ChevronTexaco provides no warranties, either express or implied, as to the accuracy or validity of any of the work in this report. Anyone accessing or using the reports indemnifies and holds ChevronTexaco harmless against any liability that comes from using or relying on the information contained therein.

PERSONAL AND CONFIDENTIAL

HYDROCARBON SYNTHESIS
2001-2-P 11-8-55

THE TEXAS COMPANY

RESEARCH AND TECHNICAL DEPARTMENT

REPORT ON

HYDROCARBON SYNTHESIS

EFFECT OF REDUCTION TEMPERATURE ON SYNTHESIS CATALYST

RUNS 63, 64, 65, AND 66

Laboratory Montebello

Report No. 2001-2-P

Date November 8, 1955

PERSONAL AND CONFIDENTIAL

BRIEF OF PARTIAL REPORT

Laboratory Montebello
Date Approved November 8, 1955
Date Work Completed February 4, 1952

Experiment No. 2001
Partial Report No. 2
Subject: Hydrocarbon Synthesis

Subject: Hydrocarbon Synthesis: Effect of Reduction Temperature on Synthesis Catalyst

Object: (1) To determine whether the poor yields at the Carthage Hydrocol, Inc., plant at Brownsville, Texas, were due in part to methods of catalyst preparation. (2) To determine whether high reduction temperature could be used to speed the preparation of catalyst without affecting catalyst quality.

History: The yields at the Carthage Hydrocol, Inc., plant had never reached design level nor had they ever been as high as those obtained in pilot plants. It was desired to increase the capacity of the catalyst reduction facilities and one possibility was to use higher reduction temperatures.

Experimental Work: A run was made with the Montebello hydrocarbon synthesis reactor evaluating Bethlehem mill scale catalyst promoted, sized, and reduced at Brownsville. Three additional runs were made using Bethlehem mill scale catalysts reduced at different temperatures. During part of one run the effects of recycle/fresh feed ratio were investigated. Near the end of another run, an attempt was made to increase the promoter on the catalyst by the addition of anhydrous potassium carbonate.

Conclusions:

1. The mill scale catalyst treated and reduced at Brownsville exhibited no difference from mill scale catalysts prepared at Montebello.
2. Variation of the catalyst reduction temperature in the range of 650°F to 800°F had no effect on the quality of the catalyst.
3. Increasing the recycle/fresh feed ratio in the range of 0.06/1 to 2.0/1 increased the yields of saleable liquid products and suppressed the yields of methane and CO_2.
4. The addition of anhydrous potassium carbonate to the catalyst bed during a run had no effect on the synthesis reaction.

WLS-EW

(WEK-WAMcM)-WJC(2)-RWH-HDM(2)-RLSr(2)-duBE(2)
WMS-RP-CEL-GK-FHH-[redacted] JCW

PERSONAL AND CONFIDENTIAL

HYDROCARBON SYNTHESIS

PARTIAL REPORT NO. 2

Montebello Research Laboratory — Experiment No. 2001
Work Completed: February 4, 1952 — Report Approved: Nov. 8,1955

EFFECT OF REDUCTION TEMPERATURE ON SYNTHESIS CATALYST

RUNS 63, 64, 65, AND 66

INDEX

INDEX TO FIGURES

INDEX TO TABLES

PERSONAL AND CONFIDENTIAL

HYDROCARBON SYNTHESIS

PARTIAL REPORT NO. 2

Montebello Research Laboratory — Experiment No. 2001
Work Completed: February 4, 1952 — Report Approved: Nov. 8,1955

EFFECT OF REDUCTION TEMPERATURE ON SYNTHESIS CATALYST RUNS 63, 64, 65, AND 66

I. INTRODUCTION

Production at the Carthage Hydrocol, Inc., synthetic fuels plant at Brownsville, Texas, had not reached the design yield level, nor had it reached the levels obtained by various pilot units using the same catalyst base stock. It was believed possible that the method of catalyst preparation at Brownsville was at least partially responsible for the poor yields.

For this reason Montebello Laboratory made a run with a hydrocarbon synthesis reactor, evaluating Bethlehem mill scale catalyst promoted, sized, and reduced at Brownsville. All treatment prior to the synthesis operations was the same as at Brownsville.

It was desired to increase the capacity of the catalyst reduction facilities at Brownsville, and one possibility was to use higher reduction temperatures. In order to ascertain the time advantage to be gained by higher temperatures and also to determine any deleterious effects on catalyst activity, Montebello Laboratory made three runs with a synthesis reactor using catalysts reduced at different temperatures.[1]

[1] Detailed data on the catalyst reduction rate were presented in TDC 802-45-P.

During the latter part of one of the runs, the effect of recycle/fresh feed ratio was investigated by doubling the flow rate of recycle gas. The data were compared with other data from a run in which the recycle rate had been reduced to practically nothing. Extensive investigation of the effect of recycle/fresh feed ratio had not been made at Montebello because the facilities at the commercial plant at Brownsville were not flexible enough, anyhow, to allow much deviation from the design recycle ratio.

This report concerns Runs 63, 64, 65, and 66 made between October 19, 1951, and February 2, 1952.

II. EQUIPMENT AND MATERIALS

Runs 63, 64, 65, and 66 were made in Reactor No. 5S[1], a vessel 12.5 inches in diameter by 30 feet tall with a sparger at the bottom for better inlet gas distribution. For comparison purposes, some data are included from Run 55[a] made in Reactor No. 5C. That reactor was the same as No. 5S except that it had a 60-degree cone instead of a sparger at the bottom.

The synthesis gas feed was obtained by using the Texaco Synthesis Gas Generation Process with natural gas and oxygen in a 2-cubic-foot generator. A water-wash tower was used on the synthesis gas in all runs except No. 55.

The catalyst used in Run 63 was Bethlehem mill scale, sized, promoted, and reduced at Brownsville. It was shipped to

---

[1] For description and drawing, see TDC 802-50-P.
[a] Ibid.

TABLE I

SUMMARY OF DATA AND OPERATING CONDITIONS

Period	Hours on Stream	Average Catalyst Age, Hours	Fresh Feed Rate,[1] MSCFH	Recycle Ratio	Bed Depth, Feet	Space Velocity v/hr/v	Inlet Pressure psig	Conversion H_2 + CO Per Cent	Selectivity C_3+/C_1+ Per Cent	Activity Index[2]	Yield C_3+ lbs/MCF H_2+CO	BPD Brownsville Basis
63-0	0-96	48	15.7	0.97	20.6	1118	414	86.16	79.77	28.73	9.18	7221
-1	96-216	156	16.0	0.96	20.6	1152	413	84.87	78.05	27.84	8.73	6737
-2	216-336	276	16.2	0.99	19.3	1237	406	80.39	76.30	24.90	8.13	6148
64-0	0-106	53	15.2	1.05	18.2	1229	416	84.00	80.18	27.90	8.90	6930
-1	106-194	150	15.7	1.02	18.9	1226	416	82.40	78.56	26.41	8.51	6518
-2	194-290	242	15.5	1.08	19.7	1156	414	80.56	77.44	24.18	8.11	6148
-3	290-386	338	15.6	1.07	19.8	1156	413	79.15	76.29	23.15	7.84	5866
65-0	0-112	56	15.8	1.02	18.3	1281	416	85.10	78.44	29.59	8.80	6836
-1	112-232	172	15.5	1.05	18.8	1214	414	82.77	77.37	26.61	8.43	6446
-2	232-326	279	15.4	1.04	18.7	1222	410	79.05	75.67	23.73	7.80	5871
66-0	0-94	47	16.4	0.95	19.0	1272	404	83.06	80.04	27.50	8.81	6823
-1	94-207	150	15.7	0.97	18.7	1241	403	81.73	77.71	26.01	8.33	6310
-2	207-296	252	15.0	1.03	18.7	1179	403	80.59	75.40	24.45	8.10	6122
-3	296-416	356	14.3	1.07	18.6	1125	401	79.78	75.50	23.28	8.02	6003
-4	416-500	458	15.2	1.05	16.3	1369	398	72.84	74.83	20.94	7.03	5212
-5	500-619	560	15.0	2.09	8.2	2668	404	72.28	79.56	28.79	7.72	5819

[1] MSCFH = thousand standard cubic feet per hour, based on 60°F and 14.73 psia.

[2] Activity Index $= \sqrt{v/h/v} \log\left(\frac{100}{(100-\text{conversion})}\right)$

Montebello in sealed, stainless steel drums and loaded into the reactor in air-tight cans pressured with cylinder nitrogen. The nitrogen was obtained from Air Reduction Company.

The catalysts used in Runs 64, 65, and 66 also were received from Brownsville, but in the unreduced state. They were reduced in the Montebello reactor at, respectively, 730°F, 800°F, and 650°F average bed temperature.[1] Linde cylinder hydrogen was used for reducing the catalyst.

III. OPERATIONS

The average operating conditions are summarized in Table I, opposite.[2]

Run 63

The reduced catalyst for Run 63 was transferred from the stainless steel drums in which it was received from Brownsville to the reactor in 50-pound batches, using sealed cans pressured slightly with cylinder nitrogen. During the loading into the reactor, natural gas was circulated at 500°F and 75 psig. Analysis of the circulated gas at the beginning of the loading showed 0.11 per cent free oxygen. After the loading, the oxygen content was too low to be detected.

After 18 hours the reactor pressure was increased to 120 psi with natural gas and then to 215 psi with hydrogen. The circulated mixture was maintained at approximately 45 per cent hydrogen at 700°F for 24 hours before the fresh feed was cut in. This

---

[1] Reduction data are summarized in Tables IV, V, and VI in the Appendix. Analyses of catalysts are in the Appendix, Table III.

[2] Further details of the operating conditions are given in the daily average data sheets in the Appendix.

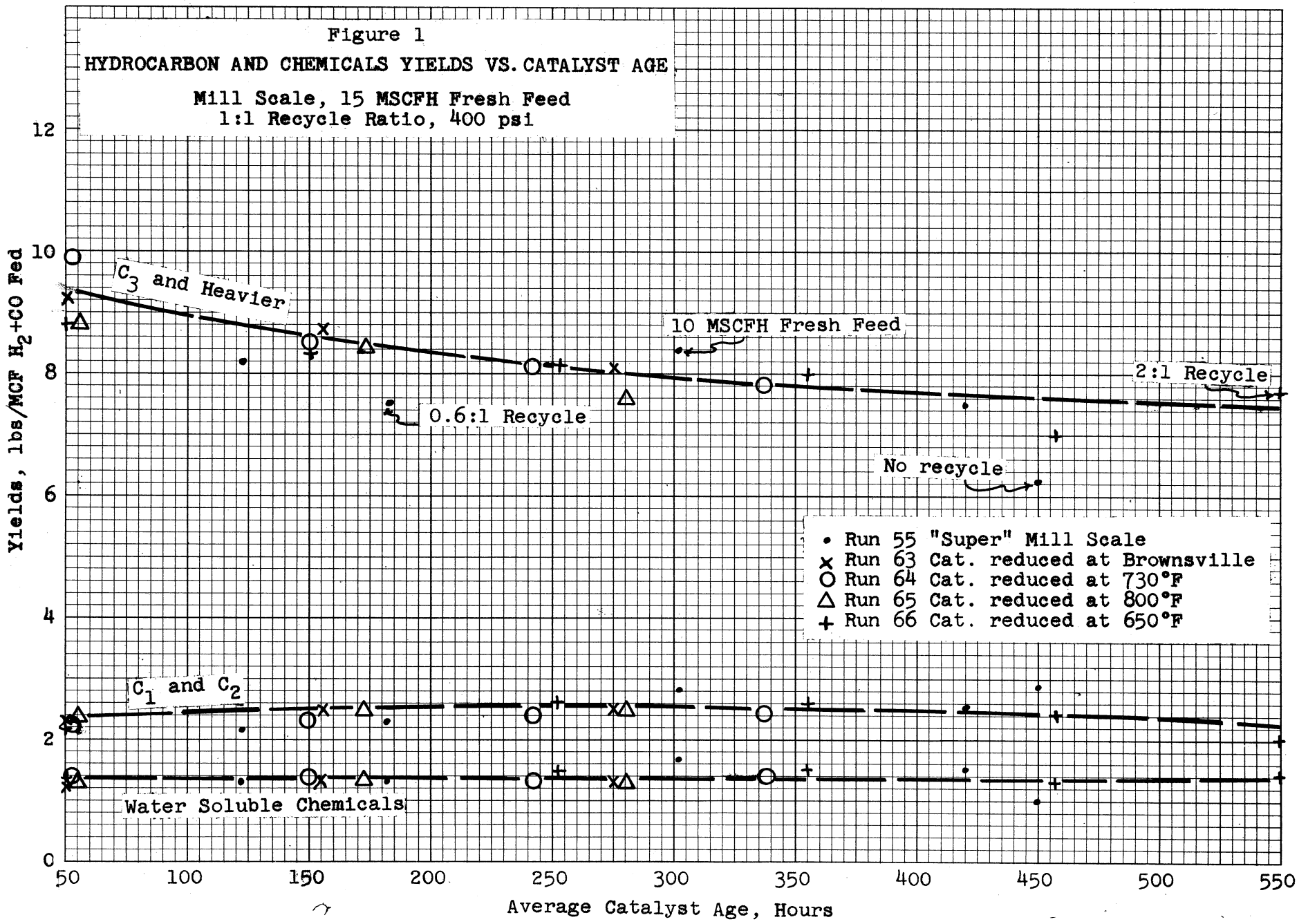
Figure 1
HYDROCARBON AND CHEMICALS YIELDS VS. CATALYST AGE
Mill Scale, 15 MSCFH Fresh Feed
1:1 Recycle Ratio, 400 psi
Yields, lbs/MCF H_2+CO Fed
Average Catalyst Age, Hours
C_3 and Heavier
C_1 and C_2
Water Soluble Chemicals
0.6:1 Recycle
10 MSCFH Fresh Feed
2:1 Recycle
No recycle
• Run 55 "Super" Mill Scale
× Run 63 Cat. reduced at Brownsville
○ Run 64 Cat. reduced at 730°F
△ Run 65 Cat. reduced at 800°F
+ Run 66 Cat. reduced at 650°F
0
2
4
6
8
10
12
50
100
150
200
250
300
350
400
450
500
550

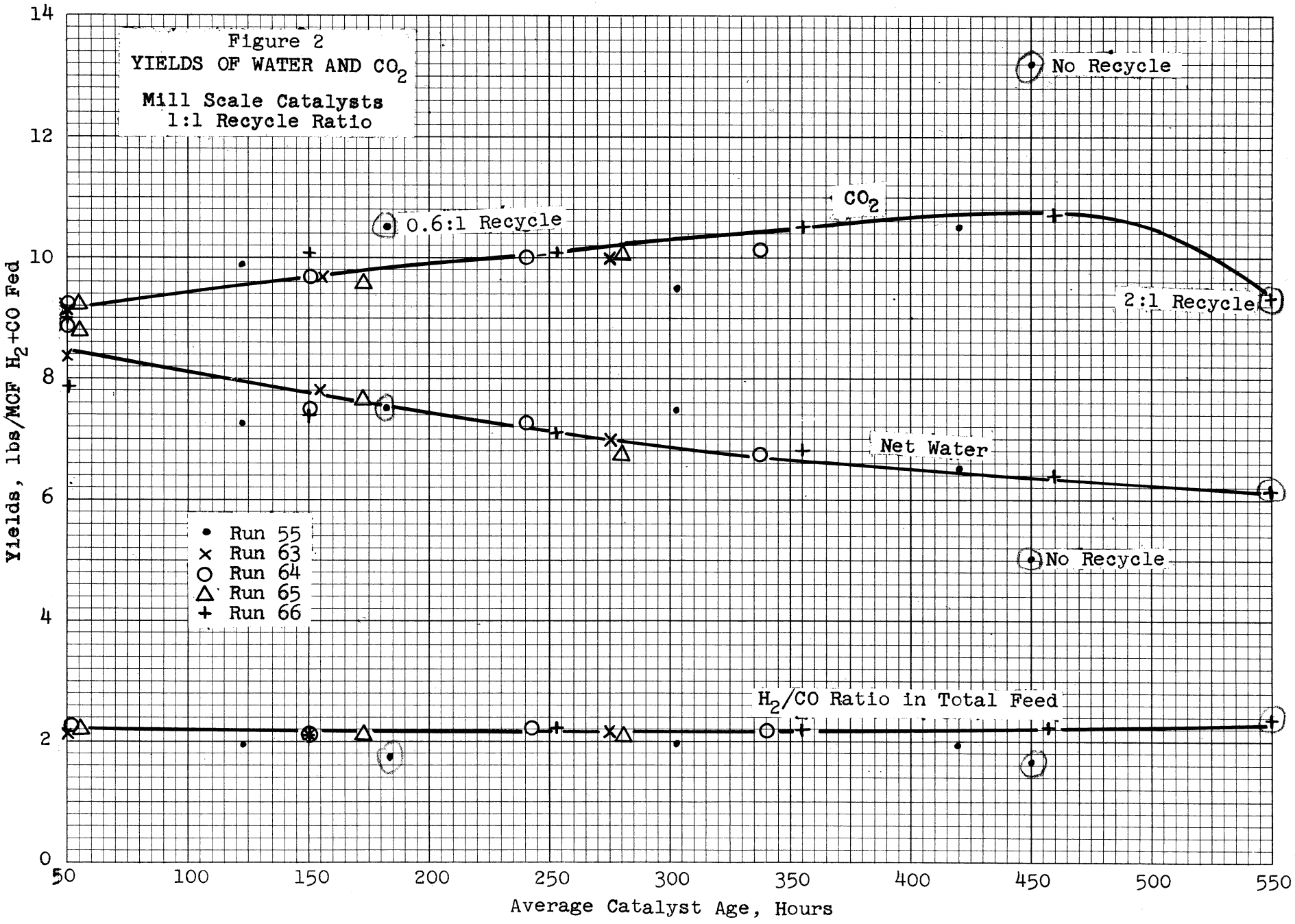
Figure 2
YIELDS OF WATER AND CO_2
Mill Scale Catalysts
1:1 Recycle Ratio
No Recycle
CO_2
0.6:1 Recycle
2:1 Recycle
Net Water
No Recycle
H_2/CO Ratio in Total Feed
Run 55
Run 63
Run 64
Run 65
Run 66
Yields, lbs/MCF H_2+CO Fed
Average Catalyst Age, Hours
0
2
4
6
8
10
12
14
50
100
150
200
250
300
350
400
450
500
550

procedure was followed in order to duplicate as much as possible the Brownsville start-up practice.

The initial load of 2000 pounds of catalyst resulted in a 22-foot depth, which gradually declined to 19 feet during the run. The fresh feed rate was 16 MSCFH with a recycle-to-fresh-feed ratio of 1:1.

Runs 64, 65, and 66

These runs were made with catalyst base stock shipped from Brownsville but the reduction was carried out at various temperatures in the Montebello reactor. The general operating conditions were similar to those of Run 63. No make-up catalyst was added during any of the runs.

Between Runs 64 and 65 the line between the feed heater and the reactor was changed from carbon steel to 18-8 stainless steel to allow higher reduction temperatures.

Near the end of the Run 65, period J, 20 pounds of potassium carbonate was added to the approximately 2000 pounds of catalyst in the reactor in an effort to increase the yield.

During the terminal 119 hours of Run 66 the recycle/fresh feed ratio was increased from 1/1 to 2/1.

IV. RESULTS AND DISCUSSION

Effect of Catalyst Reduction Conditions

The yields of hydrocarbons and water-soluble chemicals have been plotted as a function of average catalyst age in Figure 1, page 5. The yields of carbon dioxide and water are shown similarly in Figure 2, opposite. It is evident that the yield structures were the same for Runs 63 through 66 when the only variables were the catalyst reduction conditions previously discussed.

H_2/CO in Effluent 5.628
H_2/CO in Combined Feed 1.654
H_2/CO in F.F. 1.604

TABLE II

EFFECT OF RECYCLE RATIO ON PRODUCT DISTRIBUTION

Run No.	55-2	55-3	55-4	55-5	66-3	66-4	66-5
Periods	L-Q	R-Z	AA-FF	GG-KK	P-T	U-X	Y-CC
Hours	235-379	379-570	570-714	714-834	296-416	416-500	500-619
Recycle Ratio	0.63	0.96	1.01	0.06	1.07	1.05	2.09
Fresh Feed, SCFH	14111	9922	14581	14776	14293	15232	15014
CO_2 in Total Feed, ~~mol %~~ mol/hr.	6.23	8.22	11.74	1.57	12.39	11.37	19.78
Space Velocity, v/hr/v	1097	720	1021	1069	1125	1369	2668
Conversion of H_2+CO, %	73.03	83.47	76.06	73.64	79.78	72.84	72.28
Selectivity, C_3+/C_1+, %	76.51	75.06	74.86	69.12	75.50	74.83	79.56
Yield of C_1+, lbs/MCF H_2+CO	9.82	11.19	10.07	8.96	10.63	9.39	9.71
Product Distribution, Weight Per Cent of C_1+							
CH_4	12.93	12.94	12.86	18.00	13.02	13.87	10.73
C_2H_4	6.32	5.95	6.83	7.64	6.28	6.37	6.06
C_2H_6	4.23	6.05	5.45	5.24	5.20	4.93	3.65
C_1+C_2	23.48	24.94	25.14	30.88	24.50	25.17	20.44
C_3H_6	12.46	12.65	11.93	11.91	11.87	11.49	10.37
C_3H_8	1.90	1.70	1.50	1.23	1.32	1.31	1.09
C_4H_8	8.73	8.97	9.53	8.62	9.13	8.75	9.12
C_4H_{10}	4.80	2.51	2.83	3.20	2.81	2.85	2.85
C_5+ Recovered Oil	34.81	34.42	34.36	33.17	36.43	36.32	41.46
C_3+	62.70	60.25	60.15	58.13	61.56	60.72	64.89
Alcohols	10.67	11.59	11.11	9.22	10.52	10.66	10.37
Acids	3.15	3.22	3.60	1.77	3.42	3.45	4.30
Water Soluble Chemicals	13.82	14.81	14.71	10.99	13.94	14.11	14.67
Yield Basis Brownsville Design Feed Rate, 9488 MCFH H_2+CO BPD							
Liquid Hydrocarbons	4336	5051	4480	3814	4988	4301	4854
Alcohols	731	915	772	582	766	688	682
Acids	215	254	250	112	249	223	283
Total Liquid	5282	6220	5502	4508	6003	5212	5819

Effect of Recycle/Fresh Feed Ratio

The data from Run 55 also have been shown in Figures 1 and 2. During this run there were two periods of low recycle ratio, Periods 55-2 with 0.06/1 ratio and Period 55-5 with no recycle gas except the bleed gas through the pressure taps. This flow corresponds to a 0.06/1 ratio. Otherwise the conditions were similar to those of Run 63 through 66, made with a recycle ratio of 1/1 except for Period 66-5, made with 2/1 recycle ratio.

It can be seen in Figure 2 that the H_2/CO ratio in the total feed stream tended to be constant at about 2.2/1. Since the H_2/CO ratio in the fresh feed was fixed at about 1.65 to 1, the composition of recycle gas changed sufficiently, when the recycle ratio was raised from 1/1 to 2/1, to maintain the constant H_2/CO ratio in the total feed. A similar change in the opposite direction took place when the recycle ratio was decreased. Of course, when the recycle flow was practically stopped, then the total feed composition became almost the same as the fresh feed.

The period of lower recycle ratio in Run 55 showed lower yields of C_3 and heavier hydrocarbons, lower yields of water-soluble chemicals, lower yields of water, higher yields of C_1 and C_2 hydrocarbons, and higher yields of CO_2. The effect of raising the recycle ratio in Run 66 was to increase the yields of C_3 and heavier hydrocarbons (even though the catalyst volume was less). The yields of CO_2 were decreased, but there was only a slight effect on the yield of other products.

Additional data on the effects of recycle ratio are shown in Table II, opposite. The tabulated data show in more detail the same effects of recycle ratio shown graphically in Figures 1 and 2.

In summary, higher recycle/fresh feed ratio was beneficial in the range of 0.06/1 to 2.0/1. The yields of useful liquid product increased with recycle ratio, and the yields of methane and CO_2 were suppressed. Since the selectivity and conversion decrease with catalyst age, and the CO_2 yields increase, the beneficial effects of increasing the recycle ratio may be more pronounced as the catalyst gets older.

Effect of Addition of Potassium Carbonate

The addition of anhydrous potassium carbonate during period 65-J had no apparent effect on the synthesis reaction.

V. CONCLUSIONS

1. The mill scale catalyst treated and reduced at Brownsville exhibited no difference from mill scale catalysts prepared at Montebello.

2. Variation of the catalyst reduction temperature in the range of 650°F to 800°F had no effect on the quality of the catalyst.

3. Increasing the recycle/fresh feed ratio in the range of 0.06/1 to 2.0/1 increased the yields of saleable liquid products and suppressed the yields of methane and CO_2.

4. The addition of anhydrous potassium carbonate during a run had no effect on the synthesis reaction.

REPORT PREPARED BY Signed: W. L. Slater

WLS-EW

REPORT APPROVED BY Signed: duBois Eastman

(WEK-WAMcM)-WJC(2)-RWH-HDM(2)
RLSr(2)-duBE(2)
WMS-RP-CEL-GK-Jcw

Exp. No. 2001-2-P-11

WORK DONE BY

duBois Eastman	Director of Research
R. A. Beck	Supervisor
W.L. Slater	Chemical Engineer
Clyde Potter	Operator
James Elliott	Operator
Lawrence Estabrook	Operator
Gerald Scott	Operator
Willard Herrick	Operator
Charles Turbyfill	Operator
Lowell Bell	Operator
Roy Gothard	Assistant Operator
John Klein	Assistant Operator
Harvey Rupp	Assistant Operator
James Stanchfield	Assistant Operator
John Hughes	Assistant Operator
Cecil Mitchell	Assistant Operator
Ernest Brown	Assistant Operator

REPORT WRITTEN BY

W. L. Slater	Chemical Engineer

(WEK-WAMcM)-WJC(2)-RWH-HDM(2)-RLSr(2)-duBE(2)
WMS
RP
CEL
GK
JCW

VI. APPENDIX

INDEX TO APPENDIX

TABLE III

ANALYSES OF CATALYSTS

Run	63 S.D.*	64, 65, 66 Raw*	64 A *	64 S.D.**	65 Red.*	65 A *	65 S.D.*	66 A	66 C	66 D *	66 S.D.*
Screen Analysis, Weight Per Cent											
On U.S. No.											
40 (420 microns)	2.0	0.6	1.2	0.4	1.0			0.8	1.0	0.5	1.0
100 (150 microns)	48.3	45.3	53.4		52.7			63.8	68.4	58.1	70.6
150 (105 microns)	23.4	16.9	19.0	20.3	19.2			21.0	19.2	21.4	25.2
200 (74 microns)	14.8	12.1	11.0	71.5	12.7			9.6	7.8	13.0	2.0
250 (62 microns)	5.1	3.4	5.4	2.2	1.4			4.0	2.6	2.6	0.4
325 (44 microns)	4.3	10.4	7.6	5.7	8.1			0.4	0.6	3.8	0.2
Through 325	2.1	11.3	2.4	2.0	4.9			0.4	0.4	0.6	0.6
50 Per Cent Point, microns	150	140	150	95	150			180	190	170	190
Bulk Density, lbs/cu. ft.											
Aerated	151		157	131	139	139	133	146	140		120
Settled	156		159	132	140	140	135	148	141		121
Compacted	172		187	159	174	186	160	180	174		128
Specific Gravity	4.93		5.90	3.98	6.44	5.35	3.74	4.98	3.66		4.82
Per Cent Iron				78.2	97.7		77.6				74.4
Per Cent Oil Soluble in CCl_4	1.8			0.15							
Per Cent Carbon after extraction with CCl_4				11.2							
Per Cent K_2O basis Fe					1.17						

*S.D.=catalyst sampled after reactor shutdown; Raw = catalyst before reduction;
Red.:catalyst sampled after reduction but before cutting in feed gas.

TABLE IV

[redacted]

MONTEBELLO RUN 64 REDUCTION
BETHLEHEM MILL SCALE

Loaded 2200#

Hours above 600°F.	Water Production lbs. Spot	lbs. Total	% of Total	lbs./hr.	m/hr.	Temperature - °F Heater	Bed	Meter Run	Recycle √h	Recycle Press. psig.	Total H_2 m/hr.	H_2 Conv. %	Carry-over lbs. Spot	Carry-over lbs. Total	H_2 Flow Recycle SCFH	H_2 Flow Bleed SCFH	H_2 Flow Total SCFH
1	16	16	2.6	16	0.888		628	90	5.8	251	52.35	0.848	18	18	18122	1746	19868
4	14½	30½	4.9	4.83	0.268		668	93	6.23	226	54.77	0.489	20½	38½	19007	1780	20787
7	35½	66	10.6	11.83	0.657		689	91	5.93	226	52.67	1.247	43½	82	18289	1698	19987
9	33	99	15.9	16.5	0.916		702	88	5.60	236	50.70	1.807	34	116	17602	1637	19239
11	49	148	23.8	24.5	1.360		719	88	5.75	231	52.38	2.597	32	148	18177	1703	19880
13	53	201	32.3	26.5	1.471		714	96	5.95	229	49.96	2.944	22½	170½	17254	1705	18959
15	36½	237½	38.1	18.25	1.013		718	100	5.65	226	48.67	2.081	13½	184	16866	1604	18470
17	55½	293	47.0	27.75	1.540		730	96	5.65	230	48.85	3.153	12½	196½	16908	1630	18538
19	48½	341½	54.8	24.25	1.346		733	90	5.60	225	48.28	2.788	6½	203	16725	1598	18323
21	59	400½	64.3	29.5	1.637		741	90	5.55	228	49.92	3.279	8	211	17344	1599	18943
23	48½	449	72.1	24.25	1.346		747	92	5.70	229	48.78	2.759	8	219	16870	1640	18511
25	46	495	79.5	23.0	1.277		750	90	5.60	226	48.44	2.636	7½	226½	16779	1603	18382
27	42	537	86.2	21.0	1.166		752	88	5.60	226	48.54	2.402	6	232½	16814	1606	18420
29	35	572	91.8	17.5	0.971		756	88	5.60	216	47.60	2.040	5	237½	16844	1575	18063
31	26½	598½	96.1	13.25	0.735		768	88	5.75	225	49.09	1.497	5½	243	16986	1644	18630
33	6	604½	97.0	3.0	0.167		788	87	5.50	229	48.82	0.341	5	248	16937	1589	18528
35	11½	616	98.9	5.75	0.319		731	94	5.95	226	51.23	0.623	5½	253½	17744	1698	19442
39	2	618	99.2	0.50	0.028		785	93	6.03	234	52.18	0.053	8½	262	18044	1755	19800
46	1½	619½	99.5	0.21	0.012		778	91	7.39	230	51.14	0.023	11	273	17232	2175	19408
57	3½	623		0.32	0.018		800	88	7.4	230	51.14	0.035			17232	2175	19408
Average 7-27					1.3072		730			228.7	49.452	2.643					

Flow Rate = $\frac{(49.45)(379.5)}{3600}$ $(\frac{14.7}{244.7})(\frac{1191}{520})$ = 0.7172 CFS V= 1.08 ft./sec.

Average Inventory = 2200# @160#/CF = 13.75 CF @67% V = 9.213 CF

t = 9.213/0.7172 = 12.84 sec.

Exp. No. 2001-2-P-15

TABLE V

[redacted]

MONTEBELLO RUN 65 REDUCTION
BETHLEHEM MILL SCALE

Loaded 2445#

Hours above 600°F	Water Production lbs. Spot	lbs. Total	% of Total	lbs/hr	m/hr	Temperature - °F Heater	Bed	Meter Run	Recycle √h	Press. psig.	Rate SCFH	Bleed √h	Rate SCFH	Total Feed SCFH	m/hr	Hydrogen Conv. %	Carry-over lbs. Spot	Total	Density #/CF	Depth Ft.
3	56	56	9.1	18.67	1.036	1140	739	62	4.01	235	19032	6.2	1860	20892	55.05	1.88	91	91	167	20.9
5	82	138	22.5	41.0	2.276	1140	809	60	3.94	236	18754	5.3	1595	20349	53.62	4.14	68	159	165	19.9
7	92	230	37.4	46.0	2.553	1090	815	61	3.85	231	18122	5.0	1488	19610	51.67	4.94	43	202		
9	86½	316½	51.5	43.25	2.401	1095	802	59	3.95	223	18333	5.0	1471	19804	52.18	4.60	29	231	165	17.8
11	75	391½	63.7	37.5	2.081	1085	800	54	3.75	224	17523	4.9	1449	18972	49.99	4.17	17	248	162	17.4
7AM 12	52	443½	72.2	52.0	2.886	1080	800	53	3.63	225	17012	4.9	1450	18462	48.65	5.92	10	258		
13	24½	468	76.2	24.5	1.360	1085	784	55	3.55	220	16432	6.5	1925	18357	48.37	2.81	4½	262½	161	16.6
14	37½	505½	82.3	37.5	2.081	1095	786	62	3.55	215	16152	6.5	1870	18022	47.49	4.40	5	267½	156	16.8
15	24½	530	86.2	24.5	1.360	1085	792	65	3.65	225	16908	6.5	1910	18818	49.59	2.74	4	271½	155	16.6
16	28½	558½	90.9	28.5	1.582	1040	800	66	4.00	225	18530	6.5	1905	20435	53.85	2.94	4½	276	160	15.8
17	26	584½	95.1	26.0	1.443	1020	794	70	4.00	225	18442	6.0	1750	20192	53.21	2.72	6½	282½	159	15.7
18	18½	603	98.1	18.5		1005	794	72	4.30	220		6.2					6½	289	158	15.5
19	5	608	98.9	5.0		934	793	75		226		6.2					4	293	159	15.4
20	2	610	99.3	2.0		950	790	74		230		6.4					3	296	160	15.2
23	4½	614½		1.5													7½	303½	164	14.8
Average 3-15					2.125		799			225					50.195	4.23			161	17.6

Flow Rate = $\frac{(50.195)(379.5)}{3600}$ $(\frac{14.7}{229.7})(\frac{1259}{520})$ = 0.820 CFS = 1.24 ft/sec.

Average Inventory = 2445
1590
2017 /160 = 12.60 CF @67% V = 8.442/0.820 = 10.30 sec.

TABLE VI

[redacted]

MONTEBELLO RUN 66 REDUCTION
BETHLEHEM MILL SCALE

Loaded 2883#

Hours above 600°F.	Water Production lbs. Spot	lbs. Total	% of Total	lbs./hr.	m/hr.	Temperature - °F. Heater	Bed	Meter Run	Recycle √h	Press. psig.	Rate SCFH	Bleed √h	Rate SCFH	Total Feed SCFH	m/hr.	Hydrogen Conv. %	Carry-over lbs. Spot	Total
4	27	27	4.75	6.75		800	633	54	6.0	226		8.5						
6	12	39	6.86	6.0		790	649	50	5.9	238		7.9					75	75
8	20	59	10.38	10.0		795	654	50	5.9	245		7.05					61	136
10	29	88	15.5	14.5		790	657	46	5.9	232		6.7					58½	194½
12	33½	121½	21.4	16.65		788	657	45	5.95	235		6.8					34	228½
14	34	155½	27.4	17.0		782	653	45	5.98	235		6.95					26	254½
16	38½	194	34.1	19.25		786	656	46	6.0	235		7.2					24	278½
18	31½	225½	39.7	15.75		780	652	52	6.0	232		7.25					18½	297
19	28	253½	44.6	28.0		780	653	65	6.0	230		7.2					16½	313½
21	33	286½	50.4	16.5		780	653	72	6.0	232		7.3					12½	326
23	43½	330	58.0	21.75		785	652	73	6.0	222		6.7					11½	337½
25	36	366	64.4	18.0		751	650	64	5.95	232		6.7					10	347½
27	31	397	69.8	15.5		750	630	60	5.95	240		6.9					6½	354
29	30	427	75.1	15.0		761	647	53	5.98	235		6.5					5½	359½
31	29	456	80.2	14.5		760	649	49	5.98	230		6.8					5	364½
33	27	483	85.0	18.5		760	652	48	5.98	235		6.8					6	370½
35	25	508	89.4	12.5		760	654	45	5.9	225		6.7					5½	376
37	21	529	93.0	10.5		760	657	45	6.0	235		6.5					6	382
39	15	544	95.7	7.5		755	659	42	5.95	227		6.0					4	386
41	11½	555½	97.7	5.75		750	655	45	6.05	235		6.5					5½	391½
43	7	562½	98.9	3.5		752	657	56	6.08	231		6.7					4½	396
45	4	566½	99.6	2.0		752	663	69	6.02	225		6.7					4	400
47	2	568½		1.0		740	653	72	6.05	225		6.5					3	403
Average 8-33 25 hours	424			16.96	0.9413		651	55	5.97	233	28472	6.9	2080	30555	80.51	1.17		

Recycle Flow = (79.31)(3.7854)(5.97)(√250)(1.0048) = 28472
Bleed Flow = (5.02)(3.7854)(6.9)(15.81)(1.0048) = 2083
30555

$\left(\frac{30555}{3600}\right)\left(\frac{14.7}{250}\right)\left(\frac{1111}{520}\right)$ = 1.066 Cu. Ft./sec. = 1.61 ft./sec.

Average Inventory = 2420# @160#/CF = 15.13 Cu. Ft. @67% Void = 10.14 CF Void

t = 10.14/1.066 = 9.51 sec.

Exp. No. 2001-2-P-17

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 63-0 (A-E)
HOURS 0-96
CATALYST Bethlehem MS

FRESH FEED				WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED								
					At Wt. Balance							CONDENSATE								
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*				
CO 28.010	37.075	15.340	429.67	6.756	0.870	24.37	2.720	18.060	3.590	-14.470	-405.30						CORRECTED HEMPEL, %	gal/hr	TREATING RECOVERY,%	gal/hr
H_2 2.016	59.906	24.787	49.97	36.381	4.684	9.44	14.645	39.432	19.329	-20.103	-40.53				83.17	400 EP	78.80	8.118	98.0	7.956
CO_2 44.010	2.345	0.970	42.69	32.187	4.144	182.38	12.957	13.927	17.101	3.174	139.69	9.173			9.46	400-550	11.92	1.228	91.4	1.122
N_2 28.016	0.268	0.111	3.11	1.682	0.217	6.08	0.677	0.788	0.894						7.37	550 +	9.28	0.956	114.6	1.096
CH_4 16.042	0.406	0.168	2.70	10.525	1.355	21.74	4.237	4.405	5.592	1.187	19.04	1.250								
C_2H_4 28.052				2.524	0.325	9.12	1.016	1.016	1.341	0.325	9.12	0.599					RECOVERY %	#/hr	gal/hr	
C_3H_6 30.068				1.890	0.243	7.31	0.761	0.761	1.004	0.243	7.31	0.480				PROPYLENE	45.8	8.02		
C_1+C_2											35.47	2.329				C_3 POLY GASO.	87.5	7.02	1.174	
C_3H_8 42.078				3.231	0.416	17.50	1.301	1.301	1.717	0.416	17.50	1.149	4.32	4.051	0.266	C_3 POLY TAR	12.5	1.00	0.133	
C_3H_8 44.094				0.295	0.038	1.68	0.119	0.119	0.157	0.038	1.68	0.110	4.24	0.396	0.026					
C_4H_8 56.104				2.836	0.288	16.16	0.900	0.900	1.188	0.288	16.16	1.062	5.00	3.232	0.212		#/gal	#/hr	gal/hr	RVP
C_4H_{10} 58.120				0.746	0.096	5.58	0.300	0.300	0.396	0.096	5.58	0.366	4.88	1.148	0.075	C_4H_8	5.00	0.24	0.048	68.0
C_5H_{10} 70.130				0.994	0.128	8.98	0.400	0.400	0.528	0.128	8.98	0.590	5.45	1.648	0.108	C_4 POLY GASO.	5.98	13.93	2.329	1.5
C_5H_{12} 72.146				0.264	0.034	2.45	0.106	0.106	0.140	0.034	2.45	0.161	5.28	0.467	0.031	C_4H_{10}	4.86	5.58	1.148	68.0
C_6H_{12} 84.158				0.289	0.037	3.11	0.116	0.116	0.153	0.037	3.11	0.204	5.64	0.561	0.037	C_4 FREE GASO.			11.806	5.8
C_5-C_6											55.46	3.642		11.503	0.755	C_4 POLY TAR	7.58	1.99	0.264	
TOTAL		41.376	528.14		12.875	315.90	40.254	81.630	61.041											
H_2+CO	96.981	40.127	15,228 SCFH		5.554		17.365	57.492	22.919	-34.573							gal/hr	gal/MCF	Bbl/Day	
H_2/CO		1.62	Factor 656685		5.38		5.38	2.18	5.38	1.39						10 # RVP 400 EP GASOLINE	15.331	1.0068	5458	
Weight Recovery, % 90.45			Catalyst Age, hrs. 48			Space Velocity, vhv 1118			RECOVERED OIL	0.472	66.17	4.345		10.302	0.677	GAS OIL	1.122	0.0737	400	
Pressure, psig 414			Inlet Velocity, Ft/sec 0.96			Catalyst 13.62			TOTAL OIL		121.63	7.987		21.805	1.432	FUEL OIL	1.096	0.0720	390	
Temperature, °F 655			Bed Depth, Ft 20.64			Weight, # 2111			WATER SOLUBLE CHEMICALS Acids	0.344	12.66 5.57	0.831 0.366	7.815	1.620 0.713	0.153	POLY TAR	0.396	0.0261	142	
Recycle Ratio 0.97			Bed Density, #/CF 155			Effluent $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ shift Ratio = 13.0			TOTAL LIQUID PRODUCTS C_4+		139.86	9.184		24.138	1.585	TOTAL	17.946	1.1786	6390	
FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY		NET WATER	7.096	127.84	8.394		15.347	1.008	W. S. CHEM.	1.620 0.713	1.064 0.468	577 254	
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_2+/C_1+		GROSS WATER		146.07	9.592		17.680	1.161	TOTAL	20.279	1.3318	7221	
68.88	94.33	81.10	86.16	80.12	50.98	60.14	79.77		HYDROCARBON TOTAL—C_1+		175.33	11.514								

Form ML—11

g/NCM = 16.91 × #/MCF *0488 MCPH H_2+CO, Bbl/Day = 5421.6 × gal/MCF

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 63-1 (F-J)
HOURS 96-216
CATALYST Bethlehem MS

FRESH FEED				WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED								
					At Wt. Balance							CONDENSATE								
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*				
CO 28.010	37.358	15.774	441.83	7.691	1.063	29.77	3.114	18.888	4.177	-14.711	-412.06						CORRECTED HEMPEL, %	gal/hr	TREATING RECOVERY,%	gal/hr
H_2 2.016	60.271	25.449	51.31	37.427	5.176	10.43	15.153	40.602	20.329	-20.273	-40.88				86.99	400 EP	82.88	7.344	98.0	7.197
CO_2 44.010	2.061	0.870	38.29	31.151	4.307	189.55	12.613	13.483	16.920	3.437	151.26	9.669			8.17	400-550	10.76	0.953	91.4	0.871
N_2 28.016	0.196	0.083	2.33	1.709	0.236	6.61	0.692	0.774	0.928						4.84	550 +	6.36	0.564	114.6	0.646
CH_4 16.042	0.114	0.048	0.77	9.630	1.332	21.37	3.899	3.947	5.231	1.284	20.60	1.317								
C_2H_4 28.052				2.596	0.359	10.07	1.051	1.051	1.410	0.359	10.07	0.644					RECOVERY %	#/hr	gal/hr	
C_3H_6 30.068				1.860	0.257	7.73	0.753	0.753	1.010	0.257	7.73	0.494				PROPYLENE	43.4	8.25		
C_1+C_2											38.40	2.455				C_3 POLY GASO.	87.5	7.22	1.207	
C_3H_8 42.078				3.269	0.452	19.02	1.324	1.324	1.776	0.452	19.02	1.216	4.32	4.403	0.281	C_3 POLY TAR	12.5	1.03	0.137	
C_3H_8 44.094				0.292	0.040	1.76	0.118	0.118	0.158	0.040	1.76	0.113	4.24	0.415	0.027					
C_4H_8 56.104				2.201	0.304	17.06	0.891	0.891	1.195	0.304	17.06	1.091	5.00	3.412	0.218		#/gal	#/hr	gal/hr	RVP
C_4H_{10} 58.120				0.671	0.093	5.41	0.272	0.272	0.365	0.093	5.41	0.346	4.88	1.113	0.071	C_4H_8	5.00	0.29	0.058	68.0
C_5H_{10} 70.130				0.985	0.136	9.54	0.399	0.399	0.535	0.136	9.54	0.610	5.45	1.750	0.112	C_4 POLY GASO.	5.98	14.67	2.454	1.5
C_5H_{12} 72.146				0.217	0.030	2.16	0.088	0.088	0.118	0.030	2.16	0.138	5.28	0.411	0.026	C_4H_{10}	4.86	5.41	1.113	68.0
C_6H_{12} 84.158				0.301	0.042	3.53	0.122	0.122	0.164	0.042	3.53	0.226	5.84	0.637	0.041	C_4 FREE GASO.			11.202	5.8
C_5-C_6											58.48	3.740		12.141	0.776	C_4 POLY TAR	7.58	2.10	0.279	
TOTAL		42.224	534.53		13.827	334.01	40.489	82.713	61.926											
H_2+CO	97.629	41.223	15644 SCFH		6.239		18.267	59.490	24.506	34.984							gal/hr	gal/MCF	Bbl/Day	
H_2/CO		1.61	Factor 639222		4.87		4.87	2.15	4.87	1.38						10 # RVP 400 EP GASOLINE	14.827	0.9478	5139	
Weight Recovery, % 92.28			Catalyst Age, hrs. 156			Space Velocity, vhv 1152			RECOVERED OIL	0.405	56.82	3.632		8.861	0.566	GAS OIL	0.871	0.0557	302	
Pressure, psig 413			Inlet Velocity, Ft/sec 0.98			Catalyst 13.58			TOTAL OIL		115.30	7.372		21.002	1.342	FUEL OIL	0.646	0.0413	224	
Temperature, °F 657			Bed Depth, Ft 20.57			Weight, # 2091			WATER SOLUBLE CHEMICALS	0.400	21.21	1.356	7.919	2.678	0.171	POLY TAR	0.416	0.0266	144	
Recycle Ratio 0.96			Bed Density, #/CF 154			Effluent $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ shift Ratio = 12.1			TOTAL LIQUID PRODUCTS C_4+		136.51	8.728		23.680	1.513	TOTAL	16.760	1.0714	5809	
FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY		NET WATER	6.805	122.60	7.837		14.718	0.941	W. S. CHEM.	2.678	0.1712	928	
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_2+/C_1+		GROSS WATER		143.81	9.193		17.396	1.112	TOTAL	19.438	1.2426	6737	
67.25	93.26	79.66	84.87	77.89	49.93	58.81	78.05		HYDROCARBON TOTAL—C_1+		174.91	11.181								

Form ML—11

g/NCM = 16.91 × #/MCF *0488 MCPH H_2+CO. Bbl/Day = 5421.6 × gal/MCF

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 63-2 (K-O)
HOURS 216-336
CATALYST Bethlehem MS

FRESH FEED				WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED								
					At Wt. Balance							CONDENSATE								
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*				
CO 28.010	36.981	15.751	441.19	9.255	1.475	41.31	3.900	19.651	5.375	-14.276	-399.88						CORRECTED HEMPEL, %	gal/hr	TREATING RECOVERY,%	gal/hr
H_2 2.016	60.683	25.847	52.11	41.937	6.684	13.47	17.672	43.519	24.356	-19.163	-38.64				89.03	400 EP	84.56	6.232	98.0	6.107
CO_2 44.010	1.850	0.788	34.68	27.338	4.357	191.75	11.521	12.309	15.878	3.569	157.07	9.950			7.39	400-550	10.40	0.766	91.4	0.700
N_2 28.016	0.217	0.092	2.58	1.394	0.222	6.22	0.587	0.679	0.809						3.58	550 +	5.04	0.371	114.6	0.425
CH_4 16.042	0.269	0.115	1.84	8.871	1.414	22.68	3.738	3.853	5.152	1.299	20.84	1.320								
C_2H_4 28.052				2.407	0.384	10.77	1.014	1.014	1.398	0.384	10.77	0.682					RECOVERY %	#/hr	gal/hr	
C_3H_6 30.068				1.723	0.275	8.27	0.726	0.726	1.001	0.275	8.27	0.524				PROPYLENE	37.6	7.12		
C_1+C_2											39.88	2.526				C_3 POLY GASO.	87.5	6.23	1.042	
C_3H_8 42.078				2.823	0.450	18.94	1.190	1.190	1.640	0.450	18.94	1.200	4.32	4.384	0.278	C_3 POLY TAR	12.5	0.89	0.118	
C_3H_8 44.094				0.298	0.047	2.07	0.126	0.126	0.173	0.047	2.07	0.131	4.84	0.488	0.031					
C_4H_8 56.104				1.929	0.307	17.22	0.813	0.813	1.120	0.307	17.22	1.091	5.00	3.444	0.218		#/gal	#/hr	gal/hr	RVP
C_4H_{10} 58.120				0.631	0.101	5.87	0.266	0.266	0.367	0.101	5.87	0.373	4.88	1.208	0.077	C_4H_8	5.00	--	--	68.0
C_5H_{10} 70.130				0.894	0.142	9.96	0.377	0.377	0.519	0.142	9.96	0.631	5.45	1.828	0.116	C_4 POLY GASO.	5.98	15.07	2.520	1.5
C_5H_{12} 72.146				0.213	0.034	2.45	0.090	0.090	0.124	0.034	2.45	0.155	5.28	0.467	0.030	C_4H_{10}	4.86	(5.87) 5.36	(1.208) 1.103	68.0
C_6H_{12} 84.158				0.287	0.046	3.87	0.121	0.121	0.167	0.046	3.87	0.245	5.84	0.699	0.044	C_4 FREE GASO.			10.143	5.8
C_5-C_6											60.38	3.825		12.518	0.794	C_4 POLY TAR	7.58	2.15	0.286	
TOTAL		42.593	532.40		15.938	354.85	42.141	84.734	64.902											
H_2+CO	97.664	41.598	15786 SCFH		8.159		21.572	63.170	29.731	-33.439							gal/hr	gal/MCF	Bbl/Day	
H_2/CO		1.64	Factor 633472		4.53		4.53	2.21	4.53	1.34						10 # RVP 400 EP GASOLINE	13.766	0.8720	4728	
Weight Recovery, % 91.88			Catalyst Age, hrs. 276			Space Velocity, vhv 1237			RECOVERED OIL	0.338	47.42	3.004		7.369	0.467	GAS OIL	0.700	0.0443	240	
Pressure, psig 406			Inlet Velocity, Ft/sec 1.02			Catalyst 12.76			TOTAL OIL		107.80	6.829		19.887	1.261	FUEL OIL	0.485	0.0269	146	
Temperature, °F 660			Bed Depth, Ft 19.33			Weight, # 1876			WATER SOLUBLE CHEMICALS	0.388	20.58	1.304	7.899	2.605	0.165	POLY TAR	0.404	0.0256	139	
Recycle Ratio 0.99			Bed Density, #/CF 147			Effluent $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ shift Ratio = 11.8			TOTAL LIQUID PRODUCTS C_4+		128.38	8.133		22.492	1.426	TOTAL	15.295	0.9688	5253	
FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY		NET WATER	6.097	109.85	6.959		13.187	0.835	W. S. CHEM.	2.605	0.1650	895	
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_2+/C_1+		GROSS WATER		130.43	8.262		15.792	1.000	TOTAL	17.900	1.1338	6148	
62.58	90.64	74.14	80.39	72.65	44.03	52.93	76.30		HYDROCARBON TOTAL—C_1+		168.26	10.659								

Form ML—11

g/NCM = 16.91 × #/MCF *0488 MCPH H_2+CO, Bbl/Day = 5421.6 × gal/MCF

RUN NO. 63-A
HOURS 0-17
CATALYST Mill Scale Red. at Brownsville

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

FRESH FEED				WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED								
					At Wt. Balance							CONDENSATE								
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*	CORRECTED HEMPEL %	gal/hr	TREATING RECOVERY,%	gal/hr
CO 28.010	37.805	15.213	426.12	6.885	0.859	24.03	2.740	17.953	3.598	-14.355	-402.09									
H_2 2.016	59.020	23.751	47.88	36.305	4.524	9.12	14.448	38.199	18.972	-19.227	-38.76					400 EP	77	8.466	98.0	8.297
CO_2 44.010	2.780	1.119	49.25	34.820	4.339	190.96	13.857	14.976	18.196	3.220	141.71	9.583				400-550	14	1.539	91.4	1.407
N_2 28.016	0.345	0.139	3.89	1.625	0.203	5.69	0.647	0.786	0.850							550 +	9	0.990	114.6	1.135
CH_4 16.042	0.050	0.020	0.32	9.100	1.134	18.19	3.621	3.641	4.755	1.114	17.87	1.208								
C_2H_6 28.052				2.355	0.293	8.22	0.937	0.937	1.230	0.293	8.22	0.556					RECOVERY %	#/hr	gal/hr	
C_3H_8 30.068				1.540	0.192	5.77	0.613	0.613	0.805	0.192	5.77	0.390				PROPYLENE	46.0	6.79		
C_4+C_5											31.86	2.154				C_3 POLY GASO.	87.5	5.94	0.993	
C_2H_2 26.038				2.815	0.351	14.77	1.120	1.120	1.471	0.351	14.77	0.999	4.32	3.419	0.231	C_3 POLY TAR	12.5	0.85	0.113	
C_3H_8 44.094				0.255	0.032	1.41	0.101	0.101	0.133	0.032	1.41	0.095	4.24	0.333	0.023					
C_4H_8 56.104				2.055	0.256	14.36	0.818	0.818	1.074	0.256	14.36	0.971	5.00	2.872	0.194		#/gal	#/hr	gal/hr	RVP
C_5H_{10} 84.120				0.700	0.087	5.06	0.279	0.279	0.366	0.087	5.06	0.342	4.86	1.041	0.070	C_4H_8	5.00	0.58	0.116	68.0
C_6H_{10} 70.130				0.935	0.117	8.21	0.372	0.372	0.489	0.117	8.21	0.555	5.45	1.506	0.102	C_4 POLY GASO.	5.98	12.06	2.016	1.5
C_7H_{12} 72.146				0.310	0.039	2.81	0.123	0.123	0.162	0.039	2.81	0.190	5.25	0.535	0.036	C_4H_{10}	4.86	5.06	1.041	68.0
$C_{17}H_{32}$ 24.156				0.300	0.037	3.11	0.119	0.119	0.156	0.037	3.11	0.210	5.54	0.561	0.038	C_4 FREE GASO.			11.892	5.8
C_3-C_8											49.73	3.362		10.267	0.694	C_4 POLY TAR	7.53	1.72	0.228	
TOTAL		40.242	527.46		12.462	311.71	39.795	80.037	60.425											
H_2+CO	96.825	38.964	14787	SCFH	5.382		17.188	56.152	22.570	-33.582							gal/hr	gal/MCF	Bbl/Day	
H_2/CO		1.56	Factor	676269	5.27		5.27	2.13	5.27	1.34						10 # RVP 400 EP GASOLINE	15.065	1.0188	5524	

Weight Recovery, %	88.58	Catalyst Age, hrs.	17	Space Velocity, vhv	1039	RECOVERED OIL	0.5074**	71.09	4.808	10.995	0.744
Pressure, psig	415	Inlet Velocity, Ft/sec	0.94	Catalyst Vol., CF	14.23	TOTAL OIL		120.82	8.170	21.262	1.438
Temperature, °F	653	Bed Depth, Ft	21.56	Weight, #	2191	WATER SOLUBLE CHEMICALS	0.190**	10.07	0.681	1.310	0.089
Recycle Ratio	0.99	Bed Density, #/CF	154	Effluent $(H_2)(CO_2)$ / Shift Ratio $(H_2O)(CO)$ =	12.84	TOTAL LIQUID PRODUCTS C_5+		130.89	8.851	22.572	1.527
						NET WATER	7.471**	134.59	9.102	16.157	1.093
						GROSS WATER		144.66	9.783	17.467	1.182
						HYDROCARBON TOTAL—C_1+		162.75	11.006		

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_2+ / C_1+
69.03	94.36	80.95	86.19	79.96	50.33	59.81	80.42

Form ML—11

**Included in Reactor Effluent Total

#/NCM = 16.91×#/MCF

*9488 MCFH H_2+CO, Bbl/Day = 5421.6×gal/MCF

OPERATING CONDITIONS				
PRESSURES PSIG		RATES S.C.F.H.		
Oxygen	439	Fresh Feed	15,272	
Natural Gas	435	Recycle	15,102	
Generator Outlet	417	Combined Feed	30,374	
Reactor Inlet	415	Wet Gas—Measured	3,815	
Condenser Inlet		Adjusted	4,729	
Product Accumulator	360	Loss	914	
TEMPERATURES—°F.		Recycle/Fresh Feed	0.99	
Oxygen	419	Inlet Velocity—ft./sec.	0.94	
Natural Gas	761	Fresh Feed Rate—S.C.F.H.	14787	
Generator		per Cu. Ft. Dense Bed	1039	
Quench Accumulator	154	per Lb. Catalyst	6.75	
Reactor Inlet	381	per Sq. Ft.	22405	
Condenser Inlet	578			
Product Accumulator	89	Heat Transfer Calculations		
Catalyst No. Height		Steam Rate = 221 #/hr.		
1 0'0"	626	@707 psia & 505°F		
2 0'9"	654	= 1201 Btu/#		
3 1'9"	648	Water in @60° F = 28 Btu/#		
4 4'5"	657	= 1173 Btu		
5 7'0"	662	(1173)(221) = 259,233 Btu/hr.		
6 12'3"	660	Ave. Bed Temp. = 653°F		
7 17'5"	650	dT = 653-505 = 148°F		
8 20'0"	642	Tube Area = 37.8 sq. ft.		
9 22'7"	635	$K = \frac{259,233}{(37.8)(148)} = 46.3$ Btu/°F/sq. ft.		
10 25'2"	631			
11 26'11"	516			

PRODUCT TESTS		
	OIL	WATER
°API	50.7	10.8
Neut. No.	39.7	32.5
Sap. No.	46.8	36.7
Hydrox. No.		
Bromine No.	75	
Pour °F.		
Chemicals, % by K_2CO_3		7.5
HEMPEL DIST. %		°API
205 °F.		
400	76	55.4
400-550	14	34.7
550+	10	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	96	
10%	137	
50%	226	
90%	380	
EP	396	
Rec.	96	

CATALYST DATA		
INVENTORY DATA		
In Reactor at Start of Period		
Fresh Catalyst Added		
Total		
Catalyst Recovered	58	
In Reactor at End of Period		
REACTOR d-p, Inches H_2O		
No. Height		
0 0-21 3/8	-	
1 21 3/8-52 3/4	75	
2 52 3/4-84	76	
3 84-115 3/8	83	
4 115 3/8-353 1/8	375	
Total	609	
CALCULATED FROM dp		
Density, Lbs./Cu.Ft.	154	
Inventory, Lbs.	2191	
Bed Depth, Ft.	21.56	
Vol., Cu. Ft.	14.23	

PARTICLE SIZE				
	Screen Analysis		Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+		80+	
100	150		40—80	
150	105		20—40	
200	74		10—20	
250	62		0—20	
325	44			
<325				

CATALYST
Bulk Density, Lbs./Cu.Ft.
Aerated
Settled
Compacted
Particle Density, gm./cc.
NH_3 Value, ml./gm.
N_2 Surface, m^2/gm.
CHEMICAL ANALYSIS
Fe
C
O
H
K_2O, W+, % basis Fe
X-Ray Analysis—
Fe_2nC_9
Fe_3O_4
Fe

GAS ANALYSES					GENERATOR BALANCE								
HOUR	2200	0600		AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.18	10.735 0.023			21.516
CO 28.010	37.37	38.24		37.805	15.213	15.213		15.213	CO_2 44.010	1.40	0.183	0.183		0.366
H_2 2.016	59.37	58.67		59.020	23.751		47.502		N_2 28.016	1.25	0.163			
CO_2 44.010	2.85	2.71		2.780	1.119	1.119		2.238	CH_4 16.042	82.63	10.773	10.773	43.092	
N_2 28.016	0.36	0.33		0.345	0.139				C_2H_6 30.068	6.73	0.877	1.754	5.262	
CH_4 16.042	0.05	0.05		0.050	0.020	0.020	0.080		C_3H_8 44.094	5.40	0.704	2.112	5.632	
			M. W	13.107178					C_4H_{10} 58.120	1.67	0.218	0.872	2.180	
			H_2O 18.016				9.305	4.653	C_5H_{12} 72.146	0.74	0.097	0.485	1.164	
						16.352	56.887	22.104	MW =	20.1885814				
			BALANCE			101.07	99.23	101.01	TOTAL			16.179	57.330	21.882

WEIGHT BALANCE		
	#/hr Measured	At Wt. Balance
WET GAS	251.45	311.71
OIL	71.09	71.09
WATER	144.66	144.66
TOTAL	467.20	527.46
FRESH FEED	527.46	
WEIGHT BALANCE	88.58	
WET GAS FACTOR	1239650	
INDICATED LOSS—S C F H	914	

WET GAS					GAS FLOW RATES								LIQUID PRODUCT RATES Basis 15 hours							
CO 28.010	6.70	7.07		6.885		$\sqrt{R}$	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL HR
H_2 2.016	36.93	35.68		36.305			414.8	67	2208713			OIL	5'6"	292.57	57	1.0015	293.01	50.7 6.466	1894.60	
CO_2 44.010	35.15	34.49		34.820	FRESH FEED	79.31	20.724	0.9933	1.4862	15.272	40.242		2'5½"	130.04	65	0.9975	129.71		838.70	
N_2 28.016	1.58	1.67		1.625			1.49	65	1157445								+1.62		+10.50	71.09
CH_4 16.042	9.00	9.20		9.100	WET GAS	158.44	4.024	0.9952	1.0758	3.815	10.053						164.92		1066.40	10.995
C_2H_6 28.052	2.23	2.48		2.355			413.3	122												
C_3H_8 33.068	1.50	1.58		1.540	RECYCLE	79.31	20.688	0.9452	1.0758	14.153	37.294									
C_4H_{10} 48.078	2.60	3.03		2.815	BLEED															
C_5H_{12} 44.094	0.22	0.29		0.255		5.02	20.688	1.0000	1.0758	949	2.501	WATER	7'3-3/4	387.50	74	0.99846	386.90	10.8 8.282	3204.31	
C_6H_{14} 58.104	1.91	2.20		2.055	NATURAL GAS		435.4	198	1433978				5'7½"	299.12	74	0.99846	298.66		2473.50	
C_7H_{16} 88.120	0.65	0.75		0.700		28.43	21.216	0.8890	1.1975	4.948	13.038		4'2-3/4	226.01	71	0.99883	225.75		1869.66	
C_8H_{18} 72.232	0.88	0.99		0.935	OXYGEN		438.8	69					1'0"	52.00	64	0.99963	51.98		430.50	144.66
C_9H_{20} 72.146	0.36	0.26		0.310		27.07	21.296	0.9915		4.074	10.735						262.01		2169.97	17.467
$C_{10}H_{22}$ 84.188	0.29	0.31		0.300	STEAM		30.6 4.7 35.3													
			M. W.	25.01198	215.7	3.489	0.2940		221 #/hr.											

20

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 63-B
HOURS 17-28
CATALYST Mill Scale Red. at Brownsville

	Fresh Feed %	Fresh Feed m/hr	Fresh Feed #/hr	Wet Gas %	Wet Gas (At Wt. Balance) m/hr	Wet Gas (At Wt. Balance) #/hr	Recycle m/hr	Combined Feed m/hr	Effluent m/hr	Net Change m/hr	Net Change #/hr	#/MCF	Condensate #/gal	Condensate gal/hr	Condensate gal/MCF
CO 28.010	36.88	15.343	429.76	6.81	0.898	25.15	2.782	18.125	3.680	-14.445	-404.61				
H_2 2.016	60.25	25.065	50.53	37.44	4.939	9.96	15.294	40.359	20.233	-20.126	-40.57				
CO_2 44.010	2.08	0.865	38.07	31.19	4.115	181.12	12.742	13.607	16.857	3.250	143.05	9.328			
N_2 28.016	0.31	0.129	3.61	1.51	0.199	5.58	0.617	0.746	0.816						
CH_4 16.042	0.48	0.200	3.21	11.18	1.475	23.66	4.567	4.767	6.042	1.275	20.45	1.334			
C_2H_4 28.052				2.46	0.324	9.09	1.005	1.005	1.329	0.324	9.09	0.593			
C_2H_6 30.068				1.70	0.224	6.74	0.695	0.695	0.919	0.224	6.74	0.440			
C_1+C_2											36.28	2.367			
C_3H_6 42.078				2.89	0.381	16.03	1.181	1.181	1.562	0.381	16.03	1.045	4.32	3.711	0.242
C_3H_8 44.094				0.26	0.034	1.50	0.106	0.106	0.140	0.034	1.50	0.098	4.24	0.354	0.023
C_4H_8 56.104				2.17	0.286	16.05	0.887	0.887	1.173	0.286	16.05	1.047	5.00	3.210	0.209
C_4H_{10} 58.120				0.76	0.100	5.81	0.310	0.310	0.410	0.100	5.81	0.379	4.86	1.195	0.078
C_5H_{10} 70.130				1.01	0.133	9.33	0.413	0.413	0.546	0.133	9.33	0.608	5.45	1.712	0.112
C_5H_{12} 72.146				0.31	0.041	2.96	0.127	0.127	0.168	0.041	2.96	0.193	5.25	0.564	0.037
C_6H_{12} 84.156				0.31	0.041	3.45	0.127	0.127	0.168	0.041	3.45	0.225	5.54	0.623	0.041
C_3-C_6											55.13	3.595		11.369	0.742
TOTAL		41.602	525.18		13.190	316.43	40.853	82.455	62.031						
H_2+CO	97.13	40.408	15335	SCFH	5.837		18.076	58.484	23.913	-34.571					
H_2/CO		1.63	Factor 652103		5.50		5.50	2.23	5.50						

Weight Recovery, %	87.62	Catalyst Age, hrs. 28	Space Velocity, vhv 1079	RECOVERED OIL	0.477**	66.92	4.364		10.349	0.675
Pressure, psig	414	Inlet Velocity, Ft/sec 0.97	Catalyst Vol.,CF 14.21	TOTAL OIL		122.05	7.959		21.718	1.417
Temperature, °F	656	Bed Depth, Ft 21.53	Weight, # 2217	WATER SOLUBLE CHEMICALS	0.186**	9.87	0.644		1.284	0.084
Recycle Ratio	0.98	Bed Density, #/CF 156	Effluent $(H_2)(CO_2)$ / Shift Ratio $(H_2O)(CO)$ = 12.65	TOTAL LIQUID PRODUCTS C_3+		131.92	8.603		23.002	1.501
FRESH FEED CONVERSION — %		TOTAL FEED CONVERSION — %	SELECTIVITY	NET WATER	7.325**	131.96	8.605		15.841	1.033

Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+						
								GROSS WATER		141.83	9.249	17.125	1.117
68.29	94.15	80.30	85.55	79.70	49.37	59.11	78.43	HYDROCARBON TOTAL—C_1+		168.20	10.970		

YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*

	Corrected Hempel, %	gal/hr	Treating Recovery, %	gal/hr
400 EP	77	7.969	98.0	7.810
400-550	14	1.449	91.4	1.324
550 +	9	0.931	114.6	1.067

	Recovery %	#/hr	gal/hr
PROPYLENE	44.9	7.20	
C_3 POLY GASO.	87.5	6.30	1.054
C_3 POLY TAR	12.5	0.90	0.120

	#/gal	#/hr	gal/hr	RVP
C_4H_8	5.00	-	-	68.0
C_4 POLY GASO.	5.98	14.04	2.348	1.5
C_4H_{10}	4.86	5.81	1.195	68.0
C_4-FREE GASO.			11.763	5.8
C_4 POLY TAR	7.53	2.01	0.267	

	gal/hr	gal/MCF	Bbl/Day
10 # RVP 400 EP GASOLINE	15.306	0.9981	5411
GAS OIL	1.324	0.0863	468
FUEL OIL	1.067	0.0696	377
POLY TAR	0.387	0.0252	137
TOTAL	18.084	1.1792	6393
W. S. CHEM.	1.284	0.0837	454
TOTAL	19.368	1.2629	6847

Form ML—11 **Included in Reactor Effluent Total g/NCM = 16.91 × #/MCF *9488 MCFH H_2 + CO, Bbl/Day = 5421.6 × gal/MCF

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	440	Fresh Feed	15,788
Natural Gas	437	Recycle	15,504
Generator Outlet	416	Combined Feed	31,292
Reactor Inlet	414	Wet Gas—Measured	3,977
Condenser Inlet		Adjusted	5,006
Product Accumulator	360	Loss	1,029
TEMPERATURES—°F.		Recycle/Fresh Feed	0.98
Oxygen	494	Inlet Velocity—ft./sec.	0.97
Natural Gas	775	Fresh Feed Rate—S.C.F.H. H_2 + CO	15,335
Generator	2212	per Cu.Ft. Dense Bed	1079
Quench Accumulator	145	per Lb. Catalyst	6.92
Reactor Inlet	399	per Sq. Ft.	23235
Condenser Inlet	579		
Product Accumulator	94	Heat Transfer Calculations	
Catalyst No. Height		Steam Rate = 229 #/hr.	
1 See Period A	590	@706 psia & 506°F.=	
2	662	= 1201 Btu/#	
3	652	Water in @71.8°F = 40 Btu/#	
4	660	Net Heat Transferred/# steam =	
5	666	= 1161 Btu	
6	662	(1161)(229) = 265,869 Btu/hr.	
7	649	Ave. Bed Temp. = 656°F	
8	641	dT = 656-506 = 150°F	
9	634	Tube Area = 37.8 sq. ft.	
10	629	K = 265,869 / (150)(37.8) =	
11	515	= 46.9 Btu/°F/sq. ft.	

PRODUCT TESTS

	OIL	WATER
°API	50.7	10.8
Neut. No.	39.7	32.5
Sap. No.	46.8	36.7
Hydrox. No.		
Bromine No.	75	
Pour °F.		
Chemicals, % by K_2CO_3		7.5
HEMPEL, DIST. %		°API
205 °F.		
400	76	55.4
400-550	14	34.7
550+	10	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	96	
10%	137	
50%	226	
90%	380	
EP	396	
Rec.	96	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	
Total	
Catalyst Recovered	36
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height	
0 See Period A	-
1	73
2	85
3	78
4	380
Total	616
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	156
Inventory, Lbs.	2217
Bed Depth, Ft.	21.53
Vol., Cu. Ft.	14.21

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+		80+	
100	150		40—80	
150	105		20—40	
200	74		10—20	
250	62		0—20	
325	44			
<325				

CATALYST

Bulk Density, Lbs./Cu.Ft.	
Aerated	
Settled	
Compacted	
Particle Density, gm./cc.	
NH_3 Value, ml./gm.	
N_2 Surface, m²/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, W+. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES / GENERATOR BALANCE

HOUR	1400	AVERAGE	M/HR	C	H	O
FRESH FEED						
CO 28.010	36.88	36.88	15.343	15.343		15.343
H_2 2.016	60.25	60.25	25.065		50.130	
CO_2 44.010	2.08	2.08	0.865	0.865		1.730
N_2 28.016	0.31	0.31	0.129			
CH_4 16.042	0.48	0.48	0.200	0.200	0.800	
M. W.	12.62399					
H_2O 18.016					7.020	3.510
				16.408	57.950	20.583
BALANCE				101.39	101.06	98.55

	Mol %	M/Hr	C	H	O
O_2 32.000	0.18	10.237 / 0.023			20.520
CO_2 44.010	1.40	0.183	0.183		0.366
N_2 28.016	1.25	0.163			
CH_4 16.042	82.63	10.775	10.775	43.100	
C_2H_6 30.068	6.73	0.878	1.756	5.268	
C_3H_8 44.094	5.40	0.704	2.112	5.632	
C_4H_{10} 58.120	1.67	0.218	0.872	2.180	
C_5H_{12} 72.146	0.74	0.097	0.485	1.164	
MW = 20.1885814					
TOTAL			16.183	57.344	20.886

WEIGHT BALANCE

	#/hr Measured	At Wt. Balance
WET GAS	251.41	316.43
OIL	66.92	66.92
WATER	141.83	141.83
TOTAL	460.16	525.18
FRESH FEED	525.18	
WEIGHT BALANCE	87.62	
WET GAS FACTOR	1258621	
INDICATED LOSS—S C F H	1028	

WET GAS

CO 28.010	6.81	6.81
H_2 2.016	37.44	37.44
CO_2 44.010	31.19	31.19
N_2 28.016	1.51	1.51
CH_4 16.042	11.18	11.18
C_2H_4 28.052	2.46	2.46
C_2H_6 30.068	1.70	1.70
C_3H_6 42.078	2.89	2.89
C_3H_8 44.094	0.26	0.26
C_4H_8 56.104	2.17	2.17
C_4H_{10} 58.120	0.76	0.76
C_5H_{10} 70.130	1.01	1.01
C_5H_{12} 72.146	0.31	0.31
C_6H_{12} 84.156	0.31	0.31
M. W.		23.98948

GAS FLOW RATES

		$\sqrt{R}$	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR
FRESH FEED	79.31	6.470	414 / 20.705	80 / 0.9813	2293252 / 1.514	15,788	41.602
WET GAS	158.44	5.750	1.50 / 4.025	73.6 / 0.9874	1206779 / 1.0985	3,977	10.480
RECYCLE	79.31	8.530	413 / 20.681	128 / 0.9404	1.0985	14,453	38.084
BLEED	5.02	9.220	20.681	1.0000	1.0985	1,051	2.769
NATURAL GAS	28.43	7.700	437 / 21.253	199 / 0.8883	1433978 / 1.1975	4,949	13.041
OXYGEN	27.07	6.890	440 / 21.324	85 / 0.9768		3,885	10.237
STEAM	215.7	3.540	32.3 / 4.7 / 37.0 / 0.3004		229 #/hr.		

LIQUID PRODUCT RATES — Basis 11 hours

HOUR	GAGE	GAL.	°F	FACTOR	GAL AT 60	API° #/GAL.	#	#/HR GAL HR
OIL	7'1-3/4	378.77	71	0.9956	377.10	50.7	2438.33	
	5'6"	292.57	57	1.0015	293.01	6.466	1894.60	
	2'4-3/4	127.74	72	0.9941	126.99		821.12	
	1'10½"	98.28	72	0.9941	97.70		631.73	
					+0.46		+3.00	66.92
					113.84		736.12	10.349
WATER	5'11-3/4"	370.04	79	0.99775	369.21	10.8	3057.80	
	4'2-3/4"	226.01	71	0.99883	225.75	8.282	1869.66	
	1'2½"	62.73	83	0.99709	62.55		518.04	
	0'4"	17.70	86	0.99656	17.64		146.09	141.83
					188.37		1560.09	17.125

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 63-C
HOURS 28-48
CATALYST Mill Scale Red. at Brownsville

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE	
	%	m/hr	#/hr	%	At Wt. Balance m/hr	At Wt. Balance #/hr	m/hr	m/hr	m/hr	m/hr	#/hr
$CO_{28.010}$	37.043	15.338	429.61	6.387	0.834	23.36	2.535	17.873	3.369	-14.504	-406.25
$H_{2.016}$	59.197	24.512	49.42	35.937	4.695	9.47	14.264	38.776	18.959	-19.817	-39.95
$CO_{44.010}$	2.373	0.983	43.26	32.304	4.221	185.77	12.823	13.806	17.044	3.238	142.51
$N_{28.016}$	0.220	0.091	2.55	1.513	0.198	5.55	0.601	0.692	0.799		
$CH_{4\ 16.042}$	1.167	0.483	7.75	10.923	1.427	22.89	4.336	4.819	5.763	0.944	15.14
$C_2H_{4\ 28.052}$				2.633	0.344	9.65	1.045	1.045	1.389	0.344	9.65
$C_2H_{6\ 30.068}$				1.937	0.253	7.61	0.769	0.769	1.022	0.253	7.61
C_3+C_3											32.40
$C_3H_{6\ 42.078}$				3.273	0.428	18.01	1.299	1.299	1.727	0.428	18.01
$C_3H_{8\ 44.094}$				0.353	0.046	2.03	0.140	0.140	0.186	0.046	2.03
$C_4H_{8\ 56.104}$				2.320	0.303	17.00	0.921	0.921	1.224	0.303	17.00
$C_4H_{10\ 58.120}$				0.757	0.099	5.75	0.300	0.300	0.399	0.099	5.75
$C_5H_{10\ 70.130}$				1.093	0.143	10.03	0.434	0.434	0.577	0.143	10.03
$C_5H_{12\ 72.146}$				0.223	0.029	2.09	0.089	0.089	0.118	0.029	2.09
$C_6H_{12\ 84.158}$				0.347	0.045	3.79	0.138	0.138	0.183	0.045	3.79
C_5+C_6											58.70
TOTAL		41.407	532.59		13.065	323.00	39.694	81.101	60.792		
H_2+CO	96.240	39.850	15123 SCFH		5.529		16.799	56.649	22.328	-34.321	
H_2/CO		1.60	Factor 661244		5.63		5.63	2.17	5.63	1.37	

YIELD BASIS H_2+CO FED				
	#/MCF	CONDENSATE #/gal	gal/hr	gal/MCF
	1.001			
	0.638			
	0.503			
	2.142			
	1.191	4.32	4.169	0.276
	0.134	4.24	0.479	0.032
	1.124	5.00	3.400	0.225
	0.380	4.86	1.183	0.078
	0.663	5.45	1.840	0.122
	0.138	5.25	0.398	0.026
	0.251	5.54	0.684	0.045
	3.881		12.153	0.804
	8.107		22.119	1.463
	0.918		1.758	0.116
	9.025		23.877	1.579
	8.715		15.821	1.046
	9.633		17.579	1.162
	11.168			

YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*				
	CORRECTED HEMPEL, %	gal/hr	TREATING RECOVERY,%	gal/hr
400 EP	79	7.873	98.0	7.716
400-550	10	0.997	91.4	0.911
550 +	11	1.096	114.6	1.256
	RECOVERY %	#/hr	gal/hr	
PROPYLENE	45.1	8.12		
C_3 POLY GASO.	87.5	7.10	1.187	
C_3 POLY TAR	12.5	1.02	0.135	
	#/gal	#/hr	gal/hr	RVP
C_4H_8	5.00	0.17	0.034	68.0
C_4 POLY GASO.	5.98	14.73	2.463	1.5
C_4H_{10}	4.86	5.75	1.183	68.0
C_4 FREE GASO.			11.825	5.8
C_4 POLY TAR	7.53	2.10	0.279	
	gal/hr	gal/MCF	Bbl/Day	
10 # RVP 400 EP GASOLINE	15.505	1.0253	5559	
GAS OIL	0.911	0.0602	326	
FUEL OIL	1.256	0.0831	451	
POLY TAR	0.414	0.0274	149	
TOTAL	18.086	1.1960	6485	
W. S. CHEM.	1.758	0.1162	630	
TOTAL	19.844	1.3122	7115	

Weight Recovery, %	88.83	Catalyst Age, hrs.	48	Space Velocity, vhv	1085	RECOVERED OIL	0.456**	63.91	4.226	9.966	0.659
Pressure, psig	412	Inlet Velocity, Ft/sec	0.96	Catalyst Vol., CF	13.94	TOTAL OIL		122.61	8.107	22.119	1.463
Temperature, °F	655	Bed Depth, Ft	21.12	Weight, #	2133	WATER SOLUBLE CHEMICALS	0.262**	13.89	0.918	1.758	0.116
Recycle Ratio	0.96	Bed Density, #/CF	153	Effluent $(H_2)(CO_2)$ / Shift Ratio $(H_2O)(CO)$ = 13.11		TOTAL LIQUID PRODUCTS C_5+		136.50	9.025	23.877	1.579
						NET WATER	7.315**	131.79	8.715	15.821	1.046
						GROSS WATER		145.68	9.633	17.579	1.162
						HYDROCARBON TOTAL—C_1+		168.90	11.168		

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3+/C_1+
68.45	94.56	80.85	86.13	81.15	51.11	60.59	80.82

Form ML—11

**Included in Reactor Effluent Total

g/NCM = 16.91X#/MCF *9488 MCFH H_2+CO, Bbl/Day = 5421.6X gal/MCF

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	439	Fresh Feed	15,714
Natural Gas	442	Recycle	15,064
Generator Outlet	417	Combined Feed	30,778
Reactor Inlet	412	Wet Gas—Measured	4,045
Condenser Inlet		Adjusted	4,958
Product Accumulator	361	Loss	913
TEMPERATURES—°F.		Recycle/Fresh Feed	0.96
Oxygen	478	Inlet Velocity—ft./sec.	0.96
Natural Gas	747	Fresh Feed Rate—S.C.F.H. H_2+CO	15123
Generator	2068	per Cu. Ft. Dense Bed	1085
Quench Accumulator	151	per Lb. Catalyst	7.09
Reactor Inlet	357	per Sq. Ft.	22914
Condenser Inlet	577		
Product Accumulator	92	Heat Transfer Calculations	
Catalyst No. Height		Steam Rate = 237 #/hr.	
1 See Period A	565	@705 psia & 506°F =	
2	658	1201 Btu/#	
3	651	Water in @63°F = 31 Btu/#	
4	660	Net Heat Trans./# steam =	
5	664	1170 Btu	
6	662	(1170)(237) = 277,290 Btu	
7	650	Ave. Bed Temp. = 655°F	
8	641	dT = 655-506 = 149°F	
9	634	Tube Area = 37.6 sq. ft.	
10	629	$K = \frac{277,290}{(37.6)(149)} = 49.5$ Btu/°F/sq.ft.	
11			

PRODUCT TESTS	OIL	WATER
°API	52.2	10.7
Neut. No.	40.0	31.9
Sap. No.	47.7	35.0
Hydrox. No.		
Bromine No.	82	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL. DIST. %		°API
205 °F.		
400	78	55.2
400-550	10	30.2
550+	12	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	107	
10%	134	
50%	221	
90%	350	
EP	411	
Rec.		

CATALYST DATA					
INVENTORY DATA		PARTICLE SIZE			
		Screen Analysis		Sedimentation	
In Reactor at Start of Period		Mesh	Microns	Microns	%
Fresh Catalyst Added		On 40	419+	80+	
Total		100	150	40—80	
Catalyst Recovered	33	150	105	20—40	
In Reactor at End of Period		200	74	10—20	
		250	62	0—20	
REACTOR d-p, Inches H_2O		325	44		
No. Height		<325			
0 See Period A	-				
1	76	CATALYST			
2	75	Bulk Density, Lbs./Cu.Ft.			
3	81	Aerated			
4	360	Settled			
Total	592	Compacted			
		Particle Density, gm./cc.			
CALCULATED FROM dp		NH_3 Value, ml./gm.			
Density, Lbs./Cu.Ft.	153	N_2 Surface, m^2/gm.			
Inventory, Lbs.	2133				
Bed Depth, Ft.	21.12	CHEMICAL ANALYSIS			
Vol., Cu. Ft.	13.94	Fe			
		C			
		O			
		H			
		K_2O, W+, % basis Fe			
		X-Ray Analysis—			
		Fe_2O_3			
		Fe_3O_4			
		Fe			

	GAS ANALYSES				GENERATOR BALANCE									
HOUR	1400	2200	0600	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.23	10.364 0.030			20.788
$CO_{28.010}$	37.02	36.15	37.96	37.043	15.338	15.338		15.338	$CO_{2\ 44.010}$	1.42	0.186	0.186		0.372
$H_{2\ 2.016}$	60.08	58.38	59.13	59.197	24.512		49.024		$N_{2\ 28.016}$	0.42	0.055			
$CO_{2\ 44.010}$	2.05	2.41	2.66	2.373	0.983	0.983		1.966	$CH_{4\ 16.042}$	83.32	10.914	10.914	43.656	
$N_{2\ 28.016}$	0.19	0.27	0.20	0.220	0.091				$C_2H_{6\ 30.068}$	7.13	0.934	1.868	5.604	
$CH_{4\ 16.042}$	0.66	2.79	0.05	1.167	0.483	0.483	1.932		$C_3H_{8\ 44.094}$	5.29	0.693	2.079	5.544	
			M. W	12.862358					$C_4H_{10\ 58.120}$	1.56	0.204	0.816	2.040	
			H_2O 18.016				6.926	3.463	$C_5H_{12\ 72.146}$	0.63	0.083	0.415	0.996	
						16.804	57.882	20.767	MW =	20.02002				
			BALANCE			103.23	100.07	99.90	TOTAL			16.278	57.840	20.788

WEIGHT BALANCE		
	#/hr Measured	At Wt. Balance
WET GAS	263.51	323.00
OIL	63.91	63.91
WATER	145.68	145.68
TOTAL	473.10	532.59
FRESH FEED	532.59	
WEIGHT BALANCE	88.83	
WET GAS FACTOR	1225759	
INDICATED LOSS—S C F H	913	

WET GAS				
$CO_{28.010}$	6.31	6.17	6.68	6.387
$H_{2\ 2.016}$	36.55	35.82	35.44	35.937
$CO_{2\ 44.010}$	29.71	33.33	33.87	32.304
$N_{2\ 28.016}$	1.42	1.63	1.49	1.513
$CH_{4\ 16.042}$	12.40	10.25	10.12	10.923
$C_2H_{4\ 28.052}$	2.79	2.52	2.59	2.633
$C_2H_{6\ 30.068}$	1.96	1.93	1.92	1.937
$C_3H_{6\ 42.078}$	3.45	3.12	3.25	3.273
$C_3H_{8\ 44.094}$	0.41	0.28	0.37	0.353
$C_4H_{8\ 56.104}$	2.49	2.30	2.17	2.320
$C_4H_{10\ 58.120}$	0.72	0.89	0.66	0.757
$C_5H_{10\ 70.130}$	1.18	1.12	0.98	1.093
$C_5H_{12\ 72.146}$	0.26	0.25	0.16	0.223
$C_6H_{12\ 84.158}$	0.35	0.39	0.30	0.347
			M. W.	24.72153

GAS FLOW RATES									
		$\sqrt{H}$	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR
FRESH FEED			412.3	72	2250753			
			1.50	66	1171044			
WET GAS								
	158.44	5.895	4.025	0.9943	1.0821	4,045	10.659	
			411.6	127				
RECYCLE								
	79.31	8.482	20.647	0.9412	1.0821	14,146	37.275	
BLEED								
	5.02	8.182	20.647	1.0000	1.0821	918	2.419	
			442.3	201	1446052			
NATURAL GAS								
	28.43	7.668	21.378	0.8870	1.2025	4,971	13.099	
			438.7	73				
OXYGEN								
	27.07	6.909	21.293	0.9877		3,933	10.364	
			30.6					
STEAM			4.7					
	215.7	3.759	34.7 0.2917		237 #/hr.			

LIQUID PRODUCT RATES Basis 19 hours							
HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	6'0¾"	320.94	54	1.0030	321.90	52.2	2064.34	
	2'6¾"	135.80	68	0.9961	135.27	6.413	867.49	
					42.73		17.50	63.91
					189.36		1214.35	9.966
WATER	7'3"	384.23	74	0.99846	383.64	10.7	3179.22	
	1'11½"	102.89	73	0.99858	102.74	8.287	851.41	
	2'6"	133.50	66	0.99942	133.42		1105.65	
	1'6¾"	80.37	68	0.99920	80.31		665.53	145.68
					334.01		2767.93	17.579

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 63-D
HOURS 48-72
CATALYST Mill Scale Red. at Brownsville

FRESH FEED	%	m/hr	#/hr
CO 28.010	37.043	15.511	434.47
H_2 2.016	60.237	25.224	50.85
CO_2 44.010	2.300	0.963	42.38
N_2 28.016	0.243	0.102	2.86
CH_4 16.042	0.177	0.074	1.19
C_2H_4 28.052			
C_2H_6 30.068			
C_3+C_4			
C_3H_6 42.078			
C_3H_8 44.094			
C_4H_8 56.104			
C_4H_{10} 58.120			
C_5H_{10} 70.130			
C_5H_{12} 72.146			
C_6H_{12} 84.156			
C_5-C_6			
TOTAL		41.874	531.74
H_2+CO	97.280	40.735	15459 SCFH
H_2/CO		1.63	Factor 646872

WET GAS	%	At Wt. Balance m/hr	At Wt. Balance #/hr
CO 28.010	6.530	0.858	24.03
H_2 2.016	36.277	4.765	9.60
CO_2 44.010	30.750	4.037	177.65
N_2 28.016	1.520	0.200	5.60
CH_4 16.042	11.500	1.511	24.24
C_2H_4 28.052	2.667	0.350	9.82
C_2H_6 30.068	2.173	0.285	8.57
C_3H_6 42.078	3.690	0.485	20.41
C_3H_8 44.094	0.320	0.042	1.85
C_4H_8 56.104	2.373	0.312	17.50
C_4H_{10} 58.120	0.720	0.095	5.52
C_5H_{10} 70.130	0.987	0.130	9.12
C_5H_{12} 72.146	0.243	0.032	2.31
C_6H_{12} 84.156	0.250	0.033	2.78
C_5-C_6			
TOTAL		13.135	319.00
H_2+CO		5.623	
H_2/CO		5.55	

RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE	#/hr
2.657	18.168	3.515	-14.653	-410.44
14.759	39.983	19.524	-20.459	-41.25
12.511	13.474	16.548	3.074	135.27
0.618	0.720	0.818	.	
4.679	4.753	6.190	1.437	23.05
1.085	1.085	1.435	0.350	9.82
0.884	0.884	1.169	0.285	8.57
				41.44
1.501	1.501	1.986	0.485	20.41
0.130	0.130	0.172	0.042	1.85
0.965	0.965	1.277	0.312	17.50
0.293	0.293	0.388	0.095	5.52
0.402	0.402	0.532	0.130	9.12
0.099	0.099	0.131	0.032	2.31
0.102	0.102	0.135	0.033	2.78
				59.49
40.685	82.559	62.031		
17.416	58.151	23.039	-35.112	
5.55	2.20	5.55	1.40	

YIELD BASIS H_2+CO FED	#/MCF	#/gal	gal/hr	gal/MCF
CONDENSATE				
	1.491			
	0.635			
	0.554			
	2.690			
	1.320	4.32	4.725	0.306
	0.120	4.24	0.436	0.028
	1.132	5.00	3.500	0.226
	0.357	4.86	1.136	0.073
	0.590	5.45	1.673	0.108
	0.149	5.25	0.440	0.028
	0.180	5.54	0.502	0.032
	3.848		12.412	0.801
	0.842		1.665	0.108
	8.864		24.171	1.562
	8.747		16.233	1.050
	9.589		17.998	1.158
	11.544			

YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*	CORRECTED HEMPEL, %	gal/hr	TREATING RECOVERY, %	gal/hr
400 EP	80.0	8.075	98.0	7.914
400-550	10.4	1.050	91.4	0.960
550 +	9.6	0.969	114.6	1.110

	RECOVERY %	#/hr	gal/hr
PROPYLENE	45.4	9.27	
C_3 POLY GASO.	87.5	8.11	1.356
C_3 POLY TAR	12.5	1.16	0.154

	#/gal	#/hr	gal/hr	RVP
C_4H_8	5.00	0.45	0.090	68.0
C_4 POLY GASO.	5.98	14.92	2.495	1.5
C_4H_{10}	4.86	5.52	1.136	68.0
C_4 FREE GASO.			11.885	5.8
C_4 POLY TAR	7.53	2.13	0.283	

	gal/hr	gal/MCF	Bbl/Day
10 # RVP 400 EP GASOLINE	15.606	1.0095	5473
GAS OIL	0.960	0.0621	337
FUEL OIL	1.110	0.0718	389
POLY TAR	0.437	0.0283	153
TOTAL	18.113	1.1717	6352
W. S. CHEM.	1.665	0.1077	584
TOTAL	19.778	1.2794	6936

Weight Recovery, %	92.82	Catalyst Age, hrs.	72	Space Velocity, vhv	1096	RECOVERED OIL	0.460**	64.52
Pressure, psig	415	Inlet Velocity, Ft/sec	0.97	Catalyst Vol.CF	14.10	TOTAL OIL		124.01
Temperature, °F	655	Bed Depth, Ft	21.37	Weight, #	2228	WATER SOLUBLE CHEMICALS	0.245**	13.01
Recycle Ratio	0.97	Bed Density, #/CF	158	Effluent $(H_2)/(CO_2)$ Shift Ratio $(H_2O)/(CO)$	= 12.25	TOTAL LIQUID PRODUCTS C_5+		137.02
						NET WATER	7.506**	135.22
						GROSS WATER		148.23
						HYDROCARBON TOTAL—C_1+		178.46

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3+/C_1+
68.63	94.47	81.11	86.20	80.65	51.17	60.38	76.78

	9.749	8.022	22.506	1.454
	0.842		1.665	0.108
	8.864		24.171	1.562
	8.747		16.233	1.050
	9.589		17.998	1.158
	11.544			

Form ML—11

**Included in Reactor Effluent Total

g/NCM = 16.91 × #/MCF

*9488 MCFH H_2+CO, Bbl/Day = 5421.6 × gal/MCF

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	443	Fresh Feed	15,891
Natural Gas	445	Recycle	15,440
Generator Outlet	420	Combined Feed	31,331
Reactor Inlet	415	Wet Gas—Measured	4,388
Condenser Inlet		Adjusted	4,984
Product Accumulator	364	Loss	596
TEMPERATURES—°F.		Recycle/Fresh Feed	0.97
Oxygen	503	Inlet Velocity—ft./sec.	0.97
Natural Gas	796	Fresh Feed Rate = S.C.F.H. H_2+CO	15459
Generator	2267	per Cu. Ft. Dense Bed	1096
Quench Accumulator	153	per Lb. Catalyst	6.94
Reactor Inlet	338	per Sq. Ft.	23423
Condenser Inlet	577		
Product Accumulator	91		
Catalyst No. Height			
1 See Period A	557		
2	659		
3	653		
4	659		
5	663		
6	660		
7	649		
8	642		
9	636		
10	631		
11	516		

PRODUCT TESTS	OIL	WATER
°API	52.8	10.8
Neut. No.	44.0	33.0
Sap. No.	55.0	36.3
Hydrox. No.		
Bromine No.	88	
Pour °F.		
Chemicals, % by K_2CO_3		9.3
HEMPEL. DIST. %		°API
205 °F.		
400	79.0	55.8
400-550	10.4	36.0
550+	10.6	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	93	
10%	120	
50%	200	
90%	324	
EP	348	
Rec.	98	

CATALYST DATA		PARTICLE SIZE				
INVENTORY DATA		Screen Analysis			Sedimentation	
In Reactor at Start of Period		Mesh	Microns	%	Microns	%
Fresh Catalyst Added		On 40	419+		80+	
Total		100	150		40—80	
Catalyst Recovered	49	150	105		20—40	
In Reactor at End of Period		200	74		10—20	
		250	62		0—20	
REACTOR d-p, Inches H_2O		325	44			
No. Height		<325				
0 See Period A	-					
1	76	CATALYST				
2	81	Bulk Density, Lbs./Cu.Ft.				
3	82	Aerated				
4	380	Settled				
Total	619	Compacted				
		Particle Density, gm./cc.				
CALCULATED FROM dp		NH_3 Value, ml./gm.				
Density, Lbs./Cu.Ft.	158	N_2 Surface, m^2/gm.				
Inventory, Lbs.	2228					
Bed Depth, Ft.	21.37	CHEMICAL ANALYSIS				
Vol., Cu. Ft.	14.10	Fe				
		C				
		O				
		H				
		K_2O, W+, % basis Fe				
		X-Ray Analysis—				
		Fe_2C_9				
		Fe_3O_4				
		Fe				

GAS ANALYSES	1400	2200	0600	AVERAGE
HOUR				
FRESH FEED				
CO 28.010	36.94	37.02	37.17	37.043
H_2 2.016	60.19	60.37	60.15	60.237
CO_2 44.010	2.27	2.29	2.34	2.300
N_2 28.016	0.25	0.21	0.27	0.243
CH_4 16.042	0.35	0.11	0.07	0.177
			M. W	12.698825
			H_2O 18.016	
			BALANCE	
WET GAS				
CO 28.010	6.48	6.29	6.82	6.530
H_2 2.016	36.04	35.26	37.53	36.277
CO_2 44.010	32.01	32.91	27.33	30.750
N_2 28.016	1.49	1.29	1.78	1.520
CH_4 16.042	11.65	11.04	11.81	11.500
C_2H_4 28.052	2.55	2.73	2.72	2.667
C_2H_6 30.068	1.99	2.15	2.38	2.173
C_3H_6 42.078	3.57	3.57	3.93	3.690
C_3H_8 44.094	0.41	0.27	0.28	0.320
C_4H_8 56.104	2.12	2.30	2.70	2.373
C_4H_{10} 58.120	0.55	0.66	0.95	0.720
C_5H_{10} 70.130	0.79	1.00	1.17	0.987
C_5H_{12} 72.146	0.18	0.26	0.29	0.243
C_6H_{12} 84.156	0.17	0.27	0.31	0.250
			M. W.	24.28715

GENERATOR BALANCE	M/HR	C	H	O
FRESH FEED	15.511	15.511		15.511
	25.224		50.448	
	0.963	0.963		1.926
	0.102			
	0.074	0.074	0.296	
			7.525	3.763
		16.548	58.269	21.200
		101.92	100.98	98.69
WET GAS				
	6.530			
	36.277			
	30.750			
	1.520			
	11.500			
	2.667			
	2.173			
	3.690			
	0.320			
	2.373			
	0.720			
	0.987			
	0.243			
	0.250			
	100.000			

	Mol %	M/Hr	C	H	O
O_2 32.000	0.21	10.522 0.028			21.100
CO_2 44.010	1.44	0.191	0.191		0.382
N_2 28.016	1.79	0.237			
CH_4 16.042	82.33	10.918	10.918	43.672	
C_2H_6 30.068	6.80	0.902	1.804	5.412	
C_3H_8 44.094	5.28	0.700	2.100	5.600	
C_4H_{10} 58.120	1.55	0.206	0.824	2.060	
C_5H_{12} 72.146	0.60	0.080	0.400	0.960	
MW =	20.116332				
TOTAL			16.237	57.704	21.482

WEIGHT BALANCE	#/hr Measured	At Wt. Balance
WET GAS	280.83	319.00
OIL	64.52	64.52
WATER	148.23	148.23
TOTAL	493.58	531.75
FRESH FEED	531.75	
WEIGHT BALANCE	92.82	
WET GAS FACTOR	1135918	
INDICATED LOSS—S C F H	596	

GAS FLOW RATES	V"R	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR
FRESH FEED		415	70	2279738		
	6,463	20.729	0.9905	1.5099	15,891	41.874
WET GAS		1.51	64	1191988		
	6,325	4.026	0.9962	1.0918	4,388	11.563
RECYCLE		415.3	118			
	8,479	20.736	0.9485	1.0918	14,440	38.050
BLEED						
	8,800	20.736	1.0000	1.0918	1,000	2,635
NATURAL GAS		445	191	1439129		
	7,700	21.441	0.8938	1.1996	5,033	13.262
OXYGEN		442.6	70			
	6,963	21.385	0.9905		3,993	10.522
STEAM		30.1 4.7 34.8				
	3,354	0.2920		211 #/hr.		

LIQUID PRODUCT RATES	GAGE	GAL.	°F	FACTOR	GAL AT 60	API° #/GAL.	#	#/HR GAL HR
OIL	7'3½"	386.41	65	0.9975	385.44	52.8	2463.73	
	6'0½"	320.94	54	1.0030	321.90	6.392	2057.58	
	4'4"	231.47	53	1.0035	232.28		1484.73	
	1'1½"	57.39	72	0.9941	57.05		364.66	
					+3.48		+22.25	64.52
					242.25		1548.47	10.094
WATER	7'7"	401.69	76	0.99819	400.96	10.8	3320.75	
	2'6"	133.50	66	0.99942	133.42	8.282	1104.98	
	4'5½"	238.01	66	0.99942	237.87		1970.04	
	1'5½"	75.97	74	0.99846	75.85		628.19	148.23
					489.56		3557.62	17.898

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 63-E
HOURS 72-96
CATALYST Mill Scale Red. at Brownsville

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED								
					At Wt. Balance							CONDENSATE								
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*				
CO 28.010	36.603	15.284	428.08	7.167	0.897	25.12	2.884	18.168	3.781	-14.387	-402.96						CORRECTED HEMPEL, %	gal/hr	TREATING RECOVERY, %	gal/hr
H_2 2.016	60.827	25.397	51.20	35.947	4.501	9.08	14.467	39.864	18.968	-20.896	-42.12					400 EP	81.0	8.187	98.0	8.023
CO_2 44.010	2.193	0.916	40.30	31.870	3.991	175.65	12.825	13.741	16.816	3.075	135.35	8.767				400-550	11.2	1.132	91.4	1.035
N_2 28.016	0.220	0.092	2.58	2.243	0.281	7.87	0.903	0.995	1.184							550 +	7.8	0.789	114.6	0.904
CH_4 16.042	0.157	0.066	1.06	9.924	1.243	19.94	3.994	4.060	5.237	1.177	18.88	1.223								
C_2H_6 30.068				2.503	0.313	8.78	1.007	1.007	1.320	0.313	8.78	0.569					RECOVERY %	#/hr	gal/hr	
C_3H_6 42.078				2.103	0.263	7.91	0.846	0.846	1.109	0.263	7.91	0.512				PROPYLENE	47.6	8.75		
C_4+C_5											35.57	2.304				C_3 POLY GASO.	87.5	7.66	1.281	
C_3H_8 42.078				3.487	0.437	18.39	1.403	1.403	1.840	0.437	18.39	1.191	4.32	4.257	0.276	C_3 POLY TAR	12.5	1.09	0.145	
C_4H_8 44.094				0.287	0.036	1.59	0.115	0.115	0.151	0.036	1.59	0.103	4.24	0.375	0.024					
C_4H_{10} 58.104				2.260	0.283	15.88	0.909	0.909	1.192	0.283	15.88	1.029	5.00	3.176	0.206		#/gal	#/hr	gal/hr	RVP
C_5H_{10} 70.130				0.793	0.099	5.75	0.319	0.319	0.418	0.099	5.75	0.372	4.86	1.183	0.077	C_4H_8	5.00	0.02	0.004	68.0
C_5H_{12} 72.150				0.943	0.118	8.28	0.379	0.379	0.497	0.118	8.28	0.536	5.45	1.519	0.098	C_5 POLY GASO.	5.98	13.88	2.321	1.5
C_6H_{12} 84.162				0.233	0.029	2.09	0.094	0.094	0.123	0.029	2.09	0.135	5.25	0.398	0.026	C_4H_{10}	4.86	5.75	1.183	68.0
C_6H_{14} 86.178				0.240	0.030	2.52	0.097	0.097	0.127	0.030	2.52	0.163	5.54	0.455	0.029	C_4 FREE GASO.			11.676	5.8
C_5-C_6											54.50	3.529		11.363	0.736	C_4 POLY TAR	7.53	1.98	0.263	
TOTAL		41.755	523.22		12.521	308.85	40.242	81.997	60.942											
H_2+CO	97.430	40.681	15439 SCFH		5.398		17.351	58.032	22.749	-35.283							gal/hr	gal/MCF	Bbl/Day	
H_2/CO		1.66	Factor 647710		5.02		5.02	2.19	5.02	1.45						10 # RVP 400 EP GASOLINE	15.184	0.9335	5332	
Weight Recovery, %	94.39	Catalyst Age, hrs.	96	Space Velocity, vhv	1084	RECOVERED OIL	0.459**	64.40	4.171		10.108	0.655				GAS OIL	1.035	0.0670	363	
Pressure, psig	414	Inlet Velocity, Ft/sec	0.96	Catalyst Vol., CF	14.24	TOTAL OIL		118.90	7.700		21.471	1.391				FUEL OIL	0.904	0.0586	318	
Temperature, °F	656	Bed Depth, Ft	21.57	Weight, #	2221	WATER SOLUBLE CHEMICALS	0.310**	16.47	1.067		2.082	0.135				POLY TAR	0.408	0.0264	143	
Recycle Ratio	0.96	Bed Density, #/CF	156	Effluent Shift Ratio $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$	11.38	TOTAL LIQUID PRODUCTS C_5+		135.37	8.767		23.553	1.526				TOTAL	17.531	1.1355	6156	
FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY	NET WATER	7.410**	133.50	8.647		16.026	1.038		W. S CHEM.	2.082	0.1349	731	
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3+/C_1+	GROSS WATER		149.97	9.714		18.108	1.173		TOTAL	19.613	1.2704	6887	
70.01	94.13	82.28	86.73	79.19	52.42	60.80	79.19	HYDROCARBON TOTAL—C_4+		170.94	11.071									

Form ML—11

**Included in Reactor Effluent Total

#/NCM = 16.91 × #/MCF #488 MCFH H_2 + CO, Bbl/Day = 5421.6 × gal/MCF

OPERATING CONDITIONS				PRODUCT TESTS			CATALYST DATA					
PRESSURES PSIG		RATES S.C.F.H.			OIL	WATER	INVENTORY DATA		PARTICLE SIZE			
Oxygen	441	Fresh Feed	15,846						Screen Analysis		Sedimentation	
Natural Gas	445	Recycle	15,272	°API	53.4	10.8	In Reactor at Start of Period		Mesh	Microns	%	Microns	%
Generator Outlet	417	Combined Feed	31,118	Neut. No.	43.0	33.2	Fresh Catalyst Added		On 40	419+		80+	
Reactor Inlet	414	Wet Gas—Measured	4,300	Sap. No.	56.7	36.2	Total		100	150		40—80	
Condenser Inlet		Adjusted	4,752	Hydrox. No.			Catalyst Recovered	42	150	105		20—40	
Product Accumulator	362	Loss	452	Bromine No.	96		In Reactor at End of Period		200	74		10—20	
				Pour °F.					250	62		0—20	
				Chemicals, % by K_2CO_3		11.5	REACTOR d-p, Inches H_2O		325	44			
							No. Height						
TEMPERATURES—°F.		Recycle/Fresh Feed	0.96				0 See Period A	-	<325				
Oxygen	502	Inlet Velocity—ft./sec.	0.96				1	75	CATALYST				
Natural Gas	792	Fresh Feed Rate—$\frac{S.C.F.H_2}{H_2+CO}$	15439	HEMPEL. DIST. %		°API	2	79	Bulk Density, Lbs./Cu.Ft.				
Generator	2259	per Cu.Ft. Dense Bed	1084	205 °F.			3	83	Aerated				
Quench Accumulator	137	per Lb. Catalyst	6.95	400	80.0	55.8	4	380	Settled				
Reactor Inlet	331	per Sq. Ft.	23392	400-550	11.2	35.4	Total	617	Compacted				
Condenser Inlet	578			550+	8.8				Particle Density, gm./cc.				
Product Accumulator	88						CALCULATED FROM dp		NH_3 Value, ml./gm.				
Catalyst No. Height				A. S. T. M. DIST. ON			Density, Lbs./Cu.Ft.	156	N_2 Surface, m^2/gm.				
1	567			Naphtha °F.			Inventory, Lbs.	2221					
2	659			IBP	83		Bed Depth, Ft.	21.57	CHEMICAL ANALYSIS				
3	654			10%	124		Vol., Cu. Ft.	14.24	Fe				
4	659			50%	201				C				
5	663			90%	326				O				
6	661			EP	384				H				
7	650			Rec.	97.5				K_2O, W+, % basis Fe				
8	643								X-Ray Analysis—				
9	637								$Fe_{20}C_9$				
10	632								Fe_3O_4				
11	517								Fe				

	GAS ANALYSES				GENERATOR BALANCE										WEIGHT BALANCE		
HOUR	1400	2200	0600	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		#/hr Measured	At Wt. Balance
FRESH FEED									O_2 32.000	0.29	10.495 0.038			21.066	WET GAS	279.50	308.85
CO 28.010	35.93	36.97	36.91	36.603	15.284	15.284		15.284	CO_2 44.010	1.24	0.164	0.164		0.328	OIL	64.40	64.40
H_2 2.016	61.19	60.69	60.60	60.827	25.397		50.794		N_2 28.016	1.98	0.262				WATER	149.97	149.97
CO_2 44.010	2.38	2.02	2.18	2.193	0.916	0.916		1.832	CH_4 16.042	61.91	10.825	10.825	43.300		TOTAL	493.87	523.22
N_2 28.016	0.29	0.16	0.21	0.220	0.092				C_2H_6 30.068	7.24	0.957	1.914	5.742		FRESH FEED	523.22	
CH_4 16.042	0.21	0.16	0.10	0.157	0.066	0.066	0.264		C_3H_8 44.094	5.51	0.728	2.184	5.824		WEIGHT BALANCE	94.39	
			M. W	12.53073					C_5H_{12} 86.120	1.35	0.178	0.712	1.780				
			H_2O 18.016				7.450	3.725	C_6H_{12} 72.146	0.48	0.063	0.315	0.756		WET GAS FACTOR	1105008	
						16.266	58.508	20.841	MW = 20.070666						INDICATED LOSS—S C F H	452	
			BALANCE			100.94	101.93	97.42	TOTAL			16.114	57.402	21.394			

WET GAS					GAS FLOW RATES								LIQUID PRODUCT RATES								
CO 28.010	6.66	7.16	7.68	7.167		$\sqrt{T}$	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL HR
H_2 2.016	36.64	35.68	35.52	35.947	FRESH FEED		414.0	63	2310319			OIL	7'3½"	386.41	58	1.0010	386.80	53.4	2464.30	
CO_2 44.010	31.96	31.53	32.12	31.870	79.31	6.367	20.705	0.9971	1.5200	15,846	41.755		4'4"	231.47	53	1.0035	232.28	6.371	1479.86	
N_2 28.016	1.72	1.72	3.29	2.243	WET GAS		1.50	60	1173628				2'7"	138.11	49	1.0054	138.86		884.68	
CH_4 16.042	10.76	10.25	8.76	9.924	158.44	6.225	4.025	1.0000	1.0833	4,300	11.331		1'0"	52.00	52	1.0039	52.20		332.57	
C_2H_6 28.052	2.61	2.49	2.41	2.503	RECYCLE		412.8	119									+1.41		+9.00	64.40
C_3H_8 33.068	2.09	2.13	2.09	2.103	79.31	8.483	20.676	0.9477	1.0833	14,281	37.631						242.59		1545.55	10.108
C_3H_8 42.078	3.42	3.64	3.40	3.487	BLEED															
C_4H_8 44.094	0.30	0.28	0.28	0.287	5.02	8.813	20.676	1.0000	1.0833	991	2.611	WATER	7'3"	384.23	74	0.99846	383.64	10.8	3177.31	
C_4H_{10} 58.104	1.98	2.62	2.18	2.260	NATURAL GAS		445.3	196	1442403				4'5½"	238.01	66	0.99942	237.87	8.282	1970.04	
C_5H_{10} 68.120	0.61	0.85	0.92	0.793	28.43	7.692	21.447	0.8903	1.2010	5,015	13.215		6'2 5/8"	330.22	66	0.99942	330.03		2733.31	
C_5H_{12} 70.130	0.84	1.11	0.88	0.943	OXYGEN		440.6	64					0'9½"	41.26	70	0.99896	41.22		341.38	149.97
C_6H_{12} 72.162	0.16	0.26	0.28	0.233	27.07	6.921	21.338	0.9262		3,985	10.495						434.58		3599.20	18.108
C_6H_{14} 86.186	0.25	0.28	0.19	0.240	STEAM		29.9 4.7 34.6													
			M. W.	24.66709	215.7	2.950	0.2913		185 #/hr.											

RUN NO. 63-F
HOURS 96-120
CATALYST Mill Scale Red. at Brownsville

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS At Wt. Balance m/hr	WET GAS At Wt. Balance #/hr	RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF
CO 28.010	37.247	15.639	438.04	7.447	0.983	27.53	3.012	18.651	3.995	-14.656	-410.51				
H_2 2.016	60.526	25.413	51.23	36.844	4.861	9.80	14.899	40.312	19.760	-20.552	-41.43				
CO_2 44.010	1.917	0.805	35.43	31.634	4.174	183.67	12.793	13.598	16.967	3.369	148.24	9.515			
N_2 28.016	0.217	0.091	2.55	1.940	0.256	7.17	0.785	0.876	1.041						
CH_4 16.042	0.093	0.039	0.63	9.763	1.288	20.66	3.948	3.987	5.236	1.249	20.03	1.286			
C_2H_4 28.052				2.663	0.351	9.85	1.077	1.077	1.428	0.351	9.85	0.632			
C_2H_6 30.068				1.777	0.234	7.04	0.719	0.719	0.953	0.234	7.04	0.452			
C_1+C_2											36.92	2.370			
C_3H_6 42.078				3.420	0.451	18.98	1.383	1.383	1.834	0.451	18.98	1.218	4.32	4.394	0.282
C_3H_8 44.094				0.317	0.042	1.85	0.128	0.128	0.170	0.042	1.85	0.119	4.24	0.436	0.028
C_4H_8 56.104				2.143	0.283	15.88	0.867	0.867	1.150	0.283	15.88	1.019	5.00	3.176	0.204
C_4H_{10} 58.120				0.703	0.093	5.41	0.284	0.284	0.377	0.093	5.41	0.347	4.86	1.113	0.071
C_5H_{10} 70.130				0.893	0.118	8.28	0.361	0.361	0.479	0.118	8.28	0.531	5.45	1.519	0.098
C_5H_{12} 72.146				0.213	0.028	2.02	0.086	0.086	0.114	0.028	2.02	0.130	5.25	0.385	0.025
C_6H_{12} 84.156				0.243	0.032	2.69	0.098	0.098	0.130	0.032	2.69	0.173	5.54	0.486	0.031
C_3-C_6											55.11	3.537		11.509	0.739
TOTAL		41.987	527.88		13.194	320.83	40.440	82.427	61.606						
H_2+CO	97.773	41.052	15579	SCFH	5.844		17.911	58.963	23.755	-35.208					
H_2/CO		1.62	Factor 641889		4.95		4.95	2.16	4.95	1.40					

YIELD BASIS H_2+CO FED — YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*

	CORRECTED HEMPEL, %	gal/hr	TREATING RECOVERY, %	gal/hr
400 EP	82.2	7.887	98.0	7.729
400-550	9.6	0.921	91.4	0.842
550 +	8.2	0.788	114.6	0.903

	RECOVERY %	#/hr	gal/hr
PROPYLENE	45.3	8.60	
C_3 POLY GASO.	87.5	7.52	1.258
C_3 POLY TAR	12.5	1.08	0.143

	#/gal	#/hr	gal/hr	RVP
C_4H_8	5.00	0.23	0.046	68.0
C_4 POLY GASO.	5.98	13.69	2.290	1.5
C_4H_{10}	4.86	5.41	1.113	68.0
C_4-FREE GASO.			11.377	5.8
C_4 POLY TAR	7.53	1.96	0.260	

	gal/hr	gal/MCF	Bbl/Day
10 # RVP 400 EP GASOLINE	14.826	0.9517	5160
GAS OIL	0.842	0.0540	293
FUEL OIL	0.903	0.0580	314
POLY TAR	0.403	0.0259	140
TOTAL	16.974	1.0896	5907
W. S. CHEM.	1.938	0.1244	674
TOTAL	18.912	1.2140	6581

							m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF
Weight Recovery, %	92.80	Catalyst Age, hrs.	120	Space Velocity, vhv	1095	RECOVERED OIL	0.436**	61.17	3.926		9.596	0.616
Pressure, psig	413	Inlet Velocity, Ft/sec	0.97	Catalyst Vol., CF	14.23	TOTAL OIL		116.28	7.463		21.105	1.355
Temperature, °F	656	Bed Depth, Ft	21.56	Weight, #	2191	WATER SOLUBLE CHEMICALS	0.288**	15.30	0.982		1.938	0.124
Recycle Ratio	0.96	Bed Density, #/CF	154	Effluent Shift Ratio $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$	= 11.58	TOTAL LIQUID PRODUCTS C_3+		131.58	8.445		23.043	1.479
						NET WATER	7,248**	130.58	8.382		15.676	1.006
						GROSS WATER		145.88	9.364		17.614	1.130
						HYDROCARBON TOTAL—C_1+		168.50	10.816			

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
68.58	93.71	80.87	85.76	78.58	50.98	59.71	78.09

Form ML—11 **Included in Reactor Effluent Total g/NCM = 16.91 × #/MCF *9488 MCFH H_2 + CO, Bbl/Day = 5421.6 × gal/MCF

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	441	Fresh Feed	15,934
Natural Gas	446	Recycle	15,347
Generator Outlet	416	Combined Feed	31,281
Reactor Inlet	413	Wet Gas—Measured	4,414
Condenser Inlet		Adjusted	5,007
Product Accumulator	362	Loss	593
TEMPERATURES—°F.		Recycle/Fresh Feed	0.96
Oxygen	478	Inlet Velocity—ft./sec.	0.97
Natural Gas	781	Fresh Feed Rate—S.C.F.H. H_2 + CO	15579
Generator	2282	per Cu. Ft. Dense Bed	1095
Quench Accumulator	153	per Lb. Catalyst	7.11
Reactor Inlet	318	per Sq. Ft.	23605
Condenser Inlet	582		
Product Accumulator	91		
Catalyst No. Height			
1 See Period A	564		
2	657		
3	650		
4	657		
5	663		
6	662		
7	653		
8	647		
9	640		
10	636		
11	519		

Heat Transfer Calculations
Steam Rate = 164 #/hr.
@705 psia & 506°F =
= 1201 Btu/#
Water in @54°F = 22 Btu/#
Net Heat Trans./# steam =
(1179)(164) = 193,356 Btu/hr.
Ave. Bed Temp. = 656°F
dT = 656-506 = 150°F
Tube Area = 37.8 sq. ft.
$K = \frac{193,356}{(37.8)(150)} = 34.1$ Btu/°F/sq.ft.

PRODUCT TESTS

	OIL	WATER
°API	53.3	10.8
Neut. No.	41.8	34.5
Sap. No.	55.5	37.0
Hydrox. No.		
Bromine No.	95	
Pour °F.		
Chemicals, % by K_2CO_3		11.0
HEMPEL, DIST. %		°API
205 °F.		
400	81.2	56.1
400-550	9.6	35.2
550+	9.2	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	94	
10%	128	
50%	212	
90%	330	
EP	384	
Rec.	96.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	
Total	
Catalyst Recovered	28
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height	
0 See Period A	
1	74
2	80
3	80
4	375
Total	609
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	154
Inventory, Lbs.	2191
Bed Depth, Ft.	21.56
Vol., Cu. Ft.	14.23

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+		80+	
100	150		40—80	
150	105		20—40	
200	74		10—20	
250	62		0—20	
325	44			
<325				

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	
Settled	
Compacted	
Particle Density, gm./cc.	
NH_3 Value, ml./gm.	
N_2 Surface, m^2/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, W+. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES / GENERATOR BALANCE

HOUR	1300	2200	0600	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	37.25	37.29	37.20	37.247	15.639	15.639		15.639
H_2 2.016	60.57	60.52	60.49	60.526	25.413		50.826	
CO_2 44.010	1.84	1.89	2.02	1.917	0.805			1.610
N_2 28.016	0.24	0.20	0.21	0.217	0.091			
CH_4 16.042	0.10	0.10	0.08	0.093	0.039	0.039	0.156	
			M. W	12.572474			6.888	4.279
			H_2O 18.016				7.723	3.862
						16.483	58.705	21.111
			BALANCE			101.40	101.44	98.06

	Mol %	M/Hr	C	H	O
O_2 32.000	0.20	10.551 0.026			21.154
CO_2 44.010	1.41	0.187	0.187		0.374
N_2 28.016	1.19	0.158			
CH_4 16.042	82.85	10.967	10.967	43.868	
C_2H_6 30.068	7.00	0.927	1.854	5.562	
C_3H_8 44.094	5.37	0.711	2.133	5.688	
C_4H_{10} 58.120	1.48	0.196	0.784	1.960	
C_5H_{12} 72.146	0.50	0.066	0.330	0.792	
MW=	20.00224				
TOTAL			16.255	57.870	21.528

WEIGHT BALANCE

	#/hr Measured	At Wt. Balance
WET GAS	282.82	320.83
OIL	61.17	61.17
WATER	145.88	145.88
TOTAL	489.87	527.88
FRESH FEED	527.88	
WEIGHT BALANCE	92.80	
WET GAS FACTOR	1134396	
INDICATED LOSS—S C F H	593	
	5007	

WET GAS	1300	2200	0600	AVERAGE
CO 28.010	7.60	7.22	7.52	7.447
H_2 2.016	36.44	37.14	36.95	36.844
CO_2 44.010	31.88	31.53	31.49	31.634
N_2 28.016	2.36	1.74	1.72	1.940
CH_4 16.042	9.25	10.10	9.94	9.763
C_2H_4 28.052	2.43	2.77	2.79	2.663
C_2H_6 30.068	1.87	1.65	1.81	1.777
C_3H_6 42.078	3.32	3.34	3.60	3.420
C_3H_8 44.094	0.31	0.31	0.33	0.317
C_4H_8 56.104	2.25	2.12	2.06	2.143
C_4H_{10} 58.120	0.83	0.71	0.57	0.703
C_5H_{10} 70.130	0.96	0.89	0.83	0.893
C_5H_{12} 72.146	0.25	0.24	0.15	0.213
C_6H_{12} 84.156	0.25	0.24	0.24	0.243
			M. W.	24.315996

GAS FLOW RATES

	√H	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR
FRESH FEED 79.31	6.433	413.0 / 20.681	65 / 0.9952	2392649 / 1.5174	15,934	41.987
WET GAS 158.44	6.350	1.53 / 4.029	62 / 0.9981	1190574 / 1.0911	4,414	11.631
RECYCLE 79.31	8.508	412.5 / 20.669	122 / 0.9452	1.0911	14,383	37.900
BLEED 5.02	8.513	20.669	1.0000	1.0911	964	2.540
NATURAL GAS 28.43	7.700	445.7 / 21.457	198 / 0.8890	1447337 / 1.2031	5,024	13.238
OXYGEN 27.07	6.979	440.5 / 21.335	67 / 0.9933		4,004	10.551
STEAM 215.7	2.633	29.3 / 4.7 / 0.2889		164 #/hr.		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL. HR
OIL	6'10 1/8"	364.59	53	1.0035	365.87	53.3	2332.42	
	2'7"	138.11	49	1.0054	138.86	6.375	885.23	
					+3.29		+21.00	61.17
					230.30		1468.19	9.596
WATER	7'3"	384.23	67	0.99932	383.97	10.8		
	6'2 5/8"	330.22	66	0.99942	330.03	8.282		
	7'3 1/2"	385.32	68	0.99920	385.01			
	0'7"	30.98	72	0.99872	30.94			
	1'11 3/4"	104.04	62	0.99982	104.02			
	1'8 1/2"	89.24	53	1.00052	89.29			145.88
					482.74		3501.13	17.614

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 63-G
HOURS 120-144
CATALYST Mill Scale Red. at Brownsville

FRESH FEED	%	m/hr	#/hr
CO 28.010	37.203	15.777	441.89
H_2 2.016	60.417	25.621	51.64
CO_2 44.010	2.140	0.908	39.96
N_2 28.016	0.160	0.068	1.91
CH_4 16.042	0.080	0.034	0.55
C_2H_4 28.052			
C_2H_6 30.068			
C_3+C_4			
C_3H_6 42.078			
C_3H_8 44.094			
C_4H_8 56.104			
C_4H_{10} 58.120			
C_5H_{10} 70.130			
C_5H_{12} 72.146			
C_6H_{12} 84.156			
C_5+C_6			
TOTAL		42.408	535.95
H_2+CO	97.620	41.398	15711 SCFH
H_2/CO		1.62	Factor 636496

WET GAS	%	At Wt. Balance m/hr	At Wt. Balance #/hr
CO 28.010	7.810	1.052	29.47
H_2 2.016	36.584	4.929	9.94
CO_2 44.010	31.410	4.232	186.25
N_2 28.016	1.710	0.230	6.44
CH_4 16.042	9.640	1.299	20.84
C_2H_4 28.052	2.553	0.344	0.65
C_2H_6 30.068	1.973	0.266	8.00
C_3H_6 42.078	3.447	0.464	19.52
C_3H_8 44.094	0.313	0.042	1.85
C_4H_8 56.104	2.373	0.320	17.95
C_4H_{10} 58.120	0.613	0.083	4.82
C_5H_{10} 70.130	1.077	0.145	10.17
C_5H_{12} 72.146	0.187	0.025	1.80
C_6H_{12} 84.156	0.310	0.042	3.53
C_5+C_6			
TOTAL		13.473	330.23
H_2+CO		5.981	
H_2/CO		4.68	

RECYCLE	COMBINED FEED	EFFLUENT
m/hr	m/hr	m/hr
3.137	18.914	4.189
14.693	40.314	19.622
12.615	13.523	16.847
0.687	0.755	0.917
3.872	3.906	5.171
1.025	1.025	1.369
0.792	0.792	1.058
1.384	1.384	1.848
0.126	0.126	0.168
0.953	0.953	1.273
0.246	0.246	0.329
0.433	0.433	0.578
0.075	0.075	0.100
0.125	0.125	0.167
40.163	82.571	61.606
17.830	59.228	23.811
4.68	2.13	4.68

NET CHANGE	
m/hr	#/hr
-14.725	-412.42
-20.692	-41.70
3.324	146.29
1.265	20.29
0.344	9.65
0.266	8.00
	37.94
0.464	19.52
0.042	1.85
0.320	17.95
0.083	4.82
0.145	10.17
0.025	1.80
0.042	3.53
	59.64
12.383	0.790
-35.417	
1.41	

YIELD BASIS H_2+CO FED — CONDENSATE			
#/MCF	#/gal	gal/hr	gal/MCF
9.311			
1.291			
0.614			
0.509			
2.414			
1.242	4.32	4.519	0.288
0.118	4.24	0.436	0.028
1.143	5.00	3.590	0.229
0.307	4.86	0.992	0.063
0.647	5.48	1.866	0.119
0.115	5.25	0.343	0.022
0.225	5.54	0.637	0.041
3.797		12.383	0.790
7.255**		130.71	8.320
9.300		17.631	1.122
10.985		172.59	

YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*	CORRECTED HEMPEL. %	gal/hr	TREATING RECOVERY %	gal/hr
400 EP	83.0	7.732	98.0	7.577
400-550	10.6	0.988	91.4	0.903
550 +	6.4	0.596	114.6	0.683

	RECOVERY %	#/hr	gal/hr
PROPYLENE	44.4	8.67	
C_3 POLY GASO.	87.5	7.59	1.269
C_3 POLY TAR	12.5	1.08	0.143

	#/gal	#/hr	gal/hr	RVP
C_4H_8	5.00	1.08	0.216	68.0
C_4 POLY GASO.	5.98	14.76	2.468	1.5
C_4H_{10}	4.86	4.82	0.992	68.0
C_4 FREE GASO.			11.692	5.8
C_4 POLY TAR	7.53	2.11	0.280	

	gal/hr	gal/MCF	Bbl/Day
10 # RVP 400 EP GASOLINE	15.368	0.9782	5303
GAS OIL	0.903	0.0575	312
FUEL OIL	0.683	0.0435	236
POLY TAR	0.423	0.0269	146
TOTAL	17.377	1.1061	5997
W. S. CHEM.	1.939	0.1234	669
TOTAL	19.316	1.2295	6666

Weight Recovery, %	92.47	Catalyst Age, hrs.	144	Space Velocity, vhv	1114
Pressure, psig	416	Inlet Velocity, Ft/sec	0.97	Catalyst Vol, CF	14.10
Temperature, °F	656	Bed Depth, Ft	21.37	Weight, #	2200
Recycle Ratio	0.95	Bed Density, #/CF	156	Effluent $(H_2)(CO_2)$ / Shift Ratio $(H_2O)(CO)$	= 10.88

RECOVERED OIL	0.425**
TOTAL OIL	
WATER SOLUBLE CHEMICALS	0.290**
TOTAL LIQUID PRODUCTS C_5+	
NET WATER	
GROSS WATER	
HYDROCARBON TOTAL—C_1+	

FRESH FEED CONVERSION — %			
Contraction	CO	H_2	H_2+CO
68.23	93.33	80.76	85.55

TOTAL FEED CONVERSION — %			
CO	H_2	$CO+H_2$	C_5+/C_1+
77.85	51.33	59.80	78.02

SELECTIVITY
7.255**
8.320
9.300
10.985

Form ML—11

**Included in Reactor Effluent Total

g/NCM = 16.91 × #/MCF *948 MCFH H_2+CO, Bbl/Day = 5421.6 × gal/MCF

OPERATING CONDITIONS

PRESSURES PSIG	
Oxygen	446
Natural Gas	452
Generator Outlet	422
Reactor Inlet	416
Condenser Inlet	
Product Accumulator	367
TEMPERATURES—°F.	
Oxygen	469
Natural Gas	785
Generator	2293
Quench Accumulator	152
Reactor Inlet	326
Condenser Inlet	584
Product Accumulator	95
Catalyst No. Height	
1 See Period A	-
2	655
3	651
4	658
5	662
6	661
7	654
8	649
9	641
10	637
11	523

RATES S.C.F.H.	
Fresh Feed	16,094
Recycle	15,242
Combined Feed	31,336
Wet Gas—Measured	4,488
Adjusted	5,113
Loss	625
Recycle/Fresh Feed	0.95
Inlet Velocity—ft./sec.	0.97
Fresh Feed Rate = SCFH / H_2+CO	15711
per Cu. Ft. Dense Bed	1114
per Lb. Catalyst	7.14
per Sq. Ft.	23805

Heat Transfer Calculations

Steam Rate = 160#/hr.

@705 psia & 506°P. =

1201 Btu/#

Water in @60°P. = 28 Btu/#

Net Heat Transferred/# steam =

1173 Btu

(1173)(160) = 187,680 Btu/hr.

Ave. Bed Temp. = 656°F.

dT = 656-506 = 150°F.

Tube Area = 37.7 sq. ft.

$K = \frac{187,680}{(37.7)(150)} = 33.2$ Btu/°F./sq. ft.

PRODUCT TESTS

	OIL	WATER
°API	52.6	10.7
Neut. No.	43.9	34.6
Sap. No.	55.0	36.6
Hydrox. No.		
Bromine No.	86	
Pour °F.		
Chemicals, % by K_2CO_3		11.0

HEMPEL DIST. %		°API
205 °F.		
400	82.0	55.3
400-550	10.6	33.3
550+	7.4	

A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	98	
10%	128	
50%	213	
90%	343	
EP	386	
Rec.	97.0	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	
Total	
Catalyst Recovered	38
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height	
See Period A	
1	76
2	80
3	80
4	375
Total	611
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	156
Inventory, Lbs.	2200
Bed Depth, Ft.	21.37
Vol., Cu. Ft.	14.10

PARTICLE SIZE — Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+		80+	
100	150		40—80	
150	105		20—40	
200	74		10—20	
250	62		0—20	
325	44			
<325				

CATALYST

Bulk Density, Lbs./Cu.Ft.

Aerated

Settled

Compacted

Particle Density, gm./cc.

NH_3 Value, ml./gm.

N_2 Surface, m^2/gm.

CHEMICAL ANALYSIS

Fe

C

O

H

K_2O. W+. % basis Fe

X-Ray Analysis—

$Fe_{20}C_9$

Fe_3O_4

Fe

GAS ANALYSES	1400	2200	0600	AVERAGE
HOUR				
FRESH FEED				
CO 28.010	37.17	37.23	37.21	37.203
H_2 2.016	60.51	60.47	60.27	60.417
CO_2 44.010	2.04	2.10	2.28	2.140
N_2 28.016	0.14	0.15	0.19	0.160
CH_4 16.042	0.14	0.05	0.05	0.080
			M. W	12.63804
			H_2O 18.016	
			BALANCE	
WET GAS				
CO 28.010	7.46	8.12	7.85	7.810
H_2 2.016	37.32	36.18	36.25	36.584
CO_2 44.010	30.30	31.58	32.35	31.410
N_2 28.016	1.35	1.91	1.87	1.710
CH_4 16.042	10.69	9.08	9.15	9.640
C_2H_4 28.052	2.66	2.43	2.57	2.553
C_2H_6 30.068	2.02	1.94	1.96	1.973
C_3H_6 42.078	3.56	3.31	3.47	3.447
C_3H_8 44.094	0.32	0.30	0.32	0.313
C_4H_8 56.104	2.35	2.57	2.20	2.373
C_4H_{10} 58.120	0.46	0.80	0.58	0.613
C_5H_{10} 70.130	1.05	1.21	0.97	1.077
C_5H_{12} 72.146	0.16	0.24	0.16	0.187
C_6H_{12} 84.156	0.30	0.33	0.30	0.310
			M. W.	24.51075

GENERATOR BALANCE

M/HR	C	H	O
15.777	15.777		15.777
25.621		51.242	
0.908	0.908		1.816
0.068			
0.034	0.034	0.136	
		7.571	3.836
	16.719	58.949	21.429
	101.88	101.14	98.71

	Mol %	M/Hr	C	H	O
O_2 32.000	0.28	10.675 / 0.037			21.424
CO_2 44.010	1.08	0.143	0.143		0.286
N_2 28.016	1.44	0.191			
CH_4 16.042	82.30	10.902	10.902	43.608	
C_2H_6 30.068	7.09	0.939	1.878	5.634	
C_3H_8 44.094	5.55	0.735	2.205	5.880	
C_4H_{10} 58.120	1.60	0.212	0.848	2.120	
C_5H_{12} 72.146	0.66	0.087	0.435	1.044	
MW =	20.156026				
TOTAL			16.411	58.286	21.710

GAS FLOW RATES

	VTR	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR
		416	67	2290703		
FRESH FEED						
79.31	6.504	20.753	0.9933	1.5135	16,094	42.408
		1.50	66	1181114		
WET GAS						
158.44	6.513	4.025	0.9943	1.0868	4,488	11.826
		416.5	126			
RECYCLE						
79.31	8.454	20.765	0.9420	1.0868	14,254	37.560
BLEED						
5.02	8,721	20.765	1.0000	1.0868	988	2.603
		451.8	203	1436295		
NATURAL GAS						
28.43	7.713	21.599	0.8856	1.1985	5,027	13.246
		446.0	71			
OXYGEN						
27.07	7.046	21.464	0.9896		4,051	10.675
		29.0				
		4.7				
STEAM		33.7				
215.7	2.579	0.2878		160 #/hr.		

WEIGHT BALANCE

	#/hr Measured	At Wt. Balance
WET GAS	289.86	330.23
OIL	59.61	59.61
WATER	146.11	146.11
TOTAL	495.58	535.95
FRESH FEED	535.95	
WEIGHT BALANCE	92.47	
WET GAS FACTOR	1139274	
INDICATED LOSS—S C F H	625	

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR. GAL. HR
OIL	7'0½"	373.32	52	1.0039	374.78	52.6	2398.22	
	6'10¾"	364.59	53	1.0035	365.87	6.399	2341.20	
	5'0"	266.38	52	1.0038	267.42		1711.22	
	1'11"	56.30	50	1.0049	56.58		362.06	
					+3.83		+24.50	59.61
					223.58		1430.68	9.316
WATER	7'3⅜"	387.50	80	0.99759	386.57	10.7	3803.51	
	1'11¼"	104.04	62	0.99982	104.02	8.287	862.01	
	3'7⅝"	193.88	68	0.99920	193.66		1604.86	
	1'10½"	53.06	60	1.00000	53.06		439.71	146.11
					423.15		3506.85	17.631

RUN NO. 63-H
HOURS 144-168
CATALYST Mill Scale Reduced at Brownsville

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

FRESH FEED	%	m/hr	#/hr	WET GAS	%	At Wt. Balance m/hr	At Wt. Balance #/hr	RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr
CO 28.010	37.203	15.684	439.31	7.460	1.014	28.40		3.022	18.706	4.036	-14.670	-410.91
H_2 2.016	60.340	25.438	51.28	36.930	5.020	10.12		14.958	40.396	19.978	-20.418	-41.16
CO_2 44.010	2.147	0.905	39.83	31.484	4.280	188.37		12.753	13.658	17.033	3.375	148.54
N_2 28.016	0.187	0.079	2.21	1.650	0.224	6.28		0.668	0.747	0.892		
CH_4 16.042	0.123	0.052	0.84	10.020	1.362	21.85		4.059	4.111	5.421	1.310	21.01
C_2H_4 28.052				2.554	0.347	9.73		1.035	1.035	1.382	0.347	9.73
C_2H_6 30.068				1.920	0.261	7.85		0.778	0.778	1.039	0.261	7.85
C_1+C_2												38.59
C_3H_6 42.078				3.360	0.457	19.23		1.361	1.361	1.818	0.457	19.23
C_3H_8 44.094				0.293	0.040	1.76		0.119	0.119	0.159	0.040	1.76
C_4H_8 56.104				2.193	0.298	16.72		0.888	0.888	1.186	0.298	16.72
C_4H_{10} 58.120				0.717	0.097	5.64		0.290	0.290	0.387	0.097	5.64
C_5H_{10} 70.130				0.943	0.128	8.98		0.382	0.382	0.510	0.128	8.98
C_5H_{12} 72.146				0.213	0.029	2.09		0.086	0.086	0.115	0.029	2.09
C_6H_{12} 84.156				0.263	0.036	3.03		0.107	0.107	0.143	0.036	3.03
C_3+C_4												57.45
TOTAL		42.158	533.47		13.593	330.05		40.506	82.664	62.078		
H_2+CO	97.543	41.122	15606 SCFH		6.034			17.980	59.102	24.014	-35.088	
H_2/CO		1.62	Factor 640779		4.95			4.95	2.16	4.95	1.39	

Weight Recovery, %	93.29	Catalyst Age, hrs.	168	Space Velocity, vhv	1102	RECOVERED OIL	0.405** 56.76
Pressure, psig	415	Inlet Velocity, Ft/sec	0.97	Catalyst Vol., CF.	14.16	TOTAL OIL	114.21
Temperature, °F	657	Bed Depth, Ft	21.46	Weight, #	2166	WATER SOLUBLE CHEMICALS	0.291** 15.45
Recycle Ratio	0.96	Bed Density, #/CF	153	Effluent $(H_2)(CO_2)$ / Shift Ratio $(H_2O)(CO)$ =	11.58	TOTAL LIQUID PRODUCTS C_3+	129.66

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY	NET WATER	7.283** 131.21
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3^+/C_1^+	GROSS WATER	146.66
67.76	93.53	80.27	85.33	78.42	50.54	59.37	77.06	HYDROCARBON TOTAL—C_1+	168.25

YIELD BASIS H_2+CO FED	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF
	9.518			
	1.346			
	0.623			
	0.503			
	2.472			
	1.232	4.32	4.451	0.285
	0.113	4.24	0.415	0.027
	1.071	5.00	3.344	0.214
	0.361	4.86	1.160	0.074
	0.575	5.45	1.648	0.106
	0.134	5.25	0.398	0.026
	0.194	5.54	0.547	0.035
	3.680		11.963	0.767
	3.637		8.846	0.567
	7.317		20.809	1.334
	0.990		1.947	0.125
	8.307		22.756	1.459
	8.408		15.751	1.009
	9.398		17.698	1.134
	10.781			

YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*	CORRECTED HEMPEL, %	gal/hr	TREATING RECOVERY, %	gal/hr
400 EP	83.0	7.342	98.0	7.195
400-550	11.2	0.991	91.4	0.906
550 +	5.8	0.513	114.6	0.588

	RECOVERY %	#/hr	gal/hr
PROPYLENE	44.1	8.48	
C_3 POLY GASO.	87.5	7.42	1.241
C_3 POLY TAR	12.5	1.06	0.141

	#/gal	#/hr	gal/hr	RVP
C_4H_8	5.00	-	-	68.0
C_4 POLY GASO.	5.98	12.38	2.446	1.5
C_4H_{10}	4.86	5.64	1.160	68.0
C_4 FREE GASO.			11.029	5.8
C_4 POLY TAR	7.53	2.09	0.278	

	gal/hr	gal/MCF	Bbl/Day
10 # RVP 400 EP GASOLINE	14.635	0.9378	5084
GAS OIL	0.906	0.0581	315
FUEL OIL	0.588	0.0377	204
POLY TAR	0.419	0.0268	145
TOTAL	16.548	1.0604	5748
W. S. CHEM.	1.947	0.1248	677
TOTAL	18.495	1.1851	6425

Form ML—:1

**Included in Reactor Effluent Total

g/NCM = 16.91X#/MCF

*9488 MCFH H_2+CO, Bbl/Day = 5421.6 × gal/MCF

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	444	Fresh Feed	15,999
Natural Gas	450	Recycle	15,372
Generator Outlet	419	Combined Feed	31,371
Reactor Inlet	415	Wet Gas—Measured	4,599
Condenser Inlet		Adjusted	5,159
Product Accumulator	365	Loss	560
TEMPERATURES—°F.		Recycle/Fresh Feed	0.96
Oxygen	493	Inlet Velocity—ft./sec.	0.97
Natural Gas	812	Fresh Feed Rate—S.C.F.H. / H_2+CO	15606
Generator	2277	per Cu. Ft. Dense Bed	1102
Quench Accumulator	154	per Lb. Catalyst	7.20
Reactor Inlet	333	per Sq. Ft.	23645
Condenser Inlet	584		
Product Accumulator	94		
Catalyst No. Height			
1 See Period A			
2	656		
3	650		
4	660		
5 Average 657	663		
6	663		
7	656		
8	650		
9	643		
10	638		
11	524		

PRODUCT TESTS	OIL	WATER
°API	52.1	10.7
Neut. No.	44.7	34.2
Sap. No.	56.7	37.9
Hydrox. No.		
Bromine No.	86	
Pour °F.		
Chemicals, % by K_2CO_3		11.0
HEMPEL. DIST. %		°API
205 °F.		
400	82.0	54.6
400-550	11.2	35.2
550+	6.8	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	101	
10%	132	
50%	212	
90%	329	
EP	375	
Rec.	97.0	

CATALYST DATA		PARTICLE SIZE			
INVENTORY DATA		Screen Analysis		Sedimentation	
In Reactor at Start of Period		Mesh	Microns	%	Microns	%
Fresh Catalyst Added		On 40	419+		80+	
Total		100	150		40—80	
Catalyst Recovered	40	150	105		20—40	
In Reactor at End of Period		200	74		10—20	
		250	62		0—20	
REACTOR d-p, Inches H_2O		325	44			
No. Height		<325				
0 See Period A						
1	73	CATALYST				
2	81	Bulk Density, Lbs./Cu.Ft.				
3	78	Aerated				
4	370	Settled				
Total	602	Compacted				
		Particle Density, gm./cc.				
CALCULATED FROM dp		NH_3 Value, ml./gm.				
Density, Lbs./Cu.Ft.	153	N_2 Surface, m^2/gm.				
Inventory, Lbs.	2166					
Bed Depth, Ft.	21.46	CHEMICAL ANALYSIS				
Vol., Cu. Ft.	14.16	Fe				
		C				
		O				
		H				
		K_2O, W+. % basis Fe				
		X-Ray Analysis—				
		$Fe_{20}C_9$				
		Fe_3O_4				
		Fe				

GAS ANALYSES	1400	2200	0600	AVERAGE
HOUR				
FRESH FEED				
CO 28.010	37.24	37.03	37.34	37.203
H_2 2.016	60.37	60.42	60.23	60.340
CO_2 44.010	2.00	2.30	2.14	2.147
N_2 28.016	0.17	0.20	0.19	0.187
CH_4 16.042	0.22	0.05	0.10	0.123
			M. W	12.65403
			H_2O 18.016	
			BALANCE	

GENERATOR BALANCE	M/HR	C	H	O
FRESH FEED				
CO 28.010	15.684	15.684		15.684
H_2 2.016	25.438		50.876	
CO_2 44.010	0.905	0.905		1.810
N_2 28.016	0.079			
CH_4 16.042	0.052	0.052	0.208	
			7.503	3.752
		16.641	58.587	21.246
BALANCE		101.86	100.91	98.77

	Mol %	M/Hr	C	H	O
O_2 32.000	0.27	10.540 0.036			21.152
CO_2 44.010	1.36	0.179	0.179		0.358
N_2 28.016	0.83	0.110			
CH_4 16.042	83.02	10.955	10.955	43.820	
C_2H_6 30.068	6.90	0.911	1.822	5.466	
C_3H_8 44.094	5.45	0.719	2.157	5.752	
C_6H_{14} 86.120	1.56	0.206	0.824	2.060	
C_6H_{12} 72.146	0.61	0.080	0.400	0.960	
MW =	20.06012				
TOTAL			16.337	58.058	21.510

WEIGHT BALANCE	#/hr Measured	At Wt. Balance
WET GAS	294.25	330.05
OIL	56.76	56.76
WATER	146.66	146.66
TOTAL	497.67	533.47
FRESH FEED	533.47	
WEIGHT BALANCE	93.29	
WET GAS FACTOR	1121665	
INDICATED LOSS—S C F H	560	

WET GAS				
CO 28.010	7.38	7.47	7.53	7.460
H_2 2.016	37.23	37.12	36.44	36.930
CO_2 44.010	30.81	31.47	32.17	31.484
N_2 28.016	1.54	1.62	1.79	1.650
CH_4 16.042	10.43	9.93	9.70	10.020
C_2H_4 28.052	2.53	2.65	2.48	2.554
C_2H_6 30.068	1.90	1.95	1.91	1.920
C_3H_6 42.078	3.44	3.49	3.15	3.360
C_3H_8 44.094	0.31	0.29	0.28	0.293
C_4H_8 56.104	2.25	2.18	2.15	2.193
C_6H_{12} 86.120	0.70	0.54	0.91	0.717
C_5H_{10} 70.130	0.97	0.91	0.95	0.943
C_6H_{12} 72.146	0.23	0.15	0.26	0.213
C_6H_{12} 84.156	0.28	0.23	0.28	0.263
			M. W.	24.28001

GAS FLOW RATES	V̄R	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR
		414.9	70	2287808		
FRESH FEED	79.31	6.496	20.727	0.9905	1.5126	15.999	42.158
		1.51	68	1192338		
WET GAS	158.44	6.654	4.026	0.9924	1.0919	4.599	12.119
		414.8	126			
RECYCLE	79.31	8.500	20.724	0.9420	1.0919	14.370	37.866
BLEED	5.02	8.821	20.724	1.0000	1.0919	1.002	2.640
		449.9	204	1443162		
NATURAL GAS	28.43	7.688	21.555	0.8849	1.2013	5.008	13.196
		443.5	74			
OXYGEN	27.07	6.995	21.406	0.9868		4.000	10.540
STEAM	215.7	2.471					

LIQUID PRODUCT RATES	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL		7'3½"	386.41	70	0.9951	384.52	52.1	2467.08	
		5'0"	266.38	52	1.0039	267.42	6.416	1715.77	
		3'1⅝"	169.79	52	1.0039	170.45		1093.61	
		1'5¾"	77.06	72	0.9941	76.61		491.53	
						+1.36		+8.75	56.76
						212.30		1362.14	8.846
WATER		7'1⅝"	388.59	84	0.99692	387.39	10.7		
		3'0⅝"	193.82	68	0.99920	193.66	8.287		
		4'7½"	246.74	70	0.99896	246.48			
		0'3½"	15.49	79	0.99775	15.46			146.66
						424.75		3519.90	17.698

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 63-I
HOURS 168-192
CATALYST Mill Scale Red. at Brownsville

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS At Wt. Balance m/hr	WET GAS At Wt. Balance #/hr	RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF
CO 28.010	37.337	15.891	445.11	7.587	1.070	29.97	3.060	18.951	4.130	-14.821	-415.14				
H_2 2.016	60.323	25.674	51.76	37.974	5.355	10.80	15.316	40.990	20.671	-20.319	-40.96				
CO_2 44.010	1.987	0.846	37.23	30.707	4.331	190.60	12.386	13.232	16.717	3.485	153.37	9.723			
N_2 28.016	0.210	0.089	2.49	1.780	0.251	7.03	0.718	0.807	0.969						
CH_4 16.042	0.143	0.061	0.98	9.360	1.320	21.18	3.775	3.836	5.095	1.259	20.20	1.281			
C_2H_4 28.052				2.630	0.371	10.41	1.061	1.061	1.432	0.371	10.41	0.660			
C_2H_6 30.068				1.833	0.259	7.79	0.739	0.739	0.998	0.259	7.79	0.494			
C_1+C_2											38.40	2.435			
C_3H_6 42.078				3.083	0.435	18.30	1.244	1.244	1.679	0.435	18.30	1.160	4.32	4.236	0.269
C_3H_8 44.094				0.250	0.035	1.54	0.101	0.101	0.136	0.035	1.54	0.098	4.24	0.363	0.023
C_4H_8 56.104				2.280	0.322	18.07	0.920	0.920	1.242	0.322	18.07	1.146	5.00	3.614	0.229
C_4H_{10} 58.120				0.753	0.106	6.16	0.304	0.304	0.410	0.106	6.16	0.391	4.86	1.267	0.080
C_5H_{10} 70.130				1.113	0.157	11.01	0.449	0.449	0.606	0.157	11.01	0.698	5.45	2.020	0.128
C_5H_{12} 72.146				0.223	0.031	2.24	0.090	0.090	0.121	0.031	2.24	0.142	5.25	0.427	0.027
C_6H_{12} 84.156				0.427	0.060	5.05	0.172	0.172	0.232	0.060	5.05	0.320	5.54	0.912	0.058
C_3-C_6											62.37	3.955		12.839	0.814
TOTAL		42.561	537.57		14.103	340.15	40.335	82.896	62.124						
H_2+CO	97.660	41.565	15774	SCFH	6.425		18.376	59.941	24.801	-35.140					
H_2/CO		1.62	Factor 633954		5.01		5.01	2.16	5.01	1.37					

Weight Recovery, %	92.20	Catalyst Age, hrs.	192	Space Velocity, vhv	1126
Pressure, psig	412	Inlet Velocity, Ft/sec	0.98	Catalyst Vol., CF.	14.01
Temperature, °F	658	Bed Depth, Ft	21.23	Weight, #	2158
Recycle Ratio	0.95	Bed Density, #/CF	154	Effluent Shift Ratio $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$	= 11.98

	NET CHANGE m/hr	NET CHANGE #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL	0.394**	55.25	3.503		8.593	0.545
TOTAL OIL		117.62	7.458		21.432	1.359
WATER SOLUBLE CHEMICALS	0.308**	16.34	1.036		2.060	0.131
TOTAL LIQUID PRODUCTS C_3+		133.96	8.494		23.492	1.490
NET WATER	6.984**	125.83	7.977		15.106	0.958
GROSS WATER		142.17	9.013		17.166	1.088
HYDROCARBON TOTAL—C_1+		172.36	10.929			

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	$CO+H_2$	SELECTIVITY C_3+/C_1+
66.86	93.27	79.14	84.51	78.21	49.57	58.62	77.72

YIELD BASIS H_2+CO FED — YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*

	CORRECTED HEMPEL, %	gal/hr	TREATING RECOVERY, %	gal/hr
400 EP	82.0	7.047	98.0	6.906
400-550	11.2	0.962	91.4	0.879
550 +	6.8	0.584	114.6	0.669

	RECOVERY %	#/hr	gal/hr
PROPYLENE	42.9	7.85	
C_3 POLY GASO.	87.5	6.87	1.149
C_3 POLY TAR	12.5	0.98	0.130

	#/gal	#/hr	gal/hr	RVP
C_4H_8	5.00	-	-	68.0
C_4 POLY GASO.	5.98	15.81	2.644	1.5
C_4H_{10}	4.86	6.16	1.267	68.0
C_4-FREE GASO.			11.414	5.8
C_4 POLY TAR	7.53	2.26	0.300	

	gal/hr	gal/MCF	Bbl/Day
10 # RVP 400 EP GASOLINE	15.273	0.9682	5249
GAS OIL	0.879	0.0557	302
FUEL OIL	0.669	0.0424	230
POLY TAR	0.430	0.0273	148
TOTAL	17.251	1.0936	5929
W. S. CHEM.	2.060	0.1306	708
TOTAL	19.311	1.2242	6637

Form ML—11

**Included in Reactor Effluent Total

g/NCM = 16.91 × #/MCF   *9488 MCFH H_2 + CO, Bbl/Day = 5421.6 × gal/MCF

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	440	Fresh Feed	16,152
Natural Gas	448	Recycle	15,307
Generator Outlet	416	Combined Feed	31,459
Reactor Inlet	412	Wet Gas—Measured	4,692
Condenser Inlet		Adjusted	5,352
Product Accumulator	360	Loss	660
TEMPERATURES—°F.		Recycle/Fresh Feed	0.95
Oxygen	488	Inlet Velocity—ft./sec.	0.98
Natural Gas	790	Fresh Feed Rate—S.C.F.H. H_2 + CO	15774
Generator	2283	per Cu. Ft. Dense Bed	1126
Quench Accumulator	150	per Lb. Catalyst	7.31
Reactor Inlet	343	per Sq. Ft.	23900
Condenser Inlet	586		
Product Accumulator	96	Heat Transfer Calculations	
Catalyst No. / Height		Steam Rate = 414 #/hr.	
1 See Period A	-	@705 psia & 506°F. =	
2	658	1201 Btu/#	
3	650	Water in @ 70°F.= 38°F.	
4	660	Net Heat Transferred/# steam =	
5	665	= 1163 Btu	
6	665	(1163)(414) = 481,482 Btu/hr.	
7	658	Ave. Bed Temp. = 658°F.	
8	652	dT = 658-506 = 152°F.	
9	644	Tube Area = 37.7 sq. ft.	
10	640	$K = \frac{481,482}{(37.7)(152)} =$	
11	524	= 84.0 Btu/°F./sq. ft.	

PRODUCT TESTS

	OIL	WATER
°API	51.7	10.8
Neut. No.	44.8	34.6
Sap. No.	55.6	35.6
Hydrox. No.		
Bromine No.	86	
Pour °F.		
Chemicals, % by K_2CO_3		12.0
HEMPEL, DIST. %		°API
205 °F.		
400	81.0	54.2
400-550	11.2	35.6
550+	7.8	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	104	
10%	129	
50%	221	
90%	338	
EP	390	
Rec.	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	
Total	
Catalyst Recovered	20.5
In Reactor at End of Period	
REACTOR d-p, Inches H_2O No. / Height	
0 See Period A	-
1	73
2	87
3	74
4	365
Total	599
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	154
Inventory, Lbs.	2158
Bed Depth, Ft.	21.23
Vol., Cu. Ft.	14.01

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+		80+	
100	150		40—80	
150	105		20—40	
200	74		10—20	
250	62		0—20	
325	44			
<325				

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	
Settled	
Compacted	
Particle Density, gm./cc.	
NH_3 Value, ml./gm.	
N_2 Surface, m^2/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, W+. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES / GENERATOR BALANCE

HOUR	1400	2200	0600	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	37.37	37.48	37.16	37.337	15.891	15.891		15.891
H_2 2.016	60.29	60.13	60.55	60.323	25.674		51.348	
CO_2 44.010	1.91	2.08	1.97	1.987	0.846	0.846		1.692
N_2 28.016	0.22	0.24	0.17	0.210	0.089			
CH_4 16.042	0.21	0.07	0.15	0.143	0.061	0.061	0.244	
			M. W	12.63046				
			H_2O 18.016				7.406	3.703
						16.798	58.998	21.286
			BALANCE			101.34	100.41	99.44

	Mol %	M/Hr	C	H	O
O_2 32.000	0.24	10.503 0.032			21.070
CO_2 44.010	1.27	0.168	0.168		0.336
N_2 28.016	0.37	0.049			
CH_4 16.042	83.23	11.003	11.003	44.012	
C_2H_6 30.068	6.96	0.920	1.840	5.520	
C_3H_8 44.094	5.49	0.726	2.178	5.808	
C_4H_{10} 58.120	1.69	0.223	0.892	2.230	
C_5H_{12} 72.146	0.75	0.099	0.495	1.188	
MW=	20.127959				
TOTAL			16.576	58.758	21.406

WEIGHT BALANCE

	#/hr Measured	At Wt. Balance
WET GAS	298.21	340.15
OIL	55.25	55.25
WATER	142.17	142.17
TOTAL	495.63	537.57
FRESH FEED	537.57	
WEIGHT BALANCE	92.20	
WET GAS FACTOR	1140639	
INDICATED LOSS—S C F H	660	

WET GAS	1400	2200	0600	AVERAGE
CO 28.010	7.63	7.62	7.51	7.587
H_2 2.016	38.61	37.05	38.26	37.974
CO_2 44.010	29.98	31.47	30.67	30.707
N_2 28.016	1.58	1.68	2.08	1.780
CH_4 16.042	9.84	0.29	8.95	9.360
C_2H_4 28.052	2.64	2.61	2.64	2.630
C_2H_6 30.068	1.82	1.90	1.78	1.833
C_3H_6 42.078	3.31	2.90	3.04	3.083
C_3H_8 44.094	0.31	0.21	0.23	0.250
C_4H_8 56.104	2.22	2.38	2.24	2.280
C_4H_{10} 58.120	0.57	0.89	0.80	0.753
C_5H_{10} 70.130	1.04	1.23	1.07	1.113
C_5H_{12} 72.146	0.16	0.32	0.19	0.223
C_6H_{12} 84.156	0.29	0.45	0.54	0.427
			M. W.	24.11905

GAS FLOW RATES

	√H	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR
FRESH FEED 79.31	6.596	411.6 / 20.647	73 / 0.9877	2292078 / 1.5140	16,152	42.561
WET GAS 158.44	6.783	1.52 / 4.027	71 / 0.9896	1200296 / 1.0956	4,692	12.364
RECYCLE 79.31	8.508	412.3 / 20.664	128 / 0.9404	1.0956	14,366	37.855
BLEED 5.02	8.283	20.664	1.0000	1.0956	941	2.480
NATURAL GAS 28.43	7.717	448.2 / 21.515	202 / 0.8863	1438297 / 1.1993	5,017	13.220
OXYGEN 27.07	7.008	440.4 / 21.333	76 / 0.9850		3,986	10.503
STEAM 215.7	6.665	29.1 + 4.7 = 33.8 / 0.2882		414 #/hr.		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR / GAL HR
OIL	6'10 3/4"	365.68	60	1.0000	365.68	51.7	2351.32	
	3'1 7/8"	169.79	52	1.0039	170.45	6.430	1095.99	
					+11.00		+70.75	55.25
					206.23		1326.08	8.593
WATER	7'3 1/4"	385.32	80	0.99759	384.39	10.8		
	4'7 1/2"	246.74	70	0.99896	246.48	8.282		
	6'4"	336.22	75	0.99832	335.66			
	1'2 1/4"	61.74	80	0.99759	61.59			142.17
					411.98		3412.02	17.166

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 63-J
HOURS 192-216
CATALYST Mill Scale Red. at Brownsville

FRESH FEED	%	m/hr	#/hr
CO 28.010	37.800	15.878	444.72
H_2 2.016	59.747	25.096	50.59
CO_2 44.010	2.113	0.888	39.08
N_2 28.016	0.207	0.087	2.44
CH_4 16.042	0.133	0.056	0.90
C_2H_4 28.052			
C_3H_6 30.068			
C_4+C_5			
C_3H_8 42.078			
C_4H_8 44.094			
C_4H_8 56.104			
C_4H_{10} 58.120			
C_5H_{10} 70.130			
C_6H_{12} 72.146			
C_6H_{12} 84.156			
C_5-C_6			
TOTAL		42.005	537.73
H_2+CO	97.547	40.974	15550 SCFH
H_2/CO		1.58	Factor 643086

WET GAS	%	At Wt. Balance m/hr	At Wt. Balance #/hr
CO 28.010	8.150	1.204	33.72
H_2 2.016	38.803	5.732	11.56
CO_2 44.010	30.520	4.511	198.52
N_2 28.016	1.466	0.217	6.08
CH_4 16.042	9.366	1.384	22.20
C_2H_4 28.052	2.580	0.381	10.69
C_3H_6 42.078	1.797	0.265	7.97
C_3H_8 44.094	3.037	0.449	18.89
C_4H_8 56.104	0.287	0.042	1.85
C_4H_{10} 58.120	2.017	0.298	16.72
C_5H_{10} 70.130	0.570	0.084	4.88
C_6H_{12} 72.146	0.900	0.133	9.33
C_6H_{12} 84.156	0.247	0.036	2.60
C_7H_{14} 98.182	0.260	0.038	3.20
C_5-C_6			
TOTAL		14.774	348.21
H_2+CO	6.936		
H_2/CO	4.76		

RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE m/hr	NET CHANGE #/hr
3.342	19.220	4.546	-14.674	-411.00
15.910	41.006	21.642	-19.364	-39.03
12.514	13.402	17.025	3.623	159.44
0.601	0.688	0.818		
3.940	3.896	5.224	1.328	21.30
1.058	1.058	1.439	0.381	10.69
0.737	0.737	1.002	0.265	7.97
1.245	1.245	1.694	0.449	18.89
0.118	0.118	0.160	0.042	1.85
0.827	0.827	1.125	0.298	16.72
0.234	0.234	0.318	0.084	4.88
0.369	0.369	0.502	0.133	9.33
0.101	0.101	0.137	0.036	2.60
0.107	0.107	0.145	0.038	3.20
				57.47
41.003	83.008	63.294	-34.038	
19.252	60.226	26.188		
4.76	2.13	4.76	1.32	

YIELD BASIS H_2+CO FED	#/MCF	#/gal	gal/hr	gal/MCF
	0.513			
	2.570			
	1.215	4.32	4.373	0.281
	0.119	4.24	0.436	0.028
	0.314	4.86	1.004	0.065
	0.600	5.45	1.712	0.110
	0.167	5.25	0.495	0.032
	0.206	5.54	0.578	0.037
	3.696		11.942	0.768
	6.995		19.897	1.280
	0.914		1.902	0.116
	7.909		21.699	1.396
	6.883**		14.987	0.957
	8.389		16.689	1.073
	10.479			

YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*	CORRECTED HEMPEL. %	gal/hr	TREATING RECOVERY,%	gal/hr
400 EP	84.2	6.698	98.0	6.564
400-550	11.2	0.891	91.4	0.814
550 +	4.6	0.366	114.6	0.419
	RECOVERY %	#/hr	gal/hr	
PROPYLENE	40.1	7.57		
C_3 POLY GASO.	87.5	6.62	1.107	
C_3 POLY TAR	12.5	0.95	0.126	
	#/gal	#/hr	gal/hr	RVP
C_4H_8	5.00	0.50	0.100	68.0
C_4 POLY GASO.	5.98	14.19	2.373	1.5
C_4H_{10}	4.86	4.98	1.004	68.0
C_4 FREE GASO.			10.456	5.8
C_4 POLY TAR	7.53	2.03	0.270	
	gal/hr	gal/MCF	Bbl/Day	
10 # RVP 400 EP GASOLINE	13.933	0.8960	4858	
GAS OIL	0.814	0.0523	284	
FUEL OIL	0.419	0.0269	146	
POLY TAR	0.396	0.0255	138	
TOTAL	15.562	1.0007	5426	
W. S. CHEM.	1.802	0.1159	628	
TOTAL	17.364	1.1166	6054	

Weight Recovery, %	90.63	Catalyst Age, hrs.	216	Space Velocity, vhv	1112	RECOVERED OIL
Pressure, psig	409	Inlet Velocity, Ft/sec	0.99	Catalyst Vol., CF	13.99	TOTAL OIL
Temperature, °F	658	Bed Depth, Ft	21.19	Weight, #	2126	WATER SOLUBLE CHEMICALS
Recycle Ratio	0.98	Bed Density, #/CF	152	Effluent $(H_2)(CO_2)$ / Shift Ratio $(H_2O)(CO)$	11.78	TOTAL LIQUID PRODUCTS C_4+

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3+/C_1+
64.83	92.42	77.16	83.07	76.35	47.22	56.52	75.48

NET WATER	6.883**	124.01	7.975
GROSS WATER		138.22	8.389
HYDROCARBON TOTAL—C_1+		162.94	10.479

Form ML—11

**Included in Reactor Effluent Total

g/NCM = 16.91 X #/MCF

*9488 MCFH H_2+CO, Bbl/Day = 5421.6 X gal/MCF

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	439	Fresh Feed	15941
Natural Gas	447	Recycle	15561
Generator Outlet	414	Combined Feed	31502
Reactor Inlet	409	Wet Gas—Measured	4795
Condenser Inlet		Adjusted	5607
Product Accumulator	360	Loss	812
TEMPERATURES—°F.		Recycle/Fresh Feed	0.98
Oxygen	500	Inlet Velocity—ft./sec.	0.99
Natural Gas	791	Fresh Feed Rate—S.C.F.H.	15550
Generator	2270	per Cu. Ft. Dense Bed	1112
Quench Accumulator	147	per Lb. Catalyst	7.31
Reactor Inlet	342	per Sq. Ft.	23561
Condenser Inlet	590		
Product Accumulator	97	Heat Transfer Calculations	
Catalyst No. Height		Steam Rate = 407#/hr.	
1 See Period A		@705 psis & 506°F =	
2	658	1201 Btu/#	
3	650	Water in @69°F = 37 Btu/#	
4	660	Net Heat Trans./#steam	
5	665	1164 Btu	
6	665	(1164)(407) = 473,748 Btu/hr.	
7	660	Ave. Bed Temp.= 658°F.	
8	650	dT = 658-506 = 152°F	
9	646	Tube Area = 37.8 sq. ft.	
10	642	$K = \frac{473,748}{(37.8)(152)}$ =	
11	526	82.5 Btu/°F/sq.ft.	

PRODUCT TESTS	OIL	WATER
°API	51.2	10.8
Neut. No.	49.2	36.4
Sap. No.	61.0	40.2
Hydrox. No.		
Bromine No.	82	
Pour °F.		
Chemicals, % by K_2CO_3		12.0
HEMPEL. DIST. %		°API
205 °F.		
400	83.2	53.0
400-550	11.2	53.8
550+	5.6	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	102	
10%	132	
50%	218	
90%	339	
EP	389	
Rec.	97.0	

CATALYST DATA					
INVENTORY DATA		PARTICLE SIZE			
In Reactor at Start of Period		Screen Analysis		Sedimentation	
Fresh Catalyst Added		Mesh	Microns	%	Microns	%
Total		On 40	419+		80+	
Catalyst Recovered	33	100	150		40—80	
In Reactor at End of Period		150	105		20—40	
		200	74		10—20	
REACTOR d-p, Inches H_2O		250	62		0—20	
No. Height		325	44			
0 See Period A		<325				
1	74	CATALYST				
2	88	Bulk Density, Lbs./Cu.Ft.				
3	68	Aerated				
4	360	Settled				
Total	590	Compacted				
		Particle Density, gm./cc.				
CALCULATED FROM dp		NH_3 Value, ml./gm.				
Density, Lbs./Cu.Ft.	152	N_2 Surface, m^2/gm.				
Inventory, Lbs.	2126					
Bed Depth, Ft.	21.19	CHEMICAL ANALYSIS				
Vol., Cu. Ft.	13.99	Fe				
		C				
		O				
		H				
		K.O. W+. % basis Fe				
		X-Ray Analysis—				
		$Fe_{20}C_9$				
		Fe_2O_4				
		Fe				

GAS ANALYSES				
HOUR	1400	2200	0600	AVERAGE
FRESH FEED				
CO 28.010	37.77	37.74	37.89	37.800
H_2 2.016	59.70	59.77	59.77	59.747
CO_2 44.010	2.08	2.17	2.09	2.113
N_2 28.016	0.23	0.20	0.19	0.207
CH_4 16.042	0.22	0.12	0.06	0.133
			M. W	12.80154
			H_2O 18.016	
			BALANCE	

GENERATOR BALANCE	M/HR	C	H	O
	25.096		50.192	
	0.888	0.888		1.776
	0.087			
	0.056	0.056	0.224	
			7.510	3.755
		16.822	57.926	21.409
		102.93	99.87	100.17

	Mol %	M/Hr	C	H	O
O_2 32.000	0.26	10.472 0.034			21.012
CO_2 44.010	1.36	0.180	0.180		0.360
N_2 28.016	1.16	0.153			
CH_4 16.042	82.76	10.927	10.927	43.708	
C_2H_4 28.052	6.79	0.897	1.794	5.382	
C_3H_6 42.078	5.34	0.705	2.115	5.640	
C_4H_{10} 58.120	1.61	0.213	0.852	2.130	
C_6H_{12} 72.146	0.72	0.095	0.475	1.140	
MW =	20.13450				
TOTAL				16.343	58.000	21.372

WEIGHT BALANCE	#/hr Measured	At Wt. Balance
WET GAS	297.80	348.21
OIL	51.30	51.30
WATER	138.22	138.22
TOTAL	487.32	537.73
FRESH FEED	537.73	
WEIGHT BALANCE	90.63	
WET GAS FACTOR	1169274	
INDICATED LOSS—S C F H	812	

WET GAS				
CO 28.010	7.86	8.20	8.39	8.150
H_2 2.016	38.81	38.83	38.77	38.803
CO_2 44.010	30.22	30.62	30.72	30.520
N_2 28.016	1.49	1.45	1.46	1.466
CH_4 16.042	9.64	0.39	9.07	0.366
C_2H_4 28.052	2.53	2.57	2.64	2.580
C_3H_6 33.068	1.85	1.79	1.75	1.797
C_3H_8 42.078	3.14	2.98	2.99	3.037
C_4H_8 44.094	0.29	0.29	0.28	0.287
C_4H_8 56.104	2.13	1.94	1.98	2.017
C_4H_{10} 58.120	0.57	0.57	0.57	0.570
C_5H_{10} 70.130	0.96	0.87	0.87	0.900
C_6H_{12} 72.146	0.25	0.24	0.25	0.247
C_6H_{12} 84.156	0.26	0.26	0.26	0.260
			M. W.	23.569744

GAS FLOW RATES						
	V	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR
		408.8	71	2261446		
FRESH FEED	6.563	20.579	0.9896	1.5038	15,941	42.005
		1.51	71	1228269		
WET GAS	6.854	4.026	0.9896	1.1083	4,795	12.635
		410.8	128			
RECYCLE	8.529	20.628	0.9404	1.1083	14,543	38.321
BLEED	8.867	20.628	1.0000	1.1083	1,018	2.682
		446.9	200	1437830		
NATURAL GAS	7.708	21.485	0.8876	1.1991	5,011	13.204
		439.3	74			
OXYGEN	6.983	21.307	0.9868		3,974	10.472
		28.7				
STEAM		4.7				
	6.579	33.4 0.2866		407 #/hr.		

LIQUID PRODUCT RATES						
HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'1¾"	390.78	63	0.9985	390.19	51.2		
	6'10 31/64"	365.68	60	1.0000	365.68	6.448		
	3'4"	179.09	60	1.0000	179.09			
	0'4"	17.70	68	0.9961	17.63			
					+4.96		+32.00	51.30
					190.93		1231.12	7.955
WATER	7'3½"	386.41	74	0.99846	385.81	10.8		
	6'4"	336.22	75	0.99832	335.66	8.282		
	7'1¾"	377.68	77	0.99804	376.94			
	1'8 3/64"	90.37	69	0.99907	90.29			
	2'12¼"	115.92	76	0.99819	115.71			
	1'0"	52.00	64	0.99963	51.98			138.22
					400.53		3317.19	16.689

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 63-K
HOURS 216-240
CATALYST Mill Scale Red. at Brownsville

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS At Wt. Balance m/hr	WET GAS At Wt. Balance #/hr	RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr
CO 28.010	36.430	15.432	432.28	8.256	1.210	33.89	3.435	18.867	4.645	-14.222	-398.39
H_2 2.016	61.240	25.943	52.30	40.136	5.880	11.85	16.701	42.644	22.581	-20.063	-40.45
CO_2 44.010	1.927	0.816	35.91	28.863	4.229	186.08	12.010	12.826	16.239	3.413	150.17
N_2 28.016	0.263	0.111	3.11	1.397	0.205	5.74	0.581	0.692	0.786		
CH_4 16.042	0.140	0.059	0.95	9.376	1.374	22.04	3.901	3.960	5.275	1.315	21.09
C_2H_4 28.052				2.527	0.370	10.38	1.051	1.051	1.421	0.370	10.36
C_3H_6 42.078				1.837	0.269	8.09	0.764	0.764	1.033	0.269	8.09
C_4+C_5											39.56
C_3H_6 42.078				3.140	0.460	19.36	1.307	1.307	1.767	0.460	19.36
C_3H_8 44.094				0.327	0.048	2.12	0.136	0.136	0.184	0.048	2.12
C_4H_8 56.104				2.077	0.304	17.06	0.864	0.864	1.168	0.304	17.06
C_4H_{10} 58.120				0.647	0.095	5.52	0.269	0.269	0.364	0.095	5.52
C_5H_{10} 70.130				0.940	0.138	9.68	0.391	0.391	0.529	0.138	9.66
C_5H_{12} 72.146				0.177	0.026	1.88	0.074	0.074	0.100	0.026	1.88
C_5H_{12} 84.156				0.300	0.044	3.70	0.125	0.125	0.169	0.044	3.70
C_5+C_6											59.32
TOTAL		42.361	524.55		14.652	337.39	41.610	83.971	63.698		
H_2+CO	97.670	41.375	15701	SCFH	7.090		20.136	61.511	27.226	-34.285	
H_2/CO		1.63	Factor	636902	4.86		4.86	2.26	4.86	1.41	

YIELD BASIS H_2+CO FED — CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF
9.564			
1.343			
0.661			
0.515			
2.519			
1.233	4.32	4.481	0.285
0.135	4.24	0.500	0.032
1.087	5.00	3.412	0.217
0.352	4.86	1.136	0.072
0.617	5.45	1.776	0.113
0.120	5.25	0.358	0.023
0.236	5.54	0.668	0.043
3.780		12.331	0.785

YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*	CORRECTED HEMPEL, %	gal/hr	TREATING RECOVERY, %	gal/hr
400 EP	85.0	6.605	98.0	6.473
400-550	10.4	0.808	91.4	0.739
550 +	4.6	0.357	114.6	0.409
	RECOVERY %	#/hr	gal/hr	
PROPYLENE	40.8	7.90		
C_3 POLY GASO.	87.5	6.91	1.156	
C_3 POLY TAR	12.5	0.99	0.131	
	#/gal	#/hr	gal/hr	RVP
C_4H_8	5.00	-	-	68.0
C_4 POLY GASO.	5.98	14.93	2.496	i.5
C_4H_{10}	4.86	(5.52 5.45	(1.156) 1.121	68.0
C_4 FREE GASO.			10.431	5.8
C_4 POLY TAR	7.53	2.13	0.283	
	gal/hr	gal/MCF	Bbl/Day	
10 # RVP 400 EP GASOLINE	14.048	0.8947	4851	
GAS OIL	0.739	0.0471	255	
FUEL OIL	0.409	0.0260	141	
POLY TAR	0.414	0.0264	143	
TOTAL	15.610	0.9942	5390	
W. S. CHEM.	1.920	0.1159	628	
TOTAL	17.430	1.1101	6018	

Weight Recovery, %	92.84	Catalyst Age, hrs.	240	Space Velocity, vhv	1133	RECOVERED OIL	0.357**	50.08	3.190	7.770	0.495
Pressure, psig	409	Inlet Velocity, Ft/sec	1.01	Catalyst	Vol., CF 13.86	TOTAL OIL		109.40	6.970	20.101	1.280
Temperature, °F	661	Bed Depth, Ft	21.00	Weight, #	2079	WATER SOLUBLE CHEMICALS	0.272**	14.45	0.920	1.820	0.116
Recycle Ratio	0.99	Bed Density, #/CF	150	Effluent $(H_2)(CO_2)$ / Shift Ratio $(H_2O)(CO)$ =	11.60	TOTAL LIQUID PRODUCTS C_5+		123.85	7.890	21.921	1.396
						NET WATER	6.807**	122.63	7.810	14.722	0.938
						GROSS WATER		137.08	8.730	16.542	1.054
						HYDROCARBON TOTAL—C_1+		163.41	10.409		

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
65.41	92.16	77.33	82.86	75.38	47.05	55.74	75.79

Form ML—11

**Included in Reactor Effluent Total

g/NCM = 16.91 × #/MCF

*9488 MCFH H_2 + CO, Bbl/Day = 5421.6 × gal/MCF

OPERATING CONDITIONS		RATES S.C.F.H.	
PRESSURES PSIG			
Oxygen	438	Fresh Feed	16,076
Natural Gas	450	Recycle	15,891
Generator Outlet	414	Combined Feed	31,967
Reactor Inlet	409	Wet Gas—Measured	4,941
Condenser Inlet		Adjusted	5,560
Product Accumulator	359	Loss	619
		Recycle/Fresh Feed	0.99
TEMPERATURES—°F.		Inlet Velocity—ft./sec.	1.01
Oxygen	481	Fresh Feed Rate—S.C.F.H. H_2 + CO	15701
Natural Gas	787	per Cu. Ft. Dense Bed	1133
Generator	2294	per Lb. Catalyst	7.55
Quench Accumulator	124	per Sq. Ft.	23789
Reactor Inlet	358		
Condenser Inlet	593		
Product Accumulator	95	Heat Transfer Calculations	
Catalyst No. Height		Steam Rate = 404#/hr.	
1 See Period A	-	@705 psia & 506°F. =	
2	660	1201 Btu/#	
3	652	Water in @62°F = 30 Btu/#	
4	662	Net Heat Trans/# steam =	
5	668	1171 Btu	
6	667	(1171)(404) = 473,084 Btu/hr.	
7	662	Ave. Bed Temp. = 661°F.	
8	656	dT = 661-506 = 155°F.	
9	650	Tube Area = 37.6 sq. ft.	
10	646	K = 473,084 / (37.6)(155) =	
11	528	81.2 Btu/°F/sq.ft.	

PRODUCT TESTS	OIL	WATER
°API	51.3	10.7
Neut. No.	49.3	35.2
Sap. No.	61.0	39.0
Hydrox. No.		
Bromine No.	78	
Pour °F.		
Chemicals, % by K_2CO_3		11.0
HEMPEL. DIST. %		°API
205 °F.		
400	84.0	53.5
400-550	10.4	34.0
550+	5.6	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	98	
10%	130	
50%	220	
90%	334	
EP	394	
Rec.	37.4	

CATALYST DATA — INVENTORY DATA		PARTICLE SIZE Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
In Reactor at Start of Period						
Fresh Catalyst Added		On 40	419+		80+	
Total		100	150		40—80	
Catalyst Recovered	39.5	150	105		20—40	
In Reactor at End of Period		200	74		10—20	
		250	62		0—20	
REACTOR d-p, Inches H_2O		325	44			
No. Height		<325				
0 See Period A						
1	72	CATALYST				
2	87	Bulk Density, Lbs./Cu.Ft.				
3	68	Aerated				
4	350	Settled				
Total	577	Compacted				
		Particle Density, gm./cc.				
CALCULATED FROM dp		NH_3 Value, ml./gm.				
Density, Lbs./Cu.Ft.	150	N_2 Surface, m^2./gm.				
Inventory, Lbs.	2079					
Bed Depth, Ft.	21.00	CHEMICAL ANALYSIS				
Vol., Cu. Ft.	13.86	Fe				
		C				
		O				
		H				
		K_2O, W+, % basis Fe				
		X-Ray Analysis—				
		Fe_2C_6				
		Fe_3O_4				
		Fe				

GAS ANALYSES HOUR	1400	2200	0600	AVERAGE
FRESH FEED				
CO 28.010	36.51	36.50	36.28	36.430
H_2 2.016	61.00	61.27	61.45	61.240
CO_2 44.010	2.06	1.79	1.93	1.927
N_2 28.016	0.34	0.24	0.21	0.263
CH_4 16.042	0.09	0.20	0.13	0.140
			M. W.	12.38286
			H_2O 18.016	
			BALANCE	
WET GAS	8.20	7.98	8.59	8.256
H_2 2.016	39.74	40.53	40.14	40.136
CO_2 44.010	29.38	28.77	28.44	28.863
N_2 28.016	1.39	1.32	1.48	1.397
CH_4 16.042	9.23	9.69	9.21	9.376
C_2H_4 28.052	2.54	2.56	2.48	2.527
C_3H_6 33.056	1.86	1.81	1.84	1.837
C_3H_6 42.078	3.15	3.16	3.11	3.140
C_3H_8 44.094	0.33	0.33	0.32	0.327
C_4H_8 56.104	2.09	2.00	2.14	2.077
C_4H_{10} 58.120	0.58	0.57	0.79	0.647
C_5H_{10} 70.130	1.00	0.88	0.94	0.940
C_5H_{12} 72.146	0.14	0.14	0.25	0.177
C_5H_{12} 84.156	0.37	0.26	0.27	0.300
			M. W.	23.0271

GENERATOR BALANCE M/HR	C	H	O		Mol %	M/Hr	C	H	O
				O_2 32.000	0.21	10.406 0.028			20.872
15.432	15.432		15.432	CO_2 44.010	1.31	0.173	0.173		0.346
25.943		51.886		N_2 28.016	1.41	0.187			
0.816	0.816		1.632	CH_4 16.042	82.79	10.952	10.952	43.808	
0.111				C_2H_4 28.052	6.79	0.898	1.796	5.388	
0.059	0.059	0.236		C_3H_6 44.094	5.31	0.702	2.106	5.616	
				C_4H_{10} 58.120	1.56	0.206	0.824	2.060	
		7.021	3.511	C_5H_{12} 72.146	0.62	0.082	0.410	0.984	
	16.307	59.143	20.575	MW = 20.056914					
	100.28	102.22	96.97	TOTAL				16.261	57.856	21.218

WEIGHT BALANCE	#/hr Measured	At Wt. Balance
WET GAS	299.81	337.39
OIL	50.08	50.08
WATER	137.08	137.08
TOTAL	486.97	524.55
FRESH FEED	524.55	
WEIGHT BALANCE	92.84	
WET GAS FACTOR	1125346	
INDICATED LOSS—S C F H	619	

GAS FLOW RATES						
	VR	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR
FRESH FEED		408.7	68	2337909		
	6.492	20.577	0.9924	1.5290	16,076	42.361
WET GAS		1.50	68	1257214		
	6.963	4.025	0.9924	1.1213	4,941	13.020
RECYCLE		409.5	124			
	8.554	20.596	0.9436	1.1213	14,784	38.957
BLEED						
	8.688	20.596	1.0000	1.1213	1,007	2.653
NATURAL GAS		450.2	198	1443392		
	7.667	21.562	0.8890	1.2014	5,020	13.228
OXYGEN		437.9	89			
	6.917	21.274	0.9915		3,950	10.408
STEAM		29.1 4.7 33.8				
215.7	6.504	0.2882		404 #/hr.		

LIQUID PRODUCT RATES HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	6'9⅜"	360.22	57	1.0015	360.76	51.3		
	3'4"	179.09	60	1.0000	179.09	6.445		
					44.81		431.00	50.08
					186.48		1201.86	7.770
WATER	7'2¾"	383.14	78	0.99788	382.33	10.7		
	2'2½"	115.92	76	0.99819	115.71	8.287		
	3'7½"	193.28	71	0.99883	193.05			
	1'2½"	62.73	70	0.99896	62.66			137.08
					397.01		3290.02	16.542

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 63-L
HOURS 240-264
CATALYST

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE	
	%	m/hr	#/hr	%	At Wt. Balance m/hr	At Wt. Balance #/hr	m/hr	m/hr	m/hr	m/hr	#/hr
CO 28.010	37.170	15.763	441.53	9.120	1.408	39.44	3.825	19.588	5.233	-14.355	-402.09
H_2 2.016	60.604	25.701	51.81	41.153	6.354	12.81	17.260	42.961	23.614	-19.347	-39.00
CO_2 44.010	1.790	0.759	33.40	27.710	4.278	188.26	11.621	12.380	15.899	3.519	154.86
N_2 28.016	0.173	0.073	2.05	1.493	0.231	6.47	0.626	0.699	0.857		
CH_4 16.042	0.263	0.112	1.80	9.313	1.438	23.07	3.906	4.018	5.344	1.326	21.27
C_2H_6 28.052				2.417	0.373	10.46	1.014	1.014	1.387	0.373	10.46
C_3H_8 30.068				1.767	0.273	8.21	0.741	0.741	1.014	0.273	8.21
C_1+C_2											39.24
C_2H_4 42.078				2.790	0.431	18.14	1.170	1.170	1.601	0.431	18.14
C_3H_6 44.094				0.287	0.044	1.94	0.120	0.120	0.164	0.044	1.94
C_4H_8 56.104				1.863	0.288	16.16	0.781	0.781	1.069	0.288	16.16
C_5H_{10} 58.120				0.740	0.114	6.63	0.310	0.310	0.424	0.114	6.63
C_5H_{10} 70.130				0.830	0.128	8.98	0.348	0.348	0.476	0.128	8.98
C_6H_{12} 72.146				0.260	0.040	2.89	0.109	0.109	0.149	0.040	2.89
C_6H_{12} 84.156				0.257	0.040	3.37	0.108	0.108	0.148	0.040	3.37
C_3-C_6											58.11
TOTAL		42.408	530.59		15.440	346.83	41.939	84.347	64.543		
H_2+CO	97.774	41.464	15736	SCFH	7.762		21.085	62.549	28.847	-33.702	
H_2/CO		1.63	Factor 635485		4.51		4.51	2.19	4.51	1.35	

Weight Recovery, %	92.18	Catalyst Age, hrs.	264	Space Velocity, vhv	1149	RECOVERED OIL	0.35788	50.02	3.179	7.757	0.493
Pressure, psig	408	Inlet Velocity, Ft/sec	1.01	Catalyst Vol., CF	13.70	TOTAL OIL		108.13	6.872	19.816	1.260
Temperature, °F	661	Bed Depth, Ft	20.76	Weight, #	2041	WATER SOLUBLE CHEMICALS	0.31668	16.79	1.067	2.098	0.133
Recycle Ratio	0.99	Bed Density, #/CF	149	Effluent $(H_2)(CO_2)$ / Shift Ratio $(H_2O)(CO)$	11.05	TOTAL LIQUID PRODUCTS C_5+		124.92	7.939	21.914	1.393
						TOTAL WATER	6.49188	116.95	7.432	14.040	0.892
						GROSS WATER		133.74	8.499	16.138	1.025
						HYDROCARBON TOTAL—C_1+		164.86	10.478		

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
63.59	91.07	75.28	81.28	73.29	45.03	53.88	75.77

YIELD BASIS H_2+CO FED

CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF
9.841			
1.352			
0.665			
0.522			
2.539			
1.153	4.32	4.199	0.267
0.123	4.24	0.458	0.029
1.027	5.00	3.232	0.205
0.421	4.86	1.364	0.087
0.571	5.45	1.648	0.105
0.184	5.25	0.550	0.035
0.214	5.54	0.608	0.039
3.693		12.059	0.767

YIELDS BASIS BROWNSVILLE DESIGN FEED RATE*	CORRECTED MONPEL, %	gal/hr	TREATING RECOVERY, %	gal/hr
400 EP	86.2	6.687	98.0	6.553
400-550	3.2	0.636	91.4	0.581
550 +	5.6	0.434	114.6	0.497

	RECOVERY %	#/hr	gal/hr
PROPYLENE	38.6	7.00	
C_3 POLY GASO.	87.5	6.12	1.023
C_3 POLY TAR	12.5	0.88	0.117

	#/gal	#/hr	gal/hr	RVP
C_4H_8	5.00	-	-	68.0
C_4 POLY GASO.	5.98	14.14	2.365	i.5
C_4H_{10}	4.86	(5.53) 5.54	(1.354) 1.098	68.0
C_4 FREE GASO.			10.382	5.8
C_4 POLY TAR	7.53	2.02	0.268	

	gal/hr	gal/MCF	Bbl/Day
10 # RVP 400 EP GASOLINE	13.845	0.8798	4770
GAS OIL	0.581	0.0369	200
FUEL OIL	0.497	0.0316	171
POLY TAR	0.385	0.0245	133
TOTAL	15.308	0.9728	5274
W. S. CHEM.	2.098	0.1333	723
TOTAL	17.406	1.1061	5997

Form ML—11

**Included in Reactor Effluent Total

g/NCM = 16.91 × #/MCF

*9488 MCFH H_2 + CO, Bbl/Day = 5421.6 × gal/MCF

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	436	Fresh Feed	16,094
Natural Gas	459	Recycle	15,916
Generator Outlet	413	Combined Feed	32,010
Reactor Inlet	408	Wet Gas—Measured	5,159
Condenser Inlet		Adjusted	5,860
Product Accumulator	358	Loss	701
TEMPERATURES—°F.		Recycle/Fresh Feed	0.99
Oxygen	492	Inlet Velocity—ft./sec.	1.01
Natural Gas	765	Fresh Feed Rate—S.C.F.H. / 32 × 60	15,736
Generator	2264	per Cu. Ft. Dense Bed	1149
Quench Accumulator	109	per Lb. Catalyst	7.71
Reactor Inlet	353	per Sq. Ft.	23842
Condenser Inlet	597		
Product Accumulator	91	Heat Transfer Calculations	
Catalyst No. Height		Steam Rate = 399#/hr.	
1 See Period A	-	@705 psia & 506°F.=	
2	661	1201 Btu/#	
3	650	Water in @56°F = 24 Btu/#	
4	660	Net Heat Trans/# steam=	
5	668	1177 Btu	
6	668	(1177)(399) = 469,623 Btu/hr.	
7	663	Ave. Bed Temp. = 661°F.	
8	659	dT = 661-506 = 155°F.	
9	651	Tube AREA = 37.5 Sq. ft.	
10	648	K = 469,623 / (37.5)(155) = 80.8 Btu/°F.sq.ft.	
11			

PRODUCT TESTS	OIL	WATER
°API	51.2	10.7
Neut. No.	48.5	37.4
Sap. No.	65.1	39.2
Hydrox. No.		
Bromine No.	76	
Pour °F.		
Chemicals, % by K_2CO_3		13.0
HEMPEL. DIST. %		°API
205 °F.		
400	85.2	52.8
400-550	8.2	34.0
550+	6.6	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	98	
10%	128	
50%	210	
90%	330	
EP	394	
Rec.	97.9	

CATALYST DATA					
INVENTORY DATA		PARTICLE SIZE			
In Reactor at Start of Period		Screen Analysis		Sedimentation	
Fresh Catalyst Added		Mesh	Microns %	Microns	%
Total		On 40	419+	80+	
Catalyst Recovered	11	100	150	40—80	
In Reactor at End of Period		150	105	20—40	
		200	74	10—20	
REACTOR d-p, Inches H_2O		250	62	0—20	
No. Height		325	44		
0 See Period A	-	<325			
1	71	CATALYST			
2	90	Bulk Density, Lbs./Cu.Ft.			
3	65	Aerated			
4	340	Settled			
Total	566	Compacted			
		Particle Density, gm./cc.			
CALCULATED FROM dp		NH_3 Value, ml./gm.			
Density, Lbs./Cu.Ft.	149	N_2 Surface, m^2./gm.			
Inventory, Lbs.	2041				
Bed Depth, Ft.	20.76	CHEMICAL ANALYSIS			
Vol., Cu. Ft.	13.70	Fe			
		C			
		O			
		H			
		K_2O, W+, % basis Fe			
		X-Ray Analysis—			
		$Fe_{2.2}C_9$			
		Fe_3O_4			
		Fe			

GAS ANALYSES	1400	2200	0600	AVERAGE
HOUR				
FRESH FEED				
CO 28.010	37.12	37.44	36.95	37.170
H_2 2.016	60.55	60.41	60.85	60.604
CO_2 44.010	1.78	1.81	1.78	1.790
N_2 28.016	0.14	0.19	0.19	0.173
CH_4 16.042	0.41	0.15	0.23	0.263
			M. W	12.51153
			H_2O 18.016	
			BALANCE	
WET GAS				
CO 28.010	9.76	8.62	8.98	9.120
H_2 2.016	40.62	40.93	41.91	41.153
CO_2 44.010	27.21	28.32	27.60	27.710
N_2 28.016	1.26	1.71	1.51	1.493
CH_4 16.042	9.84	9.12	8.98	9.313
C_2H_6 28.052	2.39	2.38	2.48	2.417
C_2H_4 28.036	1.76	1.75	1.79	1.767
C_2H_2 26.078	2.75	2.83	2.79	2.790
C_3H_8 44.094	0.27	0.29	0.30	0.287
C_4H_8 56.104	1.94	1.90	1.75	0.863
C_5H_{12} 58.120	0.78	0.77	0.67	0.740
C_5H_{10} 70.130	0.89	0.85	0.75	0.830
C_6H_{14} 72.146	0.26	0.26	0.26	0.260
C_6H_{12} 84.156	0.27	0.27	0.23	0.257
			M. W.	22.46269

GENERATOR BALANCE							
	Mol %	M/Hr	C	H	O	M/HR	
O_2 32.000	0.23	10.472 / 0.031			21.006	15.763	15.763		15.763
CO_2 44.010	1.19	0.160	0.160		0.320	25.701		51.402	
N_2 28.016	1.39	0.186				0.759	0.759		1.518
CH_4 16.042	82.49	11.062	11.062	44.248		0.073			
C_2H_6 30.068	7.35	0.986	1.972	5.916		0.112	0.112	0.448	
C_3H_8 44.094	5.34	0.716	2.148	5.728					
C_4H_{10} 58.120	1.48	0.198	0.792	1.980					
C_6H_{12} 72.146	0.53	0.071	0.355	0.852				7.482	3.741
MW = 20.026955						16.634	59.332	21.022	
TOTAL			16.489	58.724	21.326	100.88	101.04	98.57	

GAS FLOW RATES						
	V	PRESSURE	TEMP.	M. W.	S. C. F. H.	M/HR
FRESH FEED		407.9	65	2313865		
WET GAS	6.521	20.557	0.9952	1.5211	16,094	42.408
		1.57	66	1288803		
RECYCLE	7.150	4.034	0.9943	1.1353	5,159	13.594
		407.9	123			
BLEED	8.546	20.557	0.9444	1.1353	14,939	39.365
NATURAL GAS	8.338	20.557	1.0000	1.1353	977	2.574
		458.6	202	1445551		
OXYGEN	7.721	21.755	0.8863	1.2023	5,089	13.410
	6.963	435.8	67			
STEAM		21.225	0.9933		3,974	10.472
		29.5 / 4.7 / 34.2				
	6,392	0.2897		399 #/hr.		

WEIGHT BALANCE	#/hr Measured	At Wt. Balance
WET GAS	305.36	346.83
OIL	50.02	50.02
WATER	133.74	133.74
TOTAL	489.12	530.59
FRESH FEED	530.59	
WEIGHT BALANCE	92.18	
WET GAS FACTOR	1135806	
INDICATED LOSS—S C F H	701	

LIQUID PRODUCT RATES						
HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'10"	371.14	54	1.0030	372.25	51.2		
	6'9½"	360.22	57	1.0015	360.76	6.448		
	3'7½"	193.28	54	1.0030	193.86			
	0'5½"	24.34	50	1.0049	24.46			
					45.27		+34.00	50.02
					186.16		120036	7.757
WATER	7'3⅝"	387.50	76	0.99819	386.80	10.7		
	3'7½"	193.28	71	0.99883	193.05	8.287		
	4'7⅝"	247.83	66	0.99942	247.69			
	1'0½"	54.14	63	0.99973	54.13			133.74
					387.31		3209.64	16.138