A. METHOD OF CALCULATION AND DETAILED MONTEBELLO DATA

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

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

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 Yields on this basis have been largely superseded by yields calculated more exactly on a Brownsville basis as discussed in Section C of the Appendix.

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 42 A
HOURS 0-16

	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	37.095	14.506	406.51	10.723	1.214	34.00	4.020	18.526	5.234	-13.292	372.51					Distribution of					
H_2 2.016	58.980	23.065	46.50	35.171	3.982	8.03	13.184	36.249	17.166	-19.083	38.47					Recovered Oil					
CO_2 44.010	2.855	1.116	49.12	30.497	3.452	151.92	11.432	12.548	14.884	2.336	102.80	7.220								0.684	
N_2 28.016	1.025	0.401	11.23	4.183	0.474	13.28	1.568	1.969	2.042								400-550			0.197	
CH_4 16.042	0.045	0.018	0.29	10.187	1.153	18.50	3.819	3.837	4.972	1.135	18.21	1.279					550+			0.106	
C_2H_4 28.026				2.523	0.286	8.02	0.946	0.946	1.232	0.286	8.02	0.563									69.8
C_3H_8 30.048				1.093	0.124	3.73	0.410	0.410	1.534	0.124	3.73	0.262									
C_1+C_3											29.96	2.104									
C_3H_6 42.078				2.880	0.326	13.72	1.080	1.080	1.406	0.326	13.72	0.964	4.32	3.176	0.223	12.35	0.867	6.28	1.976	0.139	96.2
C_3H_8 44.094				0.113	0.013	0.57	0.042	0.042	0.055	0.013	0.57	0.040	4.24	0.134	0.009						
C_4H_8 56.104				1.467	0.166	9.31	0.550	0.550	0.716	0.166	9.31	0.654	5.00	1.862	0.151	8.84	0.621	6.10	1.450	0.102	74.6
C_4H_{10} 58.120				0.500	0.057	3.31	0.187	0.187	0.244	0.057	3.31	0.232	4.86	0.681	0.048	3.31	0.232	4.86	0.681	0.048	
C_5H_{10} 70.130				0.440	0.050	3.51	0.165	0.165	0.215	0.050	3.51	0.247	5.45	0.644	0.045	3.51	0.247	5.45	0.644	0.045	61.5
C_6H_{12} 72.146				0.100	0.011	0.79	0.037	0.037	0.048	0.011	0.79	0.055	5.25	0.150	0.011	0.79	0.055	5.25	0.150	0.011	
C_6H_{12} 84.162				0.123	0.014	1.18	0.046	0.046	0.060	0.014	1.18	0.083	5.54	0.213	0.015	1.18	0.083	5.54	0.213	0.015	
C_4+C_6											32.39	2.275		6.860	0.482	29.98	2.105		5.114	0.359	
TOTAL		39.106			11.321	269.87	37.485														
H_2+CO		37.571	14,239 S.C.F.H.		5.196		17.204	54.775	22.400	-32.375											
H_2/CO		1.59	702297		3.28			1.96	3.28	1.44											

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

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

EFFLUENT									
RECOVERED OIL	0.655	91.85	6.451	6.557	14.051	0.987	91.85	6.451	14.051	0.987	
TOTAL OIL		124.24	8.725		20.911	1.469	121.83	8.556	19.165	1.346	
WATER SOLUBLE CHEMICALS		10.43	0.732	8.168	1.277	0.090	10.43	0.732	1.277	0.090	
TOTAL LIQUID PRODUCTS C_3+		134.67	9.458		22.188	1.558	132.26	9.289	20.442	1.436	
NET WATER	7.845	141.33	9.926	8.328	16.971	1.192					
GROSS WATER		151.76	10.658		18.248	1.282					
HYDROCARBON TOTAL—C_1+		164.65	11.562								

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

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

OPERATING CONDITIONS					
PRESSURES PSIG		RATES S.C.F.H.			
Oxygen	418	Fresh Feed	14821		
Natural Gas	405	Recycle	14208		
Generator Outlet	399	Combined Feed	29029		
Reactor Inlet	385	Wet Gas—Measured	3985		
Condenser Inlet		Adjusted	4291		
Product Accumulator	360	Loss	306		
TEMPERATURES—°F.		Recycle/Fresh Feed	0.959		
Oxygen	351	Inlet Velocity—ft./sec.	0.958		
Natural Gas	629	Fresh Feed Rate—S.C.F.H.			
Generator	2155	per Cu. Ft. Dense Bed			
Quench Accumulator		per Lb. Catalyst			
Reactor Inlet	256				
Condenser Inlet					
Product Accumulator	65	Heat Transfer Calculations			

Catalyst No.	Height		
1	12.0	652	
2	43.2	652	
3	74.4	689	
4	105.6		
5	136.8	683	
6	168.0		
7	199.2	680	
8	230.4		
9	261.6		
10	292.8		
12	342.0	639	

Steam Rate = 354.1#/hr
@ 810 psia & 519°F
= 1196 BTU/#
Water in @ 167°F = 135 BTU/#
Heat Transferred/lb. steam
= 1061 BTU
(1061)(354.1) = 375,700 BTU/hr
dT = 671-519 = 162°F
Tube Area = 30.9 ft^2
$K = \frac{375700}{(162)(30.9)} = 75.2$

PRODUCT TESTS	OIL	WATER
°API	48.7	10.2
Neut. No.	42.5	40.5
Sap. No.	49.4	48.3
Hydrox. No.		
Bromine No.	81.6	
Pour °F.		
Chemicals, % by K_2CO_3		7.0
HEMPEL. DIST. %		°API
205 °F.		
400	69.5	55.5
400-550	20.0	36.0
550+	10.7	
A. S. T. M. DIST. ON		
Naphtha °F.		
IBP	106	
10%	138	
50%	232	
90%	355	
EP	406	
	98.0	

CATALYST DATA					
INVENTORY DATA	1750 Fe	PARTICLE SIZE			
In Reactor at Start of Period	2652*	Screen Analysis			Sedimentation
Fresh Catalyst Added	0	Mesh	Microns	%	Microns %
Total		On 40	419+	16.3	80+
Catalyst Recovered	258	100	150	59.9	40-80
In Reactor at End of Period	2394	150	105	12.4	20-40
		200	74	8.6	10-20
REACTOR d-p, Inches H_2O		250	62	1.0	0-20
No. Height		325	44	1.0	
1 12-43.2	66	<325		0.8	
2 43.2-74.4	80	CATALYST			
3 74.4-105.6	85	Bulk Density, Lbs./Cu.Ft.			
4 off scale		Aerated			159
		Settled			161
		Compacted			180
		Particle Density, gm./cc.			4.7
CALCULATED FROM dp		NH_3 Value, ml./gm.			0.41
Density, Lbs./Cu.Ft.	154	N_2 Surface, m^2/gm.			1.1
Inventory, Lbs.					
Bed Depth, Ft.		CHEMICAL ANALYSIS			
		Fe			88.9
* At 66% Fe		C			0.22
		O			
		H			0.07
		K_2O, W+. % basis Fe			
		X-Ray Analysis—			
		$Fe_{20}C_9$			
		Fe_3O_4			
		Fe			100

	GAS ANALYSES				GENERATOR BALANCE									WEIGHT BALANCE		
HOUR				AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		# hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.56	10.280 0.078			20.716	WET GAS	250.64	269.87
CO 28.010	36.97	37.22		37.095	14.506	14.506		14.506	CO 28.010						OIL	91.85	91.85
H_2 2.016	59.22	58.74		58.980	23.065		46.130		H_2 2.016						WATER	151.76	151.76
CO_2 44.010	2.75	2.96		2.855	1.116	1.116		2.232	CO_2 44.010	2.30	0.319	0.319		0.638	TOTAL	494.25	513.48
N_2 28.016	1.01	1.04		1.025	0.401				N_2 28.016	3.20	0.444				FRESH FEED	513.48	
CH_4 16.042	0.05	0.04		0.045	0.018	0.018	0.072		CH_4 16.042	81.24	11.266	11.266	45.064		WEIGHT BALANCE	96.25	
			M. W.	13.1302					C_2H_4 30.048	8.83	1.224	2.448	7.344				
			H_2O 18.016				9.932	4.966	C_3H_6 44.094	3.50	0.485	1.455	3.880		WET GAS FACTOR		1.0767235
									C_4H_{10} 58.120	0.35	0.049	0.195	0.490		INDICATED LOSS—S C F H		306
					39.106	15.640	56.134	21.704	TOTAL	0.02	0.003	0.015	0.036				
			BALANCE			99.62	98.80	101.64					15.699	56.814	21.354		

WET GAS					GAS FLOW RATES							LIQUID PRODUCT RATES							
CO 28.010	11.16	9.46	11.55	10.723		VTR	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	35.92	32.24	37.55	35.171	FRESH FEED		384.8	73.6				OIL	4'2 1/2	224.92	61	0.9995	224.81	48.7	1469.6	91.85
CO_2 44.010	31.01	28.29	32.19	30.497	79.31	6.38	19.99	0.9868	14621	1.4849	39.106							6.537		14.05
N_2 28.016	3.59	5.48	3.48	4.183	WET GAS		1.62	63												
CH_4 16.042	9.09	14.84	6.63	10.187	158.44	5.66	4.04	0.9981	3985	1.102	10.514									
C_2H_4 28.052	2.50	2.87	2.20	2.523	RECYCLE		352.6	124												
C_3H_8 33.068	1.07	1.35	0.88	1.093	79.31	8.48	19.17	0.9436	13407	1.102	35.373									
C_3H_6 42.078	2.61	2.53	3.50	2.880	BLEED															
C_4H_8 44.094	0.34			0.113	5.02	8.0	19.17	0.9436	801	1.102	2.112	WATER								
C_4H_8 56.104	1.49	1.42	1.49	1.467	NATURAL GAS		405.3	206	14208		37.485		5'6	292.57	78	0.9979	291.96	10.2	2428.2	151.76
C_4H_{10} 58.120	0.40	0.08	0.42	0.500	28.43	8.39	20.49	0.8836	5256	1.217	13.867							8.317		18.248
C_5H_{10} 70.130	0.62	0.60	0.10	0.440	OXYGEN		417.6	67												
C_6H_{12} 72.146	0.07	0.15	0.08	0.100	27.07	6.97	20.79	0.9933	3896		10.280									
C_6H_{12} 84.162	0.13	0.11	0.13	0.125	STEAM		35.9 -10.0 *		* Correction for hydraulic head.											
			M. W.	25.856	315.7	5.23	0.3139		354.1#/hr											

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 B
HOURS 16-34

	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	37.127	14.705	411.89	11.085	1.310	36.69	4.523	19.228	5.833	-13.395	375.20
H_2 2.016	59.330	23.499	47.37	41.520	4.907	9.89	16.940	40.439	21.847	-18.592	37.48
CO_2 44.010	2.540	1.006	44.27	27.645	3.267	143.78	11.279	12.285	14.546	2.261	99.51
N_2 28.016	0.935	0.370	10.37	2.455	0.290	8.12	1.002	1.372	1.292		
CH_4 16.042	0.068	0.027	0.43	7.750	0.916	14.69	3.162	3.189	4.078	0.889	14.26
C_2H_4 28.052				2.530	0.299	8.39	1.032	1.032	1.331	0.299	8.39
C_2H_6 30.068				0.890	0.105	3.16	0.363	0.363	0.468	0.105	3.16
C_1+C_2											25.81
C_3H_6 42.078				2.565	0.303	12.75	1.047	1.047	1.350	0.303	12.75
C_3H_8 44.094											
C_4H_8 56.104				1.745	0.206	11.56	0.712	0.712	0.918	0.206	11.56
C_4H_{10} 58.120				0.645	0.076	4.42	0.263	0.263	0.339	0.076	4.42
C_5H_{10} 70.130				0.790	0.093	6.52	0.322	0.322	0.415	0.093	6.52
C_5H_{12} 72.146				0.185	0.022	1.59	0.075	0.075	0.097	0.022	1.59
C_6H_{12} 84.156				0.195	0.023	1.94	0.080	0.080	0.103	0.023	1.94
C_3-C_6											38.78
TOTAL		39.608	314.33		11.819	263.59	40.800	80.408			
H_2+CO		38.204	14479 S.C.F.H.		6.217		21.463	59.667	27.680	31.987	
H_2/CO		1.60	69064		3.75			2.10	3.75	1.39	

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	6.873					400-			0.661	
N_2						400-550			0.161	
CH_4	0.985					550+			0.109	
C_2H_4	0.579									74.0
C_2H_6	0.218									
C_1+C_2	1.783									
C_3H_6	0.880	4.32	2.951	0.204	11.48	0.793	6.25	1.837	0.127	100.00
C_3H_8		4.24								
C_4H_8	0.798	5.00	2.312	0.160	10.98	0.758	6.10	1.800	0.124	73.00
C_4H_{10}	0.305	4.86	0.909	0.063	4.42	0.305	4.86	0.909	0.063	
C_5H_{10}	0.450	5.45	1.196	0.082	6.52	0.450	5.45	1.196	0.082	81.00
C_5H_{12}	0.110	5.25	0.303	0.021	1.59	0.110	5.25	0.303	0.021	
C_6H_{12}	0.134	5.54	0.350	0.024	1.94	0.134	5.54	0.350	0.024	
C_3-C_6	2.678		8.021	0.554	36.93	2.551		6.395	0.442	

CUMULATIVE TOTALS

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

EFFLUENT

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

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

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

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

OPERATING CONDITIONS

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

PRODUCT TESTS

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

CATALYST DATA

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

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

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

Reactor Cross Section = 0.66 sq.Ft.

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

Volume = (20.8)(0.66)

PARTICLE SIZE

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

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

GAS ANALYSES

HOUR				AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010				37.127	14.705	14.705		14.705
H_2 2.016				59.330	23.499		46.998	
CO_2 44.010				2.540	1.006	1.006		2.012
N_2 28.016				0.935	0.370			
CH_4 16.042				0.068	0.027	0.027	0.108	
			M. W.	12.98608				
			H_2O 18.016				9.956	4.978
						15.738	57.062	21.695
			BALANCE			98.07	98.29	102.34
WET GAS								
CO 28.010	10.45	11.72		11.085				
H_2 2.016	42.65	40.39		41.520				
CO_2 44.010	25.73	29.56		27.645				
N_2 28.016	2.36	2.55		2.455				
CH_4 16.042	8.82	6.68		7.750				
C_2H_4 28.052	2.42	2.64		2.530				
C_2H_6 30.068	0.88	0.90		0.890				
C_3H_6 42.078	2.53	2.60		2.565				
C_3H_8 44.094								
C_4H_8 56.104	1.95	1.54		1.745				
C_4H_{10} 58.120	0.75	0.54		0.645				
C_5H_{10} 70.130	0.96	0.62		0.790				
C_5H_{12} 72.146	0.23	0.14		0.185				
C_6H_{12} 84.156	0.27	0.12		0.195				
			M. W.	22.301				

GENERATOR BALANCE

	Mol %	M/Hr	C	H	O
O_2 32.000	0.59	10.191 0.083			20.548
CO 28.010					
H_2 2.016					
CO_2 44.010	2.30	0.325	0.325		0.650
N_2 28.016	2.96	0.418			
CH_4 16.042	81.54	11.522	11.522	46.088	
C_2H_6 30.068	8.46	1.195	2.390	7.170	
C_3H_8 44.094	3.82	0.540	1.620	4.320	
C_4H_{10} 58.120	0.31 0.02	0.044 0.003	0.176 0.015	0.440 0.036	
TOTAL			16.048	58.054	21.198

WEIGHT BALANCE

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

GAS FLOW RATES

	√H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED 79.31	6.49	19.96	0.9786	15012	1.4931	39.608
WET GAS 158.44	6.24	4.067	0.9868	4519	1.139	11.924
RECYCLE 79.31	8.45	20.19	0.9388	14468	1.139	38.175
BLEED 5.02	9.18	20.19	0.9388	995	1.139	2.625
				15463		40.800
NATURAL GAS 28.43	8.59	20.44	0.8816	5356	1.217	14.131
OXYGEN 27.07	7.02	20.75	0.9795	3862	1.000	10.191
STEAM 215.7	5.71	34.3 0.3079		379.2#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	#/HR GAL/HR
OIL	7'4	388.59	80	0.9901	384.74	49.0	2510.8	87.82
	4'2 1/2	224.92	61	0.9995	224.81	6.526	1469.6	13.479
	1'9 1/2	93.76	62	0.9990	93.67	48.7	611.3	
	0'2 1/2	11.06	74	0.9930	10.98	6.537	71.7	
					242.62		1580.8	
WATER								
	7'3 1/2	386.41	78	0.9979	385.60	10.8	3207.0	162.94
	5'6	292.57	78	0.9979	291.96	8.317	2428.2	19.59
	5'2	275.11	80	0.9976	274.45		2282.6	
	0'3 1/2	15.49	82	0.9974	15.45		128.5	
					352.64		2932.9	

THE TEXAS COMPANY -- MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 C
HOURS 34-59

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	.../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	37.127	14.937	418.40	12.473	1.755	49.16	5.121	20.058	6.876	-13.182	369.24					Distribution of					
H_2 2.016	59.350	23.870	48.12	41.586	5.852	11.80	17.075	40.945	22.925	-18.018	36.32					Recovered Oil					
CO_2 44.010	2.540	1.022	44.98	28.227	3.973	174.85	11.588	13.610	15.561	1.951	129.87	8.827				400 F				0.529	
N_2 28.016	0.935	0.376	10.53	3.027	0.426	11.93	1.243	1.619	1.669							400-550				0.135	
CH_4 16.042	0.068	0.027	0.43	6.197	0.872	13.99	2.544	2.571	3.416	0.845	13.56					550+				0.068	
C_2H_4 28.052				2.283	0.321	9.00	0.937	0.937	1.258	0.321	9.00										74.3
C_3H_6 30.068				0.787	0.111	3.38	0.323	0.323	0.434	0.111	3.38										
C_4+C_5											25.94	1.765									
C_2H_6 42.078				2.190	0.308	12.96	0.899	0.899	1.207	0.308	12.96	0.881	4.32	3.000	0.204	11.66	0.793	6.25	1.866	0.127	92.8
C_3H_8 44.094				0.170	0.024	1.06	0.070	0.070	0.094	0.024	1.06	0.072	4.24	0.250	0.017						
C_4H_8 56.104				1.460	0.205	11.50	0.599	0.599	0.804	0.205	11.50	0.782	5.00	2.300	0.156	10.93	0.743	6.10	1.792	0.122	72.7
C_4H_{10} 58.120				0.547	0.077	4.48	0.224	0.224	0.301	0.077	4.48	0.305	4.86	0.922	0.063	4.48	0.305	4.86	0.922	0.063	
C_5H_{10} 70.130				0.703	0.099	6.94	0.289	0.289	0.388	0.099	6.94	0.472	5.45	1.273	0.087	6.94	0.472	5.45	1.273	0.087	83.7
C_6H_{12} 72.146				0.137	0.019	1.37	0.056	0.056	0.075	0.019	1.37	0.093	5.25	0.261	0.018	1.37	0.093	5.25	0.261	0.018	
C_6H_{12} 84.156				0.180	0.025	2.10	0.074	0.074	0.099	0.025	2.10	0.143	5.54	0.379	0.026	2.10	0.143	5.54	0.379	0.026	
C_5-C_6																					
TOTAL		40.232	522.46		14.071	314.48	41.054	81.286			40.41	2.747		8.385	0.571	37.48	2.549		6.493	0.443	
H_2+CO	96.457	38.807	14712 S.C.F.H.							-31.200											
H_2/CO	1.60		679717					2.04													

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

EFFLUENT SHIFT RATIO											
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.5	RECOVERED OIL		72.04	4.897	6.512	11.062	0.752	72.04	4.597	6.512	11.062	0.752	
	TOTAL OIL		112.45	7.643		19.447	1.323	109.52	7.446		17.555	1.195	
	WATER SOLUBLE CHEMICALS		10.56	0.718	8.067	1.309	0.089	10.56	0.718	8.067	1.309	0.089	
	TOTAL LIQUID PRODUCTS C_3+		123.01	8.361		70.756	1.412	120.08	8.164		18.864	1.284	
	MET WATER		6.959	125.38	8.522	8.328	15.055	1.023					
	GROSS WATER			135.94	9.240		16.364	1.112					
	HYDROCARBON TOTAL—C_1+			148.95	10.124								

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

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

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

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

CATALYST DATA					
INVENTORY DATA	2257	PARTICLE SIZE			
In Reactor at Start of Period		Screen Analysis			Sedimentation
Fresh Catalyst Added		Mesh	Microns	%	Microns %
Total		On 40	419+	12.0	80+
Catalyst Recovered	60	100	150	64.0	40—80
In Reactor at End of Period	2197	150	105	12.4	20—40
		200	74	7.8	10—20
REACTOR d-p, Inches H_2O		250	62	1.4	0—20
No. Height"		325	44	1.2	
1 12 - 43.2	64	<325		1.2	
2 43.2 - 74.4	68	CATALYST			
3 74.4 - 105.6	75	Bulk Density, Lbs./Cu.Ft.			
4 105.6 - 342.0	290	Aerated			143
		Settled			145
(Calc) 0-12"	27	Compacted			159
total	524	Particle Density, gm./cc.			4.3
CALCULATED FROM dp		NH_3 Value, ml./gm.			2.37
Density, Lbs./Cu.Ft.	138	N_2 Surface, m^2/gm.			
Inventory, Lbs.	1798				
Bed Depth, Ft.	19.54	CHEMICAL ANALYSIS			
Volume, Cu Ft	12.90	Fe			
		C			
		O			
		H			
		K_2O, W+, % basis Fe			
		X-Ray Analysis—			
		$Fe_{2.2}C_3$			
		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	0.57	10.573 / 0.081			21.308	WET GAS	279.51	314.48
CO 28.010	36.99	37.47	37.29	37.177	14.937	14.937		14.937	CO 28.010						OIL	72.04	72.04
H_2 2.016	59.36	58.13	58.71	59.330	23.870		47.740		H_2 2.016						WATER	135.94	135.94
CO_2 44.010	2.12	3.40	3.09	2.540	1.022	1.022		2.044	CO_2 44.010	2.30	0.328	0.328		0.656	TOTAL	487.49	522.46
N_2 28.016	0.87	0.96	0.84	0.935	0.376				N_2 28.016	3.08	0.439				FRESH FEED	522.46	
CH_4 16.042	0.06	0.04	0.07	0.068	0.027	0.027	0.108		CH_4 16.042	81.39	11.596	11.596	46.384		WEIGHT BALANCE	93.28	
			M. W.	12.98608					C_2H_6 30.068	8.65	1.232	2.464	7.392				
			H_2O 18.016				10.272	5.136	C_3H_8 44.094	3.66	0.521	1.563	4.168		WET GAS FACTOR		1.125112
									C_4H_{10} 58.120	0.33	0.047	0.188	0.470				
						15.986	58.120	22.117		0.02	0.003	0.018	0.056		INDICATED LOSS—S C F H		523
			BALANCE			98.96	99.44	100.70	TOTAL			16.154	58.450	21.964			

WET GAS					GAS FLOW RATES							LIQUID PRODUCT RATES							
CO 28.010	11.96	13.00	12.46	12.473		$\sqrt{\Delta P}$	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	43.75	40.09	40.92	41.586			383.7	79				OIL								
CO_2 44.010	27.34	29.08	28.26	28.227	FRESH FEED 79.31	6.57	19.96	0.9822	15252	1.4951	40.232		7'0	371.14	65	0.9975	370.21	49.3	2412.3	72.04
N_2 28.016	2.55	2.52	4.01	3.027			1.94	71					1'9 1/2	93.76	62	0.9990	93.67	49.0	611.3	11.062
CH_4 16.042	6.34	6.34	5.91	6.197	WET GAS 158.44	6.51	4.08	0.9896	4740	1.1361	12.506						276.54		1801.0	
C_2H_4 28.052	2.36	2.46	2.03	2.283			391.7	189												
C_3H_6 30.068	0.81	0.85	0.72	0.787	RECYCLE 79.31	8.48	20.16	0.9396	14499	1.1361	38.256									
C_2H_6 42.078	2.19	2.40	1.98	2.190			391.7	129												
C_3H_8 44.094		0.12	0.39	0.170	BLEED 5.02	9.8	20.16	0.9396	1061	1.1361	2.798	WATER								
C_4H_8 56.104	1.34	1.63	1.41	1.460	NATURAL GAS		403.6	211	15560		41.054		7'7	401.69	82	0.9972	400.57	10.3 8.311	3329.1	135.94
C_4H_{10} 58.120	0.53	0.43	0.68	0.547	28.43	8.67	20.45	0.8803	5400	1.217	14.248		5'2	275.11	80	0.9976	274.45	10.2 8.317	2282.6	16.364
C_5H_{10} 70.130	0.57	0.81	0.73	0.703			416.4	79												
C_6H_{12} 72.146	0.14	0.10	0.17	0.137	OXYGEN 27.07	7.26	20.76	0.9822	4007	1.000	10.573		5'3	296.94	80	0.9976	296.23		2462.0	
C_6H_{12} 84.156	0.12	0.19	0.25	0.180			34.5						0'5	13.28	90	0.9970	13.24		110.0	
			M. W.	22.35088	STEAM 215.7	5.77	0.3079		383.2#/hr								409.11		3398.5	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 D
HOURS 69-79

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED								
					At. Wt. Balance							CONDENSATE				POLYMER				%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	36.383	14.890	417.07	13.343	1.875	52.53	5.484	20.314	7.299	-13.015	364.54					Distribution of					
H_2 2.016	60.164	24.623	49.64	39.850	5.600	11.29	16.198	40.821	21.798	-19.023	38.35					Recovered Oil					
CO_2 44.010	2.593	1.061	46.70	27.593	3.877	170.62	11.216	12.277	15.093	2.816	123.92	8.275				400 ₹				0.582	
N_2 28.016	0.800	0.327	9.16	3.727	0.524	14.68	1.515	1.842	2.039							400-550				0.152	
CH_4 16.042	0.060	0.025	0.40	6.297	0.884	14.20	2.560	2.585	3.444	0.859	13.80	0.922				550+				0.083	
C_2H_6 28.052				2.390	0.336	9.43	0.971	0.971	1.307	0.336	9.43	0.630									72.3
C_3H_8 30.068				0.917	0.128	3.86	0.375	0.373	0.501	0.128	3.86	0.254									
C_4+C_5											27.04	1.806									
C_3H_6 42.079				2.460	0.346	14.56	1.000	1.000	1.346	0.346	14.56	0.972	4.32	3.370	0.225	13.10	0.875	6.25	2.096	0.140	85.3
C_3H_8 44.094				0.423	0.059	2.61	0.172	0.172	0.231	0.059	2.61	0.174	4.24	0.616	0.041						
C_4H_8 56.104				1.526	0.214	12.03	0.620	0.620	0.834	0.214	12.03	0.803	5.00	2.406	0.161	11.43	0.763	6.10	1.874	0.125	73.3
C_4H_{10} 58.120				0.557	0.078	4.55	0.226	0.226	0.304	0.078	4.55	0.304	4.86	0.936	0.063	4.55	0.304	4.86	0.936	0.063	
C_5H_{10} 70.130				0.677	0.095	6.66	0.275	0.275	0.370	0.095	6.66	0.445	5.45	1.222	0.082	6.66	0.445	5.45	1.222	0.082	87.5
C_5H_{12} 72.146				0.097	0.013	0.97	0.039	0.039	0.052	0.013	0.97	0.065	5.25	0.185	0.012	0.97	0.065	5.25	0.185	0.012	
C_6H_{14} 94.186				0.143	0.020	1.69	0.058	0.058	0.078	0.020	1.69	0.113	5.54	0.305	0.020	1.69	0.113	5.54	0.305	0.020	
C_5-C_8											43.07	2.876		9.040	0.604	38.40	2.564		6.618	0.442	
TOTAL		40.926	522.97		14.052	319.67	40.647	81.573													
H_2+CO		39.513	14,975 S.C.F.H.		7.475		21.622	61.135	29.097	32.038											
H_2/CO		1.65	66776		2.99		2.99	2.01	2.99	1.46											

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

EFFLUENT								
	RECOVERED OIL				80.27	5.360		12.233	0.817	80.27	5.360		12.233	0.817	
SHIFT RATIO	TOTAL OIL				123.34	8.236		21.273	1.421	118.67	7.924		18.851	1.259	
	WATER SOLUBLE CHEMICALS				9.60	0.641	8.11	1.184	0.079	9.60	0.641		1.184	0.079	
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.2	TOTAL LIQUID PRODUCTS C_5+				132.94	8.877		22.457	1.500	128.27	8.565		20.035	1.338	
	NET WATER				113.43	7.574	8.328	13.620	0.909						
	GROSS WATER				123.03	8.215		14.804							
	HYDROCARBON TOTAL—C_1+				159.96	10.683									

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

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

OPERATING CONDITIONS

PRESSURES PSIG	
Oxygen	419
Natural Gas	405
Generator Outlet	397
Reactor Inlet	384
Condenser Inlet	
Product Accumulator	363

TEMPERATURES—°F.	
Oxygen	458
Natural Gas	671
Generator	2375
Quench Accumulator	
Reactor Inlet	314
Condenser Inlet	
Product Accumulator	72

Catalyst No.	Height "	
1	12.0	648
2	43.2	648
3	74.4	681
4	105.6	
5	136.8	664
6	168.0	
7	199.2	665
8	230.4	
9	261.6	
10	292.8	
12	342.0	633

RATES S.C.F.H.	
Fresh Feed	15511
Recycle	15405
Combined Feed	30916
Wet Gas—Measured	4768
Adjusted	5325
Loss	577
Recycle/Fresh Feed	0.993
Inlet Velocity—ft./sec.	1.021
Fresh Feed Rate—S.C.F.H.	14975
per Cu. Ft. Dense Bed	1120
per Lb. Catalyst	8.28

Heat Transfer Calculations

Steam Rate = 364.1 #/hr @ 845.2 psia & 524°F
= 1195 BTU/#
Water in @ 186°F = 153 BTU/#
Heat Transferred/lb. steam
= 1042 BTU
(1042)(364.1) = 379400 BTU/hr
Ave. Bed Temperature
= 661°F
dT = 661-524 = 137°F
Tube Area = 31.1 ft²
$K = \frac{379400}{(137)(31.1)} = 89.1$

PRODUCT TESTS

	OIL	WATER
°API	48.8	10.4
Neut. No.	45.3	41.7
Sap. No.	51.9	44.4
Hydrox. No.		
Bromine No.	84.7	
Pour °F.		
Chemicals, % by K_2CO_3		8.0

HEMPEL, DIST. %		°API
205 °F.		
400	71.3	55.4
400-550	18.6	36.0
550+	10.1	

A. S. T. M. DIST. ON	
Naphtha °F.	
IBP	106
10%	144
50%	240
90%	361
EP	410
	98.0

CATALYST DATA

INVENTORY DATA	
In Reactor at Start of Period	2197
Fresh Catalyst Added 68=	103*
Total	2300
Catalyst Recovered	33
In Reactor at End of Period	2267

REACTOR d-p, Inches H_2O		
No.	Height "	
1	12 - 43.2	60
2	43.2 - 74.4	66
3	74.4 - 105.6	75
4	105.6 - 342.0	300
(Calc)	0-12"	26
	total	527

CALCULATED FROM dp

Density, Lbs./Cu.Ft.	134
Inventory, Lbs.	1809
Bed Depth, Ft.	20.25
Volume, Cu Ft	13.37

* At 66% Fe

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

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	148
Settled	150
Compacted	163
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	6.77
N_2 Surface, m^2/gm.	

CHEMICAL ANALYSIS	
Fe	66.1
C	
O	
H	
K_2O, W+, % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	30
Fe_3O_4	65
Fe	5

GAS ANALYSES

HOUR				AVERAGE
FRESH FEED				
CO 28.010	36.79	36.31	36.05	36.383
H_2 2.016	59.85	60.04	60.60	60.164
CO_2 44.010	2.73	2.67	2.38	2.593
N_2 28.016	0.59	0.92	0.89	0.800
CH_4 16.042	0.04	0.06	0.08	0.060
			M. W.	12.7787
			H_2O 18.016	
			BALANCE	
WET GAS				
CO 28.010	12.69	12.89	14.45	13.343
H_2 2.016	42.72	41.66	35.17	39.850
CO_2 44.010	26.47	27.91	28.40	27.593
N_2 28.016	2.21	2.39	6.58	3.727
CH_4 16.042	6.97	5.71	6.21	6.297
C_2H_6 28.052	2.27	2.38	2.52	2.390
C_3H_8 33.068	0.96	0.88	0.91	0.917
C_3H_6 42.078	2.37	2.56	2.45	2.460
C_3H_8 44.094	0.49	0.39	0.39	0.423
C_4H_8 56.104	1.41	1.70	1.47	1.526
C_4H_{10} 58.120	0.57	0.51	0.59	0.557
C_5H_{10} 70.130	0.63	0.76	0.64	0.677
C_5H_{12} 72.146	0.08	0.10	0.11	0.097
C_6H_{14} 86.166	0.16	0.16	0.11	0.143
			M. W.	23.7515

GENERATOR BALANCE

	Mol %	M/Hr	C	H	O
O_2 32.000	0.57	10.707			21.576
		0.081			
CO 28.010					
H_2 2.016					
CO_2 44.010	2.30	0.325	0.325		0.650
N_2 28.016	3.08	0.436			
CH_4 16.042	81.39	11.510	11.510	46.040	
C_2H_6 30.068	8.65	1.223	2.446	7.338	
C_3H_8 44.094	3.66	0.517	1.551	4.136	
C_4H_{10} 58.120	0.33	0.047	0.188	0.470	
C_5H_{12} 72.146	0.02	0.003	0.015	0.056	
TOTAL			16.035	58.020	22.226

WEIGHT BALANCE

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

GAS FLOW RATES

		VP	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED			383.5	61			
	79.31	6.64	19.96	0.9804	15511	1.5052	40.926
WET GAS			1.82	72			
	158.44	6.64	4.064	0.9887	4768	1.1280	12.581
RECYCLE			395.2	130			
	79.31	8.46	20.20	0.9388	14353	1.1280	37.870
BLEED			395.2	130			
	5.02	9.8	20.20	0.9388	1052	1.1280	2.777
NATURAL GAS			404.7	209	15405		40.647
	28.45	8.58	20.48	0.8816	5360	1.217	14.142
OXYGEN			419.4	80			
	27.07	7.33	20.84	0.9815	4058		10.707
STEAM			33.3				
	215.7	5.56	0.3042		364.1#/hr		

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'6	397.32	66	0.9970	396.13	48.8	2588.3	80.265
	7'0	371.14	65	0.9975	370.21	6.554	2412.3	12.233
	4'5 1/2	238.01	66	0.9970	237.30	49.3	1550.5	
	0'4 1/2	19.92	74	0.9930	19.78	6.516	129.2	
					41.22		48.0	
					244.66		1605.3	
WATER	6'11	296.24	80	0.9976	296.23	10.3	2462.0	123.03
	5'7	244.56	80	0.9976	243.97	8.311	2026.2	14.804
	5'11	268.02	78	0.9979	267.47	10.4	2171.5	
	0'4	17.70	80	0.9976	17.66	8.305	146.7	
					296.07		2460.8	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 E
HOURS 79-104

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED								
					At. Wt. Balance							CONDENSATE				POLYMER				%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	36.233	14.565	407.97	11.327	1.505	42.16	4.562	19.127	6.067	-13.060	365.81					Distribution of					
H_2 2.016	59.764	24.024	48.43	40.757	5.416	10.92	16.414	40.438	21.830	-18.608	37.51					Recovered Oil					
CO_2 44.010	2.853	1.147	50.48	30.140	4.005	176.26	12.138	13.285	16.143	2.858	125.78	8.600				400 EP			0.520		
N_2 28.016	1.063	0.427	11.96	1.413	0.188	5.27	0.569	0.996	0.757							400-550			0.094		
CH_4 16.042	0.087	0.035	0.56	7.087	0.942	15.11	2.854	2.889	3.796	0.907	14.55	0.995				550+			0.096		
C_2H_6 28.052				2.473	0.329	9.23	0.996	0.996	1.325	2.473	9.23	0.631									71.8
C_3H_8 30.068				0.970	0.129	3.88	0.391	0.391	0.520	0.970	3.88	0.265									
C_1+C_2											27.66	1.891									
C_2H_2 42.078				2.487	0.330	13.89	1.002	1.002	1.332	2.487	13.89	0.950	4.32	5.215	0.220	12.50	0.855	6.25	2.000	0.137	83.5
C_3H_8 44.094				0.490	0.065	2.87	0.197	0.197	0.262	0.490	2.87	0.196	4.24	0.677	0.046						
C_4H_8 56.104				1.517	0.202	11.33	0.611	0.611	0.813	1.517	11.33	0.775	5.00	2.266	0.155	10.76	0.736	6.10	1.764	0.121	79.0
C_4H_{10} 58.120				0.423	0.056	3.25	0.170	0.170	0.226	0.423	3.25	0.222	4.86	0.669	0.046	3.25	0.222	4.86	0.669	0.046	
C_5H_{10} 70.130				0.663	0.088	6.17	0.267	0.267	0.355	0.663	6.17	0.422	5.45	1.132	0.077	6.17	0.422	5.45	1.132	0.077	87.7
C_5H_{12} 72.146				0.093	0.012	0.87	0.037	0.037	0.049	0.093	0.87	0.059	5.28	0.166	0.011	0.87	0.059	5.28	0.166	0.011	
C_6H_{12} 84.156				0.160	0.021	1.77	0.064	0.064	0.085	0.160	1.77	0.121	5.54	0.318	0.022	1.77	0.121	5.54	0.318	0.022	
C_7-C_8											40.15	2.745		8.444	0.577	35.32	2.415		6.050	0.414	
TOTAL		40.198			13.288		40.272	80.400													
H_2+CO		38.589	14,325 S.C.F.H.		6.921		20.976	59.565	27.897	31.668											
H_2/CO		1.65	68375		3.60		3.60	2.11	3.60												

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

EFFLUENT							
	RECOVERED OIL			67.39	4.608	10.381	0.710
SHIFT RATIO	TOTAL OIL			107.54	7.355	18.825	1.287
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.8	WATER SOLUBLE CHEMICALS			14.37	0.9838.00	1.796	0.123
	TOTAL LIQUID PRODUCTS C_4+			121.91	8.336	20.621	1.410
	NET WATER			7.473	134.64	9.2068.328	16.167	1.105
	GROSS WATER				149.01	10.189	17.963	1.228
	HYDROCARBON TOTAL—C_1+				149.57	10.227		

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3+/C_1+
66.94	89.67	77.46	82.06	68.28	46.02	53.17	81.51

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

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

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

CATALYST DATA				
INVENTORY DATA		PARTICLE SIZE		
		Screen Analysis		Sedimentation
In Reactor at Start of Period	2267	Mesh	Microns	%	Microns	%
Fresh Catalyst Added 108=	164	On 40	419+	15.5	80+	
Total	2431	100	150	64.4	40—80	
Catalyst Recovered	143	150	105	9.7	20—40	
In Reactor at End of Period	2288	200	74	5.8	10—20	
		250	62	1.4	0—20	
REACTOR d-p, Inches H_2O		325	44	1.0		
No. Height "		<325		2.2		
1 12 - 43.2	65	CATALYST				
2 43.2 - 74.4	73	Bulk Density, Lbs./Cu.Ft.		
3 74.4 - 105.6	68	Aerated		147
4 105.6 - 342.0	310	Settled		149
(Calc) 0-12"	26	Compacted		165
total	542	Particle Density, gm./cc.		4.4
CALCULATED FROM dp		NH_3 Value, ml./gm.		21.00
Density, Lbs./Cu.Ft.	137	N_2 Surface, m^2/gm.		
Inventory, Lbs.	1860			
Bed Depth, Ft.	20.36	CHEMICAL ANALYSIS		
Volume, Cu Ft	13.44	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				AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		#/hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.48	10.500 0.067			21.134	WET GAS	287.58	303.01
CO 28.010	36.19	36.37	36.14	36.233	14.565	14.565		14.565	CO 28.010						OIL	67.39	67.39
H_2 2.016	59.99	59.85	59.45	59.764	24.024		48.048		H_2 2.016						WATER	149.01	149.01
CO_2 44.010	2.69	3.00	2.87	2.853	1.147	1.147		2.294	CO_2 44.010	2.02	0.281	0.281		0.562	TOTAL	503.98	519.41
N_2 28.016	0.99	0.72	1.48	1.063	0.427				N_2 28.016	2.55	0.355				FRESH FEED	519.41	
CH_4 16.042	0.14	0.06	0.06	0.087	0.035	0.035	0.140		CH_4 16.042	80.90	11.263	11.263	45.052		WEIGHT BALANCE	97.03	
			M. W.	12.96108					C_2H_6 30.068	8.49	1.182	2.364	7.092				
			H_2O 18.016				9.962	4.981	C_3H_8 44.094	5.27	0.734	2.202	5.872		WET GAS FACTOR		1.0536546
						15.747	58.150	21.840	C_4H_{10} 58.120	0.25 0.04	0.035 0.006	0.140 0.036	0.350 0.072		INDICATED LOSS—S C F H		256
			BALANCE			96.69	99.51	100.66	TOTAL				16.286	58.458 21.696			

WET GAS					GAS FLOW RATES							LIQUID PRODUCT 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	10.85	10.85	12.28	11.327			372.9	78				OIL								
H_2 2.016	40.52	40.80	40.95	40.757	FRESH FEED								7'8 1/2	406.15	74	0.9930	405.29	49.4	2659.2	67.39
CO_2 44.010	30.07	30.60	29.75	30.140	79.31	6.63	19.69	0.9831	15235	1.4968	40.198		4'5 1/2	238.01	66	0.9970	237.30	48.8	1550.5	10.381
N_2 28.016	0.14	1.86	2.24	1.413			170	71					1'11½	102.89	62	0.9990	102.79		669.4	
CH_4 16.042	8.74	6.56	5.96	7.087	WET GAS															
C_2H_6 28.052	2.53	2.48	2.41	2.473	158.44	6.68	4.050	0.9896	4780	1.1268	12.611		0'2 3/4	12.17	60	1.000	12.17		79.3	
C_3H_8 33.068	1.08	0.91	0.92	0.970	RECYCLE		383.9	127									0.92 259.53		1684.8	
C_2H_2 42.078	2.57	2.48	2.41	2.487	79.51	8.49	19.95	0.9412	14254	1.1268	37.608									
C_3H_8 44.094	0.56	0.45	0.46	0.490	BLEED		383.9	127												
C_4H_8 56.104	1.56	1.59	1.40	1.517	5.02	9.50	19.96	0.9412	1010	1.1268	2.664	WATER								
C_4H_{10} 58.120	0.44	0.45	0.38	0.423	NATURAL GAS		394.7	207	15264		40.272		7'6	397.32	77	0.9980	396.53	10.5	3890.8	149.01
C_5H_{10} 70.130	0.68	0.70	0.61	0.663	28.43	8.59	20.23	0.9830	5276	1.2096	13.922		6'11	262.02	78	0.9979	261.47	10.3	2171.6	17.96
C_5H_{12} 72.146	0.10	0.10	0.08	0.093	OXYGEN		407.5	77					6'11	366.77	80	0.9976	365.89		3036.5	
C_6H_{12} 84.156	0.16	0.17	0.15	0.160	27.07	7.27	20.55	0.9840	3990		10.500		1'0	52.00	80	0.9976	51.88		430.6	
			M. W.	22.80286	STEAM		31.9										449.07		3725.2	
					215.7	5.77	0.2989		372.0#/hr											

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 F

HOURS 104-128

40

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS At. Wt. Balance m/hr	WET GAS At. Wt. Balance #/hr	RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.847	15.053	421.63	12.180	1.809	50.67	4.946	19.999	6.755	-13.244	370.96					Distribution of					
H_2 2.016	59.507	24.310	49.01	44.590	6.668	13.44	13.228	42.538	24.896	-17.642	35.57					Recovered Oil					
CO_2 44.010	2.620	1.070	47.09	26.657	3.959	174.24	10.824	11.894	14.783	2.889	127.14	8.522					400 EP			0.527	
N_2 28.016	0.943	0.385	10.79	2.380	0.354	9.92	0.966	1.351	1.320								400-550			0.135	
CH_4 16.042	0.083	0.034	0.55	5.723	0.850	13.64	2.324	2.358	3.174	0.816	13.09	0.877					550+			0.064	
C_2H_4 28.052				2.087	0.310	8.70	0.847	0.847	1.157	0.310	8.70	0.583									72.5
C_2H_6 30.068				0.793	0.118	3.55	0.322	0.322	0.440	0.118	3.55	0.238									
C_1+C_2											25.34	1.698									
C_3H_6 42.078				2.077	0.308	12.96	0.843	0.843	1.151	0.308	12.96	0.869	4.32	3.000	0.201	11.66	0.782	6.25	1.866	0.125	86.9
C_3H_8 44.094				0.313	0.046	2.03	0.127	0.127	0.173	0.046	2.03	0.136	4.24	0.479	0.032						
C_4H_8 56.104				1.390	0.206	11.56	0.564	0.564	0.770	0.206	11.56	0.775	5.00	2.312	0.155	10.98	0.736	6.10	1.800	0.121	71.2
C_4H_{10} 58.120				0.563	0.084	4.88	0.229	0.229	0.313	0.084	4.88	0.327	4.86	1.004	0.067	4.88	0.327	4.86	1.004	0.067	
C_5H_{10} 70.130				0.663	0.099	6.94	0.269	0.269	0.368	0.099	6.94	0.465	5.45	1.273	0.085	6.94	0.465	5.45	1.273	0.085	83.9
C_5H_{12} 72.146				0.127	0.019	1.37	0.052	0.052	0.071	0.019	1.37	0.092	5.25	0.261	0.017	1.37	0.092	5.25	0.261	0.017	
C_6H_{12} 84.156				0.157	0.023	1.94	0.064	0.064	0.087	0.023	1.94	0.130	5.54	0.350	0.024	1.94	0.130	5.54	0.350	0.024	
C_3-C_6											41.68	2.794		8.679	0.582	37.77	2.532		6.554	0.439	
TOTAL		40.852			14.853		40.606	81.458													
H_2+CO		39.363	14,919 S.C.F.H.		8.477		23.174	62.537	31.651	30.886											
H_2/CO		1.615	670305		3.686		3.686	2.127	3.686	1.332											

CUMULATIVE TOTALS

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

EFFLUENT		NET CHANGE m/hr	NET CHANGE #/hr	CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF
EFFLUENT	RECOVERED OIL	0.513	71.95	4.823		10.837	0.726	71.95	4.823		10.837	0.726
SHIFT RATIO	TOTAL OIL		113.63	7.617		19.516	1.308	109.72	7.355		17.391	1.166
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.7	WATER SOLUBLE CHEMICALS		13.51	0.906	7.92	1.705	0.114	13.51	0.906		1.705	0.114
	TOTAL LIQUID PRODUCTS C_3+		127.14	8.522		21.221	1.422	123.23	8.261		19.096	1.280
SELECTIVITY	NET WATER	7.092	127.77	8.564	8.328	15.342	1.028					
C_3+/C_1+	GROSS WATER		141.28	9.470		17.047	1.143					
83.38	HYDROCARBON TOTAL—C_1+		152.48	10.221								

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

g/M3 = 16.91 × #/MCF.

cc/M3 = 141.3 × gal/MCF.

OPERATING CONDITIONS

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

PRODUCT TESTS

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

CATALYST DATA

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

PARTICLE SIZE

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

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

GAS ANALYSES / GENERATOR BALANCE

HOUR				AVERAGE	M/HR	C	H	O
FRESH FEED					15.053	15.053		15.053
CO 28.010	36.95	36.62	36.97	36.847	24.310		48.620	
H_2 2.016	59.41	59.76	59.35	59.507	1.070	1.070		2.140
CO_2 44.010	2.64	2.56	2.66	2.620	0.385			
N_2 28.016	0.84	1.00	0.99	0.943	0.034	0.034	0.136	
CH_4 16.042	0.16	0.05	0.04	0.083				
			M. W.	12.95107				
			H_2O 18.016				10.424	5.212
						16.157	59.180	22.405
			BALANCE			97.88	99.41	100.80

GENERATOR BALANCE

	Mol %	M/Hr	C	H	O
O_2 32.000	0.47	10.325 0.066			20.782
CO 28.010					
H_2 2.016					
CO_2 44.010	1.58	0.223	0.223		0.446
N_2 28.016	2.31	0.326			
CH_4 16.042	81.60	11.508	11.508	46.032	
C_2H_6 30.068	8.42	1.187	2.374	7.122	
C_3H_8 44.094	5.49	0.774	2.322	6.192	
C_4H_{10} 58.120	0.10 0.03	0.014 0.004	0.056 0.024	0.140 0.048	
TOTAL			16.507	59.534	22.228

WEIGHT BALANCE

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

WET GAS

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

GAS FLOW RATES

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

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR / GAL HR
OIL								
	6'10	362.41	68	0.9961	361.00	49.4	2350.8	71.95
	1'11½	102.89	62	0.9990	102.79	6.512	669.4	10.837
					+1.46 254.67		+49.5 1690.9	
WATER								
	7'4	388.59	80	0.9976	387.66	10.6	3214.9	141.28
	6'11	366.77	80	0.9976	365.89	8.293	3036.5	17.047
	7'6	397.32	78	0.9979	396.49	10.8	3288.1	
	0'4	17.70	80	0.9976	17.66	8.299	146.5	
					400.60		3320.0	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 a
HOURS 128-152

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS At. Wt. Balance m/hr	WET GAS At. Wt. Balance #/hr	RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr	YIELD BASIS H_2+CO FED: CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	CONDENSATE gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.123	14.858	416.17	12.843	1.854	51.93	5.720	20.578	6.974	-13.004	364.24					Distribution of					
H_2 2.016	60.107	24.724	49.84	44.174	6.477	13.06	17.888	42.612	24.365	-18.247	36.79					Recovered Oil					
CO_2 44.010	2.513	1.034	45.51	26.233	3.846	169.26	10.623	11.657	14.469	2.812	123.76	8.250				400 EP				0.524	
N_2 28.016	0.807	0.332	9.30	1.930	0.283	7.93	0.782	1.114	1.065							400-550				0.137	
CH_4 16.042	0.450	0.185	2.97	6.617	0.970	15.56	2.679	2.864	3.649	0.785	12.59	0.839				550+				0.074	
C_2H_4 28.052				2.173	0.319	8.95	0.880	0.880	1.199	0.319	8.95	0.597									73.6
C_2H_2 30.068				0.780	0.114	3.43	0.316	0.316	0.430	0.114	3.43	0.229									
C_1+C_2											24.97	1.664									
C_3H_6 42.078				2.090	0.306	12.88	0.846	0.846	1.152	0.306	12.88	0.859	4.32	2.981	0.199	11.59	0.773	6.25	1.854	0.124	88.1
C_3H_8 44.094				0.283	0.041	1.81	0.114	0.114	0.155	0.041	1.81	0.121	4.24	0.427	0.028						
C_4H_8 56.104				1.493	0.219	12.29	0.604	0.604	0.823	0.219	12.29	0.819	5.00	2.458	0.164	11.68	0.779	6.10	1.915	0.128	75.8
C_4H_{10} 58.120				0.477	0.070	4.07	0.193	0.193	0.263	0.070	4.07	0.271	4.86	0.837	0.056	4.07	0.271	4.86	0.837	0.056	
C_5H_{10} 70.130				0.747	0.110	7.71	0.302	0.302	0.412	0.110	7.71	0.514	5.48	1.415	0.094	7.71	0.514	5.48	1.415	0.094	83.9
C_5H_{12} 72.146				0.143	0.021	1.52	0.058	0.058	0.079	0.021	1.52	0.101	5.25	0.290	0.019	1.52	0.101	5.25	0.290	0.019	
C_6H_{12} 84.156				0.217	0.032	2.69	0.088	0.088	0.120	0.032	2.69	0.179	5.54	0.486	0.032	2.69	0.179	5.54	0.486	0.032	
C_5-C_6											42.97	2.864		8.894	0.593	39.26	2.617		6.797	0.453	
TOTAL		41.134			14.662		40.494	81.628													
H_2+CO		39.582	15,002 S.C.F.H.		8.331		23.008	62.590	31.339	31.251											
H_2/CO		1.664	666596		3.494		3.494	2.133	3.494	1.403											

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

EFFLUENT	RECOVERED OIL	0.510	71.50
SHIFT RATIO	TOTAL OIL		114.47
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 7.2	WATER SOLUBLE CHEMICALS		13.40
	TOTAL LIQUID PRODUCTS C_3+		127.87
SELECTIVITY	WET WATER	6.985	125.84
	GROSS WATER		139.24
	HYDROCARBON TOTAL—C_1+		152.84

FRESH FEED CONVERSION — % Contraction	CO	H_2	H_2+CO
	64.36	87.52	73.80

TOTAL FEED CONVERSION — % CO	H_2	$CO+H_2$	C_3+/C_1+
78.95	66.11	42.821	49.93

83.67	10.188				8.388	8.328	15.111	1.007			
					9.282		16.790	1.119			

	4.766		11.022	0.735	71.50	4.766		11.022	0.735	
	7.631		19.916	1.328	110.76	7.383		17.819	1.188	
	0.893	7.981	1.679	0.112	13.40	0.893		1.679	0.112	
	8.524		21.595	1.440	124.16	8.276		19.498	1.300	

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

OPERATING CONDITIONS				PRODUCT TESTS	OIL	WATER	CATALYST DATA			PARTICLE SIZE			
PRESSURES PSIG		RATES S.C.F.H.					INVENTORY DATA			Screen Analysis			Sedimentation
Oxygen	396	Fresh Feed	15590	°API	50.1	10.6	In Reactor at Start of Period	2258		Mesh	Microns	%	Microns %
Natural Gas	383	Recycle	15348	Neut. No.	39.7	39.2	Fresh Catalyst Added 98#	148		On 40	419+	14.8	80+
Generator Outlet	373	Combined Feed	30938	Sap. No.	43.2	41.3	Total	2406		100	150	66.8	40—80
Reactor Inlet	360	Wet Gas—Measured	5284	Hydrox. No.			Catalyst Recovered	96		150	105	10.0	20—40
Condenser Inlet		Adjusted	5557	Bromine No.	85.3		In Reactor at End of Period	2390		200	74	4.8	10—20
Product Accumulator	337	Loss	273	Pour °F.						250	62	1.4	0—20
				Chemicals, % by K_2CO_3		10.0	REACTOR d-p, Inches H_2O			325	44	1.2	
							No. Height"			<325		1.0	
TEMPERATURES—°F.		Recycle/Fresh Feed	0.985				1 12 - 43.2	61		CATALYST			
Oxygen	429	Inlet Velocity—ft./sec.	1.090				2 43.2 - 74.4	60		Bulk Density, Lbs./Cu.Ft.			
Natural Gas	656	Fresh Feed Rate—S.C.F.H.	15002	HEMPEL, DIST. %		°API	3 74.4 - 105.6	69		Aerated			148
Generator		per Cu.Ft. Dense Bed	994	205 °F.			4 105.6 - 342.0	350		Settled			150
Quench Accumulator		per Lb. Catalyst	7.75	400	71.3	56.2	(Calc) 0-12"	24		Compacted			163
Reactor Inlet				400-550	18.6	36.7	total	564		Particle Density, gm./cc.			4.4
Condenser Inlet				550+	10.1					NH_3 Value, ml./gm.			8.29
Product Accumulator	70	Heat Transfer Calculations					CALCULATED FROM dp			N_2 Surface, m^2/gm.			
Catalyst No. Height"		Steam Rate = 302.8 #/hr		A. S. T. M. DIST. ON			Density, Lbs./Cu.Ft.	127					
1 12.0	737	@ 803 psia & 518°F		Naphtha °F.			Inventory, Lbs.	1936		CHEMICAL ANALYSIS			
2 43.2	630	= 1199 BTU/#		IBP	107		Bed Depth, Ft.	22.87		Fe			67.8
3 74.4	650	Water in @ 179°F = 137 BTU/#		10%	138		Volume, Cu Ft	15.09		C			
4 105.6		Heat Transferred/lb. steam		50%	234					O			
5 136.8	648	= 1060 BTU		90%	350					H			
6 168.0	645	(1060)(302.8) = 321000 BTU/hr		EP	399					K_2O, W+, % basis Fe			
7 199.2	639	Ave. Bed Temperature			97.5					X-Ray Analysis—			
8 230.4	634	= 662°F								$Fe_{20}C_9$			40a
9 261.6	626	dT = 662-518 = 144°F								Fe_3O_4			55
10 292.8	625	Tube Area = 30.9 ft^2								Fe			5
12 342.0	616	K = 321000 / (144)(30.9) = 72.3											

	GAS ANALYSES			AVERAGE	GENERATOR BALANCE M/HR	C	H	O		Mol %	M/Hr	C	H	O
HOUR														
FRESH FEED									O_2 32.000	0.40	10.186 0.056			20.484
CO 28.010	36.86	36.00	35.51	36.123	14.858	14.858		14.858	CO 28.010					
H_2 2.016	59.80	60.22	60.30	60.107	24.724		49.448		H_2 2.016					
CO_2 44.010	2.46	2.66	2.42	2.513	1.034	1.034		2.068	CO_2 44.010	1.87	0.263	0.263		0.526
N_2 28.016	0.68	1.05	0.69	0.807	0.332				N_2 28.016	2.29	0.322			
CH_4 16.042	0.20	0.07	1.08	0.450	0.185	0.185	0.740		CH_4 16.042	79.97	11.245	11.245	44.980	
			M. W.	12.73406					C_2H_2 30.068	9.81	1.379	2.758	8.274	
			H_2O 18.016				8.860	4.430	C_2H_4 44.052	5.27	0.741	2.223	5.928	
						16.077	59.048	21.356	C_3H_8 58.120	0.37	0.052	0.208	0.520	
			BALANCE			98.20	98.84	101.65	TOTAL	0.02	0.003	0.015	0.036	
												16.712	59.738	21.010

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

WET GAS					GAS FLOW RATES								LIQUID PRODUCT RATES							
CO 28.010	12.22	12.82	12.89	12.643		V/H	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	43.54	44.33	44.65	44.174			359.6	75				OIL								
CO_2 44.010	27.08	27.05	24.57	26.233	FRESH FEED	79.31	6.84	19.35	0.9850	15590	1.50779	41.134								
N_2 28.016	1.74	2.35	1.70	1.930				1.98	70				7'5	384.23	68	0.9961	382.73	50.1	2482.8	71.500
CH_4 16.042	6.27	5.46	8.12	6.617	WET GAS	158.44	7.07	4.09	0.9905	5284	1.1644	13.942	6'10	362.41	68	0.9961	361.00	6.487	2341.8	11.022
C_2H_4 28.052	2.18	2.12	2.22	2.173				383.4	123				4'9	253.29	66	0.9970	252.53		1638.2	
C_2H_2 33.068	0.81	0.76	0.77	0.780	RECYCLE	79.31	8.45	19.45	0.9444	14334	1.1644	37.820	0'5½	15.49	75	0.9928	14.98		97.2	
C_3H_6 42.078	2.22	1.97	2.08	2.090	BLEED												5.24		•34.0	
C_3H_8 44.094	0.40	0.27	0.18	0.283		5.02	9.44	19.45	0.9444	1014	1.1644	2.674	WATER				264.82		1716.0	
C_4H_8 56.104	1.67	1.38	1.43	1.493	NATURAL GAS			382.8	205	15348		40.494	7'0	371.14	80	0.9976	370.25	10.6	3070.5	139.24
C_4H_{10} 58.120	0.57	0.44	0.42	0.477		28.43	8.82	19.94	0.8843	5330	1.2054	14.062	0'4	17.70	80	0.9976	17.66	8.293	146.5	16.790
C_5H_{10} 70.130	0.86	0.69	0.69	0.747				395.92	75.42								352.59		2924.0	
C_5H_{12} 72.146	0.18	0.15	0.10	0.143	OXYGEN	27.07	7.14	20.26	0.9859	3861		10.186								
C_6H_{12} 84.156	0.26	0.21	0.18	0.217				31.4												
			M. W.	21.35204	STEAM	215.7	4.72	0.2974		302.8#/hr										

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 42 M
HOURS 162-176

FRESH FEED	%	m/hr	#/hr
CO 28.010	36.48	15.149	424.32
H_2 2.016	60.02	24.924	50.25
CO_2 44.010	2.62	1.088	47.88
N_2 28.016	0.63	0.262	7.34
CH_4 16.042	0.25	0.104	1.67
C_2H_4 28.052			
C_2H_6 30.068			
C_3+C_4			
C_5H_8 42.078			
C_6H_{12} 44.094			
C_6H_6 56.104			
C_6H_{10} 58.120			
C_6H_{10} 70.130			
C_6H_{12} 72.146			
C_6H_{12} 84.156			
C_7-C_8			
TOTAL		41.527	551.46
H_2+CO	96.50	40.073	15,192 S.C.F.H.
H_2/CO	1.645		65824

WET GAS	%	At. Wt. Balance m/hr	At. Wt. Balance #/hr
CO 28.010	13.42	1.978	55.43
H_2 2.016	43.26	6.379	12.86
CO_2 44.010	26.84	3.956	174.16
N_2 28.016	1.95	0.287	8.04
CH_4 16.042	6.16	0.908	14.59
C_2H_4 28.052	2.33	0.343	9.63
C_2H_6 30.068	0.77	0.114	3.43
C_3+C_4			27.65
C_5H_8 42.078	2.17	0.320	13.46
C_6H_{12} 44.094	0.42	0.062	2.73
C_6H_6 56.104	1.38	0.203	11.39
C_6H_{10} 58.120	0.39	0.057	3.31
C_6H_{10} 70.130	0.66	0.097	6.80
C_6H_{12} 72.146	0.10	0.015	1.08
C_6H_{12} 84.156	0.15	0.022	1.85
C_7-C_8			40.62
TOTAL		14.741	318.76
H_2+CO	96.50	8.357	68.29
H_2/CO	1.645	3.225	

RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr
5.449	20.598	7.427	-13.171	368.89
17.563	42.487	23.942	-18.545	37.39
10.897	11.985	14.853	2.868	126.28
0.792	1.054	1.079		
2.501	2.605	3.409	0.804	12.92
0.946	0.946	1.289	0.343	9.63
0.313	0.313	0.427	0.114	3.43
				25.98
0.881	0.881	1.201	0.320	13.46
0.171	0.171	0.233	0.062	2.73
0.560	0.560	0.763	0.203	11.39
0.158	0.158	0.215	0.057	3.31
0.268	0.268	0.365	0.097	6.80
0.041	0.041	0.056	0.015	1.08
0.061	0.061	0.083	0.022	1.85
				40.62
40.601	82.128			
	63.085	31.369	-31.716	
			1.408	

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

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

FRESH FEED CONVERSION — %	Contraction	CO	H_2	H_2+CO
	64.50	86.94	74.41	79.15

TOTAL FEED CONVERSION — %	CO	H_2	$CO+H_2$
	63.94	43.65	50.28

SELECTIVITY	C_3+/C_1+
	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.
RECOVERED OIL	0.509	71.27	4.691		10.968	0.722	71.27	4.691		10.968	0.722	
TOTAL OIL		111.89	7.365		19.475	1.282	107.24	7.059		17.149	1.129	
WATER SOLUBLE CHEMICALS		12.99	0.855	3.023	1.619	0.107	12.99	0.855		1.619	0.107	
TOTAL LIQUID PRODUCTS C_5+		124.88	8.220		21.094	1.388	120.23	7.914		18.768	1.236	
WET WATER	7.129	128.44	8.454	8.328	15.423	1.015						
GROSS WATER		141.43	9.309		17.042	1.122						
HYDROCARBON TOTAL—C_1+		150.86	9.930									

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

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	379	Fresh Feed	15745
Natural Gas	393	Recycle	15392
Generator Outlet	371	Combined Feed	31135
Reactor Inlet	358	Wet Gas—Measured	5313
Condenser Inlet		Adjusted	5588
Product Accumulator	335	Loss	275
TEMPERATURES—°F.		Recycle/Fresh Feed	0.978
Oxygen	449	Inlet Velocity—ft./sec.	1.102
Natural Gas	662	Fresh Feed Rate—S.C.F.H.	15192
Generator		per Cu. Ft. Dense Bed	1094
Quench Accumulator		per Lb. Catalyst	8.66
Reactor Inlet	286		
Condenser Inlet			
Product Accumulator	68		

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

Heat Transfer Calculations

Steam Rate = 343.9 #/hr
@ 603 psia & 518°F
= 1197 BTU/#
Water in @ 179°F
= 137 BTU/#
Heat Transferred/# steam
= 1060 BTU
(1060)(343.9)
= 364500 BTU/hr
Ave. Bed Temperature = 667°F
Δt = 667-518 F 149°F
Tube Area = 32.3 ft^2
$K = \frac{364500}{(149)(32.3)} = 75.9$

PRODUCT TESTS	OIL	WATER
°API	49.5	10.5
Neut. No.	38.6	38.1
Sap. No.	44.9	38.9
Hydrox. No.		
Bromine No.	88.0	
Pour °F.		
Chemicals, % by K_2CO_3		9.5

HEMPEL, DIST. %		°API
205 °F.		
400	72.0	55.6
400-550	17.0	36.8
550+	11.0	

A. S. T. M. DIST. ON	
Naphtha °F.	
IBP	104
10%	140
50%	235
90%	354
EP	402
	97.5

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

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

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	148
Settled	149
Compacted	165
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	15.76
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	1300	2100	0500	AVERAGE
HOUR				
FRESH FEED				
CO 28.010	36.12	36.79	36.52	36.48
H_2 2.016	60.13	60.05	59.89	60.02
CO_2 44.010	2.43	2.59	2.84	2.62
N_2 28.016	0.69	0.52	0.69	0.63
CH_4 16.042	0.64	0.05	0.07	0.25
			M. W.	12.798
			H_2O 18.016	
			BALANCE	
WET GAS				
CO 28.010	12.43	13.99	13.85	13.42
H_2 2.016	45.34	45.05	45.42	45.26
CO_2 44.010	26.25	27.31	26.96	26.84
N_2 28.016	1.87	1.85	2.15	1.95
CH_4 16.042	7.12	5.75	5.60	6.16
C_2H_4 28.052	2.63	2.17	2.18	2.33
C_2H_6 30.068	0.79	0.76	0.76	0.77
C_3H_8 42.078	2.27	2.08	2.16	2.17
C_6H_{12} 44.094	0.45	0.38	0.44	0.42
C_6H_6 56.104	1.47	1.35	1.37	1.38
C_6H_{10} 58.120	0.41	0.41	0.35	0.39
C_6H_{10} 70.130	0.72	0.66	0.59	0.66
C_6H_{12} 72.146	0.09	0.12	0.09	0.10
C_6H_{12} 84.156	0.16	0.16	0.14	0.15
			M. W.	21.683

GENERATOR BALANCE		M/HR	C	H	O
CO 28.010	36.48	15.149	15.149		15.149
H_2 2.016	60.02	24.924		49.848	
CO_2 44.010	2.62	1.088	1.088		2.176
N_2 28.016	0.63	0.262			
CH_4 16.042	0.25	0.104	0.104	0.416	
				9.144	4.572
		41.527	16.341	59.408	21.897
			96.26	97.11	104.20

	Mol %	M/Hr	C	H	O
O_2 32.000	0.30	10.186 0.043			20.458
CO 28.010					
H_2 2.016					
CO_2 44.010	1.60	0.228	0.228		0.556
N_2 28.016	1.20	0.171			
CH_4 16.042	82.36	11.762	11.762	47.048	
C_2H_4 30.068	8.90	1.271	2.542	7.626	
C_3H_8 44.094	5.46	0.780	2.340	6.240	
C_6H_{10} 58.120	0.18	0.026	0.104	0.260	
TOTAL			16.976	61.174	21.014

GAS FLOW RATES		$\sqrt{\Delta P}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
			357.583	73.79			
FRESH FEED		79.31	6.932	10.29457	0.9868	15745	1.5040	41.527
				1.990	68.45			
WET GAS		158.44	7.142	4.089	0.9924	5313	1.1571	14.015
				361.208	120.917			
RECYCLE		79.31	8.455	19.58912	0.9460	14364	1.1571	37.889
				361.208	120.917			
BLEED		5.02	9.647	19.58912	0.9460	1088	1.1571	2.718
				576.917	804.858	18592		40.601
NATURAL GAS		28.45	8.917	19.84054	0.8943	5414	1.2173	14.281
				398.875	73.583			
OXYGEN		27.07	7.358	20.18923	0.9868	3968		10.467
				32.5				
STEAM		215.7	5.30	0.5006		345.9#/hr		

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

LIQUID PRODUCT RATES	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7	4	388.59	78	0.9911	385.132			
	4	9	253.29	66	0.9970	252.530			
						132.602	50.1 6.487	860.19	
	2	8¾	146.17	62	0.9990	146.024			71.267
	3	½	15.49	72	0.9941	15.399			10.968
						130.525	49.5 6.509	850.24	
						263.227		1710.43	
WATER	7	1	375.50	76	0.99679	375.046	10.6		
	0	4	17.70	80	0.99759	17.657			
						357.389	8.995	2963.85	
	1	3¾	68.29	76	0.99679	68.307	10.5		
	0	3½	16.60	66	0.99948	16.590			
						51.617	8.340	430.49	141.43
						409.006		3394.38	17.048

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 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	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.
CO 28.010	36.580	15.212	426.09	13.757	2.168	60.73	5.687	20.899	7.855	-12.044	365.36					Distribution of					
H_2 2.016	59.540	24.760	49.92	43.489	6.854	13.82	17.977	42.737	24.831	-17.906	36.10					Recovered Oil					
CO_2 44.010	2.914	1.212	53.34	25.976	4.094	180.18	10.738	11.950	14.832	2.882	126.84	8.373				400 EP				0.317	
N_2 28.016	0.903	0.376	10.53	2.237	0.353	9.89	0.925	1.301	1.878							400-550				0.154	
CH_4 16.042	0.063	0.026	0.42	6.340	0.999	16.03	2.621	2.647	3.620	0.973	15.61	1.050				550+				0.071	
C_2H_4 28.052				2.260	0.356	9.99	0.934	0.934	1.290	0.356	9.99	0.659									73.9
C_2H_6 30.068				0.800	0.126	3.79	0.331	0.331	0.457	0.126	3.79	0.250									
C_1+C_2											29.32	1.959									
C_3H_6 42.078				2.090	0.329	13.84	0.864	0.864	1.193	0.329	13.84	0.914	4.32	3.204	0.211	12.46	0.822	6.28	1.994	0.132	64.5
C_3H_8 44.094				0.385	0.060	2.65	0.158	0.158	0.218	0.060	2.65	0.178	4.24	0.625	0.041						
C_4H_8 56.104				1.367	0.215	12.06	0.565	0.565	0.780	0.215	12.06	0.796	5.00	2.412	0.159	11.46	0.756	6.10	1.979	0.124	76.1
C_4H_{10} 58.120				0.430	0.068	3.95	0.178	0.178	0.246	0.068	3.95	0.261	4.86	0.815	0.054	3.95	0.261	4.86	0.815	0.054	
C_5H_{10} 70.130				0.617	0.097	6.80	0.255	0.255	0.352	0.097	6.80	0.449	5.45	1.248	0.082	6.80	0.449	5.45	1.248	0.082	84.1
C_6H_{12} 72.146				0.117	0.019	1.37	0.048	0.048	0.067	0.019	1.37	0.090	5.23	0.261	0.017	1.37	0.090	5.23	0.261	0.017	
C_6H_{12} 84.156				0.137	0.022	1.85	0.057	0.057	0.079	0.022	1.85	0.122	5.54	0.334	0.022	1.85	0.122	5.54	0.334	0.022	
C_3-C_6											42.52	2.807		8.897	0.587	37.89	2.501		6.529	0.431	
TOTAL		41.545	539.75		15.761	336.95	41.338	82.883													
H_2+CO		39.972	15,149 S.C.F.H.		9.022		33.664	63.636	32.686	30.950											
H_2/CO		1.63	66009		3.16			2.04		1.37											

CUMULATIVE TOTALS

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

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

EFFLUENT							
RECOVERED OIL	0.507	71.12	4.695		10.883	0.718	71.12
TOTAL OIL		113.64	7.501		19.780	1.306	109.01
WATER SOLUBLE CHEMICALS		12.60	0.832	8.39	1.501	0.099	12.60
TOTAL LIQUID PRODUCTS C_5+		126.24	8.333		21.281	1.405	121.61
WET WATER	6.610	119.08	7.860	8.32	14.299	0.944	
GROSS WATER		131.68	8.692		15.800	1.043	
HYDROCARBON TOTAL—C_1+		155.63	10.273				

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

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

OPERATING CONDITIONS		RATES S.C.F.H.	
PRESSURES PSIG			
Oxygen	416	Fresh Feed	15761
Natural Gas	402	Recycle	15667
Generator Outlet	387	Combined Feed	31428
Reactor Inlet	372	Wet Gas—Measured	5404
Condenser Inlet		Adjusted	5973
Product Accumulator	352	Loss	569
		Recycle/Fresh Feed	0.994
TEMPERATURES—°F.		Inlet Velocity—ft./sec.	1.072
Oxygen	449	Fresh Feed Rate—S.C.F.H.	15149
Natural Gas	670	per Cu.Ft. Dense Bed	1122
Generator		per Lb. Catalyst	9.18
Quench Accumulator	170		
Reactor Inlet	290		
Condenser Inlet			
Product Accumulator	69		

Catalyst No.	Height "
1	12.0
2	43.2
3	74.4
4	105.6
5	136.8
6	168.0
7	199.2
8	230.4
9	261.6
10	292.8
12	342.0

Heat Transfer Calculations

Steam Rate = 352.1 #/hr @ 819 psia & 521°F

= 1196 BTU/#

Water in @ 175°F = 143 BTU/#

Heat Transferred/lb. steam = 1053 BTU

(1053)(352.1) = 370760 BTU/hr

Ave. Bed Temperature = 679°F

dT = 679-521 = 158°F

Tube Area = 31.2 ft^2

K = 370760 / (158)(31.2) = 75.1

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

CATALYST DATA — INVENTORY DATA	
In Reactor at Start of Period	2229
Fresh Catalyst Added	
Total	
Catalyst Recovered	217
In Reactor at End of Period	2012
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	61
2 43.2 - 74.4	56
3 74.4 - 105.6	64
4 105.6 - 342.0	275
(Calc) 0-12"	23
total	481
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	122
Inventory, Lbs.	1651
Bed Depth, Ft.	20.5
Volume, Cu Ft	13.5

PARTICLE SIZE — Screen Analysis			Sedimentation	
Mesh	Microns	%	Microns	%
On 40	419+	14.9	80+	
100	150	55.6	40—80	
150	105	10.5	20—40	
200	74	4.8	10—20	
250	62	1.8	0—20	
325	44	1.4		
<325		1.6		

CATALYST

Bulk Density, Lbs./Cu.Ft.	
Aerated	134
Settled	136
Compacted	147
Particle Density, gm./cc.	4.1
NH_3 Value, ml./gm.	8.63
N_2 Surface, m^2/gm.	<1

CHEMICAL ANALYSIS

Fe	66.6
C	8.17
O	
H	0.51
K_2O, W+, % basis Fe	
X-Ray Analysis—	
$Fe_{2.2}C_3$	40[a]
Fe_3O_4	55
Fe	5

GAS ANALYSES — HOUR	1300	2100	0500	AVERAGE
FRESH FEED				
CO 28.010	36.65	36.58	36.51	36.580
H_2 2.016	59.69	59.15	59.78	59.540
CO_2 44.010	2.69	3.24	2.81	2.914
N_2 28.016	0.88	0.99	0.84	0.903
CH_4 16.042	0.09	0.04	0.06	0.063
			M. W.	12.99195
			H_2O 18.016	
			BALANCE	
WET GAS	1300	2100	0500	
CO 28.010	13.66	13.80	13.81	13.757
H_2 2.016	44.39	43.10	42.98	43.489
CO_2 44.010	25.77	26.25	25.91	25.976
N_2 28.016	2.10	2.44	2.17	2.257
CH_4 16.042	6.00	6.04	6.98	6.340
C_2H_4 28.052	2.23	2.24	2.31	2.260
C_2H_6 30.068	0.76	0.79	0.85	0.800
C_3H_6 42.078	2.15	2.20	1.98	2.090
C_3H_8 44.094	0.35	0.38	0.42	0.383
C_4H_8 56.104	1.40	1.45	1.25	1.367
C_4H_{10} 58.120	0.37	0.44	0.48	0.430
C_5H_{10} 70.130	0.60	0.65	0.60	0.617
C_5H_{12} 72.146	0.10	0.10	0.15	0.117
C_6H_{12} 84.156	0.12	0.12	0.17	0.137
			M. W.	21.37728

GENERATOR BALANCE		M/HR	C	H	O
FRESH FEED		15.212	15.212		15.212
CO 28.010		24.760		49.520	
H_2 2.016		1.212	1.212		2.424
CO_2 44.010		0.376			
N_2 28.016		0.026	0.026	0.104	
CH_4 16.042					
				10.278	5.139
		41.545	16.450	59.902	22.775
			97.47	97.94	102.84

	Mol %	M/Hr	C	H	O
O_2 32.000	0.45	10.721 0.066			21.594
CO 28.010					
H_2 2.016					
CO_2 44.010	1.88	0.276	0.276		0.552
N_2 28.016	2.53	0.372			
CH_4 16.042	82.24	12.083	12.083	48.332	
C_2H_4 30.068	8.19	1.203	2.406	7.218	
C_2H_6 44.094	4.53	0.666	1.998	5.328	
C_3H_6 56.110	0.14	0.021	0.084	0.210	
C_3H_8 58.126	0.04	0.006	0.030	0.072	
TOTAL			16.877	61.160	22.146

WEIGHT BALANCE	# hr Measured	At. Wt. Balance
WET GAS	304.83	336.95
OIL	71.12	71.12
WATER	131.68	131.68
TOTAL	507.63	539.75
FRESH FEED	539.75	539.75
WEIGHT BALANCE	94.05	
WET GAS FACTOR		1.10557
INDICATED LOSS—S C F H		569

GAS FLOW RATES		VFR	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
FRESH FEED		79.31	6.871	371.5 19.652 2.0	75 0.9859 69	15761	1.49275	41.585
WET GAS		158.44	7.233	4.087	0.9915	5404	1.1637	14.259
RECYCLE		79.31	8.458	378.7 1.983	124 0.9436	14607	1.1637	38.540
BLEED		5.02	9.7	378.7 1.983	124 0.9436	1080	1.1637	2.798
NATURAL GAS		28.45	8.900	402.0 20.413	206 0.8836	15667 5569	1.2808	41.538 14.693
OXYGEN		27.07	7.385	415.7 20.746	75 0.9877	4065		10.721
STEAM				33.0				
			215.7	5.42	0.2012		352.16/hr	

LIQUID PRODUCT RATES — HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL/HR
OIL	7'10½	372.25	67	0.9965	370.93	49.5	2414.4	
	2'8¾	146.17	62	0.9990	146.02	6.509	950.4	71.12
					824.91		1464.0	10.88
	1'1	56.30	64	0.9980	56.19	49.6	365.5	
	0'4½	19.92	60	1.000	19.92	6.505	129.6	
					56.27		47	
					261.18		1706.9	
WATER	7'4	388.59	81	0.9974	387.58		3216.5	
	1'3¾	68.29	76	0.99879	68.21	10.5	5661	131.14
						8.899		15,800
	1'6	78.16	68	0.9980	77.53	10.4	643.9	
	0'4	17.70	60	1.000	17.70	8.305	147.0	
					379.20		3147.3	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 42 J
HOURS 200-209

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS At. Wt. Balance m/hr	WET GAS At. Wt. Balance #/hr	RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr	YIELD BASIS H_2+CO FED: CONDENSATE #/MCF	CONDENSATE #/gal	CONDENSATE gal/hr	POLYMER gal/MCF	POLYMER #/hr	POLYMER #/MCF	POLYMER #/gal	POLYMER gal/hr	POLYMER gal/MCF	% Unsats.
CO 28.010	36.470	14.765		13.35																	
H_2 2.016	59.747	24.188		44.74																	
CO_2 44.010	2.890	1.170		26.04			MECHANICAL DIFFICULTIES CAUSED														
N_2 28.016	0.840	0.340		2.26			SEVERAL INTERRUPTIONS SO YIELD DATA														
CH_4 16.042	0.053	0.021		5.70			FROM THIS PERIOD ARE NOT CONSIDERED														
C_2H_4 28.052				2.06			VALID.														
C_2H_6 30.068				0.81																	
C_3+C_4																					
C_3H_6 42.078				2.12									4.32						6.23		
C_3H_8 44.094				0.45									4.24								
C_4H_8 56.104				1.31									5.00						6.10		
C_4H_{10} 58.120				0.39									4.86						4.86		
C_5H_{10} 70.130				0.57									5.45						5.45		
C_5H_{12} 72.146				0.09									5.25						5.25		
C_6H_{12} 84.156				0.11									5.54						5.54		
C_5-C_6																					
TOTAL																					
H_2+CO			S.C.F.H.																		
H_2/CO																					

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

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

EFFLUENT: RECOVERED OIL; TOTAL OIL; WATER SOLUBLE CHEMICALS; TOTAL LIQUID PRODUCTS C_5+

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY	
Contraction	CO	H_2	H_2+CO	CO	H_2	$CO+H_2$	C_3+/C_1+	NET WATER; GROSS WATER; HYDROCARBON TOTAL—C_1+

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

OPERATING CONDITIONS			
PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	420	Fresh Feed	15344
Natural Gas	405	Recycle	16274
Generator Outlet	400	Combined Feed	31618
Reactor Inlet	387	Wet Gas—Measured	5239
Condenser Inlet		Adjusted	5221
Product Accumulator	368	Loss	-18
TEMPERATURES—°F.		Recycle/Fresh Feed	1.06
Oxygen	401	Inlet Velocity—ft./sec.	1.078
Natural Gas	682	Fresh Feed Rate—S.C.F.H.	14763
Generator		per Cu. Ft. Dense Bed	1033
Quench Accumulator		per Lb. Catalyst	8.60
Reactor Inlet	228		
Condenser Inlet			
Product Accumulator	67	Heat Transfer Calculations	
Catalyst No. Height "		(data not available)	
1 12.0	733		
2 43.2	638		
3 74.4	655		
4 105.6			
5 136.8	655		
6 168.0	651		
7 199.2	632		
8 230.4	630		
9 261.6	622		
10 292.8	644		
12 342.0	638		

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

CATALYST DATA: INVENTORY DATA	
In Reactor at Start of Period	2012
Fresh Catalyst Added 65#	98
Total	2110
Catalyst Recovered	19
In Reactor at End of Period	2101
REACTOR d-p, Inches H_2O	
No. Height "	
1 12 - 43.2	80
2 43.2- 74.4	58
3 74.4- 105.6	80
4 105.6- 342.0	300
(Calc) 0-12"	22
total	500
CALCULATED FROM dp	
Density, Lbs./Cu.Ft.	119
Inventory, Lbs.	1718
Bed Depth, Ft.	21.63
Volume, Cu Ft	14.28

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

CATALYST
Bulk Density, Lbs./Cu.Ft.: Aerated; Settled; Compacted
Particle Density, gm. cc.
NH_3 Value, ml./gm. 10.26
N_2 Surface, m^2./gm.
CHEMICAL ANALYSIS: Fe; C; O; H
K.O. Wt. % basis Fe
X-Ray Analysis—
Fe_2C_5
Fe_3O_4
Fe

GAS ANALYSES				AVERAGE
HOUR				
FRESH FEED				
CO 28.010	36.22	36.89	36.30	36.470
H_2 2.016	60.18	59.31	59.75	59.747
CO_2 44.010	2.72	2.91	3.04	2.890
N_2 28.016	0.78	0.86	0.86	0.840
CH_4 16.042	0.10	0.03	0.03	0.053
			M. W.	12.9355
			H_2O 18.016	
			BALANCE	

GENERATOR BALANCE	M/HR	C	H	O
	14.765	14.765		14.765
	24.183		48.376	
	1.170	1.170		2.340
	0.340			
	0.021	0.021	0.084	
			12.942	6.471
		15.956	61.402	23.576
	92.33	98.24	102.39	

	Mol %	M/Hr	C	H	O
O_2 32.000	0.50	0.075			22.446
		11.148			
CO 28.010					
H_2 2.016					
CO_2 44.010	1.95	0.290	0.290		0.580
N_2 28.016	2.26	0.339			
CH_4 16.042	82.59	12.403	12.403	49.612	
C_2H_4 30.068	7.92	1.189	2.378	7.134	
C_3H_8 44.094	4.64	0.697	2.091	5.576	
C_4H_{10} 58.120	0.12	0.018	0.072	0.180	
	0.04	0.024	0.048		
TOTAL			17.282	62.502	23.026

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

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

GAS FLOW RATES		V"H	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR
			386.7	67			
FRESH FEED	79.31	6.50	20.03	0.9933	15344	1.496	40.485
			1.72	67			
WET GAS	158.44	7.01	4.052	0.9933	5239	1.172	13.824
			395.4	117			
RECYCLE	79.31	8.50	20.25	0.9493	15188	1.172	40.074
			395.4	117			
BLEED	5.02	9.6	20.25	0.9493	1086	1.172	2.865
			405.5	208	16274		42.939
NATURAL GAS	28.43	9.07	20.49	0.8823	5692	1.221	15.018
			419.6	67			
OXYGEN	27.07	7.54	20.84	0.9937	4225		11.148
STEAM							

LIQUID PRODUCT RATES	HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
						0.31		2.00	
	OIL	3'0"	165.75	62	0.9990	165.58	49.7	1076.45	
		1'1"	56.30	64	0.9980	56.19	6.501	365.29	
						109.70		713.16	
	WATER								
		5'5 3/4"	291.48	71	0.9988	291.13	10.5	2416.09	
		3'8 1/2"	198.73	74	0.9985	198.43	8.299	1646.77	
						92.70		769.32	

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 K

HOURS 209-221

	FRESH FEED %	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	37.137	14.828	415.33	14.377	2.194	61.45	5.599	20.427	7.793	-12.634	353.88
H_2 2.016	59.010	23.561	47.50	41.480	6.329	12.76	16.155	39.716	22.484	-17.232	34.74
CO_2 44.010	2.813	1.123	49.42	26.787	4.087	179.87	10.432	11.555	14.520	2.964	130.45
N_2 28.016	0.957	0.382	10.70	2.493	0.380	10.65	0.971	1.353	1.351		
CH_4 16.042	0.083	0.033	0.53	6.363	0.971	15.58	2.478	2.511	3.449	0.938	15.05
C_2H_4 28.052				2.287	0.349	9.79	0.891	0.891	1.240	0.349	9.79
C_2H_6 30.068				0.393	0.136	4.09	0.348	0.348	0.484	0.136	4.09
C_1+C_2											28.93
C_3H_6 42.078				2.137	0.326	13.72	0.832	0.832	1.158	0.326	13.72
C_3H_8 44.094				0.397	0.060	2.64	0.155	0.155	0.215	0.060	2.64
C_4H_8 56.104				1.393	0.213	11.95	0.543	0.543	0.756	0.213	11.95
C_4H_{10} 58.120				0.480	0.073	4.24	0.187	0.187	0.260	0.073	4.24
C_5H_{10} 70.130				0.623	0.095	6.66	0.243	0.243	0.338	0.095	6.66
C_5H_{12} 72.146				0.153	0.023	1.66	0.060	0.060	0.083	0.023	1.66
C_6H_{12} 84.156				0.137	0.021	1.77	0.053	0.053	0.074	0.021	1.77
C_3-C_6											42.64
TOTAL		39.927			15.258		38.946				
H_2+CO		38.389	14,549 S.C.F.H.		8.523		21.754	60.143	30.277	29.866	
H_2/CO		1.59	68731		2.88			1.94		1.36	

YIELD BASIS H_2+CO FED

	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	-12.634	353.88					Distribution of					
H_2	-17.232	34.74					Recovered Oil					
CO_2	2.964	130.45	8.966					400 EP			0.510	
N_2								400-550			0.128	
CH_4	0.938	15.05	1.034					550+			0.024	
C_2H_4	0.349	9.79	0.673									71.9
C_2H_6	0.136	4.09	0.281									
C_1+C_2		28.93	1.988									
C_3H_6	0.326	13.72	0.943	4.32	3.176	0.218	12.35	0.849	6.25	1.976	0.136	84.3
C_3H_8	0.060	2.64	0.181	4.24	0.623	0.043						
C_4H_8	0.213	11.95	0.821	5.00	2.390	0.164	11.35	0.780	6.10	1.861	0.128	69.6
C_4H_{10}	0.073	4.24	0.291	4.86	0.872	0.060	4.24	0.291	4.86	0.872	0.060	
C_5H_{10}	0.095	6.66	0.458	5.45	1.222	0.084	6.66	0.458	5.45	1.222	0.084	80.3
C_5H_{12}	0.023	1.66	0.114	5.25	0.316	0.022	1.66	0.114	5.25	0.316	0.022	
C_6H_{12}	0.021	1.77	0.122	5.54	0.319	0.022	1.77	0.122	5.54	0.319	0.022	
C_3-C_6		42.64	2.931		8.918	0.613	38.03	2.614		6.566	0.451	
RECOVERED OIL		62.57	4.300		9.634	0.662	62.57	4.300		9.634	0.662	
TOTAL OIL		105.21	7.231		18.552	1.275	100.60	6.914		16.200	1.113	
WATER SOLUBLE CHEMICALS		12.02	0.826	8.04	1.495	0.103	12.02	0.826		1.495	0.103	
TOTAL LIQUID PRODUCTS C_3+		117.23	8.057		20.047	1.378	112.62	7.740		17.695	1.216	
NET WATER	6.218	112.02	7.699	8.328	13.451	0.925						
GROSS WATER		124.04	8.525		14.946	1.027						
HYDROCARBON TOTAL—C_1+		146.16	10.046									

CUMULATIVE TOTALS

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

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

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

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

OPERATING CONDITIONS

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

PRODUCT TESTS

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

CATALYST DATA

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

PARTICLE SIZE

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

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	142
Settled	145
Compacted	161
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	12.2
N_2 Surface, m²/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, W+. % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES / GENERATOR BALANCE

HOUR				AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	37.04	37.17	37.20	37.137	14.828	14.828		14.828
H_2 2.016	59.11	59.11	58.81	59.010	23.561		47.122	
CO_2 44.010	2.91	2.72	2.81	2.813	1.123	1.123		2.246
N_2 28.016	0.85	0.91	1.11	0.957	0.382			
CH_4 16.042	0.10	0.08	0.07	0.083	0.033	0.033	0.132	
			M. W.	13.11114				
			H_2O 18.016				10.670	5.335
						15.984	57.924	22.409
			BALANCE			97.42	97.64	103.23
WET GAS								
CO 28.010	14.07	15.02	14.04	14.377				
H_2 2.016	42.93	38.85	42.66	41.480				
CO_2 44.010	26.27	28.06	26.03	26.787				
N_2 28.016	2.31	2.74	2.43	2.493				
CH_4 16.042	6.28	6.45	6.36	6.363				
C_2H_4 28.052	2.25	2.39	2.22	2.287				
C_2H_6 30.068	0.89	0.97	0.86	0.893				
C_3H_6 42.078	1.84	2.27	2.30	2.137				
C_3H_8 44.094	0.34	0.47	0.38	0.397				
C_4H_8 56.104	1.28	1.48	1.42	1.393				
C_4H_{10} 58.120	0.57	0.43	0.44	0.480				
C_5H_{10} 70.130	0.61	0.63	0.63	0.623				
C_5H_{12} 72.146	0.20	0.18	0.08	0.153				
C_6H_{12} 84.156	0.16	0.10	0.15	0.137				
			M. W.	22.07879				

GENERATOR BALANCE (natural gas / oxygen)

	Mol %	M/Hr	C	H	O
O_2 32.000	0.49	10.523 0.070			21.186
CO 28.010					
H_2 2.016					
CO_2 44.010	1.84	0.261	0.261		0.522
N_2 28.016	2.39	0.339			
CH_4 16.042	82.12	11.650	11.650	46.600	
C_2H_6 30.068	8.00	11.35	2.270	6.810	
C_3H_8 44.094	4.97	0.705	2.115	5.640	
C_4H_{10} 58.120	0.13 0.06	0.018 0.008	0.072 0.040	0.180 0.096	
TOTAL			16.408	59.326	21.708

WEIGHT BALANCE

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

GAS FLOW RATES

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

LIQUID PRODUCT RATES

HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	5'5½	290.39	70	0.9951	288.97	49.9	1876.5	62.57
	3'3¼	175.82	83	0.9886	173.82	6.494	1128.8	9.634
					115.15		747.7	
					0.46		43.0	
					115.61		750.7	
WATER								
	7'1	375.50	80	0.9976	374.60	10.5	3108.80	124.04
	5'6½	294.75	82	0.9973	293.95	8.299	2439.52	14.946
	2'1½	112.25	80	0.9976	111.98		929.33	
	0'3	13.28	61	0.9994	13.27		110.14	
					179.35		1488.46	

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 L

HOURS 221-245

	FRESH FEED			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	36.580	14.775	413.82	13.937	2.084	58.38	5.785	20.560	7.869	-12.691	355.44					Distribution of					
H_2 2.016	59.629	24.085	48.55	43.422	6.495	13.09	18.024	42.107	24.519	-17.589	35.46					Recovered Oil					
CO_2 44.010	2.377	0.960	42.25	23.477	3.511	154.55	9.745	10.705	13.256	2.551	112.30	7.623				400 EP				0.520	
N_2 28.016	0.697	0.282	7.90	2.057	0.308	8.63	0.854	1.136	1.162							400-550				0.146	
CH_4 16.042	0.717	0.290	4.65	8.210	1.228	19.71	3.408	3.698	4.636	0.939	15.06	1.022				550+				0.041	
C_2H_6 28.052				2.233	0.334	9.37	0.927	0.927	1.261	0.334	9.37	0.636									72.0
C_3H_8 30.068				0.870	0.130	3.91	0.361	0.361	0.491	0.130	3.91	0.265									
C_4+C_5										1.403	28.34	1.924									
C_3H_6 42.078				2.160	0.323	13.59	0.897	0.897	1.220	0.323	13.59	0.922	4.32	3.146	0.214	12.23	0.830	6.25	1.797	0.122	84.0
C_4H_8 44.094				0.410	0.061	2.69	0.170	0.170	0.231	0.061	2.69	0.183	4.24	0.634	0.043						
C_5H_8 56.104				1.543	0.231	12.96	0.640	0.640	0.871	0.231	12.96	0.880	5.00	2.592	0.176	12.31	0.836	6.10	2.018	0.137	74.2
C_4H_{10} 58.120				0.537	0.080	4.65	0.223	0.223	0.303	0.080	4.65	0.316	4.86	0.957	0.065	4.65	0.316	4.86	0.957	0.065	
C_5H_{10} 70.130				0.770	0.115	8.06	0.320	0.320	0.435	0.115	8.06	0.547	5.45	1.479	0.100	8.06	0.547	5.45	1.479	0.100	82.2
C_6H_{12} 72.146				0.167	0.025	1.80	0.069	0.069	0.094	0.025	1.80	0.122	5.25	0.343	0.023	1.80	0.122	5.25	0.343	0.023	
C_5H_{12} 84.156				0.207	0.031	2.61	0.086	0.086	0.117	0.031	2.61	0.177	5.54	0.471	0.032	2.61	0.177	5.54	0.471	0.032	
C_5-C_6											46.36	3.147		9.622	0.653	41.66	2.828		7.065	0.479	
TOTAL		40.390	517.17		14.956	314.00	41.509	81.899													
H_2+CO		38.859	14,732 S.C.F.H.		7.579		23.809	62.667	32.388	30.280											
H_2/CO		1.63	678794		3.12		3.12	2.05	3.12	1.38											

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

EFFLUENT	RECOVERED OIL		67.73	4.597		10.416	0.707	67.73	4.597		10.416	0.707	
SHIFT RATIO	TOTAL OIL		114.09	7.744		20.038	1.360	109.39	7.425		17.481	1.187	
	WATER SOLUBLE CHEMICALS		13.08	0.888	8.01	1.633	0.111	13.08	0.888		1.633	0.111	
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.1	TOTAL LIQUID PRODUCTS C_3^+		127.17	8.632		21.671	1.471	122.47	8.313		19.114	1.297	
	NET WATER	6.792	122.36	8.306	8.32	14.593	0.997						
	GROSS WATER		135.44	9.194		16.326	1.108						
	HYDROCARBON TOTAL—C_1+		155.51	10.556									

FRESH FEED CONVERSION — %				TOTAL FEED CONVERSION — %			SELECTIVITY
Contraction	CO	H_2	H_2+CO	CO	H_2	CO+H_2	C_3^+ C_4^+
62.97	85.90	73.03	77.92	61.73	41.77	48.32	81.77

g/M3 × 16.91 ÷ = MCF.

cc/M3 = 141.3 × gal/MCF.

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

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

CATALYST DATA		PARTICLE SIZE			
INVENTORY DATA			Screen Analysis		Sedimentation
In Reactor at Start of Period	2027		Mesh	Microns %	Microns %
Fresh Catalyst Added 52=	79		On 40	419+ 16.3	80+
Total	2106		100	150 63.8	40—80
Catalyst Recovered	80		150	105 10.0	20—40
In Reactor at End of Period	2026		200	74 5.6	10—20
			250	62 0.2	0—20
REACTOR d-p, Inches H_2O			325	44 1.0	
No. Height "			<325	3.1	
1 12 - 43.2	58				
2 43.2 - 74.4	55		CATALYST		
3 74.4 - 105.6	55		Bulk Density, Lbs./Cu.Ft.		
4 105.6 - 342.0	280		Aerated		148
(Calc) 0-12"	22		Settled		147
total	470		Compacted		166
			Particle Density, gm. cc.		4.3
CALCULATED FROM dp			NH_3 Value, ml. gm.		26.40
Density, Lbs./Cu.Ft.	112		N_2 Surface, m^2/gm.		
Inventory, Lbs.	1613				
Bed Depth, Ft.	21.60		CHEMICAL ANALYSIS		
Volume, Cu Ft	14.26		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	1300	2100	0500	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		# hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.48	10.106 0.068			20.348	WET GAS	298.50	314.00
CO 28.010	36.47	36.25	37.02	36.580	14.775	14.775		14.775	CO 28.010						OIL	67.73	67.73
H_2 2.016	59.71	59.73	59.45	59.629	24.083		48.166		H_2 2.016						WATER	135.44	135.44
CO_2 44.010	2.46	2.27	2.40	2.377	0.960	0.960		1.920	CO_2 44.010	1.83	0.260	0.260		0.520	TOTAL	501.67	517.17
N_2 28.016	0.60	0.70	0.79	0.697	0.282				N_2 28.016	1.79	0.254				FRESH FEED	517.17	517.17
CH_4 16.042	0.76	1.05	0.34	0.717	0.290	0.290	1.160		CH_4 16.042	81.34	11.537	11.537	46.148		WEIGHT BALANCE	97.00	
			M. W.	12.8046					C_2H_6 30.068	8.77	1.244	2.488	7.464				
			H_2O 18.016				9.639	4.820	C_3H_8 44.094	5.58	0.791	2.373	6.328		WET GAS FACTOR		1.051926
						15.995	58.965	21.515	C_4H_{10} 58.120	0.15 0.06	0.021 0.009	0.084 0.045	0.210 0.108		INDICATED LOSS—S C F H		280
			BALANCE			95.3	97.8	103	TOTAL				16.787	60.258	20.868		

WET GAS					GAS FLOW RATES								LIQUID PRODUCT RATES							
						V-R	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	13.61	13.81	14.39	13.937			393.4	80.8												
H_2 2.016	43.40	44.18	42.69	43.422	FRESH FEED							OIL	7'3	384.23	82	0.9891	380.04		2467.98	
CO_2 44.010	24.49	21.64	24.30	23.477	79.31	6.483	20.202	0.9804	15312	1.5036	40.390		5'5½	290.39	70	0.9951	288.97	49.9 6.494	1876.57	
N_2 28.016	1.63	2.36	2.18	2.057			1.86	73.8									91.07 + 1.08		47.00	
CH_4 16.042	7.99	9.11	7.53	8.210	WET GAS 158.44	7.208	4.07308	0.9866	5310	1.17427	14.218		3'5½	185.64	78	0.9911	183.99	49.7	1197.12	
C_2H_6 28.052	2.18	2.28	2.24	2.233			398.70	123.0					0'6	26.55	90	0.9851	26.15	6.501	170.00	
C_3H_8 33.068	0.87	0.90	0.84	0.870	RECYCLE 115.14	5.661	20.333	0.9444	14731	1.17427	38.858						157.84			67.73
C_3H_6 42.078	2.22	2.30	1.96	2.160			398.7	123.0									249.99		1625.53	10.416
C_3H_8 44.094	0.41	0.46	0.36	0.410	BLEED 5.02	8.875	20.333	0.9444	1005	1.17427	2.651	WATER	7'½	373.32	84	0.9969	372.16		3088.56	
C_4H_{10} 58.104	1.57	1.50	1.56	1.543			411.9	200.8	15736		41.539							10.5		
C_4H_{10} 58.120	0.47	0.48	0.66	0.537	NATURAL GAS 28.43	8.524	20.655	0.8870	5377	1.211113	14.184		2'1½	112.25	80	0.9976	111.98	8.299	929.32	
C_5H_{10} 70.130	0.78	0.71	0.82	0.770			425.6	80.2												
C_5H_{12} 72.146	0.14	0.10	0.26	0.167	OXYGEN 27.07	6.873	20.9840	0.9813	3851		10.106		2'9½	149.62	78	0.9979	149.31	10.7	1237.73	
C_6H_{12} 84.156	0.23	0.17	0.22	0.207			34.8						0'4	17.70	76	0.9982	17.67	8.287	146.43	
			M. W	20.9948	STEAM 215.7	5.84	0.3097	390.1#/hr												135.44
																	391.82		3250.54	16.326

THE TEXAS COMPANY — MONTEBELLO LABORATORY

YIELD CALCULATIONS

RUN NO. 49 M

HOURS 245-269

	FRESH FEED			WET GAS			RECYCLE	COMBINED FEED	EFFLUENT	NET CHANGE		YIELD BASIS H_2+CO FED								
					At. Wt. Balance							CONDENSATE				FOLYMER				%
	%	m/hr	#/hr	%	m/hr	#/hr	m/hr	m/hr	m/hr	m/hr	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	#/hr	#/MCF	#/gal	gal/hr	gal/MCF	Unsats.
CO 28.010	37.037	14.731	412.62	14.300	2.124	59.49	5.861	20.592	7.986	-12.607	353.13					Distribution of					
H_2 2.016	59.207	23.548	47.47	43.113	6.403	12.91	17.669	41.217	24.073	-17.145	34.56					Recovered Oil					
CO_2 44.010	2.820	1.122	49.38	25.953	3.854	169.61	10.637	11.759	14.491	2.732	120.23	8.287				400 EP			0.550		
N_2 28.016	0.843	0.335	9.38	2.143	0.318	8.91	0.878	1.213	1.197							400-550			0.143		
CH_4 16.042	0.093	0.037	0.59	6.213	0.923	14.81	2.546	2.583	3.469	0.886	14.22	0.980				550+			0.047		
C_2H_6 28.052				2.137	0.317	8.89	0.876	0.876	1.193	0.317	8.89	0.615									71.9
C_3H_8 30.068				0.837	0.124	3.73	0.343	0.343	0.467	0.124	3.73	0.257									
C_4+C_5											26.84	1.850									
C_3H_6 42.078				2.210	0.328	13.80	0.906	0.906	1.234	0.328	13.80	0.951	4.32	3.195	0.220	12.42	0.856	6.23	1.987	0.137	83.2
C_4H_8 44.094				0.447	0.066	2.91	0.183	0.183	0.250	0.066	2.91	0.201	4.24	0.686	0.047						
C_4H_8 56.104				1.420	0.211	11.84	0.582	0.582	0.793	0.211	11.84	0.816	5.00	2.368	0.163	11.25	0.776	6.10	1.844	0.127	77.7
C_5H_{10} 58.120				0.407	0.060	3.49	0.167	0.167	0.227	0.060	3.49	0.240	4.86	0.718	0.049	3.49	0.240	4.86	0.718	0.049	
C_5H_{10} 70.130				0.607	0.090	6.31	0.249	0.249	0.339	0.090	6.31	0.435	5.45	1.158	0.080	6.31	0.435	5.45	1.158	0.080	86.7
C_5H_{12} 72.146				0.093	0.014	1.01	0.038	0.038	0.052	0.014	1.01	0.070	5.25	0.192	0.013	1.01	0.070	5.25	0.192	0.013	
C_5H_{12} 84.162				0.120	0.018	1.51	0.049	0.049	0.067	0.018	1.51	0.104	5.54	0.273	0.019	1.51	0.104	5.54	0.273	0.019	
C_7-C_8											40.87	2.817		8.590	0.592	35.99	2.481		6.172	0.425	
TOTAL		39.773			14.852		40.984	80.757													
H_2+CO		38.279	14,508 S.C.F.H.		8.527		23.530	61.809	32.058	29.752											
H_2/CO		1.60	689287		3.01		3.01	2.00	3.01	1.36											

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

EFFLUENT	RECOVERED OIL			69.90	4.818		10.733	0.740	69.90	4.818		10.733	0.740	
SHIFT RATIO	TOTAL OIL			110.77	7.635		19.325	1.332	105.89	7.299		16.905	1.165	
$\frac{(H_2)(CO_2)}{(H_2O)(CO)}$ 6.7	WATER SOLUBLE CHEMICALS			12.53	0.864	47.981	1.570	0.108	12.53	0.864		1.570	0.108	
	TOTAL LIQUID PRODUCTS C_5+			123.30	8.499		20.893	1.440	118.42	8.163		18.475	1.273	
	NET WATER	6.534		117.71	8.114	48.328	14.134	0.974						
	GROSS WATER			130.24	8.977		15.704	1.082						
	HYDROCARBON TOTAL—C_1+			150.14	10.349									

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

g/M3 = 16.91 × #/MCF

cc/M3 = 141.3 × gal/MCF.

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	428	Fresh Feed	15074
Natural Gas	414	Recycle	15533
Generator Outlet	407	Combined Feed	30607
Reactor Inlet	392	Wet Gas—Measured	5252
Condenser Inlet		Adjusted	5629
Product Accumulator	374	Loss	377
TEMPERATURES—°F.		Recycle/Fresh Feed	1.030
Oxygen	469	Inlet Velocity—ft./sec.	0.993
Natural Gas	715	Fresh Feed Rate—S.C.F.H.	14508
Generator	2360	per Cu. Ft. Dense Bed	1085
Quench Accumulator	165	per Lb. Catalyst	8.73
Reactor Inlet	323		
Condenser Inlet			
Product Accumulator	73	Heat Transfer Calculations	

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

Steam Rate = 395.0 #/hr

@ 798 psia & 518°F

= 1197 BTU/#

Water in @ 183°F = 151 BTU/#

Heat Transferred/lb. steam

= 1046 BTU

(1046)(395.0) = 413128 BTU/hr

Ave. Bed Temperature = 672°F

ΔT = 672-518 = 154°F

Ave. Tube Area = 30.9 ft^2

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

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

INVENTORY DATA		
In Reactor at Start of Period	2026	
Fresh Catalyst Added 50±	76	
Total	2102	
Catalyst Recovered	61	
In Reactor at End of Period	2041	
REACTOR d-p, Inches H_2O		
No. Height "		
1 12 - 43.2	57	
2 43.2 - 74.4	65	
3 74.4 - 105.6	65	
4 105.6 - 342.0	275	
(Calc) 0-12"	24	
total	484	
CALCULATED FROM dp		
Density, Lbs./Cu.Ft.	125	
Inventory, Lbs.	1661	
Bed Depth, Ft.	20.26	
Volume, Cu Ft	13.37	

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

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	145
Settled	147
Compacted	166
Particle Density, gm./cc.	4.2
NH_3 Value, ml./gm.	14.88
N_2 Surface, m^2/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, W+, % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

	GAS ANALYSES				GENERATOR BALANCE								
HOUR	1300		0600	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.34	0.048 10.475			21.046
CO 28.010	36.87	37.07	37.17	37.037	14.731	14.731		14.731	CO 28.010					
H_2 2.016	59.40	58.97	59.25	59.207	23.548		47.096		H_2 2.016					
CO_2 44.010	2.74	2.93	2.79	2.820	1.122	1.122		2.244	CO_2 44.010	2.14	0.303	0.303		0.606
N_2 28.016	0.81	0.97	0.75	0.843	0.335				N_2 28.016	2.44	0.345			
CH_4 16.042	0.18	0.06	0.04	0.093	0.037	0.037	0.148		CH_4 16.042	81.74	11.561	11.561	46.244	
			M. W.	13.0598					C_2H_6 30.068	9.00	1.273	2.546	7.638	
			H_2O 18.016				10.534	5.267	C_3H_6 44.094	3.83	0.542	1.626	4.336	
									C_4H_{10} 58.120	0.43	0.061	0.244	0.610	
						15.890	57.778	22.242		0.08	0.011	0.006	0.132	
			BALANCE			97.21	97.99	102.72	TOTAL			14.346	58.960	21.652

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

WET GAS	1300	2100	0600	
CO 28.010	13.80	13.99	15.11	14.300
H_2 2.016	43.06	43.06	43.22	43.113
CO_2 44.010	25.73	26.27	25.86	25.953
N_2 28.016	2.06	2.51	2.06	2.143
CH_4 16.042	6.93	6.03	5.68	6.213
C_2H_6 28.052	2.14	2.17	2.10	2.137
C_3H_8 30.068	0.88	0.82	0.81	0.837
C_3H_6 42.078	2.24	2.21	2.18	2.210
C_4H_8 44.094	0.49	0.43	0.42	0.447
C_4H_8 56.104	1.44	1.43	1.39	1.420
C_5H_{10} 58.120	0.41	0.43	0.38	0.407
C_5H_{10} 70.130	0.62	0.63	0.57	0.607
C_5H_{12} 72.146	0.08	0.10	0.10	0.093
C_5H_{12} 84.162	0.12	0.12	0.12	0.120
			M. W.	21.4987

GAS FLOW RATES							
	$\sqrt{\Delta R}$	PRESSURE	TEMP.	S. C. F. H.	M. W.	M/HR	
FRESH FEED		391.5	79				
	79.31	6.45	20.15	0.9822	15074	1.4889	32.773
WET GAS			1.94	73			
	158.44	7.09	4.078	0.9877	5252	1.1604	13.857
RECYCLE			397.7	125			
	115.14	5.64	20.31	0.9428	14512	1.1604	38.290
BLEED			397.7	125			
	5.02	9.1	20.31	0.9428	1021	1.1604	2.694
NATURAL GAS			414.1	208	15533		40.984
	28.43	8.48	20.71	0.8823	5361	1.2169	14.144
OXYGEN			427.9	78			
	27.07	7.09	21.04	0.9831	3970		10.475
STEAM			36.4				
	215.7	5.80	0.3157		395.0#/hr		

LIQUID PRODUCT RATES									
HOUR	GAGE	GAL.	°F	FACTOR	GAL. AT 60	API° #/GAL.	#	# HR GAL HR
OIL	7'1½	377.68	76	0.9920	374.66	49.4	2432.8	69.90
	3'5½	185.64	78	0.9911	183.99	6.512	1198.1	10.733
	1'7	82.59	65	0.9975	82.38		536.5	
	0'3½	15.49	64	0.9980	15.46		100.7	
					257.59		1677.5	
WATER								
	7'3	384.25	84	0.9969	383.04	10.6	3176.6	130.24
	2'9½	149.62	78	0.9979	149.31	8.293	1238.2	15.704
	3'0	161.14	77	0.9980	160.82		1333.7	
	0'4	17.70	82	0.9975	17.65		146.4	
					376.90		3125.7	

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 N
HOURS 269-293

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

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

EFFLUENT

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

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

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

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

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

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

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

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

CATALYST	
Bulk Density, Lbs./Cu.Ft.	
Aerated	140
Settled	141
Compacted	158
Particle Density, gm./cc.	4.3
NH_3 Value, ml./gm.	17.77
N_2 Surface, m²/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, W+, % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES HOUR	1300	2100	0800	AVERAGE	GENERATOR BALANCE M/HR	C	H	O		Mol %	M/Hr	C	H	O
FRESH FEED									O_2 32.000	0.45	0.064 10.598			21.324
CO 28.010	36.63	37.00	36.54	36.848	15.064	15.064		15.064	CO 28.010					
H_2 2.016	59.53	59.15	59.95	59.512	24.329		48.658		H_2 2.016					
CO_2 44.010	2.73	2.96	2.63	2.708	1.107	1.107		2.214	CO_2 44.010	1.73	0.246	0.246		0.492
N_2 28.016	0.85	0.84	0.78	0.782	0.320				N_2 28.016	1.73	0.246			
CH_4 16.042	0.26	0.05	0.10	0.150	0.061	0.061	0.244		CH_4 16.042	81.54	11.604	11.604	46.416	
			M. W.	12.9558					C_2H_6 30.068	8.69	1.237	2.474	7.422	
			H_2O 18.016				10.374	5.187	C_3H_8 44.094	5.66	0.805	2.415	6.440	
						16.232	59.276	22.465	C_4H_{10} 58.120	0.15 0.05	0.021 0.007	0.084 0.035	0.210 0.084	
			BALANCE			96.29	97.86	102.97	TOTAL			16.858	60.572	21.816

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

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

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

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

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 0
HOURS 293-317

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS At. Wt. Balance m/hr	WET GAS At. Wt. Balance #/hr	RECYCLE m/hr	COMBINED FEED m/hr	EFFLUENT m/hr	NET CHANGE m/hr	NET CHANGE #/hr
CO 28.010	36.753	14.904	417.46	14.113	2.139	59.91	5.852	20.756	7.991	-12.765	357.55
H_2 2.016	59.600	24.169	48.73	43.842	6.645	13.40	18.179	42.348	24.823	-17.524	35.33
CO_2 44.010	2.703	1.096	48.23	25.767	3.905	171.86	10.684	11.780	14.589	2.809	123.63
N_2 28.016	0.867	0.352	9.86	2.350	0.356	9.97	0.974	1.326	1.331		
CH_4 16.042	0.077	0.031	0.50	5.850	0.887	14.23	2.426	2.457	3.312	0.856	13.73
C_2H_4 28.052				2.137	0.324	9.09	0.886	0.886	1.210	0.324	9.09
C_2H_6 30.068				0.830	0.126	3.79	0.344	0.344	0.470	0.126	3.79
C_1+C_2											26.61
C_3H_6 42.078				2.180	0.370	13.89	0.904	0.904	1.234	0.330	13.89
C_3H_8 44.094				0.417	0.063	2.78	0.173	0.173	0.236	0.063	2.78
C_4H_8 56.104				1.347	0.204	11.44	0.559	0.559	0.767	0.204	11.44
C_4H_{10} 58.120				0.390	0.059	3.43	0.162	0.162	0.221	0.059	3.43
C_5H_{10} 70.130				0.597	0.091	6.38	0.248	0.248	0.338	0.091	6.38
C_5H_{12} 72.146				0.080	0.012	0.87	0.033	0.033	0.045	0.012	0.87
C_6H_{12} 84.156				0.100	0.015	1.26	0.041	0.041	0.057	0.015	1.26
C_3-C_6											40.05
TOTAL		40.552			15.156		41.464	82.016			
H_2+CO		39.073	14,809 S.C.F.H.		8.784		24.031	63.104	32.814	30.289	
H_2/CO		1.62	675280		3.11			2.04		1.37	

	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	8.348					400 EP			0.522	
N_2						400-550			0.110	
CH_4	0.927					550+			0.073	
C_2H_4	0.614									72.0
C_2H_6	0.256									
C_1+C_2	1.797									
C_3H_6	0.938	4.32	3.215	0.217	12.50	0.844	6.25	2.000	0.135	83.9
C_3H_8	0.188	4.24	0.656	0.044						
C_4H_8	0.773	5.00	2.288	0.155	10.87	0.734	6.10	1.782	0.120	77.5
C_4H_{10}	0.232	4.86	0.706	0.048	3.43	0.232	4.86	0.706	0.048	
C_5H_{10}	0.431	5.45	1.171	0.079	6.38	0.431	5.45	1.171	0.079	88.2
C_5H_{12}	0.059	5.25	0.166	0.011	0.87	0.059	5.25	0.166	0.011	
C_6H_{12}	0.085	5.54	0.227	0.015	1.26	0.085	5.54	0.227	0.015	
C_3-C_6	2.704		8.429	0.569	35.31	2.384		6.052	0.409	

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

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

	m/hr	#/hr	CONDENSATE #/MCF	#/gal	gal/hr	gal/MCF	POLYMER #/hr	#/MCF	#/gal	gal/hr	gal/MCF
RECOVERED OIL	0.485	67.96	4.589		10.441	0.705	67.96	4.589		10.441	0.705
TOTAL OIL		108.01	7.294		18.870	1.274	103.27	6.974		16.493	1.114
WATER SOLUBLE CHEMICALS		12.94	0.874	7.98	1.622	0.110	12.94	0.874		1.622	0.110
TOTAL LIQUID PRODUCTS C_3+		120.95	8.168		20.492	1.384	116.21	7.847		18.115	1.223
NET WATER	6.747	121.55	8.208	8.328	14.595	0.986					
GROSS WATER		134.49	9.082		16.217	1.095					
HYDROCARBON TOTAL—C_1+		147.56	9.964								

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

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

OPERATING CONDITIONS

PRESSURES PSIG		RATES S.C.F.H.	
Oxygen	431	Fresh Feed	15369
Natural Gas	417	Recycle	15715
Generator Outlet	409	Combined Feed	31084
Reactor Inlet	395	Wet Gas—Measured	5413
Condenser Inlet		Adjusted	5744
Product Accumulator	377	Loss	331
TEMPERATURES—°F.		Recycle/Fresh Feed	1.023
Oxygen	439	Inlet Velocity—ft./sec.	1.044
Natural Gas	743	Fresh Feed Rate—S.C.F.H.	14809
Generator		per Cu. Ft. Dense Bed	1083
Quench Accumulator	157	per Lb. Catalyst	9.09
Reactor Inlet	318		
Condenser Inlet			
Product Accumulator	73	Heat Transfer Calculations	

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

Heat Transfer Calculations

Steam Rate = 389.8 #/hr
@ 818 psia & 521°F
= 1196 BTU/#
Water in @ 185°F = 153 BTU/#
Heat Transferred/lb. steam
= 1043 BTU
(1043)(389.8) = 406561 BTU/hr
Ave. Bed Temperature = 659°F
dT = 659-521 = 138°F
Tube Area = 31.3 ft²

$$K = \frac{406561}{(138)(31.3)} = 94.3$$

PRODUCT TESTS

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

CATALYST DATA

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

PARTICLE SIZE

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

CATALYST	
Bulk Density. Lbs./Cu.Ft.	
Aerated	144
Settled	147
Compacted	160
Particle Density, gm./cc.	4.4
NH_3 Value, ml./gm.	19.09
N_2 Surface, m²/gm.	
CHEMICAL ANALYSIS	
Fe	
C	
O	
H	
K_2O, Wt., % basis Fe	
X-Ray Analysis—	
$Fe_{20}C_9$	
Fe_3O_4	
Fe	

GAS ANALYSES / GENERATOR BALANCE

HOUR	1300	2100	0500	AVERAGE	M/HR	C	H	O
FRESH FEED								
CO 28.010	36.53	37.02	36.71	36.753	14.904	14.904		14.904
H_2 2.016	60.01	59.07	59.72	59.600	24.169		48.338	
CO_2 44.010	2.57	2.99	2.55	2.703	1.096	1.096		2.192
N_2 28.016	0.81	0.88	0.91	0.867	0.352			
CH_4 16.042	0.08	0.04	0.11	0.077	0.031	0.031	0.124	
			M. W.	12.94089				
			H_2O 18.016				10.566	5.283
						16.031	59.028	22.334
			BALANCE			96.23	98.86	101.34

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

WEIGHT BALANCE

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

WET GAS	1300	2100	0500	AVERAGE
CO 28.010	13.73	14.10	14.51	14.113
H_2 2.016	43.73	43.67	44.13	43.842
CO_2 44.010	26.19	26.17	24.94	25.767
N_2 28.016	2.05	2.23	2.77	2.350
CH_4 16.042	5.96	5.92	5.67	5.850
C_2H_4 28.052	2.21	2.18	2.02	2.137
C_2H_6 30.068	0.81	0.82	0.86	0.830
C_3H_6 42.078	2.27	2.15	2.12	2.180
C_3H_8 44.094	0.45	0.41	0.39	0.417
C_4H_8 56.104	1.42	1.25	1.37	1.347
C_4H_{10} 58.120	0.37	0.37	0.43	0.390
C_5H_{10} 70.130	0.63	0.55	0.61	0.597
C_5H_{12} 72.146	0.08	0.08	0.08	0.080
C_6H_{12} 84.156	0.10	0.10	0.10	0.100
			M. W.	21.26694

GAS FLOW RATES

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

LIQUID PRODUCT RATES

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

THE TEXAS COMPANY — MONTEBELLO LABORATORY
YIELD CALCULATIONS

RUN NO. 49 P
HOURS 317-341

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	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	37.163	14.927	418.11	14.760	2.260	63.30	6.162	21.089	8.422	-12.667	354.81					Distribution of					
H_2 2.016	59.144	23.756	47.89	44.515	6.817	13.74	18.584	42.340	25.401	-16.939	34.15					Recovered Oil					
CO_2 44.010	2.683	1.078	47.44	25.170	3.855	169.66	10.508	11.586	14.362	2.777	122.22	8.336				400 EP				0.518	
N_2 28.016	0.870	0.349	9.78	2.120	0.325	9.11	0.885	1.234	1.210							400-550				0.095	
CH_4 16.042	0.140	0.056	0.90	5.635	0.863	13.84	2.352	2.408	3.215	0.807	12.94	0.883				550+				0.100	
C_2H_6 28.052				2.055	0.315	8.84	0.858	0.858	1.173	0.315	8.84	0.603									71.5
C_2H_4 30.068				0.820	0.126	3.79	0.342	0.342	0.468	0.126	3.75	0.258									
C_1+C_2											25.57	1.744									
C_3H_6 42.078				2.130	0.326	13.72	0.889	0.889	1.215	0.326	13.72	0.936	4.32	3.176	0.217	12.35	0.842	6.25	1.976	0.135	82.7
C_3H_8 44.094				0.445	0.068	3.00	0.186	0.186	0.254	0.068	3.00	0.205	4.24	0.708	0.048						
C_4H_8 56.104				1.285	0.197	11.05	0.536	0.536	0.733	0.197	11.05	0.754	5.00	2.210	0.151	10.50	0.716	6.10	1.721	0.117	79.6
C_4H_{10} 58.120				0.330	0.051	2.96	0.138	0.138	0.188	0.051	2.96	0.202	4.86	0.609	0.042	2.96	0.202	4.86	0.609	0.042	
C_5H_{10} 70.132				0.545	0.083	5.82	0.228	0.228	0.311	0.083	5.82	0.397	5.45	1.068	0.073	5.82	0.397	5.45	1.068	0.073	88.6
C_5H_{12} 72.146				0.070	0.011	0.79	0.029	0.029	0.040	0.011	0.79	0.054	5.25	0.150	0.010	0.79	0.054	5.25	0.150	0.010	
C_6H_{12} 84.156				0.120	0.019	1.60	0.050	0.050	0.068	0.019	1.60	0.109	5.54	0.289	0.020	1.60	0.109	5.54	0.289	0.020	
C_3-C_6											38.94	2.656		8.210	0.560	34.08	2.320		5.813	0.397	
TOTAL		40.167			15.314		41.747	80.430													
H_2+CO		38.683	14,661 S.C.F.H.		9.077			63.429		29.606											
H_2/CO		1.591	682088		3.016			2.01		1.357											

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

EFFLUENT								
RECOVERED OIL		68.01	4.639		10.459	0.713	68.01	4.639		10.459	0.713	
TOTAL OIL		106.95	7.295		18.669	1.275	102.03	6.959		16.272	1.110	
WATER SOLUBLE CHEMICALS		12.99	0.886	7.98	1.628	0.111	12.99	0.886		1.628	0.111	
TOTAL LIQUID PRODUCTS C_5+		119.94	8.126		20.297	1.384	115.02	7.845		17.900	1.221	
NET WATER	6.772	122.01	8.322	8.32	14.651	0.999						
GROSS WATER		135.00	9.208		16.279	1.110						
HYDROCARBON TOTAL—C_1+		145.51	9.925									

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

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

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

OPERATING CONDITIONS					
PRESSURES PSIG		RATES S.C.F.H.			
Oxygen	431	Fresh Feed	15223		
Natural Gas	417	Recycle	15822		
Generator Outlet	409	Combined Feed	31045		
Reactor Inlet	393	Wet Gas—Measured	5457		
Condenser Inlet		Adjusted	5804		
Product Accumulator	376	Loss	343		
TEMPERATURES—°F.		Recycle/Fresh Feed	1.039		
Oxygen	473	Inlet Velocity—ft./sec.	1.005		
Natural Gas	566	Fresh Feed Rate—S.C.F.H.	14661		
Generator		per Cu. Ft. Dense Bed	1163		
Quench Accumulator	150	per Lb. Catalyst	9.28		
Reactor Inlet	313				
Condenser Inlet					
Product Accumulator		Heat Transfer Calculations			
Catalyst No. Height #		Steam Rate = 383.4 #/hr			
1	12.0	679	@ 816 psia & 520°F = 1196 BTU/#		
2	43.2	648	Water in @ 183°F = 151 BTU/#		
3	74.4	670	Heat Transferred/lb. steam		
4	105.6		= 1045 BTU/#		
5	136.8	659	(1045)(383.4) = 400653 BTU/hr		
6	168.0	653	Ave. Rad Temperature		
7	199.2	642	= 659°F		
8	230.4	632	dT = 659-520 = 139°F		
9	261.6	628	Tube Area = 30.9 ft²		
10	292.8	627	X = 400653 / (139)(30.9) =	93.3	
12	342.0	617			

PRODUCT TESTS			
	OIL	WATER	
°API	42.9	10.6	
Neut. No.	38.9	38.5	
Sap. No.	48.3	42.8	
Hydrox. No.			
Bromine No.	79.9		
Pour °F.			
Chemicals, % by K_2CO_3		10.0	
HEMPEL. DIST. %		°API	
205 °F.			
400	72.6	54.4	
400-550	13.3	35.9	
550+	14.1		
A. S. T. M. DIST. ON			
Naphtha °F.			
IBP	107		
10%	147		
50%	235		
90%	351		
EP	402		
	98		

CATALYST DATA					
INVENTORY DATA		PARTICLE SIZE			
In Reactor at Start of Period	1962	Screen Analysis			Sedimentation	
Fresh Catalyst Added 51#	77	Mesh	Microns	%	Microns	%
Total	2039	On 40	419+	8.8	80+	
Catalyst Recovered	69	100	150	62.1	40—80	
In Reactor at End of Period	1970	150	105	12.9	20—40	
		200	74	7.8	10—20	
REACTOR d-p, Inches H_2O		250	62	3.5	0—20	
No. Height "		325	44	3.3		
1 12 - 43.2	57	<325		1.6		
2 43.2 - 74.4	61	CATALYST				
3 74.4 - 105.6	68	Bulk Density, Lbs./Cu.Ft.				
4 105.6 - 342.0	250	Aerated			144	
(Calc) 0-12"	24	Settled			146	
total	460	Compacted			165	
		Particle Density, gm./cc.			4.3	
CALCULATED FROM dp		NH_3 Value, ml./gm.			14.16	
Density, Lbs./Cu.Ft.	124	N_2 Surface, m^2/gm.				
Inventory, Lbs.	1579					
Bed Depth, Ft.	12.10	CHEMICAL ANALYSIS				
Volume, Cu Ft	12.61	Fe				
		C				
		O				
		H				
		K_2O. W+. % basis Fe				
		X-Ray Analysis—				
		$Fe_{2.2}C_0$				
		Fe_2O_3				
		Fe				

GAS ANALYSES					GENERATOR BALANCE									WEIGHT BALANCE		
HOUR	1300	2100	0500	AVERAGE	M/HR	C	H	O		Mol %	M/Hr	C	H	O		# hr Measured	At. Wt. Balance
FRESH FEED									O_2 32.000	0.52	0.074 10.633			21.414	WET GAS	301.91	321.11
CO 28.010	37.28	36.90	37.31	37.163	14.927	14.927		14.927	CO 28.010						OIL	68.01	68.01
H_2 2.016	59.16	59.31	58.96	59.144	23.756		47.512		H_2 2.016						WATER	135.00	135.00
CO_2 44.010	2.63	2.62	2.90	2.683	1.078	1.078		2.156	CO_2 44.010	1.76	0.251	0.251		0.502	TOTAL	504.92	
N_2 28.016	0.75	0.98	0.88	0.870	0.349				N_2 28.016	2.00	0.285				FRESH FEED	524.12	
CH_4 16.042	0.18	0.19	0.05	0.140	0.056	0.056	0.224		CH_4 16.042	81.44	11.610	11.610	46.440		WEIGHT BALANCE	96.34	
			M. W.	13.0486					C_2H_6 30.068	8.74	1.246	2.492	7.476				
			H_2O 18.016				11.112	5.556	C_2H_4 44.024	5.38	0.767	2.301	6.136		WET GAS FACTOR		1.06359
						16.061	58.848	22.639	C_3H_6 58.120	0.12 0.04	0.017 0.006	0.068 0.030	0.170 0.072		INDICATED LOSS—S C F H		343
			BALANCE			95.88	97.60	103.30	TOTAL				16.752	60.294	21.916			

WET GAS				GAS FLOW RATES								LIQUID PRODUCT RATES							
CO 28.010	14.66		14.86	14.760		V-B	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	44.59		44.44	44.515	FRESH FEED		393.4	75.8				OIL	7'5½	386.41	72	0.9941	384.13		2503.0	
CO_2 44.010	24.92		25.42	25.170	79.31	6.476	20.2022	0.9850	15223	1.4895	40.167		4'11½	219.46	66	0.9970	218.80	49.5 6.509	1424.2	
N_2 28.016	1.96		2.28	2.120	WET GAS		1.788	70.6									165.33		1078.8	
CH_4 16.042	5.88		5.39	5.635	158.44	7.288	4.0642	0.9896	5457	1.1750	14.398		1'11½	102.89	66	0.9970	102.58	49.9	662.6	
C_2H_6 28.052	2.01		2.10	2.055	RECYCLE		397.9	121.7					0'4	17.70	64	0.9980	17.66	6.459	114.1	68.01
C_2H_4 33.068	0.82		0.82	0.820	115.14	5.670	20.5132	0.9452	14728	1.1750	38.860						84.92		548.5	10.459
C_3H_6 42.078	2.16		2.10	2.130	BLEED		397.9	121.7									40.77 251.02		48 1638.5	
C_3H_8 44.094	0.44		0.45	0.445	5.02	9.660	20.5132	0.9452	1094	1.1750	2.867	WATER	7'12½	383.14	64	0.9969	381.95	10.6	3167.5	
C_4H_8 56.104	1.32		1.25	1.285	NATURAL GAS		416.6	204.3	15822		41.747		4'2½	224.92	80	0.9976	224.36	8.293	1860.8	
C_4H_{10} 58.120	0.42		0.24	0.330	28.43	8.523	20.7684	0.8849	5403	1.2153	14.256						157.57		1306.7	
C_5H_{10} 70.130	0.60		0.49	0.545	OXYGEN		431.0	77.1					4'7½	246.74	74	0.9985	246.37	10.6	2043.1	
C_5H_{12} 72.146	0.07		0.07	0.070	27.07	7.166	21.1123	0.9840	4030				0'3	13.28	80	0.9976	13.25	8.293	109.9	135.00
C_6H_{12} 84.156	0.15		0.09	0.120	STEAM		58.0										233.12		1933.2	16.879
			M. W.	20.9688	215.7	5.53	0.3814		383.4#/hr								390.69		3239.9	