THE TEXAS COMPANY

REFINING DEPARTMENT
TECHNICAL & RESEARCH DIVISION

REPORT ON

SYNTHESIS OPERATIONS ON ALAN WOOD CATALYST UNDER BROWNSVILLE CONDITIONS

MONTEBELLO RUN 49

Laboratory MONTEBELLO

Report No. TDC-802-37-P

Date JANUARY 10, 1951

PERSONAL AND CONFIDENTIAL

STRICTLY CONFIDENTIAL

BRIEF OF PARTIAL REPORT

Laboratory Montebello	Experiment No. TDC-802
Date Approved January 10, 1951	Partial Report No. 37
Date Work Completed Aug. 17, 1949	Subject: Hydrocarbon Synthesis

Subject: Synthesis Operations on Alan Wood Catalyst Under Brownsville Conditions - Montebello Run 49

Object: To study the synthesis operation with Alan Wood Catalyst in the Montebello Reactor, revised to duplicate the vertical gas velocity gradient of the Brownsville reactor design.

Experimental Work: The reactor was changed in the following respects from that used in Runs 45-48: Approximately ten feet was added to the length of the 12-inch diameter reactor thus extending it eleven feet above the top of the three steam cooling tubes. This change made the reactor 29 feet tall. Run 49 was made with Alan Wood magnetite catalyst, 1.2 K_2O/100 Fe, at 650°F., 400 psig, and with a 1:1 recycle ratio using a fresh feed rate of 15 MCFH. These are equivalent to Brownsville design conditions. From 497 hours to 528 hours (the end of the run), the fresh feed rate was 11 MCFH.

Conclusions:

1. The data for Run 49 show that the catalyst level can be increased from the design level of about 10 feet to a maximum level of about 20 feet.

2. This increase in catalyst level resulted in an increase in total liquid yield, basis Brownsville, from 5000 Bbls./day to 6400 Bbls./day. This is still substantially below the Brownsville design value of 7855 Bbls./day.

3. Data from the Stanolind 8-inch reactor on Alan Wood catalyst at one-half the bed depth and one-half the linear velocity agree very closely with Montebello data on this same catalyst.

4. Catalyst replacement rates in the range of 20 to 50 tons per day at Brownsville (300 to 120 Bbls./ton) is not important economically.

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HYDROCARBON SYNTHESIS

PARTIAL REPORT NO. 37

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SYNTHESIS OPERATIONS ON ALAN WOOD CATALYST UNDER BROWNSVILLE CONDITIONS

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HYDROCARBON SYNTHESIS

PARTIAL REPORT NO. 37

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SYNTHESIS OPERATIONS ON ALAN WOOD CATALYST UNDER BROWNSVILLE CONDITIONS MONTEBELLO RUN 49

I. INTRODUCTION

At the end of Run 48[1] it was apparent that Brownsville design yields could not be obtained at Montebello under the Brownsville design conditions. It was indicated, however, that higher yields might be obtained if the catalyst level could be raised above the top of the steam cooling tubes and extended into the upper spherical head of the Brownsville reactor. In order to test this possibility the Montebello reactor was rebuilt employing a vertical velocity gradient duplicating the Brownsville design.

This report is based on Run 49 which was made with this revised reactor (No. 4) over the period July 15 to August 17, 1949.

II. EQUIPMENT AND CATALYST

A. Reactor Changes

In order to match the Brownsville velocity gradient, the shell of the Montebello reactor was extended 11 feet above the top of the three steam cooling tubes. These tubes were swaged into a 5-inch IPS header 2 feet long which was swaged in turn into a single 2-inch tube which led through a packing gland at the top of the reactor. This arrangement is shown in Figure 1, following, and the velocity gradient is compared with the Brownsville design in Figure 2, page 3. The relation of the reactor to the cyclone system is shown in Figure 3, page 4.

[1] Partial Report No. 33, Experiment No. TDC-802.

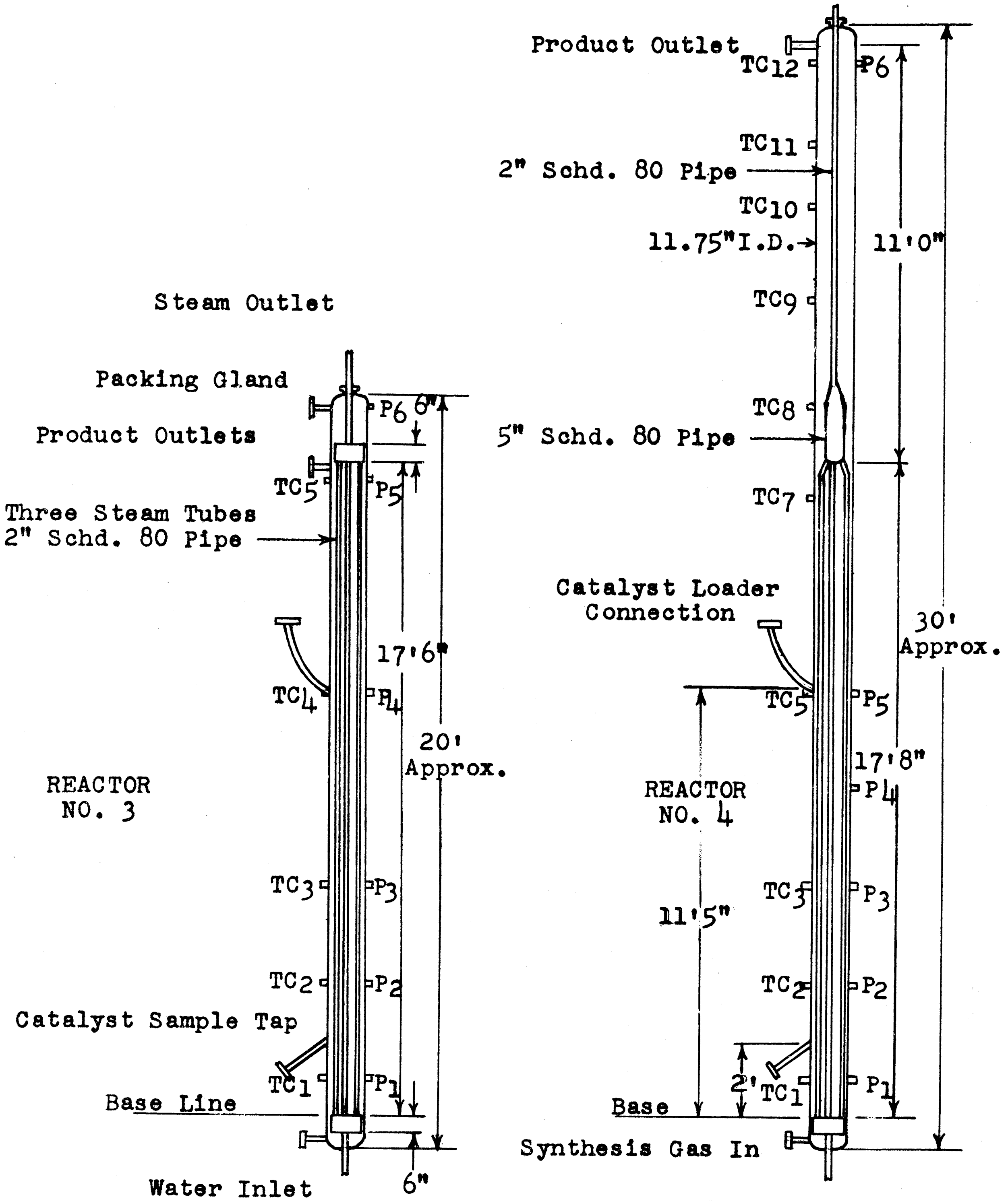


FIGURE 1
COMPARISON OF REACTOR NO. 3 WITH REACTOR NO. 4

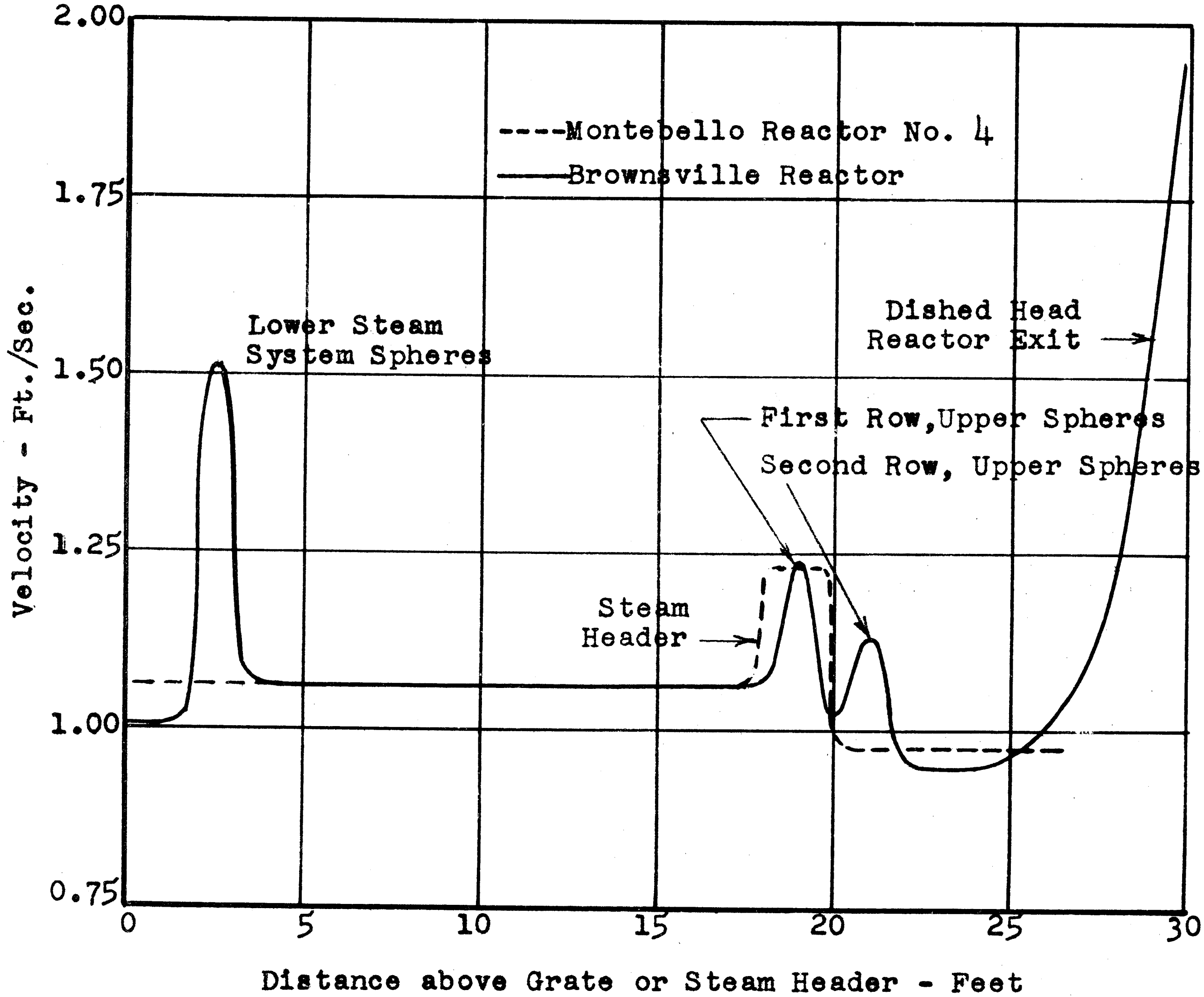


FIGURE 2

COMPARISON OF GAS VELOCITY THROUGH MONTEBELLO REACTOR NO. 4 AND BROWNSVILLE REACTOR

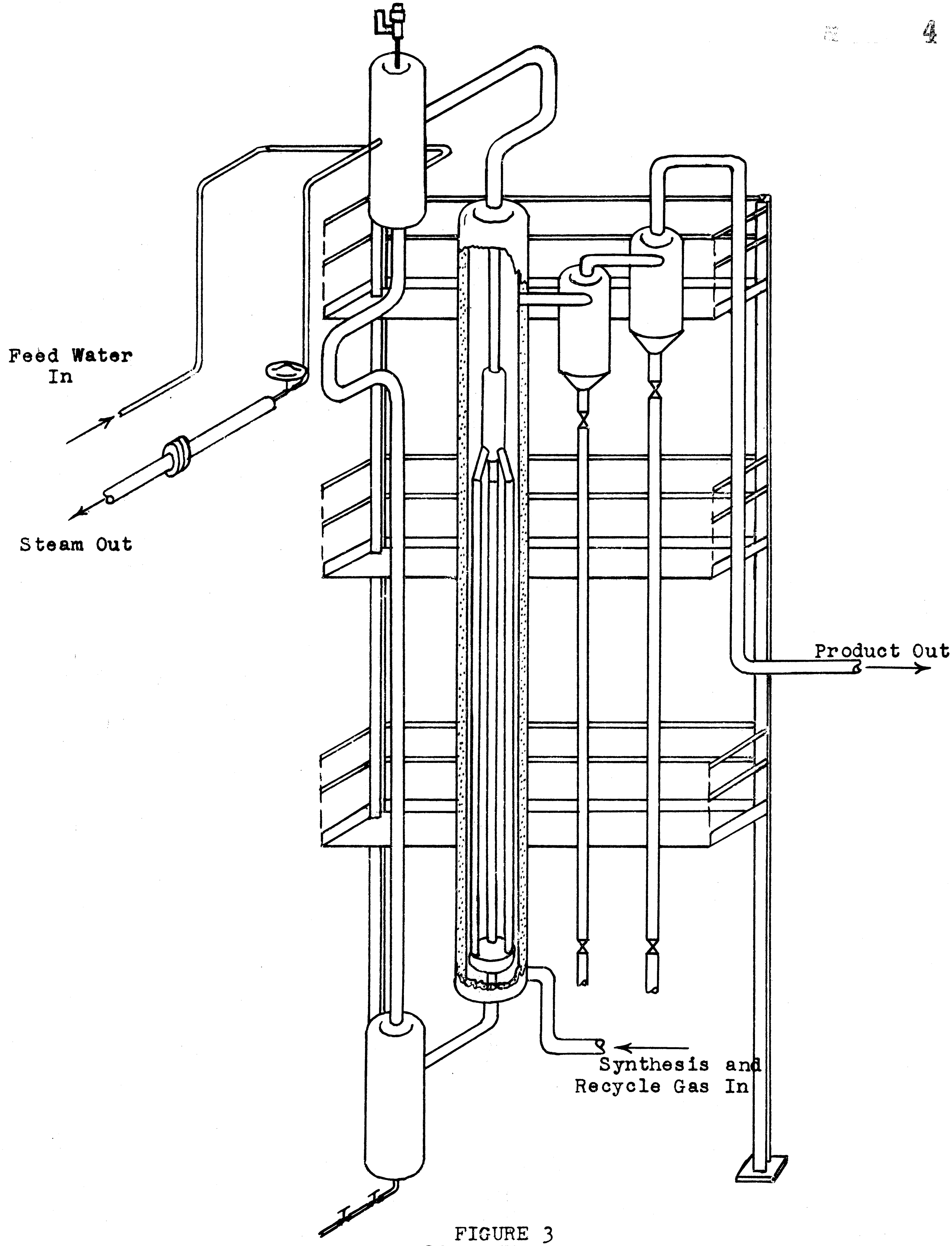


FIGURE 3
SCHEMATIC LAYOUT
MONTEBELLO REACTOR NO. 4

B. Catalyst

As in Runs 46 and 48 the catalyst consisted of unground Alan Wood magnetite concentrate impregnated with Baker c.p. potassium carbonate. The carbonate was added in water solution to a water slurry of catalyst and the mixture evaporated to dryness. Since used catalyst samples from Runs 46 and 48 showed that about half the alkali had been lost (0.3 weight per cent K_2O basis Fe vs. 0.6 added) and since the used catalyst level was near the minimum[1], dosage was increased for Run 49 to give 1.2 weight per cent K_2O basis Fe with the expectation that this would fall to about 0.6 per cent for operation. The chemical composition and particle size of the raw catalyst were:

	Chemical Analysis Weight Per Cent
Fe	67.20
SiO_2	5.21
P	0.019
S	Trace
H_2O	3.96

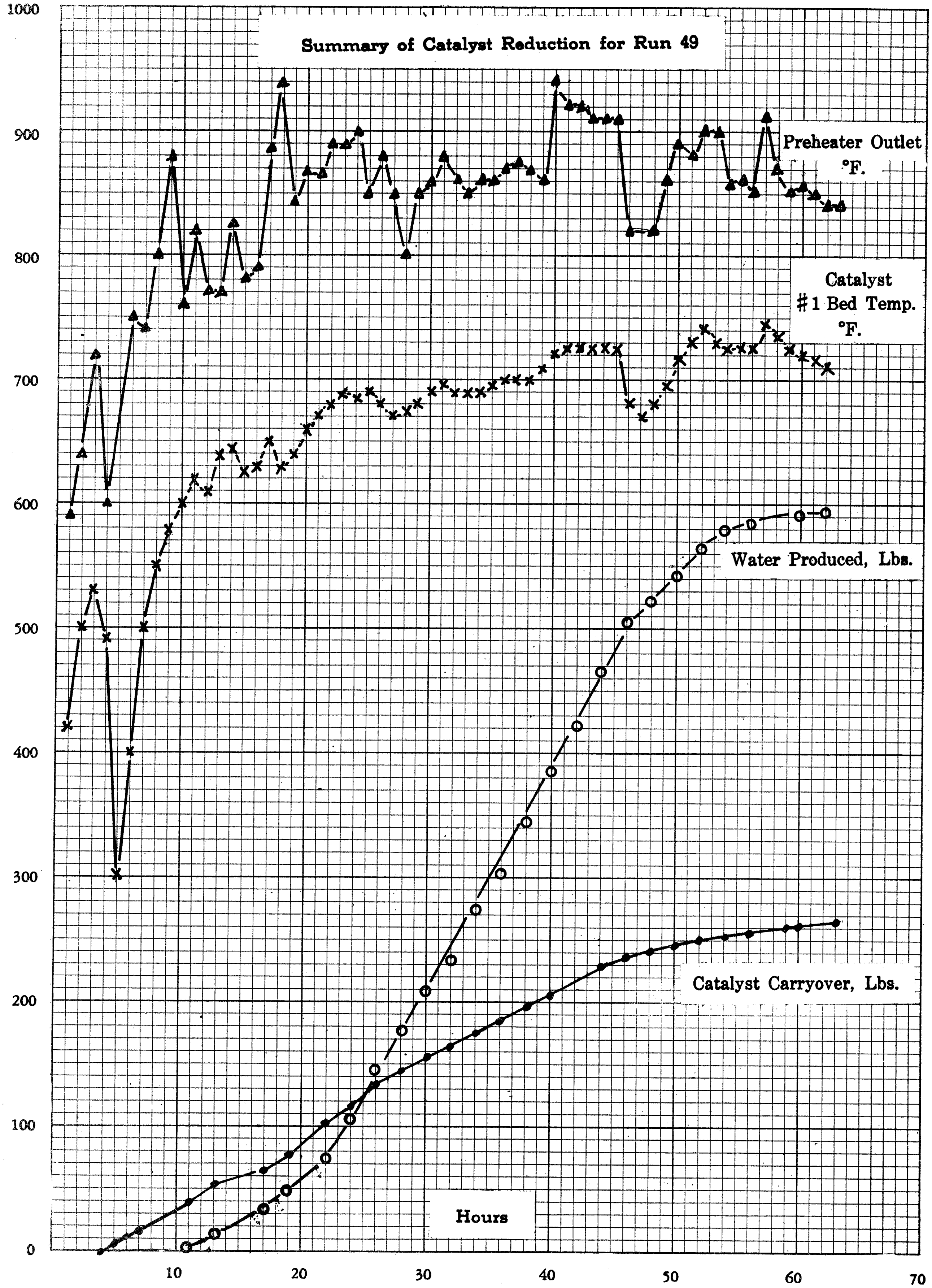
Sieve Analysis Mesh	Weight %	Cumulative Wt. % Coarser Than
40	26.3	26.3
100	46.0	72.3
150	8.3	80.6
200	7.3	87.9
250	2.6	90.5
325	0.8	91.3
Through 325	8.7	

C. Auxiliary Equipment

As in the past, feed gas was prepared from natural gas and Linde oxygen in a generator of 1.9 cubic foot volume at a pressure slightly above reactor pressure. The reactor steam system was operated at 800 psig and bed temperatures were controlled by adjusting the temperature of the combined feed to the reactor. The reactor effluent stream passed through two 10-inch cyclone separators in series and a 210 sq. ft. shell-and-tube condenser to a product accumulator which operated at reactor pressure and atmospheric temperature. Oil and water layers were withdrawn

[1]Partial Report No. 44, Experiment No. TDC-101.

Fig. 4


Summary of Catalyst Reduction for Run 49
Preheater Outlet °F.
Catalyst #1 Bed Temp. °F.
Water Produced, Lbs.
Catalyst Carryover, Lbs.
Hours
1000
900
800
700
600
500
400
300
200
100
0
10
20
30
40
50
60
70

separately from this accumulator to running tanks operating at atmospheric pressure and temperature. Part of the gas from the accumulator was compressed and recycled, the balance being vented through a back-pressure regulator. The gas vented from the running tanks was combined with the vent from the accumulator, the combined stream being metered and analyzed as wet gas.

III. SUMMARY OF OPERATIONS

A. Catalyst Reduction

The original charge of catalyst was reduced in place by circulating cylinder hydrogen at 200 psig and 700°F. at a linear velocity of one foot per second through the reactor system until water production had virtually ceased. The weight of water recovered after 62 hours corresponded to 95 per cent reduction. This was later confirmed by X-ray diffraction analysis.

The progress of reduction is shown in the opposite Figure 4 which indicates that the rate of water production was low at the beginning (presumably because of the low temperature) and was also low at the end as the reaction approached completion. During the central portion the rate of water production was 18.2 lbs. per hour. This indicates that the rate is controlled by hydrogen availability.

During the reduction the original charge of 2558 lbs. of oxide yielded 595 lbs. of water and 265 lbs. of fines were carried out of the reactor leaving 1750 lbs. of reduced catalyst.

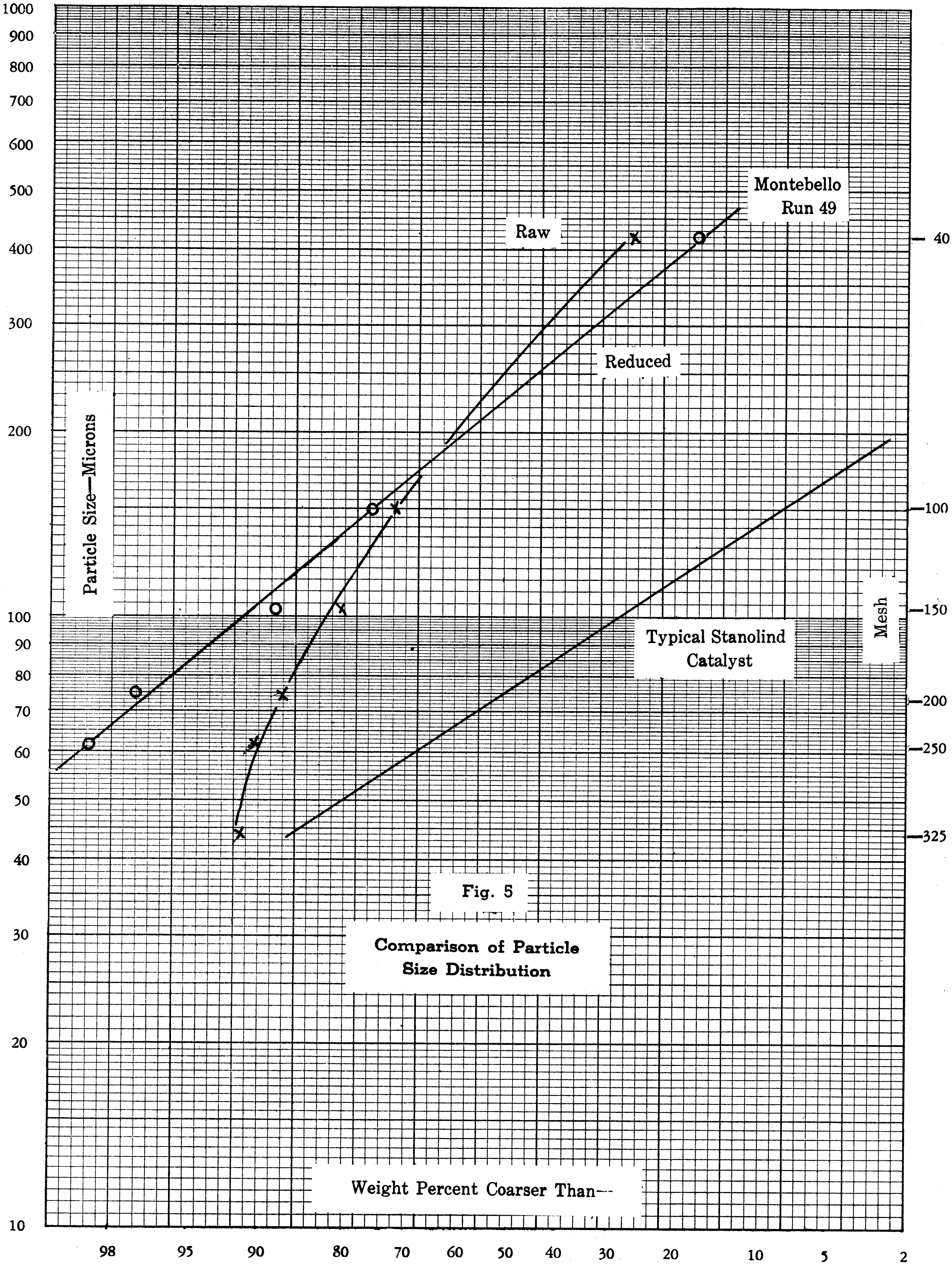


Fig. 5

Comparison of Particle Size Distribution

The screen analyses of raw and reduced catalyst showed:

Screen Analyses of Raw and Reduced Catalysts

Wt. Per Cent on		Raw	Reduced
40 mesh,	419 microns	26.3	16.3
100 "	150 "	46.0	59.9
150 "	105 "	8.3	12.4
200 "	74 "	7.3	8.6
250 "	62 "	2.6	1.0
325 "	44 "	0.8	1.0
Through 325 "		8.7	0.8

If it is assumed that all of the fines were through 325 mesh, the reduced catalyst screen analysis can be corrected for the loss and then shows:

Wt. Per Cent on	
40 mesh	14.7
100 "	53.9
150 "	11.2
200 "	7.7
250 "	0.9
325 "	0.9
Through 325 "	10.7

Comparing this corrected analysis with the raw feed the indicated changes in the various fractions are:

	Raw	Corrected Product	Change
0-40 mesh	26.3	14.7	-11.6
40-100 mesh	46.0	53.9	+ 7.9
100-150 mesh	8.3	11.2	+ 2.9
150-200 mesh	7.3	7.7	+ 0.4
200-250 mesh	2.6	0.9	- 1.7
250-325 mesh	0.8	0.9	+ 0.1
below 325 mesh	8.7	10.7	+ 2.0

This shows that the principal changes on reduction were the fracture of about half the 0-40 mesh particles into the 40-150 mesh range and the elutriation of most of the particles below 325 mesh in size. This effect is illustrated by the opposite Figure 5 where the logarithm of particle size has been plotted against a normal probability function. The raw catalyst shows a curved distribution on this plot, whereas the reduced catalyst shows a linear relationship. This linear form was retained throughout the run and is characteristic of all operations on the Montebello unit. It is believed to be inherent to an elutriating system.

This inability of a bed of coarsely ground catalyst to retain very fine particles is believed to explain the absence of "bug-dusting" on the Montebello unit. During Run 49, for example, the catalyst removed at the end of the run did not differ greatly from the freshly reduced catalyst as shown by the following table:

	Weight Per Cent	
Screen Analysis	Initial	500 Hours
On 40 mesh	16.3	14.1
100 "	59.9	66.6
150 "	12.4	10.9
200 "	8.6	4.8
250 "	1.0	1.4
325 "	1.0	1.0
Thru 325 "	0.8	1.2
Bulk Density - Lbs./Cu. Ft.		
In Reactor	154	121
Lab. Aerated Density	159	122

Over this period there was no material decline in heat transfer coefficient, indicating that the excellent scouring action of the freshly reduced catalyst was retained throughout the run.

A typical particle size distribution for the Stanolind operations at Tulsa is also shown in Figure 5. This unit has commonly experienced difficulty with "defluidization", presumably as a result of the finer catalyst grind which is used. This finer catalyst has a much less effective scrubbing action and is much more susceptable to wetting than the coarser catalyst used at Montebello and it is therefore not surprising that the unit should show greater difficulty in operation.

B. Start-Up Procedure

The synthesis unit was put on-stream in the same way as in Runs 46 and 48. After reduction was finished, water was fed to the boiler system and the circulation of hot hydrogen continued until a water level was established and pressure built up to 500 psig. This gave a catalyst temperature of 470°F. Fresh feed was then introduced and preheat reduced to hold the bed in the range of 650°F. The above procedure requires less than two hours.

C. Synthesis Operation

The system was lined out at 420 psig inlet pressure, 650°F. bed temperature, 15 thousand standard cubic feet per hour of fresh feed, and a recycle ratio of 1/1. This gave an inlet velocity of 1 foot per second. These conditions were maintained for 340 hours with a catalyst addition rate of 50 lbs. per day.

The recycle rate was then increased to give a recycle ratio of 1.5/1 and the run continued for an additional 156 hours. Other conditions remained unchanged.

At the end of this time, the fresh feed rate was reduced to 10 thousand standard cubic feet per hour and the recycle ratio returned to 1/1 for an additional 30 hours. The data obtained in this last short period are not reliable due to low weight recovery (71 per cent) caused by a leak in the product condenser.

This leak apparently started at about 460 hours when weight recovery fell from 95 to 85 per cent. Inspection of the

TABLE I

SUMMARY OF DATA - RUN 49

400 psig, 650°F., Alan Wood - 1.2% K_2O basis Fe

Test Period	Hours on Stream	Average Cat. Age Hours	Rates MCFH Feed	Rates MCFH Recycle	Inlet Vel. ft/sec.	Bed Depth Ft.	Space Vel. v/hr/v	Conversion % of H_2+CO Fed	Selectivity C_3+ ÷ C_1+	Yield of C_3+ #/MCF(1)	Chemicals from water #/MCF
A	16	16	14.8	14.2	0.96	20	1000	86.2	81.8	9.46	0.73
B	34	34	15.0	15.5	1.01	20.8	1055	83.7	84.3	9.57	0.83
C	59	59	15.3	15.6	1.02	19.5	1140	80.4	82.6	8.36	0.72
D	79	79	15.5	15.4	1.02	20.3	1120	81.1	83.1	8.88	0.64
E	104	104	15.2	15.3	1.04	20.4	1088	82.1	81.5	8.34	0.94
F	128	120	15.5	15.4	1.08	22.7	997	78.5	83.4	8.52	0.91
G	152	135	15.6	15.3	1.09	22.8	994	79.0	83.7	8.52	0.89
H	176	151	15.7	15.4	1.10	21.1	1094	79.2	82.8	8.22	0.86
I	200	174	15.8	15.7	1.07	20.5	1122	77.4	81.1	8.33	0.83
K	221	186	15.1	14.8	0.97	21.3	1037	77.8	80.2	8.06	0.83
L	245	202	15.3	15.7	1.01	21.6	1033	77.9	81.8	8.63	0.89
M	269	217	15.1	15.5	0.99	20.3	1085	77.7	82.1	8.50	0.86
N	293	231	15.5	15.7	1.01	20.1	1127	78.6	82.7	8.47	0.89
O	317	244	15.4	15.7	1.04	20.7	1083	77.5	82.0	8.17	0.87
P	341	257	15.2	15.8	1.01	19.1	1163	76.5	81.9	8.13	0.89
49-1 Avg.		192	15.42	15.5	1.037	21.02	1074	78.01	82.26	8.369	0.871
Q	365	274	15.6	23.2	1.24	19.8	1142	77.1	82.1	8.44	0.90
R	389	285	15.8	24.5	1.39	18.5	1244	76.3	83.6	8.27	0.96
S	413	295	15.8	23.3	1.36	18.4	1256	76.7	83.1	8.32	0.88
T	437	304	15.5	23.1	1.35	18.7	1203	76.5	82.4	8.43	0.91
U	461	312	16.2	23.6	1.41	18.8	1252	76.5	82.4	7.96	0.95
V	473	305	16.1	23.5	1.41	19.8	1185	75.6	83.3	8.09	0.92
W	497	312	16.1	23.4	1.39	19.2	1219	76.1	82.6	8.02	0.94
49-2 Avg.		298	15.87	23.51	1.364	19.03	1214	76.40	82.79	8.208	0.921
X	521	316	10.6	11.2	0.79	17.2	894	83.0	85.4	9.80	1.26
Y	528	301	10.7	10.6	0.77	18.2	856	83.2	85.1	9.57	1.32

(1) Includes Chemicals from Water

tube bundle showed that the leak was caused by the penetration of a pit from the water side of one of the tubes at the hot end of the condenser. This tube bundle had been in service from the time the Montebello unit was first started - about 3 years total service. The bundle was carbon steel and there was no measurable corrosion from the vapor side. The pitting on the cooling water side was confined to a few tubes at the hot end with a single case where the pit penetrated through the tube wall.

IV. RESULTS AND DISCUSSION

A. Changes in Yield with Time

Yields and operating conditions are summarized in the opposite Table I. It is evident that the yield declined very rapidly from the first two test periods reaching a substantially steady condition after about 100 hours on stream. From this point onward there was undoubtedly some further decline in yield but over the interval 104 to 257 hours average catalyst age where the conditions were held constant, the effect is too small to be measured by the present data. The value of catalyst age used here is calculated from the catalyst addition and the loss rates on the assumption that the age of the catalyst lost at any time is the average age of all the catalyst in the reactor.

This very sharp initial decline followed by a long period of relatively constant yield coincides with a very rapid initial change in catalyst composition and is also followed by a long period of relatively constant composition.

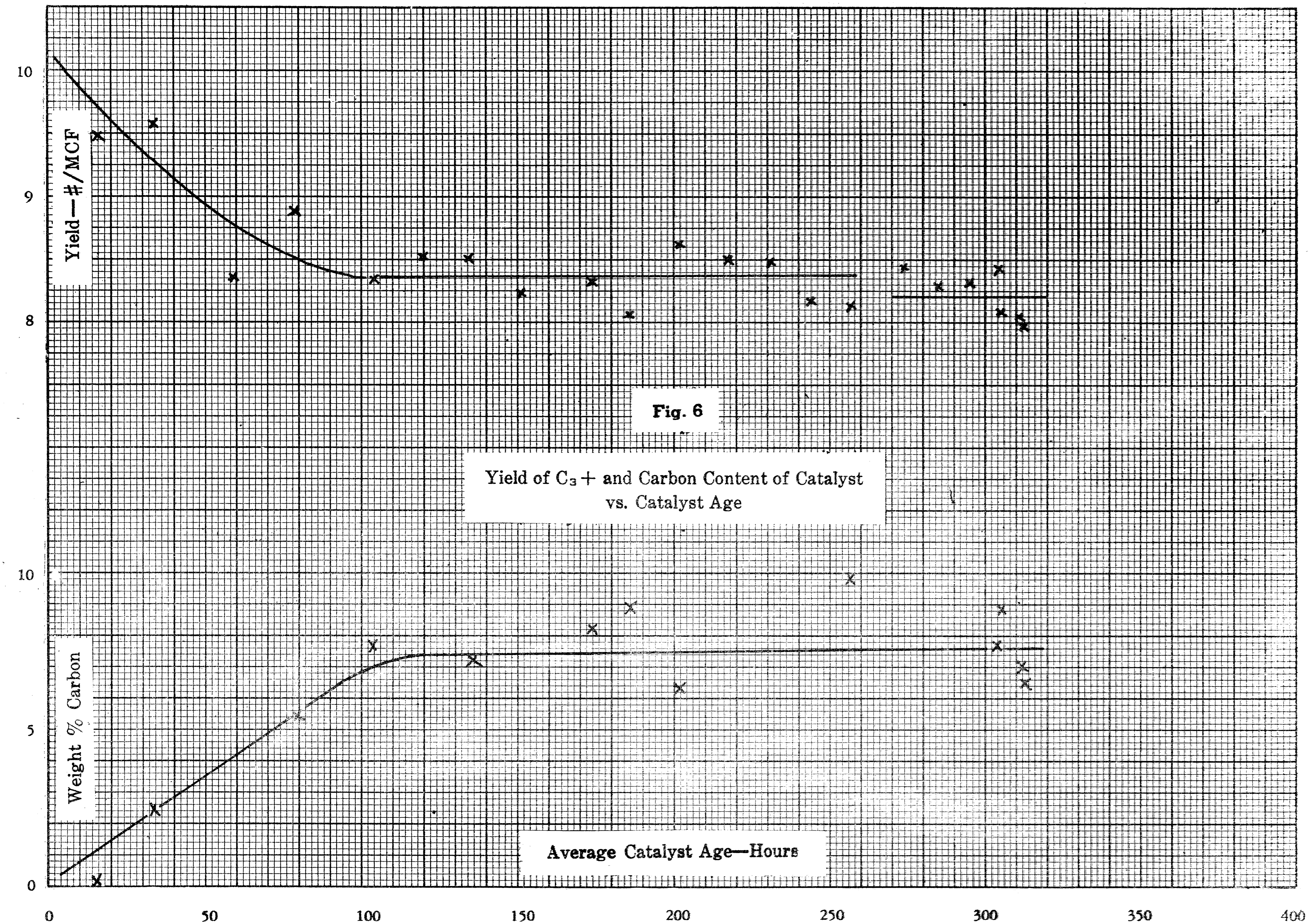


Fig. 6
Yield of C_3 + and Carbon Content of Catalyst vs. Catalyst Age
Yield—#/MCF
Weight % Carbon
Average Catalyst Age—Hours
10
9
8
10
5
0
0
50
100
150
200
250
300
350
400

These changes are shown in the opposite Figure 6 where yield and the carbon content of the catalyst have been plotted against age. The catalyst test data are detailed in Table II, following. It should not be inferred from the plot in Figure 6 that the change in yield is necessarily a result of the change in carbon content since several other catalyst properties show similar changes during this period.

The point of importance is that the catalyst required about 100 hours to adjust itself to the operating conditions used in this run. During this period yields declined rapidly and then reached a substantially steady state. This means that yield data obtained during the conditioning period, the first 100 hours in this run, are not representative of stable operation and should therefore be disregarded.

It also means that the rate of catalyst addition used in this run was unnecessarily high and that the rate of addition could have been materially reduced without serious loss in yield. This is confirmed by the Stanolind data obtained on Alan Wood catalyst in their 8-inch reactor, Run D-201-29, which are given in Table III, page 17. These data show the same very rapid initial decline followed by a nearly constant operation over a very long period. Since little catalyst was added during this run, the time on stream is nearly identical with the catalyst age, reaching a value of 695 hours at the end of the run.

Some idea of the economics of catalyst addition rate can be obtained from the Stanolind decline rate. If it is assumed that the v./hr./v. at Brownsville is 1000, the catalyst density

TABLE II
CATALYST TEST DATA - RUN 49

Test Period	Average Age-Hrs.	Wt. % Carbon	Wt.% Fe	NH_3 Value	Particle Density	X-Ray Diffraction - % Fe_2C_9	X-Ray Diffraction - % Fe_3O_4	X-Ray Diffraction - % Fe
A	16	0.22	88.9	0.4	4.7	--	--	100
B	34	2.41	68.8	2.2	4.4	40	55	5
C	59			2.4	4.3			
D	79	5.4	66.1	7	4.3	30	65	5
E	104	7.7		21	4.4			
F	120			12	4.3			
G	135	7.2	67.8	8	4.4	40	55	5
H	151			16	4.3			
I	174	9.5/6.6	66.6	9	4.1	40	55	5
J	180	5.6		10	--			
K	186	8.9		12	4.3			
L	202	6.3		26	4.3			
M	217			15	4.2			
N	231			18	4.3			
O	244			19	4.4			
P	257	9.9		14	4.3			
Q	274			12	3.8			
R	285			10	4.3			
S	295			22	4.0			
T	304	7.7		24	4.0			
U	312	6.5		17	4.2			
V	305	8.9		4	4.2			
W	312	7.0		21	4.2			
X	316	9.8		15	3.8			
Y	301			25	4.1			

TABLE III
SUMMARY OF DATA - STANOLIND RUN D-201-29

400 psig, 650°F., Alan Wood

Test Period	Hours on Stream Avg. Cat. Age	Rates MCFH Feed	Rates MCFH Recycle	Inlet Vel. ft/sec.	Bed Depth Ft.	Space Vel. v/hr/v	Conversion % of H_2+CO Fed	Selectivity $C_3+ \div C_1+$	Yield of C_3+ #/MCF(1)	Chemicals from water #/MCF
1	21	3.62	3.75	0.47	12.5	851	90.0	80.1	9.95	1.00
2	47	3.60	3.68	0.46	12.3	866	86.6	88.0	9.63	1.08
3	119	3.62	3.64	0.46	11.8	922	87.9	72.7	8.71	1.03
4	191	3.63	3.58	0.46	11.8	926	82.4	79.1	8.54	1.18
5	263	3.65	3.66	0.48	11.0	1003	79.7	78.3	8.49	1.18
6	349	3.54	3.61	0.55	11.8	904	80.1	78.4	8.54	1.24
7	456	3.60	3.64	0.51	11.8	906	80.4	78.4	8.48	1.15
8	481	3.62	3.60	0.45	11.5	946	79.0	78.5	8.31	1.12
9	652	3.59	3.60	0.46	11.3	966	77.5	78.1	7.91	1.18
10	695	3.61	3.64	0.47	11.8	922	81.8	76.4	8.02	1.15

TABLE IV
ECONOMICS OF CATALYST REPLACEMENT RATE

Data from Stanolind Run D-201-29

Average of Periods 5 and 6 - 306 Hours Average Age

Gasoline	4,224 Bbl/Day	$5.04/Bbl	$21,289
Gas Oil	491	3.25	1,596
Waxy Bottoms	347	1.30	451
Polymer Tar	112	1.30	146
Hydrocarbons	5,174		$23,482
Chemicals from			
Gas	100	$10.00	
Oil	113		
Water	803		
	1,016		10,160
Total Products	6,190		$33,642

Average of Periods 9 and 10 - 673 Hours Average Age

Gasoline	4,085 Bbl/Day	$5.04/Bbl	$20,588
Gas Oil	430	3.25	1,398
Waxy Bottoms	303	1.30	394
Polymer Tar	102	1.30	133
Hydrocarbons	4,920		$22,513
Chemicals from			
Gas	91		
Oil	160		
Water	786		
	1,037	$10.00	10,370
Total Products	5,957		$32,883

is 125 lbs. per cubic foot and the fresh feed rate is 9488 MCFH of H_2 + CO; catalyst inventory will be 600 tons. Comparing the average results of Periods 5 and 6 (corresponding to a catalyst age of 306 hours) with the average of Periods 9 and 10 (corresponding to a catalyst age of 673 hours) catalyst addition rates will be 47 and 21 tons per day respectively.

The equivalent Brownsville production rates for these periods have been calculated by the method described in the Appendix, and are listed in the opposite Table IV together with the values of the various products. The price used for the chemicals fraction is higher than the minimum guarantee carried in the Brownsville contracts but is lower than the expected return and is believed to represent a reasonable value.

This tabulation shows that an increase in catalyst addition rate from 21 to 47 tons per day will increase the value of the products at Brownsville by $759. This makes the value of the additional 26 tons of catalyst to Brownsville, $29 per ton or substantially equivalent to the cost of the catalyst.

A firm conclusion as to the economics of catalyst replacement rate should not be reached on the basis of the present very limited data, but it is clear that replacement rate is not a matter of great importance over the range of 300 to 700 hours age under the Brownsville conditions.

B. Effect of Space Velocity

Since the cost of a synthesis reactor is determined by its volume and is independent of the density of the catalyst used, throughput is properly expressed in terms of the volume of feed per unit of time per unit of catalyst volume or cubic feet of fresh feed per hour per cubic foot of catalyst. This is inconvenient because the volume of catalyst in an operating reactor is considerably more difficult to measure than the weight.

There is also evidence from pyrites runs at Montebello that conversion is actually a function of catalyst volume and independent of catalyst weight. Run 22[1], for example, showed the following results:

Test Period	Hours on Stream	Catalyst Bed Depth Ft.	Catalyst Bed Density #/CF	Fresh Feed $H_2 + CO$ v/hr/w	Fresh Feed $H_2 + CO$ v/hr/v	Conversion %	Yield of C_3+ #/MCF
A	24	3	98	29	2820	52	7.2
B	48	3	84	38	3160	61	7.2
C	72	7	90	24	2160	67	7.5
D	96	18	34	21	725	86	9.9
E	120	22	29	20	580	87	9.1
F	144	14	36	21	780	92	7.9
G	168	29	24	19	460	89	10.4
H	192	18	10	38	570	89	8.5
I	216	30	8	59	470	87	9.0
J	240	30	14	34	470	92	8.8

Conditions were unstable during this run and the results are therefore somewhat erratic but it is evident from this tabulation that the disintegration of this catalyst, which took place at about 75 hours, resulted in a three-fold change in v/hr/v, very little change in v/hr/w, and a substantial increase in both conversion and yield. This increase in yield can be considered to result either from a change in the specific activity of the catalyst or from the change in volume. Since the current data on the Alan Wood catalysts, obtained under stable conditions, show changes in yield with space velocity which are comparable to those

[1]Partial Report No. 13, Experiment No. TDC-802.

TABLE V
YIELD vs. SPACE VELOCITY

Run Number	46-1	46-2	46-3	45-1	49-2	49-1	29-3/6
Hours on Stream	108 204	204 369	369 537	96 299	341 497	104 341	119 349
Avg. Cat. Age, Hours	168	183	162	140	298	198	231
Space Vel., v/hr/v.	2825	2314	2178	1646	1215	1072	939
YIELD BASIS BROWNSVILLE, BBL/DAY							
Gasoline	2863	3362	3562	3844	4534	4721	4568 (1)
Gas Oil	363	449	454	443	628	629	496
Fuel Oil	534	467	446	462	495	448	480
Chemicals from Water	467	527	541	488	620	588	776
Total	4227	4805	5003	5237	6277	6386	6320
Conversion, % of H_2+CO fed	58.4	64.6	67.5	71.4	76.4	78.0	85.1
Selectivity, % $C_3+ \div C_1+$	80.1	82.3	81.9	77.5	82.8	82.3	77.1
C_3+ #/MCF of H_2+CO fed	5.96	6.46	6.64	7.07	8.21	8.37	8.57

(1) Includes 214 Bbls. Water Soluble Chemicals Scrubbed from Gas and Oil

observed in Run 22, there is a strong presumption that the disintegration of the catalyst was unimportant and that the essential change was the increase in catalyst volume.

The present data on the relation of yield to space velocity are given in the opposite Table V. Run 46 was made on Alan Wood catalyst under the original Brownsville design conditions: 400 psig, 650°F., 24 MCFH/sq. ft., and a bed depth of 8 to 10 feet. Run 49 was made under the same conditions except that the bed depth was increased to 20 feet. The Stanolind Run 201-29 was made under conditions similar to those used in Montebello Run 49 except that both bed depth and feed rate were one half those of Run 49. Run 45 was the first run made with the 12-inch reactor at Montebello and was made on a mill scale catalyst.

These yield data are plotted against space velocity in **Figure 7, following,** which shows a linear relationship for the Alan Wood data. The Stanolind point falls slightly below the Montebello line but is considered an excellent check in view of the large differences in bed depth, linear velocity, and the particle size of the catalyst. This implies that these are factors of small importance over the range covered.

A comparison of periods 49-1 and 49-2 which were made with recycle ratios of 1/1 and 1.5/1 shows no effect except for a slight increase in v/hr./v at the higher recycle ratio and a corresponding decrease in yield. This increase in v/hr./v resulted from the increase in inlet velocity from 1.01 to 1.37 ft./second which increased carryover and reduced the bed depth

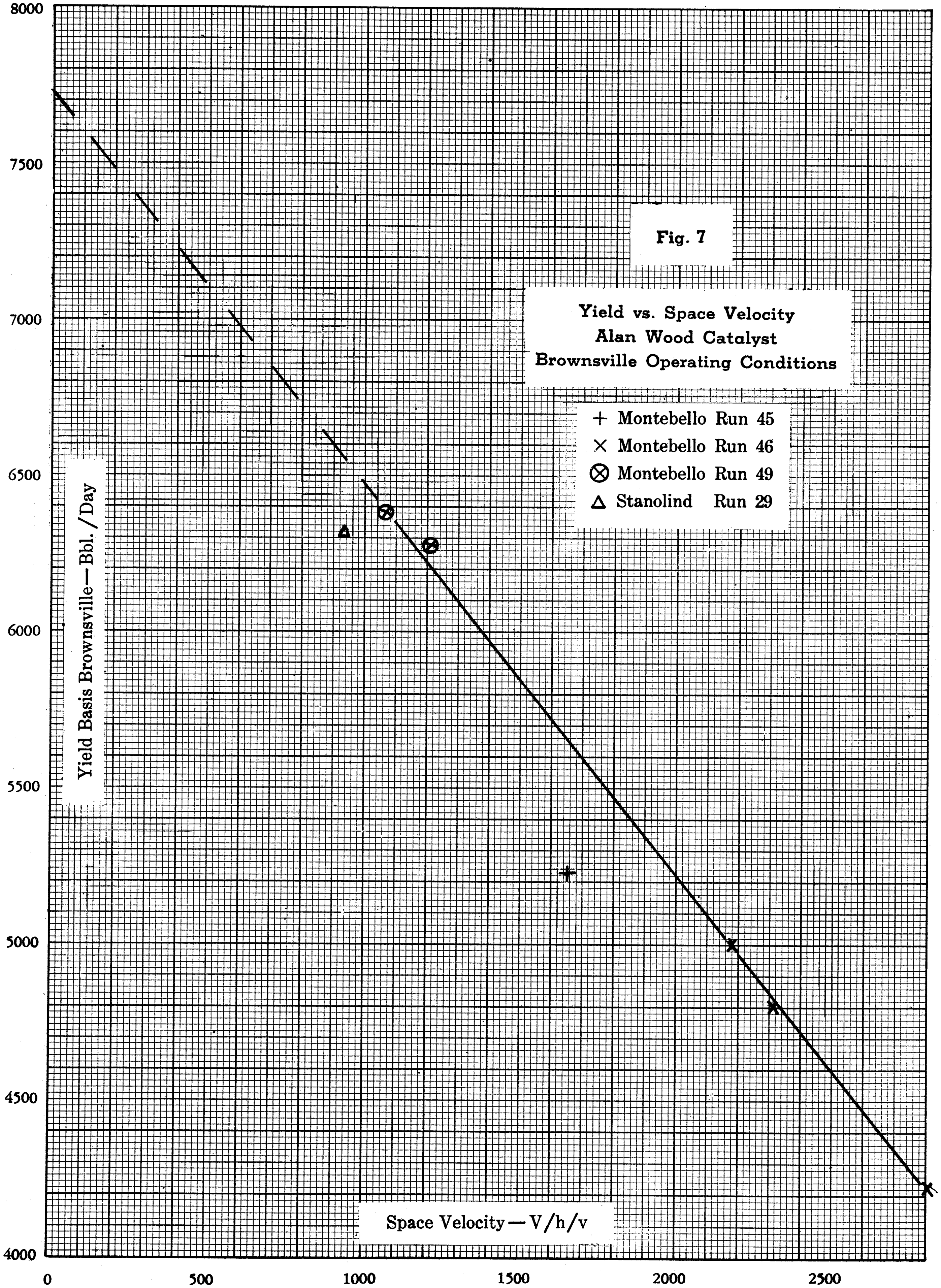


Fig. 7

Yield vs. Space Velocity
Alan Wood Catalyst
Brownsville Operating Conditions

TABLE VI
COMPARISON OF YIELD DATA

Alan Wood Catalyst

	Montebello Run 49	Stanolind D-201-29	Brownsville Design
Production, Bbls/Day			
Gasoline	4,562	4,358	6,079
Gas Oil	629	496	947
Fuel Oil	448	480	198
Total	5,639	5,334	7,223
Chemicals from:			
Gas	86*	114	--
Oil	73*	96	--
Water	588	776	631
Total	6,386	6,320	7,855
Prices, $/Bbl.			
Gasoline	5.04	5.04	5.04
Gas Oil	3.25	3.25	3.25
Fuel Oil	1.30	1.30	1.30
Chemicals	10.00	10.00	3.70
Value - $/Day	$33,089	$34,060	$36,308

*Estimated Basis Stanolind Data

from 21 to 19 feet. It is possible that the effect of recycle ratio is offset in these data by the greater age of the catalyst (298 vs. 192 hours), and that the two effects are of comparable magnitude.

The yield shown for Run 45 falls somewhat below the line in Figure 7 indicating that the Finkelstein Mill Scale is slightly inferior to the Alan Wood catalyst.

C. Comparison with Brownsville Design

The yield data obtained in Run 49 and in the Stanolind Run D-201-29 are compared with the Brownsville design values in the opposite Table VI, which shows that both pilot plant results are nearly 20 per cent below the design value. Product distribution is about the same in all cases.

This dificiency is not as serious economically as it might appear from the yield data. Since Brownsville has been set up to scrub both gas and oil products to recover water soluble chemicals, the rate of chemicals production is indicated to be considerably higher than design in spite of the lower total liquid production. The chemicals fraction, furthermore, was priced at 1.1 cents per pound in the original economics, whereas it is now evident that the value is actually at least 3 cents per pound. When these differences are considered, it is seen that the actual return to Brownsville is over 90 per cent of the amount originally used.

It might appear from Figure 7, page 23, that the maximum possible yield from the Brownsville feed would be about 7700 Bbls./day since the linear space velocity-yield relation

TABLE VII

YIELDS FROM PYRITES AND STANOLIND MILL SCALE

RUN NUMBER	Montebello Run 22-G	Stanolind Run 201-2-9
Hours on Stream	144-168	215-239
Space Velocity, v/hr/v	460	1790
Catalyst	Pyrites	C. F. & I Mill Scale
YIELDS BASIS BROWNSVILLE - BBL/DAY		
Gasoline	5,571	6,522
Gas Oil	862	1,094
Fuel Oil	934	825
Chemicals	1,420	1,081
Total	8,788	9,521

extrapolates to this value at zero space velocity. It is possible that this is actually true for the Alan Wood catalyst but it is certainly not true in general for the synthesis reaction since the data in Table VII, opposite, from both Montebello and Stanolind on other catalysts show that much higher yields can actually be obtained. As stated above the Montebello Run 22 operation was very erratic and the results are not considered altogether reliable. This is not true, however, of the original Stanolind C F & I Mill Scale data from Runs D-201-2 through D-201-8 which are generally similar to the results shown for D-201-2. Unfortunately, the Colorado Fuel and Iron Company's mill where this scale was produced has been extensively altered and this mill scale is no longer available. Samples of mill scale from other sources, such as the Finkelstein mill scale used at Montebello, have been poorer than the original Stanolind catalyst and it is indicated that a further, more extensive search should be made for more active catalysts.

V. CONCLUSIONS

1. The data for Run 49 show that the catalyst level can be increased from the design level of about 10 feet to a maximum level of about 20 feet.

2. This increase in catalyst level resulted in an increase in total liquid yield, basis Brownsville, from 5000 Bbls./day to 6400 Bbls./day. This is still substantially below the Brownsville design value of 7855 Bbls./day.

3. Data from the Stanolind 8-inch reactor on Alan Wood catalyst at one-half the bed depth and one-half the linear velocity agree very closely with Montebello data on this same catalyst.

4. Catalyst replacement rates in the range of 20 to 50 tons per day at Brownsville (300 to 120 Bbls./ton) is not important economically.

VI. RECOMMENDATIONS

1. Additional work should be done at a lower feed rate with Alan Wood catalyst, corresponding to the provision of additional reactor capacity at Brownsville.

2. An active search should be made for catalysts of higher activity.

REPORT PREPARED BY du Bois Eastman

APPROVED BY du Bois Eastman

dBE:HV

WEK-LCKJr-CEL-WJC-dBE

WMS-RFB-KGM-JMB

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Lowell Bell	Operator Helper
Roy Gothard	Operator Helper
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WMS-RFB-KGM-JMB

VII. APPENDIX

INDEX TO APPENDIX

INDEX TO FIGURES

INDEX TO TABLES

A. METHOD OF CALCULATION AND DETAILED MONTEBELLO DATA

the measured gravities and entered under gal./hr. The chemicals content of the water as measured by salting out with K_2CO_3 is taken to represent a liquid volume fraction and entered as gal./hr. of water soluble chemicals. The net water figure is obtained as the difference between gross water and chemicals and is multiplied by the density of pure water to obtain the lbs./hr. of net water. The difference in lbs./hr. of gross and net water divided by the chemicals yield calculated above in gal./hr. gives a figure of about 8 lbs./gal.

Each #/hr. item in the Net Change column is then divided by the H_2 + CO fresh feed rate and the result entered under #/MCF. Each item above C_3H_6 is divided by density and then by the H_2 + CO fresh feed rate and the result entered under gal./MCF.

Yields are similarly calculated on an arbitrary Polymer Basis where it is assumed that 90 per cent of the C_3H_6 and 95 per cent of the C_4H_8 will be recovered as polymers of the densities indicated. Yields on this basis have been largely superseded by yields calculated more exactly on a Brownsville basis as discussed in Section C of the Appendix.

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 A
HOURS 0-16

35

	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	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	37.095	14.506	406.31	10.723	1.214	34.00	4.020	18.526	5.234	-13.292	372.31					Distribution of					
H_2 2.016	58.980	23.065	46.50	35.171	3.982	8.03	13.184	36.249	17.166	-19.083	38.47					Recovered Oil					
CO_2 44.010	2.855	1.116	49.12	30.497	3.452	151.92	11.432	12.548	14.884	2.336	102.80	7.220					[illegible]			0.684	
N_2 28.016	1.025	0.401	11.23	4.183	0.474	13.28	1.568	1.969	2.042								400-550			0.197	
CH_4 16.042	0.045	0.018	0.29	10.187	1.153	18.50	3.819	3.837	4.972	1.135	18.21	1.279					550+			0.106	
C_2H_4 28.052				2.523	0.286	8.02	0.946	0.946	1.232	0.286	8.02	0.563									69.8
C_2H_6 30.068				1.093	0.124	3.73	0.410	0.410	?.534	0.124	3.73	0.262									
C_1+C_2											29.96	2.104									
C_3H_6 42.078				2.880	0.326	13.72	1.080	1.080	1.406	0.326	13.72	0.964	4.32	3.176	0.223	12.35	0.867	6.28	1.976	0.139	96.2
C_3H_8 44.094				0.113	0.013	0.57	0.042	0.042	0.055	0.013	0.57	0.040	4.24	0.134	0.009						
C_4H_8 56.104				1.467	0.166	9.31	0.550	0.550	0.716	0.166	9.31	0.654	5.00	1.862	0.131	8.84	0.621	6.10	1.450	0.102	74.6
C_4H_{10} 58.120				0.500	0.057	3.31	0.187	0.187	0.244	0.057	3.31	0.232	4.86	0.681	0.048	3.31	0.232	4.86	0.681	0.048	
C_5H_{10} 70.130				0.440	0.050	3.51	0.165	0.165	0.215	0.050	3.51	0.247	5.45	0.644	0.045	3.51	0.247	5.45	0.644	0.045	81.5
C_5H_{12} 72.146				0.100	0.011	0.79	0.037	0.037	0.048	0.011	0.79	0.055	5.25	0.150	0.011	0.79	0.055	5.25	0.150	0.011	
C_6H_{12} 84.156				0.123	0.014	1.18	0.046	0.046	0.060	0.014	1.18	0.083	5.54	0.213	0.015	1.18	0.083	5.54	0.213	0.015	
C_3-C_6											32.39	2.275		6.860	0.482	29.98	2.105		5.114	0.359	
TOTAL		39.106			11.321	269.87	37.485														
H_2+CO		37.571	14,239 S.C.F.H.		5.196		17.204	54.775	22.400	-32.375											
H_2/CO		1.59	702297		3.28			1.96	3.28	1.44											

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT / SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.2	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF
RECOVERED OIL	0.655	91.85	6.451	6.537	14.051	0.987	91.85	6.451		14.051	0.987
TOTAL OIL		124.24	8.725		20.911	1.469	121.83	8.556		19.165	1.346
WATER SOLUBLE CHEMICALS		10.43	0.732	8.168	1.277	0.090	10.43	0.732		1.277	0.090
TOTAL LIQUID PRODUCTS C_3+		134.67	9.458		22.188	1.558	132.26	9.289		20.442	1.436
NET WATER	7.845	141.33	9.926	8.328	16.971	1.192					
GROSS WATER		151.76	10.658		18.248	1.282					
HYDROCARBON TOTAL—C_1+		164.63	11.562								

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
71.05	91.63	82.74	86.17	71.75	52.64	59.11	81.80

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS / PRODUCT TESTS / CATALYST DATA

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	418	Fresh Feed	14821
Natural Gas	405	Recycle	14208
Generator Outlet	399	Combined Feed	29029
Reactor Inlet	385	Wet Gas—Measured	3985
Condenser Inlet		Adjusted	4291
Product Accumulator	360	Loss	306

TEMPERATURES—°F.			
Oxygen	351	Recycle/Fresh Feed	0.959
Natural Gas	629	Inlet Velocity—ft./sec.	0.958
Generator	2155	Fresh Feed Rate—S.C.F.H. per Cu.Ft. Dense Bed	
Quench Accumulator		per Lb. Catalyst	
Reactor Inlet	256		
Condenser Inlet			
Product Accumulator	63	Heat Transfer Calculations	

Catalyst No.	Height "		
1	12.0	652	Steam Rate = 354.1#/hr
2	43.2	652	@ 810 psia & 519°F = 1196 BTU/#
3	74.4	689	Water in @ 167°F = 135 BTU/#
4	105.6		Heat Transferred/lb. steam
5	136.8	683	= 1061 BTU
6	168.0		(1061)(354.1) = 375,700 BTU/hr
7	199.2	680	dT = 671-519 = 162°F
8	230.4		Tube Area = 30.9 ft^2
9	261.6		$K = \frac{375700}{(162)(30.9)} = 75.2$
10	292.8		
12	342.0	639	

PRODUCT TESTS	OIL	WATER
° API	48.7	10.2
Neut. No.	42.5	40.5
Sap. No.	49.4	48.3
Hydrox. No.		
Bromine No.	81.6	
Pour °F.		
Chemicals, % by K_2CO_3		7.0
HEMPEL. DIST. %		°API
205 °F.		
400	69.3	55.5
400-550	20.0	36.0
550+	10.7	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	106	
10%	138	
50%	232	
90%	355	
EP	406	
	98.0	

INVENTORY DATA	1750 Fe
In Reactor at Start of Period	2652*
Fresh Catalyst Added	0
Total	
Catalyst Recovered	258
In Reactor at End of Period	2394
REACTOR d-p, Inches H_2O — No. / Height "	
1 — 12-43.2	66
2 — 43.2-74.4	80
3 — 74.4-105.6	85
4 — off scale	
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	154
Inventory, Lbs.	
Bed Depth, Ft.	

* At 66% Fe

PARTICLE SIZE Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	16.3	80+	
100	150	59.9	40—80	
150	105	12.4	20—40	
200	74	8.6	10—20	
250	62	1.0	0—20	
325	44	1.0		
<325		0.8		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	159
Settled	161
Compacted	180
Particle Density, gm./cc.	4.7
NH_3 Value, ml./gm.	0.41
N_2 Surface, m^2/gm.	1.1
CHEMICAL ANALYSIS	
Fe	88.9
C	0.22
O	
H	0.07
K_2O, W+. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	100

GAS ANALYSES / GENERATOR BALANCE / WEIGHT BALANCE

HOUR				AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.97	37.22		37.095	14.506	14.506		14.506
H_2 2.016	59.22	58.74		58.980	23.065		46.130	
CO_2 44.010	2.75	2.96		2.855	1.116	1.116		2.232
N_2 28.016	1.01	1.04		1.025	0.401			
CH_4 16.042	0.05	0.04		0.045	0.018	0.018	0.072	
			M. W.	13.1302				
			H_2O 18.016				9.932	4.966
					39.106	15.640	56.134	21.704
			BALANCE			99.62	98.80	101.64

GENERATOR BALANCE	Mol %	M/Hr	C	H	O
O_2 32.000	0.56	10.280 0.078			20.716
CO 28.010					
H_2 2.016					
CO_2 44.010	2.30	0.319	0.319		0.638
N_2 28.016	3.20	0.444			
CH_4 16.042	81.24	11.266	11.266	45.064	
C_2H_6 30.068	8.83	1.224	2.448	7.344	
C_3H_8 44.094	3.50	0.485	1.455	3.880	
C_4H_{10} 58.120	0.35 0.02	0.049 0.003	0.196 0.015	0.490 0.036	
TOTAL			15.699	56.814	21.354

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
WET GAS	250.64	269.87
OIL	91.85	91.85
WATER	151.76	151.76
TOTAL	494.25	513.48
FRESH FEED	513.48	
WEIGHT BALANCE	96.25	
WET GAS FACTOR		1.0767235
INDICATED LOSS—S C F H		306

WET GAS				
CO 28.010	11.16	9.46	11.55	10.723
H_2 2.016	35.92	32.24	37.35	35.171
CO_2 44.010	31.01	28.29	32.19	30.497
N_2 28.016	3.59	5.48	3.48	4.183
CH_4 16.042	9.09	14.84	6.63	10.187
C_2H_4 28.052	2.50	2.87	2.20	2.523
C_2H_6 30.068	1.07	1.33	0.88	1.093
C_3H_6 42.078	2.61	2.53	3.50	2.880
C_3H_8 44.094	0.34			0.113
C_4H_8 56.104	1.49	1.42	1.49	1.467
C_4H_{10} 58.120	0.40	0.08	0.42	0.500
C_5H_{10} 70.130	0.62	0.60	0.10	0.440
C_5H_{12} 72.146	0.07	0.15	0.08	0.100
C_6H_{12} 84.156	0.13	0.11	0.13	0.123
			M. W.	23.856

GAS FLOW RATES	$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED		384.8	73.6			
79.31	6.38	19.99	0.9868	14821	1.4849	39.106
WET GAS		1.62	63			
158.44	5.66	4.04	0.9981	3985	1.102	10.514
RECYCLE		352.6	124			
79.31	8.48	19.17	0.9436	13407	1.102	35.373
BLEED						
5.02	8.0	19.17	0.9436	801	1.102	2.112
NATURAL GAS		405.3	206	14208		37.485
28.43	8.39	20.49	0.8836	5256	1.217	13.867
OXYGEN		417.6	67			
27.07	6.97	20.79	0.9933	3896		10.280
STEAM		35.9 -10.0 *	* Correction for hydraulic head.			
815.7	5.23	0.3139		354.1#/hr		

LIQUID PRODUCT RATES HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL	4'2 1/2	224.92	61	0.9995	224.81	48.7	1469.6	91.85
						6.537		14.05
WATER								
	5'6	292.57	78	0.9979	291.96	10.2	2488.2	151.76
						8.317		18.248

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 B
HOURS 16-34

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED — CONDENSATE				POLYMER					% Unsats.
	%	m/hr	#/hr	%	At. Wt. Balance m/hr	At. Wt. Balance #/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	
CO 28.010	37.127	14.705	411.89	11.085	1.310	36.69	4.523	19.228	5.833	-13.395	375.20					Distribution of					
H_2 2.016	59.330	23.499	47.37	41.520	4.907	9.89	16.940	40.439	21.847	-18.592	37.48					Recovered Oil					
CO_2 44.010	2.540	1.006	44.27	27.645	3.267	143.78	11.279	12.285	14.546	2.261	99.51	6.873					400-			0.661	
N_2 28.016	0.935	0.370	10.37	2.455	0.290	8.12	1.002	1.372	1.292								400-550			0.161	
CH_4 16.042	0.068	0.027	0.43	7.750	0.916	14.69	3.162	3.189	4.078	0.889	14.26	0.985					550+			0.109	
C_2H_4 28.052				2.530	0.299	8.39	1.032	1.032	1.331	0.299	8.39	0.579									74.0
C_2H_6 30.068				0.890	0.105	3.16	0.363	0.363	0.468	0.105	3.16	0.218									
C_1+C_2											25.81	1.783									
C_3H_6 42.078				2.565	0.303	12.75	1.047	1.047	1.350	0.303	12.75	0.880	4.32	2.951	0.204	11.48	0.793	6.25	1.837	0.127	100.00
C_3H_8 44.094													4.24								
C_4H_8 56.104				1.745	0.206	11.56	0.712	0.712	0.918	0.206	11.56	0.798	5.00	2.312	0.160	10.98	0.758	6.10	1.800	0.124	73.00
C_4H_{10} 58.120				0.645	0.076	4.42	0.263	0.263	0.339	0.076	4.42	0.305	4.86	0.909	0.063	4.42	0.305	4.86	0.909	0.063	
C_5H_{10} 70.130				0.790	0.093	6.52	0.322	0.322	0.415	0.093	6.52	0.450	5.45	1.196	0.082	6.52	0.450	5.45	1.196	0.082	81.00
C_5H_{12} 72.146				0.185	0.022	1.59	0.075	0.075	0.097	0.022	1.59	0.110	5.25	0.303	0.021	1.59	0.110	5.25	0.303	0.021	
C_6H_{12} 84.156				0.195	0.023	1.94	0.080	0.080	0.103	0.023	1.94	0.134	5.54	0.350	0.024	1.94	0.134	5.54	0.350	0.024	
C_3-C_6											38.78	2.678		8.021	0.554	36.93	2.551		6.395	0.442	
TOTAL		39.608	314.33		11.819	263.59	40.800	80.408													
H_2+CO		38.204	14479 S.C.F.H.		6.217		21.463	59.667	27.680	31.987											
H_2/CO		1.60	69064		3.75			2.10	3.75	1.39											

CUMULATIVE TOTALS

	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.5

	Net Change m/hr	Net Change #/hr	Condensate #/MCF	#/gal	gal/hr	gal/MCF	Polymer #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL		87.82	6.065		13.479	0.931	87.82	6.065		13.479	0.931
TOTAL OIL		126.60	8.744		21.500	1.485	124.75	8.616		19.874	1.373
WATER SOLUBLE CHEMICALS		12.020	0.830	8.182	1.469	0.101	12.02	0.830		1.469	0.101
TOTAL LIQUID PRODUCTS C_3+		138.62	9.574		22.969	1.586	136.77	9.446		21.343	1.474
NET WATER	8.377	150.92	10.423	8.328	18.122	1.252					
GROSS WATER		162.94	11.253		19.591	1.353					
HYDROCARBON TOTAL—C_1+		164.43	11.356								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+ / C_1+
70.16	91.09	79.12	83.73	69.66	45.98	53.61	84.31

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	416	Fresh Feed	15012
Natural Gas	403	Recycle	15463
Generator Outlet	397	Combined Feed	30475
Reactor Inlet	384	Wet Gas—Measured	4519
Condenser Inlet		Adjusted	4479
Product Accumulator	360	Loss	-40
TEMPERATURES—°F.		Recycle/Fresh Feed	1.030
Oxygen	434	Inlet Velocity—ft./sec.	1.006
Natural Gas	699	Fresh Feed Rate—S.C.F.H.	14479
Generator	2350	per Cu.Ft. Dense Bed	696
Quench Accumulator	150	per Lb. Catalyst	7.48
Reactor Inlet	309		
Condenser Inlet			
Product Accumulator	74	Heat Transfer Calculations	
Catalyst No. Height"	647	Steam Rate = 379.2 #/hr	
1 12.0	648	@ 845 psia & 524°F	
2 43.2	680	= 1196	BTU/#
3 74.4		Water in @ 179°F =	146 BTU/#
4 105.6	660	Heat Transferred/# steam	
5 136.8		= 1050	BTU
6 168.0	663	(379.2)(1050)=398200	BTU/hr
7 199.2		Ave. Bed Temp. = 660°F	
8 230.4		dT = 660-524 = 136°F	
9 261.6		Tube Area = 31.4 ft²	
10 292.8		$K = \frac{398200}{(136)(31.4)}$ =	93.8
12 342.0	639		

PRODUCT TESTS

	OIL	WATER
°API	49.0	10.2
Neut. No.	42.0	39.3
Sap. No.	50.9	43.3
Hydrox. No.		
Bromine No.	79.5	
Pour °F.		
Chemicals, % by K_2CO_3		7.5
HEMPEL, DIST. %		°API
205 °F.		
400	71.0	55.8
400-550	17.3	36.5
550+	11.7	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	112	
10%	144	
50%	238	
90%	358	
EP	402	
	98.0	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2394
Fresh Catalyst Added	0
Total	
Catalyst Recovered	137
In Reactor at End of Period	2257
REACTOR d-p, Inches H_2O	
No. Height"	
1 12 - 43.2	72
2 43.2 - 74.4	75
3 74.4 - 105.6	65
4 105.6 - 342.0	325
(Calc) 0 - 12"	27
total	564
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	141
Inventory, Lbs.	1936
Bed Depth, Ft.	20.8
Volume, Cu Ft	13.7

Density = $\frac{(72+75+65)}{3}\frac{(62.4)}{(31.2)}$

Bed Depth = $\frac{(564)(62.4)}{(141)(12)}$

Reactor Cross Section = 0.66 sq.Ft.

Inv. =(20.8)(0.66)(141)

Volume = (20.8)(0.66)

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	22.5	80+	
100	150	65.7	40—80	
150	105	7.8	20—40	
200	74	3.0	10—20	
250	62	0.6	0—20	
325	44	0.3		
<325		0.1		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	154
Settled	155
Compacted	169
Particle Density, gm./cc.	4.4
NH_3 Value, ml./gm.	2.16
N_2 Surface, m²/gm.	<1
CHEMICAL ANALYSIS	
Fe	68.8
C	2.41
O	
H	0.13
K_2O, W+, % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	40
Fe_3O_4	55
Fe	5

GAS ANALYSES / GENERATOR BALANCE

HOUR				AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.59	10.191 0.083			20.548
CO 28.010				37.127	14.705	14.705		14.705	CO 28.010					
H_2 2.016				59.330	23.499		46.998		H_2 2.016					
CO_2 44.010				2.540	1.006	1.006		2.012	CO_2 44.010	2.30	0.325	0.325		0.650
N_2 28.016				0.935	0.370				N_2 28.016	2.96	0.418			
CH_4 16.042				0.068	0.027	0.027	0.108		CH_4 16.042	81.54	11.522	11.522	46.088	
			M. W.	12.98608					C_2H_6 30.068	8.46	1.195	2.390	7.170	
			H_2O 18.016				9.956	4.978	C_3H_8 44.094	3.82	0.540	1.620	4.320	
						15.738	57.062	21.695	C_4H_{10} 58.120	0.31 0.02	0.044 0.003	0.176 0.015	0.440 0.036	
			BALANCE			98.07	98.29	102.34	TOTAL			16.048	58.054	21.198

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	265.93	263.59
OIL	87.82	87.82
WATER	162.94	162.94
TOTAL	516.69	514.35
FRESH FEED	514.35	
WEIGHT BALANCE	100.45	
WET GAS FACTOR		0.991201
INDICATED LOSS—S C F H		-40

WET GAS				
CO 28.010	10.45	11.72		11.085
H_2 2.016	42.65	40.39		41.520
CO_2 44.010	25.73	29.56		27.645
N_2 28.016	2.36	2.55		2.455
CH_4 16.042	8.82	6.68		7.750
C_2H_4 28.052	2.42	2.64		2.530
C_2H_6 30.068	0.88	0.90		0.890
C_3H_6 42.078	2.53	2.60		2.565
C_3H_8 44.094				
C_4H_8 56.104	1.95	1.54		1.745
C_4H_{10} 58.120	0.75	0.54		0.645
C_5H_{10} 70.130	0.96	0.62		0.790
C_5H_{12} 72.146	0.23	0.14		0.185
C_6H_{12} 84.156	0.27	0.12		0.195
			M. W.	22.3017

GAS FLOW RATES

	√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	6.49	19.96	0.9786	15012	1.4931	39.[illegible]
WET GAS 158.44	6.24	4.067	0.9868	4519	1.139	11.924
RECYCLE 79.31	8.45	20.19	0.9388	14468	1.139	38.175
BLEED 5.02	9.18	20.19	0.9388	995	1.139	2.625
				15463		40.800
NATURAL GAS 28.43	8.59	20.44	0.8816	5356	1.217	14.131
OXYGEN 27.07	7.02	20.75	0.9795	3862	1.000	10.191
STEAM 215.7	5.71	34.5 0.3079		379.2#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL	7'4	388.59	80	0.9901	384.74	49.0	2510.8	87.82
	4'2 1/2	224.92	61	0.9995	224.81	6.526	1469.6	13.479
	1'9 1/2	93.76	62	0.9990	93.67	48.7	611.3	
	0'2 1/2	11.06	74	0.9930	10.98	6.537	71.7	
					242.62		1580.8	
WATER								
	7'3 1/2	386.41	78	0.9979	385.60	10.2	3207.0	162.94
	5'6	292.57	78	0.9979	291.96	8.317	2428.2	19.59
	5'2	275.11	80	0.9976	274.45		2282.6	
	0'3 1/2	15.49	88	0.9974	15.45		128.5	
					358.64		2938.9	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 C
HOURS 34-59

	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	YIELD BASIS H_2+CO FED — CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	37.127	14.937	418.40	12.473	1.755	49.16	5.121	20.058	6.876	-13.182	369.24					Distribution of					
H_2 2.016	59.330	23.870	48.12	41.586	5.852	11.80	17.073	40.943	22.925	-18.018	36.32					Recovered Oil					
CO_2 44.010	2.540	1.022	44.98	28.227	3.973	174.85	11.588	13.610	15.561	1.951	129.87	8.827					400 EP			0.529	
N_2 28.016	0.935	0.376	10.53	3.027	0.426	11.93	1.243	1.619	1.669								400-550			0.135	
CH_4 16.042	0.068	0.027	0.43	6.197	0.872	13.99	2.544	2.571	3.416	0.845	13.56						550+			0.088	
C_2H_4 28.052				2.283	0.321	9.00	0.937	0.937	1.258	0.321	9.00										74.3
C_2H_6 30.068				0.787	0.111	3.38	0.323	0.323	0.434	0.111	3.38										
C_1+C_2											25.94	1.763									
C_3H_6 42.078				2.190	0.308	12.96	0.899	0.899	1.207	0.308	12.96	0.881	4.32	3.000	0.204	11.66	0.793	6.25	1.866	0.127	92.8
C_3H_8 44.094				0.170	0.024	1.06	0.070	0.070	0.094	0.024	1.06	0.072	4.24	0.250	0.017						
C_4H_8 56.104				1.460	0.205	11.50	0.599	0.599	0.804	0.205	11.50	0.782	5.00	2.300	0.156	10.93	0.743	6.10	1.792	0.122	72.7
C_4H_{10} 58.120				0.547	0.077	4.48	0.224	0.224	0.301	0.077	4.48	0.305	4.86	0.922	0.063	4.48	0.305	4.86	0.922	0.063	
C_5H_{10} 70.130				0.703	0.099	6.94	0.289	0.289	0.388	0.099	6.94	0.472	5.45	1.273	0.087	6.94	0.472	5.45	1.273	0.087	83.7
C_5H_{12} 72.146				0.137	0.019	1.37	0.056	0.056	0.075	0.019	1.37	0.093	5.25	0.261	0.018	1.37	0.093	5.25	0.261	0.018	
C_6H_{12} 84.156				0.180	0.025	2.10	0.074	0.074	0.099	0.025	2.10	0.143	5.54	0.379	0.026	2.10	0.143	5.54	0.379	0.026	
C_3-C_6																					
TOTAL		40.232	522.46		14.071	314.48	41.054	81.286			40.41	2.747		8.385	0.571	37.48	2.549		6.493	0.443	
H_2+CO	96.457	38.807	14712 S.C.F.H.							-31.200											
H_2/CO	1.60		679717					2.04													

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.5

	m/hr	#/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL		72.04	4.897	6.512	11.062	0.752	72.04	4.697	6.512	11.062	0.752
TOTAL OIL		112.45	7.643		19.447	1.323	109.52	7.446		17.555	1.195
WATER SOLUBLE CHEMICALS		10.56	0.718	8.067	1.309	0.089	10.56	0.718	8.067	1.309	0.089
TOTAL LIQUID PRODUCTS C_3+		123.01	8.361		70.756	1.412	120.08	8.164		18.864	1.284
NET WATER	6.959	125.38	8.522	8.328	15.055	1.023					
GROSS WATER		135.94	9.240		16.364	1.112					
HYDROCARBON TOTAL—C_1+		148.95	10.124								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
65.03	88.25	75.48	80.40	65.72	44.01	51.15	82.58

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG			RATES S.C.F.H.	
Oxygen		416	Fresh Feed	15252
Natural Gas		404	Recycle	15560
Generator Outlet		399	Combined Feed	30812
Reactor Inlet		384	Wet Gas—Measured	4740
Condenser Inlet			Adjusted	5333
Product Accumulator		360	Loss	593
TEMPERATURES—°F.			Recycle/Fresh Feed	1.020
Oxygen		438	Inlet Velocity—ft./sec.	1.017
Natural Gas		662	Fresh Feed Rate—S.C.F.H.	14712
Generator		2355	per Cu.Ft. Dense Bed	1140
Quench Accumulator			per Lb. Catalyst	8.18
Reactor Inlet		303		
Condenser Inlet				
Product Accumulator		71	Heat Transfer Calculations	
Catalyst No.	Height"		Steam Rate = 383.2 #/hr	
1	12.0	649	@ 835 psia & 523°F	
2	43.2	650	= 1196 BTU/#	
3	74.4	682	Water in @ 184°F = 152 BTU/#	
4	105.6		Heat transferred/lb steam	
5	136.8	662	= 1044 BTU	
6	168.0		(1044)(383.2) = 400061 BTU/hr	
7	199.2	667	Ave. Bed Temperature	
8	230.4		= 662°F	
9	261.6		dT = 662-523 = 139°F	
10	292.8		Tube Area = 30.9 ft²	
12	342.0	626	$K = \frac{400061}{(139)(30.9)} = 93.4$	

PRODUCT TESTS

	OIL	WATER
°API	49.3	10.3
Neut. No.	43.6	42.0
Sap. No.	50.9	45.3
Hydrox. No.		
Bromine No.	84.2	
Pour °F.		
Chemicals, % by K_2CO_3		8.0
HEMPEL, DIST. %		°API
205 °F.		
400	70.3	55.9
400-550	18.0	36.4
550+	11.7	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	104	
10%	140	
50%	235	
90%	341	
EP	400	
	98.0	

CATALYST DATA

INVENTORY DATA	2257
In Reactor at Start of Period	
Fresh Catalyst Added	
Total	
Catalyst Recovered	60
In Reactor at End of Period	2197
REACTOR d-p, Inches H_2O	
No. Height"	
1 12 - 43.2	64
2 43.2 - 74.4	68
3 74.4 - 105.6	75
4 105.6 - 342.0	290
(Calc) 0-12"	27
total	524
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	138
Inventory, Lbs.	1798
Bed Depth, Ft.	19.54
Volume, Cu Ft	12.90

PARTICLE SIZE — Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	12.0	80+	
100	150	64.0	40—80	
150	105	12.4	20—40	
200	74	7.8	10—20	
250	62	1.4	0—20	
325	44	1.2		
<325		1.2		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	143
Settled	145
Compacted	159
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	2.37
N_2 Surface, m²/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, Wt. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES / GENERATOR BALANCE

HOUR				AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.57	10.573 0.081			21.308
CO 28.010	36.99	37.47	37.29	37.177	14.937	14.937		14.937	CO 28.010					
H_2 2.016	59.36	58.13	58.71	59.330	23.870		47.740		H_2 2.016					
CO_2 44.010	2.12	3.40	3.09	2.540	1.022	1.022		2.044	CO_2 44.010	2.30	0.328	0.328		0.656
N_2 28.016	0.87	0.96	0.84	0.935	0.376				N_2 28.016	3.08	0.439			
CH_4 16.042	0.06	0.04	0.07	0.068	0.027	0.027	0.108		CH_4 16.042	81.39	11.596	11.596	46.384	
			M. W.	12.98608					C_2H_6 30.068	8.65	1.232	2.464	7.392	
			H_2O 18.016				10.272	5.136	C_3H_8 44.094	3.66	0.521	1.563	4.168	
						15.986	58.120	22.117	C_4H_{10} 58.120	0.33 0.02	0.047 0.003	0.188 0.018	0.470 0.036	
			BALANCE			98.96	99.44	100.70	TOTAL			16.154	58.450	21.964

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
WET GAS	279.51	314.48
OIL	72.04	72.04
WATER	135.94	135.94
TOTAL	487.49	522.46
FRESH FEED	522.46	
WEIGHT BALANCE	93.28	
WET GAS FACTOR		1.125112
INDICATED LOSS—S C F H		593

WET GAS				
CO 28.010	11.96	13.00	12.46	12.473
H_2 2.016	43.75	40.09	40.92	41.586
CO_2 44.010	27.34	29.08	28.26	28.227
N_2 28.016	2.55	2.52	4.01	3.027
CH_4 16.042	6.34	6.34	5.91	6.197
C_2H_4 28.052	2.36	2.46	2.03	2.283
C_2H_6 30.068	0.81	0.83	0.72	0.787
C_3H_6 42.078	2.19	2.40	1.98	2.190
C_3H_8 44.094		0.12	0.39	0.170
C_4H_8 56.104	1.34	1.63	1.41	1.460
C_4H_{10} 58.120	0.53	0.43	0.68	0.547
C_5H_{10} 70.130	0.57	0.81	0.73	0.703
C_5H_{12} 72.146	0.14	0.10	0.17	0.137
C_6H_{12} 84.156	0.12	0.19	0.23	0.180
			M. W.	22.35083

GAS FLOW RATES

		√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	6.57	383.7 19.96	79 0.9822	15252	1.4931	40.232
WET GAS	158.44	6.51	1.94 4.08	71 0.9896	4740	1.1381	12.506
RECYCLE	79.31	8.48	391.7 20.16	129 0.9396	14499	1.1381	38.256
BLEED	5.02	9.8	391.7 20.16	129 0.9396	1061	1.1381	2.798
NATURAL GAS	28.43	8.67	403.6 20.45	211 0.8803	15560 5400	1.217	41.054 14.248
OXYGEN	27.07	7.26	416.4 20.76	79 0.9822	4007	1.000	10.573
STEAM	215.7	5.77	34.3 0.3079		383.2#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL HR
OIL	7'0	371.14	65	0.9975	370.21	49.3	2412.3	72.04
	1'9 1/2	93.76	62	0.9990	93.67	49.0	611.3	11.062
					276.54		1801.0	
WATER								
	7'7	401.69	82	0.9972	400.57	10.3 8.311	3329.1	135.94
	5'2	275.11	80	0.9976	274.45	10.2 8.317	2282.6	16.364
	5'3	296.94	80	0.9976	296.23		2462.0	
	0'3	13.28	90	0.9970	13.24		110.0	
					409.11		3398.5	

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THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 D

HOURS 59-79

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED: CONDENSATE				POLYMER					%
	%	m/hr	#/hr	%	At. Wt. Balance m/hr	At. Wt. Balance #/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	36.383	14.890	417.07	13.343	1.875	52.53	5.424	20.314	7.299	-13.015	364.54					Distribution of					
H_2 2.016	60.164	24.623	49.64	39.850	5.600	11.29	16.198	40.821	21.798	-19.023	38.35					Recovered Oil					
CO_2 44.010	2.593	1.061	46.70	27.593	3.877	170.62	11.216	12.277	15.093	2.816	123.92	8.275					400 EP			0.582	
N_2 28.016	0.800	0.327	9.16	3.727	0.524	14.68	1.515	1.842	2.039								400-550			0.152	
CH_4 16.042	0.060	0.025	0.40	6.297	0.884	14.20	2.560	2.585	3.444	0.859	13.80	0.922					550+			0.083	
C_2H_4 28.052				2.390	0.336	9.43	0.971	0.971	1.307	0.336	9.43	0.630									72.3
C_2H_6 30.068				0.917	0.128	3.86	0.373	0.373	0.501	0.128	3.86	0.254									
C_1+C_2											27.04	1.806									
C_3H_6 42.078				2.460	0.346	14.56	1.000	1.000	1.346	0.346	14.56	0.972	4.32	3.370	0.225	13.10	0.875	6.25	2.096	0.140	85.3
C_3H_8 44.094				0.423	0.059	2.61	0.172	0.172	0.231	0.059	2.61	0.174	4.24	0.616	0.041						
C_4H_8 56.104				1.526	0.214	12.03	0.620	0.620	0.834	0.214	12.03	0.803	5.00	2.406	0.161	11.43	0.763	6.10	1.874	0.125	73.3
C_4H_{10} 58.120				0.557	0.078	4.55	0.226	0.226	0.304	0.078	4.55	0.304	4.86	0.936	0.063	4.55	0.304	4.86	0.936	0.063	
C_5H_{10} 70.130				0.677	0.095	6.66	0.275	0.275	0.370	0.095	6.66	0.445	5.45	1.222	0.082	6.66	0.445	5.45	1.222	0.082	87.5
C_5H_{12} 72.146				0.097	0.013	0.97	0.039	0.039	0.052	0.013	0.97	0.065	5.25	0.185	0.012	0.97	0.065	5.25	0.185	0.012	
C_6H_{12} 84.156				0.143	0.020	1.69	0.058	0.058	0.078	0.020	1.69	0.113	5.54	0.305	0.020	1.69	0.113	5.54	0.305	0.020	
C_3-C_6											43.07	2.876		9.040	0.604	38.40	2.564		6.618	0.442	
TOTAL		40.926	522.97		14.052	319.67	40.647	81.573													
H_2+CO		39.513	14,975 S.C.F.H.		7.475		21.622	61.135	29.097	32.038											
H_2/CO		1.65	66776		2.99		2.99	2.01	2.99	1.46											

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.2

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Polymer #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL		80.27	5.360		12.233	0.817	80.27	5.360		12.233	0.817
TOTAL OIL		123.34	8.236		21.273	1.421	118.67	7.924		18.851	1.259
WATER SOLUBLE CHEMICALS		9.60	0.641	8.11	1.184	0.079	9.60	0.641		1.184	0.079
TOTAL LIQUID PRODUCTS C_3+		132.94	8.877		22.457	1.500	128.27	8.565		20.035	1.338
NET WATER	6.296	113.43	7.574	8.328	13.620	0.909					
GROSS WATER		123.03	8.215		14.804						
HYDROCARBON TOTAL—C_1+		159.98	10.683								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
65.66	87.41	77.26	81.08	64.07	46.60	52.41	83.09

g/M3 = 16.91 × #/MCF.

cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	419	Fresh Feed	15511
Natural Gas	405	Recycle	15405
Generator Outlet	397	Combined Feed	30916
Reactor Inlet	384	Wet Gas—Measured	4768
Condenser Inlet		Adjusted	5325
Product Accumulator	363	Loss	577
TEMPERATURES—°F.		Recycle/Fresh Feed	0.993
Oxygen	458	Inlet Velocity—ft./sec.	1.021
Natural Gas	671	Fresh Feed Rate—S.C.F.H.	14975
Generator	2375	per Cu.Ft. Dense Bed	1120
Quench Accumulator		per Lb. Catalyst	8.28
Reactor Inlet	314		
Condenser Inlet			
Product Accumulator	72	Heat Transfer Calculations	
Catalyst No. Height "		Steam Rate = 364.1 #/hr	
1 12.0	648	@ 845.2 psia & 524°F	
2 43.2	648	= 1195 BTU/#	
3 74.4	681	Water in @ 186°F = 153 BTU/#	
4 105.6		Heat Transferred/lb. steam	
5 136.8	664	= 1042 BTU	
6 168.0		(1042)(364.1) = 379400 BTU/hr	
7 199.2	665	Ave. Bed Temperature	
8 230.4		= 661°F	
9 261.6		dT = 661-524 = 137°F	
10 292.8		Tube Area = 31.1 ft²	
12 342.0	633	$K = \frac{379400}{(137)(31.1)}$ =	89.1

PRODUCT TESTS

	OIL	WATER
°API	48.8	10.4
Neut. No.	45.3	41.7
Sap. No.	51.9	44.4
Hydrox. No.		
Bromine No.	84.7	
Pour °F.		
Chemicals, % by K_2CO_3		8.0
HEMPEL, DIST. %		°API
205 °F.		
400	71.3	55.4
400-550	18.6	36.0
550+	10.1	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	106	
10%	144	
50%	240	
90%	361	
EP	410	
	98.0	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2197
Fresh Catalyst Added 68=	103*
Total	2300
Catalyst Recovered	33
In Reactor at End of Period	2267
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	60
2 43.2 - 74.4	66
3 74.4 - 105.6	75
4 105.6 - 342.0	300
(Calc) 0-12"	26
total	527
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	134
Inventory, Lbs.	1809
Bed Depth, Ft.	20.25
Volume, Cu Ft	13.37
* At 66% Fe	

PARTICLE SIZE: Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	11.4	80+	
100	150	65.4	40—80	
150	105	11.2	20—40	
200	74	8.2	10—20	
250	62	1.2	0—20	
325	44	1.4		
<325		1.2		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	148
Settled	150
Compacted	163
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	6.77
N_2 Surface, m²/gm.	
CHEMICAL ANALYSIS	
Fe	66.1
C	
O	
H	
K_2O, W+, % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	30
Fe_3O_4	65
Fe	5

GAS ANALYSES

HOUR				AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.79	36.31	36.05	36.383	14.890	14.890		14.890
H_2 2.016	59.85	60.04	60.60	60.164	24.623		49.246	
CO_2 44.010	2.73	2.67	2.38	2.593	1.061	1.061		2.122
N_2 28.016	0.59	0.92	0.89	0.800	0.327			
CH_4 16.042	0.04	0.06	0.08	0.060	0.025	0.025	0.100	
			M. W.	12.7787				
			H_2O 18.016					
			BALANCE					

WET GAS				
CO 28.010	12.69	12.89	14.45	13.343
H_2 2.016	42.72	41.66	35.17	39.850
CO_2 44.010	26.47	27.91	28.40	27.593
N_2 28.016	2.21	2.39	6.58	3.727
CH_4 16.042	6.97	5.71	6.21	6.297
C_2H_4 28.052	2.27	2.38	2.52	2.390
C_2H_6 30.068	0.96	0.88	0.91	0.917
C_3H_6 42.078	2.37	2.56	2.45	2.460
C_3H_8 44.094	0.49	0.39	0.39	0.423
C_4H_8 56.104	1.41	1.70	1.47	1.526
C_4H_{10} 58.120	0.57	0.51	0.59	0.557
C_5H_{10} 70.130	0.63	0.76	0.64	0.677
C_5H_{12} 72.146	0.08	0.10	0.11	0.097
C_6H_{12} 84.156	0.16	0.16	0.11	0.143
			M. W.	22.7515

GENERATOR BALANCE

	Mol %	M/Hr	C	H	O
O_2 32.000	0.57	10.707 0.081			21.576
CO 28.010					
H_2 2.016					
CO_2 44.010	2.30	0.325	0.325		0.650
N_2 28.016	3.08	0.436			
CH_4 16.042	81.39	11.510	11.510	46.040	
C_2H_6 30.068	8.65	1.223	2.446	7.338	
C_3H_8 44.094	3.66	0.517	1.551	4.136	
C_4H_{10} 58.120	0.33 0.02	0.047 0.003	0.188 0.015	0.470 0.036	
TOTAL			16.035	58.020	22.226

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	286.21	319.67
OIL	80.27	80.27
WATER	123.03	123.03
TOTAL	489.51	522.97
FRESH FEED	522.97	
WEIGHT BALANCE	93.60	
WET GAS FACTOR		1.11690
INDICATED LOSS—S C F H		557

GAS FLOW RATES

		√h	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED			383.5	81			
	79.31	6.64	19.96	0.9804	15511	1.5052	40.926
WET GAS			1.82	72			
	158.44	6.64	4.064	0.9887	4768	1.1280	12.581
RECYCLE			393.2	130			
	79.31	8.46	20.20	0.9388	14353	1.1280	37.870
BLEED			393.2	130			
	5.02	9.8	20.20	0.9388	1052	1.1280	2.777
NATURAL GAS			404.7	209	15405		40.647
	28.43	8.58	20.48	0.8816	5360	1.217	14.142
OXYGEN			419.4	80			
	27.07	7.33	20.84	0.9813	4058		10.707
STEAM			33.3				
	215.7	5.55	0.3042		364.1#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'6	397.32	66	0.9970	396.13	48.8	2588.3	80.265
	7'0	371.14	65	0.9975	370.21	6.534	2412.3	12.233
	4'5 1/2	238.01	66	0.9970	237.30	49.3	1550.5	
	0'4 1/2	19.92	74	0.9930	19.78	6.516	129.2	
					+1.22 244.66		+8.0 1605.3	
WATER								
	6'11	296.94	80	0.9976	296.23	10.3	2462.0	123.03
	5'7	244.56	80	0.9976	243.97	8.311	2026.2	14.804
	5'11	262.02	78	0.9979	261.47	10.4	2171.5	
	0'4	17.70	80	0.9976	17.66	8.305	146.7	
					296.07		2460.6	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 E
HOURS 79-104

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	36.233	14.565	407.97	11.327	1.505	42.16	4.562	19.127	6.067	-13.060	365.81					Distribution of					
H_2 2.016	59.764	24.024	48.43	40.757	5.416	10.92	16.414	40.438	21.830	-18.608	37.51					Recovered Oil					
CO_2 44.010	2.853	1.147	50.48	30.140	4.005	176.26	12.138	13.285	16.143	2.858	125.78	8.600					400 EP			0.520	
N_2 28.016	1.063	0.427	11.96	1.413	0.188	5.27	0.569	0.996	0.757								400-550			0.094	
CH_4 16.042	0.087	0.035	0.56	7.087	0.942	15.11	2.854	2.889	3.796	0.907	14.55	0.995					550+			0.096	
C_2H_4 28.052				2.473	0.329	9.23	0.996	0.996	1.325	2.473	9.23	0.631									71.8
C_2H_6 30.068				0.970	0.129	3.88	0.391	0.391	0.520	0.970	3.88	0.265									
C_1+C_2											27.66	1.891									
C_3H_6 42.078				2.487	0.330	13.89	1.002	1.002	1.332	2.487	13.89	0.950	4.32	3.215	0.220	12.50	0.855	6.25	2.000	0.137	83.5
C_3H_8 44.094				0.490	0.065	2.87	0.197	0.197	0.262	0.490	2.87	0.196	4.24	0.677	0.046						
C_4H_8 56.104				1.517	0.202	11.33	0.611	0.611	0.813	1.517	11.33	0.775	5.00	2.266	0.155	10.76	0.736	6.10	1.764	0.121	79.0
C_4H_{10} 58.120				0.423	0.056	3.25	0.170	0.170	0.226	0.423	3.25	0.222	4.86	0.669	0.046	3.25	0.222	4.86	0.669	0.046	
C_5H_{10} 70.130				0.663	0.088	6.17	0.267	0.267	0.355	0.663	6.17	0.422	5.45	1.132	0.077	6.17	0.422	5.45	1.132	0.077	87.7
C_5H_{12} 72.146				0.093	0.012	0.87	0.037	0.037	0.049	0.093	0.87	0.059	5.25	0.166	0.011	0.87	0.059	5.25	0.166	0.011	
C_6H_{12} 84.156				0.160	0.021	1.77	0.064	0.064	0.085	0.160	1.77	0.121	5.54	0.319	0.022	1.77	0.121	5.54	0.319	0.022	
C_3-C_6				-							40.15	2.745		8.444	0.577	35.32	2.415		6.050	0.414	
TOTAL		40.198			13.288		40.272	80.400													
H_2+CO		38.589	14,625 S.C.F.H.		6.921		20.976	59.565	27.897	31.668											
H_2/CO		1.65	68375		3.60		3.60	2.11	3.60												

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

		NET CHANGE m/hr	#/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
EFFLUENT	RECOVERED OIL		67.39	4.608		10.381	0.710	67.39	4.608		10.381	0.710
SHIFT RATIO	TOTAL OIL		107.54	7.353		18.825	1.287	102.71	7.023		16.431	1.123
	WATER SOLUBLE CHEMICALS		14.37	0.983	8.00	1.796	0.123	14.37	0.983		1.796	0.123
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.8	TOTAL LIQUID PRODUCTS C_3+		121.91	8.336		20.621	1.410	117.08	8.005		18.227	1.246
SELECTIVITY	NET WATER	7.473	134.64	9.206	8.328	16.167	1.105					
C_3+/C_1+	GROSS WATER		149.01	10.189		17.963	1.228					
81.51	HYDROCARBON TOTAL—C_1+		149.57	10.227								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %		
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2
66.94	89.67	77.46	82.06	68.28	46.02	53.17

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	408	Fresh Feed	15235
Natural Gas	395	Recycle	15264
Generator Outlet	388	Combined Feed	30499
Reactor Inlet	373	Wet Gas—Measured	4780
Condenser Inlet		Adjusted	5036
Product Accumulator	353	Loss	256
TEMPERATURES—°F.		Recycle/Fresh Feed	1.002
Oxygen	448	Inlet Velocity—ft./sec.	1.038
Natural Gas	707	Fresh Feed Rate—S.C.F.H.	14625
Generator	2380	per Cu.Ft. Dense Bed	1088
Quench Accumulator		per Lb. Catalyst	7.86
Reactor Inlet	301		
Condenser Inlet			
Product Accumulator	71	Heat Transfer Calculations	
Catalyst No. Height"		Steam Rate = 372.0#/hr	
1 12.0	644	@ 805 psia & 518°F	
2 43.2	642	= 1196 BTU/#	
3 74.4	660	Water in @ 183°F = 151 BTU/#	
4 105.6		Heat Transferred/lb steam	
5 136.8	648	= 1045 BTU	
6 168.0		(1045)(372.0) = 388700 BTU/#	
7 199.2	649	Ave. Bed Temperature	
8 230.4		= 649°F	
9 261.6		dT = 649-518 = 131°F	
10 292.8		Tube Area = 31.1 ft^2	
12 342.0	611	$K = \frac{388700}{(131)(31.1)}$ =	95.8

PRODUCT TESTS

	OIL	WATER
°API	49.4	10.5
Neut. No.	39.8	39.2
Sap. No.	46.9	40.8
Hydrox. No.		
Bromine No.	88.0	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	73.2	55.6
400-550	13.5	36.3
550+		
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	101	
10%	136	
50%	232	
90%	354	
EP	406	
	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2267
Fresh Catalyst Added 108=	164
Total	2431
Catalyst Recovered	143
In Reactor at End of Period	2288
REACTOR d-p. Inches H_2O	
No. Height "	
1 12 - 43.2	65
2 43.2 - 74.4	73
3 74.4 - 105.6	68
4 105.6 - 342.0	310
(Calc) 0-12"	26
total	542
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	137
Inventory, Lbs.	1860
Bed Depth, Ft.	20.36
Volume, Cu Ft	13.44

PARTICLE SIZE				
Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	15.5	80+	
100	150	64.4	40—80	
150	105	9.7	20—40	
200	74	5.8	10—20	
250	62	1.4	0—20	
325	44	1.0		
<325		2.2		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	147
Settled	149
Compacted	165
Particle Density, gm./cc.	4.4
NH_3 Value, ml./gm.	21.00
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				AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.19	36.37	36.14	36.233	14.565	14.565		14.565
H_2 2.016	59.99	59.85	59.45	59.764	24.024		48.048	
CO_2 44.010	2.69	3.00	2.87	2.853	1.147	1.147		2.294
N_2 28.016	0.99	0.72	1.48	1.063	0.427			
CH_4 16.042	0.14	0.06	0.06	0.087	0.035	0.035	0.140	
			M. W.	12.92108				
			H_2O 18.016				9.962	4.981
						15.747	58.150	21.840
			BALANCE			96.69	99.51	100.66

	Mol %	M/Hr	C	H	O
O_2 32.000	0.48	10.500 0.067			21.134
CO 28.010					
H_2 2.016					
CO_2 44.010	2.02	0.281	0.281		0.562
N_2 28.016	2.55	0.355			
CH_4 16.042	80.90	11.263	11.263	45.052	
C_2H_6 30.068	8.49	1.182	2.364	7.092	
C_3H_8 44.094	5.27	0.734	2.202	5.872	
C_4H_{10} 58.120	0.25 0.04	0.035 0.006	0.140 0.036	0.350 0.072	
TOTAL			16.286	58.438	21.696

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	287.58	303.01
OIL	67.39	67.39
WATER	149.01	149.01
TOTAL	503.98	519.41
FRESH FEED	519.41	
WEIGHT BALANCE	97.03	
WET GAS FACTOR		1.0536546
INDICATED LOSS—S C F H		256

WET GAS

WET GAS				
CO 28.010	10.85	10.85	12.28	11.327
H_2 2.016	40.52	40.80	40.95	40.757
CO_2 44.010	30.07	30.60	29.75	30.140
N_2 28.016	0.14	1.86	2.24	1.413
CH_4 16.042	8.74	6.56	5.96	7.087
C_2H_4 28.052	2.53	2.48	2.41	2.473
C_2H_6 30.068	1.08	0.91	0.92	0.970
C_3H_6 42.078	2.57	2.48	2.41	2.487
C_3H_8 44.094	0.56	0.45	0.46	0.490
C_4H_8 56.104	1.56	1.59	1.40	1.517
C_4H_{10} 58.120	0.44	0.45	0.38	0.423
C_5H_{10} 70.130	0.68	0.70	0.61	0.663
C_5H_{12} 72.146	0.10	0.10	0.08	0.093
C_6H_{12} 84.156	0.16	0.17	0.15	0.160
			M. W.	22.80288

GAS FLOW RATES

		$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	6.63	372.9 19.69	78 0.9831	15235	1.4968	40.198
WET GAS	158.44	6.68	170 4.050	71 0.9896	4780	1.1268	12.611
RECYCLE	79.31	8.49	383.9 19.96	127 0.9412	14254	1.1268	37.608
BLEED	5.02	9.50	383.9 19.96	127 0.9412	1010	1.1268	2.664
					15264		40.272
NATURAL GAS	28.43	8.59	394.7 20.23	207 0.8830	5276	1.2095	13.922
OXYGEN	27.07	7.27	407.5 20.55	77 0.9840	3980		10.500
STEAM	215.7	5.77	31.9 0.2989		372.0#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'8 1/2	408.15	74	0.9930	405.29	49.4	2639.2	67.39
	4'5 1/2	238.01	66	0.9970	237.30	48.8	1550.5	10.381
	1'11½	102.89	62	0.9990	102.79		669.4	
	0'2 3/4	12.17	60	1.000	12.17		79.3	
					0.92 259.53		1684.8	
WATER								
	7'6	397.32	77	0.9980	396.53	10.5	3290.8	149.01
	5'11	262.02	78	0.9979	261.47	10.3	2171.5	17.96
	6'11	366.77	80	0.9976	365.89		3036.5	
	1'0	52.00	80	0.9976	51.88		430.6	
					449.07		3725.2	

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 F

HOURS 104-128

	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	36.847	15.053	421.63	12.180	1.809	50.67	4.946	19.999	6.755	-13.244	370.96
H_2 2.016	59.507	24.310	49.01	44.590	6.668	13.44	13.228	42.538	24.896	-17.642	35.57
CO_2 44.010	2.620	1.070	47.09	26.657	3.959	174.24	10.824	11.894	14.783	2.889	127.14
N_2 28.016	0.943	0.385	10.79	2.380	0.354	9.92	0.966	1.351	1.320		
CH_4 16.042	0.083	0.034	0.55	5.723	0.850	13.64	2.324	2.358	3.174	0.816	13.09
C_2H_4 28.052				2.087	0.310	8.70	0.847	0.847	1.157	0.310	8.70
C_2H_6 30.068				0.793	0.118	3.55	0.322	0.322	0.440	0.118	3.55
C_1+C_2											25.34
C_3H_6 42.078				2.077	0.308	12.96	0.843	0.843	1.151	0.308	12.96
C_3H_8 44.094				0.313	0.046	2.03	0.127	0.127	0.173	0.046	2.03
C_4H_8 56.104				1.390	0.206	11.56	0.564	0.564	0.770	0.206	11.56
C_4H_{10} 58.120				0.563	0.084	4.88	0.229	0.229	0.313	0.084	4.88
C_5H_{10} 70.130				0.663	0.099	6.94	0.269	0.269	0.368	0.099	6.94
C_5H_{12} 72.146				0.127	0.019	1.37	0.052	0.052	0.071	0.019	1.37
C_6H_{12} 84.156				0.157	0.023	1.94	0.064	0.064	0.087	0.023	1.94
C_3-C_6											41.68
TOTAL		40.852			14.853		40.606	81.458			
H_2+CO		39.363	14,919 S.C.F.H.		8.477		23.174	62.537	31.651	30.886	
H_2/CO		1.615	670305		3.686		3.686	2.127	3.686	1.332	

	YIELD BASIS H_2+CO FED — CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF	% Unsats.
CO					Distribution of					
H_2					Recovered Oil					
CO_2	8.522					400 EP			0.527	
N_2						400-550			0.135	
CH_4	0.877					550+			0.064	
C_2H_4	0.583									72.5
C_2H_6	0.238									
C_1+C_2	1.698									
C_3H_6	0.869	4.32	3.000	0.201	11.66	0.782	6.25	1.866	0.125	86.9
C_3H_8	0.136	4.24	0.479	0.032						
C_4H_8	0.775	5.00	2.312	0.155	10.98	0.736	6.10	1.800	0.121	71.2
C_4H_{10}	0.327	4.86	1.004	0.067	4.88	0.327	4.86	1.004	0.067	
C_5H_{10}	0.465	5.45	1.273	0.085	6.94	0.465	5.45	1.273	0.085	83.9
C_5H_{12}	0.092	5.25	0.261	0.017	1.37	0.092	5.25	0.261	0.017	
C_6H_{12}	0.130	5.54	0.350	0.024	1.94	0.130	5.54	0.350	0.024	
C_3-C_6	2.794		8.679	0.582	37.77	2.532		6.554	0.439	

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT

SHIFT RATIO

$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.7

	m/hr	#/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL	0.513	71.95	4.823		10.837	0.726	71.95	4.823		10.837	0.726
TOTAL OIL		113.63	7.617		19.516	1.308	109.72	7.355		17.391	1.166
WATER SOLUBLE CHEMICALS		13.51	0.906	7.92	1.705	0.114	13.51	0.906		1.705	0.114
TOTAL LIQUID PRODUCTS C_3+		127.14	8.522		21.221	1.422	123.23	8.261		19.096	1.280
NET WATER	7.092	127.77	8.564	8.328	15.342	1.028					
GROSS WATER		141.28	9.470		17.047	1.143					
HYDROCARBON TOTAL—C_1+		152.48	10.221								

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
63.64	87.98	72.57	78.46	66.22	41.47	49.39	83.38

g/M3 = 16.91 × #/MCF.

cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	393	Fresh Feed	15483
Natural Gas	380	Recycle	15389
Generator Outlet	375	Combined Feed	30872
Reactor Inlet	362	Wet Gas—Measured	5183
Condenser Inlet		Adjusted	5629
Product Accumulator	339	Loss	446
TEMPERATURES—°F.		Recycle/Fresh Feed	0.994
Oxygen	485	Inlet Velocity—ft./sec.	1.081
Natural Gas	701	Fresh Feed Rate—S.C.F.H.	14919
Generator		per Cu.Ft. Dense Bed	997
Quench Accumulator		per Lb. Catalyst	7.65
Reactor Inlet	228		
Condenser Inlet			
Product Accumulator	70	**Heat Transfer Calculations**	
Catalyst No. Height"		Steam Rate = 323.2 #/hr	
1 12.0	724	@ 800 psia & 518°F	
2 43.2	632	= 1197 BTU/#	
3 74.4	652	Water in @ 179°F = 148 BTU/#	
4 105.6		Heat Transferred/lb. steam	
5 136.8	652	= 1049 BTU	
6 168.0		(1049)(323.2) = 339000 BTU/hr	
7 199.2	646	Ave. Bed Temperature	
8 230.4		= 661°F	
9 261.6		dT = 661-518 = 143°F	
10 292.8		Tube Area = 32.5 ft^2	
12 342.0	610	$K = \frac{339000}{(143)(32.5)}$ =	73.1

PRODUCT TESTS	OIL	WATER
°API	49.4	10.6
Neut. No.	40.5	38.3
Sap. No.	47.4	41.6
Hydrox. No.		
Bromine No.	74.4	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	72.6	55.5
400-550	18.6	36.6
550+	8.8	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	108	
10%	143	
50%	238	
90%	362	
EP	408	
	98.0	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2288
Fresh Catalyst Added 107=	162
Total	2450
Catalyst Recovered	192
In Reactor at End of Period	2258
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	61
2 43.2 - 74.4	62
3 74.4 -105.6	70
4 105.6 -342.0	350
(Calc) 0-12"	25
total	568
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	129
Inventory, Lbs.	1949
Bed Depth, Ft.	22.66
Volume, Cu Ft	14.93

PARTICLE SIZE — Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	16.5	80+	
100	150	62.8	40—80	
150	105	10.1	20—40	
200	74	6.6	10—20	
250	62	0.6	0—20	
325	44	1.2		
<325		2.2		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	141
Settled	142
Compacted	157
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	12.45
N_2 Surface, m^2/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, Wt. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES HOUR				AVERAGE	GENERATOR BALANCE M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED					15.053	15.053		15.053	O_2 32.000	0.47	10.325 0.066			20.782
CO 28.010	36.95	36.62	36.97	36.847	24.310		48.620		CO 28.010					
H_2 2.016	59.41	59.76	59.35	59.507	1.070	1.070		2.140	H_2 2.016					
CO_2 44.010	2.64	2.56	2.66	2.620	0.385				CO_2 44.010	1.58	0.223	0.223		0.446
N_2 28.016	0.84	1.00	0.99	0.943	0.034	0.034	0.136		N_2 28.016	2.31	0.326			
CH_4 16.042	0.16	0.05	0.04	0.083					CH_4 16.042	81.60	11.508	11.508	46.032	
			M. W.	12.95107					C_2H_6 30.068	8.42	1.187	2.374	7.122	
			H_2O 18.016				10.424	5.212	C_3H_8 44.094	5.49	0.774	2.322	6.192	
						16.157	59.180	22.405	C_4H_{10} 58.120	0.10 0.03	0.014 0.004	0.056 0.024	0.140 0.048	
			BALANCE			97.88	99.41	100.80	TOTAL			16.507	59.534	22.228

WEIGHT BALANCE	# hr Measured	At. Wt. Balance
WET GAS	290.82	315.85
OIL	71.95	71.95
WATER	141.28	141.28
TOTAL	504.05	529.08
FRESH FEED	529.08	
WEIGHT BALANCE	95.27	
WET GAS FACTOR		1.0860669
INDICATED LOSS—S C F H		446

WET GAS				
CO 28.010	11.75	12.90	11.89	12.180
H_2 2.016	43.95	44.01	46.71	44.890
CO_2 44.010	27.78	26.08	26.11	26.657
N_2 28.016	2.17	2.97	2.00	2.380
CH_4 16.042	6.05	5.85	5.27	5.723
C_2H_4 28.052	2.15	2.11	2.00	2.087
C_2H_6 30.068	0.75	0.87	0.76	0.793
C_3H_6 42.078	2.22	1.97	2.04	2.077
C_3H_8 44.094	0.39	0.15	0.40	0.313
C_4H_8 56.104	1.44	1.37	1.36	1.390
C_4H_{10} 58.120	0.46	0.67	0.56	0.563
C_5H_{10} 70.130	0.66	0.69	0.64	0.663
C_5H_{12} 72.146	0.09	0.16	0.13	0.127
C_6H_{12} 84.156	0.14	0.20	0.13	0.157
			M. W.	21.26484

GAS FLOW RATES	√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	6.84	361.6 19.40	77 0.9840	15483	1.4951	40.852
WET GAS 158.44	6.96	1.84 4.067	70 0.9905	5183	1.1668	13.676
RECYCLE 79.31	8.46	363.7 19.45	124 0.9436	14368	1.1668	37.911
BLEED 5.02	9.50	363.7 19.45	124 0.9436	1021	1.1668	2.695
NATURAL GAS 28.43	8.82	380.0 19.87	207 0.8830	15389 5345	1.2149	40.606 14.103
OXYGEN 27.07	7.28	392.5 20.18	77 0.9840	3913		10.325
STEAM 215.7	5.07	31.0 0.2955		323.2#/hr		

LIQUID PRODUCT RATES HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL								
	6'10	362.41	68	0.9961	361.00	49.4	2350.8	71.95
	1'11	102.89	62	0.9990	102.79	6.512	669.4	10.837
					+1.46 254.67		+9.5 1690.9	
WATER								
	7'4	388.59	80	0.9976	387.66	10.6	3214.9	141.28
	6'11	366.77	80	0.9976	365.89	8.293	3036.5	17.047
	7'6	397.32	78	0.9979	396.49	10.8	3288.1	
	0'4	17.70	80	0.9976	17.66	8.299	146.5	
					400.60		3320.0	

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 G
HOURS 128-152

	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	YIELD BASIS H_2+CO FED: CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.123	14.858	416.17	12.643	1.854	51.93	5.720	20.578	6.974	-13.004	364.24					Distribution of					
H_2 2.016	60.107	24.724	49.84	44.174	6.477	13.06	17.888	42.612	24.365	-18.247	36.79					Recovered Oil					
CO_2 44.010	2.513	1.034	45.51	26.233	3.846	169.26	10.623	11.657	14.469	2.812	123.76	8.250					400 EP			0.524	
N_2 28.016	0.807	0.332	9.30	1.930	0.283	7.93	0.782	1.114	1.065								400-550			0.137	
CH_4 16.042	0.450	0.185	2.97	6.617	0.970	15.56	2.679	2.864	3.649	0.785	12.59	0.839					550+			0.074	
C_2H_4 28.052				2.173	0.319	8.95	0.880	0.880	1.199	0.319	8.95	0.597									73.6
C_2H_6 30.068				0.780	0.114	3.43	0.316	0.316	0.430	0.114	3.43	0.229									
C_1+C_2											24.97	1.664									
C_3H_6 42.078				2.090	0.306	12.88	0.846	0.846	1.152	0.306	12.88	0.859	4.32	2.981	0.199	11.59	0.773	6.25	1.854	0.124	88.1
C_3H_8 44.094				0.283	0.041	1.81	0.114	0.114	0.155	0.041	1.81	0.121	4.24	0.427	0.028						
C_4H_8 56.104				1.493	0.219	12.29	0.604	0.604	0.823	0.219	12.29	0.819	5.00	2.458	0.164	11.68	0.779	6.10	1.915	0.128	75.8
C_4H_{10} 58.120				0.477	0.070	4.07	0.193	0.193	0.263	0.070	4.07	0.271	4.86	0.837	0.056	4.07	0.271	4.86	0.837	0.056	
C_5H_{10} 70.130				0.747	0.110	7.71	0.302	0.302	0.412	0.110	7.71	0.514	5.45	1.415	0.094	7.71	0.514	5.45	1.415	0.094	83.9
C_5H_{12} 72.146				0.143	0.021	1.52	0.058	0.058	0.079	0.021	1.52	0.101	5.25	0.290	0.019	1.52	0.101	5.25	0.290	0.019	
C_6H_{12} 84.156				0.217	0.032	2.69	0.088	0.088	0.120	0.032	2.69	0.179	5.54	0.486	0.032	2.69	0.179	5.64	0.486	0.032	
C_3-C_6											42.97	2.864		8.894	0.593	39.26	2.617		6.797	0.453	
TOTAL		41.134			14.662		40.494	81.628													
H_2+CO		39.582	15,002 S.C.F.H.		8.331		23.008	62.590	31.339	31.251											
H_2/CO		1.664	666596		3.494		3.494	2.133	3.494	1.403											

CUMULATIVE TOTALS

	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT

SHIFT RATIO

$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.2

EFFLUENT	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL	0.510	71.50	4.766		11.022	0.735	71.50	4.766		11.022	0.735
TOTAL OIL		114.47	7.631		19.916	1.328	110.76	7.383		17.819	1.188
WATER SOLUBLE CHEMICALS		13.40	0.893	7.981	1.679	0.112	13.40	0.893		1.679	0.112
TOTAL LIQUID PRODUCTS C_3+		127.87	8.524		21.595	1.440	124.16	8.276		19.498	1.300
NET WATER	6.985	125.84	8.388	8.328	15.111	1.007					
GROSS WATER		139.24	9.282		16.790	1.119					
HYDROCARBON TOTAL—C_1+		152.84	10.188								

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
64.36	87.52	73.80	78.95	66.11	42.821	49.93	83.67

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	396	Fresh Feed	15590
Natural Gas	383	Recycle	15348
Generator Outlet	373	Combined Feed	30938
Reactor Inlet	360	Wet Gas—Measured	5284
Condenser Inlet		Adjusted	5557
Product Accumulator	337	Loss	273
TEMPERATURES—°F.		Recycle/Fresh Feed	0.985
Oxygen	429	Inlet Velocity—ft./sec.	1.090
Natural Gas	656	Fresh Feed Rate—S.C.F.H.	15002
Generator		per Cu.Ft. Dense Bed	994
Quench Accumulator		per Lb. Catalyst	7.75
Reactor Inlet			
Condenser Inlet			
Product Accumulator	70	Heat Transfer Calculations	
Catalyst No. Height"		Steam Rate = 302.8 #/hr	
1 12.0	737	@ 803 psia & 518°F	
2 43.2	630	= 1197 BTU/#	
3 74.4	650	Water in @ 179°F = 137 BTU/#	
4 105.6		Heat Transferred/lb. steam	
5 136.8	648	= 1060 BTU	
6 168.0	645	(1060)(302.8) = 321000 BTU/hr	
7 199.2	639	Ave. Bed Temperature	
8 230.4	634	= 662°F	
9 261.6	626	dT = 662-518 = 144°F	
10 292.8	625	Tube Area = 30.9 ft²	
12 342.0	616	$K = \frac{321000}{(144)(30.9)} = 72.3$	

PRODUCT TESTS

	OIL	WATER
°API	50.1	10.6
Neut. No.	39.7	39.2
Sap. No.	43.2	41.3
Hydrox. No.		
Bromine No.	85.3	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	71.3	56.2
400-550	18.6	36.7
550+	10.1	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	107	
10%	138	
50%	234	
90%	350	
EP	399	
	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2258
Fresh Catalyst Added 98	148
Total	2406
Catalyst Recovered	96
In Reactor at End of Period	2390
REACTOR d-p, Inches H_2O	
No. Height"	
1 12 - 43.2	61
2 43.2 - 74.4	60
3 74.4 - 105.6	69
4 105.6 - 342.0	350
(Calc) 0-12"	24
total	564
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	127
Inventory, Lbs.	1936
Bed Depth, Ft.	22.87
Volume, Cu Ft	15.09

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	14.8	80+	
100	150	66.8	40—80	
150	105	10.0	20—40	
200	74	4.8	10—20	
250	62	1.4	0—20	
325	44	1.2		
<325		1.0		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	148
Settled	150
Compacted	163
Particle Density, gm./cc.	4.4
NH_3 Value, ml./gm.	8.29
N_2 Surface, m²/gm.	
CHEMICAL ANALYSIS	
Fe	67.8
C	
O	
H	
K_2O. W+. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	40[a]
Fe_3O_4	55
Fe	5

GAS ANALYSES / GENERATOR BALANCE

HOUR				AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.86	36.00	35.51	36.123	14.858	14.858		14.858
H_2 2.016	59.80	60.22	60.30	60.107	24.724		49.448	
CO_2 44.010	2.46	2.66	2.42	2.513	1.034	1.034		2.068
N_2 28.016	0.68	1.05	0.69	0.807	0.332			
CH_4 16.042	0.20	0.07	1.08	0.450	0.185	0.185	0.740	
			M. W.	12.73406				
			H_2O 18.016				8.860	4.430
						16.077	59.048	21.356
			BALANCE			96.20	98.84	101.65

	Mol %	M/Hr	C	H	O
O_2 32.000	0.40	10.186 0.056			20.484
CO 28.010					
H_2 2.016					
CO_2 44.010	1.87	0.263	0.263		0.526
N_2 28.016	2.29	0.322			
CH_4 16.042	79.97	11.245	11.245	44.980	
C_2H_6 30.068	9.81	1.379	2.758	8.274	
C_3H_8 44.094	5.27	0.741	2.223	5.928	
C_4H_{10} 58.120	0.37 0.02	0.052 0.003	0.208 0.015	0.520 0.036	
TOTAL			16.712	59.738	21.010

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS	297.69	315.06
OIL	71.50	71.50
WATER	139.24	139.24
TOTAL	508.43	523.80
FRESH FEED	523.80	
WEIGHT BALANCE	97.07	
WET GAS FACTOR		1.051631
INDICATED LOSS—S C F H		273

WET GAS

CO 28.010	12.22	12.82	12.89	12.643
H_2 2.016	43.54	44.33	44.65	44.174
CO_2 44.010	27.08	27.05	24.57	26.233
N_2 28.016	1.74	2.35	1.70	1.930
CH_4 16.042	6.27	5.46	8.12	6.617
C_2H_4 28.052	2.18	2.12	2.22	2.173
C_2H_6 30.068	0.81	0.76	0.77	0.780
C_3H_6 42.078	2.22	1.97	2.08	2.090
C_3H_8 44.094	0.40	0.27	0.18	0.283
C_4H_8 56.104	1.67	1.38	1.43	1.493
C_4H_{10} 58.120	0.57	0.44	0.42	0.477
C_5H_{10} 70.130	0.86	0.69	0.69	0.747
C_5H_{12} 72.146	0.18	0.15	0.10	0.143
C_6H_{12} 84.156	0.26	0.21	0.18	0.217
			M. W.	21.35204

GAS FLOW RATES

	$\sqrt{h}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
		359.6	76			
FRESH FEED 79.31	6.84	19.35	0.9850	15590	1.50779	41.134
		1.98	70			
WET GAS 158.44	7.07	4.09	0.9905	5284	1.1644	13.942
		363.4	123			
RECYCLE 79.31	8.45	19.45	0.9444	14334	1.1644	37.820
BLEED 5.02	9.44	19.45	0.9444	1014	1.1644	2.674
		382.8	205	15348		40.494
NATURAL GAS 28.43	8.82	19.94	0.8843	5330	1.2054	14.062
		395.92	75.42			
OXYGEN 27.07	7.14	20.26	0.9859	3861		10.186
		31.4				
STEAM 215.7	4.72	0.2974		302.8#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL								
	7'3	384.23	68	0.9961	382.73	50.1	2482.8	71.500
	6'10	362.41	68	0.9961	361.00	6.487	2341.8	11.022
	4'9	253.29	66	0.9970	252.53		1638.2	
	0'3½	15.49	75	0.9928	14.98		97.2	
					5.24 264.52		+34.0 1716.0	
WATER								
	7'0	371.14	80	0.9976	370.25	10.6	3070.5	139.24
	0'4	17.70	80	0.9976	17.66	8.293	146.5	16.790
					352.59		2924.0	

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THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 H
HOURS 168-176

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	36.48	15.149	424.32	13.42	1.978	55.43	5.449	20.598	7.427	-13.171	368.89					Distribution of					
H_2 2.016	60.02	24.924	50.25	43.26	6.379	12.86	17.563	42.487	23.942	-18.545	37.39					Recovered Oil					
CO_2 44.010	2.62	1.088	47.88	26.84	3.956	174.16	10.897	11.985	14.853	2.868	126.28	8.312					400 EP			0.520	
N_2 28.016	0.63	0.262	7.34	1.95	0.287	8.04	0.792	1.054	1.079								400-550			0.123	
CH_4 16.042	0.25	0.104	1.67	6.16	0.908	14.59	2.501	2.605	3.409	0.804	12.92	0.850					550+			0.079	
C_2H_4 28.052				2.33	0.343	9.63	0.946	0.946	1.289	0.343	9.63	0.634									75.2
C_2H_6 30.068				0.77	0.114	3.43	0.313	0.313	0.427	0.114	3.43	0.226									
C_1+C_2						27.65					25.98	1.710									
C_3H_6 42.078				2.17	0.320	13.46	0.881	0.881	1.201	0.320	13.46	0.886	4.32	3.116	0.204	12.11	0.797	6.25	1.938	0.128	83.8
C_3H_8 44.094				0.42	0.062	2.73	0.171	0.171	0.233	0.062	2.73	0.180	4.24	0.644	0.043						
C_4H_8 56.104				1.38	0.203	11.39	0.560	0.560	0.763	0.203	11.39	0.750	5.00	2.278	0.150	10.82	0.712	6.10	1.774	0.117	78.0
C_4H_{10} 58.120				0.39	0.057	3.31	0.158	0.158	0.215	0.057	3.31	0.218	4.86	0.681	0.045	3.31	0.218	4.86	0.681	0.045	
C_5H_{10} 70.130				0.66	0.097	6.80	0.268	0.268	0.365	0.097	6.80	0.448	5.45	1.248	0.082	6.80	0.448	5.45	1.248	0.082	86.8
C_5H_{12} 72.146				0.10	0.015	1.08	0.041	0.041	0.056	0.015	1.08	0.071	5.25	0.206	0.014	1.08	0.071	5.25	0.206	0.014	
C_6H_{12} 84.156				0.15	0.022	1.85	0.061	0.061	0.083	0.022	1.85	0.122	5.54	0.334	0.022	1.85	0.122	5.54	0.334	0.022	
C_3-C_6						40.62					40.62	2.675		8.507	0.560	35.97	2.368		6.181	0.408	
TOTAL		41.527	531.46		14.741	318.76	40.601	82.128													
H_2+CO	96.50	40.073	15,192 S.C.F.H.		8.357	68.29		63.085	31.369	-31.716											
H_2/CO	1.645		65824		3.225					1.408											

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.7

	NET CHANGE m/hr	#/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL	0.509	71.27	4.691		10.968	0.722	71.27	4.691		10.968	0.722
TOTAL OIL		111.89	7.365		19.475	1.282	107.24	7.059		17.149	1.129
WATER SOLUBLE CHEMICALS		12.99	0.855	8.023	1.619	0.107	12.99	0.855		1.619	0.107
TOTAL LIQUID PRODUCTS C_3+		124.88	8.220		21.094	1.388	120.23	7.914		18.768	1.236
NET WATER	7.129	128.44	8.454	8.328	15.423	1.015					
GROSS WATER		141.43	9.309		17.042	1.122					
HYDROCARBON TOTAL—C_1+		150.86	9.930								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
64.50	86.94	74.41	79.15	63.94	43.65	50.28	82.78

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	379	Fresh Feed	15743
Natural Gas	393	Recycle	15392
Generator Outlet	371	Combined Feed	31135
Reactor Inlet	358	Wet Gas—Measured	5313
Condenser Inlet		Adjusted	5588
Product Accumulator	335	Loss	275
TEMPERATURES—°F.		Recycle/Fresh Feed	0.978
Oxygen	449	Inlet Velocity—ft./sec.	1.102
Natural Gas	662	Fresh Feed Rate—S.C.F.H.	15192
Generator		per Cu.Ft. Dense Bed	1094
Quench Accumulator		per Lb. Catalyst	8.66
Reactor Inlet	286		
Condenser Inlet			
Product Accumulator	68	Heat Transfer Calculations	

Catalyst No.	Height"	
1	12.0	744
2	43.2	643
3	74.4	661
4	105.6	
5	136.8	655
6	168.0	652
7	199.2	647
8	230.4	644
9	261.6	635
10	292.8	634
12	342.0	626

Heat Transfer Calculations
Steam Rate = 343.9 #/hr
@ 803 psia & 518°F
= 1197 BTU/#
Water in @ 179°F
= 137 BTU/#
Heat Transferred/# steam
= 1060 BTU
(1060)(343.9)
= 364500 BTU/hr
Ave. Bed Temperature = 667°F
dT = 667-518 = 149°F
Tube Area = 32.3 ft²
$K = \frac{364500}{(149)(32.3)} = 75.9$

PRODUCT TESTS

	OIL	WATER
°API	49.5	10.5
Neut. No.	38.6	38.1
Sap. No.	44.9	38.9
Hydrox. No.		
Bromine No.	88.0	
Pour °F.		
Chemicals, % by K_2CO_3		9.5
HEMPEL, DIST. %		°API
205 °F.		
400	72.0	55.6
400-550	17.0	36.8
550+	11.0	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	104	
10%	140	
50%	235	
90%	354	
EP	402	
	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2390
Fresh Catalyst Added 88m	133
Total	2523
Catalyst Recovered	294
In Reactor at End of Period	2229
REACTOR d-p, Inches H_2O	
No. Height"	
1 12 - 43.2	61
2 43.2- 74.4	58
3 74.4- 105.6	68
4 105.6- 342.0	300
(Calc) 0-12"	24
total	511
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	125
Inventory, Lbs.	1754
Bed Depth, Ft.	21.05
Volume, Cu Ft	13.89

PARTICLE SIZE				
Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	10.9	80+	
100	150	68.2	40—80	
150	105	11.3	20—40	
200	74	6.0	10—20	
250	62	0.9	0—20	
325	44	0.9		
<325		1.8		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	148
Settled	149
Compacted	163
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	15.76
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	1300	2100	0500	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.30	10.186 0.043			20.458
CO 28.010	36.12	36.79	36.52	36.48	15.149	15.149		15.149	CO 28.010					
H_2 2.016	60.13	60.05	59.89	60.02	24.924		49.848		H_2 2.016					
CO_2 44.010	2.43	2.59	2.84	2.62	1.088	1.088		2.176	CO_2 44.010	1.60	0.228	0.228		0.556
N_2 28.016	0.69	0.52	0.69	0.63	0.262				N_2 28.016	1.20	0.171			
CH_4 16.042	0.64	0.05	0.07	0.25	0.104	0.104	0.416		CH_4 16.042	82.36	11.762	11.762	47.048	
			M. W.	12.798					C_2H_6 30.068	8.90	1.271	2.542	7.626	
			H_2O 18.016				9.144	4.572	C_3H_8 44.094	5.46	0.780	2.340	6.240	
					41.527	16.341	59.408	21.897	C_4H_{10} 58.120	0.18	0.026	0.104	0.260	
			BALANCE			96.26	97.11	104.20	TOTAL			16.976	61.174	21.014

WET GAS	1300	2100	0500	AVERAGE
CO 28.010	12.43	13.99	13.85	13.42
H_2 2.016	43.34	43.05	43.42	43.26
CO_2 44.010	26.25	27.31	26.96	26.84
N_2 28.016	1.87	1.85	2.13	1.95
CH_4 16.042	7.12	5.75	5.60	6.16
C_2H_4 28.052	2.63	2.17	2.18	2.33
C_2H_6 30.068	0.79	0.76	0.76	0.77
C_3H_6 42.078	2.27	2.08	2.16	2.17
C_3H_8 44.094	0.45	0.38	0.44	0.42
C_4H_8 56.104	1.47	1.35	1.31	1.38
C_4H_{10} 58.120	0.41	0.41	0.35	0.39
C_5H_{10} 70.130	0.72	0.66	0.59	0.66
C_5H_{12} 72.146	0.09	0.12	0.09	0.10
C_6H_{12} 84.156	0.16	0.16	0.14	0.15
			M. W.	21.623

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	303.05	318.76
OIL	71.27	71.27
WATER	141.43	141.43
TOTAL	515.75	531.46
FRESH FEED	531.46	531.46
WEIGHT BALANCE	97.04	
WET GAS FACTOR		1.05183
INDICATED LOSS—S C F H		275

GAS FLOW RATES

	√R	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
		357.583	73.79			
FRESH FEED 79.31	6.932	19.29451	0.9868	15743	1.5040	41.527
		1.990	68.45			
WET GAS 158.44	7.142	4.089	0.9924	5313	1.1571	14.015
		361.208	120.917			
RECYCLE 79.31	8.435	19.38912	0.9460	14364	1.1571	37.889
		361.208	120.917			
BLEED 5.02	9.647	19.38912	0.9460	1028	1.1571	2.712
		378.917	204.958	15392		40.601
NATURAL GAS 28.43	8.917	19.84054	0.8843	5414	1.2173	14.281
		392.875	73.583			
OXYGEN 27.07	7.358	20.18923	0.9868	3968		10.467
		32.5				
STEAM 215.7	5.30	0.5008		343.9#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL	7'4	388.59	78	0.9911	385.132			
	4'9	253.29	66	0.9970	252.530			
					132.602	50.1 6.487	860.19	
	2'8¾	146.17	62	0.9990	146.024			71.267
	3½	15.49	72	0.9941	15.399			10.968
					130.625	49.5 6.509	850.24	
					263.227		1710.43	
WATER	7'1	375.50	76	0.99879	375.046	10.6		
	0'4	17.70	80	0.99759	17.657			
					357.389	8.293	2963.83	
	1'3¾	68.29	76	0.99879	68.207	10.5		
	0'3¾	16.60	66	0.99942	16.590			
					51.617	8.340	430.49	141.43
					409.006		3394.32	17.042

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 I
HOURS 176-200

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	36.580	15.212	426.09	13.757	2.168	60.73	5.687	20.899	7.855	-13.044	365.36					Distribution of					
H_2 2.016	59.540	24.760	49.92	43.489	6.854	13.82	17.977	42.737	24.831	-17.906	36.10					Recovered Oil					
CO_2 44.010	2.914	1.212	53.34	25.976	4.094	180.18	10.738	11.950	14.832	2.882	126.84	8.373					400 EP			0.517	
N_2 28.016	0.903	0.376	10.53	2.237	0.353	9.89	0.925	1.301	1.278								400-550			0.134	
CH_4 16.042	0.063	0.026	0.42	6.340	0.999	16.03	2.621	2.647	3.620	0.973	15.61	1.030					550+			0.071	
C_2H_4 28.052				2.260	0.356	9.99	0.934	0.934	1.290	0.356	9.99	0.659									73.9
C_2H_6 30.068				0.800	0.126	3.79	0.331	0.331	0.457	0.126	3.79	0.250									
C_1+C_2											29.39	1.939									
C_3H_6 42.078				2.090	0.329	13.84	0.864	0.864	1.193	0.329	13.84	0.914	4.32	3.204	0.211	12.46	0.822	6.25	1.994	0.132	84.5
C_3H_8 44.094				0.383	0.060	2.65	0.158	0.158	0.218	0.060	2.65	0.178	4.24	0.625	0.041						
C_4H_8 56.104				1.367	0.215	12.06	0.565	0.565	0.780	0.215	12.06	0.796	5.00	2.412	0.159	11.46	0.756	6.10	1.879	0.124	76.1
C_4H_{10} 58.120				0.430	0.068	3.95	0.178	0.178	0.246	0.068	3.95	0.261	4.86	0.813	0.054	3.95	0.261	4.86	0.813	0.054	
C_5H_{10} 70.130				0.617	0.097	6.80	0.255	0.255	0.352	0.097	6.80	0.449	5.45	1.248	0.082	6.80	0.449	5.45	1.248	0.082	84.1
C_5H_{12} 72.146				0.117	0.019	1.37	0.048	0.048	0.067	0.019	1.37	0.090	5.25	0.261	0.017	1.37	0.090	5.25	0.261	0.017	
C_6H_{12} 84.156				0.137	0.022	1.85	0.057	0.057	0.079	0.022	1.85	0.122	5.54	0.334	0.022	1.85	0.122	5.54	0.334	0.022	
C_3-C_6											42.52	2.807		8.897	0.587	37.89	2.501		6.529	0.431	
TOTAL		41.545	539.75		15.761	336.95	41.338	82.883													
H_2+CO		39.972	15,149 S.C.F.H.		9.022		33.664	63.636	32.686	30.950											
H_2/CO		1.63	66009		3.16			2.04		1.37											

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.1

	NET CHANGE m/hr	#/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL	0.507	71.12	4.695		10.883	0.718	71.12	4.695		10.883	0.718
TOTAL OIL		113.64	7.501		19.780	1.306	109.01	7.501		17.412	1.149
WATER SOLUBLE CHEMICALS		12.60	0.832	8.39	1.501	0.099	12.60	0.832		1.501	0.099
TOTAL LIQUID PRODUCTS C_3+		126.24	8.333		21.281	1.405	121.61	8.333		18.913	1.248
NET WATER	6.610	119.08	7.860	8.328	14.299	0.944					
GROSS WATER		131.68	8.692		15.800	1.043					
HYDROCARBON TOTAL—C_1+		155.63	10.273								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
62.06	85.75	72.32	77.43	62.41	41.90	48.64	81.12

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG			RATES S.C.F.H.	
Oxygen		416	Fresh Feed	15761
Natural Gas		402	Recycle	15667
Generator Outlet		387	Combined Feed	31428
Reactor Inlet		372	Wet Gas—Measured	5404
Condenser Inlet			Adjusted	5973
Product Accumulator		352	Loss	569
TEMPERATURES—°F.			Recycle/Fresh Feed	0.994
Oxygen		449	Inlet Velocity—ft./sec.	1.072
Natural Gas		670	Fresh Feed Rate—S.C.F.H.	15149
Generator			per Cu.Ft. Dense Bed	1122
Quench Accumulator		170	per Lb. Catalyst	9.18
Reactor Inlet		290		
Condenser Inlet				
Product Accumulator		69	Heat Transfer Calculations	
Catalyst No.	Height"		Steam Rate = 352.1 #/hr	
1	12.0	745	@ 819 psia & 521°F	
2	43.2	650	= 1196 BTU/#	
3	74.4	673	Water in @ 175°F = 143 BTU/#	
4	105.6		Heat Transferred/lb. steam	
5	136.8	666	= 1053 BTU	
6	168.0	659	(1053)(352.1) = 370760 BTU/hr	
7	199.2	651	Ave. Bed Temperature	
8	230.4	648	= 679°F	
9	261.6	639	dT = 679-521 = 158°F	
10	292.8	639	Tube Area = 31.2 ft²	
12	342.0	631	$K = \frac{370760}{(158)(31.2)} = 73.1$	

PRODUCT TESTS

	OIL	WATER
°API	49.6	10.4
Neut. No.	39.3	38.1
Sap. No.	46.5	41.0
Hydrox. No.		
Bromine No.	75	
Pour °F.		
Chemicals, % by K_2CO_3		9.5
HEMPEL, DIST. %		°API
205 °F.		
400	72.6	55.4
400-550	18.6	36.1
550+	8.8	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	102	
10%	140	
50%	236	
90%	352	
EP	400	
	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2229
Fresh Catalyst Added	
Total	
Catalyst Recovered	217
In Reactor at End of Period	2012
REACTOR d-p, Inches H_2O	
No. Height"	
1 12 - 43.2	61
2 43.2 - 74.4	58
3 74.4 - 105.6	64
4 105.6 - 342.0	275
(Calc) 0-12"	23
total	481
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	122
Inventory, Lbs.	1651
Bed Depth, Ft.	20.5
Volume, Cu Ft	13.5

PARTICLE SIZE				
Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	14.9	80+	
100	150	65.6	40—80	
150	105	10.3	20—40	
200	74	4.6	10—20	
250	62	1.6	0—20	
325	44	1.4		
<325		1.6		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	134
Settled	136
Compacted	147
Particle Density, gm./cc.	4.1
NH_3 Value, ml./gm.	8.63
N_2 Surface, m²/gm.	<1
CHEMICAL ANALYSIS	
Fe	66.6
C	8.17
O	
H	0.51
K_2O, W+, % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	40*
Fe_3O_4	55
Fe	5

GAS ANALYSES / GENERATOR BALANCE

HOUR	1300	2100	0500	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED					15.212	15.212		15.212	O_2 32.000	0.45	10.721 0.066			21.594
CO 28.010	36.65	36.58	36.51	36.580	24.760		49.520		CO 28.010					
H_2 2.016	59.69	59.15	59.78	59.540	1.212	1.212		2.424	H_2 2.016					
CO_2 44.010	2.69	3.24	2.81	2.914	0.376				CO_2 44.010	1.88	0.276	0.276		0.552
N_2 28.016	0.88	0.99	0.84	0.903	0.026	0.026	0.104		N_2 28.016	2.53	0.372			
CH_4 16.042	0.09	0.04	0.06	0.063					CH_4 16.042	82.24	12.083	12.083	48.332	
			M. W.	12.99193					C_2H_6 30.068	8.19	1.203	2.406	7.218	
			H_2O 18.016				10.278	5.139	C_3H_8 44.094	4.53	0.666	1.998	5.328	
					41.545	16.450	59.902	22.775	C_4H_{10} 58.120	0.14 0.04	0.021 0.006	0.084 0.030	0.210 0.072	
			BALANCE			97.47	97.94	102.84	TOTAL			16.877	61.160	22.146

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	304.83	336.95
OIL	71.12	71.12
WATER	131.68	131.68
TOTAL	507.63	539.75
FRESH FEED	539.75	539.75
WEIGHT BALANCE	94.05	
WET GAS FACTOR		1.10537
INDICATED LOSS—S C F H		569

WET GAS	1300	2100	0500	
CO 28.010	13.66	13.80	13.81	13.757
H_2 2.016	44.39	43.10	42.98	43.489
CO_2 44.010	25.77	26.25	25.91	25.976
N_2 28.016	2.10	2.44	2.17	2.237
CH_4 16.042	6.00	6.04	6.98	6.340
C_2H_4 28.052	2.23	2.24	2.31	2.260
C_2H_6 30.068	0.76	0.79	0.85	0.800
C_3H_6 42.078	2.15	2.20	1.92	2.090
C_3H_8 44.094	0.35	0.38	0.42	0.383
C_4H_8 56.104	1.40	1.45	1.25	1.367
C_4H_{10} 58.120	0.37	0.44	0.48	0.430
C_5H_{10} 70.130	0.60	0.65	0.60	0.617
C_5H_{12} 72.146	0.10	0.10	0.15	0.117
C_6H_{12} 84.156	0.12	0.12	0.17	0.137
			M. W.	21.37798

GAS FLOW RATES

	$\sqrt{h}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	6.871	371.5 19.652	75 0.9859	15761	1.49275	41.585
WET GAS 158.44	7.233	2.0 4.087	69 0.9915	5404	1.1637	14.259
RECYCLE 79.31	8.458	378.7 1.983	124 0.9436	14607	1.1637	38.540
BLEED 5.02	9.7	378.7 1.983	124 0.9436	1060	1.1637	2.798
NATURAL GAS 28.43	8.900	402.0 20.413	206 0.8836	15667 5569	1.2202	41.338 14.693
OXYGEN 27.07	7.325	415.7 20.746	73 0.9877	4063		10.721
STEAM 215.7	5.42	33.0 0.3012		352.1#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL	7'0½	372.25	67	0.9965	370.93	49.5	2414.4	
	2'8¾	146.17	62	0.9990	146.02	6.509	950.4	71.12
					224.91		1464.0	10.88
	1'1	56.30	64	0.9980	56.19	49.6	365.5	
	0'4½	19.92	60	1.000	19.92	6.505	129.6	
					36.27 261.18		47 1706.9	
WATER	7'4	388.59	81	0.9974	387.58		3216.5	
	1'3¾	68.29	76	0.99879	68.21	10.5	5661	131.14
						8.299		15.800
	1'6	78.16	68	0.9920	77.53	10.4	643.9	
	0'4	17.70	60	1.000	17.70	8.305	147.0	
					379.20		3147.3	

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THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 J

HOURS 200-209

	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	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.470	14.765		13.35																	
H_2 2.016	59.747	24.188		44.74																	
CO_2 44.010	2.890	1.170		26.04																	
N_2 28.016	0.840	0.340		2.26																	
CH_4 16.042	0.053	0.021		5.70																	
C_2H_4 28.052				2.06																	
C_2H_6 30.068				0.81																	
C_1+C_2																					
C_3H_6 42.078				2.12									4.32					6.25			
C_3H_8 44.094				0.45									4.24								
C_4H_8 56.104				1.31									5.00					6.10			
C_4H_{10} 58.120				0.39									4.86					4.86			
C_5H_{10} 70.130				0.57									5.45					5.45			
C_5H_{12} 72.146				0.09									5.25					5.25			
C_6H_{12} 84.156				0.11									5.54					5.54			
C_3-C_6																					
TOTAL																					
H_2+CO			S.C.F.H.																		
H_2/CO																					

MECHANICAL DIFFICULTIES CAUSED SEVERAL INTERRUPTIONS SO YIELD DATA FROM THIS PERIOD ARE NOT CONSIDERED VALID.

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

RECOVERED OIL; TOTAL OIL; WATER SOLUBLE CHEMICALS; TOTAL LIQUID PRODUCTS C_3+; NET WATER; GROSS WATER; HYDROCARBON TOTAL—C_1+

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION—% CO	H_2	CO+H_2	SELECTIVITY C_3 + /C_1 +

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	420	Fresh Feed	15344
Natural Gas	405	Recycle	16274
Generator Outlet	400	Combined Feed	31618
Reactor Inlet	387	Wet Gas—Measured	5239
Condenser Inlet		Adjusted	5221
Product Accumulator	368	Loss	-18
TEMPERATURES—°F.		Recycle/Fresh Feed	1.06
Oxygen	401	Inlet Velocity—ft./sec.	1.078
Natural Gas	682	Fresh Feed Rate—S.C.F.H.	14763
Generator		per Cu. Ft. Dense Bed	1033
Quench Accumulator		per Lb. Catalyst	8.60
Reactor Inlet	228		
Condenser Inlet			
Product Accumulator	67	Heat Transfer Calculations (data not available)	

Catalyst No.	Height "	
1	12.0	733
2	43.2	638
3	74.4	655
4	105.6	
5	136.8	655
6	168.0	651
7	199.2	632
8	230.4	630
9	261.6	622
10	292.8	644
12	342.0	638

PRODUCT TESTS

	OIL	WATER
°API		
Neut. No.		
Sap. No.		
Hydrox. No.		
Bromine No.		
Pour °F.		
Chemicals, % by K_2CO_3		
HEMPEL, DIST. %		
205 °F.		
400		
400-550		
550+		
A. S. T. M. DIST. ON Naphtha °F.		
IBP		
10%		
50%		
90%		
EP		

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2012
Fresh Catalyst Added 65=	98
Total	2110
Catalyst Recovered	19
In Reactor at End of Period	2101
REACTOR d-p, Inches H_2O — No. Height "	
1 12 - 43.2	60
2 43.2- 74.4	58
3 74.4- 105.6	60
4 105.6- 342.0	300
(Calc) 0-12"	22
total	500
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	119
Inventory, Lbs.	1716
Bed Depth, Ft.	21.63
Volume, Cu Ft	14.28

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.	10.26
N_2 Surface, m². gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, Wt. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES / GENERATOR BALANCE

HOUR				AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.22	36.89	36.30	36.470	14.765	14.765		14.765
H_2 2.016	60.18	59.31	59.75	59.747	24.183		48.376	
CO_2 44.010	2.72	2.91	3.04	2.890	1.170	1.170		2.340
N_2 28.016	0.78	0.86	0.88	0.840	0.340			
CH_4 16.042	0.10	0.03	0.03	0.053	0.021	0.021	0.084	
			M. W.	12.9355				
			H_2O 18.016				12.942	6.471
						15.956	61.402	23.576
			BALANCE			92.33	98.24	102.39

	Mol %	M/Hr	C	H	O
O_2 32.000	0.50	0.075 11.148			22.446
CO 28.010					
H_2 2.016					
CO_2 44.010	1.93	0.290	0.290		0.580
N_2 28.016	2.26	0.339			
CH_4 16.042	82.59	12.403	12.403	49.612	
C_2H_6 30.068	7.92	1.189	2.378	7.134	
C_3H_8 44.094	4.64	0.697	2.091	5.576	
C_4H_{10} 58.120	0.12 0.04	0.018 0.024	0.072 0.048	0.180	
TOTAL			17.282	62.502	23.026

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS		
OIL		
WATER		
TOTAL		
FRESH FEED		
WEIGHT BALANCE		
WET GAS FACTOR		
INDICATED LOSS—S C F H		

WET GAS				
CO 28.010				13.35
H_2 2.016				44.74
CO_2 44.010				26.04
N_2 28.016				2.26
CH_4 16.042				5.70
C_2H_4 28.052				2.06
C_2H_6 30.068				0.81
C_3H_6 42.078				2.12
C_3H_8 44.094				0.45
C_4H_8 56.104				1.31
C_4H_{10} 58.120				0.39
C_5H_{10} 70.130				0.57
C_5H_{12} 72.146				0.09
C_6H_{12} 84.156				0.11
			M. W.	21.0798

GAS FLOW RATES

		$\sqrt{h}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	6.50	386.7 20.03	67 0.9933	15344	1.496	40.485
WET GAS	158.44	7.01	1.72 4.052	67 0.9933	5239	1.172	13.824
RECYCLE	79.31	8.50	395.4 20.25	117 0.9493	15188	1.172	40.074
BLEED	5.02	9.6	395.4 20.25	117 0.9493	1086	1.172	2.865
NATURAL GAS	28.43	9.07	405.3 20.49	208 0.8823	16274 5692	1.221	42.939 15.018
OXYGEN	27.07	7.54	419.6 20.84	67 0.9937	4225		11.148
STEAM							

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	3'0"	165.75	62	0.9990	0.31 165.58	49.7	2.00 1076.45	
	1'1"	56.30	64	0.9980	56.19	6.501	365.29	
					109.70		713.16	
WATER								
	5'5 3/4	291.48	71	0.9988	291.13	10.5	2416.09	
	3'8½"	198.73	74	0.9985	198.43	8.299	1646.77	
					92.70		769.32	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 K
HOURS 209-221

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	37.137	14.828	415.33	14.377	2.194	61.45	5.599	20.427	7.793	-12.634	353.88					Distribution of					
H_2 2.016	59.010	23.561	47.50	41.480	6.329	12.76	16.155	39.716	22.484	-17.232	34.74					Recovered Oil					
CO_2 44.010	2.813	1.123	49.42	26.787	4.087	179.87	10.432	11.555	14.520	2.964	130.45	8.966					400 EP			0.510	
N_2 28.016	0.957	0.382	10.70	2.493	0.380	10.65	0.971	1.353	1.351								400-550			0.128	
CH_4 16.042	0.083	0.033	0.53	6.363	0.971	15.58	2.478	2.511	3.449	0.938	15.05	1.034					550+			0.024	
C_2H_4 28.052				2.287	0.349	9.79	0.891	0.891	1.240	0.349	9.79	0.673									71.9
C_2H_6 30.068				0.393	0.136	4.09	0.348	0.348	0.484	0.136	4.09	0.281									
C_1+C_2											28.93	1.988									
C_3H_6 42.078				2.137	0.326	13.72	0.832	0.832	1.158	0.326	13.72	0.943	4.32	3.176	0.218	12.35	0.849	6.25	1.976	0.136	84.3
C_3H_8 44.094				0.397	0.060	2.64	0.155	0.155	0.215	0.060	2.64	0.181	4.24	0.623	0.043						
C_4H_8 56.104				1.393	0.213	11.95	0.543	0.543	0.756	0.213	11.95	0.821	5.00	2.390	0.164	11.35	0.780	6.10	1.861	0.128	69.6
C_4H_{10} 58.120				0.480	0.073	4.24	0.187	0.187	0.260	0.073	4.24	0.291	4.86	0.872	0.060	4.24	0.291	4.86	0.872	0.060	
C_5H_{10} 70.130				0.623	0.095	6.66	0.243	0.243	0.338	0.095	6.66	0.458	5.45	1.222	0.084	6.66	0.458	5.45	1.222	0.084	80.3
C_5H_{12} 72.146				0.153	0.023	1.66	0.060	0.060	0.083	0.023	1.66	0.114	5.25	0.316	0.022	1.66	0.114	5.25	0.316	0.022	
C_6H_{12} 84.156				0.137	0.021	1.77	0.053	0.053	0.074	0.021	1.77	0.122	5.54	0.319	0.022	1.77	0.122	5.54	0.319	0.022	
C_3-C_6											42.64	2.931		8.918	0.613	38.03	2.614		6.566	0.451	
TOTAL		39.927			15.258		38.946														
H_2+CO		38.389	14,549 S.C.F.H.		8.523		21.754	60.143	30.277	29.866											
H_2/CO		1.59	68731		2.88			1.94		1.36											

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT

SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.7

EFFLUENT	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL		62.57	4.300		9.634	0.662	62.57	4.300		9.634	0.662
TOTAL OIL		105.21	7.231		18.552	1.275	100.60	6.914		16.200	1.113
WATER SOLUBLE CHEMICALS		12.02	0.826	8.04	1.495	0.103	12.02	0.826		1.495	0.103
TOTAL LIQUID PRODUCTS C_3+		117.23	8.057		20.047	1.378	112.62	7.740		17.695	1.216
NET WATER	6.218	112.02	7.699	8.328	13.451	0.925					
GROSS WATER		124.04	8.525		14.946	1.027					
HYDROCARBON TOTAL—C_1+		146.16	10.046								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
61.80	85.20	73.14	77.80	61.85	43.39	49.66	80.20

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	425	Fresh Feed	15132
Natural Gas	412	Recycle	14760
Generator Outlet	410	Combined Feed	29892
Reactor Inlet	392	Wet Gas—Measured	5281
Condenser Inlet		Adjusted	5783
Product Accumulator	374	Loss	502
TEMPERATURES—°F.		Recycle/Fresh Feed	0.975
Oxygen	420	Inlet Velocity—ft./sec.	0.970
Natural Gas	718	Fresh Feed Rate—S.C.F.H.	14549
Generator	2340	per Cu.Ft. Dense Bed	1037
Quench Accumulator	168	per Lb. Catalyst	8.93
Reactor Inlet	314		
Condenser Inlet			
Product Accumulator	66	Heat Transfer Calculations	
Catalyst No. Height"		Steam Rate = 382.4 #/hr	
1 12.0	738	@ 765 psia & 513°F	
2 43.2	630	= 1198 BTU/#	
3 74.4	650	Water in @ 177°F = 145 BTU/#	
4 105.6		Heat Transferred/lb. steam	
5 136.8	647	= 1053 BTU	
6 168.0	639	(1053)(382.4) = 402667 BTU/hr	
7 199.2	633	Ave. Bed Temperature	
8 230.4	625	= 657°F	
9 261.6	619	dT = 657-513 = 140°F	
10 292.8	619	Tube Area = 31.7 ft²	
12 342.0	612	$K = \frac{402667}{(144)(31.7)}$ =	88.1

PRODUCT TESTS

	OIL	WATER
°API	49.9	10.5
Neut. No.	40.4	36.9
Sap. No.	46.8	40.8
Hydrox. No.		
Bromine No.	89.7	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL DIST. %		°API
205 °F.		
400	77.0	55.1
400-550	19.3	34.0
550+	3.7	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	104	
10%	140	
50%	236	
90%	355	
EP	412	
	98.0	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2101
Fresh Catalyst Added	
Total	
Catalyst Recovered	74
In Reactor at End of Period	2027
REACTOR d-p, Inches H_2O	
No. Height"	
1 12 - 43.2	58
2 43.2 - 74.4	57
3 74.4 - 105.6	58
4 105.6 - 342.0	280
(Calc) 0-12"	22
total	475
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	115
Inventory, Lbs.	1630
Bed Depth, Ft.	21.26
Volume, Cu Ft	14.03

PARTICLE SIZE

Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	13.6	80+	
100	150	65.1	40—80	
150	105	8.9	20—40	
200	74	6.2	10—20	
250	62	0.7	0—20	
325	44	1.9		
<325		3.6		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	142
Settled	145
Compacted	161
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	12.2
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				AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.49	10.523 0.070			21.186
CO 28.010	37.04	37.17	37.20	37.137	14.828	14.828		14.828	CO 28.010					
H_2 2.016	59.11	59.11	58.81	59.010	23.561		47.122		H_2 2.016					
CO_2 44.010	2.91	2.72	2.81	2.813	1.123	1.123		2.246	CO_2 44.010	1.84	0.261	0.261		0.522
N_2 28.016	0.85	0.91	1.11	0.957	0.382				N_2 28.016	2.39	0.339			
CH_4 16.042	0.10	0.08	0.07	0.083	0.033	0.033	0.132		CH_4 16.042	82.12	11.650	11.650	46.600	
			M. W.	13.11114					C_2H_6 30.068	8.00	11.35	2.270	6.810	
			H_2O 18.016				10.670	5.335	C_3H_8 44.094	4.97	0.705	2.115	5.640	
						15.984	57.924	22.409	C_4H_{10} 58.120	0.13 0.06	0.018 0.008	0.072 0.040	0.180 0.096	
			BALANCE			97.42	97.64	103.23	TOTAL			16.408	59.326	21.708

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS	307.63	336.88
OIL	62.57	62.57
WATER	124.04	124.04
TOTAL	494.24	523.49
FRESH FEED	523.49	
WEIGHT BALANCE	94.41	
WET GAS FACTOR		1.09508
INDICATED LOSS—S C F H		502

WET GAS				
CO 28.010	14.07	15.02	14.04	14.377
H_2 2.016	42.93	38.85	42.66	41.480
CO_2 44.010	26.27	28.06	26.03	26.787
N_2 28.016	2.31	2.74	2.43	2.493
CH_4 16.042	6.28	6.45	6.36	6.363
C_2H_4 28.052	2.25	2.39	2.22	2.287
C_2H_6 30.068	0.89	0.97	0.86	0.893
C_3H_6 42.078	1.84	2.27	2.30	2.137
C_3H_8 44.094	0.34	0.47	0.38	0.397
C_4H_8 56.104	1.28	1.48	1.42	1.393
C_4H_{10} 58.120	0.57	0.43	0.44	0.480
C_5H_{10} 70.130	0.61	0.63	0.63	0.623
C_5H_{12} 72.146	0.20	0.18	0.08	0.153
C_6H_{12} 84.156	0.16	0.10	0.15	0.137
			M. W.	22.07879

GAS FLOW RATES

		$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	6.426	392.3 20.174	70 0.9905	15132	1.4859	39.927
WET GAS	158.44	7.18	1.923 4.077	66 0.9943	5281	1.1451	13.933
RECYCLE	115.14	5.423	399.2 20.344	119 0.9477	13785	1.1451	36.373
BLEED	5.02	8.8	399.2 20.344	119 0.9477	975	1.1451	2.573
NATURAL GAS	28.43	8.517	411.8 20.652	207 0.8830	14760 5376	1.2176	38.946 14.186
OXYGEN	27.07	7.094	424.9 20.967	70 0.9905	3988		10.523
STEAM	215.7	5.82	33.4 0.3046		382.4#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	5'5½	290.39	70	0.9951	288.97	49.9	1876.5	62.57
	3'3½	175.82	83	0.9886	173.82	6.494	1128.8	9.634
					115.15		747.7	
					0.46		43.0	
					115.61		750.7	
WATER								
	7'1	375.50	80	0.9976	374.60	10.5	3108.80	124.04
	5'6½	294.75	82	0.9973	293.95	8.299	2439.52	14.946
	2'1½	112.25	80	0.9976	111.98		929.33	
	0'3	13.28	61	0.9994	13.27		110.14	
					179.35		1488.46	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 L
HOURS 221-245

	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	YIELD BASIS H_2+CO FED: CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.580	14.775	413.82	13.937	2.084	58.38	5.785	20.560	7.869	-12.691	355.44					Distribution of					
H_2 2.016	59.629	24.083	48.55	43.422	6.495	13.09	18.024	42.107	24.519	-17.589	35.46					Recovered Oil					
CO_2 44.010	2.377	0.960	42.25	23.477	3.511	154.55	9.745	10.705	13.256	2.551	112.30	7.623					400 EP			0.520	
N_2 28.016	0.697	0.282	7.90	2.057	0.308	8.63	0.854	1.136	1.162								400-550			0.146	
CH_4 16.042	0.717	0.290	4.65	8.210	1.228	19.71	3.408	3.698	4.636	0.939	15.06	1.022					550+			0.041	
C_2H_4 28.052				2.233	0.334	9.37	0.927	0.927	1.261	0.334	9.37	0.636									72.0
C_2H_6 30.068				0.870	0.130	3.91	0.361	0.361	0.491	0.130	3.91	0.265									
C_1+C_2										1.403	28.34	1.924									
C_3H_6 42.078				2.160	0.323	13.59	0.897	0.897	1.220	0.323	13.59	0.922	4.32	3.146	0.214	12.23	0.830	6.25	1.797	0.122	84.0
C_3H_8 44.094				0.410	0.061	2.69	0.170	0.170	0.231	0.061	2.69	0.183	4.24	0.634	0.043						
C_4H_8 56.104				1.543	0.231	12.96	0.640	0.640	0.871	0.231	12.96	0.880	5.00	2.592	0.176	12.31	0.836	6.10	2.018	0.137	74.2
C_4H_{10} 58.120				0.537	0.080	4.65	0.223	0.223	0.303	0.080	4.65	0.316	4.86	0.957	0.065	4.65	0.316	4.86	0.957	0.065	
C_5H_{10} 70.130				0.770	0.115	8.06	0.320	0.320	0.435	0.115	8.06	0.547	5.45	1.479	0.100	8.06	0.547	5.45	1.479	0.100	82.2
C_5H_{12} 72.146				0.167	0.025	1.80	0.069	0.069	0.094	0.025	1.80	0.122	5.25	0.343	0.023	1.80	0.122	5.25	0.343	0.023	
C_6H_{12} 84.156				0.207	0.031	2.61	0.086	0.086	0.117	0.031	2.61	0.177	5.54	0.471	0.032	2.61	0.177	5.54	0.471	0.032	
C_3-C_6											46.36	3.147		9.622	0.653	41.66	2.828		7.065	0.479	
TOTAL		40.390	517.17		14.956	314.00	41.509	81.899													
H_2+CO		38.859	14,732 S.C.F.H.		7.579		23.809	62.667	32.388	30.280											
H_2/CO		1.63	678794		3.12		3.12	2.05	3.12	1.38											

CUMULATIVE TOTALS

	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO

$$\frac{(H_2)(CO_2)}{(H_2O)(CO)} \; 6.1$$

	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF
RECOVERED OIL		67.73	4.597		10.416	0.707	67.73	4.597		10.416	0.707
TOTAL OIL		114.09	7.744		20.038	1.360	109.39	7.425		17.481	1.187
WATER SOLUBLE CHEMICALS		13.08	0.888	8.01	1.633	0.111	13.08	0.888		1.633	0.111
TOTAL LIQUID PRODUCTS C_3+		127.17	8.632		21.671	1.471	122.47	8.313		19.114	1.297
NET WATER	6.792	122.36	8.306	8.328	14.693	0.997					
GROSS WATER		135.44	9.194		16.326	1.108					
HYDROCARBON TOTAL—C_1+		155.51	10.556								

FRESH FEED CONVERSION — %: Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — %: CO	H_2	CO+H_2	SELECTIVITY: C_3+ C_1+
62.97	85.90	73.03	77.92	61.73	41.77	48.32	81.77

g/M3 = 16.91 × # MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG			RATES S.C.F.H.	
Oxygen		426	Fresh Feed	15312
Natural Gas		412	Recycle	15736
Generator Outlet		410	Combined Feed	31048
Reactor Inlet		393	Wet Gas—Measured	5390
Condenser Inlet			Adjusted	5670
Product Accumulator		374	Loss	280
TEMPERATURES—°F.			Recycle/Fresh Feed	1.028
Oxygen		450	Inlet Velocity--ft./sec.	1.005
Natural Gas		669	Fresh Feed Rate—S.C.F.H.	14732
Generator		2325	per Cu.Ft. Dense Bed	1033
Quench Accumulator		163	per Lb. Catalyst	9.13
Reactor Inlet		313		
Condenser Inlet				
Product Accumulator		74	Heat Transfer Calculations	
Catalyst No.	Height		Steam Rate = 390.1 #/hr	
1	12.0	737	@ 781 psia & 515°F	
2	43.2	644	= 1197 BTU/#	
3	74.4	668	Water in @ 180°F = 148 BTU/#	
4	105.6		Heat Transferred/lb. steam	
5	136.8	662	= 1049 BTU	
6	168.0	655	(1049)(390.1) = 4 215 BTU/hr	
7	199.2	647	Ave. Bed Temperature = 669°F	
8	230.4	641	dT = 669-515 = 154°F	
9	261.6	634	Tube Area = 31.9 ft^2	
10	292.8	631	$K = \frac{409215}{(154)(31.9)} =$	83.2
12	342.0	623		

PRODUCT TESTS

	OIL	WATER
°API	10.7	49.7
Neut. No.	40.4	38.1
Sap. No.	47.1	40.2
Hydrox. No.		
Bromine No.	92.6	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL. DIST. %		°API
205 °F.		
400	73.6	55.4
400-550	20.6	35.4
550+	5.8	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	106	
10%	141	
50%	239	
90%	357	
EP	410	
	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2027
Fresh Catalyst Added 52=	79
Total	2106
Catalyst Recovered	80
In Reactor at End of Period	2026
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	58
2 43.2 - 74.4	55
3 74.4 - 105.6	55
4 105.6 - 342.0	280
(Calc) 0-12"	.22
total	470
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	112
Inventory, Lbs.	1613
Bed Depth, Ft.	21.60
Volume, Cu Ft	14.26

PARTICLE SIZE

Screen Analysis: Mesh	Microns	%	Sedimentation: Microns	%
On 40	419+	16.3	80+	
100	150	63.8	40—80	
150	105	10.0	20—40	
200	74	5.6	10—20	
250	62	0.2	0—20	
325	44	1.0		
<325		3.1		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	148
Settled	147
Compacted	166
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	26.40
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	2100	0500	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.47	36.25	37.02	36.580	14.775	14.775		14.775
H_2 2.016	59.71	59.73	59.45	59.629	24.083		48.166	
CO_2 44.010	2.46	2.27	2.40	2.377	0.960	0.960		1.920
N_2 28.016	0.60	0.70	0.79	0.697	0.282			
CH_4 16.042	0.76	1.05	0.34	0.717	0.290	0.290	1.160	
			M. W.	12.8046				
			H_2O 18.016				9.639	4.820
						15.995	58.965	21.515
			BALANCE			95.3	97.8	103

	Mol %	M/Hr	C	H	O
O_2 32.000	0.48	10.106 0.068			20.348
CO 28.010					
H_2 2.016					
CO_2 44.010	1.83	0.260	0.260		0.520
N_2 28.016	1.79	0.254			
CH_4 16.042	81.34	11.537	11.537	46.148	
C_2H_6 30.068	8.77	1.244	2.488	7.464	
C_3H_8 44.094	5.58	0.791	2.373	6.328	
C_4H_{10} 58.120	0.15 0.06	0.021 0.009	0.084 0.045	0.210 0.108	
TOTAL			16.787	60.258	20.868

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS	298.50	314.00
OIL	67.73	67.73
WATER	135.44	135.44
TOTAL	501.67	517.17
FRESH FEED	517.17	517.17
WEIGHT BALANCE	97.00	
WET GAS FACTOR		1.051926
INDICATED LOSS—S C F H		280

WET GAS	1300	2100	0500	AVERAGE
CO 28.010	13.61	13.81	14.39	13.937
H_2 2.016	43.40	44.18	42.69	43.422
CO_2 44.010	24.49	21.64	24.30	23.477
N_2 28.016	1.63	2.36	2.18	2.057
CH_4 16.042	7.99	9.11	7.53	8.210
C_2H_4 28.052	2.18	2.28	2.24	2.233
C_2H_6 30.068	0.87	0.90	0.84	0.870
C_3H_6 42.078	2.22	2.30	1.96	2.160
C_3H_8 44.094	0.41	0.46	0.36	0.410
C_4H_8 56.104	1.57	1.50	1.56	1.543
C_4H_{10} 58.120	0.47	0.48	0.66	0.537
C_5H_{10} 70.130	0.78	0.71	0.82	0.770
C_5H_{12} 72.146	0.14	0.10	0.26	0.167
C_6H_{12} 84.156	0.23	0.17	0.22	0.207
			M. W	20.9948

GAS FLOW RATES

		$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	6.483	393.4 20.202	80.8 0.9804	15312	1.5036	40.390
WET GAS	158.44	7.208	1.86 4.07308	73.8 0.9868	5310	1.17427	14.218
RECYCLE	115.14	5.661	398.70 20.333	123.0 0.9444	14731	1.17427	38.858
BLEED	5.02	8.875	398.7 20.333	123.0 0.9444	1005	1.17427	2.651
NATURAL GAS	28.43	8.524	411.9 20.655	200.8 0.8870	15736 5377	1.211113	41.539 14.184
OXYGEN	27.07	6.873	425.6 20.9840	80.2 0.9813	3831		10.106
STEAM	215.7	5.84	34.8 0.3097	390.1#/hr			

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'3	384.23	82	0.9891	380.04		2467.98	
	5'5⅛	290.39	70	0.9951	288.97	49.9 6.494	1876.57	
					91.07 + 1.08		+7.00	
	3'5⅛	185.64	78	0.9911	183.99	49.7	1197.12	
	0'6	26.55	90	0.9851	26.15	6.501	170.00	
					157.84			67.73
					249.99		1625.53	10.416
WATER	7'⅛	373.32	84	0.9969	372.16		3088.56	
	2'1⅛	112.25	80	0.9976	111.98	10.5 8.299	929.32	
	2'9⅛	149.62	78	0.9979	149.31	10.7	1237.73	
	0'4	17.70	76	0.9982	17.67	8.287	146.43	
								135.44
					391.82		3250.54	16.326

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THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 M

HOURS 245-269

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	37.037	14.731	412.62	14.300	2.124	59.49	5.861	20.592	7.985	-12.607	353.13					Distribution of					
H_2 2.016	59.207	23.548	47.47	43.113	6.403	12.91	17.669	41.217	24.073	-17.145	34.56					Recovered Oil					
CO_2 44.010	2.820	1.122	49.38	25.953	3.854	169.61	10.637	11.759	14.491	2.732	120.23	8.287					400 EP			0.550	
N_2 28.016	0.843	0.335	9.38	2.143	0.318	8.91	0.878	1.213	1.197								400-550			0.143	
CH_4 16.042	0.093	0.037	0.59	6.213	0.923	14.81	2.546	2.583	3.469	0.886	14.22	0.980					550+			0.047	
C_2H_4 28.052				2.137	0.317	8.89	0.876	0.876	1.193	0.317	8.89	0.613									71.9
C_2H_6 30.068				0.837	0.124	3.73	0.343	0.343	0.467	0.124	3.73	0.257									
C_1+C_2											26.84	1.850									
C_3H_6 42.078				2.210	0.328	13.80	0.906	0.906	1.234	0.328	13.80	0.951	4.32	3.195	0.220	12.42	0.856	6.25	1.987	0.137	83.2
C_3H_8 44.094				0.447	0.066	2.91	0.183	0.183	0.250	0.066	2.91	0.201	4.24	0.686	0.047						
C_4H_8 56.104				1.420	0.211	11.84	0.582	0.582	0.793	0.211	11.84	0.816	5.00	2.368	0.163	11.25	0.775	6.10	1.844	0.127	77.7
C_4H_{10} 58.120				0.407	0.060	3.49	0.167	0.167	0.227	0.060	3.49	0.240	4.86	0.718	0.049	3.49	0.240	4.86	0.718	0.049	
C_5H_{10} 70.130				0.607	0.090	6.31	0.249	0.249	0.339	0.090	6.31	0.435	5.45	1.158	0.080	6.31	0.435	5.45	1.158	0.080	86.7
C_5H_{12} 72.146				0.093	0.014	1.01	0.038	0.038	0.052	0.014	1.01	0.070	5.25	0.192	0.013	1.01	0.070	5.25	0.192	0.013	
C_6H_{12} 84.156				0.120	0.018	1.51	0.049	0.049	0.067	0.018	1.51	0.104	5.54	0.273	0.019	1.51	0.104	5.54	0.273	0.019	
C_3-C_6											40.87	2.817		8.590	0.592	35.99	2.481		6.172	0.425	
TOTAL		39.773			14.852		40.984	80.757													
H_2+CO		38.279	14,508 S.C.F.H.		8.527		23.530	61.809	32.058	29.752											
H_2/CO		1.60	689287		3.01		3.01	2.00	3.01	1.36											

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.7

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Polymer #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL		69.90	4.818		10.733	0.740	69.90	4.818		10.733	0.740
TOTAL OIL		110.77	7.635		19.323	1.332	105.89	7.299		16.905	1.165
WATER SOLUBLE CHEMICALS		12.53	0.864	7.981	1.570	0.108	12.53	0.864		1.570	0.108
TOTAL LIQUID PRODUCTS C_3+		123.30	8.499		20.893	1.440	118.42	8.163		18.475	1.273
NET WATER	6.534	117.71	8.114	8.328	14.134	0.974					
GROSS WATER		130.24	8.977		15.704	1.082					
HYDROCARBON TOTAL—C_1+		150.14	10.349								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
62.66	85.58	72.81	77.72	61.22	41.60	48.14	82.12

g/M3 = 16.91 × #/MCF.

cc/M3 = 141.3 × gal/MCF.

PRESSURES PSIG	
Oxygen	428
Natural Gas	414
Generator Outlet	407
Reactor Inlet	392
Condenser Inlet	
Product Accumulator	374
TEMPERATURES—°F.	
Oxygen	469
Natural Gas	715
Generator	2360
Quench Accumulator	165
Reactor Inlet	323
Condenser Inlet	
Product Accumulator	73

Catalyst No.	Height"	
1	12.0	719
2	43.2	651
3	74.4	669
4	105.6	
5	136.8	665
6	168.0	656
7	199.2	646
8	230.4	638
9	261.6	632
10	292.8	630
12	342.0	624

RATES S.C.F.H.	
Fresh Feed	15074
Recycle	15533
Combined Feed	30607
Wet Gas—Measured	5252
Adjusted	5629
Loss	377
Recycle/Fresh Feed	1.030
Inlet Velocity—ft./sec.	0.993
Fresh Feed Rate—S.C.F.H.	14508
per Cu. Ft. Dense Bed	1085
per Lb. Catalyst	8.73

Heat Transfer Calculations

Steam Rate = 395.0 #/hr

@ 798 psia & 518°F

= 1197 BTU/#

Water in @ 183°F = 151 BTU/#

Heat Transferred/lb. steam

= 1046 BTU

(1046)(395.0) = 413128 BTU/hr

Ave. Bed Temperature = 672°F

dT = 672-518 = 154°F

Ave. Tube Area = 30.9 ft^2

$K = \frac{413128}{(154)(30.9)} = 84.8$

	OIL	WATER
°API	49.4	10.6
Neut. No.	38.2	36.5
Sap. No.	47.1	42.2
Hydrox. No.		
Bromine No.	100	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	74.3	54.8
400-550	19.3	34.9
550+	6.4	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	106	
10%	140	
50%	238	
90%	354	
EP	409	
	98.0	

INVENTORY DATA	
In Reactor at Start of Period	2026
Fresh Catalyst Added 50=	76
Total	2102
Catalyst Recovered	61
In Reactor at End of Period	2041
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	57
2 43.2 - 74.4	63
3 74.4 - 105.6	65
4 105.6 - 342.0	275
(Calc) 0-12"	24
total	484
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	123
Inventory, Lbs.	1661
Bed Depth, Ft.	20.26
Volume, Cu Ft	13.37

PARTICLE SIZE				
Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	12.5	80+	
100	150	69.1	40—80	
150	105	9.0	20—40	
200	74	5.6	10—20	
250	62	1.6	0—20	
325	44	1.2		
<325		1.0		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	145
Settled	147
Compacted	166
Particle Density, gm./cc.	4.2
NH_3 Value, ml./gm.	14.88
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	1300		0600	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.34	0.048 10.475			21.046
CO 28.010	36.87	37.07	37.17	37.037	14.731	14.731		14.731	CO 28.010					
H_2 2.016	59.40	58.97	59.25	59.207	23.548		47.096		H_2 2.016					
CO_2 44.010	2.74	2.93	2.79	2.820	1.122	1.122		2.244	CO_2 44.010	2.14	0.303	0.303		0.606
N_2 28.016	0.81	0.97	0.75	0.843	0.335				N_2 28.016	2.44	0.345			
CH_4 16.042	0.18	0.06	0.04	0.093	0.037	0.037	0.148		CH_4 16.042	81.74	11.561	11.561	46.244	
			M. W.	13.0598					C_2H_6 30.068	9.00	1.273	2.546	7.638	
			H_2O 18.016				10.534	5.2[illegible]7	C_3H_8 44.094	3.83	0.542	1.626	4.336	
						15.890	57.778	22.242	C_4H_{10} 58.120	0.43 0.08	0.061 0.011	0.244 0.006	0.610 0.132	
			BALANCE			97.21	97.99	102.72	TOTAL			16.346	58.960	21.652

WEIGHT BALANCE	# hr Measured	At. Wt. Balance
WET GAS	297.90	319.29
OIL	69.90	69.90
WATER	130.24	130.24
TOTAL	498.04	519.43
FRESH FEED	519.43	
WEIGHT BALANCE	95.88	
WET GAS FACTOR		1.07180
INDICATED LOSS—S C F H		377

WET GAS	1300	2100	0600	
CO 28.010	13.80	13.99	15.11	14.300
H_2 2.016	43.06	43.06	43.22	43.113
CO_2 44.010	25.73	26.27	25.86	25.953
N_2 28.016	2.06	2.31	2.06	2.143
CH_4 16.042	6.93	6.03	5.68	6.213
C_2H_4 28.052	2.14	2.17	2.10	2.137
C_2H_6 30.068	0.88	0.82	0.81	0.837
C_3H_6 42.078	2.24	2.21	2.18	2.210
C_3H_8 44.094	0.49	0.43	0.42	0.447
C_4H_8 56.104	1.44	1.43	1.39	1.420
C_4H_{10} 58.120	0.41	0.43	0.38	0.407
C_5H_{10} 70.130	0.62	0.63	0.57	0.607
C_5H_{12} 72.146	0.08	0.10	0.10	0.093
C_6H_{12} 84.156	0.12	0.12	0.12	0.120
			M. W.	21.4987

GAS FLOW RATES		$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED			391.5	79			
	79.31	6.45	20.15	0.9822	15074	1.4889	39.773
WET GAS			1.94	73			
	158.44	7.09	4.079	0.9877	5252	1.1604	13.857
RECYCLE			397.7	125			
	115.14	5.64	20.31	0.9428	14512	1.1604	38.290
BLEED			397.7	125			
	5.02	9.1	20.31	0.9428	1021	1.1604	2.694
NATURAL GAS			414.1	208	15533		40.984
	28.43	8.48	20.71	0.8823	5361	1.2169	14.144
OXYGEN			427.9	78			
	27.07	7.09	21.04	0.9831	3970		10.475
STEAM			36.4				
	215.7	5.80	0.3157		395.0#/hr		

LIQUID PRODUCT RATES								
HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'1½	377.68	76	0.9920	374.66	49.4	2439.8	69.90
	3'5½	185.64	78	0.9911	183.99	6.512	1198.1	10.733
	1'7	82.59	65	0.9975	82.38		536.5	
	0'3½	15.49	64	0.9980	15.46		100.7	
					257.59		1677.5	
WATER								
	7'3	384.23	84	0.9969	383.04	10.6	3176.6	130.24
	2'9½	149.62	78	0.9979	149.31	8.293	1238.2	15.704
	3'0	161.14	77	0.9980	160.82		1333.7	
	0'4	17.70	82	0.9973	17.65		146.4	
					376.90		3125.7	

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 N

HOURS 269-293

	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	YIELD BASIS H_2+CO FED: CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.848	15.064	421.94	13.353	1.985	55.60	5.527	20.591	7.512	-13.079	366.34					Distribution of					
H_2 2.016	59.512	24.329	49.05	43.322	6.440	12.98	17.933	42.262	24.373	-17.889	36.07					Recovered Oil					
CO_2 44.010	2.708	1.107	48.72	26.543	3.946	173.66	10.987	12.094	14.933	2.839	124.94	8.368					400 EP			0.520	
N_2 28.016	0.782	0.320	8.97	1.993	0.296	8.29	0.825	1.145	1.121								400-550			0.118	
CH_4 16.042	0.150	0.061	0.98	6.217	0.924	14.82	2.574	2.635	3.498	0.863	1[illegible].84	0.927					550+			0.071	
C_2H_4 28.052				2.187	0.325	9.12	0.905	0.905	1.230	0.325	9.12	0.611									73.1
C_2H_6 30.068				0.803	0.119	3.58	0.332	0.332	0.451	0.119	3.58	0.240									
C_1+C_2											26.54	1.778									
C_3H_6 42.078				2.163	0.322	13.55	0.895	0.895	1.217	0.322	13.55	0.908	4.32	3.137	0.210	12.20	0.817	6.25	1.952	0.131	83.7
C_3H_8 44.094				0.420	0.062	2.73	0.174	0.174	0.236	0.062	2.73	0.183	4.24	0.644	0.043						
C_4H_8 56.104				1.463	0.218	12.23	0.606	0.606	0.824	0.218	12.23	0.819	5.00	2.446	0.164	11.62	0.778	6.10	1.905	0.128	75.7
C_4H_{10} 58.120				0.470	0.070	4.07	0.195	0.195	0.265	0.070	4.07	0.273	4.86	0.837	0.056	4.07	0.273	4.86	0.837	0.056	
C_5H_{10} 70.130				0.720	0.107	7.50	0.298	0.298	0.405	0.107	7.50	0.502	5.45	1.376	0.092	7.50	0.502	5.45	1.376	0.092	85.4
C_5H_{12} 72.146				0.123	0.018	1.30	0.051	0.051	0.069	0.018	1.30	0.087	5.25	0.248	0.017	1.30	0.087	5.25	0.248	0.017	
C_6H_{12} 84.156				0.223	0.033	2.78	0.092	0.092	0.125	0.033	2.78	0.186	5.54	0.502	0.034	2.78	0.186	5.54	0.502	0.034	
C_3-C_6											44.16	2.958		9.190	0.616	39.47	2.644		6.820	0.457	
TOTAL		40.881			14.865		41.395														
H_2+CO		39.393	14,930 S.C.F.H.		8.425		23.460	62.853	36.885	30.968											
H_2/CO		1.62	669795		3.24		3.24	2.05	3.24	1.37											

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.0

	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF
RECOVERED OIL		68.95	4.618		10.582	0.709	68.95	4.618		10.582	0.709
TOTAL OIL		113.11	7.576		19.772	1.324	108.42	7.262		17.402	1.166
WATER SOLUBLE CHEMICALS		13.32	0.892	7.98	1.670	0.112	13.32	0.892		1.670	0.112
TOTAL LIQUID PRODUCTS C_3+		126.43	8.468		21.442	1.436	121.74	8.154		19.072	1.277
NET WATER	6.948	125.17	8.384	8.328	15.030	1.007					
GROSS WATER		138.49	9.276		16.700	1.119					
HYDROCARBON TOTAL—C_1+		152.97	10.246								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
63.64	86.82	73.53	78.61	63.52	42.33	49.27	82.65

g/M3 = 16.91 × #/MCF.

cc/M3 = 141.3 × gal/MCF.

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	429	Fresh Feed	15494
Natural Gas	415	Recycle	15689
Generator Outlet	408	Combined Feed	31183
Reactor Inlet	394	Wet Gas—Measured	5320
Condenser Inlet		Adjusted	5633
Product Accumulator	374	Loss	313
TEMPERATURES—°F.		Recycle/Fresh Feed	1.013
Oxygen	452	Inlet Velocity—ft./sec.	1.007
Natural Gas	714	Fresh Feed Rate—S.C.F.H.	14930
Generator	2270	per Cu. Ft. Dense Bed	1127
Quench Accumulator	165	per Lb. Catalyst	9.46
Reactor Inlet	330		
Condenser Inlet			
Product Accumulator	73	Heat Transfer Calculations	
Catalyst No. Height"		Steam Rate = 390.5 #/hr	
1 12.0	702	@ 822 psia & 521°F	
2 43.2	652	= 1196 BTU/#	
3 74.4	667	Water in @ 184°F = 152 BTU/#	
4 105.6		Heat Transferred/lb. steam	
5 136.8	661	= 1044 BTU	
6 168.0	656	(1044)(390.5) = 407682 BTU/hr	
7 199.2	646	Ave. Bed Temperature	
8 230.4	636	= 664°F	
9 261.6	631	dT = 664-521 = 143°F	
10 292.8	630	Tube Area = 30.9 ft²	
12 342.0	623	$K = \frac{407682}{(143)(30.9)}$ =	92.1

	OIL	WATER
°API	49.3	10.6
Neut. No.	39.7	38.1
Sap. No.	43.4	38.8
Hydrox. No.		
Bromine No.	84.9	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	73.3	55.9
400-550	16.6	35.6
550+	10.1	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	104	
10%	137	
50%	231	
90%	343	
EP	398	
	97.5	

INVENTORY DATA	
In Reactor at Start of Period	2041
Fresh Catalyst Added 51#	77
Total	2118
Catalyst Recovered	108
In Reactor at End of Period	2010
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	57
2 43.2 - 74.4	60
3 74.4 - 105.6	60
4 105.6 - 342.0	260
(Calc) 0-12"	23
total	460
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	118
Inventory, Lbs.	1579
Bed Depth, Ft.	20.07
Volume, Cu Ft	13.25

PARTICLE SIZE: Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	15.3	80+	
100	150	68.3	40—80	
150	105	9.6	20—40	
200	74	3.6	10—20	
250	62	1.2	0—20	
325	44	0.6		
<325		1.4		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	140
Settled	141
Compacted	158
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	17.77
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 HOUR	1300	2100	0800	AVERAGE	GENERATOR BALANCE M/HR	C	H	O
FRESH FEED								
CO 28.010	36.63	37.00	36.54	36.848	15.064	15.064		15.064
H_2 2.016	59.53	59.15	59.95	59.512	24.329		48.658	
CO_2 44.010	2.73	2.96	2.63	2.708	1.107	1.107		2.214
N_2 28.016	0.85	0.84	0.78	0.782	0.320			
CH_4 16.042	0.26	0.05	0.10	0.150	0.061	0.061	0.244	
			M. W.	12.9558				
			H_2O 18.016				10.374	5.187
						16.232	59.276	22.465
			BALANCE			96.29	97.86	102.97

GENERATOR BALANCE	Mol %	M/Hr	C	H	O
O_2 32.000	0.45	0.064 10.598			21.324
CO 28.010					
H_2 2.016					
CO_2 44.010	1.73	0.246	0.246		0.492
N_2 28.016	1.73	0.246			
CH_4 16.042	81.54	11.604	11.604	46.416	
C_2H_6 30.068	8.69	1.237	2.474	7.422	
C_3H_8 44.094	5.66	0.805	2.415	6.440	
C_4H_{10} 58.120	0.15 0.05	0.021 0.007	0.084 0.035	0.210 0.084	
TOTAL			16.858	60.572	21.816

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
WET GAS	304.29	322.21
OIL	68.95	68.95
WATER	138.49	138.49
TOTAL	511.73	529.65
FRESH FEED	529.65	
WEIGHT BALANCE	96.62	
WET GAS FACTOR		1.05889
INDICATED LOSS—S C F H		313

WET GAS	1700	2100	0500	
CO 28.010	12.83	13.67	13.56	13.353
H_2 2.016	42.75	42.89	44.32	43.322
CO_2 44.010	26.54	27.14	25.95	26.543
N_2 28.016	1.78	2.10	2.10	1.993
CH_4 16.042	7.17	5.71	5.77	6.217
C_2H_4 28.052	2.28	2.10	2.18	2.187
C_2H_6 30.068	0.83	0.77	0.01	0.803
C_3H_6 42.078	2.11	2.30	2.08	2.163
C_3H_8 44.094	0.39	0.47	0.40	0.420
C_4H_8 56.104	1.57	1.45	1.37	1.463
C_4H_{10} 58.120	0.54	0.43	0.44	0.470
C_5H_{10} 70.130	0.81	0.65	0.70	0.720
C_5H_{12} 72.146	0.17	0.10	0.10	0.123
C_6H_{12} 84.156	0.23	0.22	0.22	0.223
			M. W.	21.6764

GAS FLOW RATES	$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	6.59	393.6 20.21	80 0.9813	15494	1.4948	40.881
WET GAS 158.44	7.21	1.91 4.076	73 0.9887	5320	1.1557	14.038
RECYCLE 115.14	5.73	398.6 20.33	123 0.9452	14652	1.1557	38.659
BLEED 5.02	9.3	398.6 20.33	123 0.9452	1037	1.1557	2.736
NATURAL GAS 28.43	8.55	414.9 20.73	207 0.8830	15689 5394	1.2122	41.395 14.231
OXYGEN 27.07	7.17	429.1 21.07	79 0.9822	4017		10.598
STEAM 215.7	5.64	37.9 0.3210		390.5#/hr		

LIQUID PRODUCT RATES HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL HR
OIL	6'4	336.22	69	0.9956	334.74	49.3	2181.2	68.95
	1'7	82.59	65	0.9975	82.38	6.516	536.8	10.582
					+1.61		+10.5	
					253.97		1654.9	
WATER								
	7'1	375.50	84	0.9969	374.34	10.6		138.49
	3'0	161.14	77	0.9980	160.82	8.293		16.700
	3'10	205.28	75	0.9983	204.93			
	0'4	17.70	80	0.9976	17.66			
					400.79		3323.8	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 0
HOURS 293-317

	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	YIELD BASIS H_2+CO FED: CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.753	14.904	417.46	14.113	2.139	59.91	5.852	20.756	7.991	-12.765	357.58					Distribution of					
H_2 2.016	59.600	24.169	48.73	43.842	6.645	13.40	18.179	42.348	24.823	-17.524	35.33					Recovered Oil					
CO_2 44.010	2.703	1.096	48.23	25.767	3.905	171.86	10.684	11.780	14.589	2.809	123.63	8.348					400 EP			0.522	
N_2 28.016	0.867	0.352	9.86	2.350	0.356	9.97	0.974	1.326	1.331								400-550			0.110	
CH_4 16.042	0.077	0.031	0.50	5.850	0.887	14.23	2.426	2.457	3.312	0.856	13.73	0.927					550+			0.073	
C_2H_4 28.052				2.137	0.324	9.09	0.886	0.886	1.210	0.324	9.09	0.614									72.0
C_2H_6 30.068				0.830	0.126	3.79	0.344	0.344	0.470	0.126	3.79	0.256									
C_1+C_2											26.63	1.797									
C_3H_6 42.078				2.180	0.370	13.89	0.904	0.904	1.234	0.330	13.89	0.938	4.32	3.215	0.217	12.50	0.844	6.25	2.000	0.135	83.9
C_3H_8 44.094				0.417	0.063	2.78	0.173	0.173	0.236	0.063	2.78	0.188	4.24	0.656	0.044						
C_4H_8 56.104				1.347	0.204	11.44	0.559	0.559	0.767	0.204	11.44	0.773	5.00	2.288	0.155	10.87	0.734	6.10	1.782	0.120	77.5
C_4H_{10} 58.120				0.390	0.059	3.43	0.162	0.162	0.221	0.059	3.43	0.232	4.86	0.706	0.048	3.43	0.232	4.86	0.706	0.048	
C_5H_{10} 70.130				0.597	0.091	6.38	0.248	0.248	0.338	0.091	6.38	0.431	5.45	1.171	0.079	6.38	0.431	5.45	1.171	0.079	88.2
C_5H_{12} 72.146				0.080	0.012	0.87	0.033	0.033	0.045	0.012	0.87	0.059	5.25	0.166	0.011	0.87	0.059	5.25	0.166	0.011	
C_6H_{12} 84.156				0.100	0.015	1.26	0.041	0.041	0.057	0.015	1.26	0.085	5.54	0.227	0.015	1.26	0.085	5.54	0.227	0.015	
C_3-C_6											40.05	2.704		8.429	0.569	35.31	2.384		6.052	0.409	
TOTAL		40.552			15.156		41.464	82.016													
H_2+CO		39.073	14,809 S.C.F.H.		8.784		24.031	63.104	32.814	30.289											
H_2/CO		1.62	675280		3.11			2.04		1.37											

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.7

EFFLUENT	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF
RECOVERED OIL	0.485	67.96	4.589		10.441	0.705	67.96	4.589		10.441	0.705
TOTAL OIL		108.01	7.294		18.870	1.274	103.27	6.974		18.493	1.114
WATER SOLUBLE CHEMICALS		12.94	0.874	7.98	1.622	0.110	12.94	0.874		1.622	0.110
TOTAL LIQUID PRODUCTS C_3+		120.95	8.168		20.492	1.384	116.21	7.847		18.115	1.223
NET WATER	6.747	121.55	8.208	8.328	14.595	0.986					
GROSS WATER		134.49	9.082		16.217	1.095					
HYDROCARBON TOTAL—C_1+		147.56	9.964								

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
62.63	85.65	72.51	77.52	61.50	41.38	48.00	81.98

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	431	Fresh Feed	15369
Natural Gas	417	Recycle	15715
Generator Outlet	409	Combined Feed	31084
Reactor Inlet	395	Wet Gas—Measured	5413
Condenser Inlet		Adjusted	5744
Product Accumulator	377	Loss	331

TEMPERATURES—°F.			
		Recycle/Fresh Feed	1.023
Oxygen	439	Inlet Velocity—ft./sec.	1.044
Natural Gas	743	Fresh Feed Rate—S.C.F.H.	14809
Generator		per Cu. Ft. Dense Bed	1083
Quench Accumulator	157	per Lb. Catalyst	9.09
Reactor Inlet	318		
Condenser Inlet			
Product Accumulator	73		

Catalyst No.	Height "	
1	12.0	687
2	43.2	651
3	74.4	666
4	105.6	
5	136.8	658
6	168.0	653
7	199.2	641
8	230.4	632
9	261.6	628
10	292.8	626
12	342.0	617

Heat Transfer Calculations
Steam Rate = 389.8 #/hr
@ 818 psia & 521°F
= 1196 BTU/#
Water in @ 185°F = 153 BTU/#
Heat Transferred/lb. steam
= 1043 BTU
(1043)(389.8) = 406561 BTU/hr
Ave. Bed Temperature = 659°F
dT = 659-521 = 138°F
Tube Area = 31.3 ft^2
$K = \frac{406561}{(138)(31.3)} = 94.3$

PRODUCT TESTS

	OIL	WATER
°API	49.5	10.6
Neut. No.	41.0	39.2
Sap. No.	48.8	44.5
Hydrox. No.		
Bromine No.	86.5	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	74.0	55.8
400-550	15.6	36.6
550+	10.4	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	97.0	
10%	135	
50%	232	
90%	347	
EP	398	
	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2010
Fresh Catalyst Added 54=	82
Total	2092
Catalyst Recovered	130
In Reactor at End of Period	1962
REACTOR d-p, Inches H_2O No. Height "	
1 12 - 43.2	57
2 43.2 - 74.4	60
3 74.4 - 105.6	60
4 105.6 - 342.0	275
(Calc) 0-12"	23
total	475
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	118
Inventory, Lbs.	1630
Bed Depth, Ft.	20.72
Volume, Cu Ft	13.67

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	14.8	80+	
100	150	71.2	40—80	
150	105	9.1	20—40	
200	74	3.7	10—20	
250	62	0.6	0—20	
325	44	0.3		
<325		0.3		

CATALYST	
Bulk Density. Lbs./Cu.Ft.	
Aerated	144
Settled	147
Compacted	160
Particle Density, gm./cc.	4.4
NH_3 Value, ml./gm.	19.09
N_2 Surface, m^2/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, Wt. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES

HOUR	1300	2100	0500	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.53	37.02	36.71	36.753	14.904	14.904		14.904
H_2 2.016	60.01	59.07	59.72	59.600	24.169		48.338	
CO_2 44.010	2.57	2.99	2.55	2.703	1.096	1.096		2.192
N_2 28.016	0.81	0.88	0.91	0.867	0.352			
CH_4 16.042	0.08	0.04	0.11	0.077	0.031	0.031	0.124	
			M. W.	12.94089				
			H_2O 18.016				10.566	5.283
						16.031	59.028	22.334
			BALANCE			96.23	98.86	101.34
WET GAS								
CO 28.010	13.73	14.10	14.51	14.113				
H_2 2.016	43.73	43.67	44.13	43.842				
CO_2 44.010	26.19	26.17	24.94	25.767				
N_2 28.016	2.05	2.23	2.77	2.350				
CH_4 16.042	5.96	5.92	5.67	5.850				
C_2H_4 28.052	2.21	2.18	2.02	2.137				
C_2H_6 30.068	0.81	0.82	0.86	0.830				
C_3H_6 42.078	2.27	2.15	2.12	2.180				
C_3H_8 44.094	0.45	0.41	0.39	0.417				
C_4H_8 56.104	1.42	1.25	1.37	1.347				
C_4H_{10} 58.120	0.37	0.37	0.43	0.390				
C_5H_{10} 70.130	0.63	0.55	0.61	0.597				
C_5H_{12} 72.146	0.08	0.08	0.08	0.080				
C_6H_{12} 84.156	0.10	0.10	0.10	0.100				
			M. W.	21.26694				

GENERATOR BALANCE

	Mol %	M/Hr	C	H	O
O_2 32.000	0.48	0.068 10.665			21.476
CO 28.010					
H_2 2.016					
CO_2 44.010	1.98	0.281	0.281		0.562
N_2 28.016	2.41	0.342			
CH_4 16.042	80.88	11.472	11.472	45.888	
C_2H_6 30.068	8.41	1.193	2.386	7.158	
C_3H_8 44.094	5.61	0.796	2.382	6.320	
C_4H_{10} 58.120	0.19 0.04	0.027 0.006	0.108 0.030	0.270 0.072	
TOTAL			16.659	59.708	22.038

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS	303.72	322.32
OIL	67.96	67.96
WATER	134.49	134.49
TOTAL	506.17	524.77
FRESH FEED	524.77	
WEIGHT BALANCE	96.46	
WET GAS FACTOR		1.06124
INDICATED LOSS—S C F H		331

GAS FLOW RATES

	$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	6.52	395.2 20.25	80 0.9813	15369	1.4957	40.552
WET GAS 158.44	7.30	1.79 4.061	73 0.9877	5413	1.1667	14.281
RECYCLE 115.14	5.70	398.9 20.34	126 0.9420	14671	1.1667	38.710
BLEED 5.02	9.3	398.9 20.34	126 0.9420	1044	1.1667	2.754
		416.9	207	15715		41.464
NATURAL GAS 28.43	8.53	20.77	0.8830	5376	1.2087	14.184
OXYGEN 27.07	7.21	430.9 21.11	80 0.9813	4043		10.668
STEAM 215.7	5.63	37.9 0.3210		389.8#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'2½	380.96	71	0.9946	378.90	49.5	2466.3	67.96
	6'4	336.22	69	0.9956	334.74	6.509	2178.8	10.441
	4'1½	219.46	66	0.9970	218.80		1424.2	
	0'3	13.28	80	0.9901	13.15		85.6	
					+0.77		+5.0	
					250.58		1631.1	
WATER								
	7'6	397.32	82	0.9973	396.25	10.6	3286.1	134.49
	3'10	205.28	75	0.9983	204.93	8.293	1699.5	16.217
	4'2½	224.92	80	0.9976	224.38		1860.8	
	0'6	26.55	78	0.9979	26.49		219.7	
					389.21		3227.7	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 P
HOURS 317-341

	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	YIELD BASIS H_2+CO FED — CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	37.163	14.927	418.11	14.760	2.260	63.30	6.162	21.089	8.422	-12.667	354.81					Distribution of					
H_2 2.016	59.144	23.756	47.89	44.515	6.817	13.74	18.584	42.340	25.401	-16.939	34.15					Recovered Oil					
CO_2 44.010	2.683	1.078	47.44	25.170	3.855	169.66	10.508	11.586	14.362	2.777	122.22	8.336					400 EP			0.518	
N_2 28.016	0.870	0.349	9.78	2.120	0.325	9.11	0.885	1.234	1.210								400-550			0.095	
CH_4 16.042	0.140	0.056	0.90	5.635	0.863	13.84	2.352	2.408	3.215	0.807	12.94	0.883					550+			0.100	
C_2H_4 28.052				2.055	0.315	8.84	0.858	0.858	1.173	0.315	8.84	0.603									71.5
C_2H_6 30.068				0.820	0.126	3.79	0.342	0.342	0.468	0.126	3.79	0.258									
C_1+C_2											25.57	1.744									
C_3H_6 42.078				2.130	0.326	13.72	0.889	0.889	1.215	0.326	13.72	0.936	4.32	3.176	0.217	12.35	0.842	6.25	1.976	0.135	82.7
C_3H_8 44.094				0.445	0.068	3.00	0.186	0.186	0.254	0.068	3.00	0.205	4.24	0.708	0.048						
C_4H_8 56.104				1.285	0.197	11.05	0.536	0.536	0.733	0.197	11.05	0.754	5.00	2.210	0.151	10.50	0.716	6.10	1.721	0.117	79.6
C_4H_{10} 58.120				0.330	0.051	2.96	0.138	0.138	0.188	0.051	2.96	0.202	4.86	0.609	0.042	2.96	0.202	4.86	0.609	0.042	
C_5H_{10} 70.130				0.545	0.083	5.82	0.228	0.228	0.311	0.083	5.82	0.397	5.45	1.068	0.073	5.82	0.397	5.45	1.068	0.073	88.6
C_5H_{12} 72.146				0.070	0.011	0.79	0.029	0.029	0.040	0.011	0.79	0.054	5.25	0.150	0.010	0.79	0.054	5.25	0.150	0.010	
C_6H_{12} 84.156				0.120	0.019	1.60	0.050	0.050	0.068	0.019	1.60	0.109	5.54	0.289	0.020	1.60	0.109	5.54	0.289	0.020	
C_3-C_6											38.94	2.656		8.210	0.560	34.02	2.320		5.813	0.397	
TOTAL		40.167			15.314		41.747	80.430													
H_2+CO		38.683	14,661 S.C.F.H.		9.077			63.429		29.606											
H_2/CO		1.591	682088		3.016			2.01		1.337											

EFFLUENT	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL		68.01	4.639		10.459	0.713	68.01	4.639		10.459	0.713
TOTAL OIL		106.95	7.295		18.669	1.273	102.03	6.959		16.272	1.110
WATER SOLUBLE CHEMICALS		12.99	0.886	7.98	1.628	0.111	12.99	0.886		1.628	0.111
TOTAL LIQUID PRODUCTS C_3+		119.94	8.126		20.297	1.384	115.02	7.845		17.900	1.221
NET WATER	6.772	122.01	8.322	8.328	14.651	0.999					
GROSS WATER		135.00	9.208		16.279	1.110					
HYDROCARBON TOTAL—C_1+		145.51	9.925								

CUMULATIVE TOTALS

	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.4

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
61.87	84.86	71.30	76.53	60.06	40.01	46.68	81.87

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	431	Fresh Feed	15223
Natural Gas	417	Recycle	15822
Generator Outlet	409	Combined Feed	31045
Reactor Inlet	393	Wet Gas—Measured	5457
Condenser Inlet		Adjusted	5804
Product Accumulator	376	Loss	343
TEMPERATURES—°F.		Recycle/Fresh Feed	1.039
Oxygen	473	Inlet Velocity—ft./sec.	1.005
Natural Gas	666	Fresh Feed Rate—S.C.F.H.	14661
Generator		per Cu. Ft. Dense Bed	1163
Quench Accumulator	150	per Lb. Catalyst	9.28
Reactor Inlet	313		
Condenser Inlet			
Product Accumulator			

Catalyst No.	Height "	
1	12.0	679
2	43.2	648
3	74.4	670
4	105.6	
5	136.8	659
6	168.0	653
7	199.2	642
8	230.4	632
9	261.6	628
10	292.8	627
12	342.0	617

Heat Transfer Calculations
Steam Rate = 383.4 #/hr
@ 816 psia & 520°F = 1196 BTU/#
Water in @ 183°F = 151 BTU/#
Heat Transferred/lb. steam = 1045 BTU/#
(1045)(383.4) = 400653 BTU/hr
Ave. Bed Temperature = 659°F
dT = 659-520 = 139°F
Tube Area = 30.9 ft²
$K = \frac{400653}{(139)(30.9)} = 93.3$

PRODUCT TESTS

	OIL	WATER
° API	49.9	10.6
Neut. No.	38.9	38.5
Sap. No.	48.3	42.8
Hydrox. No.		
Bromine No.	79.9	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL. DIST. %		°API
205 °F.		
400	72.6	54.4
400-550	13.3	35.9
550+	14.1	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	107	
10%	147	
50%	235	
90%	351	
EP	402	
	98	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	1962
Fresh Catalyst Added 51#	77
Total	2039
Catalyst Recovered	69
In Reactor at End of Period	1970
REACTOR d-p, Inches H_2O — No. Height "	
1 12 - 43.2	57
2 43.2 - 74.4	61
3 74.4 - 105.6	68
4 105.6 - 342.0	250
(Calc) 0-12"	24
total	460
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	124
Inventory, Lbs.	1579
Bed Depth, Ft.	19.10
Volume, Cu Ft	12.61

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	8.8	80+	
100	150	62.1	40—80	
150	105	12.9	20—40	
200	74	7.8	10—20	
250	62	3.5	0—20	
325	44	3.3		
<325		1.6		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	144
Settled	146
Compacted	165
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	14.16
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	1300	2100	0500	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.52	0.074 10.633			21.414
CO 28.010	37.28	36.90	37.31	37.163	14.927	14.927		14.927	CO 28.010					
H_2 2.016	59.16	59.31	58.96	59.144	23.756		47.512		H_2 2.016					
CO_2 44.010	2.63	2.62	2.90	2.683	1.078	1.078		2.156	CO_2 44.010	1.76	0.251	0.251		0.502
N_2 28.016	0.75	0.98	0.88	0.870	0.349				N_2 28.016	2.00	0.285			
CH_4 16.042	0.18	0.19	0.05	0.140	0.056	0.056	0.224		CH_4 16.042	81.44	11.610	11.610	46.440	
			M. W.	13.0486					C_2H_6 30.068	8.74	1.246	2.492	7.476	
			H_2O 18.016				11.112	5.556	C_3H_8 44.094	5.38	0.767	2.301	6.136	
						16.061	58.848	22.639	C_4H_{10} 58.120	0.12 0.04	0.017 0.006	0.068 0.030	0.170 0.072	
			BALANCE			95.88	97.60	103.30	TOTAL			16.752	60.294	21.916

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS	301.91	321.11
OIL	68.01	68.01
WATER	135.00	135.00
TOTAL	504.92	
FRESH FEED	524.12	
WEIGHT BALANCE	96.34	
WET GAS FACTOR		1.06359
INDICATED LOSS—S C F H		343

WET GAS				
CO 28.010	14.66		14.86	14.760
H_2 2.016	44.59		44.44	44.515
CO_2 44.010	24.92		25.42	25.170
N_2 28.016	1.96		2.28	2.120
CH_4 16.042	5.88		5.39	5.635
C_2H_4 28.052	2.01		2.10	2.055
C_2H_6 30.068	0.82		0.82	0.820
C_3H_6 42.078	2.16		2.10	2.130
C_3H_8 44.094	0.44		0.45	0.445
C_4H_8 56.104	1.32		1.25	1.285
C_4H_{10} 58.120	0.42		0.24	0.330
C_5H_{10} 70.130	0.60		0.49	0.545
C_5H_{12} 72.146	0.07		0.07	0.070
C_6H_{12} 84.156	0.15		0.09	0.120
			M. W.	20.9688

GAS FLOW RATES

		√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	6.476	393.4 20.2022	75.8 0.9850	15223	1.4895	40.167
WET GAS	158.44	7.288	1.788 4.0642	70.6 0.9896	5457	1.1750	14.398
RECYCLE	115.14	5.670	397.9 20.3132	121.7 0.9452	14728	1.1750	38.860
BLEED	5.02	9.660	397.9 20.3132	121.7 0.9452	1094	1.1750	2.867
NATURAL GAS	28.43	8.523	416.6 20.7684	204.3 0.8849	15822 5403	1.2133	41.727 14.256
OXYGEN	27.07	7.166	431.0 21.1123	77.1 0.9840	4030		
STEAM	215.7	5.53	38.0 0.3214		383.4#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'3½	386.41	72	0.9941	384.13		2503.0	
	4'1½	219.46	66	0.9970	218.80	49.5 6.509	1424.2	
					165.33		1078.8	
	1'11½	102.89	66	0.9970	102.58	49.9	662.6	
	0'4	17.70	64	0.9980	17.66	6.459	114.1	68.01
					84.92		548.5	10.459
					+0.77 251.02		+5 1632.3	
WATER	7'2¾	383.14	84	0.9969	381.95	10.6	3167.5	
	4'2½	224.92	80	0.9976	224.38	8.293	1860.8	
					157.57		1306.7	
	4'7½	246.74	74	0.9985	246.37	10.6	2043.1	
	0'3	13.28	80	0.9976	13.25	8.293	109.9	135.00
					233.12		1933.2	16.279
					390.69		3239.9	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 Q
HOURS 341-365

	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	36.710	15.077	422.31	14.283	2.206	61.79	8.752	23.829	10.959	-12.871	360.52
H_2 2.016	59.200	24.313	49.02	44.087	6.810	13.73	27.016	51.329	33.826	-17.503	35.29
CO_2 44.010	2.896	1.189	52.33	25.743	3.976	174.98	15.775	16.964	19.751	2.787	122.65
N_2 28.016	1.137	0.467	13.08	1.930	0.298	8.35	1.183	1.650	1.481		
CH_4 16.042	0.057	0.023	0.37	5.820	0.899	14.42	3.566	3.589	4.465	0.876	14.05
C_2H_4 28.052				2.197	0.339	9.51	1.346	1.346	1.686	0.339	9.51
C_2H_6 30.068				0.837	0.129	3.88	0.513	0.513	0.642	0.129	3.88
C_1+C_2											27.44
C_3H_6 42.078				2.157	0.333	14.01	1.322	1.322	1.655	0.333	14.01
C_3H_8 44.094				0.380	0.059	2.60	0.233	0.233	0.292	0.059	2.60
C_4H_8 56.104				1.330	0.205	11.50	0.815	0.815	1.020	0.205	11.50
C_4H_{10} 58.120				0.413	0.064	3.72	0.253	0.253	0.317	0.064	3.72
C_5H_{10} 70.130				0.593	0.092	6.45	0.363	0.363	0.455	0.092	6.45
C_5H_{12} 72.146				0.090	0.014	1.01	0.055	0.055	0.069	0.014	1.01
C_6H_{12} 84.156				0.140	0.022	1.85	0.085	0.085	0.107	0.022	1.85
C_3-C_6											41.14
TOTAL		41.070			15.447		61.278	102.348			
H_2+CO		39.390	14,929 S.C.F.H.		9.016		35.768	75.158	44.785	30.374	
H_2/CO		1.61	669846		3.09			2.15		1.36	

YIELD BASIS H_2+CO FED

	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO					Distribution of					
H_2					Recovered Oil					
CO_2	8.216					400 EP			0.545	
N_2						400-550			0.137	
CH_4	0.941					550+			0.055	
C_2H_4	0.637									72.4
C_2H_6	0.260									
C_1+C_2	1.838									
C_3H_6	0.938	4.32	3.243	0.217	12.6[illegible]	0.845	6.28	2.018	0.135	85.0
C_3H_8	0.174	4.24	0.613	0.041						
C_4H_8	0.770	5.00	2.300	0.154	10.93	0.732	6.10	1.792	0.120	76.3
C_4H_{10}	0.249	4.86	0.765	0.051	3.72	0.249	4.86	0.765	0.051	
C_5H_{10}	0.432	5.45	1.183	0.079	6.45	0.432	5.45	1.183	0.079	86.8
C_5H_{12}	0.068	5.25	0.192	0.013	1.01	0.068	5.25	0.192	0.017	
C_6H_{12}	0.122	5.54	0.334	0.022	1.85	0.122	5.54	0.334	0.022	
C_3-C_6	2.756		8.630	0.578	36.57	2.450		6.284	0.421	

EFFLUENT		m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
	RECOVERED OIL		71.38	4.781		11.008	0.737	71.38	4.781		11.008	0.742
SHIFT RATIO	TOTAL OIL		112.52	7.537		19.638	1.315	107.95	7.231		17.292	1.158
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 8.8	WATER SOLUBLE CHEMICALS		13.45	0.901	8.098	1.661	0.111	13.45	0.901		1.661	0.111
	TOTAL LIQUID PRODUCTS C_3+		125.97	8.438		21.299	1.427	121.40	8.132		18.953	1.270
SELECTIVITY	NET WATER	6.909	124.47	8.338	8.328	14.946	1.001					
C_3+/C_1+	GROSS WATER		137.92	9.239		16.607	1.112					
82.11	HYDROCARBON TOTAL—C_1+		153.41	10.276								

CUMULATIVE TOTALS

	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2
62.39	85.37	71.99	77.11	54.01	34.10	40.41

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	433	Fresh Feed	15566
Natural Gas	419	Recycle	23225
Generator Outlet	413	Combined Feed	38791
Reactor Inlet	398	Wet Gas—Measured	5382
Condenser Inlet		Adjusted	5855
Product Accumulator	376	Loss	473
TEMPERATURES—°F.		Recycle/Fresh Feed	1.492
Oxygen	412	Inlet Velocity—ft./sec.	1.240
Natural Gas	717	Fresh Feed Rate—S.C.F.H.	14929
Generator		per Cu.Ft. Dense Bed	1142
Quench Accumulator	153	per Lb. Catalyst	9.75
Reactor Inlet	322		
Condenser Inlet			
Product Accumulator	69	Heat Transfer Calculations	
Catalyst No. Height "		Steam Rate = 348.6 #/hr	
1 12.0	629	@ 817 psia & 521°F	
2 43.2	624	= 1196 BTU/#	
3 74.4	661	Water in @ 178°F = 146 BTU/#	
4 105.6		Heat Transferred/lb. steam	
5 136.8	637	= 1050 BTU/#	
6 168.0	655	(1050)(348.6) = 366000 BTU/hr	
7 199.2	649	Ave. Bed Temperature	
8 230.4	649	= 642°F	
9 261.6	639	dT = 642-521 = 121°F	
10 292.8	629	Tube Area = 30.9 ft^2	
12 342.0	624	$K = \frac{366000}{(121)(30.9)} =$	98.0

PRODUCT TESTS

	OIL	WATER
° API	50.2	10.4
Neut. No.	43.7	43.1
Sap. No.	50.4	48.1
Hydrox. No.		
Bromine No.	71.7	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	74.0	56.2
400-550	18.6	35.9
550+	7.4	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	98.0	
10%	130	
50%	230	
90%	352	
EP	399	
	97.0	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	1970
Fresh Catalyst Added 50#	76
Total	2046
Catalyst Recovered	154
In Reactor at End of Period	1892
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	58
2 43.2 - 74.4	56
3 74.4 - 105.6	60
4 105.6 - 342.0	250
(Calc) 0-12"	22
total	446
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	116
Inventory, Lbs.	1531
Bed Depth, Ft.	19.80
Volume, Cu Ft	13.07

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	13.1	80+	
100	150	71.5	40—80	
150	105	9.3	20—40	
200	74	4.4	10—20	
250	62	0.8	0—20	
325	44	0.5		
<325		0.4		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	146
Settled	148
Compacted	162
Particle Density, gm./cc.	3.8
NH_3 Value, ml./gm.	11.88
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				AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.46	0.067 10.802			21.738
CO 28.010	36.77	36.70	36.66	36.710	15.077	15.077		15.077	CO 28.010					
H_2 2.016	58.96	59.38	59.26	59.200	24.313		48.626		H_2 2.016					
CO_2 44.010	3.06	2.74	2.89	2.896	1.189	1.189		2.378	CO_2 44.010	1.84	0.267	0.267		0.534
N_2 28.016	1.16	1.12	1.13	1.137	0.467				N_2 28.016	2.67	0.388			
CH_4 16.042	0.05	0.06	0.06	0.057	0.023	0.023	0.092		CH_4 16.042	82.74	12.013	12.013	48.052	
			M. W.	13.07816					C_2H_6 30.068	8.42	1.222	2.444	7.332	
			H_2O 18.016				10.432	5.216	C_3H_8 44.094	3.67	0.533	1.599	4.264	
						16.289	59.150	22.671	C_4H_{10} 58.120	0.16 0.04	0.023 0.006	0.092 0.036	0.230 0.072	
			BALANCE			99.02	98.67	101.79	TOTAL			16.451	59.950	22.272

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	301.35	327.82
OIL	71.38	71.38
WATER	137.92	137.92
TOTAL	510.65	510.65
FRESH FEED	537.12	
WEIGHT BALANCE	95.07	
WET GAS FACTOR		1.08783
INDICATED LOSS—S C F H		473

WET GAS	1700	2100	0900	
CO 28.010	14.45	15.34	13.06	14.283
H_2 2.016	43.85	42.93	45.48	44.087
CO_2 44.010	25.73	25.91	25.59	25.743
N_2 28.016	1.30	2.36	2.13	1.930
CH_4 16.042	6.09	5.35	6.02	5.820
C_2H_4 28.052	2.38	2.14	2.07	2.197
C_2H_6 30.068	0.92	0.81	0.78	0.837
C_3H_6 42.078	2.20	2.20	2.07	2.157
C_3H_8 44.094	0.45	0.44	0.25	0.380
C_4H_8 56.104	1.35	1.33	1.31	1.330
C_4H_{10} 58.120	0.38	0.41	0.45	0.413
C_5H_{10} 70.130	0.63	0.58	0.57	0.593
C_5H_{12} 72.146	0.09	0.08	0.10	0.090
C_6H_{12} 84.156	0.18	0.12	0.12	0.140
			M. W.	21.22130

GAS FLOW RATES

	√h	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	6.581	397.9 20.313	74 0.9868	15566	1.4878	41.070
WET GAS 158.44	7.198	1.906 4.075	69 0.9915	5382	1.1680	14.200
RECYCLE 115.14	8.502	400.8 20.384	116 0.9501	22144	1.1680	58.426
BLEED 5.02	9.52	400.8 20.384	116 0.9501	1081	1.1680	2.852
NATURAL GAS 28.43	8.565	419.0 20.825	204 0.8849	23225 5503	1.2263	61.278 14.519
OXYGEN 27.07	7.240	432.6 21.149	73 0.9877	4094		10.802
STEAM 215.7	5.10	36.7 0.3169		348.6#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	6'11	366.77	65	0.9975	365.85	50.2	2372.2	71.38
	1'11½	102.89	66	0.9970	102.58	6.484	665.1	11.008
					+0.93 264.20		+6.0 1713.1	
WATER								
	7'2	379.86	78	0.9979	379.06		3297.6	137.92
	4'7½	246.74	74	0.9985	246.37		2046.1	16.607
	5'3	279.48	72	0.9987	279.12	10.4	2318.1	
	0'3	13.28	83	0.9971	13.24	8.305	101.0	
					398.57		3310.1	

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 R

HOURS 365-389

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	37.193	15.503	434.24	15.157	2.403	67.31	9.377	24.880	11.780	-13.100	366.93					Distribution of					
H_2 2.016	58.990	24.588	49.57	44.776	7.099	14.31	27.699	52.287	34.798	-17.489	35.26					Recovered Oil					
CO_2 44.010	2.667	1.112	48.94	24.616	3.903	171.77	15.228	16.340	19.131	2.791	122.28	8.048					400 EP			0.537	
N_2 28.016	0.820	0.342	9.58	2.367	0.375	10.51	1.464	1.806	1.839	0.033	0.92	0.061					400-550			0.097	
CH_4 16.042	0.330	0.138	2.21	5.490	0.870	13.96	3.396	3.534	4.266	0.732	11.75	0.773					550+			0.093	
C_2H_4 28.052				2.057	0.326	9.14	1.273	1.273	1.599	0.326	9.14	0.602									70.9
C_2H_6 30.068				0.790	0.125	3.76	0.489	0.489	0.614	0.125	3.76	0.247									
C_1+C_2											24.65	1.622									
C_3H_6 42.078				2.057	0.326	13.72	1.273	1.273	1.599	0.326	13.72	0.903	4.32	3.176	0.209	12.35	0.813	6.25	1.976	0.130	88.9
C_3H_8 44.094				0.243	0.039	1.72	0.150	0.150	0.189	0.039	1.72	0.113	4.24	0.406	0.027						
C_4H_8 56.104				1.307	0.207	11.61	0.809	0.809	1.016	0.207	11.61	0.764	5.00	2.322	0.153	11.03	0.726	6.10	1.808	0.119	78.1
C_4H_{10} 58.120				0.353	0.056	3.25	0.218	0.218	0.274	0.056	3.25	0.214	4.86	0.669	0.044	3.25	0.214	4.86	0.669	0.044	
C_5H_{10} 70.130				0.577	0.091	6.35	0.357	0.357	0.448	0.091	6.38	0.420	5.45	1.171	0.077	6.38	0.420	5.45	1.171	0.077	85.5
C_5H_{12} 72.146				0.097	0.015	1.08	0.060	0.060	0.075	0.015	1.08	0.071	5.25	0.206	0.014	1.08	0.071	5.25	0.206	0.014	
C_6H_{12} 84.156				0.113	0.018	1.51	0.070	0.070	0.088	0.018	1.51	0.099	5.54	0.273	0.018	1.51	0.099	5.54	0.273	0.018	
C_3-C_6											39.27	2.584		8.223	0.541	35.60	2.343		6.103	0.402	
TOTAL		41.682			15.854		61.863	103.546													
H_2+CO		40.091	15,194 S.C.F.H.		9.502		37.076	77.167	46.578	30.589											
H_2/CO	1.59		658133				2.95	2.10		1.34											

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.9

	Net Change m/hr	Net Change #/hr	Condensate #/MCF	#/gal	gal/hr	gal/MCF	Polymer #/hr	#/MCF	#/gal	gal/hr	gal/MCF	% Unsats.
RECOVERED OIL		71.77	4.723		11.092	0.730	71.77	4.723		11.069	0.728	
TOTAL OIL		111.04	7.308		19.315	1.271	107.37	7.066		17.172	1.130	
WATER SOLUBLE CHEMICALS		14.55	0.958	8.061	1.805	0.119	14.55	0.958		1.805	0.119	
TOTAL LIQUID PRODUCTS C_3+		125.59	8.265		21.120	1.390	121.92	8.024		18.977	1.249	
NET WATER	7.110	128.10	8.431	8.328	15.382	1.012						
GROSS WATER		142.65	9.388		17.187	1.131						
HYDROCARBON TOTAL—C_1+		150.24	9.888									

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
61.96	84.50	71.13	76.30	52.65	33.45	39.64	83.59

g/M3 = 16.91 × #/MCF.

cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS				PRODUCT TESTS		
PRESSURES PSIG		RATES S.C.F.H.			OIL	WATER
Oxygen	434	Fresh Feed	15797	° API	50.6	10.5
Natural Gas	421	Recycle	24546	Neut. No.	40.7	41.1
Generator Outlet	414	Combined Feed	40343	Sap. No.	49.8	45.9
Reactor Inlet	399	Wet Gas—Measured	5377	Hydrox. No.		
Condenser Inlet		Adjusted	6008	Bromine No.	93.8	
Product Accumulator	375	Loss	631	Pour °F.		
				Chemicals, % by K_2CO_3		10.5
TEMPERATURES—°F.		Recycle/Fresh Feed	1.554			
Oxygen	489	Inlet Velocity—ft./sec.	1.393			
Natural Gas	724	Fresh Feed Rate—S.C.F.H.	15194	HEMPEL, DIST. %		°API
Generator		per Cu. Ft. Dense Bed	1244	205 °F.		
Quench Accumulator	150.7	per Lb. Catalyst	10.44	400	73.6	55.5
Reactor Inlet	315			400-550	13.3	36.7
Condenser Inlet				550+	15.1	
Product Accumulator	69	**Heat Transfer Calculations**				
Catalyst No. Height"		Steam Rate = 330.3 #/hr		A. S. T. M. DIST. ON		
1 12.0	665	@ 816 psia & 520°F		Naphtha °F.		
2 43.2	639	= 1196 BTU/#		IBP	100	
3 74.4	649	Water in @ 174°F		10%	135	
4 105.6		= 142 BTU/#		50%	232	
5 136.8	649	Heat Transferred/lb. steam		90%	352	
6 168.0	652	= 1054 BTU/#		EP	400	
7 199.2	641	(1054)(330.3) = 349500 BTU/hr				
8 230.4	634	Ave. Bed Temperature = 649°F				
9 261.6	629	dT = 649-520 = 129°F				
10 292.8	632	Tube Area = 30.9 ft²				
12 342.0	634	$K = \frac{349500}{(129)(30.9)} = 87.8$				

CATALYST DATA		PARTICLE SIZE				
INVENTORY DATA		Screen Analysis			Sedimentation	
In Reactor at Start of Period	1892	Mesh	Microns	%	Microns	%
Fresh Catalyst Added 50#	76	On 40	419+	12.3	80+	
Total	1968	100	150	67.3	40—80	
Catalyst Recovered	92	150	105	11.7	20—40	
In Reactor at End of Period	1876	200	74	4.9	10—20	
REACTOR d-p, Inches H_2O		250	62	1.6	0—20	
No. Height"		325	44	1.4		
1 12 - 43.2	58	<325		0.8		
2 43.2 - 74.4	60	CATALYST				
3 74.4 - 105.6	58	Bulk Density, Lbs./Cu.Ft.				
4 105.6 - 342.0	225	Aerated			141	
(Calc) 0-12"	23	Settled			143	
total	424	Compacted			159	
		Particle Density, gm./cc.			4.3	
CALCULATED FROM dp		NH_3 Value, ml./gm.			9.82	
Density, Lbs./Cu.Ft.	118	N_2 Surface, m²/gm.				
Inventory, Lbs.	1455					
Bed Depth, Ft.	18.50	CHEMICAL ANALYSIS				
Volume, Cu Ft	12.21	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	0900			AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.50	10.718 0.073			21.582
CO 28.010	36.92	37.50	37.16	37.193	15.503	15.503		15.503	CO 28.010					
H_2 2.016	59.26	58.96	58.75	58.990	24.588		49.176		H_2 2.016					
CO_2 44.010	2.79	2.18	3.03	2.667	1.112	1.112		2.224	CO_2 44.010	1.68	0.246	0.246		0.492
N_2 28.016	0.91	0.57	0.98	0.820	0.342				N_2 28.016	2.08	0.304			
CH_4 16.042	0.12	0.79	0.08	0.330	0.138	0.138	0.552		CH_4 16.042	82.27	12.040	12.040	48.160	
			M. W.	13.06341					C_2H_6 30.068	8.87	1.298	2.596	3.894	
			H_2O 18.016				8.223	4.112	C_3H_8 44.094	4.50	0.659	1.977	5.272	
						16.750	57.951	21.839	C_4H_{10} 58.120	0.05 0.05	0.007 0.007	0.028 0.035	0.070 0.084	
			BALANCE			98.98	100.81	98.93	TOTAL			16.922	57.480	22.074

WEIGHT BALANCE	# hr Measured	At. Wt. Balance
WET GAS	295.41	330.09
OIL	71.77	71.77
WATER	142.65	142.65
TOTAL	509.83	
FRESH FEED	544.51	544.51
WEIGHT BALANCE	93.63	
WET GAS FACTOR		1.11739
INDICATED LOSS—S C F H		631

WET GAS	0900	2100	0500	
CO 28.010	14.75	14.77	15.95	15.157
H_2 2.016	45.08	44.46	44.79	44.776
CO_2 44.010	24.88	24.50	24.47	24.616
N_2 28.016	2.51	2.06	2.53	2.367
CH_4 16.042	5.11	6.45	4.91	5.490
C_2H_4 28.052	2.03	2.09	2.05	2.057
C_2H_6 30.068	0.81	0.77	0.79	0.790
C_3H_6 42.078	2.14	2.09	1.94	2.057
C_3H_8 44.094	0.29	0.25	0.19	0.243
C_4H_8 56.104	1.35	1.34	1.23	1.307
C_4H_{10} 58.120	0.27	0.43	0.36	0.353
C_5H_{10} 70.130	0.60	0.57	0.56	0.577
C_5H_{12} 72.146	0.07	0.09	0.13	0.097
C_6H_{12} 84.156	0.11	0.13	0.10	0.113
			M. W.	20.82094

GAS FLOW RATES		$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	6.66	399 20.34	73 0.9877	15797	1.4887	41.682
WET GAS	158.44	7.12	1.92 4.077	69 0.9915	5377	1.1792	14.188
RECYCLE	115.14	8.50	401 20.39	115 0.9510	22378	1.1792	59.046
BLEED	5.02	9.3	401 20.39	115 0.9510	1068	1.1792	2.817
NATURAL GAS	28.43	8.66	421 20.87	206 0.8836	24546 5547	1.2217	61.863 14.635
OXYGEN	27.07	7.18	434 21.18	74 0.9868	4062		10.718
STEAM	215.7	4.88	35.9 0.3138		330.3#/hr		

LIQUID PRODUCT RATES								
HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'3½	385.32	66	0.9970	384.16	50.2	2490.9	71.77
	6'11	366.77	65	0.9975	365.85	6.484	2372.2	11.092
	4'10½	259.84	60	1.000	259.84	50.6	1680.9	
	0'3	13.28	76	0.9920	13.17	6.469	85.2	
					+1.23 266.21		+8.0 1722.4	
WATER								
	7'1	375.50	66	0.9942	373.32		3100.4	142.65
	5'3	279.48	72	0.9987	279.12	10.4	2318.1	17.187
	6'3	331.85	70	0.9990	331.52	8.305	2751.3	
	0'3	13.28	83	0.9971	13.24	10.5	109.9	
						8.299	3423.7	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 B
HOURS 389-413

	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	36.43	15.221	426.32	15.42	2.415	67.64	9.495	24.716	11.910	-12.806	358.68
H_2 2.016	59.65	24.922	50.24	44.28	6.934	13.98	27.265	52.187	34.199	-17.988	36.26
CO_2 44.010	2.78	1.162	51.14	24.63	3.857	169.74	15.166	16.328	19.023	2.695	118.60
N_2 28.016	0.89	0.372	10.42	2.24	0.351	9.83	1.379	1.751	1.730		
CH_4 16.042	0.25	0.104	1.67	5.60	0.877	14.07	3.448	3.552	4.325	0.773	12.40
C_2H_4 28.052				2.18	0.341	9.57	1.342	1.342	1.683	0.341	9.57
C_2H_6 30.068				0.80	0.125	3.76	0.493	0.493	0.618	0.125	3.76
C_1+C_2										1.239	25.73
C_3H_6 42.078				2.13	0.334	14.05	1.312	1.312	1.646	0.334	14.05
C_3H_8 44.094				0.29	0.045	1.98	0.179	0.179	0.224	0.045	1.98
C_4H_8 56.104				1.25	0.196	11.00	0.770	0.770	0.966	0.196	11.00
C_4H_{10} 58.120				0.37	0.058	3.37	0.228	0.228	0.286	0.058	3.37
C_5H_{10} 70.130				0.60	0.094	6.59	0.369	0.369	0.463	0.094	6.59
C_5H_{12} 72.146				0.08	0.013	0.94	0.049	0.049	0.062	0.013	0.94
C_6H_{12} 84.156				0.13	0.020	1.68	0.080	0.080	0.100	0.020	1.68
C_3-C_6											39.61
TOTAL		41.781	539.79		15.660	328.20	61.575	103.356			
H_2+CO	96.08	40.143	15,218 S.C.F.H.				36.760	76.903	46.109	-30.794	
H_2/CO	1.64		657116					2.111		1.405	

YIELD BASIS H_2+CO FED

	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO					Distribution of					
H_2					Recovered Oil					
CO_2	7.793					400 EP			0.534	
N_2						400-550			0.137	
CH_4	0.815					550+			0.075	
C_2H_4	0.629									71.8
C_2H_6	0.247									
C_1+C_2	1.691									
C_3H_6	0.923	4.32	3.252	0.213	12.65	0.831	6.25	2.024	0.133	87.6
C_3H_8	0.130	4.24	0.467	0.031						
C_4H_8	0.723	5.00	2.200	0.145	10.45	0.687	6.10	1.713	0.113	76.5
C_4H_{10}	0.221	4.86	0.693	0.046	3.37	0.221	4.86	0.693	0.046	
C_5H_{10}	0.433	5.45	1.209	0.079	6.59	0.433	5.45	1.209	0.079	87.5
C_5H_{12}	0.062	5.25	0.179	0.012	0.94	0.062	5.25	0.179	0.012	
C_6H_{12}	0.110	5.54	0.303	0.020	1.68	0.089	5.54	0.303	0.020	
C_3-C_6	2.602		8.303	0.546	35.68	2.323		6.121	0.403	

CUMULATIVE TOTALS

	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT

SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.8

	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF
RECOVERED OIL		73.60	4.836		11.350	0.746	73.60	4.836		11.350	0.743
TOTAL OIL		113.21	7.439		19.653	1.291	109.28	7.181		17.471	1.148
WATER SOLUBLE CHEMICALS		13.45	0.884	8.093	1.662	0.109	13.45	0.884		1.662	0.109
TOTAL LIQUID PRODUCTS C_3+		126.66	8.323		21.315	1.401	122.73	8.065		19.133	1.257
NET WATER	6.913	124.54	8.164	8.328	14.954	0.983					
GROSS WATER		137.99	9.068		16.616	1.092					
HYDROCARBON TOTAL—C_1+		152.39	10.014								

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
62.52	84.13	72.18	76.71	51.81	34.47	40.04	83.11

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	432	Fresh Feed	15839
Natural Gas	418	Recycle	23343
Generator Outlet	412	Combined Feed	39182
Reactor Inlet	398	Wet Gas—Measured	5448
Condenser Inlet		Adjusted	5937
Product Accumulator	374	Loss	489
TEMPERATURES—°F.		Recycle/Fresh Feed	1.474
Oxygen	480	Inlet Velocity—ft./sec.	1.363
Natural Gas	665	Fresh Feed Rate—S.C.F.H.	15218
Generator		per Cu. Ft. Dense Bed	1256
Quench Accumulator	152	per Lb. Catalyst	10.53
Reactor Inlet	338		
Condenser Inlet			
Product Accumulator	68	Heat Transfer Calculations	
Catalyst No. Height"		Steam Rate = 331.5 #/hr	
1 12.0	673	@ 817 psia & 521°F	
2 43.2	645	= 1196 BTU/#	
3 74.4	656	Water in @ 173°F = 141 BTU/#	
4 105.6		Heat Transferred/lb. steam	
5 136.8	652	= 1055 BTU/#	
6 168.0	652	(1055)(331.5) = 350000 BTU/hr	
7 199.2	643	Ave. Bed Temperature	
8 230.4	634	= 654°F	
9 261.6	631	dT = 654-521 = 133°F	
10 292.8	635	Tube Area = 30.9 ft^2	
12 342.0	634	$K = \frac{350000}{(133)(30.9)}$ =	85.1

PRODUCT TESTS

	OIL	WATER
°API	49.8	10.4
Neut. No.	50.8	41.5
Sap. No.	41.7	46.5
Hydrox. No.		
Bromine No.	94.9	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	71.6	56.4
400-550	18.3	36.3
550+	10.1	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	104	
10%	136	
50%	232	
90%	349	
EP	398	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	1876
Fresh Catalyst Added 49=	76
Total	1952
Catalyst Recovered	71
In Reactor at End of Period	1881
REACTOR d-p, Inches H_2O	
No. Height"	
1 12 - 43.2	58
2 43.2 - 74.4	60
3 74.4 - 105.6	60
4 105.6 - 342.0	220
(Calc) 0-12"	23
total	421
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	118
Inventory, Lbs.	1445
Bed Depth, Ft.	18.37
Volume, Cu Ft	12.12

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	13.5	80+	
100	150	69.4	40—80	
150	105	9.3	20—40	
200	74	4.8	10—20	
250	62	1.2	0—20	
325	44	1.0		
<325		0.8		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	136
Settled	138
Compacted	154
Particle Density, gm./cc.	4.0
NH_3 Value, ml./gm.	22.07
N_2 Surface, m^2/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, Wt. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES / GENERATOR BALANCE

HOUR	1300	2100	0500	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.65	35.69	36.95	36.43	15.221	15.221		15.221
H_2 2.016	59.63	60.25	59.06	59.65	24.922		49.844	
CO_2 44.010	2.35	2.99	3.00	2.78	1.162	1.162		2.324
N_2 28.016	0.75	1.00	0.92	0.89	0.372			
CH_4 16.042	0.62	0.07	0.07	0.25	0.104	0.104	0.416	
			M. W.	12.9195				
			H_2O 18.016				10.124	5.062
						16.487	60.384	22.607
			BALANCE			97.46	98.41	102.20

	Mol %	M/Hr	C	H	O
O_2 32.000	0.50	0.073 10.741			21.628
CO 28.010					
H_2 2.016					
CO_2 44.010	1.68	0.246	0.246		0.492
N_2 28.016	2.08	0.304			
CH_4 16.042	82.27	12.038	12.038	48.152	
C_2H_6 30.068	8.87	1.298	2.596	7.788	
C_3H_8 44.094	4.50	0.658	1.974	5.264	
C_4H_{10} 58.120	0.05 0.05	0.007 0.007	0.028 0.035	0.070 0.084	
TOTAL			16.917	61.358	22.120

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	301.19	328.20
OIL	73.60	73.60
WATER	137.99	137.99
TOTAL	512.78	539.79
FRESH FEED	539.79	
WEIGHT BALANCE	95.00	
WET GAS FACTOR		1.089677
INDICATED LOSS—S C F H		489

WET GAS				
CO 28.010	14.82	15.55	15.89	15.42
H_2 2.016	44.72	43.45	44.66	44.28
CO_2 44.010	23.63	25.47	24.81	24.63
N_2 28.016	2.16	2.30	2.25	2.24
CH_4 16.042	6.65	5.16	4.99	5.60
C_2H_4 28.052	2.16	2.32	2.06	2.18
C_2H_6 30.068	0.82	0.78	0.79	0.80
C_3H_6 42.078	2.14	2.22	2.04	2.13
C_3H_8 44.094	0.26	0.39	0.23	0.29
C_4H_8 56.104	1.32	1.29	1.14	1.25
C_4H_{10} 58.120	0.44	0.31	0.37	0.37
C_5H_{10} 70.130	0.64	0.60	0.56	0.60
C_5H_{12} 72.146	0.09	0.06	0.08	0.08
C_6H_{12} 84.156	0.15	0.10	0.13	0.13
			M. W.	20.9579

GAS FLOW RATES

	√h	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	6.64	398.3 20.3224	72 0.9887	15839	1.4969	41.781
WET GAS 158.44	7.225	1.948 4.0802	68 0.9924	5448	1.1753	14.371
RECYCLE 115.14	8.50	400.5 20.3765	116 0.9501	22269	1.1753	58.742
BLEED 5.02	9.4	400.5 20.3765	116 0.9501	1074	1.1753	2.833
NATURAL GAS 28.43	8.68	417.7 20.7942	204 0.8849	23343 5547	1.2217	61.575 14.632
OXYGEN 27.07	7.20	431.7 21.1289	72 0.9887	4072		10.741
STEAM 215.7	4.94	35.2 0.3111		331.5#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'4	388.59	75	0.9925	385.68	50.6	2495.0	
	4'10½	259.84	60	1.000	259.84	6.469	1680.9	
	3'1	165.75	60	1.000	165.75	49.8	1077.0	
	0'4½	19.92	71	0.9946	19.81	6.498	128.7	73.60
					+0.62 272.40		+4.0 1766.4	11.350
WATER								
	6'8½	355.86	70	0.9990	355.50	10.4	2952.4	137.99
	6'3	331.85	70	0.9990	331.52	8.305	2753.5	16.616
	7'4	388.59	72	0.9987	388.08	10.4	3223.0	
	0'3	13.20	70	0.9990	13.27	8.305	110.2	
					398.79		3311.7	

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THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 T

HOURS 413-437

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	38.063	15.556	435.71	15.823	2.499	69.99	9.622	25.178	12.121	-13.057	365.72					Distribution of					
H_2 2.016	57.754	23.603	47.58	42.380	6.693	13.49	25.772	49.375	32.465	-16.910	34.09					Recovered Oil					
CO_2 44.010	2.933	1.199	52.77	25.040	3.955	174.04	15.228	16.427	19.183	2.756	121.27	8.169					400 EP			0.531	
N_2 28.016	0.943	0.385	10.79	2.757	0.435	12.19	1.677	2.062	2.112								400-550			0.112	
CH_4 16.042	0.307	0.125	2.01	6.067	0.958	15.37	3.690	3.815	4.648	0.833	13.36	0.900					550+			0.089	
C_2H_4 28.052				2.127	0.336	9.43	1.293	1.293	1.629	0.336	9.43	0.635									71.6
C_2H_6 30.068				0.843	0.133	4.00	0.513	0.513	0.646	0.133	4.00	0.269									
C_1+C_2											26.79	1.804									
C_3H_6 42.078				2.157	0.341	14.35	1.312	1.312	1.653	0.341	14.35	0.967	4.32	3.322	0.223	12.92	0.870	6.25	2.067	0.139	88.8
C_3H_8 44.094				0.273	0.043	1.90	0.166	0.166	0.209	0.043	1.90	0.128	4.24	0.448	0.030						
C_4H_8 56.104				1.270	0.201	11.28	0.772	0.772	0.973	0.201	11.28	0.760	5.00	2.256	0.152	10.72	0.722	6.10	1.757	0.118	76.8
C_4H_{10} 58.120				0.383	0.060	3.49	0.233	0.233	0.293	0.060	3.49	0.235	4.88	0.718	0.048	3.49	0.235	4.86	0.718	0.048	
C_5H_{10} 70.130				0.640	0.101	7.08	0.389	0.389	0.490	0.101	7.08	0.477	5.45	1.299	0.088	7.08	0.477	5.45	1.299	0.088	88.6
C_5H_{12} 72.146				0.080	0.013	0.94	0.049	0.049	0.062	0.013	0.94	0.063	5.25	0.179	0.012	0.94	0.063	5.25	0.179	0.012	
C_6H_{12} 84.156				0.160	0.025	2.10	0.097	0.097	0.122	0.025	2.10	0.141	5.54	0.379	0.026	2.10	0.141	5.54	0.379	0.026	
C_3-C_6											41.14	2.771		8.601	0.579	37.25	2.508		6.399	0.431	
TOTAL		40.868	548.86		15.793	339.65	60.813	101.681													
H_2+CO	95.817	39.159	14,845 S.C.F.H.		9.192			74.553	44.586	-29.967											
H_2/CO	1.52		673627																		

EFFLUENT	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL		70.58	4.754		10.873	0.732	70.58	4.754		10.873	0.732
TOTAL OIL		111.72	7.526		19.474	1.312	107.83	7.264		17.272	1.163
WATER SOLUBLE CHEMICALS		13.43	0.905	8.042	1.670	0.112	13.43	0.905		1.670	0.112
TOTAL LIQUID PRODUCTS C_3+		125.15	8.430		21.144	1.424	121.26	8.168		18.942	1.276
NET WATER	6.949	125.20	8.434	8.328	15.034	1.013					
GROSS WATER		138.63	9.338		16.704	1.125					
HYDROCARBON TOTAL—C_1+		151.94	10.235								

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.4

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
61.35	83.94	71.64	76.53	51.86	34.25	40.20	82.36

g/M3 = 16.91 × #/MCF.

cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG			RATES S.C.F.H.	
Oxygen		432	Fresh Feed	15493
Natural Gas		419	Recycle	23054
Generator Outlet		412	Combined Feed	38547
Reactor Inlet		399	Wet Gas—Measured	5352
Condenser Inlet			Adjusted	5987
Product Accumulator		375	Loss	635
TEMPERATURES—°F.			Recycle/Fresh Feed	1.488
Oxygen		418	Inlet Velocity—ft./sec.	1.352
Natural Gas		692	Fresh Feed Rate—S.C.F.H.	14845
Generator			per Cu.Ft. Dense Bed	1203
Quench Accumulator		150	per Lb. Catalyst	10.45
Reactor Inlet		339		
Condenser Inlet				
Product Accumulator		71	Heat Transfer Calculations	
Catalyst No.	Height"		Steam Rate = 343.9 #/hr	
1	12.0	683	@ 825 psia & 522°F	
2	43.2	641	= 1196 BTU/#	
3	74.4	654	Water in @ 178°F = 146 BTU/#	
4	105.6		Heat Transferred/lb. steam	
5	136.8	652	= 1050 BTU	
6	168.0	650	(1050)(343.9) = 361000 BTU/hr	
7	199.2	639	Ave. Bed Temperature	
8	230.4	633	= 653°F	
9	261.6	630	dT = 653-522 = 131°F	
10	292.8	635	Tube Area = 30.9 ft²	
12	342.0	635	$K = \frac{361000}{(131)(30.9)}$ =	89.2

PRODUCT TESTS

	OIL	WATER
°API	49.9	10.5
Neut. No.	41.3	40.9
Sap. No.	48.0	44.7
Hydrox. No.		
Bromine No.	82.2	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL DIST. %		°API
205 °F.		
400	72.6	55.4
400-550	15.3	36.4
550+	12.1	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	104	
10%	137	
50%	235	
90%	354	
EP	402	
	98.0	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	1881
Fresh Catalyst Added 50=	76
Total	1957
Catalyst Recovered	56
In Reactor at End of Period	1901
REACTOR d-p, Inches H_2O	
No. Height"	
1 12 - 43.2	57
2 43.2 - 74.4	57
3 74.4 - 105.6	58
4 105.6 - 342.0	220
(Calc) 0-12"	22
total	414
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	114
Inventory, Lbs.	1421
Bed Depth, Ft.	18.70
Volume, Cu Ft	12.34

PARTICLE SIZE

Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	11.7	80+	
100	150	67.8	40—80	
150	105	10.7	20—40	
200	74	5.6	10—20	
250	62	1.8	0—20	
325	44	1.8		
<325		0.6		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	140
Settled	142
Compacted	155
Particle Density, gm./cc.	4.0
NH_3 Value, ml./gm.	24.42
N_2 Surface, m²/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, Wt. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES / GENERATOR BALANCE

HOUR	1300	2100	0500	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.26	39.42	38.51	38.063	15.556	15.556		15.556
H_2 2.016	59.75	56.49	57.02	57.754	23.603		47.206	
CO_2 44.010	2.52	3.06	3.22	2.933	1.199	1.199		2.398
N_2 28.016	0.78	0.92	1.13	0.943	0.385			
CH_4 16.042	0.69	0.11	0.12	0.307	0.125	0.125	0.500	
			M. W.	13.4300				
			H_2O 18.016				10.744	5.372
						16.880	58.450	23.326
			BALANCE			100.10	95.57	106.17

	Mol %	M/Hr	C	H	O
O_2 32.000	0.50	0.073 10.667			21.480
CO 28.010					
H_2 2.016					
CO_2 44.010	1.68	0.245	0.245		0.490
N_2 28.016	2.08	0.303			
CH_4 16.042	82.27	11.999	11.999	47.996	
C_2H_6 30.068	8.87	1.294	2.588	7.764	
C_3H_8 44.094	4.50	0.656	1.968	5.248	
C_4H_{10} 58.120	0.05 0.05	0.007 0.007	0.028 0.035	0.07 0.084	
TOTAL			16.863	61.162	21.970

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	303.63	339.65
OIL	70.58	70.58
WATER	138.63	138.63
TOTAL	512.84	548.86
FRESH FEED	548.86	548.86
WEIGHT BALANCE	93.44	
WET GAS FACTOR		1.118631
INDICATED LOSS—S C F H		635

WET GAS	1300	2100	0500	AVERAGE
CO 28.010	15.02	16.29	16.16	15.823
H_2 2.016	44.25	39.36	43.53	42.380
CO_2 44.010	23.67	26.53	24.92	25.040
N_2 28.016	2.17	3.78	2.32	2.757
CH_4 16.042	7.04	5.92	5.24	6.067
C_2H_4 28.052	2.06	2.22	2.10	2.127
C_2H_6 30.068	0.82	0.90	0.81	0.843
C_3H_6 42.078	2.32	2.25	1.90	2.157
C_3H_8 44.094	0.33	0.25	0.24	0.273
C_4H_8 56.104	1.28	1.24	1.29	1.270
C_4H_{10} 58.120	0.31	0.40	0.44	0.383
C_5H_{10} 70.130	0.55	0.61	0.76	0.640
C_5H_{12} 72.146	0.07	0.08	0.09	0.080
C_6H_{12} 84.156	0.11	0.17	0.20	0.160
			M. W.	21.5066

GAS FLOW RATES

		√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	6.633	399.21 20.3455	75 0.9859	15493	1.4682	40.868
WET GAS	158.44	7.202	1.96 4.0853	71 0.9890	5352	1.1602	14.118
RECYCLE	115.14	8.500	401.17 20.3936	117 0.9493	21982	1.1602	57.985
BLEED	5.02	9.510	401.17 20.3936	117 0.9493	1072	1.1602	2.828
NATURAL GAS	28.43	8.659	418.8 20.8214	207 0.8830	23054 5529	1.2219	60.813 14.585
OXYGEN	27.07	7.17	432 21.1389	75 0.9859	4044		10.667
STEAM	215.7	5.13	35.1 0.3108		343.9#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL	7'3½	386.41	68	0.9961	384.90	49.9 6.494	2499.5	
	3'1	165.75	60	1.000	165.75	49.8 6.489	1077.0	
					219.15		1422.5	
	1'½	54.14	59	1.0005	54.17	49.9		
	0'3	13.28	58	1.0010	13.29	6.494		70.58
					40.88		265.5	10.873
					+0.92 41.80		1694.0	
WATER	7'11	419.14	72	0.9987	418.60	10.5		138.63
	0'4	17.70	60	1.0000	17.70	8.299		16.704
					400.90		3327.07	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 U
HOURS 437-461

	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	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	35.190	15.034	421.36	16.273	2.580	72.26	10.126	25.169	12.706	-12.463	349.10					Distribution of					
H_2 2.016	60.716	25.956	52.33	44.549	7.061	14.23	27.720	53.676	34.781	-18.895	38.10					Recovered Oil					
CO_2 44.010	2.657	1.136	50.00	22.896	3.630	159.74	14.247	15.383	17.877	2.494	109.74	7.060					400 EP			0.497	
N_2 28.016	1.070	0.457	12.80	2.343	0.371	10.39	1.458	1.915	1.829								400-550			0.115	
CH_4 16.042	0.367	0.157	2.52	6.270	0.994	15.95	3.901	4.058	4.895	0.837	13.43	0.864					550+			0.073	
C_2H_4 28.052				2.056	0.326	9.14	1.279	1.279	1.605	0.326	9.14	0.588									71.3
C_2H_6 30.068				0.826	0.131	3.94	0.514	0.514	0.645	0.131	3.94	0.253									
C_1+C_2											26.51	1.706									
C_3H_6 42.078				2.193	0.348	14.64	1.365	1.365	1.713	0.348	14.64	0.941	4.32	3.389	0.218	13.18	0.847	6.25	2.109	0.135	88.3
C_3H_8 44.094				0.290	0.046	2.03	0.180	0.180	0.226	0.046	2.03	0.131	4.24	0.479	0.031						
C_4H_8 56.104				1.273	0.202	11.33	0.792	0.792	0.994	0.202	11.33	0.729	5.00	2.267	0.146	10.76	0.693	6.10	1.764	0.113	81.1
C_4H_{10} 58.120				0.296	0.047	2.73	0.184	0.184	0.231	0.047	2.73	0.176	4.86	0.562	0.036	2.73	0.176	4.86	0.562	0.036	
C_5H_{10} 70.130				0.566	0.090	6.31	0.352	0.352	0.442	0.090	6.31	0.406	5.45	1.158	0.074	6.31	0.406	5.45	1.158	0.075	89.6
C_5H_{12} 72.146				0.076	0.012	0.87	0.048	0.048	0.060	0.012	0.87	0.056	5.25	0.166	0.011	0.87	0.056	5.25	0.166	0.011	
C_6H_{12} 84.156				0.093	0.015	1.26	0.058	0.058	0.073	0.015	1.26	0.081	5.54	0.227	0.015	1.26	0.081	5.54	0.227	0.015	
C_3-C_6											39.17	2.520		8.248	0.531	35.11	2.259		5.986	0.385	
TOTAL		42.749	539.01		15.853	324.82	62.224	104.973													
H_2+CO		40.999	15,543 S.C.F.H.					79.845	47.487	-31.358											
H_2/CO			643376																		

CUMULATIVE TOTALS

	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT		NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF
EFFLUENT	RECOVERED OIL		69.81	4.491		10.726	0.690	69.81	4.491		10.726	0.690
SHIFT RATIO	TOTAL OIL		108.98	7.012		18.974	1.221	104.92	6.750		16.712	1.075
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.8	WATER SOLUBLE CHEMICALS		14.70	0.946	8.046	1.827	0.118	14.70	0.946		1.827	0.118
	TOTAL LIQUID PRODUCTS C_3+		123.68	7.957		20.801	1.338	119.62	7.696		18.539	1.193
SELECTIVITY	NET WATER	7.198	129.68	8.343	8.328	15.571	1.002					
C_3+/C_1+	GROSS WATER		144.38	9.289		17.398	1.119					
82.35	HYDROCARBON TOTAL—C_1+		150.19	9.663								

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
62.92	82.85	72.80	76.48	49.52	35.20	40.53	82.35

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	433	Fresh Feed	16206
Natural Gas	419	Recycle	23589
Generator Outlet	413	Combined Feed	39795
Reactor Inlet	400	Wet Gas—Measured	5569
Condenser Inlet		Adjusted	6010
Product Accumulator	375	Loss	441
TEMPERATURES—°F.		Recycle/Fresh Feed	1.456
Oxygen	421	Inlet Velocity—ft./sec.	1.414
Natural Gas	710	Fresh Feed Rate—S.C.F.H.	15543
Generator		per Cu.Ft. Dense Bed	1252
Quench Accumulator	151	per Lb. Catalyst	11.07
Reactor Inlet	355		
Condenser Inlet			
Product Accumulator	73	Heat Transfer Calculations	
Catalyst No. Height"		Steam Rate = 354.7 #/hr	
1 12.0	698	@ 828 psia & 522°F	
2 43.2	646	= 1196 BTU/#	
3 74.4	663	Water in @ 180°F = 148 BTU/#	
4 105.6		Heat Transferred/lb. steam	
5 136.8	656	= 1048 BTU	
6 168.0	654	(1048)(354.7) = 370000 BTU/hr	
7 199.2	644	Ave. Bed Temperature	
8 230.4	637	= 660°F	
9 261.6	634	dT = 660-522 = 138°F	
10 292.8	637	Tube Area = 30.9 ft²	
12 342.0	639	$K = \frac{370000}{(138)(30.9)} = 86.9$	

PRODUCT TESTS

	OIL	WATER
°API	49.5	10.5
Neut. No.	41.5	41.3
Sap. No.	50.2	45.0
Hydrox. No.		
Bromine No.	87.1	
Pour °F.		
Chemicals, % by K_2CO_3		10.5
HEMPEL, DIST. %		°API
205 °F.		
400	72.0	55.1
400-550	16.6	36.1
550+	11.4	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	100	
10%	138	
50%	235	
90%	352	
EP	401	
	98.0	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	1901
Fresh Catalyst Added 52*	78
Total	1979
Catalyst Recovered	55
In Reactor at End of Period	1924
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	56
2 43.2 - 74.4	56
3 74.4 - 105.6	55
4 105.6 - 342.0	220
(Calc) 0-12"	22
total	409
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	112
Inventory, Lbs.	1404
Bed Depth, Ft.	18.80
Volume, Cu Ft	12.41

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	10.7	80+	
100	150	69.6	40—80	
150	105	11.3	20—40	
200	74	5.2	10—20	
250	62	1.6	0—20	
325	44	1.0		
<325		0.6		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	139
Settled	140
Compacted	153
Particle Density, gm./cc.	4.2
NH_3 Value, ml./gm.	17.30
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	0500	2100	1300	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.51	36.09	32.97	35.190	15.043	15.043		15.043
H_2 2.016	59.52	59.63	63.00	60.716	25.955		51.910	
CO_2 44.010	2.80	2.86	2.31	2.657	1.136	1.136		2.272
N_2 28.016	1.00	1.24	0.97	1.070	0.457			
CH_4 16.042	0.17	0.18	0.75	0.367	0.157	0.157	0.628	
			M. W.	12.6088				
			H_2O 18.016				9.066	4.533
						16.336	61.604	21.848
			BALANCE			95.99	100.94	98.71

	Mol %	M/Hr	C	H	O
O_2 32.000	0.70	0.102 10.667			21.538
CO 28.010					
H_2 2.016					
CO_2 44.010	2.04	0.298	0.298		0.596
N_2 28.016	2.96	0.433			
CH_4 16.042	79.99	11.702	11.702	46.808	
C_2H_6 30.068	8.85	1.295	2.590	7.770	
C_3H_8 44.094	5.29	0.774	2.322	6.192	
C_4H_{10} 58.120	0.13 0.04	0.019 0.006	0.076 0.030	0.19 0.072	
TOTAL			17.018	61.032	22.134

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS	301.00	324.82
OIL	69.81	69.81
WATER	144.38	144.38
TOTAL	515.19	539.01
FRESH FEED	539.01	539.01
WEIGHT BALANCE	95.58	
WET GAS FACTOR		1.079136
INDICATED LOSS—S C F H		441

WET GAS	0500	2100	1300	AVERAGE
CO 28.010	17.11	15.65	16.06	16.273
H_2 2.016	45.17	44.50	43.98	44.549
CO_2 44.010	22.60	23.92	22.17	22.896
N_2 28.016	2.14	2.52	2.37	2.343
CH_4 16.042	5.48	5.61	7.72	6.270
C_2H_4 28.052	2.05	2.11	2.01	2.056
C_2H_6 30.068	0.78	0.81	0.89	0.826
C_3H_6 42.078	2.11	2.25	2.22	2.193
C_3H_8 44.094	0.25	0.29	0.33	0.290
C_4H_8 56.104	1.23	1.31	1.28	1.273
C_4H_{10} 58.120	0.32	0.29	0.28	0.296
C_5H_{10} 70.130	0.57	0.58	0.55	0.566
C_5H_{12} 72.146	0.08	0.08	0.07	0.076
C_6H_{12} 84.156	0.11	0.10	0.07	0.093
			M. W.	20.4900

GAS FLOW RATES

	$\sqrt{h}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	6.71	400.04 20.366	74 0.9868	16206	1.51526	42.749
WET GAS 158.44	7.32	2.00 4.0902	73 0.9877	5569	1.188647	14.690
RECYCLE 115.14	8.50	400.83 20.385	118 0.9485	22493	1.188647	59.333
BLEED 5.02	9.50	400.83 20.385	118 0.9485	1096	1.188647	2.891
NATURAL GAS 28.43	8.74	418.88 20.823	199 0.8883	23589 5546	1.20664	62.224 14.689
OXYGEN 27.07	7.17	432.63 21.151	76 0.9850	4044		10.667
STEAM 215.7	5.33	34.5 0.3085		354.7#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	5'10½	312.21	64	0.9980	311.59			
	1'½	54.14	59	1.0005	54.17	49.5 6.509		
					257.42		1675.55	69.81
								10.726
WATER	7'3	384.23	77	0.9980	383.46			
	3"	13.28	59	1.0001	13.28	10.5 8.299		
					370.18			
	1'2	60.66	70	0.9990	60.60			
	3"	13.28	82	0.9973	13.24			144.38
					47.36			17.398
					417.54		3465.16	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 Y
HOURS 461-473

	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	YIELD BASIS H_2+CO FED: CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.497	15.536	435.17	16.610	2.687	75.26	10.302	25.838	12.989	-12.849	359.90					Distribution of					
H_2 2.016	59.573	25.360	51.13	45.136	7.303	14.72	27.993	53.353	35.296	-18.057	36.40					Recovered Oil					
CO_2 44.010	2.657	1.131	49.78	22.938	3.711	163.32	14.226	15.357	17.937	2.580	113.54	7.323					400 EP			0.518	
N_2 28.016	0.890	0.379	10.62	2.320	0.375	10.51	1.439	1.818	1.814								400-550			0.138	
CH_4 16.042	0.383	0.163	2.61	5.633	0.911	14.61	3.494	3.657	4.405	0.748	12.00	0.774					550+			0.071	
C_2H_4 28.052				2.023	0.327	9.17	1.255	1.255	1.582	0.327	9.17	0.591									71.2
C_2H_6 30.068				0.817	0.132	3.97	0.507	0.507	0.639	0.132	3.97	0.256									
C_1+C_2											25.14	1.622									
C_3H_6 42.078				2.033	0.330	13.88	1.261	1.261	1.591	0.330	13.88	0.895	4.32	3.213	0.207	12.49	0.805	6.25	1.999	0.129	89.7
C_3H_8 44.094				0.233	0.038	1.68	0.145	0.145	0.183	0.038	1.68	0.108	4.24	0.396	0.025						
C_4H_8 56.104				1.190	0.192	10.77	0.738	0.738	0.930	0.192	10.77	0.695	5.00	2.154	0.139	10.23	0.660	6.10	1.677	0.108	75.3
C_4H_{10} 58.120				0.387	0.063	3.66	0.240	0.240	0.303	0.063	3.66	0.236	4.86	0.753	0.049	3.66	0.236	4.86	0.753	0.049	
C_5H_{10} 70.130				0.460	0.074	5.19	0.285	0.285	0.359	0.074	5.19	0.335	5.45	0.952	0.061	5.19	0.335	5.45	0.952	0.061	85.1
C_5H_{12} 72.146				0.083	0.013	0.94	0.051	0.051	0.064	0.013	0.94	0.061	5.25	0.179	0.012	0.94	0.061	5.25	0.179	0.012	
C_6H_{12} 84.156				0.137	0.022	1.85	0.085	0.085	0.107	0.022	1.85	0.119	5.54	0.334	0.022	1.85	0.119	5.54	0.334	0.022	
C_3-C_6											37.97	2.449		7.981	0.515	34.36	2.216		5.894	0.380	
TOTAL		42.569	549.31		16.180	329.64	62.021														
H_2+CO		40.896	15,504 S.C.F.H.			339.53	38.295	79.191	48.285	-30.906											
H_2/CO		1.63	644994		2.72			2.06		1.41											

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.6

EFFLUENT	m/hr	#/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL		73.31	4.728		11.270	0.727	73.31	4.728		11.270	0.727
TOTAL OIL		111.28	7.177		19.251	1.242	107.67	6.945		17.164	1.107
WATER SOLUBLE CHEMICALS		14.18	0.915	8.039	1.764	0.114	14.18	0.915		1.764	0.114
TOTAL LIQUID PRODUCTS C_3+		125.46	8.092		21.015	1.355	121.85	7.859		18.928	1.221
NET WATER	7.337	132.19	8.526	8.328	15.873	1.024					
GROSS WATER		146.37	9.441		17.637	1.138					
HYDROCARBON TOTAL—C_1+		150.60	9.714								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
61.99	82.70	71.20	75.57	49.73	33.84	39.03	83.30

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	444	Fresh Feed	16138
Natural Gas	425	Recycle	23512
Generator Outlet	413	Combined Feed	39650
Reactor Inlet	399	Wet Gas—Measured	5022
Condenser Inlet		Adjusted	6542
Product Accumulator	372	Loss	1520
TEMPERATURES—°F.		Recycle/Fresh Feed	1.457
Oxygen	371	Inlet Velocity—ft./sec.	1.405
Natural Gas	744	Fresh Feed Rate—S.C.F.H.	15504
Generator		per Cu.Ft. Dense Bed	1185
Quench Accumulator	158	per Lb. Catalyst	10.38
Reactor Inlet	346		
Condenser Inlet			
Product Accumulator	64	**Heat Transfer Calculations**	
Catalyst No. Height"		Steam Rate = 339.6 #/hr	
1 12.0	695	@ 850 psia & 525°F = 1195 BTU/#	
2 43.2	644		
3 74.4	654	Water in @ 175°F = 143 BTU/#	
4 105.6		Heat Transferred/lb. steam = 1052 BTU	
5 136.8	653		
6 168.0	656	(1052)(339.6) = 357000 BTU/hr	
7 199.2	649	Ave. Bed Temperature = 658°F	
8 230.4	645		
9 261.6	639	dT = 658-525 = 133°F	
10 292.8	639	Tube Area = 30.9 ft²	
12 342.0	639	$K = \frac{357000}{(133)(30.9)} = 87.1$	

PRODUCT TESTS

	OIL	WATER
°API	49.6	10.5
Neut. No.	42.5	44.3
Sap. No.	51.4	44.4
Hydrox. No.		
Bromine No.	80.9	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	71.3	55.3
400-550	19.0	36.9
550+	9.7	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	103	
10%	139	
50%	235	
90%	351	
EP	399	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	1924
Fresh Catalyst Added 50#	76
Total	2000
Catalyst Recovered	65
In Reactor at End of Period	1975
REACTOR d-p, Inches H_2O	
No. Height"	
1 12 - 43.2	58
2 43.2 - 74.4	55
3 74.4 - 105.6	60
4 105.6 - 342.0	240
(Calc) 0-12"	22
total	435
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	113
Inventory, Lbs.	1493
Bed Depth, Ft.	19.82
Volume, Cu Ft	13.08

PARTICLE SIZE: Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	11.6	80+	
100	150	66.5	40—80	
150	105	11.0	20—40	
200	74	5.9	10—20	
250	62	2.0	0—20	
325	44	1.2		
<325		1.8		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	129
Settled	131
Compacted	149
Particle Density, gm./cc.	4.2
NH_3 Value, ml./gm.	4.08
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	1300	2100	0500	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.68	36.32	36.49	36.497	15.536	15.536		15.536
H_2 2.016	59.16	59.71	59.85	59.573	25.360		50.720	
CO_2 44.010	2.54	2.90	2.53	2.657	1.131	1.131		2.262
N_2 28.016	0.81	0.98	0.88	0.890	0.379			
CH_4 16.042	0.81	0.09	0.25	0.383	0.163	0.163	0.652	
			M. W.	12.9039				
			H_2O 18.016				8.937	4.469
						16.830	60.309	22.267
			BALANCE			99.96	99.07	101.29

GENERATOR BALANCE	Mol %	M/Hr	C	H	O
O_2 32.000	0.46	0.067 10.657			21.448
CO 28.010					
H_2 2.016					
CO_2 44.010	1.84	0.268	0.268		0.536
N_2 28.016	2.52	0.367			
CH_4 16.042	81.81	11.921	11.921	47.684	
C_2H_6 30.068	8.40	1.224	2.448	7.344	
C_3H_8 44.094	4.85	0.707	2.121	5.656	
C_4H_{10} 58.120	0.08 0.04	0.012 0.006	0.048 0.030	0.12 0.07	
TOTAL			16.836	60.874	21.984

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance	
WET GAS	+500 CF 269.88	296.75	329.63
OIL	66.00	66.00	73.31
WATER	131.77	131.77	146.37
TOTAL	467.65	494.52	549.31
FRESH FEED	549.31		
WEIGHT BALANCE	85.13		
WET GAS FACTOR		1.302578	
INDICATED LOSS—S C F H	Assumed at 500 SCFH		

WET GAS	0100	2100	0500	
CO 28.010	16.91	16.55	16.38	16.610
H_2 2.016	44.57	45.44	45.41	45.136
CO_2 44.010	23.42	23.13	22.27	22.938
N_2 28.016	2.26	2.28	2.42	2.320
CH_4 16.042	5.36	5.43	6.11	5.633
C_2H_4 28.052	2.08	2.02	1.97	2.023
C_2H_6 30.068	0.82	0.82	0.81	0.817
C_3H_6 42.078	2.10	1.91	2.09	2.033
C_3H_8 44.094	0.26	0.24	0.17	0.233
C_4H_8 56.104	1.22	1.11	1.24	1.190
C_4H_{10} 58.120	0.37	0.35	0.44	0.387
C_5H_{10} 70.130	0.46	0.44	0.48	0.460
C_5H_{12} 72.146	0.06	0.13	0.06	0.083
C_6H_{12} 84.156	0.11	0.15	0.15	0.137
			M. W.	20.3727

GAS FLOW RATES

	√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	6.712	398.9 20.3378	65.0 0.9952	16138	1.4978	42.569
WET GAS 158.44	6.579	1.732 4.0573	64.3 0.9962	5022	1.19207	13.247
RECYCLE 115.14	8.443	399.8 20.3600	117.1 0.9493	22398	1.19207	59.082
BLEED 5.02	9.628	399.8 20.3600	117.1 0.9493	1114	1.19207	2.939
NATURAL GAS 28.43	8.622	424.5 20.9578	207.1 0.8830	23512 5524	1.21778	62.021 14.571
OXYGEN 27.07	7.063	443.8 21.4133	73.5 0.9868	4040		10.657
STEAM 215.7	5.45	29.3 0.2869		339.6#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL	7'2½	382.05	69	0.9956	380.37			
	6'4¾	339.49	70	0.9951	337.83	49.6	792.05	66.004
					42.54	6.505		
	1'10¼	98.28	65	0.9975	98.03			10.147
	4½"	18.81	60	1.0000	18.81			
					79.22 42.54 121.76			
WATER	5'7	296.94	70	0.99896	296.63			131.77
	2'½	106.35	79	0.99775	106.11	10.5	1581.2	
					190.53	8.299		15.878

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THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 W
HOURS 473-497

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					% Unsats.
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	
CO 28.010	36.590	15.509	434.41	16.777	2.667	74.70	10.346	25.855	13.013	-12.842	359.70					Distribut'on of					
H_2 2.016	59.350	25.157	50.72	44.327	7.047	14.21	27.333	52.490	34.380	-18.110	36.51					Recovered Oil					
CO_2 44.010	2.623	1.112	48.94	22.983	3.654	160.81	14.172	15.283	17.826	2.542	111.87	7.256					400 EP			0.516	
N_2 28.016	1.020	0.432	12.10	2.283	0.363	10.17	1.408	1.840	1.771								400-550			0.154	
CH_4 16.042	0.417	0.177	2.84	6.180	0.982	15.75	3.811	3.988	4.793	0.805	12.91	0.837					550+			0.044	
C_2H_4 28.052				2.067	0.329	9.23	1.275	1.275	1.604	0.329	9.23	0.599									71.7
C_2H_6 30.068				0.817	0.130	3.91	0.504	0.504	0.634	0.130	3.91	0.254									
C_1+C_2											26.05	1.690									
C_3H_6 42.078				2.107	0.335	14.10	1.300	1.300	1.635	0.335	14.10	0.915	4.32	3.264	0.212	12.69	0.823	6.25	2.030	0.132	88.6
C_3H_8 44.094				0.273	0.043	1.90	0.168	0.168	0.211	0.043	1.90	0.123	4.24	0.448	0.029						
C_4H_8 56.104				1.153	0.183	10.27	0.711	0.711	0.894	0.183	10.27	0.666	5.00	2.054	0.133	9.75	0.632	6.10	1.598	0.104	74.7
C_4H_{10} 58.120				0.393	0.062	3.60	0.242	0.242	0.304	0.062	3.60	0.234	4.86	0.741	0.048	3.60	0.234	4.86	0.741	0.048	
C_5H_{10} 70.130				0.460	0.073	5.12	0.284	0.284	0.357	0.073	5.12	0.332	5.45	0.939	0.062	5.12	0.332	5.45	0.939	0.062	86.9
C_5H_{12} 72.146				0.067	0.011	0.79	0.041	0.041	0.052	0.011	0.79	0.051	5.25	0.150	0.010	0.79	0.051	5.25	0.150	0.010	
C_6H_{12} 84.156				0.113	0.018	1.51	0.070	0.070	0.088	0.018	1.51	0.098	5.54	0.273	0.018	1.51	0.098	5.54	0.273	0.018	
C_3-C_6											37.29	2.419		7.869	0.510	33.46	2.170		5.731	0.372	
TOTAL		42.387	549.01		15.898	326.10	61.665	104.052													
H_2+CO		40.666	15,417 S.C.F.H.		9.714		37.679	78.345	47.393	30.952											
H_2/CO		1.62	648634		2.64			2.03		1.41											

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT

SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.2

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL		71.73	4.653		11.010	0.714	71.73	4.653		11.010	0.714
TOTAL OIL		109.02	7.071		18.879	1.225	105.19	6.823		16.741	1.086
WATER SOLUBLE CHEMICALS		14.54	0.943	7.976	1.823	0.118	14.54	0.943		1.823	0.118
TOTAL LIQUID PRODUCTS C_3+		123.56	8.015		20.702	1.343	119.73	7.766		18.564	1.204
NET WATER	7.584	136.64	8.863	8.328	16.407	1.064					
GROSS WATER		151.18	9.806		18.230	1.182					
HYDROCARBON TOTAL—C_1+		149.61	9.704								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
62.49	82.80	71.99	76.11	49.67	34.50	39.51	82.59

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG			RATES S.C.F.H.	
Oxygen		445	Fresh Feed	16069
Natural Gas		424	Recycle	23377
Generator Outlet		412	Combined Feed	39446
Reactor Inlet		398	Wet Gas—Measured	4989
Condenser Inlet			Adjusted	6395
Product Accumulator		371	Loss	1406
TEMPERATURES—°F.			Recycle/Fresh Feed	1.455
Oxygen		425	Inlet Velocity—ft./sec.	1.393
Natural Gas		698	Fresh Feed Rate—S.C.F.H.	15417
Generator			per Cu.Ft. Dense Bed	1219
Quench Accumulator		142	per Lb. Catalyst	10.67
Reactor Inlet		373		
Condenser Inlet				
Product Accumulator		72	Heat Transfer Calculations	
Catalyst No.	Height "		Steam Rate = 351.6 #/hr	
1	12.0	690	@ 851 psia & 525°F	
2	43.2	647	= 1195 BTU/#	
3	74.4	653	Water in @ 168°F = 136 BTU/#	
4	105.6		Heat Transferred/lb. steam	
5	136.8	655	= 1059 BTU	
6	168.0	654	(1059)(351.6) = 372000 BTU/hr	
7	199.2	648	Ave. Bed Temperature	
8	230.4	644	= 658°F	
9	261.6	639	dT = 658-525 = 133°F	
10	292.8	638	Tube Area = 30.9 ft²	
12	342.0	642	$K = \frac{372000}{(133)(30.9)} =$	90.8

PRODUCT TESTS

	OIL	WATER
°API	49.3	10.6
Neut. No.	40.4	41.2
Sap. No.	48.3	42.2
Hydrox. No.		
Bromine No.	78.5	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	72.3	55.8
400-550	21.6	35.7
550+	6.1	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	104	
10%	140	
50%	238	
90%	352	
EP	402	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	1975
Fresh Catalyst Added 60=	91
Total	2066
Catalyst Recovered	86
In Reactor at End of Period	1980
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	58
2 43.2 - 74.4	55
3 74.4 - 105.6	58
4 105.6 - 342.0	228
(Calc) 0-12"	22
total	421
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	113
Inventory, Lbs.	1445
Bed Depth, Ft.	19.18
Volume, Cu Ft	12.65

PARTICLE SIZE

Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	5.2	80+	
100	150	71.6	40—80	
150	105	14.6	20—40	
200	74	6.0	10—20	
250	62	1.6	0—20	
325	44	0.6		
<325		0.4		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	145
Settled	147
Compacted	158
Particle Density, gm./cc.	4.2
NH_3 Value, ml./gm.	20.76
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	1300	2100	0500	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.52	0.076 10.646			21.444
CO 28.010	37.53	35.74	36.50	36.590	15.509	15.509		15.509	CO 28.010					
H_2 2.016	58.52	60.10	59.43	59.350	25.157		50.314		H_2 2.016					
CO_2 44.010	2.69	2.69	2.49	2.623	1.112	1.112		2.224	CO_2 44.010	1.94	0.285	0.285		0.570
N_2 28.016	0.78	1.39	0.89	1.020	0.432				N_2 28.016	2.02	0.297			
CH_4 16.042	0.48	0.08	0.69	0.417	0.177	0.177	0.708		CH_4 16.042	82.86	12.190	12.190	48.760	
			M. W.	12.9524					C_2H_6 30.068	8.49	1.249	2.498	7.494	
			H_2O 18.016				9.359	4.6795	C_3H_8 44.094	4.06	0.597	1.791	4.776	
						16.798	60.381	22.413	C_4H_{10} 58.120	0.07 0.03	0.010 0.004	0.040 0.020	0.10 0.048	
			BALANCE			99.85	98.70	101.81	TOTAL			16.824	61.178	22.014

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance	
WET GAS	269.94	296.99	326.10
OIL	65.33	65.33	71.73
WATER	137.68	137.68	151.18
TOTAL	472.95	500.00	549.01
FRESH FEED	549.01		549.01
WEIGHT BALANCE	86.15		
WET GAS FACTOR			1.281766
INDICATED LOSS—S C F H		500	

WET GAS

WET GAS				
CO 28.010	16.36	16.38	17.59	16.777
H_2 2.016	44.81	44.82	43.35	44.327
CO_2 44.010	22.67	23.35	22.93	22.983
N_2 28.016	1.97	2.60	2.28	2.283
CH_4 16.042	6.68	5.43	6.43	6.180
C_2H_4 28.052	2.11	2.06	2.03	2.067
C_2H_6 30.068	0.85	0.73	0.87	0.817
C_3H_6 42.078	2.15	2.16	2.01	2.107
C_3H_8 44.094	0.26	0.28	0.28	0.273
C_4H_8 56.104	1.17	1.16	1.13	1.153
C_4H_{10} 58.120	0.35	0.39	0.44	0.393
C_5H_{10} 70.130	0.45	0.49	0.44	0.460
C_5H_{12} 72.146	0.06	0.06	0.08	0.067
C_6H_{12} 84.156	0.11	0.09	0.14	0.113
			M. W.	20.5125

GAS FLOW RATES

		$\sqrt{h}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	6.76	398.0 20.3157	74.3 0.9868	16069	1.49503	42.387
WET GAS	158.44	6.56	1.969 4.0864	72.3 0.9887	4989	1.16800	13.160
RECYCLE	115.14	8.45	399.5 20.3526	120.0 0.9469	22275	1.187995	58.758
BLEED	5.02	9.59	399.5 20.3526	120.0 0.9469	1102	1.187995	2.907
NATURAL GAS	28.43	8.65	399.5 20.9506	120.0 0.8836	23377 5577	1.22515	61.665 14.711
OXYGEN	27.07	7.05	444.6 21.4319	73.9 0.9868	4036		10.646
STEAM	215.7	5.44	32.1 0.2996		351.6#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL. HR
OIL	6'4½	338.40	62	0.9990	338.062	49.3	1568.022	65.501
	1'10½	98.28	65	0.9975	98.034	6.516	+4.00	
					240.642		1572.022	10.052
WATER	7'4	388.59	76	0.99819	387.887	10.6	3304.470	137.686
	5'7	296.94	70	0.99896	296.631	8.293		
					91.256			
	5'11½	316.58	75	0.99832	316.048			16.603
	2"	8.85	72	0.99872	8.839			
					307.209 91.256 398.465			

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 X
HOURS 497-521

	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
CO 28.010	37.837	10.558	295.70	13.927	1.176	32.94	4.130	14.688	5.306
H_2 2.016	58.133	16.220	32.70	39.994	3.376	6.81	11.860	28.080	15.236
CO_2 44.010	8.733	0.763	33.58	27.070	2.286	100.89	8.027	8.790	10.313
N_2 28.016	1.010	0.282	7.90	2.233	0.189	5.30	0.662	0.944	0.851
CH_4 16.042	0.287	0.080	1.28	7.333	0.619	9.93	2.175	0.258	2.794
C_2H_4 28.052				2.330	0.197	5.53	0.691	0.691	0.888
C_2H_6 30.068				1.113	0.094	2.83	0.330	0.330	0.424
C_1+C_2									
C_3H_6 42.078				2.760	0.233	9.80	0.818	0.818	1.051
C_3H_8 44.094				0.557	0.047	2.07	0.165	0.165	0.212
C_4H_8 56.104				1.610	0.136	7.63	0.477	0.477	0.613
C_4H_{10} 58.120				0.397	0.034	1.98	0.118	0.118	0.152
C_5H_{10} 70.130				0.513	0.043	3.02	0.152	0.152	0.195
C_5H_{12} 72.146				0.070	0.006	0.43	0.021	0.021	0.027
C_6H_{12} 84.156				0.093	0.008	0.67	0.028	0.028	0.036
C_3-C_6									
TOTAL		27.903	371.16		8.444	189.82	29.654	57.557	
H_2+CO		26.778	10,152 S.C.F.H.		4.552			42.768	20.542
H_2/CO		1.54	985027		2.87			1.91	2.87

	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO	- 9.382	262.76					Distribution of					
H_2	-12.844	25.89					Recovered Oil					
CO_2	1.523	67.31	6.833					400 EP			0.701	
N_2								400-550			0.174	
CH_4	0.539	8.65						550+			0.060	
C_2H_4	0.197	5.53										67.7
C_2H_6	0.094	2.83										
C_1+C_2		17.01	1.676									
C_3H_6	0.233	9.80	0.966	4.32	2.269	0.224	8.82	0.869	6.25	1.411	0.139	83.2
C_3H_8	0.047	2.07	0.204	4.24	0.488	0.048						
C_4H_8	0.136	7.63	0.752	5.00	1.526	0.150	7.25	0.714	6.10	1.189	0.117	80.2
C_4H_{10}	0.034	1.98	0.195	4.86	0.407	0.040	1.98	0.195	4.86	0.407	0.040	
C_5H_{10}	0.043	3.02	0.297	5.45	0.554	0.055	3.02	0.297	5.45	0.554	0.055	88.0
C_5H_{12}	0.006	0.43	0.042	5.25	0.082	0.008	0.43	0.042	5.25	0.082	0.008	
C_6H_{12}	0.008	0.67	0.066	5.54	0.121	0.012	0.67	0.066	5.54	0.121	0.012	
C_3-C_6		25.60	2.522		5.447	0.537	22.17	2.183		3.764	0.371	
TOTAL												
H_2+CO	-22.226											
H_2/CO	1.37											
RECOVERED OIL		61.16	6.024		9.490	0.935	61.16	6.024		9.490	0.935	
TOTAL OIL		86.76	8.546		14.937	1.471	83.33	8.208		13.254	1.306	
WATER SOLUBLE CHEMICALS		12.77	1.258	8.011	1.594	0.157	12.77	1.258		1.594	0.157	
TOTAL LIQUID PRODUCTS C_3+		99.53	9.804		16.531	1.628	96.10	9.466		14.848	1.463	
NET WATER	5.962	107.41	10.580	8.328	12.897	1.270						
GROSS WATER		120.18	11.838		14.491	1.427						
HYDROCARBON TOTAL—C_1+		116.54	11.480									

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 5.0

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3+/C_1+
69.74	88.86	79.19	83.00	63.88	45.74	51.97	85.40

g/M3 = 16.91 × #/MCF
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	430	Fresh Feed	10578
Natural Gas	412	Recycle	11242
Generator Outlet	411	Combined Feed	21820
Reactor Inlet	400	Wet Gas—Measured	2052
Condenser Inlet		Adjusted	3832
Product Accumulator	386	Loss	1780
TEMPERATURES—°F.		Recycle/Fresh Feed	1.063
Oxygen	454	Inlet Velocity—ft./sec.	0.785
Natural Gas	743	Fresh Feed Rate—S.C.F.H.	10152
Generator		per Cu.Ft. Dense Bed	894
Quench Accumulator	118	per Lb. Catalyst	7.32
Reactor Inlet	445		
Condenser Inlet			
Product Accumulator	66	Heat Transfer Calculations	
Catalyst No. Height "		Steam Rate = 328.1 #/hr	
1 12.0	744	@ 766 psia & 513°F	
2 43.2	648	= 1198 BTU/#	
3 74.4	654	Water in @ 173°F = 141 BTU/#	
4 105.6		Heat Transferred/lb. steam	
5 136.8	643	= 1057 BTU	
6 168.0	633	(1057)(328.1) = 346000 BTU/hr	
7 199.2	603	Ave. Bed Temperature	
8 230.4	598	= 654°F	
9 261.6	596	dT = 654-513 = 141°F	
10 292.8	594	Tube Area = 30.4 ft^2	
12 342.0	565	$K = \frac{346000}{(141)(30.4)} =$	81.1

PRODUCT TESTS

	OIL	WATER
°API	51.3	10.7
Neut. No.	38.8	38.9
Sap. No.	45.3	41.0
Hydrox. No.		
Bromine No.	85.6	
Pour °F.		
Chemicals, % by K_2CO_3		11.0
HEMPEL, DIST. %		°API
205 °F.		
400	75.0	57.1
400-550	18.6	36.6
550+	6.4	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	102	
10%	134	
50%	226	
90%	346	
EP	399	
	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	1776
Fresh Catalyst Added 67=	101
Total	1879
Catalyst Recovered	15
In Reactor at End of Period	1864
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	58
2 43.2 - 74.4	62
3 74.4 - 105.6	61
4 105.6 - 342.0	200
(Calc) 0-12"	23
total	404
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	121
Inventory, Lbs.	1387
Bed Depth, Ft.	17.19
Volume, Cu Ft	11.35

PARTICLE SIZE: Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	14.1	80+	
100	150	66.6	40—80	
150	105	10.9	20—40	
200	74	4.6	10—20	
250	62	1.4	0—20	
325	44	1.0		
<325		1.2		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	122
Settled	123
Compacted	145
Particle Density, gm./cc.	3.8
NH_3 Value, ml./gm.	15.03
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	2100	0500	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.47	7.362			14.814
CO 28.010	38.72	37.66	37.13	37.837	10.558	10.558		10.558	CO 28.010					
H_2 2.016	57.02	58.27	59.11	58.133	16.221		32.442		H_2 2.016					
CO_2 44.010	2.54	3.09	2.57	2.733	0.763	0.763		1.526	CO_2 44.010	1.68	0.162	0.162		0.324
N_2 28.016	1.10	0.90	1.03	1.010	0.282				N_2 28.016	2.15	0.208			
CH_4 16.042	0.62	0.08	0.16	0.287	0.080	0.080	0.320		CH_4 16.042	82.10	7.931	7.931	31.724	
			M. W.	13.3019					C_2H_6 30.068	8.85	0.855	1.710	5.130	
			H_2O 18.016				6.970	3.485	C_3H_8 44.094	4.65	0.449	1.347	3.632	
						11.401	39.732	15.569	C_4H_{10} 58.120	0.06 0.04	0.006 0.004	0.024 0.020	0.06 0.048	
			BALANCE			101.85	97.88	102.85	TOTAL			11.194	40.594	15.138

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance	
WET GAS	121.47	151.07	189.82
OIL	48.67	48.67	61.16
WATER	95.64	95.64	120.18
TOTAL	265.78	295.38	371.16
FRESH FEED	371.16		371.16
WEIGHT BALANCE	71.61		
WET GAS FACTOR			
INDICATED LOSS—S C F H		500	

WET GAS	1300	2100	0500	AVERAGE
CO 28.010	14.28	13.96	13.54	13.927
H_2 2.016	41.63	39.30	39.05	39.994
CO_2 44.010	25.43	27.89	27.89	27.070
N_2 28.016	1.92	2.31	2.47	2.233
CH_4 16.042	7.88	6.89	7.23	7.333
C_2H_4 28.052	2.03	2.36	2.60	2.330
C_2H_6 30.068	1.12	1.09	1.13	1.113
C_3H_6 42.078	2.50	2.80	2.98	2.760
C_3H_8 44.094	0.65	0.62	0.40	0.557
C_4H_8 56.104	1.53	1.69	1.61	1.610
C_4H_{10} 58.120	0.38	0.39	0.42	0.397
C_5H_{10} 70.130	0.49	0.53	0.52	0.513
C_5H_{12} 72.146	0.07	0.08	0.06	0.070
C_6H_{12} 84.156	0.09	0.09	0.10	0.093
			M. W.	22.4405

GAS FLOW RATES

		$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	4.504	399.8 20.3600	74.5 0.9859	10578	1.47525	27.903
WET GAS	50.54	8.961	1.345 4.0093	66.1 0.9943	2052	1.13671	5.413
RECYCLE	115.14	4.050	401.0 20.3894	119.7 0.9469	10234	1.13671	26.995
BLEED	5.02	9.153	401.0 20.3894	119.7 0.9469	1008	1.13671	2.659
NATURAL GAS	28.43	5.720	412.0 20.6574	192.0 0.8931	11242 3662	1.22065	29.654 9.660
OXYGEN	27.07	4.962	429.5 21.0767	74.8 0.9859	2791		7.362
STEAM	215.7	5.00	33.3 0.3042		328.1#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'1	375.50	66	0.9970	374.37	49.3		
	6'4½	338.40	62	0.9990	338.06	6.516	236.60	
					36.31			
	2'11	156.54	58	1.0010	156.70	51.3		
	0'3	13.28	64	0.9980	13.25	6.445	924.54	48.67
					143.45 +1.09		7.00	7.535
					180.85		1168.14	
WATER	7'0	371.14	74	0.9985	370.58	10.6		
	5'11½	316.58	75	0.9985	316.04	8.293		
					54.54		452.30	
	4'5½	238.01	66	0.9994	237.87	10.7		
	0'3½	15.49	68	0.9992	15.48	8.287	1842.95	95.64
					222.39			11.539
							2295.25	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 Y
HOURS 521-528

	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	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	37.71	10.626	297.62	13.30	1.117	31.29	3.722	14.348	4.839	-9.509	266.33					Distribution of					
H_2 2.016	58.35	16.441	33.15	40.78	3.427	6.91	11.411	27.852	14.838	-13.014	26.24					Recovered Oil					
CO_2 44.010	2.48	0.699	30.76	26.38	2.216	97.51	7.382	8.081	9.598	1.517	66.75	6.505					400 EP			0.625	
N_2 28.016	1.18	0.332	9.30	2.17	0.182	5.10	0.607	0.939	0.789								400-550			0.158	
CH_4 16.042	0.28	0.079	1.27	7.38	0.620	9.95	2.065	2.144	2.685	0.541	8.68						550+			0.078	
C_2H_4 28.052				2.45	0.206	5.78	0.686	0.686	0.892	0.206	5.78										69.1
C_2H_6 30.068				1.10	0.092	2.77	0.308	0.308	0.400	0.092	2.77										
C_1+C_2											17.23	1.68									
C_3H_6 42.078				2.92	0.245	10.31	0.817	0.817	1.062	0.245	10.31	1.004	4.32	2.387	0.232	9.28	0.905	6.23	1.485	0.145	87.2
C_3H_8 44.094				0.43	0.036	1.59	0.120	0.120	0.156	0.036	1.59	0.155	4.24	0.375	0.037						
C_4H_8 56.104				1.73	0.145	8.14	0.484	0.484	0.624	0.145	8.14	0.793	5.00	1.628	0.159	7.73	0.753	6.10	1.267	0.123	79.4
C_4H_{10} 58.120				0.45	0.038	2.21	0.126	0.126	0.164	0.038	2.21	0.215	4.86	0.455	0.044	2.21	0.215	4.86	0.455	0.044	
C_5H_{10} 70.130				0.63	0.053	3.72	0.176	0.176	0.229	0.053	3.72	0.363	5.45	0.683	0.067	3.72	0.363	5.45	0.683	0.067	82.9
C_5H_{12} 72.146				0.13	0.011	0.79	0.036	0.036	0.047	0.011	0.79	0.077	5.26	0.150	0.015	0.79	0.077	5.26	0.150	0.015	
C_6H_{12} 84.156				0.15	0.013	1.09	0.042	0.042	0.055	0.013	1.09	0.106	5.54	0.197	0.019	1.09	0.106	5.54	0.197	0.019	
C_3-C_6											27.85	2.714		5.875	0.573	24.82	2.419		4.237	0.413	
TOTAL		28.177	372.10 10,261 S.C.F.H.		8.401	187.16	27.982	56.159													
H_2+CO	96.06	27.076			4.544			42.200	19.677	-22.523											
H_2/CO	1.55	1.55	974563		3.07			1.94	3.07	1.37											

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT

SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 4.6

	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF
RECOVERED OIL		56.80	5.536		8.834	0.861	56.80	5.536		8.834	0.861
TOTAL OIL		84.65	8.250		14.709	1.433	81.62	7.954		13.071	1.274
WATER SOLUBLE CHEMICALS		13.53	1.319	7.954	1.701	0.166	13.53	1.319		1.701	0.166
TOTAL LIQUID PRODUCTS C_3+		98.18	9.568		16.410	1.599	95.15	9.273		14.772	1.440
NET WATER	6.362	114.61	11.169	8.328	13.762	1.341					
GROSS WATER		128.14	12.488		15.463	1.507					
HYDROCARBON TOTAL—C_1+		115.41	11.247								

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	$CO+H_2$	SELECTIVITY C_3+/C_1+
70.18	89.49	79.16	83.18	66.27	46.73	53.37	85.07

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	434	Fresh Feed	10682
Natural Gas	415	Recycle	10608
Generator Outlet	415	Combined Feed	21290
Reactor Inlet	402	Wet Gas—Measured	1991
Condenser Inlet		Adjusted	3872
Product Accumulator	388	Loss	1881
TEMPERATURES—°F.		Recycle/Fresh Feed	0.99
Oxygen	495	Inlet Velocity—ft./sec.	0.766
Natural Gas	786	Fresh Feed Rate—S.C.F.H.	10261
Generator		per Cu.Ft. Dense Bed	856
Quench Accumulator	122	per Lb. Catalyst	6.89
Reactor Inlet	455		
Condenser Inlet			
Product Accumulator	72	Heat Transfer Calculations	

Catalyst No.	Height "	Temp.	
1	12.0	756	Steam Rate = 340.6 #/hr
2	43.2	650	@ 769 psia & 514°F = 1198 BTU/#
3	74.4	662	Heat Transferred/lb. steam
4	105.6		= 1050 BTU
5	136.8	647	(1050)(340.6) = 358500 BTU/hr
6	168.0	637	Ave. Bed Temperature
7	199.2	608	= 660°F
8	230.4	598	dT = 660-514 = 146°F
9	261.6	597	Tube Area = 31.9 ft²
10	292.8	593	$K = \frac{358500}{(146)(31.9)} =$ 77.1
12	342.0	564	

PRODUCT TESTS

	OIL	WATER
°API	51.7	
Neut. No.	24.0	water
Sap. No.	31.8	sample
Hydrox. No.		contaminated
Bromine No.	95.8	with
Pour °F.		condenser
Chemicals, % by K_2CO_3		water
HEMPEL, DIST. %		°API
205 °F.		
400	72.6	57.8
400-550	18.3	35.7
550+	9.1	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	108	
10%	150	
50%	240	
90%	358	
EP	402	
	98.0	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	1864
Fresh Catalyst Added 50=	76
Total	1940
Catalyst Recovered	3
In Reactor at End of Period	1937
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	58
2 43.2 - 74.4	63
3 74.4 - 105.6	64
4 105.6 - 342.0	225
(Calc) 0-12"	24
total	434
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	123
Inventory, Lbs.	1489
Bed Depth, Ft.	18.16
Volume, Cu Ft	11.99

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	13.6	80+	
100	150	72.1	40—80	
150	105	9.7	20—40	
200	74	3.6	10—20	
250	62	0.4	0—20	
325	44	0.4		
<325		0.2		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	144
Settled	146
Compacted	157
Particle Density, gm./cc.	4.1
NH_3 Value, ml./gm.	25.33
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

HOUR	0900			AVERAGE
FRESH FEED				
CO 28.010	37.71			
H_2 2.016	58.35			
CO_2 44.010	2.48			
N_2 28.016	1.18			
CH_4 16.042	0.28			
		M. W.	13.2059	

GENERATOR BALANCE

	M/HR	C	H	O
CO	10.626	10.626		10.626
H_2	16.441		32.882	
CO_2	0.699	0.699		1.398
N_2	0.332			
CH_4	0.079	0.079	0.316	
H_2O 18.016			6.517	3.259
		11.404	39.715	15.283
BALANCE		103.19	99.20	101.06

	Mol %	M/Hr	C	H	O
O_2 32.000	0.47	0.045 7.356			14.802
CO 28.010					
H_2 2.016					
CO_2 44.010	1.58	0.160	0.160		0.320
N_2 28.016	2.15	0.205			
CH_4 16.042	82.11	7.830	7.830	31.320	
C_2H_6 30.068	8.85	0.844	1.688	5.064	
C_3H_8 44.094	4.65	0.443	1.329	3.544	
C_4H_{10} 58.120	0.06 0.04	0.006 0.004	0.024 0.020	0.06 0.048	
TOTAL			11.051	40.036	15.122

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance	
WET GAS	117.01	146.39	187.16
OIL	44.30	44.30	56.80
WATER	100.23	100.23	128.14
TOTAL	261.54	290.92	372.10
FRESH FEED	372.10	372.10	372.10
WEIGHT BALANCE	70.29		
WET GAS FACTOR			
INDICATED LOSS—S C F H		500	

WET GAS	
CO 28.010	13.30
H_2 2.016	40.78
CO_2 44.010	26.38
N_2 28.016	2.17
CH_4 16.042	7.38
C_2H_4 28.052	2.45
C_2H_6 30.068	1.10
C_3H_6 42.078	2.92
C_3H_8 44.094	0.43
C_4H_8 56.104	1.73
C_4H_{10} 58.120	0.45
C_5H_{10} 70.130	0.63
C_5H_{12} 72.146	0.13
C_6H_{12} 84.156	0.15
M. W.	22.2794

GAS FLOW RATES

		$\sqrt{h}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	4.590	402.2 20.4188	91.7 0.9706	10682	1.4806	28.177
WET GAS	50.54	8.78	1.292 4.0027	72.2 0.9887	1991	1.1340	5.252
RECYCLE	115.14	3.844	402.3 20.4213	126.7 0.9412	9647	1.1340	25.447
BLEED	5.02	8.786	402.3 20.4213	126.7 0.9412	961	1.1340	2.535
NATURAL GAS	28.43	5.679	414.8 20.7251	201.7 0.8663	2966 3615	1.2188	27.982 9.536
OXYGEN	27.07	5.001	433.8 21.1785	88.8 0.9732	2790		7.356
STEAM	215.7	5.20	33.0 0.3029		340.6#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	3'10½	206.37	74	0.9930	204.925	51.7		
	2'11	156.54	58	1.0010	156.697	6.430	310.11	44.30
					48.228			
								6.890
WATER	6'1	323.12	76	0.99819	322.535	10.7		
	4'5½	238.01	66	0.99942	237.872	8.287	701.60	100.23
					84.663			12.095

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 22-G

HOURS 144-168

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					% Unsats.
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	
CO 28.010	34.5	5.598	156.74	2.63	0.101	2.84	0.600	6.198	0.701	- 5.497						%	gph	#/hr	%	gph	
H_2 2.016	59.5	9.656	19.31	40.63	1.565	3.12	9.273	18.929	10.838	- 8.091					400	70.3	4.158		98.0	4.075	
CO_2 44.010	2.4	0.389	17.12	21.00	0.809	35.59	4.793	5.182	5.602	0.420	18.47	3.195			400/550	17.0	1.005		91.4	0.919	
N_2 28.016	2.9	0.146	4.09	3.70	0.142	3.98	0.844	0.990	0.986						550+	12.7	0.751		114.6	0.861	
CH_4 16.042	2.7	0.438	7.01	15.81	0.608	9.73	3.606	4.044	4.214	0.230	2.72	0.470									
C_2H_4 28.052				5.30	0.204	5.70	1.210	1.210	1.414	0.204	5.70	0.986			C3	59.1		4.37			
C_2H_6 30.068				2.39	0.092	2.76	0.545	0.545	0.637	0.092	2.76	0.477			C3Poly			3.82		0.639	
C_1+C_2											11.18	1.934			Tar			0.55		0.073	
C_3H_6 42.078				4.59	0.176	7.40	1.048	1.048	1.224	0.176	7.40	1.280	4.32	1.713	0.296			6.25			
C_3H_8 44.094				0.71	0.027	1.21	0.162	0.162	0.189	0.027	1.21	0.209	4.24	0.285	0.049	C4H8			0.246	68.0	
C_4H_8 56.104				2.31	0.089	4.98	0.527	0.527	0.616	0.089	4.98	0.861	5.00	0.996	0.172	C4Poly		6.10	0.549	1.5	
C_4H_{10} 58.120				0.43	0.016	0.94	0.098	0.098	0.114	0.016	0.94	0.162	4.86	0.193	0.033	C4H10		4.86	0.193	68.0	
C_5H_{10} 70.130				0.50	0.019	1.30	0.114	0.114	0.133	0.019	1.30	0.225	5.45	0.239	0.041	C4Free Gaso		5.45	4.953	5.8	
C_5H_{12} 72.146													5.25			C4Poly Tar		5.25	0.062		
C_6H_{12} 84.156													5.54					5.54			
C_3-C_6											15.83	2.738		3.426	0.593						
TOTAL		16.227	204.27		3.848	79.55	22.823	39.075	31.470								gal/hr.		gal/MCF	BPD	
H_2+CO		15.254	5781.3 C.F.H.		1.666		9.873	25.127	11.539	-13.588						Gasoline	5.941		1.0276	5571	
H_2/CO		1.72	1729715		15.5		15.5	3.05	15.5	1.47						Diesel	0.919		0.1590	862	

CUMULATIVE TOTALS

	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 20.1 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.273*	38.30	6.625	6.476	5.914	1.023	Waxy Btms	0.861	0.1489	807
TOTAL OIL		54.13	9.363		9.340	1.616	Poly Tar	0.135	0.0234	127
WATER SOLUBLE CHEMICALS	0.225*	11.92	2.062		1.515	0.262	Total	7.856	1.3589	7367
TOTAL LIQUID PRODUCTS C_3+		66.03	11.421		10.855	1.878	WSChem	1.515	0.2620	1420
NET WATER	4.301	77.48	13.402	8.328	9.303					
GROSS WATER		89.40	15.464	8.264	10.818					
HYDROCARBON TOTAL—C_1+		77.21	13.355							

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
76.29	98.20	83.79	89.08	88.69	42.74	54.08	85.52

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.

cc/M3 = 141.3 × gal/MCF.

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

46-1
RUN NO. 46 F/I
HOURS 108-204
168

	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	35.796	15.680	439.20	20.763	4.924	137.92	10.238	25.918	15.162	10.756	
H_2 2.016	60.159	26.353	53.13	53.055	12.584	25.37	26.162	52.515	38.746	13.769	
CO_2 44.010	2.360	1.034	45.51	16.328	3.873	170.45	8.052	9.086	11.925	2.839	124.94
N_2 28.016	0.491	0.215	6.02	0.800	0.190	5.32	0.394	0.609	0.584		
CH_4 16.042	1.194	0.523	8.39	5.003	1.187	19.04	2.467	2.990	3.654	0.664	10.65
C_2H_4 28.052				0.922	0.219	6.14	0.455	0.455	0.674	0.219	6.14
C_2H_6 30.068				0.428	0.102	3.07	0.211	0.211	0.313	0.102	3.07
C_1+C_2											19.86
C_3H_6 42.078				1.145	0.272	11.44	0.565	0.565	0.837	0.272	11.44
C_3H_8 44.094				0.275	0.065	2.87	0.136	0.136	0.201	0.065	2.87
C_4H_8 56.104				0.708	0.168	9.43	0.349	0.349	0.517	0.168	9.43
C_4H_{10} 58.120				0.195	0.046	2.67	0.096	0.096	0.142	0.046	2.67
C_5H_{10} 70.130				0.305	0.072	5.05	0.150	0.150	0.222	0.072	5.05
C_5H_{12} 72.146											
C_6H_{12} 84.156				0.073	0.017	1.43	0.036	0.036	0.043	0.017	1.43
C_3-C_6											32.89
TOTAL		43.805	552.25		23.718	400.20	49.311	93.116	78.853		
H_2+CO		42.033	15930.5 S.C.F.H.	73.818	17.508		36.400	78.433	53.908	24.525	
H_2/CO		1.68	627727		2.56			2.03		1.28	

YIELD BASIS H_2+CO FED

	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO					%	gph	#/hr.	%	gph	#/hr.
H_2				400	67.6	4.933		98.0	4.834	
CO_2	7.843			400/550	16.0	1.168		91.4	1.068	
N_2				550+	16.4	1.197		114.6	1.372	
CH_4	0.669					7.298				
C_2H_4	0.385			C_3			11.44	26.0		2.97
C_2H_6	0.193			Poly Gaso	87.5				0.435	2.60
C_1+C_2	1.247			Poly Tar	12.5				0.049	0.37
C_3H_6	0.718	4.32	2.648	0.166		Balance	6.25 for	10# RVP		
C_3H_8	0.180	4.24	0.677	0.042	C_4H_8			0.108	68.0	7.344
C_4H_8	0.592	5.00	1.886	0.118	C_4 Poly		6.10	1.301	1.5	1.951
C_4H_{10}	0.168	4.86	0.549	0.034	C_4H_{10}		4.86	0.549	68.0	37.332
C_5H_{10}	0.317	5.45	0.927	0.058	C_4 Free Gaso		5.45	6.454	5.8	37.433
C_5H_{12}		5.25					5.25	8.412		84.060
C_6H_{12}	0.090	5.54	0.258	0.016	C4 Poly Tar		5.54	0.147		
C_3-C_6	2.065		6.945	0.436						
TOTAL						gal/hr.		gal/MCF*	Bbl/Day	
H_2+CO					Gasoline		8.412	0.5281	2863	
H_2/CO					Diesel		1.068	0.0670	363	

	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF*	Bbl/Day
RECOVERED OIL	0.3367	47.22	2.964	6.470	7.298	0.458	Waxy Bottoms	1.372	0.0861	467
TOTAL OIL		80.11	5.029		14.243	0.894	Poly Tar	0.196	0.0123	67
WATER SOLUBLE CHEMICALS	0.219	11.64	0.731	8.484	1.372	0.086	Total	11.048	0.6935	3760
TOTAL LIQUID PRODUCTS C_3+		91.75	5.759		15.615	0.980	Water Soluble Chemicals	1.372	0.0861	467
NET WATER	5.268	94.91	5.958	8.321	11.406		Total	12.420	0.7796	4227
GROSS WATER		106.55	6.688		12.778					
HYDROCARBON TOTAL—C_1+		114.61	7.194							

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 5.78

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	$CO+H_2$	SELECTIVITY C_3+/C_1+
45.86	68.60	54.31	58.35	41.50	26.22	31.27	80.05

Form ML-11

*9488 MCFH H_2 + CO

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

DATA SUMMARY

HOURS 108-204
168

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen		Fresh Feed	16602
Natural Gas		Recycle	18689
Generator Outlet	428	Combined Feed	35291
Reactor Inlet	420	Wet Gas—Measured	
Condenser Inlet		Adjusted	8989
Product Accumulator		Loss	
TEMPERATURES—°F.		Recycle/Fresh Feed	1.12
Oxygen		Inlet Velocity—ft./sec.	1.07
Natural Gas		Fresh Feed Rate—S.C.F.H. H_2+CO	15931
Generator		per Cu.Ft. Dense Bed	2825
Quench Accumulator		per Lb. Catalyst	23.12
Reactor Inlet	252	per square foot	24138
Condenser Inlet			
Product Accumulator	70		
Catalyst No. Height			
1	631		
2	631		
3	656		
4	660		
5			
6			

PRODUCT TESTS

	OIL	WATER
°API	50.6	10.7
Neut. No.	37.7	39.5
Sap. No.	42.3	42.4
Hydrox. No.		
Bromine No.	83	
Pour °F.		
Chemicals, % by K_2CO_3		10.88
HEMPEL, DIST. %		
205 °F.		
400	66.6	°API 56.5
400-550	16.0	41.7
550+	17.4	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	107	
10%	148	
50%	249	
90%	358	
EP	402	
Rec.	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	
Total	
Catalyst Recovered	
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height	
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	122
Inventory, Lbs.	689
Bed Depth, Ft.	8.55
Volume, Cu. Ft.	5.64

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	16.5	80+	
100	150	65.8	40—80	
150	105	8.5	20—40	
200	74	4.0	10—20	
250	62	1.0	0—20	
325	44	0.6		
<325		3.6		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	141
Settled	143
Compacted	
Particle Density, gm./cc.	4.1
NH_3 Value, ml./gm.	6.3
N_2 Surface, m^2/gm.	
CHEMICAL ANALYSIS	
Fe	65.5
C	9.7
O	
H	0.63
K_2O, W+, % basis Fe	0.18
X-Ray Analysis—	
$Fe_{20}C_9$	30
Fe_3O_4	65
Fe	5

46-2
RUN NO. 46 J/P
HOURS 204-369
183

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

	FRESH FEED			WET GAS	At. Wt. Balance		RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED: CONDENSATE				POLYMER					% Unsats.
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	
CO 28.010	35.806	15.964	447.15	17.968	3.945	110.50	8.377	24.341	12.322	12.019	336.65					%	gph	#/hr.	%	gph	
H_2 2.016	59.508	26.531	53.49	50.509	11.089	22.36	23.547	50.078	34.636	15.442	31.13				400	71.2	6.145		98.0	6.022	
CO_2 44.010	2.228	0.993	43.70	18.258	4.008	176.39	8.512	9.505	12.518	3.015	132.69	8.239			400/550	16.9	1.458		91.4	1.333	
N_2 28.016	0.353	0.157	4.40	0.844	0.185	5.18	0.393	0.550	0.578						550+	11.9	1.027		114.6	1.177	
CH_4 16.042	2.105	0.939	15.06	7.560	1.660	26.63	3.524	4.463	5.184	0.721	11.57	0.718					8.630				
C_2H_4 28.052				1.257	0.276	7.74	0.586	0.586	0.862	0.276	7.74	0.481			C_3	29.0		3.56			72.6
C_2H_6 30.068				0.474	0.104	3.13	0.221	0.221	0.325	0.104	3.13	0.194			Poly Gaso			3.12		0.521	
C_1+C_2											22.44	1.393			Poly Tar			0.44		0.058	
C_3H_6 42.078				1.328	0.292	12.29	0.619	0.619	0.911	0.292	12.29	0.763	4.32	2.845	0.177			6.25		RVP	81.4
C_3H_8 44.094				0.303	0.066	2.91	0.141	0.141	0.207	0.066	2.91	0.181	4.24	0.686	0.043	C_4H_8			0.240	68.0	
C_4H_8 56.104				0.840	0.184	10.32	0.392	0.392	0.576	0.184	10.32	0.641	5.00	2.064	0.128	C_4 Poly		6.10	1.334	1.5	80.8
C_4H_{10} 58.120				0.200	0.044	2.56	0.093	0.093	0.137	0.044	2.56	0.159	4,86	0.527	0.033	C_4H_{10}		4.86	0.527	68.0	
C_5H_{10} 70.130				0.353	0.078	5.47	0.164	0.164	0.242	0.078	5.47	0.340	5.45	1.004	0.062	C_4 Free Gaso		5.45	7.887	5.8	92.2
C_5H_{12} 72.146				0.030	0.006	0.43	0.014	0.014	0.020	0.006	0.43	0.027	5.25	0.082	0.005	C_4 Poly Tar		5.25	0.151		
C_6H_{12} 84.156				0.077	0.017	1.43	0.036	0.036	0.053	0.017	1.43	0.089	5.54	0.258	0.016			5.54			
C_3-C_6											35.41	2.199		7.466	0.464						
TOTAL		44.584	563.80		21.954	387.34	46.620	91.204	75.210												
H_2+CO		42.495	16,105.6 S.C.F.H. 68.477		15.034		31.924	74.419	46.958	27.461											
H_2/CO		1.66	620902		2.81		2.81	2.06	2.81	1.28											

EFFLUENT		m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF
EFFLUENT	RECOVERED OIL	0.400	56.08	3.482	6.498	8.630	0.536
SHIFT RATIO	TOTAL OIL		91.49	5.681		16.096	0.999
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 5.86	WATER SOLUBLE CHEMICALS	0.236	12.54	0.779	8.00	1.567	0.097
	TOTAL LIQUID PRODUCTS C_3+		104.03	6.459		17.663	1.097
	NET WATER	6.000	108.09	6.711	8.328	12.979	
	GROSS WATER		120.63	7.490	8.293	14.546	
	HYDROCARBON TOTAL—C_1+		126.47	7.853			

	gal/hr.	gal/MCF	Bbl/D
Gasoline	9.988	0.6201	3362
Diesel	1.333	0.0828	449
Waxy Bottom	1.177	0.0731	396
Poly Tar	0.209	0.0130	71
Total	12.707	0.7890	4278
Water Soluble Chemicals	1.567	0.0973	527
Total	14.274	0.8863	4805

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
50.76	75.29	58.20	64.62	49.38	30.84	36.90	82.26

Form ML-11

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

DATA SUMMARY

HOURS 204-369
183

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen		Fresh Feed	16897
Natural Gas		Recycle	17669
Generator Outlet	431	Combined Feed	34566
Reactor Inlet		Wet Gas—Measured	
Condenser Inlet		Adjusted	8320
Product Accumulator		Loss	
TEMPERATURES—°F.		Recycle/Fresh Feed	1.04
Oxygen		Inlet Velocity—ft./sec.	1.05
Natural Gas		Fresh Feed Rate—S.C.F.H. H_2+CO	16106
Generator		per Cu.Ft. Dense Bed	2314
Quench Accumulator		per Lb. Catalyst	17.6
Reactor Inlet	217	per square foot	24403
Condenser Inlet			
Product Accumulator	70		
Catalyst No. Height			
1	633		
2	633		
3	664		
4	651		
5			
6			

PRODUCT TESTS

	OIL	WATER
°API	49.8	10.6
Neut. No.	42.3	41.9
Sap. No.	47.5	43.7
Hydrox. No.		
Bromine No.	86	
Pour °F.	[illegible]	
Chemicals, % by K_2CO_3		10.43
HEMPEL DIST. %		
205 °F.		
400	70.2	55.9
400-550	16.9	39.9
550+	12.9	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP		
10%		
50%		
90%		
EP		

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	560
Total	
Catalyst Recovered	
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height	
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	131
Inventory, Lbs.	915
Bed Depth, Ft.	10.55
Volume, Cu. Ft.	6.96

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.	7.8
N_2 Surface, m^2/gm.	<1 m^2/g.
CHEMICAL ANALYSIS	
Fe	68.9
C	6.45
Ext. O:1	1.9
H	0.22
K_2O, W+, % basis Fe	0.29
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

46-3
RUN NO. 46 Q/W
HOURS 369-537
162

	FRESH FEED			WET GAS	At. Wt. Balance		RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED: CONDENSATE				POLYMER					% Unsats.
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	
CO 28.010	35.798	15.510	434.44	17.636	3.499	98.01	8.001	23.511	11.500	-12.011	-336.43					%	gph	#/hr.	%	gph	#/hr
H_2 2.016	60.365	26.155	52.73	50.635	10.045	20.25	22.973	49.128	33.018	-16.110	- 32.48				400	73.3	6.591		98.0	6.459	
CO_2 44.010	2.281	0.988	43.48	19.465	3.862	169.97	8.831	9.819	12.693	2.874	126.49	8.010			400/550	16.1	1.448		91.4	1.323	
N_2 28.016	0.450	0.195	5.46	0.777	0.154	4.31	0.353	0.548	0.507						550+	10.6	0.953		114.6	1.092	
CH_4 16.042	1.106	0.479	7.68	6.215	1.233	19.78	2.820	3.299	4.053	0.754	12.10	0.766					8.992				
C_2H_4 28.052				1.424	0.282	7.91	0.646	0.646	0.928	0.282	7.91	0.501			C3	31.3		3.82			
C_2H_6 30.068				0.541	0.107	3.22	0.245	0.245	0.352	0.107	3.22	0.204			Poly Gaso			3.34		0.559	
C_1+C_2											23.23	1.471			Poly Tar			0.48		0.064	
C_3H_6 42.078				1.459	0.290	12.20	0.662	0.662	0.952	0.290	12.20	0.773	4.32	2.824	0.179			6.25		RVP	86.2
C_3H_8 44.094				0.234	0.046	2.03	0.106	0.106	0.152	0.046	2.03	0.129	4.24	0.479	0.030	C4H8			0.298	58.0	
C_4H_8 56.104				0.912	0.181	10.15	0.414	0.414	0.595	0.181	10.15	0.643	5.00	2.030	0.129	C4 Poly		6.10	1.267	1.5	81.4
C_4H_{10} 58.120				0.208	0.041	2.38	0.094	0.094	0.135	0.041	2.38	0.151	4.86	0.490	0.031	C4H10		4.86	0.490	68.0	
C_5H_{10} 70.130				0.379	0.075	5.26	0.172	0.172	0.247	0.075	5.26	0.333	5.45	0.965	0.061	C4Free Gaso		5.45	8.320	5.8	89.8
C_5H_{12} 72.146				0.043	0.009	0.65	0.020	0.020	0.029	0.009	0.65	0.041	5.25	0.124	0.008	C4Poly Tar		5.25	0.143		
C_6H_{12} 84.156				0.072	0.014	1.18	0.033	0.033	0.047	0.014	1.18	0.075	5.54	0.213	0.013			5.54			
C_3-C_6											33.85	2.144		7.125	0.451						
TOTAL		43.327	543.79		19.838	357.30	45.370	88.697	72.215									gal/hr.	gal/MCF		BPD
H_2+CO		41.665	15791 S.C.F.H.		13.544		30.974	72.639	44.518	28.121						Gasoline		10.375	0.6570		3562
H_2/CO		1.69	6332721		2.87		2.87	2.09	2.87	1.34						Diesel		1.323	0.0838		454

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO

$$5.74 \quad \frac{(H_2)(CO_2)}{(H_2O)(CO)}$$

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal/hr	gal/MCF	BPD
RECOVERED OIL	0.417*	58.43	3.700	6.498	8.992	0.569	Waxy Bottms	1.092	0.0692	375
TOTAL OIL		92.28	5.844		16.117	1.020	Poly Tar	0.207	0.0131	71
WATER SOLUBLE CHEMICALS	0.237*	12.57	0.796	7.99	1.574	0.100	Total	12.997	0.8231	4462
TOTAL LIQUID PRODUCTS C_3+		104.85	6.640		17.691	1.120	WS Chem.	1.574	0.0997	541
NET WATER	6.353*	114.45	7.248	8.328	13.743		Total	14.571	0.9228	5003
GROSS WATER		127.02	8.044	8.293	15.317					
HYDROCARBON TOTAL—C_1+		128.08	8.111							

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
54.21	77.44	61.60	67.49	51.09	32.79	38.71	81.86

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

DATA SUMMARY

HOURS 369-537
162

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen		Fresh Feed	16421
Natural Gas		Recycle	17195
Generator Outlet		Combined Feed	33616
Reactor Inlet	417	Wet Gas—Measured	
Condenser Inlet		Adjusted	7519
Product Accumulator		Loss	
TEMPERATURES—°F.		Recycle/Fresh Feed	1.05
Oxygen		Inlet Velocity—ft./sec.	1.05
Natural Gas		Fresh Feed Rate—S.C.F.H. H2 + CO	15791
Generator		per Cu.Ft. Dense Bed	2178
Quench Accumulator		per Lb. Catalyst	15.81
Reactor Inlet	212	per sq. ft.	23926
Condenser Inlet			
Product Accumulator			
Catalyst No. Height			
1	636		
2	632		
3	659		
4	640		
5			
6			

PRODUCT TESTS

	OIL	WATER
°API	49.8	10.6
Neut. No.	44.9	43.5
Sap. No.	48.4	43.9
Hydrox. No.		
Bromine No.	85	
Pour °F.		
Chemicals, % by K_2CO_3		9.8
HEMPEL, DIST. %		
205 °F.		°API
400	72.3	56.0
400-550	16.1	38.7
550+	11.6	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	104	
10%	140	
50%	242	
90%	359	
EP	406	
Recovered	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	1152
Total	
Catalyst Recovered	
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height	
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	138
Inventory, Lbs.	999
Bed Depth, Ft.	10.99
Vol., cu. ft.	7.25

PARTICLE SIZE

Screen Analysis: Mesh	Microns	%	Sedimentation: Microns	%
On 40	419+	15.8	80+	
100	150	63.6	40—80	
150	105	11.5	20—40	
200	74	6.0	10—20	
250	62		0—20	
325	44			
<325				

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	149
Settled	151
Compacted	169
Particle Density, gm./cc.	4.6
NH_3 Value, ml./gm.	7.4
N_2 Surface, m²/gm.	1
CHEMICAL ANALYSIS	
Fe	71.3
C	6.2
Ext. O: 1	0.9
H	0.3
K_2O, W+, % basis Fe	0.32
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

'N NO. 48 E/H
HOURS 95-190 / 137

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					% Unsats.
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	
CO 28.010	35.970	15.678	439.14	15.133	2.977	83.39	6.884	22.562	9.861	-12.701	-355.75					%	gph	#/hr	%	gph	
H_2 2.016	60.385	26.318	53.06	50.405	9.915	19.99	22.930	49.248	32.845	-16.403	- 33.07				400	74.5	7.178		98.0	7.034	
CO_2 44.010	2.718	1.185	52.15	22.618	4.449	195.80	10.289	11.474	14.738	3.264	143.65	9.023			400/550	15.0	1.445		91.4	1.321	
N_2 28.016	0.725	0.316	8.85	1.332	0.262	7.34	0.606	0.922	0.868						550+	10.5	1.012		114.6	1.160	
CH_4 16.042	0.202	0.088	1.41	4.842	0.952	15.27	2.203	2.291	3.155	0.864	13.86	0.871					9.635				
C_2H_4 28.052				1.455	0.286	8.02	0.662	0.662	0.948	0.286	8.02	0.504			C_3	31.7		3.76			71.2
C_2H_6 30.068				0.588	0.116	3.49	0.267	0.267	0.383	0.116	3.49	0.219						3.29		0.550	
C_1+C_2											25.37	1.594						0.47		0.062	
C_3H_6 42.078				1.435	0.282	11.87	0.653	0.653	0.935	0.282	11.87	0.746	4.32	2.748	0.173			6.25			77.9
C_3H_8 44.094				0.408	0.080	3.53	0.186	0.186	0.266	0.080	3.53	0.222	4.24	0.833	0.052	C_4H_8			0.212	68.0	
C_4H_8 56.104				0.937	0.184	10.32	0.426	0.426	0.610	0.184	10.32	0.648	5.00	2.064	0.130	C_4 Poly		6.10	1.355	1.5	77.3
C_4H_{10} 58.120				0.275	0.054	3.14	0.125	0.125	0.179	0.054	3.14	0.197	4,86	0.646	0.040	C_4H_{10}		4.86	0.646	68.0	
C_5H_{10} 70.130				0.452	0.089	6.24	0.206	0.206	0.295	0.089	6.24	0.392	5.45	1.145	0.072	C_4Free Gaso		5.45	9.094	5.8	
C_5H_{12} 72.146													5.25			C_4Poly Tar		5.25	0.154		
C_6H_{12} 84.156				0.120	0.024	2.02	0.055	0.055	0.079	0.024	2.02	0.127	5.54	0.365	0.023			5.54			
C_3-C_6											37.12	2.332		7.801	0.490						
TOTAL		43.585	554.61		19.670	370.42	45.492	89.077	71.773								gal./hr.	gal/MCF			BPD
H_2+CO		41.996	15920.7 S.C.F.H.		12.892		29.814	71.810	42.706	-29.104						Gasoline	11.307	0.710			3849
H_2/CO		1.68			3.33		3.33	2.18	3.33	1.29						Diesel	1.321	0.083			450

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 8.39

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal./hr.	gal/MCF	BPD
RECOVERED OIL	0.446*	62.50	3.926	6.487	9.635	0.605	Waxy Btms	1.160	0.073	396
TOTAL OIL		99.62	6.257		17.436	1.095	Poly Tar	0.216	0.014	76
WATER SOLUBLE CHEMICALS	0.236*	12.52	0.787		1.583	0.100	Total	14.004	0.880	4771
TOTAL LIQUID PRODUCTS C_3+		112.14	7.044		19.019	1.195	WS Chem	1.583	0.099	537
NET WATER	5.929*	106.82	6.710	8.328	12.827		Total	15.587	0.979	5308
GROSS WATER		119.34	7.496	8.282	14.410					
HYDROCARBON TOTAL—C_1+		137.51	8.637							

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
54.87	81.01	62.33	69.30	56.29	33.31	40.53	81.55

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

DATA SUMMARY

HOURS 95-190 / 137

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen		Fresh Feed	16523
Natural Gas		Recycle	17246
Generator Outlet		Combined Feed	33769
Reactor Inlet		Wet Gas—Measured	
Condenser Inlet		Adjusted	7457
Product Accumulator	375	Loss	
TEMPERATURES—°F.		Recycle/Fresh Feed	1.04
Oxygen		Inlet Velocity—ft./sec.	1.08
Natural Gas		Fresh Feed Rate—S.C.F.H. H_2 + CO	15921
Generator		per Cu.Ft. Dense Bed	2143
Quench Accumulator		per Lb. Catalyst	15.61
Reactor Inlet	177	per sq. ft.	24123
Condenser Inlet			
Product Accumulator			
Catalyst No. Height			
1	659		
2	646		
3	673		
4	638		
5	653		
6			

PRODUCT TESTS

	OIL	WATER
°API	50.1	10.8
Neut. No.	37.1	37.0
Sap. No.	41.6	37.0
Hydrox. No.		
Bromine No.	82	
Pour °F.		
Chemicals, % by K_2CO_3		10.4
HEMPEL, DIST. %		
205 °F.		°API
400	73.5	55.2
400-550	15.0	37.4
550+	11.5	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	111	
10%	148	
50%	240	
90%	353	
EP	404	
Recovered	97.4	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	80
Total	
Catalyst Recovered	
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height	
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	137
Inventory, Lbs.	1020
Bed Depth, Ft.	11.25
Vol., cu. ft.	7.43

PARTICLE SIZE				
Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	15.1	80+	
100	150	68.1	40—80	
150	105	10.1	20—40	
200	74	4.7	10—20	
250	62	0.6	0—20	
325	44	0.5		
<325		0.9		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	147
Settled	149
Compacted	163
Particle Density, gm./cc.	4.39
NH_3 Value, ml./gm.	5.7
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	

49-1
RUN NO. 49 F/P
HOURS 104-341
192

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	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.751	14.950	418.75	13.691	2.060	57.70	5.659	20.609	7.719	-12.890	-361.05					%	gph	#/hr	%	gph	
H_2 2.016	59.529	24.216	48.82	43.537	6.551	13.21	17.820	42.036	24.371	-17.665	- 35.61				400	74.3	7.874		98.0	7.717	
CO_2 44.010	2.677	1.089	47.93	25.926	3.901	171.68	10.608	11.697	14.509	2.812	123.76	8.326			400/550	17.8	1.887		91.4	1.725	
N_2 28.016	0.831	0.338	9.47	2.166	0.326	9.13	0.885	1.223	1.219						550+	7.9	0.837		114.6	0.959	
CH_4 16.042	0.212	0.086	1.38	6.327	0.952	15.27	2.655	2.741	3.607	0.866	13.89	0.934					10.598				
C_2H_4 28.052				2.186	0.329	9.23	0.895	0.895	1.224	0.329	9.23	0.621			C3	38.5		5.20			72.8
C_2H_6 30.068				0.817	0.123	3.70	0.335	0.335	0.458	0.123	3.76	0.249			C3Poly			4.55		0.761	
C_1+C_2											26.82	1.804			Tar			0.65		0.086	
C_3H_6 42.078				2.133	0.321	13.51	0.876	0.876	1.197	0.321	13.51	0.909	4.32	3.127	0.210			6.25			83.2
C_3H_8 44.094				0.432	0.065	2.87	0.161	0.161	0.226	0.065	2.87	0.193	4.24	0.677	0.046	C4H8			0.186	68.0	
C_4H_8 56.104				1.409	0.212	11.89	0.576	0.576	0.788	0.212	11.89	0.800	5.00	2.378	0.160	C4Poly		6.10	1.604	1.5	76.0
C_4H_{10} 58.120				0.445	0.067	3.89	0.183	0.183	0.250	0.067	3.89	0.262	4.86	0.800	0.054	C4H10		4.86	0.800	68.0	
C_5H_{10} 70.130				0.651	0.098	6.87	0.268	0.268	0.366	0.098	6.87	0.462	5.45	1.261	0.085	C4Free	Gaso	5.45	10.352	5.8	84.4
C_5H_{12} 72.146				0.120	0.018	1.30	0.048	0.048	0.066	0.018	1.30	0.087	5.25	0.248	0.017	C4Poly	Tar	5.25	0.182		
C_6H_{12} 84.156				0.160	0.024	2.02	0.064	0.064	0.088	0.024	2.02	0.136	5.54	0.365	0.024			5.54			
C_3-C_6											42.35	2.849		8.856	0.596						
TOTAL		40.679	526.34		15.047	322.28	41.033	81.712	63.599								gal/hr.	gal/MCF	BPD		
H_2+CO		39.166	14863.5 S.C.F.H.		8.611		23.479	62.645	32.090	-30.555						Gasoline	12.942	0.871	4721		
H_2/CO		1.62			3.18		3.18	2.04	3.18	1.37						Diesel	1.725	0.116	629		

	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.493*	69.10	4.649	6.52	10.598	0.713	WaxyBtms	0.959	0.064	350
TOTAL OIL		111.45	7.498		19.454	1.309	Poly Tar	0.268	0.018	98
WATER SOLUBLE CHEMICALS	0.244*	12.94	0.871	8.03	1.612	0.108	Total	15.894	1.069	5797
TOTAL LIQUID PRODUCTS C_3+		124.39	8.369		21.066	1.357	WS Chem	1.612	0.109	588
NET WATER	6.782*	122.19	8.221				Total	17.506	1.178	6386
GROSS WATER		135.13	9.091							
HYDROCARBON TOTAL—C_1+		151.21	10.173							

CUMULATIVE TOTALS

	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 6.75 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
63.01	86.22	72.95	78.01	62.55	42.02	48.77	82.26

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

HOURS 104-341
192

DATA SUMMARY

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen		Fresh Feed	15438
Natural Gas		Recycle	15572
Generator Outlet		Combined Feed	31010
Reactor Inlet	381	Wet Gas—Measured	
Condenser Inlet		Adjusted	5710
Product Accumulator	362	Loss	
TEMPERATURES—°F.		Recycle/Fresh Feed	1.01
Oxygen		Inlet Velocity—ft./sec.	1.04
Natural Gas		Fresh Feed Rate—S.C.F.H.	14864
Generator		per Cu.Ft. Dense Bed	1072
Quench Accumulator		per Lb. Catalyst	8.75
Reactor Inlet	286		
Condenser Inlet			
Product Accumulator	70		
Catalyst No. Height			
1 12"	721		
2 43.2"	643		
3 74.4"	661		
4			
5 136.8"	657		
6 168.0"	652		
7 199.2"	643	Avg. Bed Temp., °F.	659
8 230.4"	637	dT, °F.	146
9 261.6"	630	K, BTU/hr/sq.ft/°F.	83.0
10 292.8"	629		
12 342.0"	620		

PRODUCT TESTS

	OIL	WATER
° API	49.6	10.6
Neut. No.	39.7	38.1
Sap. No.	46.3	41.2
Hydrox. No.		
Bromine No.	86	
Pour °F.		
Chemicals, % by K_2CO_3		9.9
HEMPEL, DIST. %		°API
205 °F.		
400	73.3	55.4
400-550	17.8	35.9
550+	8.9	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	104	
10%	140	
50%	235	
90%	352	
EP	404	
Recovered	97.5	

CATALYST DATA

INVENTORY DATA		PARTICLE SIZE Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
In Reactor at Start of Period						
Fresh Catalyst Added	616					
Total		On 40	419+	13.8	80+	
Catalyst Recovered		100	150	66.3	40—80	
In Reactor at End of Period		150	105	9.6	20—40	
		200	74	5.0	10—20	
REACTOR d-p, Inches H_2O		250	62	1.2	0—20	
No. Height		325	44	1.3		
		<325		2.8		

		CATALYST	
		Bulk Density, Lbs./Cu.Ft.	
		Aerated	143
		Settled	145
		Compacted	161
		Particle Density, gm./cc.	4.3
CALCULATED FROM dp		NH_3 Value, ml./gm.	15.0
Density, Lbs./Cu.Ft.	121	N_2 Surface, m^2/gm.	1
Inventory, Lbs.	1698		
Bed Depth, Ft.	21.01	CHEMICAL ANALYSIS at 200 hrs.	
Vol., cu. ft.	13.87	Fe	66.6
		C	8.2
		O	
		H	0.5
		K_2O, W+, % basis Fe	0.50
		X-Ray Analysis—	
		$Fe_{20}C_9$	40
		Fe_3O_4	55
		Fe	5

49-2
RUN NO. 49 Q/W
HOURS 341-497
298

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	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.655	15.348	429.90	15.773	2.494	69.86	9.717	25.065	12.211	-12.854						%	gph	#/hr	%	gph	
H_2 2.016	59.331	24.843	50.08	44.220	6.992	14.10	27.257	52.100	34.249	-17.851					400	73.5	8.120		98.0	7.958	
CO_2 44.010	2.744	1.149	50.57	24.109	3.812	167.77	14.863	16.012	18.675	2.663	117.20	7.684			400/550	17.5	1.933		91.4	1.768	
N_2 28.016	0.967	0.405	11.35	2.326	0.367	10.28	1.430	1.835	1.797						550+	9.0	0.994		114.6	1.139	
CH_4 16.042	0.303	0.127	2.04	5.863	0.927	14.87	3.615	3.742	4.542	0.800	12.83	0.841					11.047				
C_2H_4 28.052				2.100	0.332	9.31	1.295	1.295	1.627	0.332	9.31	0.610			C3	38.0		5.36			72.0
C_2H_6 30.068				0.816	0.129	3.88	0.505	0.505	0.634	0.129	3.88	0.254			C3Poly			4.69		0.784	
C_1+C_2											26.02	1.706			Tar			0.67		0.089	
C_3H_6 42.078				2.119	0.335	14.10	1.306	1.306	1.641	0.335	14.10	0.924	4.32	3.264	0.214			6.25			88.2
C_3H_8 44.094				0.284	0.045	1.98	0.174	0.174	0.219	0.045	1.98	0.130	4.24	0.467	0.031	C4H8			0.254	68.0	
C_4H_8 56.104				1.252	0.198	11.11	0.772	0.772	0.970	0.198	11.11	0.728	5.00	2.222	0.146	C4Poly		6.10	1.440	1.5	77.0
C_4H_{10} 58.120				0.373	0.059	3.43	0.228	0.228	0.287	0.059	3.43	0.225	4,86	0.706	0.046	C4H10		4.86	0.706	68.0	
C_5H_{10} 70.130				0.557	0.088	6.17	0.343	0.343	0.431	0.088	6.17	0.405	5.45	1.132	0.074	C4Free Gaso		5.45	10.356	5.8	87.1
C_5H_{12} 72.146				0.082	0.013	0.94	0.051	0.051	0.064	0.013	0.94	0.062	5.25	0.179	0.012	C4Poly Tar		5.25	0.163		
C_6H_{12} 84.156				0.126	0.020	1.68	0.078	0.078	0.098	0.020	1.68	0.110	5.54	0.303	0.020			5.54			
C_3-C_6											39.41	2.584		8.273	0.543						
TOTAL		41.872	543.94		15.812	329.47	61.634	103.506	85.160								gal/hr.		gal/MCF	BPD	
H_2+CO		40.191	15252.5 S.C.F.H.		9.486		36.974	77.165	46.460	-30.705						Gasoline	12.756		0.836	4534	
H_2/CO		1.62			2.80		2.80	2.08	2.80	1.39						Diesel	1.768		0.116	628	

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ = 7.55

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.511*	71.74	4.703	6.494	11.047	0.724	WaxyBtms	1.139	0.075	405
TOTAL OIL		111.15	7.287		19.320	1.267	Poly Tar	0.252	0.016	90
WATER SOLUBLE CHEMICALS	0.265*	14.04	0.921	8.051	1.744	0.114	Total	15.915	1.043	5657
TOTAL LIQUID PRODUCTS C_3+		125.19	8.208		21.064	1.381	WS Chem	1.744	0.114	620
NET WATER	6.938*	124.99	8.195		15.252		Total	17.659	1.158	6277
GROSS WATER		139.03	9.116		16.996					
HYDROCARBON TOTAL—C_1+		151.21	9.914							

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION—% CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
62.24	83.75	71.86	76.40	51.28	34.26	39.79	82.79

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

HOURS 341-497
298

DATA SUMMARY

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen		Fresh Feed	15869
Natural Gas		Recycle	23359
Generator Outlet		Combined Feed	39228
Reactor Inlet	399	Wet Gas—Measured	
Condenser Inlet		Adjusted	5993
Product Accumulator	374	Loss	
TEMPERATURES—°F.		Recycle/Fresh Feed	1.472
Oxygen		Inlet Velocity—ft./sec.	1.366
Natural Gas		Fresh Feed Rate—S.C.F.H. H2 + CO	15252
Generator		per Cu.Ft. Dense Bed	1215
Quench Accumulator		per Lb. Catalyst	10.48
Reactor Inlet	341	per sq. ft.	23109
Condenser Inlet			
Product Accumulator	69		
Catalyst No. Height			
1 12"	676		
2 43.2"	641		
3 74.4"	656		
4			
5 136.8"	651		
6 168.0"	653		
7 199.2"	645		
8 230.4"	639	Avg. Bed Temp., °F.	653
9 261.6"	634	dT, °F.	131
10 292.8"	635	K, BTU/hr/sq.ft/°F.	89.3

PRODUCT TESTS

	OIL	WATER
°API	49.8	10.5
Neut. No.	43.0	41.9
Sap. No.	48.5	45.3
Hydrox. No.		
Bromine No.	84	
Pour °F.		
Chemicals, % by K_2CO_3		10.14
HEMPEL, DIST. %		°API
205 °F.		
400	72.5	55.7
400-550	17.5	36.3
550+	10.0	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	102	
10%	136	
50%	234	
90%	352	
EP	400	
Recovered	97.5	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	361
Total	
Catalyst Recovered	
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height	
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	115
Inventory, Lbs.	1456
Bed Depth, Ft.	19.02
Vol., cu. ft.	12.55

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	11.2	80+	
100	150	69.1	40—80	
150	105	11.0	20—40	
200	74	5.3	10—20	
250	62	1.5	0—20	
325	44	1.1		
<325		0.8		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	139
Settled	141
Compacted	156
Particle Density, gm./cc.	4.1
NH_3 Value, ml./gm.	15.8
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	

TABLE VIII

ANALYSES OF CATALYST SAMPLES FROM MONTEBELLO RUN NO. 49

Montebello Catalyst No.	Chemical Analyses, Per Cent by Weight				K_2O/Fe	Specific Surface, $m^2/g.$	X-Ray Analyses		
	K_2O	Fe	C	H			$Fe_{20}C_9$	Fe_3O_4	Fe
49 Red	0.57	90.4	-	-	0.585	-			100
49-A	0.57	88.9	0.22	0.07	0.641	1.1			100
49-B	0.38	68.8	2.41	0.13	0.552	<1	40	55	5
49-D	0.33	66.1	-	-	0.499	-	30	65	5
49-G	0.35	67.8	-	-	0.516	-	40[a]	55	5
49-I	0.33	66.6	8.17	0.51	0.495	<1	40[a]	55	5
49-I (Carryover)	0.52	66.4	11.00	0.57	0.783	<1	35[a]	55	10

[a]The carbide present in these catalysts has an orthorhombic structure but it is unlike that observed in catalysts prepared at Beacon, HRI, and Stanolind.

HYDROXYL NUMBERS OF RECOVERED PRODUCT OIL

RUN 49

Period	Hydroxyl No.
49-B	37
49-C	34
49-D	37
49-E	38
49-F	38
49-G	31
49-H	38
49-I	41
49-L	38
49-M	35
49-O	30
49-P	36
49-R	38
49-S	40
49-T	35
49-U	36
49-W	35
49-X	34

B. DETAILED DATA FOR STANOLIND RUN D-201-29 ALAN WOOD CATALYST

SUMMARY OF SYNTHESIS RUN NO. D-201-29

Period	1	2	3	4	5	6	7	8	9	10	Average		Montebello Run 49 L/P
Hours	21	47	119	191	263	349	456	481	652	695			221-341
Press., Psig													
Temp. °F.													
Flow Rates-SCFH													
Fresh Feed	3617	3601	3622	3630	3649	3544	3602	3620	3593	3607	3608		15294
Recycle	3717	3640	3610	3584	3635	3584	3644	3585	3575	3622	3620		15699
Wet Gas (Adj.)	925	929	1047	1154	1246	1190	1249	1281	1310	1180	1151		5691
Catalyst Data (by Δp) #/CF	112	(121)	130	134	132	119	117	113	112	109	120		119
Weight, lbs.	449	478	492	508	466	451	443	417	406	413	452		1612
Vol.-Cu. Ft.	4.01	3.95	3.79	3.79	3.53	3.79	3.79	3.69	3.63	3.79	3.78		13.43
Depth.-Ft.	12.5	12.3	11.8	11.8	11.0	11.8	11.8	11.5	11.3	11.8	11.8		20.35
Feed Rates-H_2+CO													
SCFH	3411	3421	3495	3510	3540	3427	3433	3493	3507	3495	3473		14727
SCFH/Sq.Ft.	10625	10657	10888	10935	11027	10676	10695	10882	10925	10888	10820		22313
SCFH/CF Cat.	851	866	922	926	1003	904	906	946	966	922	921		1097
SCFH/# Cat.	7.60	7.16	7.10	6.91	7.60	7.60	7.75	8.38	8.64	8.46	7.72		9.13
Recycle Ratio	1.03	1.01	1.00	0.99	1.00	1.01	1.01	0.99	1.00	1.00	1.00		1.03
Inlet Vel.Ft/Sec.	0.47	0.46	0.46	0.46	0.48	0.55	0.51	0.45	0.46	0.47	0.48		1.01
Ratio of H_2/CO in													
Fresh Feed	1.92	1.90	2.04	1.89	1.92	1.96	1.94	1.90	1.87	1.97			1.61
Combined Feed	2.81		3.10				2.81	2.70					2.03
Wet Gas	12.8	6.9	20.5	5.6	5.8	5.95	6.77	5.91	5.55	6.34			3.10
Consumed	1.69	1.67	1.73	1.58	1.55	1.60	1.55	1.51	1.47	1.62			1.37

Yields/MCF of CO+H_2 Fed	1 lbs.	1 gal.	2 lbs.	2 gal.	3 lbs.	3 gal.	4 lbs.	4 gal.	5 lbs.	5 gal.	6 lbs.	6 gal.	7 lbs.	7 gal.	8 lbs.	8 gal.	9 lbs.	9 gal.	10 lbs.	10 gal.	Average lbs.	Average gal.	lbs.	gal.	Montebello lbs.	Montebello gal.
C_3	1.475	.343	1.310	.303	1.791	.416	1.487	.345	1.508	.350	1.524	.353	1.418	.329	1.471	.342	1.258	.291	1.344	.312					1.120	.260
C_4	1.038	.209	1.088	.219	0.935	.187	0.929	.182	0.986	.198	1.083	.218	1.052	.212	1.016	.204	0.901	.182	1.018	.205					1.060	.213
C_5	0.431	.079	0.450	.083	0.441	.081	0.399	.073	0.297	.054	0.468	.086	0.449	.082	0.501	.092	0.479	.088	0.501	.092					0.540	.100
C6	0.147	.027	0.146	.026	0.143	.026	0.097	.017	0.048	.008	0.103	.019	0.122	.022	0.120	.022	0.265	.048	0.169	.030					0.132	.024
C_3 - C6																										
400 EP																										
C_3 - 400 EP																										
400+																										
WS Chem	1.000	.125	1.082	.135	1.030	.129	1.182	.148	1.178	.147	1.238	.155	1.148	.143	1.122	.140	1.178	.147	1.147	.143					0.915	.115
Total C_3+	9.946	1.697	9.626	1.638	8.712	1.523	8.536	1.465	8.487	1.458	8.535	1.476	8.481	1.456	8.310	1.430	7.913	1.348	8.015	1.368					8.418	1.427
C_1	1.572		0.488		2.014		1.248		1.297		1.284		1.317		1.248		1.195		1.339						0.946	
C_2	0.898		0.830		1.255		1.011		1.051		1.071		1.025		1.025		1.130		1.139						0.868	
C_1 + C_2	2.469		1.318		3.270		2.259		2.348		2.354		2.342		2.273		2.224		2.478						1.815	
Total C_1+	12.414		10945		11.982		10.795		10.835		10.889		10.823		10.583		10.137		10.493						10.233	
CO_2	4.375		4.168		5.402		6.570		6.204		6.506		6.191		6.564		7.052		6.258						8.173	
Net Water	10.890		11.640		8.961		9.105		8.727		9.256		9.000		8.648		8.403		8.925						8.234	

Period	1	2	3	4	5	6	7	8	9	10	Average		Montebello Run 49 L/P
Shift Ratio $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$							10.1	9.1					6.6
Conv.Basis F.F.													
CO %	97.9	95.1	98.3	92.3	91.3	91.8	92.6	91.2	90.2	92.6			85.8
H_2 %	85.9	83.9	82.8	77.2	73.7	74.9	74.1	72.5	70.8	76.3			72.7
H_2 + CO %	90.0	87.8	87.9	82.5	79.7	80.6	80.4	79.0	77.5	81.8			77.7
Selectivity % $\frac{C_3+}{C_1+}$	80.1	88.0	72.7	79.1	78.3	78.4	78.4	78.5	78.1	76.4			82.3
Weight Bal. %	90.5	86.0	98.8	94.3		93.5	93.3	93.2	96.3	97.5			96.3

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. D-201-29-1
HOURS 21

	FRESH FEED			WET GAS	At. Wt. Balance		RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED — CONDENSATE				POLYMER					%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	32.3	3.078	86.22	2.667	0.065	1.82	0.272	3.143	0.337	- 3.013						%	gph	#/hr.	%	gph	
H_2 2.016	62.0	5.909	11.91	34.099	0.831	1.68	3.506	9.415	4.337	- 5.078					400	75	2.219		98.0	2.175	
CO_2 44.010	2.1	0.200	8.80	22.117	0.539	23.72	2.181	2.381	2.720	0.339	14.92	4.375			400/550	16	0.473		91.4	0.432	
N_2 28.016	0.3	0.029	0.81	1.477	0.036	1.01	0.147	0.176	0.183						550+	9	0.266		114.6	0.305	
CH_4 16.042	3.3	0.315	5.05	26.631	0.649	10.41	2.704	3.019	3.353	0.334	5.36	1.572									
C_2H_4 28.052				3.118	0.076	2.13	0.303	0.303	0.379	0.076	2.13	0.625			$C_3^=$	56.0		2.50			71.0
C_2H_6 30.068				1.272	0.031	0.93	0.122	0.122	0.153	0.031	0.93	0.273			Poly	Gaso		2.19		0.366	
C_1+C_2											8.42	2.469			Poly	Tar		0.31		0.041	
C_3H_6 42.078				4.350	0.106	4.46	0.359	0.359	0.465	0.106	4.46	1.308	4.32	1.032	0.303			6.28		RVP	89.1
C_3H_8 44.094				0.533	0.013	0.57	0.044	0.044	0.057	0.013	0.57	0.167	4.24	0.135	0.040	C4H8			0.162	68.0	
C_4H_8 56.104				2.257	0.055	3.08	0.141	0.141	0.196	0.055	3.08	0.903	8.00	0.616	0.181	C4Poly		6.10	0.332	1.5	87.3
C_4H_{10} 58.120				0.328	0.008	0.46	0.021	0.021	0.029	0.008	0.46	0.135	4.86	0.096	0.028	C4H10		4.86	0.096	68.0	
C_5H_{10} 70.130				0.862	0.021	1.47	0.068	0.068	0.089	0.021	1.47	0.431	5.48	0.270	0.079	C4Free Gaso		5.48	2.902	5.8	
C_5H_{12} 72.146													5.28			C4Poly Tar		5.28	0.037		
C_6H_{12} 84.156				0.246	0.006	0.50	0.022	0.022	0.028	0.006	0.50	0.147	5.84	0.091	0.027			5.84			
C_3-C_6											10.54	3.090		2.240	0.657						
TOTAL		9.531	112.79		2.437	52.24	9.891	19.422	14.612									gal/hr.	gal/MCF	BPD	
H_2+CO		8.987	3410.6 S.C.F.H.		0.896		3.778	12.558	4.674	8.091						Gasoline		3.492	1.0239	5551	
H_2/CO		1.92	293206	12.8			12.9	2.99	12.9	1.69						Diesel		0.432	0.1267	687	

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 16.98 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.133#	18.67	5.474	6.310	2.959	0.868	Waxy Btms	0.305	0.0894	485
TOTAL OIL		29.21	8.564		5.199	1.524	Poly Tar	0.078	0.0229	124
WATER SOLUBLE CHEMICALS	0.089#	4.71	1.382	8.0	0.589	0.172	Total	4.307	1.2628	6846
TOTAL LIQUID PRODUCTS C_3+		33.92	9.946		5.788	1.697	WS Chem	0.589	0.1727	937
NET WATER	2.062#	37.14	10.890				Tot al	4.896	1.4355	7783
GROSS WATER										
HYDROCARBON TOTAL—C_1+		42.34	12.414							

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
74.43	97.89	85.94	90.03	95.86	53.94	64.43	80.11

Form ML-11

#Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

RATE CALCULATIONS

HOURS 21

GAS ANALYSES					GENERATOR BALANCE									WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
HOUR				AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		
FRESH FEED									O_2 32.000						WET GAS Stab. Vent	4.21 37.34	48.07
CO 28.010	32.3								CO 28.010						OIL	18.67	
H_2 2.016	62.0								H_2 2.016						WATER WSC	4.71 37.14	
CO_2 44.010	2.1								CO_2 44.010						TOTAL	102.07	
N_2 28.016	0.3								N_2 28.016						FRESH FEED	112.80	
CH_4 16.042	3.3								CH_4 16.042						WEIGHT BALANCE	90.49	
			M. W.	11.835					C_2H_4 30.068								
			H_2O 18.016						C_3H_8 44.094						WET GAS FACTOR	1.2874	
									C_4H_{10} 58.120						INDICATED LOSS—S C F H		
			BALANCE						TOTAL								

WET GAS		Stab. Vent
CO 28.010	2.75	0.9
H_2 2.016	35.45	1.9
CO_2 44.010	22.05	24.1
N_2 28.016	1.49	0.8
CH_4 16.042	27.34	9.7
C_2H_4 28.052	3.06	4.6
C_2H_6 30.068	1.23	2.4
C_3H_6 42.078	3.63	21.7
C_3H_8 44.094	0.45	2.9
C_4H_8 56.104	1.43	22.5
C_4H_{10} 58.120	0.21	2.9
C_5H_{10} 70.130	0.69	5.0
C_5H_{12} 72.146		
C_6H_{12} 84.156	0.22	0.6
	20.540	43.419	M. W.

GAS FLOW RATES		VR	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED					3617		9.531
WET GAS			Corrected		888		2.340
			Observed		690		1.818
RECYCLE					3717		9.794
~~XXXXX~~ Stab. Vent					37		0.097
NATURAL GAS							
OXYGEN							
STEAM							

LIQUID PRODUCT RATES	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL							55.2		

WATER		#/hr.	% Chem	#/Hr Chem	Net H2O
	H2O	40.55	8.4	3.41	37.14
	Gas	30.38	2.1	0.64	
	Oil	13.17	5.0	0.66	
	WSC			4.71	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. D-201-29-2
HOURS 47

	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	32.8	3.112	87.17	6.250	0.153	4.28	0.634	3.746	0.787	- 2.959	
H_2 2.016	62.2	5.902	11.90	42.933	1.051	2.19	4.360	10.262	5.411	- 4.851	
CO_2 44.010	1.8	0.171	7.53	20.221	0.495	21.78	1.949	2.120	2.444	0.324	14.26
N_2 28.016	1.2	0.114	3.19	6.413	0.157	4.40	0.630	0.744	0.787		
CH_4 16.042	2.0	0.190	3.05	12.010	0.294	4.72	1.199	1.389	1.493	0.104	1.67
C_2H_4 28.052				2.819	0.069	1.94	0.265	0.265	0.334	0.069	1.94
C_2H_6 30.068				1.225	0.030	0.90	0.115	0.115	0.145	0.030	0.90
C_1+C_2											4.51
C_3H_6 42.078				3.799	0.093	3.91	0.289	0.289	0.382	0.093	3.91
C_3H_8 44.094				0.531	0.013	0.57	0.042	0.042	0.055	0.013	0.57
C_4H_8 56.104				2.288	0.056	3.14	0.117	0.117	0.173	0.056	3.14
C_4H_{10} 58.120				0.408	0.010	0.58	0.024	0.024	0.034	0.010	0.58
C_5H_{10} 70.130				0.899	0.022	1.54	0.059	0.059	0.081	0.022	1.54
C_5H_{12} 72.146											
C_6H_{12} 84.156				0.245	0.006	0.50	0.019	0.019	0.025	0.006	0.50
C_3-C_6											10.24
TOTAL		9.489			2.448	50.45	9.703	19.192	14.581		
H_2+CO		9.014	3420.8 S.C.F.H.		1.204		4.994	14.008	6.198	7.810	
H_2/CO		1.90	292329		6.87		6.88	2.74	6.88	1.67	

YIELD BASIS H_2+CO FED

	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO					%	gph	#/hr.	%	gph	
H_2				400	75	2.123		98.0	2.081	
CO_2	4.168			400/550	16	0.453		91.4	0.414	
N_2				550+	9	0.255		114.6	0.292	
CH_4	0.488									
C_2H_4	0.567			$C_3^=$	55.2		2.16			69.7
C_2H_6	0.263			Poly	Gaso		1.90		0.317	
C_1+C_2	1.318						0.26		0.035	
C_3H_6	1.143	4.32	0.905	0.264			6.25		RVP	87.7
C_3H_8	0.167	4.24	0.134	0.039	C4H8			0.134	68.0	
C_4H_8	0.918	5.00	0.628	0.184	C4 Poly		6.10	0.361	1.5	84.8
C_4H_{10}	0.170	4.86	0.119	0.035	C4H10		4.86	0.119	68.0	
C_5H_{10}	0.450	5.45	0.283	0.083	C4Free Gaso		5.45	2.771	5.8	
C_5H_{12}		5.25			C4Poly Tar		5.25	0.041		
C_6H_{12}	0.146	5.54	0.090	0.026			5.54			
C_3-C_6	2.993		2.159	0.631						
TOTAL							gal/hr.	gal/MCF	BPD	
H_2+CO					Gasoline		3.385	0.9895	5365	
H_2/CO					Diesel		0.414	0.1210	656	

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 7.60 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

	NET CHANGE m/hr	NET CHANGE #/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.127*	17.78	5.198	6.28	2.831	0.828	WaxyBtms	0.292	0.0854	463
TOTAL OIL		28.02	8.191		4.990	1.459	Poly Tar	0.076	0.0222	120
WATER SOLUBLE CHEMICALS	0.093*	4.91	1.435		0.613	0.179	Total	4.167	1.2181	6604
TOTAL LIQUID PRODUCTS C_3+		32.93	9.626		5.603	1.638	WSChem	0.613	0.1792	971
NET WATER	2.210*	39.82	11.640				Total	4.780	1.3973	7576
GROSS WATER										
HYDROCARBON TOTAL—C_1+		37.44	10.945							

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	$CO+H_2$	SELECTIVITY C_3+/C_1+
74.20	95.08	82.19	86.64	78.99	47.27	55.75	87.95

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

RATE CALCULATIONS

HOURS 47

GAS ANALYSES HOUR				AVERAGE
FRESH FEED				
CO 28.010	32.8			
H_2 2.016	62.2			
CO_2 44.010	1.8			
N_2 28.016	1.2			
CH_4 16.042	2.0			
			M. W.	11.890
			H_2O 18.016	
			BALANCE	

GENERATOR BALANCE M/HR	C	H	O		Mol %	M/Hr	C	H	O
				O_2 32.000					
				CO 28.010					
				H_2 2.016					
				CO_2 44.010					
				N_2 28.016					
				CH_4 16.042					
				C_2H_6 30.068					
				C_3H_8 44.094					
				C_4H_{10} 58.120					
				TOTAL					

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
Stab. Vent / WET GAS	5.07 29.49	45.25
OIL	17.78	
WATER WSC	4.91 39.82	
TOTAL	97.07	
FRESH FEED	112.83	
WEIGHT BALANCE	86.03	
WET GAS FACTOR	1.5344	
INDICATED LOSS—S C F H		

WET GAS		Stab. Vent		
CO 28.010	6.53	0.8		
H_2 2.016	44.93	2.2		
CO_2 44.010	20.09	23.2		
N_2 28.016	6.49	1.5		
CH_4 16.042	12.36	4.5		
C_2H_4 28.052	2.73	5.1		
C_2H_6 30.068	1.19	2.5		
C_3H_6 42.078	2.98	20.9		
C_3H_8 44.094	0.43	2.8		
C_4H_8 56.104	1.21	24.9		
C_4H_{10} 58.120	0.25	3.5		
C_5H_{10} 70.130	0.61	7.2		
C_5H_{12} 72.146				
C_6H_{12} 84.156	0.20	0.9		
	19.3649	45.643	M. W.	

GAS FLOW RATES	$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED				3601		9.489
WET GAS		Corrected		887		2.337
		Observed		578		1.523
RECYCLE				3640		9.592
Stab. Vent.				42		0.111
NATURAL GAS						
OXYGEN						
STEAM						

LIQUID PRODUCT RATES HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL						56.1		
		#/hr.	% Chem	#/hr. Chem	Net H2O			
WATER	H2O	43.52	8.5	3.70	39.82			
	Gas	32.19	1.9	0.61				
	Oil	13.44	4.5	0.60				
	WSC			4.91				

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. D-201-29-3
HOURS 119

	FRESH FEED			WET GAS	At. Wt. Balance		RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED: CONDENSATE				POLYMER					
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	% Unsats.
CO 28.010	31.7	3.025	84.73	1.885	0.052	1.46	0.184	3.209	0.236	- 2.973						%	gph	#/hr.	%	gph	
H_2 2.016	64.8	6.185	12.47	38.565	1.064	2.14	3.779	9.964	4.843	- 5.121					400	75	1.692		98.0	1.658	
CO_2 44.010	1.7	0.162	7.13	21.421	0.591	26.01	2.055	2.217	2.646	0.429	18.88	5.402			400//550	16	0.361		91.4	0.330	
N_2 28.016	0.8	0.076	2.13	4.712	0.130	3.64	0.462	0.538	0.592						550+	9	0.203		114.6	0.233	
CH_4 16.042	1.0	0.096	1.54	19.391	0.535	8.58	1.890	1.986	2.425	0.439	7.04	2.014									
C_2H_4 28.052				3.770	0.104	2.92	0.358	0.358	0.462	0.104	2.92	0.835			$C_3^=$	49.5		2.66			68.0
C_2H_6 30.068				1.776	0.049	1.47	0.167	0.167	1.943	0.049	1.47	0.420			Poly	Gaso		2.33		0.389	
C_1+C_2											11.43	3.270			Poly	Tar		0.33		0.044	
C_3H_6 42.078				4.639	0.128	5.38	0.394	0.394	0.522	0.128	5.38	1.539	4.32	1.245	0.356			6.25			86.5
C_3H_8 44.094				0.725	0.020	0.88	0.063	0.063	0.083	0.020	0.88	0.252	4.24	0.208	0.060	C4H8			0.150	68.0	
C_4H_8 56.104				1.885	0.052	2.92	0.129	0.129	0.181	0.052	2.92	0.835	5.00	0.584	0.167	C4 Poly		6.10	0.318	1.5	89.7
C_4H_{10} 58.120				0.217	0.006	0.35	0.013	0.013	0.019	0.006	0.35	0.100	4.86	0.072	0.020	C4H10		4.86	0.072	68.0	
C_5H_{10} 70.130				0.797	0.022	1.54	0.065	0.065	0.087	0.022	1.54	0.441	5.45	0.283	0.081	C4Free Gaso		5.45	2.420	5.8	
C_5H_{12} 72.146													5.25			C4Poly Tar		5.25	0.036		
C_6H_{12} 84.156				0.217	0.006	0.50	0.020	0.020	0.026	0.006	0.50	0.143	5.54	0.090	0.026			5.54			
C_3-C_6											11.57	3.310		2.482	0.710						
TOTAL		9.544	108.00		2.759	57.79	9.579	19.123									gal/hr.		gal/MCF BPD		
H_2+CO		9.210	3495.2 S.C.F.H.		1.116		3.963	13.173	5.079	8.094						Gasoline	2.960		0.8469	4592	
H_2/CO		2.04	286107		20.46		20.5	3.24	20.5	1.72						Diesel	0.330		0.0944	512	

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF				
RECOVERED OIL	0.101*	14.19	4.060	6.290	2.256	0.645	Waxy Btms	0.233	0.0667	362
TOTAL OIL		25.76	7.370		4.738	1.356	Poly Tar	0.080	0.0229	124
WATER SOLUBLE CHEMICALS	0.088*	4.69	1.342		0.586	0.168	Total	3.603	1.0308	5589
TOTAL LIQUID PRODUCTS C_3+		30.45	8.712		5.324	1.524	WSChem	0.586	0.1677	909
NET WATER	1.738*	31.32	8.961				Total	4.189	1.1985	6498
GROSS WATER										
HYDROCARBON TOTAL—C_1+		41.88	11.982							

CUMULATIVE TOTALS

	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 31.2 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
71.09	98.28	82.80	87.88	92.65	51.40	61.44	72.71

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × = MCF
cc/M3 = 141.3 × gal/MCF

RATE CALCULATIONS

HOURS 119

GAS ANALYSES

HOUR				AVERAGE
FRESH FEED				
CO 28.010	31.7			
H_2 2.016	64.8			
CO_2 44.010	1.7			
N_2 28.016	0.8			
CH_4 16.042	1.0			
			M. W.	11.318
			H_2O 18.016	
			BALANCE	
WET GAS		Stab. Vent		
CO 28.010	1.92			
H_2 2.016	39.45	1.7		
CO_2 44.010	21.45	20.5		
N_2 28.016	4.82	0.3		
CH_4 16.042	19.73	6.1		
C_2H_4 28.052	3.74	5.6		
C_2H_6 30.068	1.74	3.2		
C_3H_6 42.078	4.11	26.5		
C_3H_8 44.094	0.66	3.1		
C_4H_8 56.104	1.35	23.8		
C_4H_{10} 58.120	0.14	3.6		
C_5H_{10} 70.130	0.68	4.7		
C_5H_{12} 72.146				
C_6H_{12} 84.156	0.21	0.9		
	20.3733	44.668	M. W.	

GENERATOR BALANCE

M/HR	C	H	O		Mol %	M/Hr	C	H	O
				O_2 32.000					
				CO 28.010					
				H_2 2.016					
				CO_2 44.010					
				N_2 28.016					
				CH_4 16.042					
				C_2H_6 30.068					
				C_3H_8 44.094					
				C_4H_{10} 58.120					
				TOTAL					

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS / Stab. Vent	2.95 53.52	54.87
OIL	14.19	
WATER / WSC	4.69 31.32	
TOTAL	106.67	
FRESH FEED	108.02	
WEIGHT BALANCE	98.75	
WET GAS FACTOR	1.0252	
INDICATED LOSS—S C F H		

GAS FLOW RATES

	$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED				3622		9.544
WET GAS		Corrected		1022		2.693
		Observed		997		2.627
RECYCLE				3610		9.513
~~XXXXX~~ Stab.Vent				25		0.066
NATURAL GAS						
OXYGEN						
STEAM						

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL						55.8		
		#/hr.	% Chem	#/hr. Chem.	Net H2O			
WATER	H2O	34.92	10.3	3.60	31.32			
	Gas	35.33	1.9	0.67				
	Oil	8.16	5.2	0.42				
	WSC			4.69				

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. D-201-29-4
HOURS 191

	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	33.5	3.204	89.74	8.125	0.247	6.92	0.783	3.987	1.030	- 2.957	
H_2 2.016	63.2	6.045	12.19	45.263	1.376	2.77	4.377	10.422	5.753	- 4.669	
CO_2 44.010	1.6	0.153	6.73	22.270	0.677	29.79	2.098	2.251	2.775	0.524	23.06
N_2 28.016	1.2	0.115	3.22	2.928	0.089	2.49	0.281	0.396	0.370		
CH_4 16.042	1.5	0.048	0.77	10.559	0.321	5.15	1.013	1.057	1.334	0.273	4.38
C_2H_4 28.052				2.862	0.087	2.44	0.264	0.264	0.351	0.087	2.44
C_2H_6 30.068				1.217	0.037	1.11	0.112	0.112	0.149	0.037	1.11
C_1+C_2											7.93
C_3H_6 42.078				3.421	0.104	4.38	0.278	0.278	0.382	0.104	4.38
C_3H_8 44.094				0.625	0.019	0.84	0.052	0.052	0.071	0.019	0.84
C_4H_8 56.104				1.743	0.053	2.97	0.107	0.107	0.160	0.053	2.97
C_4H_{10} 58.120				0.165	0.005	0.29	0.016	0.016	0.021	0.005	0.29
C_5H_{10} 70.130				0.657	0.020	1.40	0.050	0.050	0.070	0.020	1.40
C_5H_{12} 72.146											
C_6H_{12} 84.156				0.132	0.004	0.34	0.012	0.012	0.016	0.004	0.34
C_3-C_6											10.22
TOTAL		9.565	112.65		3.040	60.89	9.444	19.009	14.460		
H_2+CO		9.249	3510 S.C.F.H.		1.623		5.160	14.409	6.783	7.626	
H_2/CO		1.89	284901		5.57		5.59	2.61	5.59	1.58	

YIELD BASIS H_2+CO FED

	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO					%	gph	#/hr.	%	gph	
H_2				400	75	1.734		98.0	1.699	
CO_2	6.570			400/550	15	0.347		91.4	0.317	
N_2				550+	10	0.231		114.6	0.265	
CH_4	1.248									
C_2H_4	0.695			C_3^-	45.1		1.975			70.2
C_2H_6	0.316			Poly Gaso			1.73	0.289		
C_1+C_2	2.259			Poly Tar			0.245	0.033		
C_3H_6	1.248	4.32	1.014	0.289			6.25		RVP	84.6
C_3H_8	0.239	4.24	0.198	0.056	C_4H_8			0.166	68.0	
C_4H_8	0.846	5.00	0.594	0.169	C4Poly		6.10	0.313	1.5	91.4
C_4H_{10}	0.083	4.86	0.046	0.013	C_4H_{10}		4.86	0.046	68.0	
C_5H_{10}	0.399	5.45	0.257	0.073	C4Free Gaso		5.45	2.306	5.8	
C_5H_{12}		5.25			C4Poly Tar		5.25	0.036		
C_6H_{12}	0.097	5.54	0.061	0.017			5.54			
C_3-C_6	2.912		2.170	0.618						
TOTAL						gal./hr.		gal/MCF	BPD	
H_2+CO					Gasoline	2.831		0.8066	4373	
H_2/CO					Diesel	0.317		0.0903	490	

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 8.73 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

	NET CHANGE m/hr	NET CHANGE #/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal./hr.	gal/MCF	BPD
RECOVERED OIL	0.103*	14.47	4.122	6.257	2.312	0.659	WaxyBtms	0.265	0.0755	409
TOTAL OIL		24.69	7.034		4.482	1.277	Poly Tar	0.069	0.0197	107
WATER SOLUBLE CHEMICALS	0.099*	5.27	1.502		0.659	0.188	Total	3.482	0.9920	5379
TOTAL LIQUID PRODUCTS C_3+		29.96	8.536		5.141	1.465	WSChem	0.659	0.1877	1018
NET WATER	1.774*	31.96	9.105				Total	4.141	1.1798	6397
GROSS WATER										
HYDROCARBON TOTAL—C_1+		37.89	10.795							

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION—% CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
68.22	92.29	77.24	82.45	74.17	44.80	52.93	79.07

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF

RATE CALCULATIONS

HOURS 191

GAS ANALYSES

HOUR				AVERAGE
FRESH FEED				
CO 28.010	33.5			
H_2 2.016	63.2			
CO_2 44.010	1.6			
N_2 28.016	1.2			
CH_4 16.042	0.5			
			M. W.	11.778
			H_2O 18.016	
			BALANCE	

WET GAS		Stab. Vent		
CO 28.010	8.29	1.4		
H_2 2.016	46.35	2.2		
CO_2 44.010	22.21	25.1		
N_2 28.016	2.98	0.9		
CH_4 16.042	10.73	4.3		
C_2H_4 28.052	2.80	5.4		
C_2H_6 30.068	1.19	2.8		
C_3H_6 42.078	2.94	22.1		
C_3H_8 44.094	0.55	3.5		
C_4H_8 56.104	1.13	26.1		
C_4H_{10} 58.120	0.17	0.5		
C_5H_{10} 70.130	0.53	5.7		
C_5H_{12} 72.146				
C_6H_{12} 84.156	0.13			
	19.424	44.555	M. W.	

GENERATOR BALANCE

M/HR	C	H	O		Mol %	M/Hr	C	H	O
				O_2 32.000					
				CO 28.010					
				H_2 2.016					
				CO_2 44.010					
				N_2 28.016					
				CH_4 16.042					
				C_2H_6 30.068					
				C_3H_8 44.094					
				C_4H_{10} 58.120					
				TOTAL					

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS Stab.Vent	3.39 51.09	57.57
OIL	14.47	
WATER WSC	5.27 31.96	
TOTAL	106.18	
FRESH FEED	112.66	
WEIGHT BALANCE	94.25	
WET GAS FACTOR	1.1268	
INDICATED LOSS—S C F H		

GAS FLOW RATES

	√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED				3630		9.565
WET GAS		Corrected		1125		2.964
		Observed		998		2.630
RECYCLE				3584		9.444
Stab. Vent				29		0.076
NATURAL GAS						
OXYGEN						
STEAM						

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL						56.7		
		#/hr.	% Chem	#/hr. Chem	Net H_2O			
WATER	H_2O	36.11	11.5	4.15	31.96			
	Gas	37.37	1.4	0.52				
	Oil	10.69	5.5	0.60				
	WSC			5.27				

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. D-201-29-5
HOURS 263

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED									
					At. Wt. Balance							CONDENSATE				POLYMER					%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	33.2	3.192	89.41		0.278	7.79	0.835	4.027	1.113	- 2.914						%	gph	#/hr.	%	gph	
H_2 2.016	63.8	6.135	12.37		1.614	3.25	4.859	10.994	6.473	- 4.521					400	75	1.750		98.0	1.715	
CO_2 44.010	1.7	0.163	7.17		0.662	29.13	1.936	2.099	2.598	0.599	21.96	6.204			400/550	16	0.373		91.4	0.341	
N_2 28.016	0.5	0.048	1.34		0.032	0.90	0.094	0.142	0.126						550+	9	0.210		114.6	0.241	
CH_4 16.042	0.8	0.077	1.24		0.363	5.82	1.084	1.161	1.447	0.286	4.59	1.297									
C_2H_4 28.052					0.092	2.58	0.264	0.264	0.356	0.092	2.58	0.729			$C_3^=$	42.3		1.90			70.8
C_2H_6 30.068					0.038	1.14	0.109	0.109	0.147	0.038	1.14	0.322			Poly	Gaso		1.66		0.278	
C_1+C_2											8.31	2.348						0.24		0.032	
C_3H_6 42.078					0.107	4.50	0.267	0.267	0.374	0.107	4.50	1.271	4.32	1.042	0.294			6.25		RVP	84.9
C_3H_8 44.094					0.019	0.84	0.050	0.050	0.069	0.019	0.84	0.237	4.24	0.198	0.056	C4H8			0.116	68.0	
C_4H_8 56.104					0.054	3.03	0.098	0.098	0.152	0.054	3.03	0.856	5.00	0.606	0.171	C4Poly		6.10	0.358	1.5	87.1
C_4H_{10} 58.120					0.008	0.45	0.014	0.014	0.022	0.008	0.45	0.130	4,86	0.096	0.027	C4H10		4.86	0.096	68.0	
C_5H_{10} 70.130					0.015	1.05	0.039	0.039	0.044	0.015	1.05	0.297	5.45	0.193	0.054	C4Free Gaso		5.45	2.216	5.8	
C_5H_{12} 72.146													5.25			C4Poly Tar		5.25	0.041		
C_6H_{12} 84.156					0.002	0.17	0.008	0.008	0.010	0.002	0.17	0.048	5.54	0.030	0.008			5.54			
C_3-C_6											10.05	2.839		2.165	0.612						
TOTAL		9.615	111.53		3.284	60.66	9.657	19.272	14.861									gal/hr.	gal/MCF	BPD	
H_2+CO		9.327	3539.6 S.C.F.H.		1.892		5.694	15.021	7.586	- 7.435						Gasoline	2.786		0.7871	4267	
H_2/CO		1.92	282518		5.81		5.82	2.73	5.82	1.55						Diesel	0.341		0.0963	522	

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 8.81

$$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$$

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.105*	14.69	4.150	6.296	2.333	0.659	WaxyBtms	0.241	0.0681	369
TOTAL OIL		24.74	6.959		4.498	1.271	Poly Tar	0.073	0.0206	112
WATER SOLUBLE CHEMICALS	0.100*	5.30	1.498		0.662	0.187	Total	3.441	0.9721	5270
TOTAL LIQUID PRODUCTS C_3+		30.04	8.487		5.160	1.458	WSChem	0.662	0.1870	1015
NET WATER	1.715*	30.89	8.727				Total	4.103	1.1592	6285
GROSS WATER										
HYDROCARBON TOTAL—C_1+		38.35	10.835							

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
65.85	91.29	73.69	79.71	72.36	41.12	49.50	78.33

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

RATE CALCULATIONS

HOURS 263

GAS ANALYSES

HOUR				AVERAGE
FRESH FEED				
CO 28.010	33.2			
H_2 2.016	63.8			
CO_2 44.010	1.7			
N_2 28.016	0.5			
CH_4 16.042	0.8			
			M. W.	11.60211
			H_2O 18.016	
			BALANCE	

WET GAS		Stab. Vent		
CO 28.010	8.65	0.8		
H_2 2.016	50.32	2.2		
CO_2 44.010	20.05	24.4		
N_2 28.016	0.97	0.9		
CH_4 16.042	11.22	4.1		
C_2H_4 28.052	2.73	5.4		
C_2H_6 30.068	1.13	2.7		
C_3H_6 42.078	2.77	23.1		
C_3H_8 44.094	0.52	2.9		
C_4H_8 56.104	1.02	26.9		
C_4H_{10} 58.120	0.14	4.0		
C_5H_{10} 70.130	0.40	2.6		
C_5H_{12} 72.146				
C_6H_{12} 84.156	0.08			
	17.8349	44.4823	M. W.	

GENERATOR BALANCE

M/HR	C	H	O		Mol %	M/Hr	C	H	O
				O_2 32.000					
				CO 28.010					
				H_2 2.016					
				CO_2 44.010					
				N_2 28.016					
				CH_4 16.042					
				C_2H_6 30.068					
				C_3H_8 44.094					
				C_4H_{10} 58.120					
				TOTAL					

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS / Stab. Vent	3.51 51.28	57.16
OIL	14.69	
WATER / WSC	5.30 30.89	
TOTAL	105.67	
FRESH FEED	111.55	
WEIGHT BALANCE	94.73	
WET GAS FACTOR	1.11466	
INDICATED LOSS—S C F H		

GAS FLOW RATES

	√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED				3649		9.615
WET GAS		Corrected		1216		3.205
		Observed		1091		2.875
RECYCLE				3635		9.578
Stab. Vent				30		0.079
NATURAL GAS						
OXYGEN						
STEAM						

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL						55.6		
		#/hr.	% Chem.	#/hr. Chem.	Net H20			
WATER	H20	35.06	11.9	4.17	30.89			
	Gas	39.69	1.4	0.56				
	Oil	9.66	5.9	0.57				
	WSC			5.30				

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. D-201-29-6
HOURS 349

	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	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	32.7	3.054	85.54		0.252	7.06	0.777	3.831	1.029	- 2.802						%	gph	#/hr.	%	gph	
H_2 2.016	64.0	5.977	12.05		1.500	3.02	4.629	10.606	6.129	- 4.477					400	75	1.490		98.0	1.460	
CO_2 44.010	1.8	0.168	7.39		0.654	28.78	1.976	2.144	2.630	0.486	21.39	6.506			400/550	16	0.318		91.4	0.291	
N_2 28.016	1.1	0.103	2.89		0.097	2.72	0.298	0.401	0.395						550+	9	0.179		114.6	0.205	
CH_4 16.042	0.4	0.037	0.59		0.300	4.81	0.923	0.960	1.223	0.263	4.22	1.284									
C_2H_4 28.052					0.085	2.38	0.252	0.252	0.337	0.085	2.38	0.724			$C_3^=$	43.0		1.79			69.1
C_2H_6 30.068					0.038	1.14	0.114	0.114	0.152	0.038	1.14	0.347			Poly	Gaso		1.57		0.262	
C_1+C_2											7.74	2.354			Poly	Tar		0.22		0.029	
C_3H_6 42.078					0.099	4.17	0.269	0.269	0.368	0.099	4.17	1.268	4.32	0.964	0.293			6.25			83.8
C_3H_8 44.094					0.019	0.84	0.052	0.052	0.071	0.019	0.84	0.256	4.24	0.198	0.060	C_4H_8			0.072		
C_4H_8 56.104					0.052	2.92	0.114	0.114	0.166	0.052	2.92	0.888	5.00	0.584	0.178	C_4Poly		6.10	0.375		82.5
C_4H_{10} 58.120					0.011	0.64	0.028	0.028	0.039	0.011	0.64	0.195	4.86	0.132	0.040	C_4H_{10}		4.86	0.132		
C_5H_{10} 70.130					0.022	1.54	0.056	0.056	0.078	0.022	1.54	0.468	5.45	0.283	0.086	C_4Free Gaso		5.45	2.066		
C_5H_{12} 72.146													5.25			C_4Poly Tar		5.25	0.042		
C_6H_{12} 84.156					0.004	0.34	0.012	0.012	0.016	0.004	0.34	0.103	5.54	0.061	0.019			5.54			
C_3-C_6											10.45	3.178		2.222	0.676						
TOTAL		9.339	108.46		3.135	60.36	9.502	18.841									gal/hr.		gal/MCF	BPD	
H_2+CO		9.031	3427.3 S.C.F.H.		1.752		5.406	14.437	7.158	- 7.279						Gasoline	2.645		0.7717	4185	
H_2/CO		1.96	2917748		5.95		5.96	2.77	5.96	1.60						Diesel	0.291		0.0849	460	

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 9.27 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.089*	12.47	5.793	6.276	1.987	0.604	WaxyBtms	0.205	0.0598	324
TOTAL OIL		22.92	6.972		4.209	1.280	Poly Tar	0.071	0.0207	112
WATER SOLUBLE CHEMICALS	0.097*	5.14	1.563		0.643	0.196	Total	3.212	0.9372	5081
TOTAL LIQUID PRODUCTS C_3+		28.06	8.535		4.852	1.476	WSChem	0.643	0.1876	1017
NET WATER	1.689*	30.43	9.256				Total	3.855	1.1248	6098
GROSS WATER										
HYDROCARBON TOTAL—C_1+		35.80	10.889							

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	$CO+H_2$	SELECTIVITY C_3+/C_1+
66.43	91.75	74.90	80.60	73.14	42.21	50.42	78.38

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

RATE CALCULATIONS

HOURS 349

GAS ANALYSES HOUR				AVERAGE
FRESH FEED				
CO 28.010	32.7			
H_2 2.016	64.0			
CO_2 44.010	1.8			
N_2 28.016	1.1			
CH_4 16.042	0.4			
			M. W.	11.6140
			H_2O 18.016	
			BALANCE	

GENERATOR BALANCE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
					O_2 32.000					
					CO 28.010					
					H_2 2.016					
					CO_2 44.010					
					N_2 28.016					
					CH_4 16.042					
					C_2H_6 30.068					
					C_3H_8 44.094					
					C_4H_{10} 58.120					
					TOTAL					

WEIGHT BALANCE	# hr Measured	At. Wt. Balance
Stab. Vent	2.65	
WET GAS	50.71	57.77
OIL	12.47	
WATER WSC	5.14	
WATER	30.43	
TOTAL	101.40	
FRESH FEED	108.46	
WEIGHT BALANCE	93.49	
WET GAS FACTOR	1.13922	
INDICATED LOSS—S C F H		

WET GAS		Stab. Vent
CO 28.010	8.18	0.9
H_2 2.016	48.72	2.2
CO_2 44.010	20.80	23.7
N_2 28.016	3.14	0.9
CH_4 16.042	9.71	3.4
C_2H_4 28.052	2.65	5.3
C_2H_6 30.068	1.20	2.6
C_3H_6 42.078	2.83	21.2
C_3H_8 44.094	0.55	3.1
C_4H_8 56.104	1.20	26.7
C_4H_{10} 58.120	0.30	3.9
C_5H_{10} 70.130	0.59	5.9
C_5H_{12} 72.146		
C_6H_{12} 84.156	0.13	0.2
	18.7732	45.633
M. W.		

GAS FLOW RATES	$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED				3544		9.339
WET GAS		Corrected		1168		3.077
		Observed		1025		2.701
RECYCLE				3584		9.444
~~XXXXX~~ Stab. Vent				22		0.058
NATURAL GAS						
OXYGEN						
STEAM						

LIQUID PRODUCT RATES HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL						56.2		
		#/ hr.	% Chem	#/hr. Chem.	Net H2O			
WATER	H2O	34.50	11.8	4.07	30.43			
	Gas	35.31	1.7	0.60				
	Oil	8.32	5.6	0.47				
	WSC			5.14				

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. D-201-29-7
HOURS 456

	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	YIELD BASIS H_2+CO FED: CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	32.4	3.075	86.13		0.228	6.39	0.677	3.782	0.905	- 2.847	-79.74					%	gph	#/hr.	%	gph	
H_2 2.016	62.9	5.970	12.04		1.544	3.11	4.581	10.551	6.125	- 4.426	- 8.93				400	75	1.596		98.0	1.564	
CO_2 44.010	1.8	0.171	7.53		0.654	28.78	1.902	2.073	2.556	0.483	21.25	6.191			400/550	16	0.340		91.4	0.311	
N_2 28.016	0.6	0.057	1.60		0.035	0.98	0.101	0.158	0.136	0.022	0.62				550+	9	0.192		114.6	0.220	
CH_4 16.042	2.3	0.218	3.50		0.500	8.02	1.476	1.694	1.976	0.282	4.52	1.317									
C_2H_4 28.052					0.085	2.38	0.243	0.243	0.328	0.085	2.38	0.693			$C_3^=$	41.5		1.75			69.1
C_2H_6 30.068					0.038	1.14	0.110	0.110	0.148	0.038	1.14	0.332			Poly Gaso			1.53		0.256	
C_1+C_2											8.04	2.342						0.22		0.029	
C_3H_6 42.078					0.100	4.21	0.261	0.261	0.361	0.100	4.21	1.226	4.32	0.974	0.284			6.25			87.0
C_3H_8 44.094					0.015	0.66	0.038	0.038	0.053	0.015	0.66	0.192	4.24	0.156	0.045	C4H8			0.094		
C_4H_8 56.104					0.054	3.03	0.118	0.118	0.172	0.054	3.03	0.883	5.00	0.606	0.177	C4Poly		6.10	0.375		84.4
C_4H_{10} 58.120					0.010	0.58	0.023	0.023	0.033	0.010	0.58	0.169	4.86	0.119	0.035	C4H10		4.86	0.119		
C_5H_{10} 70.130					0.022	1.54	0.058	0.058	0.080	0.022	1.54	0.449	5.45	0.283	0.082	C4Free Gaso		5.45	2.179		
C_5H_{12} 72.146													5.25			C4Poly Tar		5.25	0.042		
C_6H_{12} 84.156					0.005	0.42	0.013	0.013	0.018	0.005	0.42	0.122	5.54	0.076	0.022			5.54			
C_3-C_6											10.44	3.041		2.214	0.645						
TOTAL		9.491	110.80		3.290		9.602	19.093	14.801												
H_2+CO		9.045	3433 S.C.F.H.		1.772		5.258	14.303	7.030	- 7.273							gal/hr.		gal/MCF BPD		
H_2/CO		1.94	29133		6.77			2.81		1.55						Gasoline	2.767		0.8061	4370	

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 10.1 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.096*	13.43	3.912	6.31	2.128	0.620	Diesel	0.311	0.0906	491
TOTAL OIL		23.87	6.954		4.342	1.265	WaxyBtms	0.220	0.0641	348
WATER SOLUBLE CHEMICALS	0.099*	5.24	1.527		0.655	0.191	Poly Tar	0.071	0.0207	112
TOTAL LIQUID PRODUCTS C_3+		29.11	8.481		4.997	1.456	Total	3.369	0.9815	5321
NET WATER	1.714*	30.89	9.000				WSChem	0.655	0.1908	1034
GROSS WATER							Total	4.024	1.1723	6356
HYDROCARBON TOTAL—C_1+		37.15	10.823							

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
65.34	92.58	74.14	80.41	75.88	41.95	50.85	78.35

*Included in Reactor Effluent Total

Form ML-11

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF

RATE CALCULATIONS

HOURS 456

GAS ANALYSES HOUR				AVERAGE
FRESH FEED				
CO 28.010	32.4			
H_2 2.016	62.9			
CO_2 44.010	1.8			
N_2 28.016	0.6			
CH_4 16.042	2.3			
			M. W.	11.6725
			H_2O 18.016	
			BALANCE	

GENERATOR BALANCE M/HR	C	H	O		Mol %	M/Hr	C	H	O
				O_2 32.000					
				CO 28.010					
				H_2 2.016					
				CO_2 44.010					
				N_2 28.016					
				CH_4 16.042					
				C_2H_6 30.068					
				C_3H_8 44.094					
				C_4H_{10} 58.120					
				TOTAL					

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
Stab. Vent	2.47	
WET GAS	51.30	58.75
OIL	13.43	
WATER WSC	5.24	
WATER	30.89	
TOTAL	103.33	
FRESH FEED	110.78	
WEIGHT BALANCE	93.27	
WET GAS FACTOR	1.14522	
INDICATED LOSS—S C F H		

WET GAS		Stab. Vent
CO 28.010	7.05	
H_2 2.016	47.71	2.3
CO_2 44.010	19.81	24.0
N_2 28.016	1.05	1.0
CH_4 16.042	15.37	5.6
C_2H_4 28.052	2.53	4.8
C_2H_6 30.068	1.15	2.7
C_3H_6 42.078	2.72	21.7
C_3H_8 44.094	0.40	3.0
C_4H_8 56.104	1.23	25.4
C_4H_{10} 58.120	0.24	3.8
C_5H_{10} 70.130	0.60	5.2
C_5H_{12} 72.146		
C_6H_{12} 84.156	0.14	0.5
M. W.	18.1593	44.926

GAS FLOW RATES	$\sqrt{R}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED				3602		9.491
WET GAS		Corrected		1228		3.235
		Observed		1072		2.825
RECYCLE				3644		9.602
~~XXXX~~ Stab.Vent				21		0.055
NATURAL GAS						
OXYGEN						
STEAM						

LIQUID PRODUCT RATES HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL						55.2		
		#/hr.	% Chem	#/hr. Chem.	Net H2O			
WATER	H2O	34.83	11.3	3.94	30.89			
	Gas	38.89	2.0	0.78				
	Oil	8.94	5.8	0.52				
	WSC			5.24				

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. D-201-29-8
HOURS 481

	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	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	33.3	3.176	88.96		0.280	7.84	0.790	3.966	1.070	- 2.896	- 81.12					%	gph	#/hr.	%	gph	
H_2 2.016	63.2	6.029	12.15		1.656	3.34	4.680	10.709	6.336	- 4.373	8.81				400	75	1.523		98.0	1.492	
CO_2 44.010	1.7	0.162	7.13		0.683	30.06	1.899	2.061	2.582	0.521	22.93	6.564			400/550	16	0.325		91.4	0.297	
N_2 28.016	0.9	0.086	2.41		0.079	2.21	0.224	0.310	0.303	0.007	0.20				550+	9	0.183		114.6	0.210	
CH_4 16.042	0.9	0.086	1.38		0.358	5.74	1.008	1.094	1.366	0.272	4.36	1.248									
C_2H_4 28.052					0.088	2.47	0.240	0.240	0.328	0.088	2.47	0.707			$C_3^=$	40.1		1.64			70.4
C_2H_6 30.068					0.037	1.11	0.103	0.103	0.140	0.037	1.11	0.318			Poly Gaso			1.44		0.240	
C_1+C_2											7.94	2.273			Poly Tar			0.20		0.027	
C_3H_6 42.078					0.097	4.08	0.248	0.248	0.345	0.097	4.08	1.168	4.32	0.944	0.270			6.25			80.2
C_3H_8 44.094					0.024	1.06	0.065	0.065	0.089	0.024	1.06	0.303	4.24	0.250	0.072	C_4H_8			0.090		
C_4H_8 56.104					0.053	2.97	0.117	0.117	0.170	0.053	2.97	0.850	5.00	0.594	0.170	C_4Poly		6.10	0.369		84.1
C_4H_{10} 58.120					0.010	0.58	0.023	0.023	0.033	0.010	0.58	0.166	4.86	0.119	0.034	C_4H_{10}		4.86	0.119		
C_5H_{10} 70.130					0.025	1.75	0.063	0.063	0.088	0.025	1.75	0.501	5.45	0.321	0.092	C4Free Gaso		5.45	2.129		
C_5H_{12} 72.146													5.25			C_4Poly		5.25	0.041		
C_6H_{12} 84.156					0.005	0.42	0.013	0.013	0.018	0.005	0.42	0.120	5.54	0.076	0.022			5.54			
C_3-C_6											10.86	3.109		2.304	0.660						
TOTAL		9.539	112.03		3.395	63.63	9.473	19.012	14.737								gal/hr.		gal/MCF	BPD	
H_2+CO		9.205	3493 S.C.F.H.		1.936		5.470	14.675	7.406	- 7.269						Gasoline	2.707		0.7749	4201	
H_2/CO		1.90	2862625		5.91			2.70		1.51						Diesel	0.297		0.0850	461	

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 9.1 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

	NET CHANGE m/hr	NET CHANGE #/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.092*	12.87	3.684	6.34	2.030	0.581	WaxyBtms	0.210	0.0601	326
TOTAL OIL		23.73	6.793		4.334	1.241	Poly Tar	0.068	0.0195	106
WATER SOLUBLE CHEMICALS	0.100*	5.30	1.517	8.0	0.662	0.189	Total	3.282	0.9395	5094
TOTAL LIQUID PRODUCTS C_3+		29.03	8.310		4.996	1.430	WSChem	0.663	0.1898	1029
NET WATER	1.677*	30.21	8.648				Total	3.945	1.1293	6123
GROSS WATER										
HYDROCARBON TOTAL—C_1+		36.97	10.583							

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
64.41	91.18	72.53	78.97	73.02	40.83	49.53	78.52

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF

RATE CALCULATIONS

HOURS 481

GAS ANALYSES HOUR				AVERAGE
FRESH FEED				
CO 28.010	33.3			
H_2 2.016	63.2			
CO_2 44.010	1.7			
N_2 28.016	0.9			
CH_4 16.042	0.9			
			M. W.	
			H_2O 18.016	
			BALANCE	

GENERATOR BALANCE M/HR	C	H	O		Mol %	M/Hr	C	H	O
				O_2 32.000					
				CO 28.010					
				H_2 2.016					
				CO_2 44.010					
				N_2 28.016					
				CH_4 16.042					
				C_2H_6 30.068					
				C_3H_8 44.094					
				C_4H_{10} 58.120					
				TOTAL					

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
WET GAS Stab.Vent	2.13 53.95	61.54
OIL	12.87	
WATER WSC	5.30 30.21	
TOTAL	104.46	
FRESH FEED	112.05	
WEIGHT BALANCE	93.23	
WET GAS FACTOR	1.14068	
INDICATED LOSS—S C F H		

WET GAS		Stab. Vent		
CO 28.010	8.34	1.0		
H_2 2.016	49.40	2.8		
CO_2 44.010	20.05	25.4		
N_2 28.016	2.37	0.3		
CH_4 16.042	10.64	4.2		
C_2H_4 28.052	2.53	5.8		
C_2H_6 30.068	1.09	2.5		
C_3H_6 42.078	2.62	20.0		
C_3H_8 44.094	0.69	2.7		
C_4H_8 56.104	1.23	24.6		
C_4H_{10} 58.120	0.24	3.6		
C_5H_{10} 70.130	0.66	6.2		
C_5H_{12} 72.146				
C_6H_{12} 84.156	0.14	0.9		
	18.38118	45.257	M. W.	

GAS FLOW RATES	$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED				3620		9.539
WET GAS		Corrected		1271		3.348
		Observed		1114		2.935
RECYCLE				3585		9.473
Stab.Vent				18		0.047
NATURAL GAS						
OXYGEN						
STEAM						

LIQUID PRODUCT RATES HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL								
		#/hr.	% Chem	#/hr. Chem.	Net H2O			
WATER	H2O	34.13	11.5	3.92	30.21			
	Gas	45.49	1.9	0.86				
	Oil	8.74	5.9	0.52				
	WSG			5.30				

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. D-201-29-9
HOURS 652

	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	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	34.0	3.219	90.16		0.317	8.88	0.883	3.536	1.200	- 2.902						%	gph	#/hr.	%	gph	
H_2 2.016	63.6	6.022	12.14		1.759	3.55	4.897	10.921	6.656	- 4.263					400	75	1.438		98.0	1.409	
CO_2 44.010	1.5	0.142	6.25		0.704	30.98	1.923	2.065	2.627	0.562	24.73	7.052			400/550	16	0.307		91.4	0.281	
N_2 28.016	0.3	0.028	0.78		0.032	0.90	0.089	0.117	0.121						550+	9	0.173		114.6	0.198	
CH_4 16.042	0.6	0.057	0.91		0.318	5.10	0.882	0.939	1.200	0.261	4.19	1.195									
C_2H_4 28.052					0.087	2.44	0.234	0.234	0.321	0.087	2.44	0.696			C_3^-	39.2		1.49			69.0
C_2H_6 30.068					0.039	1.17	0.106	0.106	0.145	0.039	1.17	0.334			Poly	Gaso		1.30		0.217	
C_1+C_2											7.80	2.224			Poly	Tar		0.19		0.025	
C_3H_6 42.078					0.090	3.79	0.222	0.222	0.312	0.090	3.79	1.081	4.32	0.877	0.250			6.25			86.5
C_3H_8 44.094					0.014	0.62	0.035	0.035	0.049	0.014	0.62	0.177	4.24	0.143	0.041	C_4H_8			0.068		
C_4H_8 56.104					0.045	2.52	0.089	0.089	0.134	0.045	2.52	0.719	5.00	0.504	0.144	C_4Poly		6.10	0.319		80.4
C_4H_{10} 58.120					0.011	0.64	0.025	0.025	0.036	0.011	0.64	0.182	4.86	0.132	0.038	C_4H_{10}		4.86	0.132		
C_5H_{10} 70.130					0.024	1.68	0.058	0.058	0.082	0.024	1.68	0.479	5.45	0.309	0.088	C_4Free Gaso		5.45	2.102		
C_5H_{12} 72.146													5.25			C_4Poly Tar		5.25	0.036		
C_6H_{12} 84.156					0.011	0.93	0.031	0.031	0.042	0.011	0.93	0.265	5.54	0.167	0.048			5.54			
C_3-C_6											10.18	2.903		2.132	0.608						
TOTAL		9.468	110.24		3.451	63.20	9.473	18.941										gal/hr.	gal/MCF	BPD	
H_2+CO		9.241	3507 S.C.F.H.		2.076		5.780	14.457	7.856	7.165						Gasoline		2.621	0.7474	4052	
H_2/CO		1.87	285147		5.55		5.55	3.09	5.55	1.47						Diesel		0.281	0.0801	434	

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 8.91 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

EFFLUENT	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	POLYMER	gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.087*	12.15	3.464	6.337	1.917	0.547	WaxyBtms	0.198	0.0565	306
TOTAL OIL		22.33	6.367		4.049	1.155	Poly Tar	0.061	0.0174	94
WATER SOLUBLE CHEMICALS	0.102*	5.42	1.546		0.677	0.193	Total	3.161	0.9013	4886
TOTAL LIQUID PRODUCTS C_3+		27.75	7.913		4.726	1.348	WSChem	0.677	0.1930	1046
NET WATER	1.636*	29.47	8.403				Total	3.838	1.0944	5933
GROSS WATER										
HYDROCARBON TOTAL—C_1+		35.55	10.137							

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
63.55	90.15	70.79	77.53	82.07	39.04	49.56	78.06

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF.

RATE CALCULATIONS

HOURS 652

GAS ANALYSES

HOUR				AVERAGE
FRESH FEED				
CO 28.010	34.0			
H_2 2.016	63.6			
CO_2 44.010	1.5			
N_2 28.016	0.3			
CH_4 16.042	0.6			
			M. W.	11.6460
			H_2O 18.016	
			BALANCE	
WET GAS				
CO 28.010	9.32	1.3		
H_2 2.016	51.69	2.8		
CO_2 44.010	20.30	26.1		
N_2 28.016	0.94	0.7		
CH_4 16.042	9.31	3.9		
C_2H_4 28.052	2.47	5.1		
C_2H_6 30.068	1.12	2.7		
C_3H_6 42.078	2.34	20.1		
C_3H_8 44.094	0.37	2.8		
C_4H_8 56.104	0.94	24.9		
C_4H_{10} 58.120	0.26	3.9		
C_5H_{10} 70.130	0.61	5.3		
C_5H_{12} 72.146				
C_6H_{12} 84.156	0.33	0.4		
	17.9049	44.9538	M. W.	

GENERATOR BALANCE

M/HR	C	H	O		Mol %	M/Hr	C	H	O
				O_2 32.000					
				CO 28.010					
				H_2 2.016					
				CO_2 44.010					
				N_2 28.016					
				CH_4 16.042					
				C_2H_6 30.068					
				C_3H_8 44.094					
				C_4H_{10} 58.120					
				TOTAL					

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
Stab. Vent	2.38	
WET GAS	56.79	60.84
OIL	12.15	
WATER WSC	5.42	
	29.47	
TOTAL	106.21	
FRESH FEED	110.26	
WEIGHT BALANCE	96.33	
WET GAS FACTOR	1.07131	
INDICATED LOSS—S C F H		

GAS FLOW RATES

	$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED				3593		9.468
WET GAS		Corrected		1290		3.398
		Observed		1204		3.172
RECYCLE				3575		9.420
~~XXXX~~ Stab.Vent				20		0.053
NATURAL GAS						
OXYGEN						
STEAM						

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL						54.4		
		#/hr.	% Chem	#/hr. Chem.	Net H2O			
WATER	H2O	33.60	12.3	4.13	29.47			
	Gas	37.23	2.0	0.74				
	Oil	8.07	6.8	0.55				
	WSC			5.42				

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THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. D-201-29-10
HOURS 695

	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		3.098			0.229		0.718	3.816	0.947	- 2.869	
H_2 2.016		6.111			1.451		4.552	10.663	6.003	- 4.660	
CO_2 44.010		0.162			0.659		2.025	2.187	2.684	0.497	21.87
N_2 28.016		0.095			0.096		0.298	0.393	0.394		
CH_4 16.042		0.038			0.330		1.029	1.067	1.359	0.292	4.68
C_2H_4 28.052					0.096		0.294	0.294	0.390	0.096	2.69
C_2H_6 30.068					0.043		0.129	0.129	0.172	0.043	1.29
C_1+C_2											8.66
C_3H_6 42.078					0.097		0.297	0.297	0.394	0.097	4.08
C_3H_8 44.094					0.014		0.039	0.039	0.053	0.014	0.62
C_4H_8 56.104					0.051		0.121	0.121	0.172	0.051	2.86
C_4H_{10} 58.120					0.012		0.031	0.031	0.043	0.012	0.70
C_5H_{10} 70.130					0.025		0.070	0.070	0.095	0.025	1.75
C_5H_{12} 72.146											
C_6H_{12} 84.156					0.007		0.022	0.022	0.029	0.007	0.59
C_3-C_6											10.60
TOTAL		9.504			3.109		9.597	12.613			
H_2+CO		9.209	3494.8 S.C.F.H.		1.680		5.270	14.479	6.950	- 7.529	
H_2/CO		1.97	286138		6.34		6.34	2.79	6.34	1.62	

YIELD BASIS H_2+CO FED

	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO					%	gph	#/hr.	%	gph	
H_2				400	75	1.412		98.0	1.384	
CO_2	6.258			400/550	16	0.301		91.4	0.275	
N_2				550+	9	0.169		114.6	0.194	
CH_4	1.339									
C_2H_4	0.770			$C_3^=$	44.0		1.80			69.1
C_2H_6	0.369			Poly Gaso			1.58		0.263	
C_1+C_2	2.478			Poly Tar			0.22		0.029	
C_3H_6	1.167	4.32	0.945	0.270			6.25			87.4
C_3H_8	0.177	4.24	0.146	0.042	C_4H_8			0.062	68.0	
C_4H_8	0.818	5.00	0.572	0.164	C4Poly		6.10	0.373	1.5	81.0
C_4H_{10}	0.200	4.86	0.144	0.041	C_4H_{10}		4.86	0.144	68.0	
C_5H_{10}	0.501	5.45	0.322	0.092	C4Free Gaso		5.45	2.075	5.8	
C_5H_{12}		5.25			C4Poly Tar		5.25	0.042		
C_6H_{12}	0.169	5.54	0.106	0.030			5.54			
C_3-C_6	3.033		2.235	0.640						
TOTAL						gal/hr.		gal/MCF	BPD	
H_2+CO					Gasoline	2.654		0.8058	4364	
H_2/CO					Diesel	0.275		0.0786	426	

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO 9.82 $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$

	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF		gal/hr.	gal/MCF	BPD
RECOVERED OIL	0.086*	12.11	3.465	6.430	1.883	0.539	WaxyBtms	0.194	0.0555	301
TOTAL OIL		22.71	6.498		4.118	1.178	Poly Tar	0.071	0.0203	110
WATER SOLUBLE CHEMICALS	0.100*	5.30	1.517		0.662	0.190	Total	3.194	0.9602	5201
TOTAL LIQUID PRODUCTS C_3+		28.01	8.015		4.780	1.368	WSChem	0.663	0.1897	1028
NET WATER	1.731*	31.19	8.925				Total	3.857	1.1499	6229
GROSS WATER										
HYDROCARBON TOTAL—C_1+		36.67	10.493							

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+/C_1+
67.29	92.61	76.26	81.76				76.38

Form ML-11

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF.
cc/M3 = 141.3 × gal/MCF

RATE CALCULATIONS

HOURS 695

GAS ANALYSES HOUR				AVERAGE
FRESH FEED				
CO 28.010	32.6			
H_2 2.016	64.3			
CO_2 44.010	1.7			
N_2 28.016	1.0			
CH_4 16.042	0.4			
			M. W.	11.52005
			H_2O 18.016	
			BALANCE	

GENERATOR BALANCE M/HR	C	H	O		Mol %	M/Hr	C	H	O
				O_2 32.000					
				CO 28.010					
				H_2 2.016					
				CO_2 44.010					
				N_2 28.016					
				CH_4 16.042					
				C_2H_6 30.068					
				C_3H_8 44.094					
				C_4H_{10} 58.120					
				TOTAL					

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
WET GAS Stab.Vent	2.36 55.81	58.53
OIL	12.11	
WATER WSC	5.30 31.19	
TOTAL	106.77	
FRESH FEED	109.49	
WEIGHT BALANCE	97.52	
WET GAS FACTOR	1.04873	
INDICATED LOSS—S C F H		

WET GAS		Stab. Vent		
CO 28.010	7.48	1.0		
H_2 2.016	47.43	2.9		
CO_2 44.010	21.10	27.2		
N_2 28.016	3.11	1.0		
CH_4 16.042	10.72	3.9		
C_2H_4 28.052	3.06	5.2		
C_2H_6 30.068	1.34	3.2		
C_3H_6 42.078	2.31	20.1		
C_3H_8 44.094	0.41	3.0		
C_4H_8 56.104	1.26	23.3		
C_4H_{10} 58.120	0.32	3.5		
C_5H_{10} 70.130	0.73	5.2		
C_5H_{12} 72.146				
C_6H_{12} 84.156	0.23	0.5		
	19.15133	44.5904	M. W.	

GAS FLOW RATES	$\sqrt{H}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED				3607		9.504
WET GAS		Corrected		1160		3.056
		Observed		1106		2.914
RECYCLE				3622		9.544
~~XXXXX~~ Stab.Vent.				20		0.053
NATURAL GAS						
OXYGEN						
STEAM						

LIQUID PRODUCT RATES HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL						51.7		
		#/hr.	% Chem	#/hr. Chem.	Net H2O			
WATER	H2O	35.20	11.4	4.01	31.19			
	Gas	33.70	2.7	0.91				
	Oil	5.66	6.7	0.38				
	WSC			5.30				

C. ADJUSTMENT OF PILOT PLANT DATA TO BROWNSVILLE CASE VI DESIGN

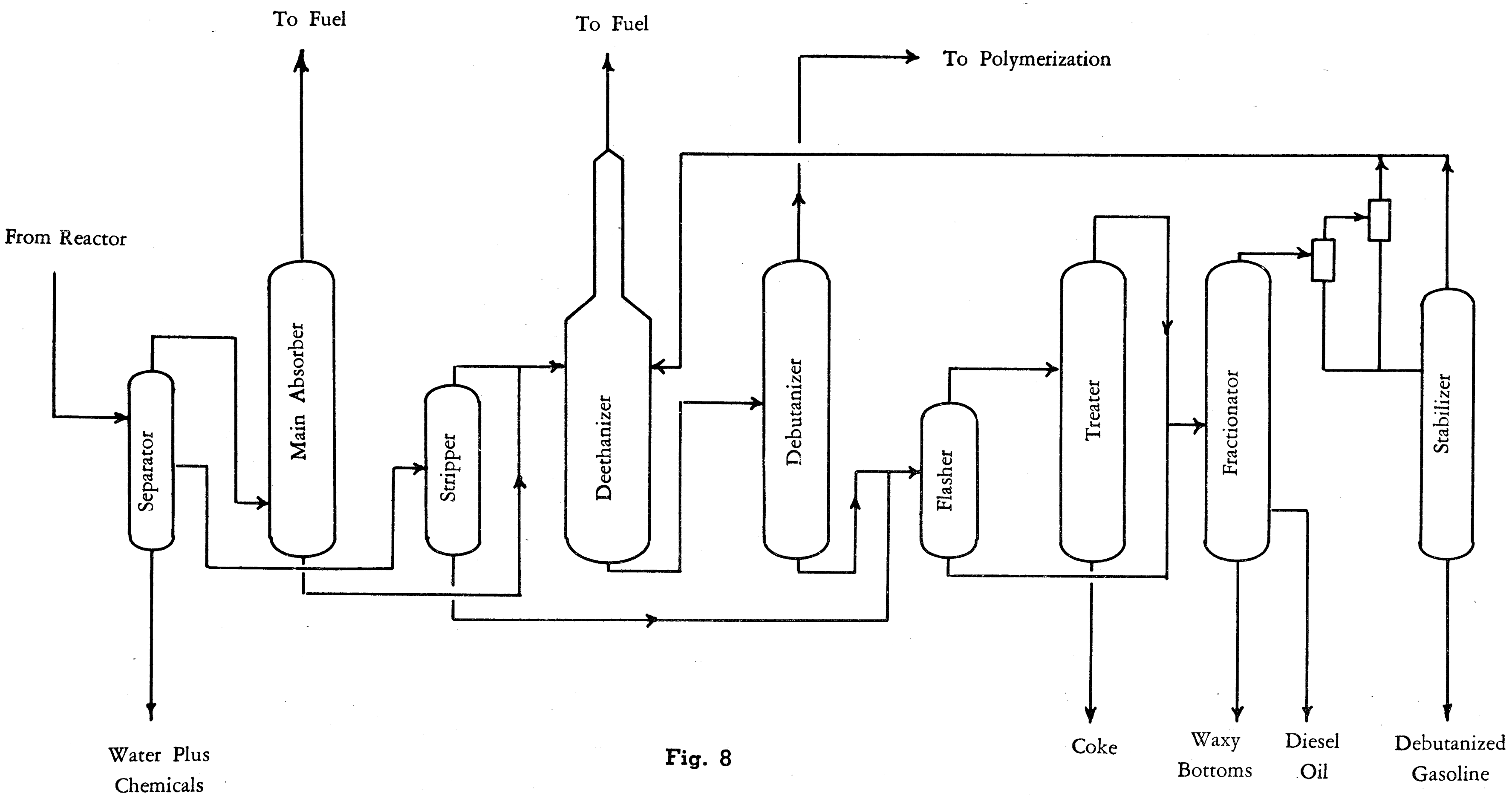

Fig. 8

Simplified Flow Diagram of Brownsville Case VI Recovery and Treating System

ADJUSTMENT OF PILOT PLANT DATA TO BROWNSVILLE CASE VI DESIGN BASIS

1. Introduction

In order to transpose pilot plant yield data to the Brownsville Case VI basis it is necessary to adjust the pilot plant yields for the recovery and polymerization of light ends and for the liquid treating operation. In the past, Montebello data have been reported on a polymer basis on the assumption that 90 per cent of the propylene and 95 per cent of the butylene would be recovered and polymerized and that there would be no liquid volume loss on treating.

2. Recovery and Treating System

A simplified flow diagram of the Brownsville Case VI recovery and treating system is shown in **Figure 8, opposite. This** shows that light ends can be lost either from the main absorber or from the de-ethanizer.

Since the absorber was sized for a velocity of 0.505 ft./sec. and the allowable velocity was 1.27 ft./sec. under design conditions, vapor handling capacity will not limit the absorber unless the feed rate is increased beyond 1.27/0.505 or 251 per cent of design. Since the design feed rate is 2364 MCF/hr. for a reactor fresh feed rate of 10066 MCF/hr. This limit to absorber vapor load will correspond to (2364)(2.51) = 5934 MCF/hr. or a contraction of 41 per cent. This value is so low that it does not seem likely that the vapor handling capacity will ever be a limitation.

Absorber recovery will decline, however, as vapor load

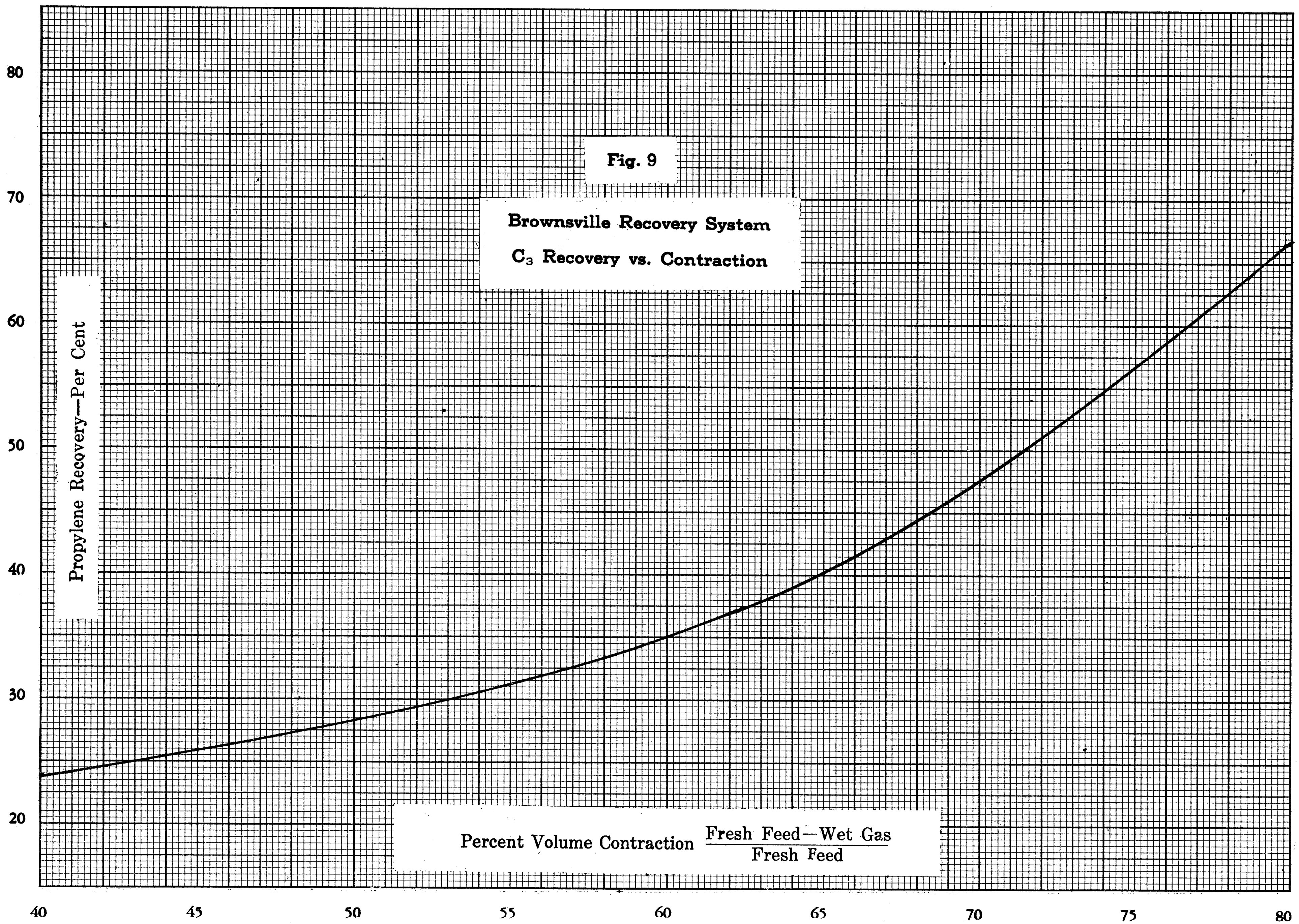
Fig. 9
Brownsville Recovery System
C_3 Recovery vs. Contraction
Propylene Recovery—Per Cent
Percent Volume Contraction $\frac{\text{Fresh Feed}-\text{Wet Gas}}{\text{Fresh Feed}}$
80
70
60
50
40
30
20
40
45
50
55
60
65
70
75
80

is increased if the design lean oil circulation is maintained. The design basis shows the following material balances for the absorber and de-ethanizer:

TABLE VIII-A
BROWNSVILLE CASE VI
MATERIAL BALANCE AROUND RECOVERY SYSTEM - DE-ETHANIZER

	Main Absorber- Lean Oil Circulation-2100 m/hr.							
Component	Feed	Absorbed	To Fuel	% Recovered	Feed	% Recovered	To Fuel	% Recovered
N_2	780.9	11.9	769.0		14.5		14.5	
CO	157.6	3.1	154.5		16.6		16.6	
H_2	2223.7	21.1	2202.6		26.0		26.0	
CO_2	1580.2	326.0	1254.2		388.7	4.7	384.0	
CH_4	722.1	45.5	676.6		249.7		249.7	
C_2H_4	216.5	44.9	171.6		62.9		62.9	
C_2H_6	188.3	55.7	132.6		88.3	8.8	79.5	
C_3H_6	139.8	100.8	39.0	72.1	146.6	120.1	26.5	81.9
C_3H_8	12.2	9.5	2.7		27.3	23.7	3.6	
C_4H_8	79.2	79.2		100.0	142.1	142.1		100.0
C_4H_{10}	6.7	6.7			38.9	38.9		
C_5H_{10}	89.3	89.3			116.3	116.3		
C_6H_{12}	27.4	27.4			29.7	29.7		
C_7	9.2	9.2			10.1	10.1		
C_8	3.4	3.4			3.9	3.9		
C_9	0.9	0.9			1.1	1.1		
C_{10}	0.4	0.4			0.5	0.5		
C_{11}	0.1	0.1			0.1	0.1		
Totals								
m/hr.	6237.9	835.1	5402.8		1363.3	500.0	863.3	
#/hr.	145038	38223	106815		56626	29394	27232	
MCF/hr.	2364	316	2048					

72.1 x 81.9 = 59.0% Overall C_3 Recovery.

The rate at which C_3 recovery declines with vapor load has been calculated for this system on the assumption that oil rate will be constant and that de-ethanizer recovery will not improve as absorber recovery declines. The results have been plotted in the opposite Figure 9 in terms of contraction - the decrease in volume of wet gas relative to synthesis reactor feed expressed as a percentage of reactor feed volume.

TABLE IX
BROWNSVILLE CASE VI
MATERIAL BALANCE AROUND LIQUID TREATER

Component	Moles Per Hour						Gallons Per Hour				
	Total Feed	Vapor to De-ethanizer	Stabilizer Bottoms	Diesel Oil	Waxy Bottoms	Coke	Total Feed	Vapor to De-ethanizer	Stabilizer Bottoms	Diesel Oil	Waxy Bottoms
N_2											
CO		12.8									
H_2											
CO_2		2.1									
CH_4		9.0									
C_2H_4		9.7									
C_2H_6		1.4									
C_3H_6		28.9						281			
C_3H_8		2.6						27			
C_4H_8	4.1	44.7					46	497			
C_4H_{10}	0.9	9.4					11	114			
C_5H_{10}	175.6	4.4	155.6				2345	59	2080		
C_5H_{12}	19.7	0.1	17.7				313	13	280		
C_6H_{12}	96.1	0.8	86.7				1525	13	1370		
C_7H_{14}	74.2	0.2	67.4				1318	4	1200		
C_8H_{16}	62.0	0.1	56.4				1219	2	1100		
C_9H_{18}	43.2		39.5				912		830		
$C_{10}H_{20}$	47.6		43.5				1080		985		
$C_{11}H_{22}$	48.1		34.6	8.52			1163		835	205	
$C_{13}H_{26}$	14.3			11.79			371			305	
$C_{15}H_{30}$	14.1			11.70			421			349	
$C_{17}H_{34}$	9.3			7.74			314			262	
$C_{20}H_{40}$	15.7			13.32	4.48		630			536	180
Totals											
m/hr.	624.9	126.2	501.4	53.07	4.48						
#/hr.	71486	5708	51702	11704	1300	1072					
gal/hr.	11668	864	8680	1657	180		11668	C_3+1010 C_4+ 702	8680	1657	180

3. Treating System

Material balances around the Brownsville treating system are given in the opposite Table IX. This balance shows liquid feed and product rates as follows:

	Treating Yields-gal./hr. Feed	Treating Yields-gal./hr. Products	Treating Yield, Vol. %
C_3H_6		281	
C_4 to 400 E.P.	9699	9382	96.7
Diesel Oil	1812	1657	91.4
Waxy Bottoms	157	180	114.6
	11668	11500	98.6

With a C_3 recovery of 60 per cent, the propylene produced in the treater will yield 122 gal./hr. of polymer and the final yields are:

	Feed	Products	Yield, Vol. %
400 E.P. Gasoline	9699	9504	98.0
Diesel Oil	1812	1657	91.4
Waxy Bottoms	157	180	114.6
	11668	11341	97.2

4. Polymerization System

Since the Brownsville polymerization unit was considerably over-designed, the following Table X was prepared showing adjustments of the Case VI base to the actual quantity of feed available and for the natural gasoline recovered in the natural gasoline absorber. The total gasoline yield has also been adjusted to an arbitrary 10#R.V.P. using vapor pressures for the individual fractions as shown.

In this calculation no credit has been taken for improved performance at reduced feed rate, the design conversion of propylene (98.5%) being retained in the final figures. The original distribution of polymerized olefin ($87\frac{1}{2}$% to gasoline - $12\frac{1}{2}$% to tar) has also been retained.

TABLE X
CORRECTION OF BROWNSVILLE CASE VI
FOR CASINGHEAD AND POLY OVERDESIGN TO 10# R.V.P. PRODUCT

	Poly Plant Design Basis Feed	Poly Plant Design Basis Dry Gas	Poly Plant Design Basis Liquid Products	Actual Feed	Casing-head	Net Feed	Dry Gas	C3 Poly Gaso-line	12½Wt.% of Tot. C3 Poly Tar	C4+ to Gaso-line	C4- to Gaso-line	12½Wt.% of Tot. C4- Poly Gasoline	C4- Poly Tar
N2													
CO													
H2													
CO2	5.5	5.5		4.7		4.7	4.7						
C1													
C2-													
C2	5.5	5.5		8.8		8.8	8.8						
C3-	286.2	4.4		120.1		120.1	3.6						
C3	80.7	80.7		23.7	13.6	10.1	10.1						
C4-	178.4		17.3	142.1		142.1					50.4		
iC4+	17.2		17.2	10.4	10.4								
nC4+	48.1		48.1	28.5	11.1	17.4				17.4			
Poly Gasoline			156.6					36.6				38.4	
Poly Tar			10.2						2.4				2.5
Total m/hr.	621.6	96.1	249.4	338.3		303.2	27.2	36.6	2.4	17.4	50.4	38.4	2.5
Total #/hr.	29756	4144	25612	16722		14926	1066	4281	612	1009	2822	4494	642
Total gal/hr.			4375					716	81	210	560	752	85

	R.V.P	Finished Stab. Gaso-line, gph	(RVP)(gph)
C4-	68.0	560	38,080
C4+	68.0	210	14,280
C5-	19.6	2,080	40,768
C6	5.0	1,370	6,850
C7	2.0	1,200	2,400
C3 Poly	1.5	716	1,074
C4 Poly	1.5	752	1,128
C8	1.0	1,100	1,100
C9	0.5	830	415
C10	0.2	985	197
C11	0.1	835	83.5
Total		10,638	106,375.5

TABLE XI

OVER-ALL PLANT BALANCE

BROWNSVILLE CASE VI EX-CASINGHEAD

	Natural Gas	Oxygen	H2O From Wash Towers	Fresh Feed to Reactors	H2O From Primary Separator	Finished Gasoline	Diesel Oil	Tar	Fuel Gas From Main Absorber	From De-ethanizer	From Poly Stabilizer	Total Fuel Gas
N_2	488.0	295.5		783.5					769.0	14.5		783.5
CO				8800.0					154.5	16.6		171.1
H_2				16233.9					2202.6	26.0		2228.6
CO_2				344.6					1254.2	384.0	4.7	1642.9
C_1	8746.0			283.7					676.6	65.7		742.3
C_2-									171.6	62.9		234.5
C_2	245.5								132.6	58.5	8.8	199.9
C_3-									39.0	26.5	3.6	69.1
C_3	51.0								2.7	3.6	10.1	16.4
C_4-						50.4						
C_4	18.4					17.4						
C_5-						155.6						
C_5												
C_6						86.7						
C_7						67.4						
Poly Gasoline						75.0						
C_8						56.4						
C_9						39.5						
C_{10}						43.5						
C_{11}						34.6	8.52					
C_{13}							11.79					
C_{15}							11.70					
C_{17}							7.74					
C_{20}							13.32	4.9 4.48				
O_2		5609.6										
H_2O			1615.6	114.8	5796.8							
WSC-$C_2H_5O_{1.5}$ = 53 MW					167.6							
Total moles/hr.	9591.2	5905.1	1615.6	26560.5			53.07	9.38	5402.8	658.3	27.2	6088.3
Total Lbs./hr.	163866	187751	29076	322571	113224	62704	11704	2554	106815	23658	1066	131539
Total gals./hr.						10638	1657	346				
Total MCF/hr.	3635	2238		10066					2047	250	10	2307
								Coke				
				Chemicals	8882 #/hr.			1072				
				Net Water	104342 #/hr.							
				Barrels Per Day		6079	947	198				

	Gals/hr.	Bbls/Day	gal./MCF
Gasoline	10638	6079	1.121
Diesel	1657	947	0.175
Tar	346	198	0.019
WSC	1105	631	0.017
	13746	7855	1.449

5. Over-All Plant Yields

Final plant yields for Brownsville Case VI are summarized in the opposite Table XI. These yields are on a casinghead-free basis, the finished gasoline being shown at 10#R.V.P.

The following material balance is shown:

Generator Feed	#/Hr.	Gal/Hr.	Bbl/Day	Yields Basis H_2 + CO Fed #/MCF	Yields Basis H_2 + CO Fed gal/MCF
Dry Natural Gas	163,866				
Oxygen	187,781				
Total Feed	351,647				
Plant Products					
Water from Wash Tower	29,076				
Water from Separator	104,342				
Fúel Gas	131,539				
Coke	1,072				
Total By-Products	266,029				
400-EP, 10#RVP Gasoline	62,704	10,638	6,079	6.600	1.120
Diesel	11,704	1,657	947	1.232	0.175
Waxy Bottoms	1,300	180	103	0.137	0.019
Poly Tar	1,253	166	95	0.131	0.017
Total Hydrocarbon Liquid	76,961	12,641	7,224	8.100	1.332
Primary W.S. Chemicals	8,882	1,104	631	0.935	0.117
Total Liquid Products	85,843	13,745	7,855	9.035	1.449
Total-All Products	351,872				

It should be noted that the yield of chemicals shown in this balance includes only the primary water soluble chemicals in the original Brownsville design basis. The extraction of chemicals in the oil scrubber and gas scrubber at Brownsville will actually reduce the yield of gasoline and increase the yield of chemicals relative to the values shown in this tabulation.

6. Adjustment of Pilot Plant Data

On the basis of the above review of the Brownsville design it is concluded that pilot plant yield data should be adjusted as follows:

a. Propylene Recovery and Polymerization

Using Figure 9, page 82, determine the recoverable propylene. Convert this to polymer assuming conversion of recovered propylene to liquid products, 87½ weight per cent gasoline and 12½ weight per cent tar.

b. Treating Yields

From the Hempel distillation on the recovered oil (adding 1 per cent for vapor loss to the 400°E. P. figure) calculate treater yields of finished liquids as follows:

400-E.P. Gasoline	98.0 Vol. Per Cent of Fraction Fed
Diesel	91.4
Waxy Bottoms	114.6

c. Butylene Polymerization

Calculate the quantity of butylene which must be polymerized to give a 10# R.V.P. finished gasoline using 68# R.V.P. for butylene, and 5.8# R.V.P. for C_4 free naphtha.

d. Sample Calculation

Period 49-B
16-34 Hours

1). Observed Yields

	#/hr.	gal./hr.
C_3H_6	12.75	2.951
C_4H_8	11.56	2.312
C_4H_{10}	4.42	0.909
C_5H_{10}	6.52	1.195
C_5H_{12}	1.59	0.303
C_6H_{12}	1.94	0.350
R. O.	87.82	13.479

Hempel on Recovered Oil

	Observed	Corrected	°API	#/gal.	#/hr.	gal/hr.
400 EP	71.0 +1.0	72.0	55.8	6.290	61.04	9.705
400/550	17.3	17.3	36.5	7.013	16.35	2.332
550+	11.7 -1.0	10.7	31.4	7.230	10.43	1.442
					87.82	13.479

2). Treating Yields

	Vol. %	gal./hr.	#/hr.
400 E.P.	98.0	9.511	59.82
Diesel	91.4	2.131	14.94
Waxy Bottoms	114.6	1.653	11.95

3). C_3 Polymerization

Contraction = 70.15 per cent Recovery = 48.0 per cent
C_3H_6 Recovered = (12.75)(0.48) = 6.12 #/hr.
C_3 Poly Gasoline = (6.12)(0.875) = 5.36 @5.98 = 0.896 gph
C_3 Poly Tar = (6.12)(0.125) = 0.76 @7.53 = 0.101 gph

4). C_4 Poly to 10# R.V.P.

	#/hr.	gal/hr.	#/gal.	RVP	(RVP)(gal/hr)
C_5H_{10}	6.52	1.195			
C_5H_{12}	1.59	0.303			
C_6H_{12}	1.94	0.350			
C_3 Poly	5.36	0.896			
Treated 400-EP	59.82	9.511			
	75.23	12.255		5.8	71.079
C_4H_{10}	4.42	0.909		68.0	61.812
C_4H_8	1.02	0.204		68.0	13.872
C_4H_8 Poly	9.22	1.542		1.5	2.313
	89.89	14.910		10.0	149.076
C_4 Poly Tar	1.32	0.175	7.53		

5). Finished Plant Yields

	#/hr.	gal/hr.	gal/MCF H2 + CO	Barrels Per Day Run 49B	Barrels Per Day Brownsville Basis
400-EP Gasoline	89.89	14.910	1.0297	5583	6079
Diesel	14.94	2.131	0.1472	798	947
Waxy Bottoms	11.95	1.653	0.1142	619	103
Poly Tar	2.08	0.276	0.0191	104	95
Total Hyd.	118.86	18.970	1.3101	7103	7224
W.S. Chemicals	12.02	1.469	0.1015	550	631
Total Liquid	140.88	20.439	1.4116	7653	7855

e. Sample Calculation

Period 49-F through P

1). Observed Yields

From Wet Gas	#/hr.	gal/hr.	#/gal.
C_3H_6	13.51	3.127	4.32
C_4H_8	11.89	2.378	5.00
C_4H_{10}	3.89	0.800	4.86
C_5H_{10}	6.87	1.261	5.45
C_5H_{12}	1.30	0.248	5.25
C_6H_{12}	2.02	0.365	5.54
R. O.	69.10	10.598	6.52

Hempel on Recovered Oil

	Observed		Corrected	°API	#/gal.	#/hr.	gal/hr.
400 EP	73.3	+1.0	74.3	55.5	6.300	49.61	7.874
400/550	17.8		17.8	35.9	7.038	13.28	1.887
550+	8.9	-1.0	7.9	27.3	7.42	6.21	0.837
						69.10	10.598

2). Treater Yields

	Vol.%	gal/hr.	#/hr.
400 E.P	98.0	7.717	48.62
Diesel	91.4	1.725	12.14
Waxy Bottoms	114.6	0.959	7.12

3). C_3 Polymerization

Contraction = 63.0 per cent Recovery = 38.5 per cent

C_3H_6 Recovered = (13.51)(0.385) = 5.20 #/hr.

C_3 Poly Gasoline = (5.20)(0.875) = 4.55 @5.98 = 0.761 gph

C_3 Poly Tar = (5.20)(0.125) = 0.65 @7.53 = 0.086 gph

4). C_4 Poly to 10# R.V.P.

	#/hr.	gal/hr.	#/gal.	RVP	(RVP)(gal/hr.)
C_5H_{10}	6.87	1.261			
C_5H_{12}	1.30	0.248			
C_6H_{12}	2.02	0.365			
C_3 Poly	4.55	0.761			
Treated 400-EP	48.62	7.717			
	63.36	10.352		5.80	60.042
C_4H_{10}	3.89	0.800		68.0	54.400
C_4H_8 Blended	0.93	0.186		68.0	12.648
C_4H_8 Poly	9.59	1.604		1.5	2.406
	77.77	12.942			129.496
C_4Poly Tar	1.37	0.182	7.53		

5). Finished Plant Yields

	#/hr.	gal/hr.	gal/MCF H2 + CO	Barrels Per Day Brownsville Basis
400-EP Gasoline	77.77	12.942	0.8707	4721
Diesel	12.14	1.725	0.1161	629
Waxy Bottoms	7.12	0.959	0.0645	350
Poly Tar	2.02	0.268	0.0180	98
Total Hydrocarbons	99.05	15.894	1.0693	5797
W.S.Chemicals	12.94	1.612	0.1085	588
Total Liquid	111.99	17.506	1.1778	6386

f. Sample Calculation
Period 49-Q through W

1). Observed Yields

From Wet Gas	#/hr.	gal./hr.	#/gal.
C_3H_6	14.10	3.264	4.32
C_4H_8	11.11	2.222	5.00
C_4H_{10}	3.43	0.706	4.86
C_5H_{10}	6.17	1.132	5.45
C_5H_{12}	0.94	0.179	5.25
C_6H_{12}	1.68	0.303	5.54
R. O.	71.74	11.047	6.494

Hempel on Recovered Oil

	Observed		Corrected	°API	#/gal.	#/hr.	gal/hr.
400 EP	72.5	+1.0	73.5	55.7	6.293	51.10	8.120
400/550	17.5		17.5	36.3	7.022	13.57	1.933
550+	10.0	-1.0	9.0	34.1	7.113	7.07	0.994
						71.74	11.047

2). Treater Yields

	Vol. %	gal./hr.	#/hr.
400 E.P.	98.0	7.958	50.08
Diesel	91.4	1.768	12.40
Waxy Bottoms	114.6	1.139	8.10

3). C_3 Polymerization

Contraction = 62.2 per cent C_3 Recovery = 38.0 per cent
C_3H_6 Recovered = (14.10)(0.38) = 5.36 #/hr.
C_3 Poly Gasoline = (5.36)(0.875) = 4.69 @5.98 = 0.784 gph
C_3 Poly Tar = (5.36)(0.125) = 0.67 @7.53 = 0.089 gph

4). C_4 Poly to 10# R.V.P.

	#/hr.	gal/hr.	#/gal.	RVP	(RVP)(gal/hr.)
C_5H_{10}	6.17	1.132			
C_5H_{12}	0.94	0.179			
C_6H_{12}	1.68	0.303			
C_3 Poly	4.69	0.784			
Treated 400-EP	50.08	7.958			
	63.56	10.356		5.8	60.065
C_4H_{10}	3.43	0.706		68.0	48.008
C_4H_8 Blended	1.27	0.254		68.0	17.272
C_4H_8 Poly	8.61	1.440		1.5	2.160
	76.87	12.756			127.505
C_4 Poly Tar	1.23	0.163	7.55		

5). Finished Plant Yields

	#/hr.	gal/hr.	gal/MCF H_2 + CO	Barrels Per Day Brownsville* Basis
400-EP Gasoline	76.87	12.756	0.8363	4534
Diesel		1.768	0.1159	628
Waxy Bottoms		1.139	0.0747	405
Poly Tar	1.90	0.252	0.0165	90
Total Hydrocarbons		15.915	1.0434	5657
W. S. Chemicals		1.744	0.1143	620
Total Liquid		17.659	1.1578	6277

*25,033.9 m/hr. = 9488 MCFH = 227,707 MCF/D ÷ 42 = 5421.6

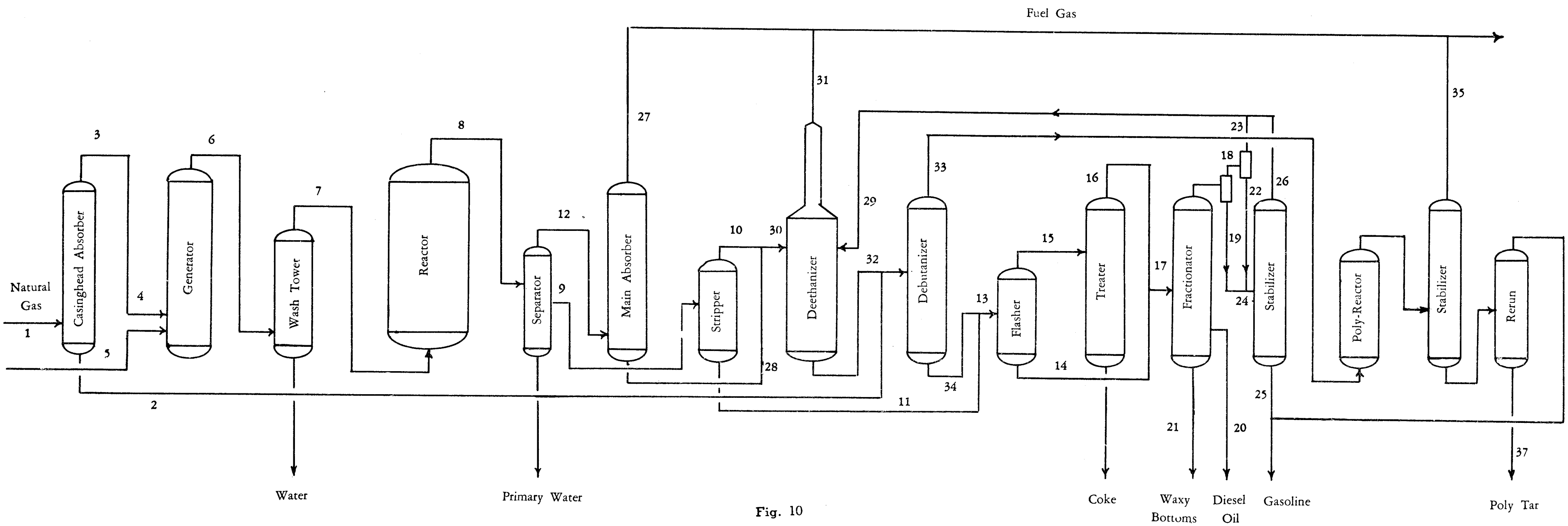

Fig. 10

Numerals refer to table XII

Flow Diagram of Brownsville Synthesis Unit

TABLE XII
DETAILED BROWNSVILLE CASE VI MATERIAL BALANCES

MW		1 Feed	2 Btms. to Deethanizer	3 Overhead to Generator	4 Dry Gas to Generator	5 Oxygen to Generator	6 Generator Effluent	7 Wash Tower Overhead Reactor Feed	8 Net Reactor Product	9 Flash Liquid to Stripper	10 Stripper overhead to Deethanizer	11 Stripper Btms. to Treater	12 Flash Vapor to Main Absorber	Wet Gas 10 + 12
		NATURAL GASOLINE ABSORBER												
28	N_2	488.0		488.0	488.0	295.5	783.5	783.5	783.5	2.6	2.6		780.9	783.5
28	CO						8800.0	8800.0	158.3	0.7	0.7		157.6	158.3
2	H_2						16233.9	16233.9	2228.6	4.9	4.9		2223.7	2228.6
44	CO_2						344.6	344.6	1640.8	60.6	60.6		1580.2	1640.8
16	C_1	8930.0	184.0	8746.0	8824.0		283.7	283.7	733.3	11.2	11.2		722.1	733.3
28	C_2^-								224.8	8.3	8.3		216.5	224.8
30	C_2	266.5	21.0	245.5	237.4				198.5	10.2	10.2		188.3	198.5
42	C_3^-								156.7	16.9	16.9		139.8	156.7
44	C_3	64.6	13.6	51.0	38.3				13.8	1.6	1.6		12.2	13.8
56	C_4^-								101.5	22.3	18.2	4.1	79.2	97.4
58	iC_4^+	22.5	10.4	12.1	3.1									
58	nC_4^+	17.4	11.1	6.3	0.4				8.9	2.2	1.3	0.9	6.7	8.0
70	C_5^-								168.8	79.5	2.8	76.7	89.3	92.1
72	C_5^+	19.7	19.7											
90	C_6								96.1	68.7	1.5	67.2	27.4	28.9
105	C_7								74.2	65.0	0.7	64.3	9.2	9.9
120	C_8								62.0	58.6	0.4	58.2	3.4	3.8
135	C_9								43.2	42.3	0.2	42.1	0.9	1.1
150	C_{10}								47.6	47.2	0.1	47.1	0.4	0.5
165	C_{11}								48.1	48.0		48.0	0.1	0.1
180	C_{13}								14.32	14.32		14.32		
210	C_{15}								14.14	14.14		14.14		
240	C_{17}								9.30	9.30		9.30		
290	C_{20}								15.66	15.66		15.66		
32	O_2					5609.6								
18	H_2O						1730.4	114,8						
Total Moles		9808.7	259.8	9548.9	9591.2	5905.1	28176.1	26560.5	6842.12	604.22	142.2	462.02	6237.9	6380.1
Total Lbs.		171114	6838	164276	163866	187781	351647	322571	209347	64309	5856	58453	145038	150894
Total Gals.												9289		
									To Stanolind					
H_2O								29076	104342					
WSChemicals									8882					
									113224					
							H_2 + CO	25034 m/hr. 9488 MCFH						
End Products														
Gal/hr.														
Lbs/hr.		171114				187781		29076	113224					

TABLE XII (CONT'D)

DETAILED BROWNSVILLE CASE VI MATERIAL BALANCES (CONT'D)

	13 Treater Feed Strpr.Btms.(11) +Debut.Btms(34)	14 Treater Flash Liquid to Fractionator	15 Treater Flash Vapor-Net Feed	16 Treater Reactor Products	17 Treater Fractionator Feed 14 + 16	18 Fractionator Overhead-Flash Vapor 22 + 23	19 Fractionator Overhead-Flash Liquid	20 Diesel Oil	21 Waxy Bottoms	22 Flash Vapor Condensate to Stabilizer	23 Flash Vapor Uncond. to Deethanizer	24 Stabilizer Feed 22 + 19
N_2												
CO				12.8	12.8	12.8					12.8	
H_2												
CO_2				2.1	2.1	2.0	0.1			0.9	1.1	1.0
C_1				9.0	9.0	8.9	0.1			1.6	7.3	1.7
C_2^-				9.7	9.7	9.3	0.4			4.2	5.1	4.6
C_2				1.4	1.4	1.3	0.1			0.7	0.6	0.8
C_3^-				28.9	28.9	24.4	4.5			18.1	6.3	22.6
C_3				2.6	2.6	2.1	0.5			1.6	0.5	2.1
C_4^-	4.1		4.1	44.7	44.7	28.7	16.0			24.8	3.9	40.8
iC_4^+												
nC_4^+	0.9		0.9	9.4	9.4	5.7	3.7			5.0	0.7	8.7
C_5^-	175.6	0.5	175.1	159.5	160.0	77.4	82.6			73.0	4.4	155.6
C_5^+	19.7	0.1	19.6	17.7	17.8	5.7	12.1			5.6	0.1	17.7
C_6	96.1	0.5	95.6	87.0	87.5	11.9	75.6			11.1	0.8	86.7
C_7	74.2	0.6	73.6	67.0	67.6	3.4	64.2			3.2	0.2	67.4
C_8	62.0	0.7	61.3	55.8	56.5	1.0	55.5			0.9	0.1	56.4
C_9	43.2	0.8	42.4	38.7	39.5	0.3	39.2			0.3		39.5
C_{10}	47.6	1.2	46.4	42.3	43.5		43.5					43.5
C_{11}	48.1	1.9	46.2	42.1	44.0		34.6	8.52				34.6
C_{13}	14.3	1.1	13.2	12.0	13.1			11.79				
C_{15}	14.1	1.9	12.2	11.1	13.0			11.70				
C_{17}	9.3	2.0	7.3	6.6	8.6			7.74				
C_{20}	15.7	5.6	10.1	9.2	14.8			13.32	4.48			
Total Moles	624.9	16.9	608.0	669.6	686.5	194.9	432.7	53.07	4.48	151.0	43.9	583.7
Total Lbs.	71486	3539	67947	66875	70414	11458	45952	11704	1300	9605	1653	55757
			Coke	1072								
End Products												
Gal/hr.								1657	180			
Lbs./hr.				1072				11704	1300			

TABLE XII (CONT'D)
DETAILED BROWNSVILLE CASE VI MATERIAL BALANCES (CONT'D)

	25 Stabilizer Bottoms	26 Stabilizer Overhead to Deethanizer	27 Main Absorber Overhead to Fuel	28 Main Absorber Bottoms to Deethanizer	29 Deethanizer Feed from Fract.Stab. 23 + 26	30 Total Deethanizer Feed 29+2+28+10	31 Deethanizer Overhead to Fuel	32 Deethanizer Btms. to Debutanizer	33 Debutanizer Overhead to Poly	34 Debutanizer Btms.to Treater	35 Poly Stab. Overhead to Fuel	36 Poly Gasoline	37 Poly Tar
N_2			769.0	11.9		14.5	14.5						
CO			154.5	3.1	12.8	16.6	16.6						
H_2			2202.6	21.1		26.0	26.0						
CO_2		1.0	1254.2	326.0	2.1	388.7	384.0	4.7	4.7		4.7		
C_1		1.7	676.6	45.5	9.0	249.7	249.7						
C_2^-		4.6	171.6	44.9	9.7	62.9	62.9						
C_2		0.8	132.6	55.7	1.4	88.3	79.5	8.8	8.8		8.8		
C_3^-		22.6	39.0	100.8	28.9	146.6	26.5	120.1	120.1		1.2		
C_3		2.1	2.7	9.5	2.6	27.3	3.6	23.7	23.7		23.7		
C_4^-		40.8		79.2	44.7	142.1		142.1	142.1			43.7	
iC_4^+						10.4		10.4	10.4			10.4	
nC_4^+		8.7		6.7	9.4	28.5		28.5	28.5			28.5	
C_5^-	155.6			89.3	4.4	96.5		96.5		96.5			
C_5	17.7				0.1	19.8		19.8		19.8			
C_6	86.7			27.4	0.8	29.7		29.7		29.7			
C_7	67.4			9.2	0.2	10.1		10.1		10.1		78.9	
C_8	56.4			3.4	0.1	3.9		3.9		3.9			
C_9	39.5			0.9		1.1		1.1		1.1			
C_{10}	43.5			0.4		0.5		0.5		0.5			
C_{11}	34.6			0.1		0.1		0.1		0.1			
C_{13}													
C_{15}													
C_{17}													
C_{20}													
												Gaso.	Tar
Total Moles	501.4	82.3	5402.8	835.1	126.2	1363.3	863.3	500.0	338.3	161.7	38.4	1615	5.1
Total Lbs.	51702	4055	106315	38223	5708	56626	27232	29394	16772	12622	1564	13933	1275
Gal./hr.												2502	169
End Products													
Gal/hr.	8680												
Lbs/hr.	51702		106815				27232				1564	13933	1275

TABLE XIII
TREATING YIELDS

	Moles Per Hour					Gallons Per Hour					
	Total Feed	To Deethanizer	Stabilizer Bottoms	Diesel	Tar	Total Feed	To Deethanizer	Stabilizer Bottoms	Diesel	Tar	Product
N_2											
CO		12.8									
H_2											
CO_2		2.1									
C_1		9.0									
C_2^-		9.7									
C_2		1.4									
C_3^-		28.9					281				
C_3		2.6					27				
C_4^-	4.1	44.7				46	497				
iC_4											
nC_4	0.9	9.4				11	114				
C_5^-	175.6	4.4	155.6			2345	59	2080			
C_5	19.7	0.1	17.7			313	13	280			
C_6	96.1	0.8	86.7			1525	13	1370			
C_7	74.2	0.2	67.4			1318	4	1200			
C_8	62.0	0.1	56.4			1219	2	1100			
C_9	43.2		39.5			912		830			
C_{10}	47.6		43.5			1080		985			
C_{11}	48.1		34.6	8.52		1163		835	205		1040, 80% to Gaso.
C_{13}	14.3			11.79		371			305		
C_{15}	14.1			11.70		421			349		
C_{17}	9.3			7.74		314			262		
C_{20}	15.7			13.32	4.48	630			536	180	716, 75% to Diesel
Total Moles	624.9	126.2	501.4	53.07	4.48						
Total Lbs.	71486	5708	51702	11704	1300						
Total Gals.	11668	864	8680	1657	180	11668	C_4+ 702 C_3+ 1010	8680	1657	180	

Vol. = 113 = 97.5% Vol.

Poly from C_3^- at 60% Rec. = (28.9)(0.60)(42)/5.98 = 122

C_4 to 400 EP Feed = 9699 — C_4 400 EP Product = 9382 = 96.7% Vol.

Total 400 EP = 9504

Diesel Feed = 1812 — Diesel Feed = 1657 = 91.4% Vol.

Fuel Oil = 157 — Fuel Oil = 180 = 114.6% Vol.

11668 — 11341 = 97.2% Vol.

TABLE XIV

CORRECTION OF BROWNSVILLE CASE VI DESIGN

FOR POLY PLANT OVERDESIGN AND CASINGHEAD FEED

	POLY PLANT DESIGN			ACTUAL BROWNSVILLE			ACTUAL BROWNSVILLE ON CASINGHEAD FREE BASIS								
										Poly Gasoline			Poly Tar		
	Feed m/hr.	Dry Gas m/hr.	Liquid Product m/hr.	Feed m/hr.	Dry Gas m/hr.	Liquid Product m/hr.	From Casinghead m/hr.	Net Feed m/hr.	Dry Gas m/hr.	m/hr.	#/hr.	gal/hr.	m/hr.	#/hr.	gal/hr.
N_2															
CO															
H_2															
CO_2	5.5	5.5		4.7	4.7			4.7	4.7						
C_1															
C_2^-															
C_2	5.5	5.5		8.8	8.8			8.8	8.8						
C_3^-	286.2	4.4		120.1	1.2			120.1	2.2						
C_3	80.7	80.7		23.7	23.7		13.6	10.1	10.1						
C_4^-	178.4		17.3	142.1		43.7		142.1			28.31	562			
iC_4	17.2		17.2	10.4		10.4	10.4								
nC_4	48.1		48.1	28.5		28.5	11.1	17.4		17.4	10.09	210			
											88.47	1479			
Poly Gaso			156.6			78.9									
Poly Tar			10.2			5.1							4.4	10.95	145
Total moles	621.6	96.1	249.4	338.3	38.4	166.6		303.2	25.8	17.4			4.4		
Total Lbs.	29756	4144	25612	16772	1564	15208		14926	1007		126.87			10.95	
Total Gals.			4375			2671						2251			145

TABLE XV
FINAL BROWNSVILLE YIELD
CASINGHEAD-FREE

Component	MW	#/gal.	RVP	MAIN STABILIZER BOTTOMS m/hr.	#/hr.	gal/hr.	Less Casinghead m/hr.	NET STABILIZER BOTTOMS m/hr.	#/hr.	gal/hr.	TOTAL GASOLINE m/hr.	#/hr.	gal/hr.	For 10#RVP
nC_4^-	56	5.04	68.0								43.7	2447	486	562
iC_4^+	58	4.80	68.0											
nC_4^+	58	4.80	68.0								17.4	1009	210	210
C_5^-	70	5.25	19.6	155.6	10892	2080		155.6	10892	2080	155.6	10892	2080	2080
C_5^+	72	5.66	19.6	17.7	1604	280	17.7							
C_6	90	5.66	5.0	86.7	7803	1370		86.7	7803	1370	86.7	7803	1370	1370
C_7	105	5.91	2.0	67.4	7077	1200		67.4	7077	1200	67.4	7077	1200	1200
Poly Gaso	117	5.98	1.5								78.9	9231	1544	1479
C_8	120	6.10	1.0	56.4	6768	1100		56.4	6768	1100	56.4	6768	1100	1100
C_9	135	6.41	0.5	39.5	5333	830		39.5	5333	830	39.5	5333	830	830
C_{10}	150	6.61	0.2	43.5	6525	985		43.5	6525	985	43.5	6525	985	985
C_{11}	165	6.83	0.1	34.6	5700	835		34.6	5700	835	34.6	5700	835	835
C_{13}	180	6.95												
C_{15}	210	7.05												
C_{17}	240	7.10												
Poly Tar	250	7.53												
C_{20}	290	7.20												
Total				501.4	51702	8680		483.7	50098	8400		62785	10640	10651

RVP 9.53

RVP of C4 Free Gaso. = 5.40

Exp. TDC-802-37-P