B. INDIVIDUAL PERIOD DATA FOR RUN 51

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 A
HOURS 0-8

FRESH FEED	%	m/hr	#/hr
CO 28.010	38.370	9.681	269.46
H_2 2.016	55.887	14.012	28.25
CO_2 44.010	4.917	1.233	54.26
N_2 28.016	0.773	0.194	5.44
CH_4 16.042	0.053	0.013	0.21
C_2H_4 28.052			
C_2H_6 30.068			
C_3+C_4			
C_3H_6 42.078			
C_3H_8 44.094			
C_4H_8 56.104			
C_4H_{10} 58.120			
C_5H_{10} 70.130			
C_5H_{12} 72.146			
C_6H_{12} 84.156			
C_5-C_6			
TOTAL		25.073	357.62
H_2+CO	94.257	23.633	8959 S.C.F.H.
H_2/CO	1.46	111619	

WET GAS	%	At Wt. Balance m/hr	At Wt. Balance #/hr
CO 28.010	6.100	0.436	12.21
H_2 2.016	27.331	1.953	3.94
CO_2 44.010	37.810	2.701	118.84
N_2 28.016	3.573	0.255	7.14
CH_4 16.042	14.510	1.037	16.64
C_2H_4 28.052	3.003	0.215	6.03
C_2H_6 30.068	1.407	0.101	3.04
C_3+C_4			
C_3H_6 42.078	2.960	0.212	8.92
C_3H_8 44.094	0.470	0.034	1.50
C_4H_8 56.104	1.503	0.107	6.00
C_4H_{10} 58.120	0.543	0.039	2.27
C_5H_{10} 70.130	0.517	0.037	2.59
C_5H_{12} 72.146	0.123	0.009	0.65
C_6H_{12} 84.156	0.150	0.011	0.93
C_5-C_6			
TOTAL		7.147	190.70
H_2+CO		2.389	
H_2/CO		4.48	

RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr
1.706	11.387	2.142	- 9.185	-257.25
7.646	21.658	9.599	-12.059	- 24.31
10.577	11.810	13.278	1.468	64.58
1.000	1.194	1.255		
4.059	4.072	5.096	1.024	16.43
0.840	0.840	1.055	0.215	6.03
0.394	0.394	0.495	0.101	3.04
				25.50
0.828	0.828	1.040	0.212	8.92
0.131	0.131	0.165	0.034	1.50
0.420	0.420	0.527	0.107	6.00
0.152	0.152	0.191	0.039	2.27
0.145	0.145	0.182	0.037	2.59
0.034	0.034	0.043	0.009	0.65
0.042	0.042	0.053	0.011	0.93
				22.86
27.974	53.047	41.061		
9.352	32.985	11.741	-21.244	
	1.91	4.48	1.31	

YIELD BASIS H_2+CO FED — CONDENSATE	#/MCF	#/gal	gal/hr	gal/MCF
	0.996	4.33	2.065	0.230
	0.167	4.24	0.354	0.040
	0.670	5.00	1.200	0.134
	0.253	4.86	0.467	0.052
	0.289	5.48	0.475	0.053
	0.073	5.25	0.124	0.014
	0.104	5.54	0.168	0.019
	2.552		4.853	0.542
	7.003		9.645	1.077
	9.555		14.507	1.619
	0.148*	7.88	0.879	0.098
		93.48	10.434	
	5.345*	96.30	10.749	8.328
		104.18	11.628	8.334
		118.98	13.280	

POLYMER	#/MCF	#/gal	gal/hr	gal/MCF	% Unsats.
Distribution of Recovered Oil					
400 EP				0.707	
400-550				0.168	
550+				0.202	
	8.03	6.23	1.284	0.143	
					66.2
	5.70	6.10	0.934	0.104	
	2.27	4.86	0.467	0.052	72.3
	2.59	5.45	0.475	0.053	
	0.65	5.25	0.124	0.014	80.4
	0.93	5.54	0.168	0.019	
	20.17		2.251	3.462	0.385
	1.077	62.74	7.003	9.645	1.077
	88.91		9.254	13.097	1.462
	7.88	90.79	10.133	14.034	1.567

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

EFFLUENT	
RECOVERED OIL	0.447*
TOTAL OIL	
WATER SOLUBLE CHEMICALS	0.148*
TOTAL LIQUID PRODUCTS C_5+	
NET WATER	5.345*
GROSS WATER	
HYDROCARBON TOTAL—C_1+	

SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 11.1

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY	
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3+/C_1+	
71.50	95.47	86.06	89.89	81.09	55.68	64.40	78.57	

* Included in Reactor Effluent Total

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

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	401	Fresh Feed	9505
Natural Gas	398	Recycle	10605
Generator Outlet	393	Combined Feed	20110
Reactor Inlet	385	Wet Gas—Measured	1901
Condenser Inlet		Adjusted	2709
Product Accumulator	365	Loss	808
TEMPERATURES—°F.		Recycle/Fresh Feed	1.11
Oxygen	521	Inlet Velocity—ft./sec.	0.66
Natural Gas	810	Fresh Feed Rate—S.C.F.H.	8959
Generator		per Cu. Ft. Dense Bed	732
Quench Accumulator	140	per Lb. Catalyst	5.05
Reactor Inlet	423	per Sq. Ft.	13574
Condenser Inlet			
Product Accumulator	55	Heat Transfer Calculations	
Catalyst No. Height "		Steam Rate = 362.7 #/hr	
1	12.0 650	@ 790.6 psia & 517°F	
2	42.2 660	= 1197 BTU/#	
3	74.4 665	Water in @ 158°F = 125 BTU/#	
5	136.8 657	Heat Transferred/lb. steam	
7	199.2 636	= 1072 BTU	
8	230.4 611	(1072)(362.7) = 388814 BTU/hr	
9	261.6 606	Ave. Bed Temperature	
10	292.8 571	= 646°F	
11	311.0 572	ΔT = 646-517 = 129°F	
12	342.0	Tube Area = 30.9 ft²	
		$K = \frac{388800}{(129)(30.9)} = 97.5$	

PRODUCT TESTS	OIL	WATER
°API	48.6	9.9
Neut. No.	39.2	57.2
Sap. No.	46.6	38.8
Hydrox. No.		
Bromine No.	78.2	
Pour °F.		
Chemicals, % by K_2CO_3		7.5
HEMPEL. DIST. %		°API
205 °F.		
400	65.6	55.1
400-550	15.6	36.6
550+	18.8	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	120	
10%	150	
50%	239	
90%	358	
EP	409	
Rec.	98.0	

CATALYST DATA — INVENTORY DATA	
In Reactor at Start of Period	2217
Fresh Catalyst Added	
Total	
Catalyst Recovered	6
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height "	
0 0 - 12	28
1 12 - 43.2	73
2 43.2 - 74.4	72
3 74.4 - 105.6	74
4 105.6 - 342.0	270
Total	517
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	145
Inventory, Lbs.	1774
Bed Depth, Ft.	18.54
Cu. Ft.	12.24
	29
Start of Period dP =	75
	76
	80
	200
	460
d = 151, h = 15.84,	
Inv. = 1579	
Vs. 1463	

PARTICLE SIZE — Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	22.7	80+	
100	150	58.1	40—80	
150	105	9.3	20—40	
200	74	7.3	10—20	
250	62	1.8	0—20	
325	44	0.6		
<325		0.2		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	150
Settled	151
Compacted	173
Particle Density, gm./cc.	4.9
NH_3 Value, ml./gm.	2.4
N_2 Surface, m^2/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, W+, % basis Fe	
X-Ray Analysis—	
Fe_2C_e	
Fe_3O_4	
Fe	

GAS ANALYSES	2200	0200	0600	AVERAGE
HOUR				
FRESH FEED				
CO 28.010	38.35	38.06	38.70	38.370
H_2 2.016	56.31	55.93	55.42	55.887
CO_2 44.010	4.53	5.16	5.06	4.917
N_2 28.014	0.73	0.81	0.78	0.773
CH_4 16.042	0.08	0.04	0.04	0.053
			M. W.	14.2632
			H_2O 18.016	
			BALANCE	
WET GAS				
CO 28.010	4.19	8.67	5.44	6.100
H_2 2.016	24.81	30.66	26.51	27.331
CO_2 44.010	27.70	40.78	44.96	37.810
N_2 28.014	4.53	3.24	2.95	3.573
CH_4 16.042	25.53	7.95	10.05	14.510
C_2H_4 28.052	3.37	2.49	3.15	3.003
C_3H_6 33.049	2.12	0.98	1.12	1.407
C_3H_8 42.078	3.54	2.53	2.81	2.960
C_4H_8 44.094	0.75	0.32	0.34	0.470
C_4H_8 56.104	1.70	1.30	1.51	1.503
C_4H_{10} 58.120	0.84	0.36	0.43	0.543
C_5H_{10} 70.130	0.54	0.49	0.52	0.517
C_5H_{12} 72.146	0.22	0.08	0.07	0.123
C_6H_{12} 84.156	0.15	0.15	0.15	0.150
			M. W.	26.6851

GENERATOR BALANCE	M/HR	C	H	O
FRESH FEED				
CO 28.010	9.621	9.621		9.621
H_2 2.016	14.012		28.024	
CO_2 44.010	1.233	1.233		2.466
N_2 28.014	0.194			
CH_4 16.042	0.013	0.013		0.042
			9.388	4.694
		10.867	37.412	16.823
		101.865	96.542	104.154
WET GAS				
	79.31	5.77	3.97	1.0048
RECYCLE	115.14	4.25	20.07	0.9469
BLEED	5.02	9.25	20.07	0.9469
NATURAL GAS	28.43	5.60	20.31	0.8897
OXYGEN	27.07	5.43	20.39	0.9952
STEAM	215.7	5.69	0.8955	

	Mol %	M/Hr	C	H	O
O_2 32.000	0.60	0.056 7.869			15.850
CO 28.010					
H_2 2.016					
CO_2 44.010	1.63	0.151	0.151		0.302
N_2 28.016	2.25	0.209			
CH_4 16.042	82.63	7.667	7.667	30.668	
C_2H_6 30.068	8.25	0.766	1.532	4.596	
C_3H_8 44.094	4.43	0.411	1.233	3.288	
C_4H_{10} 58.120	0.16	0.015	0.060	0.150	
	0.05	0.005	0.025	0.050	
TOTAL			10.668	38.752	16.152

GAS FLOW RATES	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
	385.8	69			
FRESH FEED	20.01	0.9915	9505	1.4247	25.073
	1.0	55			
WET GAS	3.97	1.0048	1901	1.0416	5.015
RECYCLE	387.9	120			
	20.07	0.9469	9686	1.0416	25.550
BLEED	387.9	120			
	20.07	0.9469	919	1.0416	2.424
NATURAL GAS	387.7	197	10605		27.974
	20.31	0.8897	3518	1.2229	9.280
OXYGEN	401.0	65			
	20.39	0.9952	2983		7.869
STEAM	31.0				
	-10.04	* Correction for hydraulic head.			
	362.7#/hr				

WEIGHT BALANCE	# hr Measured	At. Wt. Balance
WET GAS	133.82	190.70
OIL	62.74	62.74
WATER	104.18	104.18
TOTAL	300.74	357.62
FRESH FEED	357.62	
WEIGHT BALANCE	84.09	
WET GAS FACTOR		1.425048
INDICATED LOSS—S C F H		808

LIQUID PRODUCT RATES								
HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	1'10"	96.02	58	0.9961	95.65	49.6		
	0' 6	26.55	55	0.9975	26.48	6.505		
					69.17			62.74
	Accumulator - 2' @				7.76			9.645
		3.88	gal/ft		76.93		500.43	
					0.25		1.50	
					77.16		501.93	
WATER	2'3"	107.43	56	1.0003	107.46	9.2		
	0'3"	13.28	55	0.9995	13.27	8.334		
					94.19			
	Accumulator - 11' @ 3.88				5.82			104.18
					100.01		833.48	12.501

THE TEXAS COMPANY — MONTEBELLO LABORATORY

RUN NO. 51 B

HOURS 8-32

DATA SUMMARY

OPERATING CONDITIONS

PRESSURES PSIG	
Oxygen	439
Natural Gas	435
Generator Outlet	420
Reactor Inlet	410
Condenser Inlet	
Product Accumulator	397
TEMPERATURES—°F.	
Oxygen	454
Natural Gas	787
Generator	2265
Quench Accumulator	135
Reactor Inlet	387
Condenser Inlet	
Product Accumulator	71

Catalyst No.	Height "	
1	12.0	642
2	43.2	657
3	74.4	673
# 5	136.8	655
# 7	199.2	630
# 8	230.4	612
9	261.6	606
10	292.8	602
11	311.0	575
12	342.0	574

RATES S.C.F.H.	
Fresh Feed	10435
Recycle	10899
Combined Feed	21332
Wet Gas—Measured	2198
Adjusted	2799
Loss	601
Recycle/Fresh Feed	1.04
Inlet Velocity—ft./sec.	0.66
Fresh Feed Rate—S.C.F.H.	9986
per Cu. Ft. Dense Bed	755
per Lb. Catalyst	5.28
per Sq. Ft.	16130

Heat Transfer Calculations

Steam Rate = 357.9 #/hr
@ 802 psia & 518°F
= 1196 BTU/#

Water in @ 157°F = 125 BTU/#
Heat Transferred/lb. steam
= 1071 BTU

(1071)(357.9) = 383311 BTU/hr

Ave. Bed Temperature
= 646°F

dT = 646-518 = 128°F

Tube Area = 30.9 ft²

K = 383300 / (128)(30.9) = 96.9

PRODUCT TESTS

	OIL	WATER
°API	51.8	10.2
Neut. No.	41.0	37.2
Sap. No.	49.4	38.4
Hydrox. No.		
Bromine No.	84.2	
Pour °F.		
Chemicals, % by K_2CO_3		9.0

HEMPEL DIST. %		°API
205 °F.		
400	71.3	56.9
400-550	17.6	35.8
550+	11.1	

A. S. T. M. DIST. ON	
Naphtha °F.	
IBP	105
10%	136
50%	228
90%	348
EP	400
Rec.	98.0

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	0
Total	
Catalyst Recovered	18
In Reactor at End of Period	

REACTOR d-p, Inches H_2O		
No.	Height "	
0 0 - 12		28
1 12 - 43.2		72
2 43.2 - 74.4		71
3 74.4 - 105.6		75
4 105.6 - 342.0		305
Total		551

CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	143
Inventory, Lbs.	1891
Bed Depth, Ft.	20.03
Cu. Ft.	13.22

PARTICLE SIZE				
Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	18.2	80+	
100	150	56.7	40—80	
150	105	11.2	20—40	
200	74	8.6	10—20	
250	62	2.6	0—20	
325	44	1.6		
<325		0.4		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	150
Settled	151
Compacted	170
Particle Density, gm./cc.	4.5
NH_3 Value, ml./gm.	1.4
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	

FRESH FEED	%	m/hr	#/hr
CO 28.010	37.487	10.316	288.95
H_2 2.016	58.257	16.032	32.32
CO_2 44.010	3.440	0.947	41.68
N_2 28.016	0.753	0.207	5.80
CH_4 16.042	0.063	0.017	0.27
C_2H_4 28.052			
C_2H_6 30.068			
C_1+C_2			
C_3H_6 42.078			
C_3H_8 44.094			
C_4H_8 56.104			
C_4H_{10} 58.120			
C_5H_{10} 70.130			
C_5H_{12} 72.146			
C_6H_{12} 84.156			
C_3-C_6			
TOTAL		27.520	369.02
H_2+CO		26.348	9986 S.C.F.H.
H_2/CO	1.55	1.55	100141

WET GAS	%	At. Wt. Balance m/hr	At. Wt. Balance #/hr
CO 28.010	5.466	0.404	11.32
H_2 2.016	31.114	2.297	4.63
CO_2 44.010	40.082	2.960	130.27
N_2 28.016	2.443	0.180	5.04
CH_4 16.042	8.343	0.653	10.48
C_2H_4 28.052	3.123	0.231	6.48
C_2H_6 30.068	1.303	0.096	2.89
C_1+C_2			
C_3H_6 42.078	3.873	0.286	12.03
C_3H_8 44.094	0.450	0.033	1.46
C_4H_8 56.104	1.927	0.142	7.97
C_4H_{10} 58.120	0.463	0.034	1.98
C_5H_{10} 70.130	0.670	0.050	3.51
C_5H_{12} 72.146	0.073	0.005	0.36
C_6H_{12} 84.156	0.170	0.013	1.09
C_3-C_6			
TOTAL		7.384	199.46
H_2+CO		2.701	
H_2/CO		2.10	5.69

RECYCLE	
m/hr	
1.572	
8.947	
11.526	
0.703	
2.543	
0.898	
0.375	
1.114	
0.129	
0.554	
0.133	
0.193	
0.021	
0.049	
28.757	
10.519	
1.38	

COMBINED FEED m/hr	EFFLUENT m/hr
11.888	1.976
24.979	11.244
12.473	14.486
0.910	0.883
2.560	3.196
0.898	1.129
0.375	0.471
1.114	1.400
0.129	0.162
0.554	0.696
0.133	0.167
0.193	0.243
0.021	0.026
0.049	0.062
56.277	42.301
36.867	13.220
2.10	5.69

NET CHANGE m/hr	#/hr
- 9.912	277.64
-13.735	27.69
2.013	88.59
0.207	5.80
0.636	10.21
0.231	6.48
0.096	2.89
	19.58
0.286	12.03
0.033	1.46
0.142	7.97
0.034	1.98
0.050	3.51
0.005	0.36
0.013	1.09
	28.40
-23.647	
1.38	

YIELD BASIS H_2+CO FED

CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF
8.871			
1.022			
0.649			
0.289			
1.961			
1.205	4.32	2.785	0.279
0.146	4.24	0.344	0.034
0.798	5.00	1.594	0.160
0.198	4.86	0.407	0.041
0.351	5.45	0.644	0.064
0.036	5.28	0.069	0.007
0.109	5.84	0.197	0.020
2.844		6.040	0.605

POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF	% Unsats.
Distribution of					
Recovered Oil					
400 EP				0.665	
400-550				0.164	
550+				0.103	
					70.6
10.83	1.085	6.25	1.732	0.173	89.6
7.57	0.758	6.10	1.241	0.124	80.6
1.98	0.198	4.86	0.407	0.040	
3.51	0.351	5.45	0.644	0.064	90.2
0.36	0.036	5.25	0.069	0.007	
1.09	0.109	5.54	0.197	0.020	
25.34	2.538		4.290	0.430	

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

EFFLUENT							
	RECOVERED OIL	0.426*	59.83	5.991		9.309	0.932
	TOTAL OIL		88.23	8.835		15.349	1.537
SHIFT RATIO	WATER SOLUBLE CHEMICALS	0.184*	9.75	0.976	8.21	1.188	0.119
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 14.8	TOTAL LIQUID PRODUCTS C_3+		97.98	9.812		16.537	1.656
	WET WATER	5.550*	99.99	10.013		12.007	1.202
	GROSS WATER		109.74	10.989	10.2	13.195	1.321
	HYDROCARBON TOTAL—C_1+		117.56	11.773			

35.34	2.538		4.290	0.430	
94.92	9.505		14.787	1.481	

59.83	5.991		9.309	0.932	
85.17	8.529		13.599	1.362	
1.19	0.119	9.75	0.976	8.21	1.188	0.119
16.56	1.656	94.92	9.505		14.787	1.481
12.01	1.202					
13.19	1.321					

FRESH FEED CONVERSION — %			
Contraction	CO	H_2	H_2+CO
73.17	96.08	85.67	89.75

TOTAL FEED CONVERSION — %			
CO	H_2	CO+H_2	C_3+/C_1+
83.38	54.99	64.14	83.34

SELECTIVITY	
C_3+/C_1+	83.34

*Included in Reactor Effluent Total

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

GAS ANALYSES

HOUR	1400	2200	0600	AVERAGE
FRESH FEED				
CO 28.010	38.68	37.83	35.95	37.427
H_2 2.016	56.10	57.69	60.98	58.257
CO_2 44.010	4.39	3.57	2.36	3.440
N_2 28.016	0.79	0.89	0.58	0.755
CH_4 16.042	0.04	0.02	0.13	0.063
			M. W.	13.4096
			H_2O 18.016	
			BALANCE	

WET GAS	
CO 28.010	4.36
H_2 2.016	28.47
CO_2 44.010	43.59
N_2 28.016	2.85
CH_4 16.042	9.38
C_2H_4 28.052	3.22
C_2H_6 30.068	1.26
C_3H_6 42.078	3.50
C_3H_8 44.094	0.43
C_4H_8 56.104	1.76
C_4H_{10} 58.120	0.37
C_5H_{10} 70.130	0.59
C_5H_{12} 72.146	0.07
C_6H_{12} 84.156	0.15

5.20	5.84	5.436	
31.77	33.10	31.114	
41.42	35.23	40.082	
1.93	2.56	2.443	
8.65	8.50	8.843	
3.23	2.92	3.123	
1.30	1.35	1.303	
3.35	4.77	3.873	
0.27	0.55	0.450	
1.58	2.44	1.927	
0.41	0.61	0.463	
0.55	0.87	0.670	
0.08	0.07	0.073	
0.16	0.20	0.170	
	M. W.	27.0152	

GENERATOR BALANCE

	Mol %	M/Hr	C	H	O
O_2 32.000	0.98	7.647			15.492
		0.099			
CO 28.010					
H_2 2.016					
CO_2 44.010	2.47	0.249	0.249		0.498
N_2 28.016	3.78	0.381			
CH_4 16.042	80.30	8.095	8.095	32.380	
C_2H_6 30.068	8.10	0.817	1.634	4.902	
C_3H_8 44.094	4.11	0.414	1.242	3.312	
C_4H_{10} 58.120	0.15	0.015	0.060	0.150	
	0.11	0.011	0.066	0.132	
TOTAL			11.346	40.876	15.990

FRESH FEED			
10.516	10.316		10.316
16.032		32.064	
0.947	0.947		
0.207			
0.017	0.017	0.068	
		6.152	4.076
	11.880	40.284	16.886
	99.42	98.55	101.85

WET GAS			
79.51	6.73	4.02	0.9896
116.14	4.30	20.61	0.9420
5.08	9.4	20.61	0.9420
79.43	5.74	21.20	0.9883
27.07	5.25	20.84	0.9786
215.7	5.61	31.1	0.9858

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	156.62	199.46
OIL	59.83	59.83
WATER	109.74	109.74
TOTAL	326.19	369.03
FRESH FEED	369.03	
WEIGHT BALANCE	88.391	
WET GAS FACTOR		1.27353
INDICATED LOSS—S C F H		601

GAS FLOW RATES

	V/R	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
		413.4	85			
FRESH FEED						
	4.43	20.69	0.9768	10433	1.4693	27.520
		1.50	71			
WET GAS						
	6.73	4.02	0.9896	2198	1.03522	5.798
		410.0	126			
RECYCLE						
	4.30	20.61	0.9420	9951	1.035	26.255
		410.0	126			
BLEED						
	9.4	20.61	0.9420	948	1.035	2.502
		434.8	199	10899		28.757
NATURAL GAS						
	5.74	21.20	0.9883	3720	1.2105	10.081
		419.6	83			
OXYGEN						
	5.25	20.84	0.9786	2898		7.647
STEAM		31.1				
	5.61	0.9858		357.9#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL/HR
OIL	5'11½	316.58	62	0.9990	316.27	51.8		9.309
	1'10	96.02	68	0.9961	95.65	6.427		59.83
					220.62		1417.9	
					2.90		418.0	
					223.42		1435.9	
WATER								
	7'1½	377.68	78	0.9979	376.89	10.2		13.195
	2'½	107.43	56	1.0003	107.46	8.317		109.74
	1'9½	68.75	68	0.9992	68.68			
	0'3½	15.49	64	0.9953	15.43			
					316.58		2633.8	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 G
HOURS 28-56

	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	35.125	10.536	295.11	7.437	0.606	16.97	2.301	12.837	2.907	= 9.930	278.14					Distribution of					
H_2 2.016	60.860	18.256	36.80	36.726	2.995	6.04	11.361	29.617	14.356	=15.261	30.76					Recovered Oil					
CO_2 44.010	2.533	0.760	33.45	31.830	2.596	114.25	2.847	10.607	12.443	1.836	80.80	7.404				400 EP				0.046	
N_2 28.016	0.787	0.236	6.61	2.050	0.167	4.68	0.634	0.870	0.801							400-550				0.124	
CH_4 16.042	0.697	0.209	3.35	10.520	0.858	13.76	3.254	3.463	4.112	0.649	10.41	0.954				550+				0.115	
C_2H_4 28.052				3.093	0.252	7.07	0.957	0.957	1.209	0.252	7.07	0.648									70.8
C_2H_6 30.068				1.277	0.104	3.13	0.395	0.395	0.499	0.104	3.13	0.887									
C_1+C_2											20.61	1.899									
C_3H_6 42.078				3.523	0.287	12.08	1.099	1.099	1.386	0.287	12.08	1.107	4.32	2.796	0.256	10.87	0.996	6.28	1.740	0.159	88.5
C_3H_8 44.094				0.457	0.037	1.63	0.141	0.141	0.178	0.037	1.63	0.149	4.24	0.384	0.035						
C_4H_8 56.104				1.853	0.149	8.36	0.567	0.567	0.716	0.149	8.36	0.766	5.00	1.672	0.153	7.94	0.728	6.10	1.302	0.119	81.6
C_5H_{10} 68.120				0.413	0.034	1.98	0.128	0.128	0.162	0.034	1.98	0.181	4.86	0.407	0.037	1.98	0.181	4.86	0.407	0.037	
C_6H_{10} 70.130				0.617	0.050	3.51	0.191	0.191	0.241	0.050	3.51	0.322	6.45	0.644	0.059	3.51	0.322	6.45	0.644	0.059	88.9
C_7H_{12} 72.146				0.077	0.006	0.43	0.024	0.024	0.030	0.006	0.43	0.039	6.28	0.082	0.008	0.43	0.039	6.28	0.082	0.008	
C_8H_{12} 84.160				0.147	0.012	1.01	0.045	0.045	0.057	0.012	1.01	0.093	5.84	0.182	0.017	1.01	0.093	5.84	0.182	0.017	
C_9-C_8											22.00	2.656		6.167	0.565	25.74	2.359		4.357	0.399	
TOTAL		29.997	375.32		8.155	194.90	30.935	60.932	45.676												
H_2+CO	95.985	28.792	10912 S.C.F.H.		3.601		13.662	42.454	17.263	25.191											
H_2/CO		1.733	9164082		4.94			2.307		1.54											

CUMULATIVE TOTALS

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

EFFLUENT								
SHIFT RATIO	$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 10.4	RECOVERED OIL	0.443*	62.16	5.626		9.650	0.884	62.16	5.626		9.650	0.884	
		TOTAL OIL		91.16	8.354		15.817	1.449	87.90	8.055		14.007	1.284	
		WATER SOLUBLE CHEMICALS	0.214*	11.37	1.042	7.98	1.425	0.151	11.37	1.042		1.425	0.151	
		TOTAL LIQUID PRODUCTS C_5+		102.53	9.396		17.242	1.580	99.27	9.097		15.432	1.414	
		NET WATER	5.929*	106.81	9.788	8.328	12.825	1.175						
		GROSS WATER		118.18	10.830		14.250	1.306						
		HYDROCARBON TOTAL—C_1+		123.14	11.309									

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Conversion	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3 + /C_1 +
72.81	94.25	83.59	87.49	77.35	51.53	59.34	83.26

* Included in Reactor Effluent Total

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

OPERATING CONDITIONS		RATES S.C.F.H.	
PRESSURES PSIG			
Oxygen	443	Fresh Feed	11369
Natural Gas	439	Recycle	11724
Generator Outlet	419	Combined Feed	23093
Reactor Inlet	415	Wet Gas—Measured	2680
Condenser Inlet		Adjusted	3091
Product Accumulator	396	Loss	411
TEMPERATURES—°F.		Recycle/Fresh Feed	1.03
Oxygen	408	Inlet Velocity—ft./sec.	0.71
Natural Gas	774	Fresh Feed Rate—S.C.F.H.	10912
Generator	2315	per Cu. Ft. Dense Bed	842
Quench Accumulator	135	per Lb. Catalyst	5.73
Reactor Inlet	500	per Sq. Ft.	16533
Condenser Inlet			
Product Accumulator	63	Heat Transfer Calculations	
Catalyst No. Height "		Steam Rate = 414.8 #/hr	
1	12.0 653	@ 802 psia & 518°F	
2	43.2 658	= 1197 BTU/#	
3	74.4 673	Water in @ 159°F = 127 BTU/#	
5	136.8 651	Heat Transferred/lb. steam	
7	199.2 633	= 1070 BTU	
8	230.4 620	(1070)(414.8) = 444000 BTU/hr	
9	261.6 611	Ave. Bed Temperature	
10	292.8 606	= 648°F	
11	311.0 585	dT = 648-518 = 130°F	
12	342.0 569	Tube Area = 30.9 ft^2	
		K = 444000 / (130)(30.9) =	110.5

PRODUCT TESTS	OIL	WATER
°API	51.4	10.6
Neut. No.	43.2	37.7
Sap. No.	50.6	38.9
Hydrox. No.		
Bromine No.	90.1	
Pour °F.		
Chemicals, % by K_2CO_3		10.0
HEMPEL, DIST. %		°API
205 °F.		
400	73.0	57.1
400-550	14.0	36.8
550+	13.0	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	100	
10%	134	
50%	226	
90%	348	
EP	400	
Rec.	98.0	

CATALYST DATA: INVENTORY DATA		PARTICLE SIZE: Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
In Reactor at Start of Period						
Fresh Catalyst Added 55 = 83						
Total		On 40	419+	14.4	80+	
Catalyst Recovered	18	100	150	57.2	40—80	
In Reactor at End of Period		150	105	13.0	20—40	
		200	74	9.0	10—20	
REACTOR d-p, Inches H_2O		250	62	2.8	0—20	
No. Height "		325	44	2.8		
0 0 - 12	28	<325		0.8		
1 12 - 43.2	73	CATALYST				
2 43.2 - 74.4	74	Bulk Density, Lbs./Cu.Ft.				
3 74.4 - 105.6	75	Aerated			145	
4 105.6 - 342.0	305	Settled			147	
Total	555	Compacted			162	
		Particle Density, gm./cc.			4.55	
CALCULATED FROM dp		NH_3 Value, ml./gm.			2.4	
Density, Lbs./Cu.Ft.	147	N_2 Surface, m^2/gm.				
Inventory, Lbs.	1905					
Bed Depth, Ft.	13.63	CHEMICAL ANALYSIS				
Cu. Ft.	12.96	Fe				
		C				
		O				
		H				
		K_2O, W+, % basis Fe				
		X-Ray Analysis—				
		Fe_2C_9				
		Fe_3O_4				
		Fe				

	GAS ANALYSES			AVERAGE
HOUR				
FRESH FEED				
CO 28.010	35.30	35.31	34.76	35.123
H_2 2.016	60.33	60.59	61.66	60.860
CO_2 44.010	2.90	2.33	2.37	2.533
N_2 28.016	1.24	0.61	0.51	0.787
CH_4 16.042	0.23	1.16	0.70	0.697
			M. W.	12.5180
			H_2O 18.016	
			BALANCE	
WET GAS	1400	2200	0600	
CO 28.010	8.20	6.48	7.63	7.437
H_2 2.016	34.70	34.98	40.50	36.726
CO_2 44.010	33.43	31.93	30.13	31.830
N_2 28.016	1.39	2.31	2.45	2.050
CH_4 16.042	10.95	11.40	9.23	10.520
C_2H_4 28.052	3.35	3.09	2.96	3.093
C_2H_6 30.068	1.35	1.33	1.15	1.277
C_3H_6 42.078	3.39	4.03	3.15	3.523
C_3H_8 44.094	0.49	0.48	0.41	0.457
C_4H_8 56.104	1.64	2.35	1.51	1.853
C_4H_{10} 58.120	0.37	0.60	0.37	0.413
C_5H_{10} 70.130	0.56	0.79	0.50	0.617
C_6H_{12} 72.146	0.06	0.09	0.07	0.077
C_7H_{12} 96.162	0.15	0.15	0.14	0.147
			M. W.	25.90975

GENERATOR BALANCE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED					O_2 32.000	1.07	0.111 7.589			15.000
CO 28.010	10.536	10.536		10.536	CO 28.010					
H_2 2.016	18.256		36.512		H_2 2.016					
CO_2 44.010	0.760	0.760		1.520	CO_2	2.02	0.209	0.209		0.418
N_2 28.016	0.236				N_2 28.016	4.14	0.428			
CH_4 16.042	0.209	0.209	0.836		CH_4 16.042	79.57	8.224	8.224	32.896	
					C_2H_6 30.068	8.35	0.863	1.726	5.178	
			5.752	2.876	C_3H_8 44.094	4.67	0.483	1.449	3.864	
					C_4H_{10} 58.120	0.12 0.06	0.012 0.006	0.048 0.030	0.120 0.072	
		11.505	43.100	14.932	TOTAL			11.686	42.130	15.418
		22.45	102.30	26.85						

GAS FLOW RATES			PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
		$\sqrt{R}$	415.0	77			
FRESH FEED							
	79.31	4.62	20.73	0.9840	11369	1.5211	29.997
			1.5	65			
WET GAS							
	79.31	7.66	4.08	0.9971	2680	1.1004	7.070
			415.0	120			
RECYCLE							
	115.14	4.30	20.73	0.9469	10694	1.1004	28.217
			415.0	120			
BLEED							
	5.08	9.5	20.73	0.9469	1050	1.1004	2.718
			439.8	195	11724		30.935
NATURAL GAS							
	28.43	6.00	21.30	0.9924	3917	1.208	10.335
			442.9	75			
OXYGEN							
	27.07	4.81	21.37	0.9859	2900		7.389
			34.8				
STEAM							
	215.7	6.91			414.8#/hr		

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
WET GAS	169.05	194.99
OIL	62.16	62.16
WATER	118.18	118.18
TOTAL	349.39	375.33
FRESH FEED	375.33	
WEIGHT BALANCE	93.09	
WET GAS FACTOR		1.15342
INDICATED LOSS—S C F H		411

LIQUID PRODUCT RATES	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL	7:45		390.78	78	0.9911	387.30	51.4		62.16
	5'11		316.58	62	0.9990	316.27	6.441		9.650
	3'3		174.73	55	1.0025	175.17			
	0'4		17.70	96	0.9821	17.38			
						228.82			
						2.79		819.0	
						231.61		1491.8	
WATER									
	7:3½		386.41	70	0.9990	386.09	10.8		118.18
	1'3½		68.73	68	0.9992	68.68	8.293		14.250
	0'7½		35.06	68	0.9998	35.05			
	0'3½		14.38	60	1.0	14.38			
						348.01		2826.8	

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 51 D

HOURS 56-80

	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	#/gal	gal/hr	gal/MCF	% Unsats.
CO 28.010	36.943	10.509	294.36	6.743	0.549	15.38	2.054	12.563	2.603	- 9.960	278.98					Distribution of				
H_2 2.016	58.963	16.773	33.81	36.350	2.960	5.97	11.070	27.843	14.030	-13.813	-27.84					Recovered Oil				
CO_2 44.010	2.700	0.768	33.80	32.950	2.685	118.08	10.035	10.803	12.718	1.915	84.28	8.151				400 EP			0.659	
N_2 28.016	0.807	0.230	6.44	2.107	0.172	4.82	0.642	0.872	0.814							400-550			0.118	
CH_4 16.042	0.587	0.167	2.68	9.743	0.795	12.72	2.967	3.134	3.760	0.626	10.04	0.971				550+			0.087	
C_2H_4 28.052				3.133	0.255	7.15	0.954	0.954	1.209	0.255	7.15	0.691								70.7
C_2H_6 30.068				1.300	0.106	3.19	0.396	0.396	0.502	0.106	3.19	0.309								
C_1+C_2											20.38	1.971								
C_3H_6 42.078				3.707	0.302	12.71	1.129	1.129	1.431	0.302	12.71	1.288	4.32	2.942	0.284	11.44	1.106	6.28	1.930	0.177	89.0
C_3H_8 44.094				0.457	0.037	1.63	0.139	0.139	0.176	0.037	1.63	0.158	4.24	0.384	0.037					
C_4H_8 56.104				2.110	0.172	9.65	0.643	0.643	0.815	0.172	9.65	0.933	5.00	1.930	0.187	9.17	0.887	6.10	1.503	0.145	82.5
C_4H_{10} 58.120				0.447	0.036	2.09	0.136	0.136	0.172	0.036	2.09	0.202	4.86	0.430	0.042	2.09	0.430	4.86	0.430	0.042	
C_5H_{10} 70.130				0.713	0.058	4.07	0.217	0.217	0.275	0.058	4.07	0.394	5.45	0.747	0.072	4.07	0.747	5.45	0.747	0.072	89.9
C_5H_{12} 72.140				0.080	0.007	0.51	0.024	0.024	0.031	0.007	0.51	0.049	5.25	0.097	0.009	0.51	0.097	5.25	0.097	0.009	
C_6H_{12} 84.156				0.160	0.013	1.09	0.049	0.049	0.062	0.013	1.09	0.105	5.54	0.197	0.019	1.09	0.197	5.54	0.197	0.019	
C_3-C_6											31.75	3.071		6.727	0.651	28.37	2.744		4.804	0.465	
TOTAL		28.446	371.09		8.143	199.06	30.454	58.900	44.934											
H_2+CO	95.906	27.282	10340 S.C.F.H.		3.509		13.124	40.406	16.633	23.773										
H_2/CO		1.60	9671294		5.39			2.22		1.39										

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

EFFLUENT						
	RECOVERED OIL	0.410*	57.56	5.567	676.445	8.931	0.864	57.56	5.567		8.931	0.864
SHIFT RATIO	TOTAL OIL		89.31	8.637		15.658	1.514	85.93	8.311		13.735	1.328
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 12.0	WATER SOLUBLE CHEMICALS	0.218*	11.59	1.121		1.449	0.140	11.59	1.121		1.449	0.140
	TOTAL LIQUID PRODUCTS C_5+		100.90	9.758		17.107	1.654	97.52	9.431		15.184	1.468
	WET WATER	5.709*	102.86	9.948	38.33	12.351	1.194					
	GROSS WATER		114.45	11.069		13.800	1.335					
	HYDROCARBON TOTAL—C_1+		121.28	11.729								

*Included in Reactor Effluent Total

g/M3 = 16.91 × = MCF

cc/M3 = 141.3 × gal/MCF.

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3+/C_1+
71.37	94.78	82.35	87.14	79.28	49.61	58.84	83.20

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	437	Fresh Feed	10781
Natural Gas	434	Recycle	11542
Generator Outlet	417	Combined Feed	22323
Reactor Inlet	410	Wet Gas—Measured	2984
Condenser Inlet		Adjusted	3086
Product Accumulator	395	Loss	102
TEMPERATURES—°F.		Recycle/Fresh Feed	1.07
Oxygen	361	Inlet Velocity—ft./sec.	0.69
Natural Gas	733	Fresh Feed Rate—S.C.F.H.	10340
Generator	2305	per Cu. Ft. Dense Bed	819
Quench Accumulator	120	per Lb. Catalyst	5.50
Reactor Inlet	534	per Sq. Ft.	15667
Condenser Inlet			
Product Accumulator	60	Heat Transfer Calculations	
Catalyst No. Height"		Steam Rate = 408.2 #/hr	
1	12.0 649	@ 796 psia & 518°F	
2	43.2 652	= 1197 BTU/#	
3	74.4 665	Water in @ 158°F = 125 BTU/#	
# 5	136.8 649	Heat Transferred/lb. steam	
# 7	199.2 632	= 1072 BTU	
# 8	230.4 618	(1072)(408.2) = 437590 BTU/hr	
9	261.6 611	Ave. Bed Temperature	
10	292.8 606	= 644°F	
11	311.0 586	dT = 644-518 = 126°F	
12	342.0 579	Tube Area = 30.9 ft^2	
		K = $\frac{437590}{(126)(30.9)}$ = 112.4	

PRODUCT TESTS			
		OIL	WATER
°API		51.0	10.6
Neut. No.		45.8	39.4
Sap. No.		54.4	39.7
Hydrox. No.			
Bromine No.		83.1	
Pour °F.			
Chemicals, % by K_2CO_3			10.5
HEMPEL, DIST. %			°API
205 °F.			
400		76.3	56.8
400-550		13.6	36.7
550+		10.1	
A. S. T. M. DIST. ON			
Naphtha °F.			
IBP		100	
10%		134	
50%		226	
90%		350	
EP		399	
Rec.		97.5	

CATALYST DATA						
INVENTORY DATA		PARTICLE SIZE				
In Reactor at Start of Period		Screen Analysis			Sedimentation	
Fresh Catalyst Added 53 = 80		Mesh	Microns	%	Microns	%
Total		On 40	419+	16.1	80+	
Catalyst Recovered	6	100	150	64.1	40-80	
In Reactor at End of Period		150	105	11.0	20-40	
		200	74	7.2	10-20	
REACTOR d-p, Inches H_2O		250	62	1.2	0-20	
No. Height"		325	44	0.2		
0 0 - 12	29	<325		0.2		
1 12 - 43.2	75	CATALYST				
2 43.2 - 74.4	74	Bulk Density, Lbs./Cu.Ft.				
3 74.4 - 105.6	75	Aerated			130	
4 105.6 - 342.0	295	Settled			132	
Total	548	Compacted			147	
		Particle Density, gm./cc.			4.32	
CALCULATED FROM dp		NH_3 Value, ml./gm.			2.92	
Density, Lbs./Cu.Ft.	149	N_2 Surface, m^2/gm.				
Inventory, Lbs.	1681					
Bed Depth, Ft.	19.13	CHEMICAL ANALYSIS				
Cu. Ft.	12.63	Fe				
		C				
		O				
		H				
		K_2O, W+, % basis Fe				
		X-Ray Analysis—				
		$Fe_{20}C_9$				
		Fe_3O_4				
		Fe				

	GAS ANALYSES				GENERATOR BALANCE								WEIGHT BALANCE		
HOUR				AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		# hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.45	7.293 0.044			14.674	WET GAS	192.45	199.06
CO 28.010	37.28	37.04	36.51	36.943	10.509	10.509		10.509	CO 28.010						OIL	57.56	57.56
H_2 2.016	58.93	58.95	59.01	58.963	16.773		33.546		H_2 2.016						WATER	114.45	114.45
CO_2 44.010	2.71	2.76	2.63	2.700	0.768	0.768		1.536	CO_2 44.010	2.05	0.208	0.208		0.416	TOTAL	364.46	371.07
N_2 28.016	0.71	0.91	0.80	0.807	0.230				N_2 28.016	1.71	0.174				FRESH FEED	371.07	
CH_4 16.042	0.37	0.34	1.05	0.587	0.167	0.167	0.668		CH_4 16.042	82.88	8.410	8.410	33.640		WEIGHT BALANCE	98.22	
			M. W.	13.0450					C_2H_6 30.068	8.43	0.855	1.710	5.130				
			H_2O 18.016				7.170	3.585	C_3H_8 44.094	4.32	0.438	1.314	3.504		WET GAS FACTOR		1.034347
						11.444	41.384	15.630	C_4H_{10} 58.120	0.13 0.05	0.013 0.005	0.052 0.025	0.130 0.060		INDICATED LOSS—S C F H		108
			BALANCE			97.65	97.46	103.58	TOTAL				11.719	42.464	15.080		

WET GAS				
CO 28.010	6.17	7.74	6.32	6.743
H_2 2.016	38.09	54.97	35.99	36.350
CO_2 44.010	33.55	32.74	32.56	32.950
N_2 28.016	1.79	2.42	2.11	2.107
CH_4 16.042	8.84	9.46	10.93	9.743
C_2H_4 28.052	3.36	3.04	3.00	3.133
C_2H_6 30.068	1.22	1.36	1.32	1.300
C_3H_6 42.078	3.22	4.05	3.85	3.707
C_3H_8 44.094	0.33	0.54	0.50	0.457
C_4H_8 56.104	1.98	2.28	2.07	2.110
C_4H_{10} 58.120	0.45	0.43	0.46	0.447
C_5H_{10} 70.130	0.71	0.76	0.67	0.713
C_5H_{12} 72.146	0.10	0.07	0.07	0.080
C_6H_{12} 84.156	0.19	0.14	0.15	0.160
			M. W.	24.44317

GAS FLOW RATES							
	V/R	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR	
		412.4	73				
FRESH FEED	4.50	20.53	0.9877	10781	1.4897	28.446	
		1.50	60				
WET GAS	8.60	4.02	1.000	2984	1.0883	7.873	
		409.6	118				
RECYCLE	4.30	20.60	0.9485	10528	1.0883	27.778	
		409.6	118				
BLEED	9.5	20.60	0.9485	1014	1.0883	2.676	
		433.5	196	11542		30.454	
NATURAL GAS	5.87	21.17	0.8903	3846	1.2227	10.147	
		437.0	72				
OXYGEN	4.86	21.25	0.9887	2764		7.293	
		33.8					
STEAM	6.18	0.3062		408.2#/hr			
215.7							

LIQUID PRODUCT RATES							
HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'4	388.59	60	1.000	388.59	51.0		57.56
	3'3	174.73	55	1.0025	175.17	6.445		8.931
					213.42		1375.5	
					0.93		+6.0	
					214.35		1381.5	
WATER								
	6'10½	364.59	69	0.9991	364.26	10.6		114.45
	0'7½	33.06	62	0.9998	33.05	8.295		13.800
					331.21		2746.7	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 R
HOURS 80-104

	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	36.995	10.408	291.53	8.167	0.703	19.69	2.586	12.994	3.289	- 9.705	-271.84
H_2 2.016	58.084	16.341	32.94	35.540	3.059	6.17	10.254	26.595	13.313	-13.282	- 26.77
CO_2 44.010	2.550	0.717	31.56	30.042	2.586	113.81	9.513	10.230	12.099	1.869	82.25
N_2 28.016	0.755	0.212	5.94	2.300	0.198	5.55	0.728	0.940	0.926		
CH_4 16.042	1.620	0.456	7.32	13.187	1.135	18.21	4.175	4.632	5.311	0.679	10.89
C_2H_6 28.052				2.897	0.249	6.98	0.917	0.917	1.166	0.249	6.98
C_3H_8 30.068				1.267	0.108	3.25	0.398	0.398	0.506	0.108	3.25
C_4-C_5											21.12
C_3H_6 42.078				3.350	0.288	12.12	1.061	1.061	1.349	0.288	12.12
C_3H_8 44.094				0.423	0.036	1.59	0.134	0.134	0.170	0.036	1.59
C_4H_8 56.104				1.863	0.143	8.02	0.527	0.527	0.670	0.143	8.02
C_4H_{10} 58.120				0.397	0.034	1.98	0.126	0.126	0.160	0.034	1.98
C_5H_{10} 70.130				0.557	0.048	3.37	0.176	0.176	0.224	0.048	3.37
C_5H_{12} 72.142				0.070	0.006	0.43	0.022	0.022	0.028	0.006	0.43
C_6H_{12} 84.152				0.150	0.013	1.09	0.047	0.047	0.060	0.013	1.09
C_5-C_6											28.60
TOTAL		28.143	369.29		8.608	202.26	31.665	59.808	46.405		
H_2+CO	95.077	26.749	10138 S.C.F.H.		3.762		12.840	39.589	16.602	22.987	
H_2/CO		1.57	9864004		4.35			2.05		1.37	

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.
Distribution of Recovered Oil										
400 EP									0.648	
400-550									0.103	
550+									0.109	
	1.074									
	0.688									69.7
	0.321									
	2.083									
	1.196	4.32	2.806	0.277	10.91	1.076	6.28	1.745	0.172	88.8
	0.157	4.24	0.375	0.037						
	0.791	5.00	1.604	0.158	7.62	0.752	6.10	1.249	0.123	80.7
	0.195	4.86	0.407	0.040	1.98	0.195	4.86	0.407	0.040	
	0.332	5.45	0.618	0.061	3.37	0.332	5.45	0.618	0.061	88.8
	0.042	5.25	0.082	0.008	0.43	0.042	5.25	0.082	0.008	
	0.108	5.84	0.208	0.021	1.09	0.108	5.54	0.208	0.021	
	2.821		6.100	0.602	25.40	2.505		4.309	0.425	

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

EFFLUENT					
	RECOVERED OIL	0.395*	55.45	5.470	8.718	0.860	55.45	5.470	8.718	0.860	
SHIFT RATIO	TOTAL OIL		84.05	8.291	14.818	1.462	80.85	7.975	13.027	1.285	
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 8.9	WATER SOLUBLE CHEMICALS	0.233*	12.34	1.217	7.98	1.547	0.153	12.34	1.217	1.547	0.153	
	TOTAL LIQUID PRODUCTS C_5+		96.39	9.508		16.365	1.614	93.19	9.192	14.574	1.438	
	NET WATER	5.504*	99.17	9.782		11.908	1.175					
	GROSS WATER		111.51	10.999		13.455	1.327					
	HYDROCARBON TOTAL—C_1+		117.51	11.591							

*Included in reactor effluent 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+	
73.03	93.25	81.28	85.94	74.69	49.94	58.06	82.03	

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

OPERATING CONDITIONS		RATES S.C.F.H.	
PRESSURES PSIG			
Oxygen	437	Fresh Feed	10663
Natural Gas	434	Recycle	12001
Generator Outlet	422	Combined Feed	22664
Reactor Inlet	418	Wet Gas—Measured	2937
Condenser Inlet		Adjusted	3263
Product Accumulator	399	Loss	326
TEMPERATURES—°F.		Recycle/Fresh Feed	1.13
Oxygen	339	Inlet Velocity—ft./sec.	0.69
Natural Gas	727	Fresh Feed Rate—S.C.F.H.	10138
Generator	2330	per Cu. Ft. Dense Bed	777
Quench Accumulator		per Lb. Catalyst	5.25
Reactor Inlet	572	per Sq. Ft.	15361
Condenser Inlet			
Product Accumulator	55	Heat Transfer Calculations	
Catalyst No. Height "		Steam Rate = 408.2 #/hr	
1 12.0	645	@ 799.4 psia & 518°F	
2 43.2	649	= 1197 BTU/#	
3 74.4	657	Water in @ 156°F = 124 BTU/#	
# 5 136.8	640	Heat Transferred/lb. steam	
# 7 199.2	628	= 1073 BTU/hr	
# 8 230.4	615	(1073)(408.2) = 438000 BTU/hr	
9 261.6	606	Ave. Bed Temperature	
10 292.8	602	= 639°F	
11 311	586	dT = 639-518 = 121°F	
12 342	575	Tube Area = 30.9 ft²	
		K = 438000/(121)(30.9) =	117.1

PRODUCT TESTS	OIL	WATER
°API	53.7	10.7
Neut. No.	41.5	37.8
Sap. No.	48.8	42.1
Hydrox. No.		
Bromine No.	85.1	
Pour °F.		
Chemicals, % by K_2CO_3		11.5
HEMPEL. DIST. %		°API
205 °F.		
400	75.3	57.5
400-550	12.0	37.1
550+	12.7	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	100	
10%	131	
50%	221	
90%	352	
EP	403	
Rec.	97.5	

CATALYST DATA — INVENTORY DATA		PARTICLE SIZE	Screen Analysis			Sedimentation	
In Reactor at Start of Period		Mesh	Microns	%	Microns	%
Fresh Catalyst Added 59 = 89		On 40	419+	18.6	80+	
Total		100	150	65.0	40—80	
Catalyst Recovered	21	150	105	9.0	20—40	
In Reactor at End of Period		200	74	5.2	10—20	
		250	62	1.0	0—20	
REACTOR d-p, Inches H_2O		325	44	1.0		
No. Height "		<325		0.2		
0 0 - 12	28					
1 12.0 - 43.2	74	CATALYST				
2 43.2 - 74.4	74	Bulk Density, Lbs./Cu.Ft.				
3 74.4 - 105.6	75	Aerated			129	
4 105.6 - 342.0	312	Settled			131	
Total	563	Compacted			148	
CALCULATED FROM dp		Particle Density, gm./cc.			4.6	
Density, Lbs./Cu.Ft.	148	NH_3 Value, ml./gm.				
Inventory, Lbs.	1932	N_2 Surface, m²/gm.				
Bed Depth, Ft.	19.78	CHEMICAL ANALYSIS				
Cu. Ft.	13.05	Fe				
		C				
		O				
		H				
		K_2O, W+, % basis Fe				
		X-Ray Analysis—				
		$Fe_{20}C_9$				
		Fe_3O_4				
		Fe				

GAS ANALYSES HOUR				AVERAGE
FRESH FEED				
CO 28.010	36.68	36.95	37.35	36.993
H_2 2.016	57.54	58.08	58.63	58.084
CO_2 44.010	2.65	2.45	2.57	2.550
N_2 28.016	0.80	0.65	0.81	0.753
CH_4 16.042	2.35	1.87	0.64	1.620
			M. W.	13.1258
			H_2O 18.016	
			BALANCE	

GENERATOR BALANCE	M/HR	C	H	O
FRESH FEED				
CO 28.010	10.408	10.408		10.408
H_2 2.016	16.341		32.682	
CO_2 44.010	0.717	0.717		1.434
N_2 28.016	0.212			
CH_4 16.042	0.456	0.456	1.824	
			5.028	2.514
		11.581	32.53	14.356
		102.70	100.04	99.96

	Mol %	M/Hr	C	H	O
O_2 32.000	0.96	6.885 0.095			13.960
CO 28.010					
H_2 2.016					
CO_2 44.010	2.03	0.201	0.201		0.402
N_2 28.016	4.32	0.428			
CH_4 16.042	79.04	7.836	7.836	31.344	
C_2H_6 30.068	8.61	0.854	1.708	5.124	
C_3H_8 44.094	4.83	0.479	1.437	3.832	
C_4H_{10} 58.120	0.16 0.05	0.016 0.005	0.064 0.030	0.160 0.060	
TOTAL			11.276	39.520	14.362

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
WET GAS	182.12	202.33
OIL	55.45	55.45
WATER	111.51	111.51
TOTAL	349.08	369.29
FRESH FEED	369.29	
WEIGHT BALANCE	94.53	
WET GAS FACTOR		1.110971
INDICATED LOSS—S C F H		326

WET GAS				
CO 28.010	8.56	7.82	8.12	8.167
H_2 2.016	35.86	35.64	35.12	35.540
CO_2 44.010	28.09	29.58	32.46	30.042
N_2 28.016	1.84	2.64	2.42	2.300
CH_4 16.042	15.90	13.84	9.82	13.187
C_2H_6 28.052	2.79	2.83	3.07	2.897
C_3H_8 44.094	1.16	1.19	1.42	1.257
C_3H_6 42.078	3.00	3.25	3.80	3.350
C_3H_8 44.094	0.39	0.40	0.48	0.423
C_4H_8 56.104	1.42	1.65	1.92	1.663
C_4H_{10} 58.120	0.28	0.39	0.52	0.397
C_5H_{10} 70.130	0.49	0.55	0.63	0.557
C_5H_{12} 72.144	0.07	0.07	0.07	0.070
C_6H_{12} 84.152	0.15	0.15	0.15	0.150
			M. W.	23.5032

GAS FLOW RATES		√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
			417.8	69			
FRESH FEED	79.51	4.39	20.80	0.9915	10663	1.4851	28.134
			1.50	55			
WET GAS	79.31	8.26	4.02	1.0048	2937	1.1098	7.748
			419.2	112			
RECYCLE	115.14	4.31	20.83	0.9535	10939	1.1098	28.862
			419.2	112			
BLEED	5.02	9.6	20.83	0.9535	1062	1.1098	2.803
			434.3	193	12001		31.665
NATURAL GAS	28.43	5.80	21.19	0.8924	3757	1.205	9.914
			436.7	70			
OXYGEN	27.07	4.58	21.25	0.9905	2610		6.885
			33.8				
STEAM	215.7	6.18	0.5062		408.2#/hr		

LIQUID PRODUCT RATES HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	4'1¾"	220.55	50	1.0049	221.63	53.7	1409.8	55.45
	0'5¾"	15.49	55	1.0025	15.53	6.361	98.8	8.718
					206.10		1311.0	
					3.14		20	
					209.24		1331.0	
WATER								
	7'5"	392.96	68	0.9992	392.65	10.7		111.51
	6'10¾"	364.59	69	0.9991	364.26	8.287		13.455
	5'9¾"	307.85	69	0.9998	307.79			
	0'3"	13.28	80	0.9976	13.25			
					322.93		2676.1	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 P
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	36.733	10.057	281.70	7.033	0.572	16.02	2.806	12.863	2.778	- 9.485	265.68
H_2 2.016	58.470	16.009	32.27	34.660	2.857	5.72	10.954	26.963	13.771	-13.172	26.55
CO_2 44.010	2.880	0.780	31.69	31.695	2.579	113.50	9.941	10.661	12.580	1.859	81.81
N_2 28.016	0.767	0.210	5.88	2.080	0.169	4.73	0.552	0.862	0.821		
CH_4 16.042	1.400	0.383	6.14	12.260	0.998	16.01	3.845	4.228	4.843	0.615	9.87
C_2H_6 28.052				2.970	0.241	6.76	0.932	0.932	1.173	0.241	6.76
C_3H_8 30.068				1.313	0.107	3.22	0.412	0.412	0.519	0.107	3.22
C_4+C_5											19.85
C_3H_6 42.078				3.800	0.309	13.00	1.192	1.192	1.501	0.309	13.00
C_3H_8 44.094				0.437	0.036	1.59	0.137	0.137	0.173	0.036	1.59
C_4H_8 56.104				2.127	0.173	9.71	0.667	0.667	0.840	0.173	9.71
C_4H_{10} 58.120				0.460	0.037	2.15	0.144	0.144	0.181	0.037	2.15
C_5H_{10} 70.130				0.710	0.058	4.07	0.223	0.223	0.281	0.058	4.07
C_5H_{12} 72.146				0.087	0.007	0.51	0.027	0.027	0.034	0.007	0.51
C_6H_{12} 84.162				0.170	0.014	1.18	0.053	0.053	0.067	0.014	1.18
C_5-C_6											32.21
TOTAL		27.380	357.68		8.139	198.17	31.366	58.746	45.575		
H_2+CO	95.203	26.066	9879 S.C.F.H.		5.409		13.140	39.206	16.549	22.657	
H_2/CO		1.59			5.96			2.20		1.39	

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	% Units.
Distribution of Recovered Oil										
400 EP										0.611
400-550										0.086
550+										0.140
										69.5
	0.999									
	0.684									
	0.326									
	2.009									
	1.316	4.32	5.692	0.304	11.70	1.184	6.25	1.872	0.190	89.7
	0.161	4.24	0.375	0.038						
	0.983	5.00	1.942	0.196	9.22	0.953	6.10	1.512	0.155	82.2
	0.218	4.88	0.442	0.045	2.15	0.218	4.86	0.442	0.045	
	0.412	5.45	0.747	0.076	4.07	0.412	5.48	0.747	0.076	89.1
	0.052	5.25	0.097	0.010	0.51	0.052	5.25	0.097	0.010	
	0.119	5.54	0.213	0.022	1.18	0.119	5.54	0.213	0.022	
	3.261		6.825	0.691	28.83	2.918		4.883	0.494	

CUMULATIVE TOTALS

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

EFFLUENT		
SHIFT RATIO		
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 11.8	WATER SOLUBLE CHEMICALS	0.221*
	TOTAL LIQUID PRODUCTS C_5+	
	WET WATER	5.273*
	GROSS WATER	
	HYDROCARBON TOTAL—C_1+	

	RECOVERED OIL	0.3760*	52.74	5.339		8.273	0.857	52.74	5.339		8.273	0.857
	TOTAL OIL		84.95	8.600		15.098	1.528	81.57	8.257		13.156	1.332
	WATER SOLUBLE CHEMICALS	0.221*	11.75	1.189		1.482	0.150	11.75	1.189		1.482	0.150
	TOTAL LIQUID PRODUCTS C_5+		96.70	9.789		16.580	1.678	93.32	9.446		14.638	1.482
	WET WATER	5.273*	95.00	9.616		11.407	1.155					
	GROSS WATER		106.75	10.806		12.889	1.305					
	HYDROCARBON TOTAL—C_1+		116.55	11.798								

*Included in Reactor Effluent Total

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

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO
70.27	94.31	82.28	86.92

TOTAL FEED CONVERSION — % CO	H_2	CO+H_2
77.35	48.89	57.79

SELECTIVITY C_3 + /C_1 +
82.97

OPERATING CONDITIONS

PRESSURES PSIG	
Oxygen	439
Natural Gas	437
Generator Outlet	424
Reactor Inlet	419
Condenser Inlet	
Product Accumulator	401
TEMPERATURES—°F.	
Oxygen	317
Natural Gas	721
Generator	2525
Quench Accumulator	
Reactor Inlet	620
Condenser Inlet	
Product Accumulator	56

Catalyst No.	Height "
1	12.0
2	43.2
3	74.4
# 5	136.8
# 7	199.2
# 8	230.4
9	261.6
10	292.8
11	311
12	342

RATES S.C.F.H.	
Fresh Feed	10377
Recycle	11888
Combined Feed	22265
Wet Gas—Measured	2767
Adjusted	3084
Loss	317
Recycle/Fresh Feed	1.14
Inlet Velocity—ft./sec.	0.68
Fresh Feed Rate—S.C.F.H.	9879
per Cu. Ft. Dense Bed	724
per Lb. Catalyst	4.86
per Sq. Ft.	14968

Heat Transfer Calculations

Steam Rate = 420.8 #/hr
@ 790 psia & 517°F
= 1197 BTU/#
Water in @ 153°F = 121 BTU/#
Heat Transferred/lb. steam
= 1076 BTU
(1076)(420.8) = 452781 BTU/hr
Ave. Bed Temperature
= 639°F
dT = 639-517 = 122°F
Tube Area = 31.4 ft²
K = 452781 / (122)(31.4) = 119.5

PRODUCT TESTS

	OIL	WATER
°API	53.3	10.8
Neut. No.	41.7	38.6
Sap. No.	47.8	40.3
Hydrox. No.		
Bromine No.	94.5	
Pour °F.		
Chemicals, % by K_2CO_3		11.5

HEMPEL. DIST. %		°API
205 °F.		
400	73.0	58.0
400-550	10.3	37.1
550+	16.7	

A. S. T. M. DIST. ON	
Naphtha °F.	
IBP	96
10%	127
50%	217
90%	345
EP	398
Rec.	97.5

CATALYST DATA

INVENTORY DATA		
In Reactor at Start of Period		
Fresh Catalyst Added	62 =	94
Total		
Catalyst Recovered		32
In Reactor at End of Period		

REACTOR d-p, Inches H_2O No.	Height "
0	0 - 12
1	12.0 - 43.2
2	43.2 - 74.4
3	74.4 - 105.6
4	105.6 - 342.0
-	Total

		29
		75
		74
		74
		340
		592

CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	149
Inventory, Lbs.	2032
Bed Depth, Ft.	20.66
Cu. Ft.	13.64

PARTICLE SIZE Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	13.7		80+
100	150	65.8		40—80
150	105	10.4		20—40
200	74	6.9		10—20
250	62	2.2		0—20
325	44	2.0		
<325		1.0		

CATALYST

Bulk Density, Lbs./Cu.Ft.	
Aerated	149
Settled	150
Compacted	166
Particle Density, gm./cc.	4.5
NH_3 Value, ml./gm.	
N_2 Surface, m^2/gm.	

CHEMICAL ANALYSIS

Fe	
C	
O	
H	
K_2O, W+, % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES

HOUR				AVERAGE
FRESH FEED				
CO 28.010	36.52	36.54	37.14	36.733
H_2 2.016	58.22	58.31	58.88	58.470
CO_2 44.010	2.57	2.50	2.82	2.630
N_2 28.016	0.73	0.68	0.89	0.767
CH_4 16.042	1.96	1.97	0.27	1.400
			M. W.	13.0646
			H_2O 18.016	
			BALANCE	
WET GAS				
CO 28.010	6.81	7.15	7.34	7.033
H_2 2.016	35.81	34.23	34.54	34.860
CO_2 44.010	30.76	31.09	32.25	31.695
N_2 28.016	1.75	1.65	2.84	2.080
CH_4 16.042	13.71	13.96	9.11	12.260
C_2H_6 28.052	2.94	2.84	3.13	2.970
C_3H_8 30.068	1.21	1.27	1.46	1.313
C_3H_6 42.078	3.48	3.69	4.23	3.800
C_3H_8 44.094	0.36	0.41	0.54	0.457
C_4H_8 56.104	2.00	2.19	2.19	2.127
C_4H_{10} 58.120	0.40	0.49	0.49	0.460
C_5H_{10} 70.130	0.70	0.77	0.66	0.710
C_5H_{12} 72.146	0.09	0.09	0.08	0.087
C_6H_{12} 84.162	0.18	0.17	0.16	0.170
			M. W.	24.3543

GENERATOR BALANCE

	M/HR	C	H	O
FRESH FEED				
CO 28.010	10.057	10.057		10.057
H_2 2.016	16.009		32.018	
CO_2 44.010	0.720	0.720		1.440
N_2 28.016	0.210			
CH_4 16.042	0.383	0.383	1.532	
			6.316	3.158
		11.160	39.866	14.655
		98.67	97.05	104.31

	Mol %	M/Hr	C	H	O
O_2 32.000	0.42	6.781 / 0.042			13.646
CO 28.010					
H_2 2.016					
CO_2 44.010	2.04	0.202	0.202		0.404
N_2 28.016	2.12	0.210			
CH_4 16.042	82.86	8.190	8.190	32.760	
C_2H_6 30.068	8.35	0.825	1.650	4.950	
C_3H_8 44.094	4.05	0.400	1.200	3.200	
C_4H_{10} 58.120	0.12 / 0.04	0.012 / 0.004	0.048 / 0.020	0.120 / 0.048	
TOTAL			11.310	41.078	14.050

WEIGHT BALANCE

	#/hr Measured	#/hr At. Wt. Balance
WET GAS	177.85	198.22
OIL	52.74	52.74
WATER	106.75	106.75
TOTAL	337.32	357.71
FRESH FEED	357.71	
WEIGHT BALANCE	94.30	
WET GAS FACTOR		1.11466
INDICATED LOSS—S C F H		317

GAS FLOW RATES

		PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED		418.6	72			
	4.27	20.82	0.9887	10377	1.4886	27.380
WET GAS		1.50	56			
	7.93	4.02	1.0039	2767	1.0903	7.302
RECYCLE		421.8	113			
	4.34	20.89	0.9526	10842	1.0903	28.607
BLEED		421.8	113			
	9.6	20.89	0.9526	1046	1.0903	2.759
NATURAL GAS		437.4	190	11888		31.366
	5.66	21.86	0.8944	3746	1.2843	9.884
OXYGEN		439.0	70			
	4.50	21.30	0.9905	2570		6.781
STEAM		34.4				
	6.35	0.3082				420.8#/hr

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'3"	384.23	58	1.0010	384.61	53.3		52.742
	4'1⅛"	220.55	50	1.0049	221.63	6.375		8.273
	0'10⅛"	45.50	62	0.9990	45.45			
	0'3"	13.28	54	1.0030	13.32			
					195.11 *3.45		#22.0	
					198.56			
WATER								
	7'8	406.05	72	0.9987	405.52	10.8		106.75
	5'9½	307.85	62	0.9998	307.79	8.282		12.889
	4'2½	224.92	62	0.9998	224.88			
	0'3	13.28	66	0.9998	13.27			
					309.34			

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 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	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	37.113	10.273	287.75	8.323	0.695	19.47	2.502	12.775	3.197	- 9.578	268.28					Distribution of					
H_2 2.016	58.304	16.138	32.53	36.980	3.087	6.22	11.117	27.255	14.204	-13.051	26.31					Recovered Oil					
CO_2 44.010	3.290	0.911	40.09	34.053	2.842	125.08	10.237	11.148	13.079	1.931	84.99	8.491					400 EP			0.668	
N_2 28.016	0.770	0.213	5.97	26.47	0.221	6.19	0.796	1.009	1.017								400-550			0.111	
CH_4 16.042	0.523	0.145	2.33	8.063	0.673	10.80	2.424	2.569	3.097	0.528	8.47	0.846					550+			0.100	
C_2H_4 28.052				2.837	0.237	6.65	0.853	0.853	1.090	0.237	6.65	0.664									69.5
C_2H_6 30.068				1.247	0.104	3.13	0.375	0.375	0.479	0.104	3.13	0.313									
C_1+C_2											18.25	1.823									
C_3H_6 42.078				2.997	0.250	10.52	0.901	0.901	1.151	0.250	10.52	1.051	4.32	2.435	0.243	9.47	0.946	6.25	1.515	0.151	88.6
C_3H_8 44.094				0.387	0.032	1.41	0.116	0.116	0.148	0.032	1.41	0.141	4.24	0.333	0.033						
C_4H_8 56.104				1.467	0.122	6.84	0.441	0.441	0.563	0.122	6.84	0.683	5.00	1.368	0.137	6.50	0.649	6.10	1.065	0.106	81.8
C_4H_{10} 58.120				0.327	0.027	1.57	0.098	0.098	0.125	0.027	1.57	0.157	4.86	0.323	0.032	1.57	0.157	4.86	0.323	0.032	
C_5H_{10} 70.130				0.473	0.039	2.74	0.142	0.142	0.181	0.039	2.74	0.274	5.45	0.503	0.050	2.74	0.274	5.45	0.503	0.050	87.1
C_5H_{12} 72.146				0.070	0.006	0.43	0.021	0.021	0.027	0.006	0.43	0.043	5.25	0.082	0.008	0.43	0.043	5.25	0.082	0.008	
C_6H_{12} 84.156				0.130	0.011	0.93	0.039	0.039	0.050	0.011	0.93	0.093	5.54	0.168	0.017	0.93	0.093	5.54	0.168	0.017	
C_3-C_6											24.44	2.442		5.212	0.521	21.64	2.162		3.656	0.365	
TOTAL		27.679	368.63		8.347	202.02	30.061	57.740	44.458												
H_2+CO	95.417	26.411	10009.8 S.C.F.H.		3.782		13.619	40.030		22.629											
H_2/CO		1.57	999024		4.44			2.13		1.36											

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

EFFLUENT			#/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
	RECOVERED OIL	0.4023*	56.43	5.637		8.799	0.879	56.43	5.637		8.799	0.879
SHIFT RATIO	TOTAL OIL		80.87	8.079		14.011	1.400	78.07	7.799		12.455	1.244
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 10.7	WATER SOLUBLE CHEMICALS	0.240*	12.74	1.273	7.98	1.595	0.159	12.74	1.273		1.595	0.159
	TOTAL LIQUID PRODUCTS C_3+		93.61	9.352		15.606	1.559	90.81	9.072		14.050	1.404
SELECTIVITY	NET WATER	5.408*	97.44	9.734		11.700	1.169					
C_3+/C_1+	GROSS WATER		110.18	11.007		13.295	1.328					
83.68	HYDROCARBON TOTAL—C_1+		111.86	11.175								

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2
69.84	93.23	80.87	85.68	74.97	47.88	56.53

*Included in Reactor Effluent Total

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

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	442	Fresh Feed	10490
Natural Gas	439	Recycle	11393
Generator Outlet	423	Combined Feed	21883
Reactor Inlet	418	Wet Gas—Measured	2821
Condenser Inlet		Adjusted	3163
Product Accumulator	399	Loss	342
TEMPERATURES—°F.		Recycle/Fresh Feed	1.09
Oxygen	322	Inlet Velocity—ft./sec.	0.67
Natural Gas	711	Fresh Feed Rate—S.C.F.H.	10010
Generator	2255	per Cu.Ft. Dense Bed	728
Quench Accumulator		per Lb. Catalyst	4.89
Reactor Inlet	611	per Sq. Ft.	15167
Condenser Inlet			
Product Accumulator	59	Heat Transfer Calculations	
Catalyst No. Height "		Steam Rate = 425.2 #/hr	
1 12.0	650	@ 800 psia & 518°F = 1197 BTU/#	
2 43.2	652	Water in @ 159°F = 127 BTU/#	
3 74.4	657	Heat Transferred/lb. steam	
/5 136.8	644	= 1070 BTU	
/7 199.2	631	(1070)(425.2) = 445964 BTU/hr	
/8 230.4	619	Ave. Bed Temperature	
9 261.6	617	= 642°F	
10 292.8	608	dT = 642-518 = 124°F	
11 311.0	592	Tube Area = 31.4 ft^2	
12 342.0	581	$K = \frac{445964}{(124)(31.4)} =$	114.2

PRODUCT TESTS

	OIL	WATER
°API	52.2	10.7
Neut. No.	44.0	41.1
Sap. No.	53.1	43.1
Hydrox. No.		
Bromine No.	95.0	
Pour °F.		
Chemicals, % by K_2CO_3		12.0
HEMPEL, DIST. %		°API
205 °F.		
400	76.0	56.8
400-550	12.6	36.4
550+	11.4	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	100	
10%	134	
50%	224	
90%	353	
EP	406	
Rec.	98.0	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added 50 =	76
Total	
Catalyst Recovered	26.50
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height "	
0 0 - 12	29
1 12 - 43.2	76
2 43.2 - 74.4	73
3 74.4 - 105.6	74
4 105.6 - 342.0	345
Total	597
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	149
Inventory, Lbs.	2049
Bed Depth, Ft.	20.83
Cu. Ft.	13.75

PARTICLE SIZE: Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	14.1	80+	
100	150	67.5	40—80	
150	105	9.5	20—40	
200	74	5.9	10—20	
250	62	1.0	0—20	
325	44	1.0		
<325		1.0		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	141
Settled	142
Compacted	161
Particle Density, gm./cc.	4.4
NH_3 Value, ml./gm.	7.5
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	37.26	37.04	37.04	37.113	10.273	10.273		10.273
H_2 2.016	58.65	58.13	58.13	58.304	16.138		32.276	
CO_2 44.010	2.51	3.68	3.68	3.290	0.911	0.911		1.822
N_2 28.016	0.65	0.83	0.83	0.770	0.213			
CH_4 16.042	0.93	0.32	0.32	0.523	0.145	0.145	0.580	
			M. W.	13.3183				
			H_2O 18.016				7.460	3.730
						11.329	40.316	15.825
			BALANCE			99.79	97.39	103.54

	Mol %	M/Hr	C	H	O
O_2 32.000	0.51	7.395 0.051			14.892
CO 28.010					
H_2 2.016					
CO_2 44.010	1.96	0.196	0.196		0.392
N_2 28.016	2.14	0.214			
CH_4 16.042	83.50	8.357	8.357	33.428	
C_2H_6 30.068	7.91	0.792	1.584	4.752	
C_3H_8 44.094	3.86	0.386	1.158	3.088	
C_4H_{10} 58.120	0.07 0.05	0.007 0.005	0.028 0.030	0.070 0.060	
TOTAL			11.353	41.398	15.284

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	180.18	202.02
OIL	56.43	56.43
WATER	110.18	110.18
TOTAL	346.78	368.63
FRESH FEED	368.63	
WEIGHT BALANCE	94.07	
WET GAS FACTOR		1.112124
INDICATED LOSS—S C F H		342

WET GAS				
CO 28.010	9.16	7.18	8.63	8.323
H_2 2.016	37.42	36.64	36.88	36.980
CO_2 44.010	33.64	36.15	32.37	34.053
N_2 28.016	2.20	3.04	2.70	2.647
CH_4 16.042	7.46	7.37	9.36	8.063
C_2H_4 28.052	2.78	2.87	2.86	2.837
C_2H_6 30.068	1.23	1.23	1.28	1.247
C_3H_6 42.078	3.01	2.97	3.01	2.947
C_3H_8 44.094	0.34	0.40	0.42	0.387
C_4H_8 56.104	1.71	1.27	1.42	1.467
C_4H_{10} 58.120	0.34	0.26	0.38	0.327
C_5H_{10} 70.130	0.49	0.46	0.47	0.473
C_5H_{12} 72.146	0.07	0.07	0.07	0.070
C_6H_{12} 84.156	0.15	0.09	0.15	0.130
			M. W.	24.2058

GAS FLOW RATES

		$\sqrt{h}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	4.37	417.6 20.79	73 0.9877	10490	1.474	27.679
WET GAS	79.31	8.08	1.50 4.02	59 1.0010	2821	1.094	7.444
RECYCLE	115.14	4.13	421.0 20.87	115 0.9510	10325	1.094	27.245
BLEED	5.02	9.8	421.0 20.87	115 0.9510	1068	1.094	2.818
NATURAL GAS	28.43	5.72	439.0 21.30	195 0.8910	11393 3793	1.229	30.061 10.008
OXYGEN	27.07	4.91	441.8 21.37	74 0.9868	2803		7.395
STEAM	215.7	6.35	35.0 0.3104		425.2#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	4'9¼"	254.38	52	1.0039	255.37	52.2		56.43
	0'10½"	45.50	62	0.9990	45.45	6.413		8.799
					209.92		1346.2	
					1.25		+8.0	
					211.17		1354.2	
WATER								
	7'8	406.05	76	0.9982	405.32	10.7		110.18
	4'2½	224.92	62	0.9998	224.88	8.287		13.295
	2'10	151.93	60	1.000	151.93			
	0'3	13.28	62	0.9998	13.28			
					319.09			

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 81 E
HOURS 152-176

	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	37.200	10.460	292.98	8.395	0.732	20.50	2.428	12.888	3.160	- 9.728	272.48
H_2 2.016	58.380	16.416	33.09	37.568	3.300	6.65	10.953	27.369	14.253	-13.116	26.44
CO_2 44.010	3.025	0.850	37.41	32.563	2.861	125.91	9.494	10.344	12.355	2.011	88.50
N_2 28.016	1.055	0.297	8.32	2.200	0.193	5.41	0.641	0.938	0.834		
CH_4 16.042	0.340	0.096	1.54	8.970	0.788	12.64	2.615	2.711	3.403	0.692	11.10
C_2H_4 28.052				2.880	0.253	7.10	0.840	0.840	1.093	0.253	7.10
C_2H_6 30.068				1.310	0.115	3.46	0.382	0.382	0.497	0.115	3.46
C_1+C_2											21.66
C_3H_6 42.078				3.083	0.271	11.40	0.899	0.899	1.170	0.271	11.40
C_3H_8 44.094				0.410	0.036	1.59	0.120	0.120	0.156	0.036	1.59
C_4H_8 56.104				1.563	0.137	7.69	0.456	0.456	0.593	0.137	7.69
C_4H_{10} 58.120				0.343	0.030	1.74	0.100	0.100	0.130	0.030	1.74
C_5H_{10} 70.130				0.540	0.047	3.30	0.157	0.157	0.204	0.047	3.30
C_5H_{12} 72.146				0.100	0.009	0.65	0.029	0.029	0.038	0.009	0.65
C_6H_{12} 84.156				0.147	0.013	1.09	0.043	0.043	0.056	0.013	1.09
C_3-C_4											27.46
TOTAL		28.119	373.34		8.785	209.13	29.156	57.275	44.077		
H_2+CO	95.580	26.876	10186 S.C.F.H.		4.032		13.381	40.257	17.413	22.844	
H_2/CO		1.57	98174		4.51			2.12		1.35	

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	8.688					400 EP			0.642	
N_2						400-550			0.130	
CH_4	1.090					550+			0.042	
C_2H_4	0.697									68.7
C_2H_6	0.340									
C_1+C_2	2.126									
C_3H_6	1.119	4.32	2.639	0.259	10.26	1.007	6.25	1.642	0.161	88.3
C_3H_8	0.156	4.24	0.375	0.037						
C_4H_8	0.755	5.00	1.538	0.151	7.30	0.717	6.10	1.198	0.118	82.0
C_4H_{10}	0.171	4.86	0.358	0.035	1.74	0.171	4.86	0.358	0.035	
C_5H_{10}	0.324	5.45	0.606	0.059	3.30	0.324	5.45	0.606	0.059	84.4
C_5H_{12}	0.064	5.28	0.124	0.012	0.65	0.064	5.28	0.124	0.012	
C_6H_{12}	0.107	5.84	0.197	0.019	1.09	0.107	5.84	0.197	0.019	
C_3-C_4	2.696		5.837	0.573	24.34	2.390		4.125	0.405	

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

EFFLUENT

SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 10.0

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	0.3792*	53.18	5.221		8.306	0.815	53.18	8.306		8.306	0.815
TOTAL OIL		80.64	7.917		14.143	1.388	77.52	7.610		12.431	1.220
WATER SOLUBLE CHEMICALS	0.209*	11.10	1.090	7.89	1.407	0.138	11.10	1.090		1.407	0.138
TOTAL LIQUID PRODUCTS C_3+		91.74	9.006		15.550	1.527	88.62	8.700		13.838	1.358
NET WATER	5.548*	99.96	9.813		12.003	1.178					
GROSS WATER		111.06	10.903		13.410						
HYDROCARBON TOTAL—C_1+		113.40	11.133								

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION—% CO	H_2	CO+H_2	SELECTIVITY C_3+/C_1+
68.76	93.00	79.90	85.00	75.48	47.92	56.75	80.90

*Included in Reactor Effluent Total

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

OPERATING CONDITIONS / PRODUCT TESTS

PRESSURES PSIG		RATES S.C.F.H.		PRODUCT TESTS	OIL	WATER
Oxygen	441	Fresh Feed	10657	°API	52.5	10.8
Natural Gas	438	Recycle	11050	Neut. No.	40.7	38.1
Generator Outlet	423	Combined Feed	21707	Sap. No.	50.6	40.1
Reactor Inlet	419	Wet Gas—Measured	2886	Hydrox. No.		
Condenser Inlet		Adjusted	3330	Bromine No.	88.3	
Product Accumulator	399	Loss	444	Pour °F.		
				Chemicals, % by K_2CO_3		10.5
TEMPERATURES—°F.		Recycle/Fresh Feed	1.04			
Oxygen	346	Inlet Velocity—ft./sec.	0.69			
Natural Gas	788	Fresh Feed Rate—S.C.F.H.	10186	HEMPEL. DIST. %		°API
Generator	2310	per Cu.Ft. Dense Bed	734	205 °F.		
Quench Accumulator		per Lb. Catalyst	4.93	400	78.8	57.4
Reactor Inlet	588	per Sq. Ft.	15433	400-550	16.0	36.4
Condenser Inlet				550+	5.2	
Product Accumulator	63	Heat Transfer Calculations				
Catalyst No. Height "		Steam Rate = 422.6 #/hr		A. S. T. M. DIST. ON		
1 12.0	645	@ 798.6 psia & 518°F		Naphtha °F.		
2 43.2	649	= 1197 BTU/#		IBP	96	
3 74.4	652	Water in @ 160°F = 129 BTU/#		10%	128	
5 136.8	640	Heat Transferred/lb. steam		50%	220	
7 199.2	628	= 1068 BTU		90%	351	
8 230.4	620	(1068)(422.6) = 451337 BTU/hr		EP	409	
9 261.6	618	Ave. Bed Temperature = 639°F		Rec.	97.5	
10 292.8	609	dT = 639-518 = 121°F				
11 311.0	584	Tube Area = 31.5 ft²				
12 342.0	579	$K = \frac{451337}{(121)(31.5)} =$	118.4			

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added 50 #	76
Total	
Catalyst Recovered	30
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height "	
0 0 - 12.0	29
1 12 - 43.2	76
2 43.2 - 74.4	73
3 74.4 - 105.6	74
4 105.6 - 342.0	350
Total	602
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	149
Inventory, Lbs.	2066
Bed Depth, Ft.	21.01
Cu. Ft.	13.87

PARTICLE SIZE Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	11.5	80+	
100	150	63.3	40—80	
150	105	12.3	20—40	
200	74	9.7	10—20	
250	62	1.6	0—20	
325	44	2.0		
<325		1.4		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	148
Settled	150
Compacted	163
Particle Density, gm./cc.	4.4
NH_3 Value, ml./gm.	9.03
N_2 Surface, m²/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, W+, % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES / GENERATOR BALANCE

HOUR	1400	2200	0600	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	41.20 *	37.33	37.07	37.200	10.460	10.460		10.460
H_2 2.016	53.49 *	58.18	58.58	58.380	16.416		32.832	
CO_2 44.010	3.52 *	2.89	3.16	3.025	0.851	0.851		1.702
N_2 28.014	1.06 *	1.02	1.09	1.055	0.297			
CH_4 16.042	0.74 *	0.58	0.10	0.340	0.096	0.096	0.384	
			M. W.	13.2781				
* Not averaged			H_2O 18.016				6.970	3.485
						11.407	40.186	15.647
			BALANCE			99.85	97.74	103.06
WET GAS								
CO 28.010	8.37	8.08	8.52	8.323				
H_2 2.016	38.93	36.77	37.00	37.568				
CO_2 44.010	31.58	32.15	33.96	32.563				
N_2 28.016	1.84	2.11	2.65	2.200				
CH_4 16.042	9.17	10.02	7.72	8.970				
C_2H_4 28.052	2.92	2.85	2.87	2.880				
C_2H_6 30.068	1.25	1.32	1.36	1.310				
C_3H_6 42.078	2.88	3.32	3.05	3.083				
C_3H_8 44.094	0.35	0.46	0.42	0.410				
C_4H_8 56.104	1.53	1.76	1.40	1.563				
C_4H_{10} 58.120	0.33	0.33	0.37	0.343				
C_5H_{10} 70.130	0.57	0.59	0.46	0.540				
C_5H_{12} 72.146	0.12	0.11	0.07	0.100				
C_6H_{12} 84.156	0.16	0.13	0.15	0.147				
			M. W.	23.8056				

GENERATOR BALANCE	Mol %	M/Hr	C	H	O
O_2 32.000	0.45	7.322 0.044			14.732
CO 28.010					
H_2 2.016					
CO_2 44.010	2.28	0.225	0.225		0.450
N_2 28.014	2.45	0.242			
CH_4 16.042	81.49	8.048	8.048	32.192	
C_2H_6 30.068	8.43	0.833	1.666	4.998	
C_3H_8 44.094	4.69	0.463	1.389	3.704	
C_4H_{10} 58.120	0.15 0.06	0.015 0.006	0.060 0.036	0.150 0.072	
TOTAL			11.424	41.116	15.182

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	181.26	209.13
OIL	53.18	53.18
WATER	111.06	111.06
TOTAL	345.50	373.37
FRESH FEED	373.37	
WEIGHT BALANCE	92.54	
WET GAS FACTOR		1.153757
INDICATED LOSS—S C F H		444

GAS FLOW RATES

		√R	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED	79.31	4.45	418.5 20.81	78 0.9831	10657	1.476	28.119
WET GAS	79.31	8.23	1.50 4.02	63 0.9971	2886	1.103	7.614
RECYCLE	115.14	3.98	421.8 20.89	121 0.9460	9989	1.103	26.356
BLEED	5.02	9.7	421.8 20.89	121 0.9460	1061	1.103	2.800
					11050		29.156
NATURAL GAS	28.43	5.74	437.7 21.27	199 0.8883	3743	1.214	9.876
OXYGEN	27.07	4.85	440.8 21.34	76 0.9905	2775		7.322
STEAM	215.7	6.29	35.3 0.3115		422.6#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	5'5"	288.21	60	1.000	288.21	52.5		53.18
	4'9½"	254.38	52	1.0039	255.37	6.402		8.306
	3'3½"	176.91	52	1.0039	177.60			
	0'3½"	15.49	84	0.9881	15.30			
					195.14			
					4.21		*27.0	
					199.35		1276.2	
WATER								
	6'11½"	367.86	74	0.9985	367.31	10.8		111.06
	2'10"	151.93	60	1.000	151.93	8.282		13.410
	2'3½"	121.98	64	0.9996	121.93			
	0'3½"	15.49	66	0.9994	15.48			
					321.85		2665.4	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 I
HOURS 176-200

	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	39.910	10.417	291.78	8.670	0.739	20.70	2.337	12.754	3.076	- 9.678	271.08
H_2 2.016	54.906	14.331	28.89	33.023	2.813	5.67	8.901	23.232	11.714	-11.518	23.22
CO_2 44.010	4.487	1.171	51.54	39.134	3.334	146.73	10.548	11.719	13.882	2.163	95.19
N_2 28.016	0.660	0.172	4.82	2.503	0.213	5.97	0.675	0.847	0.888		
CH_4 16.042	0.037	0.010	0.16	6.570	0.560	8.98	1.771	1.781	2.331	0.550	8.82
C_2H_6 28.052				2.853	0.243	6.82	0.769	0.769	1.012	0.243	6.82
C_3H_8 30.068				1.157	0.099	2.98	0.312	0.312	0.411	0.099	2.98
C_4+C_5											18.62
C_3H_6 42.078				2.917	0.248	10.44	0.786	0.786	1.034	0.248	10.44
C_3H_8 44.094				0.280	0.024	1.06	0.075	0.075	0.099	0.024	1.06
C_4H_8 56.104				1.660	0.141	7.91	0.447	0.447	0.588	0.141	7.91
C_4H_{10} 58.120				0.373	0.032	1.86	0.101	0.101	0.133	0.032	1.86
C_5H_{10} 70.130				0.587	0.050	3.51	0.158	0.158	0.208	0.050	3.51
C_6H_{12} 72.146				0.110	0.009	0.65	0.030	0.030	0.039	0.009	0.65
C_6H_{12} 84.156				0.163	0.014	1.18	0.044	0.044	0.058	0.014	1.18
C_5+C_6											26.61
TOTAL		26.101	377.19		8.519	224.46	26.954	53.055	41.040		
H_2+CO	94.816	24.748	9382 S.C.F.H.		3.552		11.238	35.986	14.790	-21.196	
H_2/CO	1.38		106587		3.81			1.82		1.19	

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.
Distribution of Recovered Oil										
400 EP										0.656
400-550										0.130
550+										0.066
										71.1
	0.940									
	0.727									
	0.318									
	1.985									
	1.113	4.32	2.417	0.258	9.40	1.002	6.25	1.504	0.160	91.2
	0.113	4.24	0.250	0.027						
	0.843	5.00	1.582	0.169	7.51	0.800	6.10	1.231	0.131	81.7
	0.198	4.86	0.383	0.041	1.96	0.198	4.86	0.383	0.041	
	0.374	5.45	0.644	0.069	3.51	0.374	5.45	0.644	0.069	84.2
	0.069	5.25	0.124	0.013	0.65	0.069	5.25	0.124	0.013	
	0.126	5.54	0.213	0.023	1.18	0.126	5.54	0.213	0.023	
	2.836		5.615	0.598	24.11	2.569		4.099	0.437	

EFFLUENT		
	RECOVERED OIL	0.3687* 51.71
SHIFT RATIO	TOTAL OIL	78.32
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 10.6	WATER SOLUBLE CHEMICALS	0.211* 11.18
	TOTAL LIQUID PRODUCTS C_4+	89.50
	NET WATER	4.987* 89.84
	GROSS WATER	101.02
	HYDROCARBON TOTAL—C_1+	308.12

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+
67.36	92.91	80.37	85.65	75.88	49.58	58.90	82.78

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.
TOTAL	5.512		7.989	0.852	51.71	5.512		7.989	0.852	
	8.348		13.602	1.450	75.82	8.081		12.088	1.289	
	1.192	7.97	1.402	0.149	11.18	1.192		1.402	0.149	
	9.540		15.004	1.599	87.00	9.273		13.490	1.438	
	9.576		10.788	1.150						
	10.767		12.190	1.299						
	11.524									

*Included in Reactor Effluent Total

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

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	443	Fresh Feed	9895
Natural Gas	439	Recycle	10218
Generator Outlet	416	Combined Feed	20113
Reactor Inlet	412	Wet Gas—Measured	2733
Condenser Inlet		Adjusted	3230
Product Accumulator	392	Loss	497
TEMPERATURES—°F.		Recycle/Fresh Feed	1.033
Oxygen	325	Inlet Velocity—ft./sec.	0.63
Natural Gas	770	Fresh Feed Rate—S.C.F.H.	9382
Generator		per Cu. Ft. Dense Bed	656
Quench Accumulator		per Lb. Catalyst	4.49
Reactor Inlet	627	per Sq. Ft.	14215
Condenser Inlet			
Product Accumulator	64	Heat Transfer Calculations	
Catalyst No. Height "		Steam Rate = 417.2 #/hr	
1 12.0	646	@ 796 psia & 516°F	
2 43.2	648	= 1197 BTU/#	
3 74.4	655	Water in @ 158°F = 126 BTU/#	
# 5 136.8	640	Heat Transferred/lb. steam = 1071 BTU	
# 7 199.2	626	(1071)(417.2) = 446821 BTU/hr	
# 8 230.4	618	Ave. Bed Temperature = 639°F	
9 261.6	617		
10 292.8	607	dT = 639-518 = 121°F	
11 311.0	579	Tube Area = 31.9 ft²	
12 342.0	572	K = 446821 / (121)(31.9) =	115.8

PRODUCT TESTS	OIL	WATER
°API	50.5	10.7
Neut. No.	45.0	43.1
Sap. No.	57.3	44.0
Hydrox. No.		
Bromine No.	86.0	
Pour °F.		
Chemicals, % by K_2CO_3		11.5
HEMPEL DIST. %		
205 °F.		
400	77.0	
400-550	15.3	
550+	7.7	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	98	
10%	131	
50%	225	
90%	255	
EP	401	
Rec.	97.5	

CATALYST DATA					
INVENTORY DATA		PARTICLE SIZE			
In Reactor at Start of Period		Screen Analysis			Sedimentation
Fresh Catalyst Added 50 = 76		Mesh	Microns	%	Microns %
Total		On 40	419+	13.2	80+
Catalyst Recovered	34	100	150	63.4	40-80
In Reactor at End of Period		150	105	12.0	20-40
		200	74	7.6	10-20
REACTOR d-p, Inches H_2O		250	62	1.6	0-20
No. Height "		325	44	1.6	
0 0 - 12	29	<325		0.6	
1 12 - 43.2	75	CATALYST			
2 43.2 - 74.4	71	Bulk Density, Lbs./Cu.Ft.			
3 74.4 - 105.6	74	Aerated			122
4 105.6 - 342.0	360	Settled			124
Total	609	Compacted			136
		Particle Density, gm./cc.			4.4
CALCULATED FROM dp		NH_3 Value, ml./gm.			5.39
Density, Lbs./Cu.Ft.	146	N_2 Surface, m²/gm.			
Inventory, Lbs.	2090				
Bed Depth, Ft.	21.66	CHEMICAL ANALYSIS			
Cu. Ft.	14.31	Fe			
		C			
		O			
		H			
		K_2O, W+, % basis Fe			
		X-Ray Analysis—			
		$Fe_{20}C_9$			
		Fe_3O_4			
		Fe			

GAS ANALYSES	1400	2200	0600	AVERAGE
FRESH FEED				
CO 28.010	39.44	42.18	38.11	39.910
H_2 2.016	55.56	51.92	57.24	54.906
CO_2 44.010	4.34	5.25	3.87	4.487
N_2 28.016	0.62	0.60	0.76	0.660
CH_4 16.042	0.04	0.05	0.02	0.037
			M. W.	14.4613
			H_2O 18.016	
			BALANCE	
WET GAS				
CO 28.010	8.94	8.69	8.38	8.670
H_2 2.016	33.74	32.60	32.73	33.023
CO_2 44.010	38.45	39.84	39.11	39.134
N_2 28.016	2.48	2.59	2.44	2.503
CH_4 16.042	6.69	6.56	6.46	6.570
C_2H_6 28.052	2.79	2.98	2.79	2.853
C_2H_4 28.028	1.16	1.15	1.16	1.157
C_3H_6 42.078	2.91	2.61	3.23	2.917
C_3H_8 44.094	0.29	0.20	0.35	0.280
C_4H_8 56.104	1.49	1.55	1.94	1.660
C_4H_{10} 58.120	0.29	0.39	0.44	0.373
C_5H_{10} 70.130	0.52	0.54	0.70	0.587
C_6H_{12} 72.146	0.08	0.13	0.12	0.110
C_6H_{12} 84.156	0.17	0.17	0.15	0.163
			M. W.	26.3477

GENERATOR BALANCE	M/HR	C	H	O
				10.417
	14.331		28.662	
	1.171	1.171		2.342
	0.172			
	0.010	0.010	0.040	
			10.183	5.092
		11.598	38.885	17.851
	102.84	95.55	105.35	

	Mol %	M/Hr	C	H	O
O_2 32.000	0.78	8.178			16.510
CO 28.010		0.077			
H_2 2.016					
CO_2 44.010	2.20	0.217	0.217		0.434
N_2 28.016	2.95	0.291			
CH_4 16.042	81.08	8.005	8.005	32.020	
C_2H_6 30.068	8.13	0.803	1.606	4.818	
C_3H_8 44.094	4.78	0.472	1.416	3.776	
C_4H_{10} 58.120	0.06	0.006	0.024	0.060	
	0.02	0.002	0.010	0.024	
TOTAL			11.278	40.698	16.944

WEIGHT BALANCE	# hr Measured	At. Wt. Balance
WET GAS	189.94	224.46
OIL	51.71	51.71
WATER	101.02	101.02
TOTAL	342.67	377.19
FRESH FEED	377.19	
WEIGHT BALANCE	90.85	
WET GAS FACTOR		1.181742
INDICATED LOSS—S C F H		497

GAS FLOW RATES	V̄H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
		412.0	78			
FRESH FEED	79.31	20.66	0.9851	9895	1.41537	26.101
	4.34	1.5	64			
WET GAS	79.31	4.02	0.9962	2733	1.04822	7.209
	8.21	415.2	123			
RECYCLE	115.14	20.73	0.9444	9242	1.04822	24.379
	4.10	415.2	123			
BLEED	5.02	20.73	0.9444	976	1.04822	2.575
	9.5	459.0	196	10218		26.954
NATURAL GAS	28.43	21.30	0.8903	3743	1.2137	9.873
	5.72	442.9	77			
OXYGEN	27.07	21.39	0.9840	3100		8.178
	5.44	35.8				
STEAM	815.7	0.3135		417.2#/hr		
	6.17					

LIQUID PRODUCT RATES	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
	OIL	6'11"	366.77	62	0.9990	366.40	50.5		51.71
		3'3½"	176.91	52	1.0039	177.60	6.473		7.989
						188.80			
						2.94		+19.0	
						191.74			
	WATER								
		7'6"	397.32	72	0.9987	396.80	10.7		101.08
		2'3½"	121.98	64	0.9996	121.93	8.287		12.190
		0'7"	30.98	64	0.9996	30.97			
		0'3"	13.28	64	0.9996	13.27			
						292.57			

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 J
HOURS 200-224

	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	38.543	10.248	287.07	7.890	0.657	18.40	2.255	12.503	2.912	- 9.591	-268.67
H_2 2.016	57.070	15.175	30.59	36.055	3.002	6.05	10.303	25.478	13.305	-12.173	- 24.54
CO_2 44.010	3.600	0.957	42.12	34.647	2.885	126.97	9.901	10.858	12.786	1.928	84.85
N_2 28.016	0.700	0.186	5.21	2.377	0.198	5.55	0.679	0.865	0.877		
CH_4 16.042	0.087	0.023	0.37	7.717	0.643	10.32	2.205	2.228	2.848	0.620	9.95
C_2H_6 28.052				2.900	0.241	6.76	0.829	0.829	1.070	0.241	6.76
C_3H_8 30.068				1.353	0.113	3.40	0.387	0.387	0.500	0.113	3.40
C_4-C_6											20.09
C_6H_{12} 42.078				3.433	0.286	12.03	0.981	0.981	1.267	0.286	12.03
C_3H_8 44.094				0.467	0.039	1.72	0.133	0.133	0.172	0.039	1.72
C_4H_8 56.104				1.860	0.155	8.70	0.532	0.532	0.687	0.155	8.70
C_5H_{10} 58.120				0.397	0.033	1.92	0.113	0.113	0.146	0.033	1.92
C_5H_{10} 70.130				0.653	0.054	3.79	0.187	0.187	0.241	0.054	3.79
C_6H_{12} 72.146				0.090	0.007	0.51	0.026	0.026	0.033	0.007	0.51
C_6H_{12} 84.156				0.163	0.014	1.18	0.047	0.047	0.061	0.014	1.18
C_5-C_6											29.85
TOTAL		26.589	365.36		8.327	207.29	28.578	55.167	42.611		
H_2+CO	95.613	25.423	9838 S.C.F.H.		3.659		12.558	37.981		-21.766	
H_2/CO	1.48		103755		4.569			2.04		1.269	

	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.
Distribution of Recovered Oil										
400 EP									0.674	
400-550									0.106	
550+									0.096	
	0.701									68.1
	0.355									
	2.084									
	1.246	4.32	2.785	0.289	10.83	1.123	6.25	1.735	0.180	88.0
	0.178	4.24	0.406	0.042						
	0.903	5.00	1.740	0.181	8.27	0.858	6.10	1.356	0.141	82.4
	0.199	4.86	0.395	0.041	1.92	0.199	4.86	0.395	0.041	
	0.393	5.45	0.695	0.072	3.79	0.393	5.45	0.695	0.072	88.5
	0.053	5.28	0.097	0.010	0.51	0.053	5.28	0.097	0.010	
	0.122	5.54	0.215	0.022	1.18	0.122	5.54	0.215	0.022	
	3.097		6.331	0.657	26.50	2.748		4.489	0.466	
	2.084									

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

EFFLUENT									
	RECOVERED OIL	0.3974*	54.34	5.638		8.429	0.875	54.34	5.638		8.429	0.875
SHIFT RATIO	TOTAL OIL		84.19	8.735		14.760	1.532	80.84	8.386		12.918	1.341
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 11.5	WATER SOLUBLE CHEMICALS	0.225*	11.95	1.240		1.503	0.156	11.95	1.240		1.503	0.156
	TOTAL LIQUID PRODUCTS C_5+		96.14	9.975		16.263	1.688	92.79	9.626		14.421	1.497
	WET WATER	5.094*	91.76	9.525		11.021	1.143					
	GROSS WATER		103.73	10.763		12.524	1.299					
	HYDROCARBON TOTAL—C_1+		116.23	12.059								

FRESH FEED CONVERSION — %	Conversion	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	CO+H_2	SELECTIVITY C_3+ /C_1+
	68.70	93.59	80.23	85.62	76.71	47.78	57.31	82.73

*Included in Reactor Effluent Total

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

OPERATING CONDITIONS

PRESSURES PSIG	
Oxygen	438
Natural Gas	435
Generator Outlet	415
Reactor Inlet	411
Condenser Inlet	
Product Accumulator	390

TEMPERATURES—°F.	
Oxygen	301
Natural Gas	752
Generator	
Quench Accumulator	
Reactor Inlet	635
Condenser Inlet	
Product Accumulator	67

Catalyst No.	Height "	
1	12.0	648
2	43.2	651
3	74.4	672
∦ 5	136.8	641
∦ 7	199.2	625
∦ 8	230.4	619
9	261.6	619
10	292.8	609
11	311.0	588
12	342.0	582

RATES S.C.F.H.	
Fresh Feed	10080
Recycle	10834
Combined Feed	20914
Wet Gas—Measured	2884
Adjusted	3157
Loss	273
Recycle/Fresh Feed	1.075
Inlet Velocity—ft./sec.	0.64
Fresh Feed Rate—S.C.F.H.	9638
per Cu. Ft. Dense Bed	659
per Lb. Catalyst	4.45
per Sq. Ft.	14603

Heat Transfer Calculations

Steam Rate = 419.4 #/hr
@ 796 psia & 518°F
= 1197 BTU/#
Water in @ 160°F = 127 BTU/#
Heat Transferred/lb. steam
= 1070 BTU
(1070)(419.4) = 448758 BTU/hr
Ave. Bed Temperature
= 639°F
dT = 639-518 = 121°F
Tube Area = 32.2 ft²
K = 448758 / (121)(32.2) = 114.3

PRODUCT TESTS

	OIL	WATER
°API	51.4	10.8
Neut. No.	43.3	40.1
Sap. No.	52.0	43.7
Hydrox. No.		
Bromine No.	95.4	
Pour °F.		
Chemicals, % by K_2CO_3		12.0

HEMPEL. DIST. %	°API
205 °F.	
400	77.0 56.6
400-550	12.0 36.8
550+	11.0

A. S. T. M. DIST. ON	
Naphtha °F.	
IBP	96
10%	131
50%	221
90%	346
EP	398

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added 52 ± 79	
Total	
Catalyst Recovered	21
In Reactor at End of Period	
REACTOR d-p, Inches H_2O	
No. Height"	
0 0 - 12	29
1 12.0 - 43.2	76
2 43.2 - 74.4	72
3 74.4 - 105.6	74
4 105.6 - 342.0	380
Total	631

CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	148
Inventory, Lbs.	2166
Bed Depth, Ft.	22.17
Cu. Ft.	14.63

PARTICLE SIZE — Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	9.9	80+	
100	150	63.6	40—80	
150	105	13.3	20—40	
200	74	7.8	10—20	
250	62	2.0	0—20	
325	44	1.8		
<325		1.6		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	145
Settled	146
Compacted	161
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	6.86
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

HOUR	1400	2200	0600	AVERAGE
FRESH FEED				
CO 28.010	40.57	37.39	37.67	38.543
H_2 2.016	54.22	58.66	58.33	57.070
CO_2 44.010	4.40	3.20	3.20	3.600
N_2 28.016	0.72	0.69	0.69	0.700
CH_4 16.042	0.09	0.06	0.11	0.087
			M. W.	13.7409
			H_2O 18.016	
			BALANCE	
WET GAS				
CO 28.010	7.83	8.26	7.58	7.890
H_2 2.016	37.08	36.52	34.56	36.053
CO_2 44.010	35.83	34.35	33.76	34.647
N_2 28.016	2.37	2.69	2.07	2.377
CH_4 16.042	7.01	7.38	8.76	7.717
C_2H_6 28.052	2.72	2.75	3.23	2.900
C_3H_8 30.068	1.25	1.38	1.43	1.353
C_6H_{12} 42.078	3.09	3.29	3.92	3.433
C_3H_6 42.094	0.39	0.44	0.57	0.467
C_4H_8 56.104	1.39	1.72	2.47	1.860
C_5H_{10} 58.120	0.29	0.40	0.50	0.397
C_5H_{10} 70.130	0.51	0.58	0.87	0.653
C_6H_{12} 72.146	0.08	0.08	0.11	0.090
C_6H_{12} 84.156	0.16	0.16	0.17	0.165
			M. W.	24.8940

GENERATOR BALANCE

M/HR	C	H	O
			16.284
10.248	10.248		10.248
15.174		30.348	
0.957	0.957		1.914
0.186			
0.023	0.023	0.092	
		9.939	4.970
	11.228	40.379	17.132
	98.96	97.76	102.78

	Mol %	M/Hr	C	H	O
O_2 32.000	0.41	7.736 0.406			16.284
CO 28.010					
H_2 2.016					
CO_2 44.010	1.94	0.192	0.192		0.384
N_2 28.016	1.63	0.161			
CH_4 16.042	85.77	8.287	8.287	33.148	
C_2H_6 30.068	7.98	0.789	1.578	4.734	
C_3H_8 44.094	4.11	0.407	1.221	3.256	
C_6H_{12} 59.120	0.12	0.012	0.048	0.120	
	0.04	0.004	0.020	0.048	
TOTAL			11.346	41.306	16.668

WEIGHT BALANCE

	# hr Measured	At. Wt. Balance
WET GAS	189.37	207.29
OIL	54.34	54.34
WATER	103.73	103.73
TOTAL	347.44	365.36
FRESH FEED	365.36	
WEIGHT BALANCE	95.10	
WET GAS FACTOR		1.094629
INDICATED LOSS—S C F H		273

GAS FLOW RATES

	√h	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
		411.1	74.1			
FRESH FEED	4.30	20.635	0.9868	10080	1.4515	26.589
		1.5	61.5			
WET GAS	8.39	4.025	0.9986	2884	1.0784	7.607
		413.1	122			
RECYCLE	4.05	20.683	0.9452	9831	1.0784	25.932
		413.1	122			
BLEED	9.48	20.683	0.9452	1003	1.0784	2.646
		434.8	196	10834		28.578
NATURAL GAS	5.69	21.201	0.8903	3750	1.2282	9.892
		438.1	74			
OXYGEN	5.16	21.279	0.9868	2933		7.736
		34.9				
STEAM	6.27	0.3101		419.4#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL	#	# HR GAL HR
OIL	7'7"	401.69	65	0.9985	401.09			
	6'11"	366.77	62	0.9990	366.40	50.5		
					34.69	6.473	224.55	
	3'3½	176.91	60	1.0000	176.91	51.4		
	0'3"	13.28	74	0.9930	13.19	6.441		
					165.72		1054.58	54.34
					•3.88		25.00	
					202.29		1304.07	8.429
WATER	6'3"	351.85	69	0.9991	351.55	10.8		
	0'7"	30.98	64	0.9996	30.97	8.992		
					300.58		2489.40	103.75
								12.524

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 K
HOURS 224-235

FRESH FEED	%	m/hr	#/hr
$CO_{28.010}$	38.615	10.045	221.37
$H_{2\ 2.016}$	55.725	14.488	29.08
$CO_{2\ 44.010}$	4.190	1.084	47.71
$N_{2\ 28.016}$	0.800	0.207	5.80
$CH_{4\ 16.042}$	0.470	0.122	1.96
$C_2H_{4\ 28.038}$			
$C_2H_{6\ 30.068}$			
C_1+C_2			
$C_3H_{6\ 42.078}$			
$C_3H_{8\ 44.094}$			
$C_4H_{8\ 56.104}$			
$C_4H_{10\ 58.120}$			
$C_5H_{10\ 70.130}$			
$C_6H_{12\ 72.146}$			
$C_6H_{12\ 84.156}$			
C_7-C_8			
TOTAL		25.880	365.92
H_2+CO	94.540	24.467	9275 S.C.F.H.
H_2/CO		1.44	107816

WET GAS	%	At. Wt. Balance m/hr	At. Wt. Balance #/hr
$CO_{28.010}$	8.300	0.641	17.95
$H_{2\ 2.016}$	31.005	2.393	4.82
$CO_{2\ 44.010}$	39.705	3.063	134.81
$N_{2\ 28.016}$	2.585	0.199	5.58
$CH_{4\ 16.042}$	6.465	0.499	8.00
$C_2H_{4\ 28.038}$	2.735	0.211	5.92
$C_2H_{6\ 30.068}$	1.265	0.098	2.95
C_1+C_2			
$C_3H_{6\ 42.078}$	3.570	0.276	11.61
$C_3H_{8\ 44.094}$	0.470	0.036	1.59
$C_4H_{8\ 56.104}$	2.260	0.175	9.82
$C_4H_{10\ 58.120}$	0.490	0.038	2.21
$C_5H_{10\ 70.130}$	0.840	0.065	4.56
$C_6H_{12\ 72.146}$	0.115	0.009	0.65
$C_6H_{12\ 84.156}$	0.195	0.015	1.26
C_7-C_8			
TOTAL		7.718	211.73
H_2+CO		3.034	
H_2/CO		3.73	

RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr
2.284	12.269	2.865	- 9.404	265.42
8.309	22.731	10.704	-12.020	24.26
10.640	11.724	13.708	1.979	87.10
0.695	0.900	0.895		
1.752	1.854	2.231	0.377	6.04
0.733	0.944	0.211	0.211	5.92
0.339	0.339	0.437	0.098	2.95
			14.91	1.508
0.957	0.957	1.233	0.276	11.61
0.126	0.126	0.162	0.036	1.59
0.606	0.606	0.781	0.175	9.82
0.151	0.151	0.189	0.038	2.21
0.225	0.225	0.290	0.065	4.56
0.031	0.031	0.040	0.009	0.65
0.052	0.052	0.067	0.015	1.26
			31.70	3.418
26.798	52.678	40.196		
10.533	35.000	13.569	-21.435	
	1.85		1.28	

CUMULATIVE TOTALS	H_2+CO.MCF	Catalyst #	C_5+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO			
	RECOVERED OIL	0.3593*	50.40
	TOTAL OIL		62.10
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 10.2	WATER SOLUBLE CHEMICALS	0.229*	12.13
	TOTAL LIQUID PRODUCTS C_5+		94.23
	NET WATER	5.088*	91.66
	GROSS WATER		103.79
	HYDROCARBON TOTAL—C_1+		109.14

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+ /C_1+
70.15	93.62	85.39	87.59	76.65	52.91	61.25	86.51

YIELD BASIS H_2+CO FED — CONDENSATE	#/MCF	#/gal	gal/hr	gal/MCF
	0.651			
	0.638			
	0.318			
	1.608			
	1.252	4.32	2.686	0.289
	0.171	4.24	0.375	0.040
	1.059	5.00	1.964	0.212
	0.236	4.86	0.456	0.049
	0.492	5.45	0.837	0.090
	0.070	5.25	0.124	0.013
	0.136	5.54	0.227	0.024
	3.418		6.671	0.719
	5.454		7.735	0.834
	8.852		14.406	1.553
	1.308		1.501	0.16
	10.160		15.907	1.715
	9.882		11.006	1.187
	11.190		12.507	1.348
	11.768			

YIELD BASIS H_2+CO FED — POLYMER	#/MCF	#/gal	gal/hr	gal/MCF	% Unsats.
Distribution of Recovered Oil					
400 EP				0.625	
400-550				0.108	
550+				0.103	
	10.45	6.25	1.672	0.180	88.4
	9.53	6.10	1.530	0.165	92.2
	2.21	4.86	0.456	0.049	
	4.56	5.45	0.837	0.090	88.0
	0.65	5.25	0.124	0.013	
	1.26	5.54	0.227	0.024	
	28.46		4.846	0.521	
	90.99		9.811	1.509	
	29				
	75				
	74				
	75				
	390				
	643				
	14.81				

PRODUCT TESTS	OIL	WATER
°API	50.7	10.7
Neut. No.	43.7	42.0
Sap. No.	54.3	45.1
Hydrox. No.		
Bromine No.	80.7	
Pour °F.		
Chemicals, % by K_2CO_3		12.0

HEMPEL, DIST. %	°API
205 °F.	
400	74.6
400-550	13.0
550+	12.4

A. S. T. M. DIST. ON	
Naphtha °F.	
IBP	97
10%	134
50%	221
90%	343
EP	398
Rec.	97.5

OPERATING CONDITIONS		RATES S.C.F.H.	
PRESSURES PSIG			
Oxygen	446	Fresh Feed	9811
Natural Gas	442	Recycle	10159
Generator Outlet	416	Combined Feed	19970
Reactor Inlet	411	Wet Gas—Measured	2669
Condenser Inlet		Adjusted	2926
Product Accumulator	390	Loss	257
TEMPERATURES—°F.		Recycle/Fresh Feed	1.035
Oxygen	404	Inlet Velocity—ft./sec.	0.61
Natural Gas	775	Fresh Feed Rate—S.C.F.H.	9275
Generator		per Cu. Ft. Dense Bed	626
Quench Accumulator		per Lb. Catalyst	4.20
Reactor Inlet	642	per Sq. Ft.	14053
Condenser Inlet			
Product Accumulator	69	Heat Transfer Calculations	
Catalyst No. Height "		Steam Rate = 395.2 #/hr	
1	645	@ 797 psia & 518°F	
2	647	= 1197 BTU/#	
3	652	Water in @ 158°F = 126 BTU/#	
✗ 5	657	Heat Transferred /lb. steam	
✗ 7	625	= 1071 BTU	
✗ 8	620	(1071)(395.2) = 423260 BTU/hr	
9	620	Ave. Bed Temperature = 635°F	
10	610	dT = 635-518 = 117°F	
11	587	Tube Area = 32.4 ft²	
12	577	K = 423260 / (117)(38.47) =	111.9

CATALYST DATA — INVENTORY DATA		
In Reactor at Start of Period		
Fresh Catalyst Added 50 =	76	
Total		
Catalyst Recovered	9	
In Reactor at End of Period		
REACTOR d-p, Inches H_2O		
No. Height "		
0 0 - 12	29	
1 12 - 43.2	75	
2 43.2 - 74.4	74	
3 74.4 - 105.6	75	
4 105.6 - 342.0	390	
Total	643	
CALCULATED FROM dp		
Density, Lbs./Cu.Ft.	149	
Inventory, Lbs.	2207	
Bed Depth, Ft.	22.44	
Cu. Ft.	14.81	

PARTICLE SIZE	Screen Analysis			Sedimentation	
	Mesh	Microns	%	Microns	%
	On 40	419+	11.7	80+	
	100	150	57.4	40—80	
	150	105	17.7	20—40	
	200	74	9.4	10—20	
	250	62	1.4	0—20	
	325	44	1.8		
	<325		0.06		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	153
Settled	154
Compacted	169
Particle Density, gm./cc.	4.44
NH_3 Value, ml./gm.	17.67*
N_2 Surface, m²/gm.	

* Catalyst H_2 stripped before sampling.

CHEMICAL ANALYSIS
Fe
C
O
H
K_2O, W+, % basis Fe
X-Ray Analysis—
$Fe_{20}C_9$
Fe_3O_4
Fe

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

*Included in Reactor Effluent Total

GAS ANALYSES — HOUR	1000	1400		AVERAGE
FRESH FEED				
$CO_{28.010}$	38.68	38.95		38.815
$H_{2\ 2.016}$	55.40	56.05		55.725
$CO_{2\ 44.010}$	4.20	4.18		4.190
$N_{2\ 28.016}$	0.84	0.76		0.800
$CH_{4\ 16.042}$	0.88	0.06		0.470
			M. W.	14.1390
			H_2O 18.016	
			BALANCE	
WET GAS				
$CO_{28.010}$	8.35	8.25		8.300
$H_{2\ 2.016}$	29.85	32.18		31.005
$CO_{2\ 44.010}$	40.17	39.24		39.705
$N_{2\ 28.016}$	2.73	2.44		2.585
$CH_{4\ 16.042}$	6.45	6.50		6.465
$C_2H_{4\ 28.052}$	2.77	2.70		2.735
$C_3H_{6\ 42.078}$	3.79	3.35		3.570
$C_3H_{8\ 44.094}$	0.53	0.41		0.470
$C_4H_{8\ 56.104}$	2.39	2.13		2.260
$C_4H_{10\ 58.120}$	0.49	0.49		0.490
$C_5H_{10\ 70.130}$	0.89	0.79		0.840
$C_6H_{12\ 72.146}$	0.11	0.12		0.115
$C_6H_{12\ 84.156}$	0.21	0.18		0.195
			M. W.	27.4213

GENERATOR BALANCE		Mol %	M/Hr	C	H	O
	$O_{2\ 32.000}$	0.21	8.470 0.021			16.982
	$CO_{28.010}$					
	$H_{2\ 2.016}$					
	$CO_{2\ 44.010}$	2.34	0.232	0.232		0.464
	$N_{2\ 28.016}$	1.00	0.099			
	$CH_{4\ 16.042}$	83.24	8.267	8.267	33.068	
	$C_2H_{6\ 30.068}$	8.25	0.819	1.638	4.914	
	$C_3H_{6\ 42.094}$	3.96	0.393	1.179	3.144	
	$C_4H_{10\ 58.120}$	0.11	0.011	0.044	0.110	
		0.04	0.004	0.020	0.048	
	TOTAL			11.380	41.284	17.446

GAS FLOW RATES	√R	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED		410.5	87			
	4.50	20.62	0.9750	9811	1.4309	25.880
		1.5	69			
WET GAS						
	8.26	4.00	0.9915	2669	1.0273	7.040
		413.5	128			
RECYCLE						
	4.00	20.69	0.9404	9206	1.0273	24.284
		413.5	128			
BLEED						
	9.5	20.69	0.9404	953	1.0273	2.514
		441.5	199	10159		26.798
NATURAL GAS						
	8.66	21.56	0.9895	3745	1.233	9.931
		440.0	87			
OXYGEN						
	5.67	21.46	0.9750	2211		8.470
		33.6				
STEAM						
215.7	6.0	0.9054		395.2#/hr		

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
WET GAS	193.18	211.73
OIL	50.40	50.40
WATER	103.79	103.79
TOTAL	347.31	365.92
FRESH FEED	365.92	
WEIGHT BALANCE	94.91	
WET GAS FACTOR		1.096364
INDICATED LOSS—S C F H		257

LIQUID PRODUCT RATES — HOUR	GAGE	GAL.	°F	FACTOR	GAL AT 60	API° #/GAL.	#	# HR GAL HR
OIL	4'11¾"	265.29	72	0.9941	263.72	50.7 6.466	1705.2	
	3'5½"	176.91	60	1.000	176.91	51.4	1139.5	
					0.85	6.441	565.7	
							5.0 2.5	50.40
					87.66		571.2	7.735
WATER	7'3½"	385.32	68	0.9998	385.01	10.7 8.287	3190.6	
	6'3"	351.95	69	0.9991	351.55	10.8	2745.9	
					53.46	8.282	444.7	
	1'11½"	108.89	80	0.9976	108.64	10.7		
	0'5½"	14.38	74	0.9985	14.36	8.287		
					88.28		731.6	103.79
					141.74		1176.5	18.507

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 L
HOURS 235-242

	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	36.680	10.024	280.75	9.630	0.857	24.00	2.794	12.818	3.651	- 9.167	256.75
H_2 2.016	59.155	16.165	32.59	39.007	3.468	6.99	11.318	27.483	14.786	-12.697	25.60
CO_2 44.010	3.330	0.910	40.05	31.778	2.826	124.35	9.221	10.131	12.047	1.916	84.30
N_2 28.016	0.690	0.189	5.30	2.345	0.209	5.86	0.681	0.870	0.890		
CH_4 16.042	0.145	0.040	0.64	7.420	0.660	10.59	2.153	2.193	2.813	0.620	9.95
C_2H_4 28.052				2.490	0.222	6.23	0.723	0.723	0.945	0.222	6.23
C_2H_6 30.068				1.270	0.113	3.40	0.369	0.369	0.482	0.113	3.40
C_1+C_2											19.58
C_3H_6 42.078				2.990	0.266	11.19	0.868	0.868	1.134	0.266	11.19
C_3H_8 44.094				0.455	0.041	1.81	0.132	0.132	0.173	0.041	1.81
C_4H_8 56.104				1.525	0.136	7.63	0.443	0.443	0.579	0.136	7.63
C_4H_{10} 58.120				0.385	0.034	1.98	0.112	0.112	0.146	0.034	1.98
C_5H_{10} 70.130				0.510	0.045	3.16	0.148	0.148	0.193	0.045	3.16
C_5H_{12} 72.146				0.070	0.006	0.43	0.020	0.020	0.026	0.006	0.43
C_6H_{12} 84.156				0.125	0.011	0.93	0.036	0.036	0.047	0.011	0.93
C_3-C_6											27.13
TOTAL		27.328	359.33		8.894	208.55	29.018	56.346	43.389		
H_2+CO	95.835	26.189	9929 S.C.F.H.		4.325		14.112	40.301		-21.864	
H_2/CO		1.61	100715		4.047			2.14		1.385	

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			
H_2						of Recovered Oil				
CO_2	8.490					400 EP			0.585	
N_2						400-550			0.110	
CH_4	1.002					550+			0.095	
C_2H_4	0.628									66.2
C_2H_6	0.342									
C_1+C_2	1.972									
C_3H_6	1.127	4.32	2.590	0.261	10.07	1.014	6.25	1.611	0.162	86.8
C_3H_8	0.182	4.24	0.427	0.043						
C_4H_8	0.768	5.00	1.526	0.154	7.25	0.730	6.10	1.189	0.120	79.8
C_4H_{10}	0.199	4.86	0.407	0.041	1.98	0.199	4.86	0.407	0.041	
C_5H_{10}	0.318	5.45	0.580	0.058	3.16	0.318	5.45	0.580	0.058	87.9
C_5H_{12}	0.043	5.25	0.082	0.008	0.43	0.043	5.25	0.082	0.008	
C_6H_{12}	0.094	5.54	0.168	0.017	0.93	0.094	5.54	0.168	0.017	
C_3-C_6	2.732		5.780	0.582	23.82	2.398		4.037	0.406	

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	0.353*	50.87	5.123	5.48	7.846	0.790	50.87	5.123		7.846	0.790
TOTAL OIL		78.00	7.856	5.72	13.626	1.372	74.69	7.521		11.883	1.196
WATER SOLUBLE CHEMICALS	0.217*	11.50	1.158	8.333	1.380	0.139	11.50	1.158		1.380	0.139
TOTAL LIQUID PRODUCTS C_3+		89.50	9.014		15.006	1.511	86.19	8.679		13.263	1.335
NET WATER	4.907*	88.41	8.904	8.328	10.616	1.069					
GROSS WATER		99.91	10.062		11.996	1.208					
HYDROCARBON TOTAL—C_1+		109.08	10.986								

*Included in Reactor Effluent Total

SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 9.94

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+
67.45	91.45	78.55	83.49	71.52	46.20	54.25	82.05

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

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	421	Fresh Feed	10360
Natural Gas	419	Recycle	11001
Generator Outlet	412	Combined Feed	21361
Reactor Inlet	409	Wet Gas—Measured	2969
Condenser Inlet		Adjusted	3372
Product Accumulator	356	Loss	403
TEMPERATURES—°F.		Recycle/Fresh Feed	1.06
Oxygen	341	Inlet Velocity—ft./sec.	0.67
Natural Gas	724	Fresh Feed Rate—S.C.F.H.	9929
Generator		per Cu.Ft. Dense Bed	678
Quench Accumulator		per Lb. Catalyst	4.88
Reactor Inlet	571	per Sq. Ft.	15044
Condenser Inlet			
Product Accumulator	63	Heat Transfer Calculations	

Catalyst No.	Height *		
		Steam Rate = 381.8 #/hr	
1	12.0	638	@ 829 psia & 522°F
2	43.2	644	= 1196 BTU/#
3	74.4	673	Water in @ 150°F = 118 BTU/#
5	136.8	646	Heat Transferred /lb. steam
7	199.2	630	= 1078 BTU
8	230.4	623	(1078)(381.8) = 384774 BTU/hr
9	261.6	621	Ave. Bed Temperature = 639°F
10	292.8	611	dT = 639-522 = 117°F
11	311.0	588	Tube Area = 32.2 ft^2
12	342.0	586	$K = \frac{384774}{(117)(32.2)} = 102.1$

PRODUCT TESTS

	OIL	WATER
°API	50.6	10.4
Neut. No.	40.7	39.5
Sap. No.	51.5	40.1
Hydrox. No.		
Bromine No.	80.1	
Pour °F.		
Chemicals, % by K_2CO_3		11.5
HEMPEL. DIST. %		°API
205 °F.		
400	74.0	56.5
400-550	14.0	37.9
550+	12.0	
A. S. T. M. DIST. ON Naphtha °F.		
IBP	96	
10%	136	
50%	227	
90%	344	
EP	398	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	0
Total	
Catalyst Recovered	76
In Reactor at End of Period	
REACTOR d-p, Inches H_2O — No. Height *	
0 0 - 12	26
1 12.0 - 43.2	67
2 43.2 - 74.4	72
3 74.4 - 105.6	73
4 105.6 - 342.0	355
Total	593
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	139
Inventory, Lbs.	2035
Bed Depth, Ft.	22.18
Cu. Ft.	14.64

PARTICLE SIZE

Screen Analysis Mesh	Microns	%	Sedimentation Microns	%
On 40	419+	11.7	80+	
100	150	62.7	40—80	
150	105	11.6	20—40	
200	74	8.1	10—20	
250	62	2.0	0—20	
325	44	1.7		
<325		2.2		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	150
Settled	152
Compacted	164
Particle Density, gm./cc.	4.5
NH_3 Value, ml./gm.	8.45
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	0200	0600		AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.46	7.389 0.044			14.866
CO 28.010	38.06	35.30		36.680	10.024	10.024		10.024	CO 28.010					
H_2 2.016	57.34	60.97		59.155	16.165		32.330		H_2 2.016					
CO_2 44.010	3.85	2.81		3.330	0.910	0.910		1.820	CO_2 44.010	2.20	0.210	0.210		0.420
N_2 28.016	0.69	0.69		0.690	0.189				N_2 28.016	1.74	0.166			
CH_4 16.042	0.06	0.23		0.145	0.040	0.040	0.160		CH_4 16.042	82.07	7.826	7.826	31.304	
			M. W.	13.1487					C_2H_6 30.068	8.41	0.802	1.604	4.812	
			H_2O 18.016				7.082	3.541	C_3H_8 44.094	4.92	0.469	1.407	3.752	
						10.974	39.572	15.385	C_4H_{10} 58.120	0.14 0.06	0.013 0.006	0.052 0.030	0.130 0.072	
			BALANCE			98.61	98.76	100.65	TOTAL			11.129	40.070	15.286

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	183.65	208.55
OIL	50.87	50.87
WATER	99.91	99.91
TOTAL	334.43	359.33
FRESH FEED	359.33	
WEIGHT BALANCE	93.07	
WET GAS FACTOR		1.135583
INDICATED LOSS—S C F H		403

WET GAS	0200	0600		AVERAGE
CO 28.010	9.54	9.72		9.630
H_2 2.016	38.44	39.58		39.007
CO_2 44.010	33.09	30.47		31.778
N_2 28.016	2.26	2.43		2.345
CH_4 16.042	7.13	7.71		7.420
C_2H_4 28.052	2.50	2.48		2.490
C_2H_6 30.068	1.28	1.26		1.270
C_3H_6 42.078	2.84	3.14		2.990
C_3H_8 44.094	0.47	0.44		0.455
C_4H_8 56.104	1.46	1.59		1.525
C_4H_{10} 58.120	0.34	0.43		0.385
C_5H_{10} 70.130	0.49	0.53		0.510
C_5H_{12} 72.146	0.07	0.07		0.070
C_6H_{12} 84.156	0.09	0.16		0.125
			M. W.	22.4424

GAS FLOW RATES

	√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	4.30	409.3 20.59	66 0.9943	10360	1.4838	27.328
WET GAS 8.26	8.025	1.3 4.00	52 1.0078	2969	1.11114	7.832
RECYCLE 115.14	3.95	412.9 20.68	115 0.9510	9939	1.11114	26.217
BLEED 5.02	9.68	412.9 20.68	115 0.9510	1062	1.11114	2.801
NATURAL GAS 28.43	5.70	419.3 20.83	198 0.8890	11001 3615	1.2046	29.018 9.536
OXYGEN 27.07	4.979	420.6 20.86	64 0.9962	2801		7.389
STEAM 215.7	5.869	32.6 0.3016		381.8#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL								
0600	6'0"	318.76	60	1.0000	318.76	50.6 6.469	2062.1	
2300	5'0"	266.38	64	0.9980	265.85	50.7 6.466	1719.0	
					52.91		343.1	
					+2.01		130	50.87
					54.92		356.1	7.846
WATER								
0600	3'8½"	198.73	68	0.9992	198.57	10.4 8.305	1649.1	
2300	2'2"	114.67	66	0.9994	114.60	10.7 8.287	949.7	99.91
					83.97		699.4	11.996

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 M
HOURS 242-266

	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	37.687	10.328	289.28	9.610	0.819	22.94	2.863	13.191	3.682	- 9.509	266.34					Distribution of					
H_2 2.016	58.653	16.073	32.40	38.535	3.283	6.62	11.479	27.552	14.762	-12.790	25.87					Recovered Oil					
CO_2 44.010	2.970	0.814	35.82	30.790	2.623	115.45	9.173	9.987	11.796	1.809	79.63	7.956					400 EP			0.633	
N_2 28.016	0.583	0.160	4.48	2.620	0.223	6.25	0.781	0.941	1.004								400-550			0.114	
CH_4 16.042	0.107	0.029	0.47	7.883	0.671	10.76	2.349	2.378	3.020	0.642	10.29	1.028					550+			0.086	
C_2H_4 28.052				2.727	0.232	6.51	0.812	0.812	1.044	0.232	6.51	0.650								0.833	65.6
C_2H_6 30.068				1.427	0.122	3.67	0.425	0.425	0.547	0.122	3.67	0.367									
C_1+C_2											20.47	2.045									
C_3H_6 42.078				3.147	0.268	11.28	0.938	0.938	1.206	0.268	11.28	1.127	4.32	2.611	0.261	10.15	1.014	6.25	1.624	0.162	87.7
C_3H_8 44.094				0.443	0.038	1.68	0.132	0.132	0.170	0.038	1.68	0.168	4.24	0.396	0.040						
C_4H_8 56.104				1.637	0.139	7.80	0.488	0.488	0.627	0.139	7.80	0.779	5.00	1.560	0.156	7.41	0.740	6.10	1.215	0.121	80.5
C_4H_{10} 58.120				0.397	0.034	1.98	0.118	0.118	0.152	0.034	1.98	0.198	4.86	0.407	0.041	1.98	0.198	4.86	0.407	0.041	
C_5H_{10} 70.130				0.567	0.048	3.37	0.169	0.169	0.217	0.048	3.37	0.337	5.45	0.618	0.062	3.37	0.337	5.45	0.618	0.062	86.7
C_5H_{12} 72.146				0.087	0.007	0.51	0.026	0.026	0.033	0.007	0.51	0.051	5.25	0.097	0.010	0.51	0.051	5.25	0.097	0.010	
C_6H_{12} 84.156				0.130	0.011	0.93	0.039	0.039	0.050	0.011	0.93	0.093	5.54	0.168	0.017	0.93	0.093	5.54	0.168	0.017	
C_3-C_6											27.55	2.753		5.857	0.585	24.35	2.433		4.129	0.413	
TOTAL		27.404	362.45		8.518	199.75	29.792	57.196	44.289												
H_2+CO	96.340	26.401	10009 S.C.F.H.		4.102		14.342	40.743	18.444	-22.299											
H_2/CO		1.556	999100		4.01			2.09		1.35											

CUMULATIVE TOTALS	H_2+CO, MCF	Catalyst #	C_3+, gal	gal/MCF	gal/#			m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF
						EFFLUENT	RECOVERED OIL	0.3824*	53.63	5.358		8.340	0.833	53.63	5.358		8.340	0.833
Previous Total						SHIFT RATIO	TOTAL OIL		81.18	8.111		14.197	1.418	77.98	7.791		12.469	1.246
Current Period						$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 8.82	WATER SOLUBLE CHEMICALS	0.235*	12.46	1.245		1.582	0.158	12.46	1.245		1.582	0.158
New Total							TOTAL LIQUID PRODUCTS C_3+		93.64	9.356		15.779	1.576	90.44	9.036		14.051	1.404

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	$CO+H_2$	SELECTIVITY C_3+/C_1+		m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF
								NET WATER	5.362*	96.61	9.652	8.328	11.601	1.159
								GROSS WATER		109.07	10.897		13.183	1.317
68.92	92.07	79.57	84.46	72.09	46.42	54.73	82.06	HYDROCARBON TOTAL—C_1+		114.11	11.401			

*Included in Reactor Effluent Total

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

OPERATING CONDITIONS				PRODUCT TESTS			CATALYST DATA						
PRESSURES PSIG		RATES S.C.F.H.			OIL	WATER	INVENTORY DATA		PARTICLE SIZE				
Oxygen	427	Fresh Feed	10389	°API	52.3	11.0	In Reactor at Start of Period		Screen Analysis			Sedimentation	
Natural Gas	427	Recycle	11294	Neut. No.	35.8	38.0	Fresh Catalyst Added 51 *	77	Mesh	Microns	%	Microns	%
Generator Outlet	420	Combined Feed	21683	Sap. No.	50.3	40.3	Total		On 40	419+	11.6	80+	
Reactor Inlet	415	Wet Gas—Measured	3009	Hydrox. No.			Catalyst Recovered	105	100	150	67.8	40—80	
Condenser Inlet		Adjusted	3229	Bromine No.	77.8		In Reactor at End of Period		150	105	12.4	20—40	
Product Accumulator	395	Loss	220	Pour °F.					200	74	5.6	10—20	
				Chemicals, % by K_2CO_3		12.0	REACTOR d-p, Inches H_2O		250	62	1.0	0—20	
							No. Height		325	44	1.0		
TEMPERATURES—°F.		Recycle/Fresh Feed	1.09				1 12-43.2	65	<325		0.6		
Oxygen	332	Inlet Velocity—ft./sec.	0.68				2 43.2-74.4	71	CATALYST				
Natural Gas	805	Fresh Feed Rate—S.C.F.H.	10009	HEMPEL, DIST. %			3 74.4-105.6	72	Bulk Density, Lbs./Cu.Ft.				
Generator	2375	per Cu.Ft. Dense Bed	669	205 °F.		°API	4 105.6-342.0	360	Aerated				147
Quench Accumulator		per Lb. Catalyst	4.92	400	76.0	57.2	0 0-12	25	Settled				149
Reactor Inlet	604	per Sq. Ft.	15165	400-550	13.7	37.5	Total	593	Compacted				163
Condenser Inlet				550+	10.3				Particle Density, gm./cc.				4.4
Product Accumulator	53	Heat Transfer Calculations					CALCULATED FROM dp		NH_3 Value, ml./gm.				7.4
Catalyst No. Height "		Steam Rate = 406.8 #/hr.		A. S. T. M. DIST. ON			Density, Lbs./Cu.Ft.	136	N_2 Surface, m^2/gm.				
1 12.0	645	@830 psia & 522°F = 1196 BTU/#		Naphtha °F.			Inventory, Lbs.	2035					
2 43.2	650			IBP	90		Bed Depth, Ft.	22.67	CHEMICAL ANALYSIS				
3 74.4	662	Water in @ 156°F = 124 BTU/#		10%	137		Volume, Cu. Ft.	14.96	Fe				
5 136.8	652	Heat Transferred/# steam = 1072 BTU		50%	226				C				
7 199.2	635			90%	346				O				
8 230.4	629	(1072)(406.8) = 436049 BTU/hr.		EP	398				H				
9 261.6	628	Average Bed Temperature = 643°F		Rec.	97.5				K_2O, W+, % basis Fe				
10 292.8	618								X-Ray Analysis—				
11 311.0	597	dT = 643-522 = 121°F							$Fe_{20}C_9$				
12 342.0	594	Tube Area = 32.6 ft^2							Fe_3O_4				
		$K = \frac{436049}{(32.6)(121)} = 110.5$							Fe				

HOUR	GAS ANALYSES 1400	0200	0600	AVERAGE	GENERATOR BALANCE M/HR	C	H	O		Mol %	M/Hr	C	H	O	WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.49	7.259 0.048			14.614	WET GAS	186.13	199.75
CO 28.010	37.29	38.59	37.18	37.687	10.328	10.328		10.328	CO 28.010						OIL	53.63	53.63
H_2 2.016	59.29	57.58	59.09	58.653	16.073		32.146		H_2 2.016						WATER	109.07	109.07
CO_2 44.010	2.93	3.14	2.84	2.970	0.814	0.814		1.628	CO_2 44.010	1.90	0.187	0.187		0.374	TOTAL	348.83	362.45
N_2 28.016	0.43	0.63	0.69	0.583	0.160				N_2 28.016	1.83	0.180				FRESH FEED	362.45	
CH_4 16.042	0.06	0.06	0.20	0.107	0.029	0.029	0.116		CH_4 16.042	84.13	8.275	8.275	33.100		WEIGHT BALANCE	96.24	
			M. W.	13.2262					C_2H_6 30.068	8.37	0.823	1.646	4.938				
			H_2O 18.016				7.225	3.613	C_3H_8 44.094	3.19	0.314	0.942	2.512		WET GAS FACTOR	1073174	
					27.404	11.171	39.489	15.569	C_4H_{10} 58.120	0.05 0.04	0.005 0.004	0.020 0.020	0.050 0.048		INDICATED LOSS—S C F H	220	
			BALANCE			100.73	97.15	103.88	TOTAL		9.836	11.090	40.648	14.988			

WET GAS					GAS FLOW RATES	√h	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
CO 28.010	9.94	9.62	9.27	9.610																
H_2 2.016	38.43	37.96	39.22	38.535	FRESH FEED		415.0	67				OIL	7'4"	388.59	67	0.9965	387.23		2505.0	
CO_2 44.010	31.27	31.48	29.62	30.790	79.31	4.30	20.73	0.9933	10389	1.4795	27.404		6'0"	318.76	60	1.0000	318.76	50.6 6.469	2062.1	
N_2 28.016	2.54	2.74	2.58	2.620			1.5	53												53.63
CH_4 16.042	7.34	8.11	8.20	7.883	WET GAS 8.26	8.09	4.025	1.0068	3009	1.11108	7.937		2'8"	142.71	48	1.0059	143.55	52.3	920.2	8.340
C_2H_4 28.052	2.65	2.72	2.81	2.727	RECYCLE		415.8	108					0'3"	13.28	73	0.9935	13.19	6.410	84.6	
C_2H_6 30.068	1.31	1.52	1.45	1.427	115.14	4.03	20.75	0.9568	10236	1.11108	27.001						+1.33		+8.5	
C_3H_6 42.078	3.03	3.01	3.40	3.147	BLEED		415.8	108									200.16		1287.0	
C_3H_8 44.094	0.41	0.42	0.50	0.433	5.02	9.55	20.75	0.9568	1058	1.11108	2.791	WATER	7'6"	397.32	70	0.9990	396.92	11.0 8.270	3282.5	
C_4H_8 56.104	1.74	1.45	1.72	1.637	NATURAL GAS		427.0	190	11294		29.792		3'8½"	198.73	68	0.9992	198.57	10.4 8.305	1649.1	
C_4H_{10} 58.120	0.43	0.32	0.44	0.397	28.43	5.65	21.02	0.8944	3729	1.23492	9.836									
C_5H_{10} 70.130	0.69	0.46	0.55	0.567	OXYGEN		427.0	65.0					2'6"	133.50	58	1.0002	133.53	11.0	1104.3	
C_5H_{12} 72.146	0.07	0.08	0.11	0.087	27.07	4.86	21.02	0.9952	2752		7.259		3½"	15.49	65	0.9995	15.48	8.270	120.0	13.183
C_6H_{12} 84.156	0.15	0.11	0.13	0.130	STEAM		33.4 -10.0*	251 *Correction for hydraulic head.									316.40		2617.7	109.07
			M. W.	23.4505	215.7	6.192	0.3046		406.8#/hr.											

THE TEXAS COMPANY --- MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51-N
HOURS 266-282

	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	37.280	10.432	292.20	9.930	0.894	25.04	3.017	13.449	3.911	-9.538	-267.16					Distribution of					
H_2 2.016	58.880	16.475	33.21	40.255	3.622	7.30	12.230	28.705	15.582	-12.853	- 25.91					Recovered Oil					
CO_2 44.010	3.030	0.848	37.32	29.985	2.699	118.75	9.109	9.957	11.808	1.851	81.43	7.983					400 EP		77.0%	0.630	
N_2 28.016	0.640	0.179	5.01	2.500	0.225	6.30	0.760	0.939	0.985								400-550		12.0%	0.098	
CH_4 16.042	0.170	0.048	0.77	7.705	0.694	11.13	2.341	2.389	3.035	0.646	10.36	1.016					550+		11.0%	0.090	
C_2H_4 28.052				2.465	0.222	6.23	0.749	0.749	0.971	0.222	6.23	0.611									65.7
C_2H_6 30.068				1.285	0.116	3.49	0.390	0.390	0.506	0.116	3.49	0.342									
C_1+C_2											20.08	1.968									
C_3H_6 42.078				2.825	0.254	10.69	0.858	0.858	1.112	0.254	10.69	1.048	4.32	2.475	0.243	9.62	0.943	6.25	1.539	0.151	87.7
C_3H_8 44.094				0.395	0.036	1.59	0.120	0.120	0.156	0.036	1.59	0.156	4.24	0.375	0.037						
C_4H_8 56.104				1.510	0.136	7.63	0.459	0.459	0.595	0.136	7.63	0.748	5.00	1.526	0.150	7.25	0.711	6.10	1.189	0.117	79.5
C_4H_{10} 58.120				0.390	0.035	2.03	0.118	0.118	0.153	0.035	2.03	0.199	4.86	0.418	0.041	2.03	0.199	4.86	0.418	0.041	
C_5H_{10} 70.130				0.505	0.045	3.16	0.153	0.153	0.198	0.045	3.16	0.310	5.45	0.580	0.057	3.16	0.310	5.45	0.580	0.057	82.1
C_5H_{12} 72.146				0.110	0.010	0.72	0.033	0.033	0.043	0.010	0.72	0.071	5.25	0.137	0.013	0.72	0.071	5.25	0.137	0.013	
C_6H_{12} 84.156				0.140	0.013	1.09	0.043	0.043	0.056	0.013	1.09	0.107	5.54	0.197	0.019	1.09	0.107	5.54	0.197	0.019	
C_3-C_6											26.91	2.638		5.708	0.560	23.87	2.340		4.060	0.398	
TOTAL		27.982	368.50		9.001	205.15	30.380	58.362	45.314												
H_2+CO	96.160	26.907	10201 S.C.F.H.		4.516		15.247	42.154		-22.391											
H_2/CO		1.579	980296		4.05			2.13		1.35											

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	0.376*	52.74	5.170		8.340	0.818	52.74	5.170		8.340	0.818
TOTAL OIL		79.65	7.808		14.048	1.377	76.61	7.510		12.400	1.216
WATER SOLUBLE CHEMICALS	0.256*	13.56	1.329		1.714	0.168	13.56	1.329		1.714	0.168
TOTAL LIQUID PRODUCTS C_3+		93.21	9.137		15.762	1.545	90.17	8.839		14.114	1.384
NET WATER	5.301*	95.51	9.363	8.328	11.469	1.124					
GROSS WATER		109.07	10.692		13.183	1.292					
HYDROCARBON TOTAL—C_1+		113.29	11.106								

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

SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 8.9

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO	TOTAL FEED CONVERSION — % CO	H_2	$CO+H_2$	SELECTIVITY C_3+ / C_1+
67.83	91.43	78.02	83.22	70.92	44.78	53.12	82.76

*Included in Reactor Effluent Total

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

DATA SUMMARY

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	424	Fresh Feed	10608
Natural Gas	424	Recycle	11517
Generator Outlet	415	Combined Feed	22125
Reactor Inlet	411	Wet Gas—Measured	3198
Condenser Inlet		Adjusted	3412
Product Accumulator	391	Loss	214
TEMPERATURES—°F.		Recycle/Fresh Feed	1.09
Oxygen	398	Inlet Velocity—ft./sec.	0.69
Natural Gas	723	Fresh Feed Rate—S.C.F.H.	CO+H2 10201
Generator		per Cu. Ft. Dense Bed	731
Quench Accumulator		per Lb. Catalyst	5.49
Reactor Inlet	586	per sq. ft.	15456
Condenser Inlet			
Product Accumulator	53		

Catalyst No.	Height "	Temp.
1	12.0	645
2	43.2	644
3	74.4	650
5	136.8	644
7	199.2	638
8	230.4	624
9	261.6	616
10	292.8	608
11	311.0	580
12	342.0	578

Heat Transfer Calculations
Steam Rate = 395.9#/hr.
@830 psia & 522°F = 1196 BTU/#
Water in @ 159°F = 126 BTU/#
Heat transferred/# steam = 1070 BTU
(1070)(395.9)= 423613 BTU/hr.
Average Bed Temperature = 637°F
dT = 637-522 = 115°F
Tube Area = 31.6 ft.^{2}
$K = \frac{423613}{(115)(31.6)} = 116.6$

PRODUCT TESTS

	OIL	WATER
°API	53.6	10.9
Neut. No.	40.4	37.6
Sap. No.	46.6	39.1
Hydrox. No.		
Bromine No.	88.3	
Pour °F.		
Chemicals, % by K_2CO_3		13.0
HEMPEL, DIST. %		
205 °F.		°API
400	77.0	58.4
400-550	12.0	37.8
550+	11.0	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	90	
10%	123	
50%	216	
90%	349	
EP	401	

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	
Fresh Catalyst Added	62 # 94
Total	
Catalyst Recovered	213
In Reactor at End of Period	
REACTOR d-p, Inches H_2O — No. / Height	
1 — 12-43.2	63
2 — 43.2-74.4	70
3 — 74.4-105.6	74
4 — 105.6-342.0	310
0 — 0-12	24
	541
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	133
Inventory, Lbs.	1857
Bed Depth, Ft.	21.15
Volume, Cu. Ft.	13.96

PARTICLE SIZE — Screen Analysis: Mesh	Microns	%	Sedimentation: Microns	%
On 40	419+	10.7	80+	
100	150	62.0	40—80	
150	105	12.9	20—40	
200	74	7.8	10—20	
250	62	1.8	0—20	
325	44	2.4		
<325		2.4		

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	149
Settled	151
Compacted	165
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	8.35
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	0600	1800	0600	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	37.17	37.59	37.08	37.280	10.432	10.432		10.432
H_2 2.016	59.10	58.43	59.11	58.880	16.475		32.950	
CO_2 44.010	2.84	3.24	3.01	3.030	0.848	0.848		1.696
N_2 28.016	0.69	0.64	0.59	0.640	0.179			
CH_4 16.042	0.20	0.10	0.21	0.170	0.048	0.048	0.192	
			M. W.	13.1692				
			H_2O 18.016				4.430	2.215
					27.982	11.328	37.572	14.343
			BALANCE			103.87	102.42	97.00

	Mol %	M/Hr	C	H	O
O_2 32.000	1.05	7.209 / 0.104			14.418
CO 28.010					
H_2 2.016					
CO_2 44.010	1.86	0.184	0.184		0.368
N_2 28.016	4.31	0.428			
CH_4 16.042	81.25	8.075	8.075	32.300	
C_2H_6 30.068	8.05	0.800	1.600	1.600	
C_3H_8 44.094	3.41	0.339	1.017	2.712	
C_4H_{10} 58.120	0.05 / 0.02	0.005 / 0.002	0.020 / 0.010	0.050 / 0.024	
TOTAL			10.906	36.686	14.786

WEIGHT BALANCE

	#/hr Measured	At. Wt. Balance
WET GAS	192.27	205.15
OIL	52.74	52.74
WATER	110.61	110.61
TOTAL	355.62	368.50
FRESH FEED	368.50	
WEIGHT BALANCE	96.50	
WET GAS FACTOR	1066989	
INDICATED LOSS—S C F H	214	

WET GAS	0600	1800		AVERAGE
CO 28.010	9.27	10.59		9.930
H_2 2.016	39.22	41.29		40.255
CO_2 44.010	29.62	30.35		29.985
N_2 28.016	2.58	2.42		2.500
CH_4 16.042	8.20	7.21		7.705
C_2H_4 28.052	2.81	2.12		2.465
C_2H_6 30.068	1.45	1.12		1.285
C_3H_6 42.078	3.40	2.25		2.825
C_3H_8 44.094	0.50	0.29		0.395
C_4H_8 56.104	1.72	1.30		1.510
C_4H_{10} 58.120	0.44	0.34		0.390
C_5H_{10} 70.130	0.55	0.46		0.505
C_5H_{12} 72.146	0.11	0.11		0.110
C_6H_{12} 84.156	0.13	0.15		0.140
			M. W.	22.7917

GAS FLOW RATES

	√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	4.36	410.8 / 20.63	57 / 1.0029	10608	2.19831 / 1.4827	27.982
WET GAS 8.26	8.41	1.47 / 4.021	44 / 1.0158	3198	1.2702 / 1.1270	8.436
RECYCLE 115.14	4.06	412.9 / 20.68	104 / 0.9602	10461	1.1270	27.594
BLEED 5.02	9.40	412.9 / 20.68	0.9602	1056	1.1270	2.786
NATURAL GAS 28.43	5.78	423.9 / 20.94	189 / 0.8951	3767	14956 / 1.2229	9.937
OXYGEN 27.07	4.80	423.8 / 20.93	55 / 1.0048	2733		7.209
STEAM 215.7	6.184	31.4 / -10.0* / 0.2968	250	395.9#/hr.		

*Correction for hydraulic head.

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	5'2"	275.11	45	1.0074	277.15	53.6 6.365	1764.1	
	2'8"	142.71	48	1.0059	143.55	52.3	920.2	
					133.60	6.410	843.9	52.74
								8.350
WATER	6'6½"	347.13	55	1.0004	347.27	10.9 8.276	2874.0	
	2'6"	133.50	58	1.0002	133.53	11.0	1104.3	110.61
					213.74	8.270	1769.7	13.359

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 51 0

HOURS 282-306

	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	37.870	10.615	297.33	10.150	0.915	25.63	3.057	13.672	3.972	9.700	271.70					Distribution of					
H_2 2.016	57.904	16.230	32.72	37.934	3.419	6.89	11.424	27.654	14.843	12.811	25.83					Recovered Oil					
CO_2 44.010	3.053	0.856	37.67	30.018	2.705	119.05	9.040	9.896	11.745	1.849	81.38	7.999				400 EP		78.3%	0.620		
N_2 28.016	0.640	0.179	5.01	2.233	0.201	5.63	0.672	0.851	0.873							400-550		11.0	0.087		
CH_4 16.042	0.533	0.149	2.39	9.263	0.835	13.40	2.790	2.939	3.625	0.686	11.01	1.082				550+		10.7	0.085		
C_2H_4 28.052				2.493	0.225	6.31	0.751	0.751	0.976	0.225	6.31	0.620									64.2
C_2H_6 30.068				1.390	0.125	3.76	0.419	0.419	0.544	0.125	3.76	0.370									
C_1+C_2										1.036	21.08	2.072									
C_3H_6 42.078				2.903	0.262	11.02	0.874	0.874	1.136	0.262	11.02	1.083	4.32	2.551	0.251	9.92	0.975	6.25	1.598	0.156	89.0
C_3H_8 44.094				0.360	0.032	1.41	0.108	0.104	0.140	0.032	1.41	0.139	4.24	0.333	0.033						
C_4H_8 56.104				1.763	0.159	8.92	0.531	0.531	0.690	0.159	8.92	0.877	5.00	1.784	0.175	8.47	0.832	6.10	1.389	0.136	78.8
C_4H_{10} 58.120				0.473	0.043	2.50	0.142	0.142	0.185	0.043	2.50	0.246	4.86	0.514	0.050	2.50	0.246	4.86	0.514	0.050	
C_5H_{10} 70.130				0.683	0.062	4.35	0.206	0.206	0.268	0.062	4.35	0.428	5.45	0.798	0.078	4.35	0.428	5.45	0.798	0.078	83.3
C_5H_{12} 72.146				0.137	0.012	0.87	0.041	0.041	0.053	0.012	0.87	0.086	5.25	0.166	0.016	0.87	0.086	5.25	0.166	0.016	
C_6H_{12} 84.156				0.200	0.018	1.51	0.060	0.060	0.078	0.018	1.51	0.148	5.54	0.273	0.027	1.51	0.148	5.54	0.273	0.027	
C_7-C_8											30.56	3.006		6.419	0.631	27.62	2.715		4.728	0.465	
TOTAL		28.029	375.12		9.013	211.25	30.116	58.145	45.228												
H_2+CO		26.845	10174 S.C.F.H.		4.334		14.481	41.326	18.815	22.511											
H_2/CO		1.53	982873		3.74			2.02		1.32											

CUMULATIVE TOTALS

	H_2+CO M.CF	Catalyst #	C_3^+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 8.0

EFFLUENT				
RECOVERED OIL	0.3668*	51.45	5.057	8.063 0.792
TOTAL OIL		82.03	8.063	14.482 1.423
WATER SOLUBLE CHEMICALS	0.261*	13.85	1.361	7.83 1.768 0.174
TOTAL LIQUID PRODUCTS C_3+		95.88	9.424	16.250 1.597
WET WATER	5.471*	98.56	9.687	11.835 1.163
GROSS WATER		112.41	11.046	13.603 1.337
HYDROCARBON TOTAL—C_1+		116.96	11.496	

	51.45	5.057		8.063	0.792
	82.03	8.063		14.482	1.423
	13.85	1.361	7.83	1.768	0.174
	95.88	9.424		16.250	1.597
	98.56	9.687		11.835	1.163
	112.41	11.046		13.603	1.337
	116.96	11.496			

	51.45	5.057		8.063	0.792
	79.07	7.772		12.791	1.257
	13.85	1.361		1.768	0.174
	92.92	9.133		14.559	1.431

*Included in Reactor Effluent Total

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY	
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3+C_4	
67.84	91.38	78.93	83.86	70.95	46.33	54.47	81.98	

g/M3 = 16.91 × #/MCF.

cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	423	Fresh Feed	10623
Natural Gas	424	Recycle	11414
Generator Outlet	414	Combined Feed	22037
Reactor Inlet	410	Wet Gas—Measured	3068
Condenser Inlet		Adjusted	3417
Product Accumulator	390	Loss	349
		Recycle/Fresh Feed	1.07
TEMPERATURES—°F.		Inlet Velocity—ft./sec.	0.70
Oxygen	343	Fresh Feed Rate—S.C.F.H.	H_2+CO 10174
Natural Gas	775	per Cu. Ft. Dense Bed	704
Generator	2345	per Lb. Catalyst	5.33
Quench Accumulator		per sq. ft.	15415
Reactor Inlet	575		
Condenser Inlet			
Product Accumulator	52	**Heat Transfer Calculations**	
Catalyst No. Height "		Steam Rate = 436.8 #/hr.	
1 12.0	644	@830 psia & 522°F = 1196 BTU/#	
2 43.2	651	Water in @ 160°F = 127 BTU/#	
3 74.4	662	Heat Transferred/# steam = 1069 BTU	
✗ 5 136.8	655		
✗ 7 199.2	641	(1069)(436.8) = 466940 BTU/hr.	
✗ 8 230.4	631	Average Bed Temperature = 644°F	
9 261.6	625		
10 292.8	618	dT = 644-522 = 122°F	
11 311.0	595	Tube Area = 32.1 $ft.^2$	
12 342.0	590	K = $\frac{466940}{(122)(32.1)}$ = 119.2	

PRODUCT TESTS		
	OIL	WATER
°API	11.1	53.1
Neut. No.	39.0	36.9
Sap. No.	46.0	37.4
Hydrox. No.		
Bromine No.	87.3	
Pour °F.		
Chemicals, % by K_2CO_3		13.0
HEMPEL. DIST. %		°API
205 °F.		
400	78.3	57.0
400-550	11.0	37.1
550+	10.7	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	93	
10%	131	
50%	224	
90%	361	
EP	409	
	975	

CATALYST DATA					
INVENTORY DATA		PARTICLE SIZE			
In Reactor at Start of Period		Screen Analysis		Sedimentation	
Fresh Catalyst Added 50 # 76		Mesh	Microns	%	Microns	%
Total		On 40	419+	8.9	80+	
Catalyst Recovered	19½	100	150	59.7	40—80	
In Reactor at End of Period		150	105	14.5	20—40	
		200	74	9.5	10—20	
REACTOR d-p, Inches H_2O		250	62	1.6	0—20	
No. Height		325	44	3.0		
1 12-43.2	62	<325		2.8		
2 43.2-74.4	70					
3 74.4-105.6	74	CATALYST				
4 105.6-342.0	325	Bulk Density, Lbs./Cu.Ft.				
0 0-12	25	Aerated				151
	556	Settled				152
		Compacted				165
CALCULATED FROM dp		Particle Density, gm./cc.				4.4
Density, Lbs./Cu.Ft.	132	NH_3 Value, ml./gm.				8.6
Inventory, Lbs.	1908	N_2 Surface, m^2/gm.				
Bed Depth, Ft.	21.90	CHEMICAL ANALYSIS				
Volume, Cu. Ft.	14.45	Fe				
		C				
		O				
		H				
		K_2O, W+, % basis Fe				
		X-Ray Analysis—				
		$Fe_{20}C_9$				
		Fe_3O_4				
		Fe				

GAS ANALYSES					GENERATOR BALANCE										WEIGHT BALANCE		
HOUR				AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		#/hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.44	7.129 0.045			14.348	WET GAS	189.70	211.25
CO 28.010	38.39	37.43	37.79	37.870	10.615	10.615		10.615	CO 28.010						OIL	51.45	51.45
H_2 2.016	57.17	58.64	57.90	57.904	16.230		32.460		H_2 2.016						WATER	112.41	112.41
CO_2 44.010	2.93	2.85	3.38	3.053	0.856	0.856		1.712	CO_2 44.010	1.84	0.188	0.188		0.376	TOTAL	353.56	375.11
N_2 28.016	0.61	0.72	0.59	0.640	0.179				N_2 28.016	2.01	0.205				FRESH FEED	375.11	375.11
CH_4 16.042	0.90	0.36	0.34	0.533	0.149	0.149	0.596		CH_4 16.042	84.33	8.599	8.599	34.396		WEIGHT BALANCE	94.26	
			M. W.	13.3831					C_2H_6 30.068	8.30	0.846	1.692	5.076				
			H_2O 18.016				6.870	3.435	C_3H_8 44.094	3.00	0.306	0.918	2.448		WET GAS FACTOR	1.1136	
			2.163166			11.620	39.926	15.762	C_4H_{10} 58.120	0.06 0.02	0.006 0.002	0.024 0.012	0.060 0.024		INDICATED LOSS—S C F H	3417	9013
			BALANCE			101.64	95.05	107.05	TOTAL	18.90969 1.53096			11.433	42.004	14.724		349	

WET GAS					GAS FLOW RATES							0/C = 1.288	LIQUID PRODUCT RATES							
CO 28.010	10.31	9.51	10.63	10.150		√R	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API °/GAL.	#	# HR GAL. HR
H_2 2.016	37.54	37.85	38.43	37.934			410.0	65				OIL	7'4½"	390.78	62	0.9990	390.39	53.1		51.45
CO_2 44.010	28.93	30.85	30.29	30.018	FRESH FEED	79.31	4.44	20.61	0.9952	10623	1.47077	28.029	5'2"	275.11	45	1.0074	277.14	6.381		8.063
N_2 28.016	2.00	2.43	2.27	2.233				1.50	52				1'11"	100.59	45	1.0074	101.33			
CH_4 16.042	10.56	9.32	7.91	9.263	WET GAS	79.31	8.59	4.02	1.0078	3068	1.1114	8.094	0'5"	22.13	56	1.0020	22.17			
C_2H_4 28.052	2.55	2.71	2.22	2.493				412.4	113								192.41			
C_2H_6 30.068	1.36	1.45	1.36	1.390	RECYCLE	115.14	4.12	20.67	0.9526	10381	1.1114	27.391					1.10	÷	7	
C_3H_6 42.078	2.86	2.62	3.23	2.903				412.4	113								193.51		1234.8	
C_3H_8 44.094	0.39	0.24	0.45	0.360	BLEED	5.02	9.4	20.67	0.9526	1033	1.1114	2.725	WATER							
C_4H_8 56.104	1.85	1.59	1.85	1.763				423.6	191	11414		30.116								
C_4H_{10} 58.120	0.49	0.52	0.41	0.473	NATURAL GAS	28.43	5.87	20.94	0.8938	3865	1.2373	10.197	7'8"	406.05	76	0.9982	405.32	11.1		118.41
C_5H_{10} 70.130	0.75	0.64	0.66	0.683				423.1	64				6'6½"	347.13	55	1.0004	347.27	8.264		13.605
C_5H_{12} 72.146	0.17	0.12	0.12	0.137	OXYGEN	27.07	4.78	20.92	0.9981	2702		7.129	5'3½"	281.66	59	1.0001	281.69			
C_6H_{12} 84.156	0.24	0.19	0.17	0.200				32.41					0'3"	13.28	56	1.0003	13.28			
			M. W.	23.43796	STEAM	215.6	6.15	0.3295		436.8 #/hr.							326.46		2697.9	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 P
HOURS 306-330

	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	37.620	10.304	288.68	10.127	0.890	24.95	2.933	13.237	3.823	-9.414	-263.69					Distribution of					
H_2 2.016	57.804	15.831	31.92	36.169	3.178	6.41	10.474	26.305	15.552	+12.653	-25.51					Recovered Oil					
CO_2 44.010	3.033	0.831	36.54	31.680	2.784	122.50	9.174	10.005	11.958	1.953	85.96	8.676				400 EP		77.3%	0.609		
N_2 28.016	0.873	0.239	6.70	1.980	0.169	4.73	0.556	0.795	0.725							400-550		12.0	0.094		
CH_4 16.042	0.670	0.184	2.95	9.510	0.836	13.41	2.754	2.938	3.590	0.652	10.46	1.056				550+		10.7	0.084		
C_2H_6 30.068				2.627	0.231	6.48	0.761	0.761	0.992	0.231	6.48	0.654									66.6
C_3H_8 44.094				1.320	0.116	5.49	0.382	0.382	0.498	0.116	5.49	0.552									
C_4+C_5											20.43	2.069									
C_3H_6 42.078				3.050	0.269	11.28	0.883	0.883	1.151	0.268	11.28	1.138	4.32	2.611	0.264	10.15	1.024	6.25	1.624	0.164	86.5
C_3H_8 44.094				0.477	0.042	1.85	0.138	0.138	0.180	0.042	1.85	0.187	4.24	0.436	0.044						
C_4H_8 56.104				1.777	0.156	8.75	0.515	0.515	0.671	0.156	8.75	0.883	5.00	1.750	0.177	8.31	0.839	6.10	1.362	0.137	81.8
C_5H_{10} 58.120				0.403	0.035	2.03	0.117	0.117	0.152	0.035	2.03	0.205	4.86	0.418	0.042	2.03	0.205	4.86	0.418	0.042	
C_6H_{12} 70.130				0.670	0.059	4.14	0.194	0.194	0.253	0.059	4.14	0.418	5.45	0.760	0.077	4.14	0.418	5.45	0.760	0.077	88.5
C_6H_{14} 72.146				0.087	0.008	0.58	0.025	0.025	0.033	0.008	0.58	0.059	5.28	0.110	0.011	0.58	0.059	5.28	0.110	0.011	
C_6H_{12} 84.156				0.183	0.016	1.35	0.053	0.053	0.069	0.016	1.35	0.136	5.54	0.244	0.025	1.35	0.136	5.54	0.244	0.025	
C_7-C_8											29.98	3.026		6.329	0.639	26.56	2.681		4.518	0.456	
TOTAL		27.389	366.73		8.788	211.93	28.958	56.347	43.439												
H_2+CO	95.424	26.135	9908 S.C.F.H.		4.068		13.407	39.542	17.475	-22.067											
H_2/CO		1.54	100928		3.57			1.99		1.34											

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

EFFLUENT									
SHIFT RATIO	RECOVERED OIL	0.3543*	49.70	5.016		7.801	0.787	49.70	5.016		7.801	0.787	
	TOTAL OIL		79.68	8.042		14.130	1.426	76.26	7.697		12.319	1.243	
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 8.4	WATER SOLUBLE CHEMICALS	0.254*	13.48	1.361		1.717	0.173	13.48	1.361		1.717	0.173	
	TOTAL LIQUID PRODUCTS C_3+		93.16	9.403		15.847	1.599	89.74	9.058		14.036	1.416	
	NET WATER	5.085*	91.62	9.247		11.001	1.110						
	GROSS WATER		105.10	10.608		12.718	1.284						
	HYDROCARBON TOTAL—C_1+		113.59	11.465									

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3 + C_4 +
67.91	91.36	79.93	84.43	71.12	48.10	55.81	82.08

*Included in Reactor Effluent Total

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

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	424	Fresh Feed	10383
Natural Gas	424	Recycle	10978
Generator Outlet	414	Combined Feed	21361
Reactor Inlet	411	Wet Gas—Measured	2965
Condenser Inlet		Adjusted	3331
Product Accumulator	390	Loss	366
TEMPERATURES—°F.		Recycle/Fresh Feed	1.06
Oxygen	760	Inlet Velocity—ft./sec.	0.69
Natural Gas	356	Fresh Feed Rate—S.C.F.H. H_2+CO	9908
Generator	2360	per Cu. Ft. Dense Bed	677
Quench Accumulator		per Lb. Catalyst	5.09
Reactor Inlet	603	per sq. ft.	15012
Condenser Inlet			
Product Accumulator		Heat Transfer Calculations	
Catalyst No. Height "		Steam Rate = 401.3 #/hr.	
1 12.0	646	@ 822 psia & 521°F = 1196 BTU/#	
2 43.2	652	Water in @ 158°F = 125 BTU/#	
3 74.4	656	Heat Transferred/# steam = 1071 BTU	
# 5 136.8	645		
# 7 199.2	632	(1071)(401.3) = 429792 BTU/hr.	
# 8 230.4	624	Ave. Bed Temperature = 639°F	
9 261.6	618		
10 292.8	609	ΔT = 639-521 = 118°F	
11 311.0	587	Tube Area = 32.3 $ft.^2$	
12 342.0	577	$K = \frac{429792}{(118)(32.5)} = 112.8$	

PRODUCT TESTS			
	OIL	WATER	
°API	53.4	11.1	
Neut. No.	39.1	37.1	
Sap. No.	48.7	39.7	
Hydrox. No.			
Bromine No.	95.9		
Pour °F.			
Chemicals, % by K_2CO_3		13.5	
HEMPEL. DIST. %		°API	
205 °F.			
400	77.3	58.2	
400-550	12.0	37.4	
550+	10.7		
A. S. T. M. DIST. ON			
Naphtha °F.			
IBP	92		
10%	124		
50%	214		
90%	342		
EP	398		
Rec.	98.0		

CATALYST DATA					
INVENTORY DATA		PARTICLE SIZE			
In Reactor at Start of Period		Screen Analysis		Sedimentation	
Fresh Catalyst Added 63 = 95		Mesh	Microns	%	Microns	%
Total		On 40	419+	10.2	80+	
Catalyst Recovered	36	100	150	62.9	40—80	
In Reactor at End of Period		150	105	14.7	20—40	
		200	74	6.6	10—20	
REACTOR d-p, Inches H_2O		250	62	2.0	0—20	
No. Height		325	44	1.8		
1 12-43.2	63	<325		1.8		
2 43.2-74.4	70	CATALYST				
3 74.4-105.6	75	Bulk Density, Lbs./Cu.Ft.				
4 105.6-342.0	335	Aerated			152	
0 0-12	84	Settled			154	
	567	Compacted			167	
		Particle Density, gm./cc.			4.5	
CALCULATED FROM dp		NH_3 Value, ml./gm.			10.1	
Density, Lbs./Cu.Ft.	133	N_2 Surface, m^2/gm.				
Inventory, Lbs.	1946					
Bed Depth, Ft.	22.17	CHEMICAL ANALYSIS				
Volume, Cu. Ft.	14.63	Fe				
		C				
		O				
		H				
		K_2O, W+, % basis Fe				
		X-Ray Analysis—				
		Fe_2C_9				
		Fe_3O_4				
		Fe				

	GAS ANALYSES				GENERATOR BALANCE									WEIGHT BALANCE		
HOUR	1400	2200	0600	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O	#/hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.73	6.930 0.071			14.002	WET GAS	188.62 211.93
CO 28.010	37.35	38.11	37.40	37.620	10.304	10.304		10.304	CO 28.010						OIL	49.70 49.70
H_2 2.016	57.74	57.88	57.79	57.804	15.831		31.662		H_2 2.016						WATER	105.10 105.10
CO_2 44.010	2.68	3.04	3.38	3.033	0.831	0.831		1.662	CO_2 44.010	2.22	0.217	0.217		0.434	TOTAL	343.42 366.73
N_2 28.016	0.61	0.73	1.28	0.873	0.239				N_2 28.016	3.40	0.333				FRESH FEED	366.73
CH_4 16.042	1.62	0.24	0.15	0.670	0.184	0.184	0.736		CH_4 16.042	81.89	8.019	8.019	32.076		WEIGHT BALANCE	99.64
			M.W.	13.3896					C_2H_6 30.068	7.94	0.777	1.554	4.662			
			H_2O 18.016				6.174	3.087	C_3H_8 44.094	3.60	0.353	1.059	2.824		WET GAS FACTOR	1183581
						11.319	38.572		C_5H_{10} 88.120	0.18 0.04	0.018 0.004	0.072 0.020	0.180 0.048		INDICATED LOSS—S C F H	366
			BALANCE			103.45	96.94	104.27	TOTAL	MW=19.4082			10.941	39.790	14.436	
WET GAS					GAS FLOW RATES											
CO 28.010	9.56	10.76	10.06	10.127		VR	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR					
H_2 2.016	38.75	36.21	33.55	36.169	FRESH FEED		410.7	68		2.1621						
CO_2 44.010	28.56	32.48	34.00	31.680		4.35	20.625	0.9224	10383	1.4704	27.389					
N_2 28.016	1.65	2.19	1.92	1.920	WET GAS		1.48	57		1.2004						
CH_4 16.042	12.06	7.87	8.60	9.510		8.46	4.022	1.0089	2965	1.0956	7.821					
C_2H_6 30.068	2.45	2.64	2.79	2.627	RECYCLE		412.8	116								
C_3H_8 44.094	1.18	1.51	1.47	1.320		4.02	20.676	0.9501	9962	1.0956	26.278					
C_3H_6 42.078	2.62	3.06	3.47	3.050	BLEED		412.8	116								
C_3H_8 44.094	0.39	0.46	0.69	0.477		9.4	20.676	0.9501	1016	1.0956	2.680					
C_4H_8 56.104	1.57	1.72	2.04	1.777	NATURAL GAS		424.2	191	10978	1.4916	28.958					
C_5H_{10} 58.120	0.32	0.43	0.46	0.403		5.71	20.950	0.6936	3712	1.2213	9.792					
C_5H_{10} 70.130	0.62	0.64	0.75	0.670	OXYGEN		423.7	68								
C_6H_{12} 72.146	0.11	0.07	0.08	0.087		4.67	20.938	0.9924	2627		6.930					
C_6H_{12} 84.156	0.16	0.17	0.22	0.183	STEAM		38.5									
			M.W.	24.1170	215.6	6.18	0.3018	=	401.3 #/hr.							

LIQUID PRODUCT RATES								
	O/C = 1.319							
HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL	5'3½"	281.66	52	1.0039	282.76	53.4		
	1'11	100.59	45	1.0074	101.33	6.371		
					181.43		1155.9	
							31.9	
					45.79		*5.0	49.70
					187.22		1192.8	7.801
WATER	7'3"	384.23	68	0.9992	383.92	11.1		
	5'3½"	281.66	59	1.0001	281.69	8.264		
	4'3"	216.19	58	1.0002	216.23		2528.3	105.10
	0'3"	13.28	84	0.9969	13.24			18.718
					305.22			

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 51 Q

HOURS 330-354

	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	37.473	10.157	284.51	9.790	0.915	25.63	2.893	13.050	3.808	-9.242	-258.88					Distribution of					
H_2 2.016	57.346	15.545	31.34	38.603	3.607	7.27	11.407	26.952	15.014	-11.938	-24.07					Recovered Oil					
CO_2 44.010	2.697	0.731	32.17	28.850	2.696	118.65	8.524	9.255	11.951	1.965	86.48	8.875				400 EP		77.6%	0.578		
N_2 28.016	0.697	0.189	5.30	2.033	0.190	5.32	0.601	0.790	0.980							400-550		13.0	0.097		
CH_4 16.042	1.787	0.484	7.76	10.993	1.027	16.48	3.248	3.732	4.759	0.543	8.72	0.895				550+		9.4	0.070		
C_2H_4 28.052				2.510	0.235	6.59	0.742	0.742	0.977	0.235	6.59	0.676									56.2
C_2H_6 30.068				1.280	0.120	3.61	0.378	0.378	0.498	0.120	3.61	0.371									
C_1+C_4											18.92	1.942									
C_3H_6 42.078				2.807	0.262	11.02	0.829	0.829	1.091	0.262	11.02	1.131	4.32	2.551	0.262	9.92	1.018	6.25	1.587	0.162	89.2
C_3H_8 44.094				0.377	0.035	1.54	0.111	0.111	0.146	0.035	1.54	0.158	4.24	0.363	0.037						
C_4H_8 56.104				1.567	0.146	8.19	0.463	0.463	0.609	0.146	8.19	0.841	8.00	1.638	0.168	7.78	0.798	6.10	1.275	0.131	81.6
C_4H_{10} 58.120				0.343	0.032	1.86	0.101	0.101	0.133	0.032	1.86	0.191	4.86	0.383	0.039	1.86	0.191	4.86	0.383	0.039	
C_5H_{10} 70.130				0.560	0.052	3.65	0.165	0.165	0.217	0.052	3.65	0.375	5.45	0.670	0.069	3.65	0.375	5.45	0.670	0.069	82.4
C_5H_{12} 72.146				0.120	0.011	0.79	0.035	0.035	0.046	0.011	0.79	0.081	5.25	0.150	0.015	0.79	0.081	5.25	0.150	0.015	
C_6H_{12} 84.152				0.167	0.016	1.35	0.049	0.049	0.065	0.016	1.35	0.139	5.54	0.244	0.025	1.35	0.139	5.54	0.244	0.025	
C_3-C_6											28.40	2.915		5.999	0.616	25.35	2.602		4.309	0.442	
TOTAL		27.106	361.08		9.344	211.96	29.546	56.652	44.438												
H_2+CO	94.819	25.702	9744 S.C.F.H.		4.522		14.300	40.002		-21.180											
H_2/CO		1.53	102627		3.942			2.07		1.29											

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

EFFLUENT								
	RECOVERED OIL	0.331#	46.48	4.770		7.255	0.745	46.48	4.770		7.255	0.745
SHIFT RATIO	TOTAL OIL		74.88	7.685		13.254	1.360	71.83	7.372		11.564	1.187
	WATER SOLUBLE CHEMICALS	0.247#	13.10	1.344	7.81	1.678	0.172	13.10	1.344		1.678	0.172
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 9.48	TOTAL LIQUID PRODUCTS C_5^+		87.98	9.029		14.932	1.532	84.93	8.716		13.242	1.359
	NET WATER	4.970#	89.54	9.189	8.28	10.752	1.103					
	GROSS WATER		102.64	10.534		12.430	1.276					
	HYDROCARBON TOTAL—C_1+		106.90	10.971								

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3^+ - C_1 -
65.53	90.99	76.80	82.41	70.82	44.29	52.95	82.30

*Included in Reactor Effluent Total

g/M3 = 16.91 × =/MCF.

cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS			RATES S.C.F.H.	
PRESSURES PSIG				
Oxygen		424	Fresh Feed	10276
Natural Gas		424	Recycle	11201
Generator Outlet		415	Combined Feed	21477
Reactor Inlet		411	Wet Gas—Measured	3146
Condenser Inlet			Adjusted	3542
Product Accumulator		391	Loss	396
TEMPERATURES—°F.			Recycle/Fresh Feed	1.09
Oxygen		364	Inlet Velocity—ft./sec.	0.70
Natural Gas		747	Fresh Feed Rate—S.C.F.H.	CO+H2 9744
Generator			per Cu. Ft. Dense Bed	630
Quench Accumulator			per Lb. Catalyst	4.89
Reactor Inlet		617	per sq. ft.	14764
Condenser Inlet				
Product Accumulator		63	Heat Transfer Calculations	
Catalyst No.	Height #		Steam Rate = 405.3 #/hr.	
1	12.0	645	@ 815 psia & 521°F = 1196 BTU/#	
2	43.2	650	Water in @ 158°F = 125 BTU/#	
3	74.4	654	Heat Transferred/# steam = 1071 BTU	
#5	136.8	639		
#7	199.2	626	(1071)(405.3) = 434076 BTU/hr.	
#8	230.4	620	Ave. Bed Temperature = 636°F	
9	261.6	618		
10	292.8	607	dT = 636-521 = 115°F	
11	311.0	584	Tube Area = 33.0 ft.²	
12	342.0	576	K = 434076 / (115)(33.0) = 114.4	

PRODUCT TESTS	OIL	WATER
°API	52.4	11.2
Neut. No.	39.5	38.3
Sap. No.	48.7	39.1
Hydrox. No.		
Bromine No.	84.7	
Pour °F.		
Chemicals, % by K_2CO_3		13.5
HEMPEL. DIST. %		°API
205 °F.		
400	77.6	57.3
400-550	13.0	36.6
550+	9.4	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	100	
10%	132	
50%	222	
90%	348	
EP	400	
Loss	0.5	

CATALYST DATA						
INVENTORY DATA		PARTICLE SIZE				
In Reactor at Start of Period		Screen Analysis			Sedimentation	
Fresh Catalyst Added 70 =	106	Mesh	Microns	%	Microns	%
Total		On 40	419+	8.2	80+	
Catalyst Recovered	17	100	150	58.7	40—80	
In Reactor at End of Period		150	105	14.5	20—40	
		200	74	8.8	10—20	
REACTOR d-p, Inches H_2O		250	62	2.0	0—20	
No. Height		325	44	5.6		
		<325		2.2		
1 12-43.2	63					
2 43.2-74.4	69	CATALYST				
3 74.4-105.6	75	Bulk Density, Lbs./Cu.Ft.				
4 105.6-342.0	350	Aerated			148	
0 0-12	24	Settled			149	
	581	Compacted			167	
		Particle Density, gm./cc.			4.4	
CALCULATED FROM dp		NH_3 Value, ml./gm.			8.03	
Density, Lbs./Cu.Ft.	129	N_2 Surface, m^2/gm.				
Inventory, Lbs.	1994					
Bed Depth, Ft.	23.42	CHEMICAL ANALYSIS				
Volume, Cu. Ft.	15.46	Fe				
		C				
		O				
		H				
		K_2O, W+, % basis Fe				
		X-Ray Analysis—				
		Fe_2OC_2				
		Fe_2O_4				
		Fe				

GAS ANALYSES					GENERATOR BALANCE										WEIGHT BALANCE		
HOUR	1400	2200	0600	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		# /hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.34	6.814 0.033			13.694	WET GAS	188.26	211.96
CO 28.010	36.79	38.75	36.88	37.473	10.157	10.157		10.157	CO 28.010						OIL	46.48	46.48
H_2 2.016	56.28	57.14	58.62	57.346	15.545		31.090		H_2 2.016						WATER	102.64	102.64
CO_2 44.010	2.92	2.54	2.63	2.697	0.731	0.731		1.462	CO_2 44.010	3.42	0.334	0.334		0.668	TOTAL	337.38	
N_2 28.016	0.77	0.54	0.78	0.697	0.189				N_2 28.016	2.40	0.235				FRESH FEED	361.08	
CH_4 16.042	3.24	1.03	1.09	1.787	0.484	0.484	1.936		CH_4 16.042	82.66	8.076	8.076	32.304		WEIGHT BALANCE	93.44	
			M. W.	13.3212					C_2H_6 30.068	7.64	0.747	1.494	4.482				
			H_2O 18.016				6.047	3.024	C_3H_8 44.094	3.25	0.318	0.954	2.544		WET GAS FACTOR	1125889	
					27.106	11.372	39.073	14.643	C_4H_{10} 58.120	0.23 0.06	0.022 0.006	0.088 0.030	0.220 0.072		INDICATED LOSS—S C F H	396	
			BALANCE			103.61	98.51	101.96	TOTAL		9.771	10.976	39.622	14.362			

WET GAS					GAS FLOW RATES								O/C = 1.31	LIQUID PRODUCT RATES							
CO 28.010	9.60	9.74	10.03	9.790		VR	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR	HOUR	GAGE	GAL	°F	FACTOR	GAL AT 60	API° #/GAL.	#	# HR GAL HR
H_2 2.016	37.39	39.30	39.12	38.603	FRESH FEED		411.0	76	8970274	2.173227										
CO_2 44.010	27.61	30.01	28.93	28.850		79.31	20.63	0.9850	10276	1.4742	27.106	OIL	7'5½"	395.14	68	0.9961	393.60			
N_2 28.016	1.69	2.30	2.11	2.033			1.5	63					5'3½"	281.66	52	1.0039	282.76			
CH_4 16.042	13.56	9.31	10.11	10.993	WET GAS															
C_2H_6 28.052	2.36	2.60	2.57	2.510		79.31	8.75	4.025	0.9971	3146	1.12968	8.299		1'6"	78.16	52	1.0039	78.46	52.4		
C_3H_8 44.094							413.6	124	8993725									6.406		
C_3H_8 44.094	1.14	1.29	1.41	1.280	RECYCLE								0'3½"	15.49	58	1.0010	15.50			
C_4H_8 56.104	3.01	2.72	2.69	2.807		115.14	4.0	20.695	0.9436	10160	1.12968	26.800								
C_4H_{10} 58.120							413.6	124	9216361								173.80		1113.4	46.48
C_4H_{10} 58.120	0.37	0.36	0.40	0.377	BLEED												+0.53		+2.0	
C_5H_{12} 72.146																	174.11		1118.4	7.255
C_5H_{12} 72.146	1.89	1.39	1.42	1.567		5.02	9.43	20.695	0.9436	1041	1.12968	2.746	WATER	7'7"	401.59	72	0.9987	401.17	11.2		
C_6H_{14} 86.172							424.1	197	5036403	19.4539										
C_6H_{14} 86.172	0.41	0.30	0.32	0.343	NATURAL GAS								4'1½"	216.19	58	1.0002	216.23	8.258		
C_6H_{14} 86.172	0.71	0.46	0.51	0.560		28.43	5.73	20.95	0.8897	3704	1.2199	9.771								
C_6H_{14} 86.172							424.0	75												
C_6H_{12} 72.146	0.08	0.11	0.17	0.120	OXYGEN	27.07	4.62	20.95	0.9859	2583		6.814		2'5"	128.89	62	0.9998	128.86			102.64
C_6H_{12} 84.156	0.18	0.11	0.21	0.167				32.4	251					0'3½"	15.49	62	0.9998	15.48		2463.4	12.430
			M. W.	22.68505	STEAM	215.6	6.25	0.3008	=	405.3 #/hr.								298.31			

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 R
HOURS 354-378

	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	36.923	10.237	286.74	10.127	0.960	26.89	3.004	13.241	3.964	-9.277	-259.85
H_2 2.016	58.830	16.311	32.88	38.525	3.651	7.36	11.425	27.736	15.076	-12.660	-25.52
CO_2 44.010	2.800	0.766	34.15	29.250	2.772	122.97	8.676	9.452	11.448	1.996	88.82
N_2 28.016	0.817	0.227	6.36	1.803	0.171	4.79	0.535	0.762	0.706		
CH_4 16.042	0.630	0.175	2.81	10.020	0.949	15.22	2.272	3.147	3.921	0.774	12.41
C_2H_6 30.068				2.843	0.269	7.55	0.843	0.843	1.112	0.269	7.55
C_3H_8 44.094				1.513	0.143	4.30	0.449	0.449	0.592	0.143	4.30
C_4+C_5											24.26
C_4H_8 42.078				2.840	0.269	11.32	0.842	0.842	1.111	0.269	11.32
C_3H_8 44.094				0.413	0.039	1.72	0.122	0.122	0.161	0.039	1.72
C_5H_{12} 58.104				1.533	0.145	8.14	0.455	0.455	0.600	0.145	8.14
C_5H_{10} 68.120				0.407	0.039	2.27	0.121	0.121	0.160	0.039	2.27
C_6H_{12} 70.130				0.523	0.050	3.51	0.155	0.155	0.205	0.050	3.51
C_6H_{12} 72.146				0.093	0.009	0.65	0.028	0.028	0.037	0.009	0.65
C_6H_{12} 84.156				0.110	0.010	0.84	0.033	0.033	0.043	0.010	0.84
C_7-C_8											28.45
TOTAL		27.726	362.94		9.476	216.53	29.660	57.386	44.116		
H_2+CO	95.753	26.548	10065 S.C.F.H.		4.611		14.429	40.977	19.040	-21.937	
H_2/CO		1.59	993541		3.80			2.09		1.36	

	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
					Distribution of					
					Recovered Oil					
	8.82					400 EP	79.3%	0.537		
						400-550		12.6	0.085	
	1.233					550+		8.1	0.055	
	0.750									65.3
	0.427									
	2.410									
	1.125	4.32	2.620	0.260	10.19	1.012	6.25	1.630	0.162	87.5
	0.171	4.24	0.406	0.040						
	0.809	5.00	1.628	0.162	7.73	0.768	6.10	1.267	0.126	79.0
	0.226	4.86	0.467	0.046	2.27	0.226	4.86	0.467	0.046	
	0.349	5.45	0.644	0.064	3.51	0.349	5.45	0.644	0.064	84.9
	0.065	5.25	0.124	0.012	0.65	0.065	5.25	0.124	0.012	
	0.083	5.54	0.152	0.015	0.84	0.083	5.54	0.152	0.015	
	2.827		6.041	0.600	25.19	2.503		4.284	0.425	

CUMULATIVE TOTALS

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

EFFLUENT SHIFT RATIO $\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 9.9

EFFLUENT						
RECOVERED OIL	0.3126*	43.84	4.356	6.811	0.677	43.84
TOTAL OIL		72.29	7.182	12.852	1.277	69.03
WATER SOLUBLE CHEMICALS	0.258*	13.68	1.359	7.38 1.737	0.173	13.68
TOTAL LIQUID PRODUCTS C_3+		85.97	8.541	14.589	1.449	82.71
WET WATER	4.409*	88.89	8.832	8.33 10.671	1.060	
GROSS WATER		102.57	10.191	12.408	1.233	
HYDROCARBON TOTAL—C_1+		110.23	10.952			

	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.
Previous Total										
Current Period	7.182		12.852	1.277	69.03	6.858		11.095	1.102	
New Total	8.541		14.589	1.449	82.71	8.217		12.832	1.275	

*Included in Reactor Effluent Total

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

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3+ C_4+
65.82	90.62	77.62	82.63	70.06	45.64	53.53	77.99

DATA SUMMARY

OPERATING CONDITIONS		RATES S.C.F.H	
PRESSURES PSIG		Fresh Feed	10511
Oxygen	423	Recycle	11244
Natural Gas	423	Combined Feed	21755
Generator Outlet	415	Wet Gas—Measured	3176
Reactor Inlet	411	Adjusted	3592
Condenser Inlet		Loss	416
Product Accumulator	391		
TEMPERATURES—°F.		Recycle/Fresh Feed	1.07
Oxygen	368	Inlet Velocity—ft./sec.	0.71
Natural Gas	761	Fresh Feed Rate—S.C.F.H.	10065
Generator		per Cu. Ft. Dense Bed	675
Quench Accumulator		per Lb. Catalyst	5.07
Reactor Inlet	610	per sq. ft.	15250
Condenser Inlet			
Product Accumulator	66	Heat Transfer Calculations	
Catalyst No. Height *		Steam Rate = 409.1 #/hr.	
1 12.0	647	@ 815 psia & 521°F= 1196 BTU/#	
2 43.2	653	Water in @ 161°F = 130 BTU/#	
3 74.4	655	Heat Transferred/# steam = 1066 BTU	
✗ 5 136.8	642		
✗ 7 199.2	627	(1066)(409.1) = 436101 BTU/hr.	
✗ 8 230.4	619	Ave. Bed Temperature = 637°F	
9 261.6	616	dT = 637-521 = 116°F	
10 292.8	606	Tube Area = 32.5 ft.²	
11 311.0	584	K = $\frac{436101}{(116)(32.5)}$ = 115.7	
12 342.0	576		

PRODUCT TESTS			
	OIL	WATER	
°API	51.8	11.1	
Neut. No.	41.4	38.8	
Sap. No.	50.9	39.1	
Hydrox. No.			
Bromine No.	87.4		
Pour °F.			
Chemicals, % by K_2CO_3		14.0	
HEMPEL, DIST. %		°API	
205 °F.			
400	79.3	56.3	
400-550	12.6	36.3	
550+	8.1		
A. S. T. M. DIST. ON			
Naphtha °F.			
IBP	95		
10%	132		
50%	222		
90%	352		
EP	408		
Loss	0.5		

CATALYST DATA						
INVENTORY DATA		PARTICLE SIZE				
In Reactor at Start of Period		Screen Analysis			Sedimentation	
Fresh Catalyst Added 48 = 73		Mesh	Microns	%	Microns	%
Total		On 40	419+	8.0	80+	
Catalyst Recovered	28	100	150	59.6	40—80	
In Reactor at End of Period		150	105	14.8	20—40	
		200	74	10.2	10—20	
REACTOR d-p, Inches H_2O		250	62	1.2	0—20	
No. Height		325	44	4.2		
0 0-12	25	<325		2.0		
1 12-43.2	65	CATALYST				
2 43.2-74.4	68	Bulk Density, Lbs./Cu.Ft.				
3 74.4-105.6	75	Aerated			148	
4 105.6-342.0	345	Settled			150	
Total	578	Compacted			163	
		Particle Density, gm./cc.			4.4	
CALCULATED FROM dp		NH_3 Value, ml./gm.			8.94	
Density, Lbs./Cu.Ft.	133	N_2 Surface, m^2/gm.				
Inventory, Lbs.	1984					
Bed Depth, Ft.	22.60	CHEMICAL ANALYSIS				
Volume, Cu. Ft.	14.92	Fe				
		C				
		O				
		H				
		K_2O, W+, % basis Fe				
		X-Ray Analysis—				
		$Fe_{2.2}C_9$				
		Fe_3O_4				
		Fe				

	GAS ANALYSES				GENERATOR BALANCE									WEIGHT BALANCE		
HOUR	1800	2200	0600	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		#/hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.42	6.890 0.041			13.862	WET GAS	191.45	216.53
CO 28.010	35.93	37.79	37.05	36.923	10.237	10.237		10.237	CO 28.010						OIL	43.84	43.84
H_2 2.016	59.68	58.25	58.56	58.830	16.311		32.622		H_2 2.016						WATER	102.57	102.57
CO_2 44.010	2.71	2.83	2.86	2.800	0.776	0.776		1.552	CO_2 44.010	2.07	0.202	0.202		0.404	TOTAL	337.86	362.94
N_2 28.016	0.84	0.75	0.86	0.817	0.227				N_2 28.016	1.86	0.182				FRESH FEED	362.94	
CH_4 16.042	0.84	0.38	0.67	0.630	0.175	0.175	0.700		CH_4 16.042	83.42	8.157	8.157	32.628		WEIGHT BALANCE	95.09	
			M. W.	13.0904					C_2H_6 30.068	7.66	0.749	1.498	4.494				
			H_2O 18.016				6.184	3.092	C_3H_8 44.094	4.42	0.432	1.296	3.456		WET GAS FACTOR	113100	
						11.188	39.506	14.881	C_4H_{10} 58.120	0.11 0.04	0.011 0.004	0.044 0.020	0.110 0.048		INDICATED LOSS—S C F H	416	
			BALANCE			22.74	96.98	104.31	TOTAL	MW=19.2937	9.778	11.217	40.736	14.266			

WET GAS					GAS FLOW RATES							LIQUID PRODUCT RATES							
CO 28.010	10.42	9.74	10.22	10.127			√ΔP	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API #/GAL	#	#/HR GAL/HR
H_2 2.016	36.40	40.20	38.97	38.525				411.0	77										51.8		
CO_2 44.010	29.89	28.83	29.03	29.250	FRESH FEED	79.31	4.39	20.63	0.9840	10511	1.48713	27.726	OIL	4'6"	240.20	58	1.0010	240.44	6.427	1545.3	
N_2 28.016	2.08	1.58	1.75	1.803				1.5	66										52.4		
CH_4 16.042	11.17	8.83	10.06	10.020	WET GAS	79.31	8.89	4.025	0.9943	3176	1.12555	8.378		1'6"	78.16	52	1.0039	78.46	6.406	502.6	
C_2H_6 30.068	2.59	3.24	2.60	2.843				412.5	127									161.98		1042.7	
C_3H_8 44.094	1.33	1.87	1.34	1.513	RECYCLE	115.14	4.05	20.66	0.9412	10206		26.922						41.48		9.5	63.84
C_4H_{10} 58.120	2.89	2.71	2.92	2.840				412.3	127									163.46		1052.2	6.611
C_5H_{12} 72.146	0.40	0.40	0.44	0.413	BLEED	5.02	9.45	20.66	0.9412	1038		2.738									
C_5H_{10} 70.130	1.62	1.44	1.54	1.533				423.0	195			29.660	WATER	7'2"	379.86	74	0.9985	379.29	11.1 8.264	3134.45	
C_6H_{12} 84.156	0.38	0.47	0.37	0.407	NATURAL GAS	28.43	5.71	20.92	0.8910	3707	1.22494	9.778		2'5"	128.89	62	0.9998	128.86	11.2 8.258	1064.13	
C_6H_{12} 72.146	0.55	0.49	0.53	0.523				423.3	76												
C_6H_{12} 84.156	0.08	0.11	0.09	0.093	OXYGEN	27.07	4.68	20.93	0.9850	2618		6.890		1'2"	60.66	66	0.9994	60.62	11.1	500.96	108.57
	0.10	0.09	0.14	0.110	STEAM			33.0	250					0'3"	13.28	66	0.9994	13.27	8.264	109.66	18.408
			M. W.	22.85134		215.6	6.26	.3031		409.1 #/hr.								297.78		2461.62	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 S
HOURS 378-402

FRESH FEED	%	m/hr	#/hr	WET GAS	%	At Wt. Balance m/hr	#/hr	RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	#/hr
CO 28.010	36.627	10.086	282.51	9.377	0.909	25.46	2.826	12.912	3.735	-9.177	-257.05
H_2 2.016	58.407	16.084	32.42	40.509	3.927	7.92	12.206	28.290	16.133	-12.157	-24.50
CO_2 44.010	2.973	0.819	36.04	28.510	2.764	121.64	8.591	9.410	11.355	1.955	85.60
N_2 28.016	0.800	0.220	6.16	2.107	0.204	5.72	0.635	0.855	0.859		
CH_4 16.042	1.193	0.329	5.28	10.120	0.981	15.74	3.049	3.378	4.030	0.652	10.46
C_2H_6 28.052				2.470	0.239	6.70	0.744	0.744	0.983	0.239	6.70
C_3H_8 30.068				1.253	0.121	3.64	0.378	0.378	0.499	0.121	3.64
C_4+C_5											20.80
C_5H_{12} 42.078				2.680	0.260	10.94	0.808	0.808	1.068	0.260	10.94
C_6H_{14} 44.094				0.353	0.034	1.50	0.106	0.106	0.140	0.034	1.50
C_7H_{16} 58.104				1.527	0.148	8.30	0.460	0.460	0.608	0.148	8.30
C_8H_{18} 58.120				0.327	0.032	1.86	0.099	0.099	0.131	0.032	1.86
C_9H_{20} 70.130				0.553	0.052	3.65	0.161	0.161	0.213	0.052	3.65
$C_{10}H_{22}$ 72.142				0.117	0.011	0.79	0.035	0.035	0.046	0.011	0.79
$C_{11}H_{24}$ 84.152				0.117	0.011	0.93	0.035	0.035	0.046	0.011	0.93
C_3-C_6											27.97
TOTAL		27.538	362.41		9.694	215.79	30.133	57.671	45.360		
H_2+CO	95.034	26.170	9918.45 S.C.F.H.		4.836		15.032	41.202	19.868	-21.334	
H_2/CO		1.59			4.32			2.19		1.32	

YIELD BASIS H_2+CO FED

CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF	% Unsats.
				Distribution of					
				Recovered Oil					
6.630					400 EP	78.3%	0.549		
					400-550	13.3	0.093		
1.055					550+	8.4	0.059		
0.676									66.3
0.367									
2.097									
1.103	4.32	2.532	0.255	9.85	0.993	6.25	1.575	0.159	88.4
0.151	4.24	0.354	0.037						
0.837	5.00	1.660	0.167	7.89	0.795	6.10	1.292	0.130	82.4
0.188	4.86	0.383	0.039	1.86	0.188	4.86	0.383	0.039	
0.368	5.45	0.670	0.068	3.65	0.368	5.45	0.670	0.068	82.0
0.080	5.25	0.150	0.015	0.79	0.080	5.25	0.150	0.015	
0.094	5.54	0.168	0.017	0.93	0.094	5.54	0.168	0.017	
2.820		5.917	0.597	24.97	2.499		4.238		
1.386	7.88	1.746	0.176	13.75	1.386		1.746	0.176	
8.707		14.619	1.474	83.36	8.405		12.940	1.305	
9.002		10.722	1.081						
10.389		12.468	1.257						
10.804									

CUMULATIVE TOTALS

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

EFFLUENT			
	RECOVERED OIL	0.319#*	44.64
SHIFT RATIO	TOTAL OIL		72.61
	WATER SOLUBLE CHEMICALS	0.259#*	13.75
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 9.90	TOTAL LIQUID PRODUCTS C_5^+		86.36
	NET WATER	4.956#*	89.29
	GROSS WATER		103.04
	HYDROCARBON TOTAL—C_1^+		107.16

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	$C_3 + C_4^+$
64.80	90.99	75.58	81.52	71.07	42.97	51.78	80.59

*Included in Reactor Effluent Total

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

DATA SUMMARY

OPERATING CONDITIONS		RATES S.C.F.H.	
PRESSURES PSIG			
Oxygen	424	Fresh Feed	10437
Natural Gas	425	Recycle	11420
Generator Outlet	415	Combined Feed	21857
Reactor Inlet	411	Wet Gas—Measured	3193
Condenser Inlet		Adjusted	3674
Product Accumulator	391	Loss	481
TEMPERATURES—°F.		Recycle/Fresh Feed	1.09
Oxygen	364	Inlet Velocity—ft./sec.	
Natural Gas	733	Fresh Feed Rate—S.C.F.H.	9918
Generator	2340	per Cu. Ft. Dense Bed	664
Quench Accumulator		per Lb. Catalyst	5.07
Reactor Inlet	584	per sq. ft.	15027
Condenser Inlet			
Product Accumulator	60	Heat Transfer Calculations	

Catalyst No.	Height "	
1	12.0	643
2	43.2	648
3	74.4	664
#5	136.8	643
#7	199.2	626
#8	230.4	620
9	261.6	616
10	292.8	607
11	311.0	583
12	342.0	575

Steam Rate = 388 #/hr.
@ 815 psig & 521°F = 1196 BTU/#
Water in @ 157°F = 126 BTU/#
Heat Transferred/# steam = 1070 BTU
(1070)(388) = 415160 BTU/hr.
Ave. Bed Temperature = 637°F
dT = 637-521 = 116°F
Tube Area = 32.5 ft.²
$K = \frac{415160}{(116)(32.5)} = 110.1$

PRODUCT TESTS	OIL	WATER
°API	51.9	11.1
Neut. No.	40.4	38.7
Sap. No.	51.5	39.8
Hydrox. No.		
Bromine No.	86.0	
Pour °F.		
Chemicals, % by K_2CO_3		14.0
HEMPEL DIST. %		°API
205 °F.		
400	78.3	56.8
400-550	13.3	36.5
550+	8.4	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	96	
10%	132	
50%	222	
90%	349	
EP	400	
Rec.	97.5	

CATALYST DATA		PARTICLE SIZE				
INVENTORY DATA		Screen Analysis			Sedimentation	
In Reactor at Start of Period		Mesh	Microns	%	Microns	%
Fresh Catalyst Added 50 # 76		On 40	419+	9.7	80+	
Total		100	150	61.0	40—80	
Catalyst Recovered	17#	150	105	13.5	20—40	
In Reactor at End of Period		200	74	8.2	10—20	
		250	62	3.8	0—20	
REACTOR d-p, Inches H_2O		325	44	2.0		
No. Height		<325		1.8		
0 0-12	24	CATALYST				
1 12-43.2	63	Bulk Density, Lbs./Cu.Ft.				
2 43.2-74.4	68	Aerated			150	
3 74.4-105.6	75	Settled			152	
4 105.6-342.0	340	Compacted			168	
Total	570	Particle Density, gm./cc.			4.45	
CALCULATED FROM dp		NH_3 Value, ml./gm.			9.32	
Density, Lbs./Cu.Ft.	131	N_2 Surface, m^2/gm.				
Inventory, Lbs.	1956					
Bed Depth, Ft.	22.62	CHEMICAL ANALYSIS				
Volume, Cu. Ft.	14.93	Fe				
		C				
		O				
		H				
		K_2O, W+, % basis Fe				
		X-Ray Analysis—				
		$Fe_{20}C_9$				
		Fe_3O_4				
		Fe				

GAS ANALYSES	1400	2200		AVERAGE
HOUR				
FRESH FEED				
CO 28.010	36.57	36.75	36.56	36.627
H_2 2.016	57.29	59.17	58.76	58.407
CO_2 44.010	3.23	3.06	2.63	2.973
N_2 28.016	0.77	0.85	0.78	0.800
CH_4 16.042	2.14	0.17	1.27	1.193
			M. W.	13.16331
			H_2O 18.016	
				2199295
			BALANCE	

WET GAS				
CO 28.010	9.52	9.30	9.31	9.377
H_2 2.016	40.45	40.54	40.54	40.509
CO_2 44.010	27.74	29.85	27.96	28.510
N_2 28.016	1.88	2.36	2.09	2.107
CH_4 16.042	11.15	8.86	10.35	10.120
C_2H_6 28.052	2.45	2.47	2.49	2.470
C_3H_8 32.068	1.20	1.26	1.30	1.253
C_4H_8 48.078	2.47	2.71	2.86	2.680
C_4H_8 44.094	0.33	0.38	0.36	0.353
C_6H_6 58.104	1.53	1.42	1.63	1.527
C_8H_{18} 58.120	0.35	0.28	0.35	0.327
C_9H_{20} 70.130	0.59	0.44	0.57	0.533
$C_{10}H_{22}$ 72.142	0.18	0.08	0.09	0.117
$C_{11}H_{24}$ 84.152	0.16	0.08	0.11	0.117
			M. W.	22.160563

GENERATOR BALANCE

	M/HR	C	H	O
FRESH FEED	79.31			
WET GAS	79.31	8.75	4.025	1.0000
RECYCLE	115.14	4.03	20.674	0.9444
BLEED	5.02	9.51	20.674	0.9444
NATURAL GAS	28.43	5.73	20.969	0.8917
OXYGEN	27.07	4.68	20.97	0.9896
STEAM	215.5	5.975	37.2	

	Mol %	M/Hr	C	H	O
O_2 32.000	0.43	6.937 0.042			13.958
CO 28.010		6.979			
H_2 2.016					
CO_2 44.010	2.38	0.234	0.234		0.468
N_2 28.016	1.84	0.181			
CH_4 16.042	82.89	8.143	8.143	32.572	
C_2H_6 30.068	8.11	0.797	1.594	4.782	
C_3H_8 44.094	4.25	0.418	1.254	3.344	
C_4H_{10} 58.120	0.06	0.006	0.024	0.060	
	0.04	0.004	0.020	0.048	
TOTAL			11.269	40.808	14.426

GAS FLOW RATES	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
	410.7	74			
	20.625	0.9868	10437	1.483	27.538
	1.5	60			
	4.025	1.0000	3193	1.143	8.424
	412.7	123			
	20.674	0.9444	10355	1.143	27.322
	412.7	123			
	20.674	0.9444	1065	1.143	2.811
	425.0	194	11420		30.133
	20.969	0.8917	3783	1.2224	9.824
	424.5	71			
	20.97	0.9896	2629		6.937
	32.5				
	37.2		388 #/hr.		

O/C = 1.280

WEIGHT BALANCE	#/hr Measured	At. Wt. Balance
WET GAS	186.68	214.82
OIL	44.64	
WATER	103.04	
TOTAL	334.36	
FRESH FEED	362.50	
WEIGHT BALANCE	92.24	
WET GAS FACTOR	1.15072	
INDICATED LOSS—S C F H	3674	
	481	

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL AT 60	API °/GAL.	#	#/HR GAL/HR
OIL	7'2½"	382.05	63	0.9985	381.48	51.9 6.423	2450.8	
	4'6"	240.20	58	1.0010	240.44	51.8 6.427	1545.3	
	9"	39.17	60	1.0000	39.17	51.9	251.6	
	3"	13.28	62	0.9990	13.27	6.425	85.2	44.64
					166.94		1071.3	6.956
WATER	6'9½"	360.22	70	0.9990	359.86	11.1	2973.9	
	1'2"	60.66	66	0.9994	60.62	8.264	501.0	103.04
					899.24		2478.9	13.466

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 51 7
HOURS 402-426

	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	38.460	10.258	286.80	10.177	0.970	27.17	3.026	13.284	3.996	-9.288	-259.63					Distribution of					
H_2 2.016	56.633	15.077	30.40	38.040	3.626	7.31	11.312	26.389	14.938	-11.451	-23.09					Recovered Oil					
CO_2 44.010	2.860	0.761	33.49	28.173	2.685	118.16	8.378	9.139	11.063	1.924	84.67	6.823				400 EP		78.0%	0.578		
N_2 28.016	0.610	0.162	4.54	2.137	0.204	5.72	0.635	0.797	0.859							400-550		11.3	0.084		
CH_4 16.042	1.437	0.383	6.14	11.763	1.121	17.98	3.498	3.881	4.619	0.738	11.84	1.234				550+		10.7	0.079		
C_2H_6 28.052				2.453	0.234	6.56	0.729	0.729	0.963	0.234	6.56	0.684									63.8
C_3H_8 30.068				1.397	0.133	4.00	0.415	0.415	0.548	0.133	4.00	0.417									
C_1+C_2											22.40	2.334									
C_3H_6 42.078				2.863	0.273	11.49	0.851	0.851	1.124	0.273	11.49	1.197	4.32	2.660	0.277	10.34	1.077	6.25	1.654	0.172	89.0
C_3H_8 44.094				0.353	0.034	1.50	0.105	0.105	0.139	0.034	1.50	0.156	4.24	0.354	0.037						
C_4H_8 56.104				1.457	0.139	7.80	0.433	0.433	0.572	0.139	7.80	0.813	5.00	1.560	0.163	7.41	0.772	6.10	1.215	0.127	76.8
C_4H_{10} 58.120				0.440	0.042	2.44	0.131	0.131	0.173	0.042	2.44	0.254	4.86	0.502	0.052	2.44	0.254	4.86	0.502	0.052	
C_5H_{10} 70.130				0.510	0.049	3.44	0.152	0.152	0.201	0.049	3.44	0.359	5.45	0.631	0.066	3.44	0.358	5.45	0.631	0.066	82.7
C_5H_{12} 72.146				0.107	0.010	0.72	0.032	0.032	0.042	0.010	0.72	0.075	5.25	0.137	0.014	0.72	0.075	5.25	0.137	0.014	
C_6H_{12} 84.156				0.130	0.012	1.01	0.039	0.039	0.051	0.012	1.01	0.105	5.54	0.182	0.018	1.01	0.105	5.54	0.182	0.019	
C_3-C_4											28.40	2.959		6.026	0.628	26.36	2.641		4.321	0.450	
TOTAL		26.621	361.37		9.532	215.30	29.736	56.357	44.682												
H_2+CO	95.093	25.315	9597 S.C.F.H.		4.596		14.338	39.653		-20.719											
H_2/CO	1.473		104199		3.74		3.738	1.990		1.24											

CUMULATIVE TOTALS	H_2+CO,MCF	Catalyst #	C_5^+, gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT SHIFT RATIO				
	RECOVERED OIL	0.3254*	45.64	4.756
	TOTAL OIL		74.04	7.715
	WATER SOLUBLE CHEMICALS	0.249*	13.23	1.379
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 8.5	TOTAL LIQUID PRODUCTS C_5^+		87.27	9.094
	NET WATER	4.840*	87.20	9.086
	GROSS WATER		100.43	10.465
	HYDROCARBON TOTAL—C_1^+		109.67	11.428

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3^+ + C_5^+
64.19	90.53	75.95	81.84	69.87	43.39	52.25	79.58

7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8

*Included in Reactor Effluent Total

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

DATA SUMMARY

OPERATING CONDITIONS			RATES S.C.F.H.	
PRESSURES PSIG			Fresh Feed	10092
Oxygen	423		Recycle	11273
Natural Gas	423		Combined Feed	21365
Generator Outlet	415		Wet Gas—Measured	3128
Reactor Inlet	412		Adjusted	3489
Condenser Inlet			Loss	361
Product Accumulator	392			
TEMPERATURES—°F.			Recycle/Fresh Feed	1.12
Oxygen	352		Inlet Velocity—ft./sec.	
Natural Gas	734		Fresh Feed Rate—S.C.F.H. / 60 #/ft²	9597
Generator			per Cu. Ft. Dense Bed	615
Quench Accumulator			per Lb. Catalyst	4.69
Reactor Inlet	607		per sq. ft.	14541
Condenser Inlet				
Product Accumulator	63		Heat Transfer Calculations	
Catalyst No. Height"			Steam Rate = 400.4 #/hr.	
1 12.0	646		@ 822 psia & 521°F = 1196 BTU/#	
2 43.2	650			
3 74.4	655		Water in @156°F = 125 BTU/#	
5 136.8	645		Heat Transferred/# steam = 1071 BTU	
7 199.2	627			
8 230.4	623		(1071)(400.4) = 428828 BTU/hr.	
9 261.6	621		Ave. Bed Temperature = 638°F	
10 292.8	612		dT = 638-521 = 117°F	
11 311.0	589		Tube Area = 33.2 ft.²	
12 342.0	583		K = 428828 / (117)(33.2) = 110.3	

PRODUCT TESTS	OIL	WATER
°API	51.9	11.2
Neut. No.	43.0	37.2
Sap. No.	53.1	37.7
Hydrox. No.		
Bromine No.	92.8	
Pour °F.		
Chemicals, % by K_2CO_3		14.0
HEMPEL. DIST. %		°API
205 °F.		
400	78.0	56.5
400-550	11.3	36.9
550+	10.7	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	96	
10%	132	
50%	222	
90%	348	
EP	399	
Loss	0.5	

CATALYST DATA					
INVENTORY DATA		PARTICLE SIZE			
In Reactor at Start of Period		Screen Analysis			Sedimentation
Fresh Catalyst Added 50 = 76		Mesh	Microns	%	Microns %
Total		On 40	419+	8.4	80+
Catalyst Recovered	32	100	150	58.2	40—80
In Reactor at End of Period		150	105	14.8	20—40
		200	74	14.4	10—20
REACTOR d-p, Inches H_2O		250	62	2.8	0—20
No. Height		325	44	2.0	
0 0-12	24	<325		2.4	
1 12-43.2	63	CATALYST			
2 43.2-74.4	68	Bulk Density. Lbs./Cu.Ft.			
3 74.4-105.6	76	Aerated			148
4 105.6-342.0	365	Settled			150
Total	596	Compacted			169
		Particle Density. gm./cc.			4.5
CALCULATED FROM dp		NH_3 Value, ml./gm.			9.47
Density, Lbs./Cu.Ft.	131	N_2 Surface, m^2/gm.			
Inventory, Lbs.	2045				
Bed Depth, Ft.	23.65	CHEMICAL ANALYSIS			
Volume, Cu. Ft.	15.61	Fe			
		C			
		O			
		H			
		K_2O, W+, % basis Fe			
		X-Ray Analysis—			
		$Fe_{20}C_9$			
		Fe_3O_4			
		Fe			

	GAS ANALYSES				GENERATOR BALANCE									WEIGHT BALANCE		
HOUR	1400	2200	0600	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		# hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.49	6.961 / 0.047			14.016	WET GAS	186.37	215.30
CO 28.010	37.11	41.12	37.15	38.460	10.238	10.238		10.238	CO 28.010						OIL	45.64	45.64
H_2 2.016	57.85	53.71	58.34	56.633	15.077		30.154		H_2 2.016						WATER	100.43	100.43
CO_2 44.010	2.65	3.31	2.62	2.860	0.761	0.761		1.522	CO_2 44.010	2.04	0.197	0.197		0.394	TOTAL	332.44	361.37
N_2 28.016	0.70	0.56	0.57	0.610	0.162				N_2 28.016	2.00	0.193				FRESH FEED	361.37	
CH_4 16.042	1.69	1.30	1.32	1.437	0.383	0.383	1.532		CH_4 16.042	82.18	7.939	7.939	31.756		WEIGHT BALANCE	91.99	
			M. W.	13.5745					C_2H_6 30.068	8.52	0.823	1.646	4.938				
			H_2O 18.016				7.019	3.510	C_3H_8 44.094	4.61	0.445	1.335	3.560		WET GAS FACTOR	1155228	
						101.80	95.75	105.97	C_4H_{10} 58.120	0.11 0.05	0.011 0.005	0.044 0.020	0.110 0.060		INDICATED LOSS—S C F H	361	
			BALANCE						TOTAL MW=	19.4928			11.181	40.424	14.410		

WET GAS					GAS FLOW RATES							LIQUID PRODUCT RATES						
CO 28.010	9.25	12.12	9.16	10.177		√ΔP	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR	HOUR	GAGE	GAL.	°F	FACTOR	GAL AT 60	API °/GAL	#	# HR GAL HR
H_2 2.016	38.76	37.00	38.36	38.040	FRESH FEED		412.2	73				OIL	3'10½"	207.46	58	1.0010	207.68	51.9	1333.9	
CO_2 44.010	28.22	27.70	28.60	28.173		79.31	4.27	20.66	0.9877	10092	1.4604	26.621	0'9"	39.17	60	1.0000	39.17	6.423	251.6	
N_2 28.016	2.17	2.24	2.00	2.137	WET GAS		1.5	63									168.51		1082.3	
CH_4 16.042	11.90	11.38	12.01	11.763		79.31	8.68	4.025	0.9971	3128	1.1321	8.251					+2.02		+13.0	45.64
C_2H_6 28.052	2.37	2.55	2.44	2.453	RECYCLE		413.9	125									170.56		1095.3	7.107
C_3H_8 30.068	1.30	1.43	1.46	1.397		115.14	4.02	20.70	0.9428	10227	1.1321	26.977								
C_3H_6 42.078	2.96	2.66	2.97	2.863	BLEED		413.9													
C_3H_8 44.094	0.41	0.36	0.29	0.353		5.02	9.43	20.70	0.9428	1046	1.1321	2.759	WATER	7'8½"	70	0.9990	407.83	11.2 8.258	3367.9	
C_4H_8 56.104	1.58	1.37	1.42	1.457	NATURAL GAS		423.1	195					6'9½"	360.22	70	0.9990	359.86	11.1 8.264	2973.9	
C_4H_{10} 58.120	0.36	0.36	0.60	0.440		28.43	5.67	20.92	0.8910	3662	1.2187	9.660								
C_5H_{10} 70.130	0.55	0.51	0.47	0.510	OXYGEN		422.5	73					4'11"	262.02	68	0.9992	261.81	11.2	2162.0	
C_5H_{12} 72.146	0.08	0.17	0.07	0.107		27.07	4.72	20.91	0.9877	2639		6.961	0'4"	17.70	78	0.9979	17.66	8.258	145.8	12.172
C_6H_{12} 84.156	0.09	0.15	0.15	0.130	STEAM		32.9	251									292.12		2410.2	100.43
			M. W.	22.5881		215.6	6.14	0.3025	400.4 # steam/hr.											

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 51 U

HOURS 426-450

	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
CO 28.010	38.720	10.322	289.12	8.973	0.823	23.05	2.641	12.963	3.464	9.499	266.07					Distribution of				
H_2 2.016	56.490	15.060	30.36	36.358	3.333	6.72	10.703	25.763	14.036	11.727	23.64					Recovered Oil				
CO_2 44.010	2.937	0.783	34.46	30.174	2.766	121.73	8.882	9.665	11.648	1.983	87.27	9.072					400 EP			0.577
N_2 28.016	0.703	0.187	5.24	3.687	0.338	9.47	1.085	1.272	1.423	0.151							400-550			0.089
CH_4 16.042	1.150	0.307	4.92	10.377	0.951	15.26	3.055	3.362	4.006	0.644	10.34	1.076					550+			0.74
C_2H_6 28.077				2.693	0.247	6.93	0.793	0.793	1.040	0.247	6.9	0.720								64.4
C_3H_8 30.069				1.490	0.137	4.12	0.439	0.439	0.576	0.137	4.12	0.428								
C_4+C_5											21.39	2.224								
C_2H_4 42.07				3.163	0.290	12.20	0.931	0.931	1.221	0.290	12.20	1.268	4.32	2.824	0.293	10.98	1.141	6.23	1.757	0.183	90.3
C_3H_6 44.094				0.340	0.031	1.37	0.100	0.100	0.131	0.031	1.37	0.142	4.24	0.325	0.034					
C_4H_8 56.104				1.603	0.147	8.25	0.472	0.472	0.619	0.147	8.25	0.858	5.00	1.650	0.172	7.84	0.815	6.10	1.285	0.134	81.6
C_5H_{10} 58.120				0.363	0.033	1.92	0.107	0.107	0.140	0.033	1.92	0.200	4.86	0.388	0.040	1.92	0.200	4.86	0.388	0.040	
C_6H_{12} 72.130				0.553	0.051	3.58	0.163	0.163	0.214	0.051	3.58	0.372	5.45	0.657	0.068	3.58	0.372	5.45	0.657	0.068	85.6
C_7H_{14} 72.146				0.093	0.009	0.65	0.027	0.027	0.036	0.009	0.65	0.068	5.23	0.124	0.013	0.65	0.068	5.23	0.124	0.013	
C_8H_{12} 84.156				0.133	0.012	1.01	0.039	0.039	0.051	0.012	1.01	0.105	5.54	0.182	0.019	1.01	0.105	5.54	0.182	0.019	
C_9-C_4											28.98	3.013		6.148	0.639	25.98	2.701		4.393	0.457	
TOTAL		26.659		45.331	9.167	29.77	29.437	56.096	44.101											
H_2+CO		25.382	9620 S.C.F.H.		4.156		13.344	38.726	17.500	21.226										
H_2/CO		1.46	1.039525		4.05			1.99		1.24										

CUMULATIVE TOTALS	H_2+CO MCF	Catalyst #	C_5^+ gal	gal/MCF	gal/#
Previous Total					
Current Period					
New Total					

EFFLUENT							
SHIFT RATIO		RECOVERED OIL	0.3267*	45.62	4.763	6.441	7.114	0.740	45.82	4.763		7.114	0.740
		TOTAL OIL		74.80	7.776	15.262	1.379	71.80	7.464	11.507	1.196
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 9.6		WATER SOLUBLE CHEMICALS	0.256*	13.56	1.410	7.534	1.731	0.180	13.56	1.410	1.731	0.180
		TOTAL LIQUID PRODUCTS C_5^+		88.36	9.185	14.993	1.559	85.36	8.873	13.238	1.376
		NET WATER	4.914*	88.53	9.203		10.631	1.105			
		GROSS WATER		102.09	10.612	8.23	12.362	1.285			
		HYDROCARBON TOTAL—C_1^+		109.75	11.409						

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3^+ C_4^+
65.61	92.03	77.87	83.63	73.28	45.52	54.81	80.51

*Included in Reactor Effluent Total

g/M3 = 16.91 × #/MCF

cc/M3 = 141.3 × gal/MCF.

DATA SUMMARY

OPERATING CONDITIONS		RATES S.C.F.H.	
PRESSURES PSIG			
Oxygen	424	Fresh Feed	10104
Natural Gas	424	Recycle	11157
Generator Outlet	416	Combined Feed	21261
Reactor Inlet	411	Wet Gas—Measured	3070
Condenser Inlet		Adjusted	3474
Product Accumulator	391	Loss	404
TEMPERATURES—°F.		Recycle/Fresh Feed	1.10
Oxygen	370	Inlet Velocity—ft./sec.	0.7
Natural Gas	747	Fresh Feed Rate—S.C.F.H. H_2+CO	9620
Generator	2355	per Cu. Ft. Dense Bed	627
Quench Accumulator		per Lb. Catalyst	4.78
Reactor Inlet	625	per sq. ft.	14576
Condenser Inlet			
Product Accumulator	60	Heat Transfer Calculations	

Catalyst No.	Height "	
1	12.0	650
2	43.2	654
3	74.4	664
# 5	136.8	648
# 7	199.2	634
# 8	230.4	628
9	261.6	627
10	292.8	615
11	311.0	596
12	342.0	581

Steam Rate = 412.7 #/hr.

@ 815 & 521°P = 1196 BTU/#

Water in @159°P = 126 BTU/#

Heat Transferred/# steam = 1070 BTU

(1070)(412.7)= 440915 BTU/hr.

Ave. Bed Temperature= 646°P

dT = 646-521 = 125°F

Tube Area = 32.9 $ft.^2$

$K = \frac{440915}{(125)(32.9)} = 107.7$

PRODUCT TESTS	OIL	WATER
°API	51.4	11.2
Neut. No.	45.0	38.3
Sap. No.	56.4	38.9
Hydrox. No.		
Bromine No.	83.5	
Pour °F.		
Chemicals, % by K_2CO_3		14.0
HEMPEL DIST. %		°API
205 °F.		
400	78.0	56.4
400-550	12.0	36.4
550+	10.0	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	96	
10%	132	
50%	220	
90%	344	
EP	398	
	98.0	

CATALYST DATA						
INVENTORY DATA		PARTICLE SIZE				
In Reactor at Start of Period		Screen Analysis			Sedimentation	
Fresh Catalyst Added 63 = 95		Mesh	Microns	%	Microns	%
Total		On 40	419+	9.0	80+	
Catalyst Recovered	24	100	150	57.0	40—80	
In Reactor at End of Period		150	105	14.2	20—40	
		200	74	13.1	10—20	
REACTOR d-p, Inches H_2O		250	62	3.6	0—20	
No. Height		325	44	1.6		
		<325		1.0		
1 12-43.2	63					
2 43.2-74.4	68	CATALYST				
3 74.4-105.6	76	Bulk Density, Lbs./Cu.Ft.				
4 105.6-342.0	355	Aerated			151	
0 0-12	24	Settled			153	
	586	Compacted			173	
		Particle Density, gm./cc.			4.5	
CALCULATED FROM dp		NH_3 Value, ml./gm.			12.1	
Density, Lbs./Cu.Ft.	131	N_2 Surface, m^2/gm.				
Inventory, Lbs.	2011					
Bed Depth, Ft.	23.26	CHEMICAL ANALYSIS				
Volume, Cu. Ft.	15.35	Fe				
		C				
		O				
		H				
		K_2O. W+. % basis Fe				
		X-Ray Analysis—				
		$Fe_{20}C_9$				
		Fe_3O_4				
		Fe				

GAS ANALYSES					GENERATOR BALANCE										WEIGHT BALANCE		
HOUR				AVERAGE	M.HR	C	H	O		Mol %	M/Hr	C	H	O		# hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.49	0.047 6.809			13.712	WET GAS	191.06	216.21
CO 28.010	37.99	39.07	39.10	38.720	10.322	10.322		10.322	CO 28.010		6.856				OIL	45.82	45.82
H_2 2.016	55.67	56.83	56.97	56.490	15.060		30.120		H_2 2.016						WATER	102.09	102.09
CO_2 44.010	2.93	2.90	2.98	2.937	0.783	0.783		1.566	CO_2 44.010	2.04	0.197	0.197		0.394	TOTAL	338.97	364.12
N_2 28.016	0.64	0.78	0.69	0.703	0.187				N_2 28.016	2.00	0.193				FRESH FEED	364.12	364.12
CH_4 16.042	2.77	0.42	0.26	1.150	0.307	0.307	1.228		CH_4 16.042	82.18	7.931	7.931	31.724		WEIGHT BALANCE	93.09	
			M. W.	13.6583196					C_2H_6 30.069	8.52	0.822	1.644	4.932				
			H_2O 18.016				6.738	3.369	C_3H_8 44.094	4.61	0.445	1.335	3.560		WET GAS FACTOR	1.131634	
				2.1195872		11.412	38.086	15.257	C_4H_{10} 58.120	0.11 0.05	0.011 0.005	0.044 0.025	0.110 0.060		INDICATED LOSS—S C F H	3474	
			BALANCE			102.11	94.30	108.16	TOTAL		19.49277		11.176	40.386	14.106	404	

WET GAS					GAS FLOW RATES							LIQUID PRODUCT RATES							
CO 28.010	8.80	8.50	9.62	8.973		VR	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
H_2 2.016	35.85	35.05	38.17	36.358	FRESH FEED		411.1	72.0				OIL	7'1½"	377.68	61	0.9995	377.49	51.4		45.82
CO_2 44.010	28.76	30.80	30.96	30.174	79.31	4.29	20.63	0.9887	10104	1.4559	26.659		3'10½"	207.46	58	1.0010	207.85	6.441		7.114
N_2 28.016	3.62	4.91	2.53	3.687	WET GAS		1.50	61									169.64			
CH_4 16.042	12.76	9.73	8.64	10.377	79.31	8.69	4.025	0.9990	3070	1.1079	8.101						1.09		* 7.0	
C_2H_6 28.082	2.52	2.76	2.80	2.693	RECYCLE		414.1	121									170.73			
C_3H_8 33.088	1.38	1.60	1.49	1.490	115.14	4.05	20.71	0.9460	10122	1.1079	26.706									
C_4H_{10} 58.078	3.05	3.45	2.99	3.163	BLEED		414.1	121												
C_5H_{12} 44.094	0.34	0.44	0.24	0.340	5.02	9.5	20.71	0.9460	1035	1.1079	2.731	WATER						11.2		
C_6H_{14} 86.104	1.62	1.67	1.52	1.603	NATURAL GAS		424.5	192	11157		29.437		7'7"	401.69	66	0.9994	401.45	8.258		102.09
C_7H_{16} 88.120	0.44	0.32	0.33	0.363	28.43	5.64	20.96	0.8931	3658	1.219	9.651		4'11"	262.02	68	0.9992	261.81			12.362
C_8H_{18} 72.130	0.61	0.56	0.49	0.553	OXYGEN		424.5	72					3'2"	170.36	62	0.9998	170.33			
C_9H_{20} 72.146	0.08	0.09	0.11	0.093	27.07	4.60	20.96	0.9887	2580		6.809		0'3"	13.28	61	0.9999	13.28			
$C_{10}H_{22}$ 84.156	0.17	0.12	0.11	0.133	STEAM		38.0										296.69			
			M. W.	23.584985	215.7	6.29	0.3042		412.7 #/hr.											