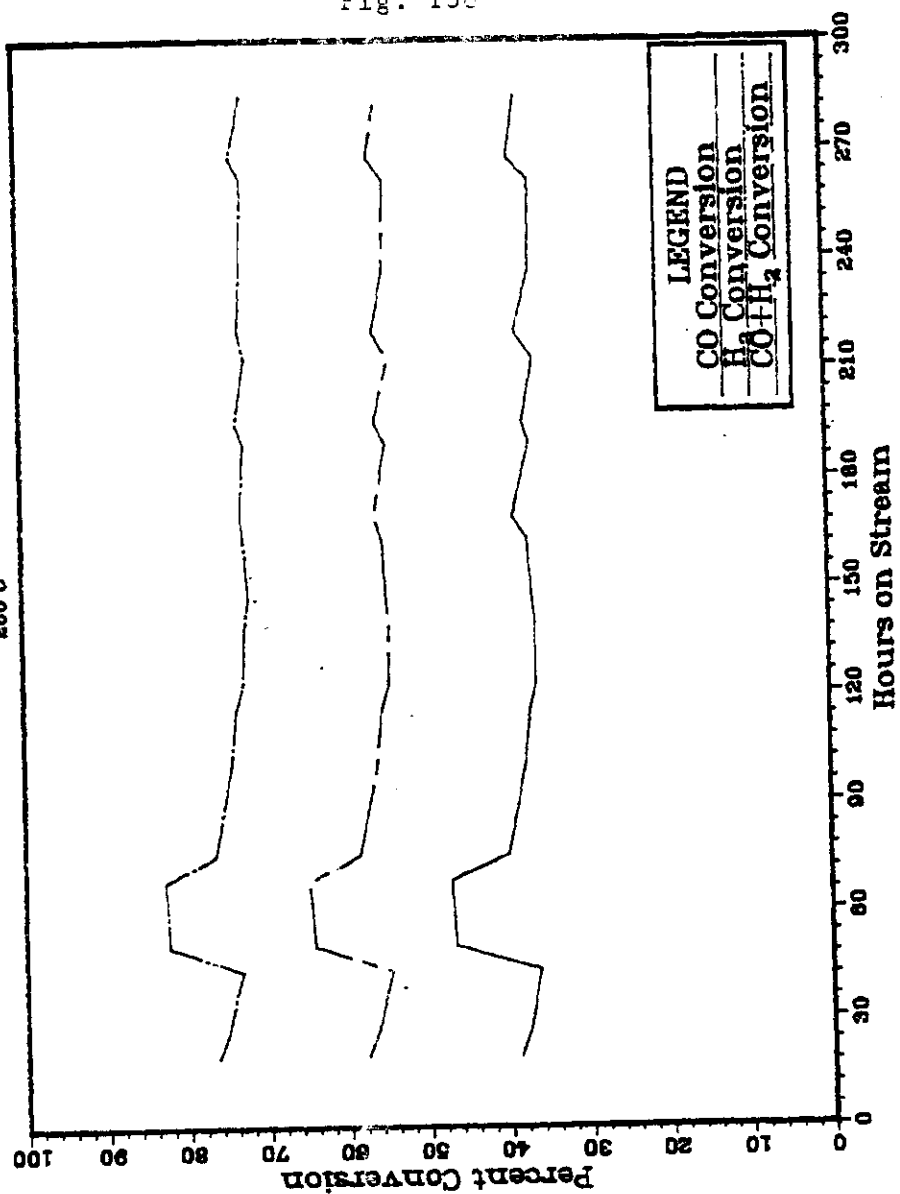


Fig. 138

# RUN 11677-11

1:1 H<sub>2</sub>:CO  
300 PSIG  
280°C

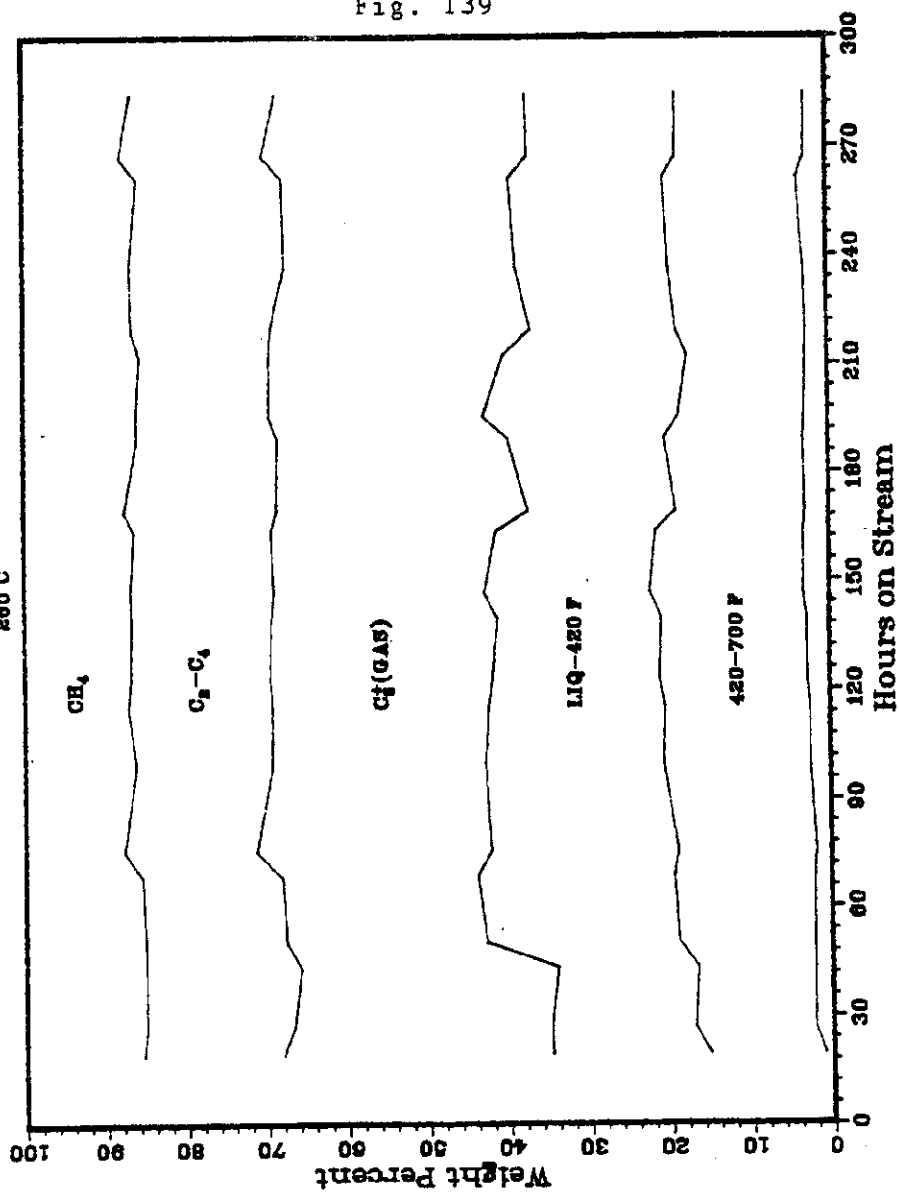
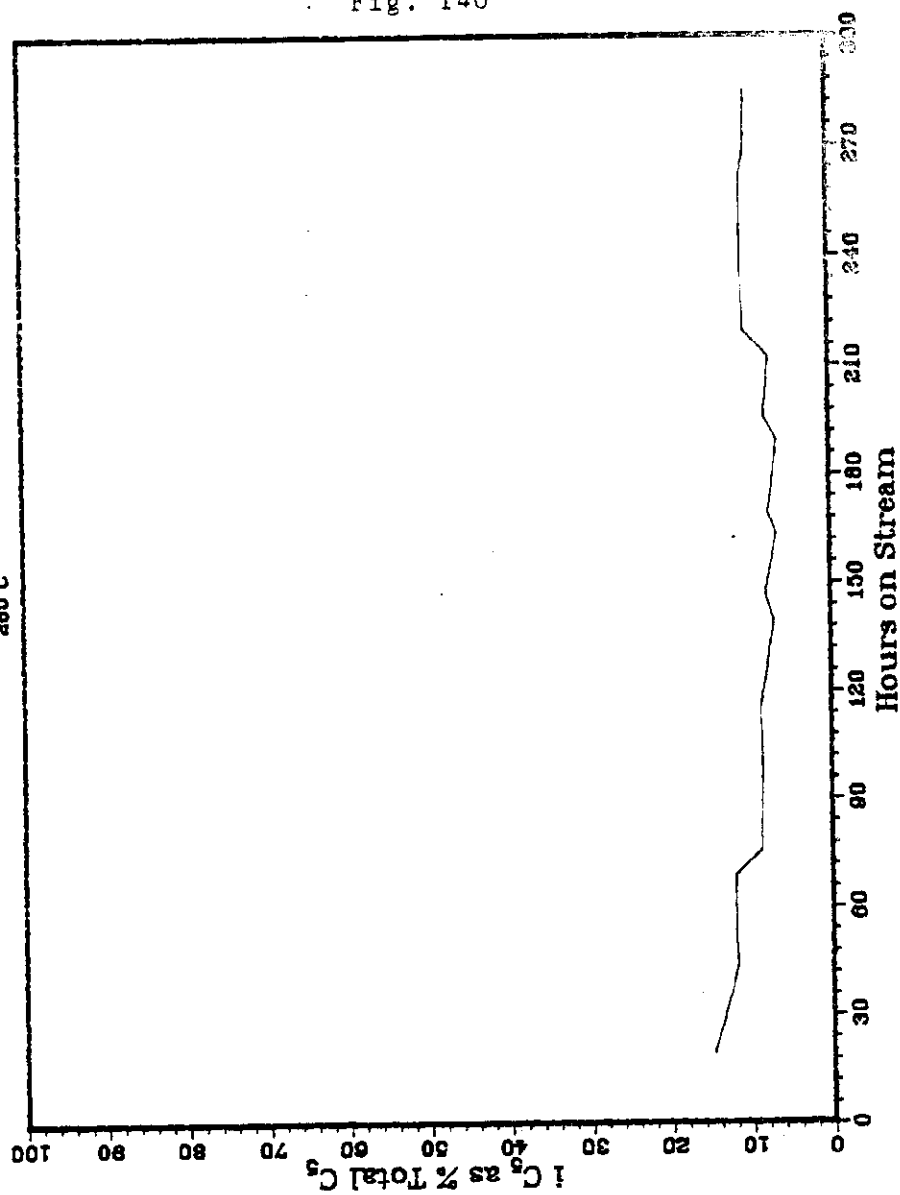


Fig. 139

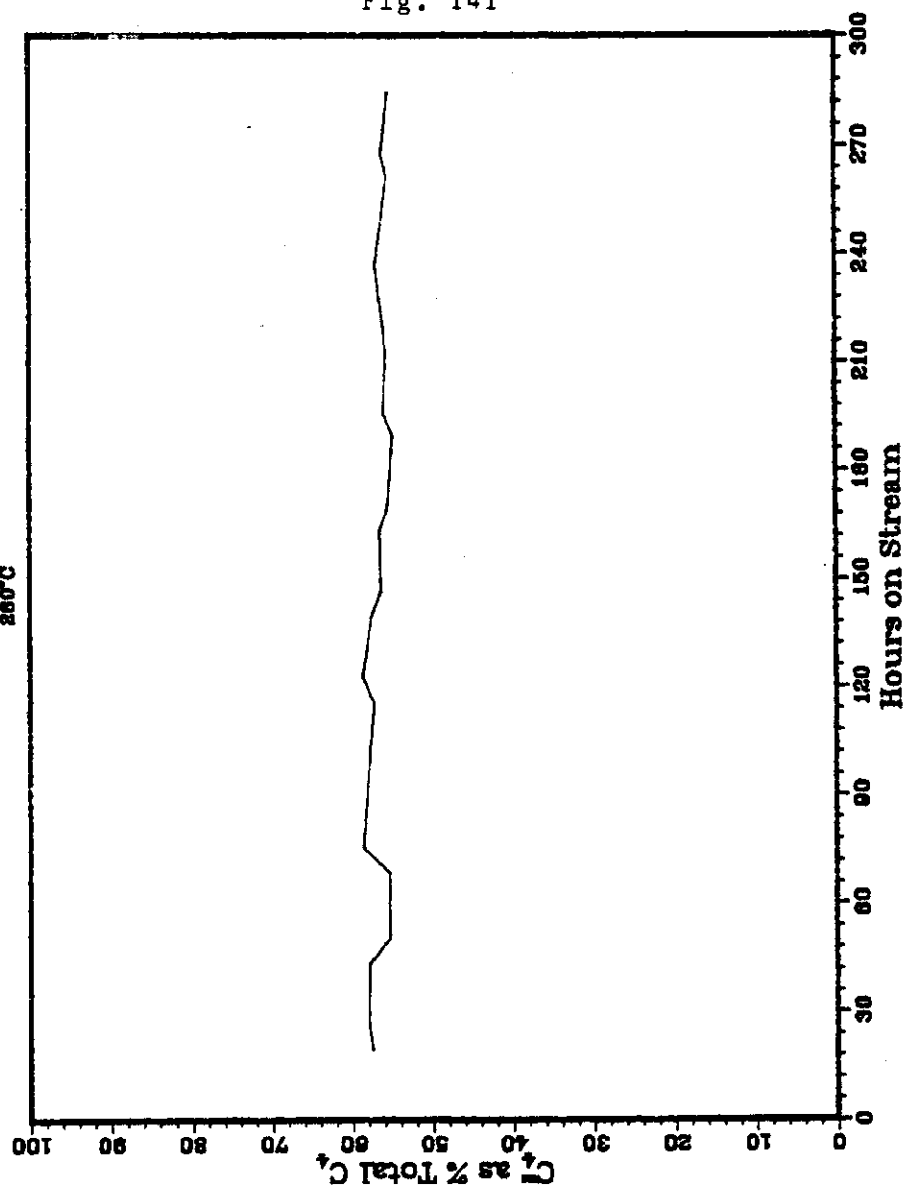
RUN 11677-11

1:1 H<sub>2</sub>:CO  
300 PSIG  
280°C



RUN 11677-11

1:1 H<sub>2</sub>:CO  
300 PSIG  
260°C





RUN 10225-08

341 H<sub>2</sub>CO  
200 PSIG  
270°C

