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TEXACO INC.

RESEARCH AND TECHNICAL DEPARTMENT

REPORT ON

PRELIMINARY REPORT ON SYNTHESIS OPERATIONS

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Laboratory MONTEBELLO

Experiment No. _____

Research Report No. _____

Date 1947

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THE TEXAS COMPANY
MONTEBELLO EXPERIMENT STATION

PRELIMINARY REPORT ON SYNTHESIS OPERATIONS

February 15, 1947

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INTRODUCTION

The following report covers the operation of the Montebello Synthesis Unit for the period July 9, 1946 through February 15, 1947. Since all of the runs have been short, and since the data have not been analyzed extensively, they should be regarded as preliminary and subject to later revision and confirmation. It is believed, however that these data clearly demonstrate the feasibility of steam cooling in the synthesis reactor and that they provide a useful confirmation of the yield and activity data obtained at other locations.

EQUIPMENT

The Montebello Unit is equipped with a synthesis gas generator having an internal volume of about 2 cu. ft. which is fed with natural gas and oxygen which have been preheated to about 900 and 600 F. respectively. An internal, tip-mixing burner is used and the generator is an open, ceramic lined chamber. Product gas from the generator is quenched with a water jet at the outlet of the generator and the mixture of gas and water separated in an accumulator.

The synthesis reactor consists of a length of 10 inch extra heavy pipe 30 ft. long which is fitted with three 2 inch extra heavy cooling tubes which extend the full length of the reactor. They are connected at the top to a steam drum and at the bottom to a mud drum, thermosyphon circulation in the boiler system being maintained by means of an external water leg. This steam system provides the only cooling for the reactor, the

external shell being insulated with 4 inches of block insulation. The product stream from the reactor passes through two 12 inch cyclone separators which are aranged in series between the reactor and the condenser. Catalyst recovered in the primary cyclone is returned continuously to the reactor by means of a standpipe, slide valve and transfer line. Catalyst is conveyed through the transfer line by means of a stream of recycle gas sufficient to maintain a velocity of about 50 ft. per sec. A second stream of recycle gas is injected at the base of the standpipe to maintain fluidization (about 0.5 ft.per sec.) and the remaining recycle stream is mixed with the fresh feed and fed to the base of the reactor. All recycle and the fresh feed stream are preheated to approximately reactor temperature. Catalyst recovered in the secondary cyclone is weighed, and provision is made to recharge catalyst to the reactor.

OPERATION

Fresh unreduced catalyst is charged to the reactor and standpipe in the desired quantity and fluidized by circulating natural gas through the system. The pressure is then raised to 200 psig and the preheaters lit and the system brought up to a temperat ure of 750 F. The outlet valve is then closed, the natural gas shut off, and the system maintained under pressure by adding hydrogen. Reduction is continued for about 12 hours at a temperature as near 750 F. as possible. Reduction is ordinarily terminated by the exhaustion of the hydrogen supply. Natural gas circulation is then resumed and reactor temperatures lowered to 650 F. The generator is then started by introducing a few glowing wood embers, flanging up the burner, starting the flow of oxygen and immediately thereafter starting the flow of

natural gas. The rates of gas and oxygen flow are adjusted to give a mixture containing about 55 to 60 % oxygen during the initial operating period and as the generator comes up to temperature, the mixture is reduced to about 40 to 45 % oxygen content. Simultaneously, the pressure is brought up to 200 psig and the mixture adjusted to give a product gas containing 3 to 4 % methane by explosion orsat.

When the generator is in full operation, fresh feed is introduced into the reactor, decreasing the flow of recycle gas to hold the desired reactor velocity. As the fresh feed is cut in, reaction starts, and the isolating valve between the water leg and the steam tubes in the cooling system is gradually opened and the boiler pressure is brought up to the operating level to hold the desired reactor temperature.

CATALYST

All of the catalyst used at Montebello has been of the potassium fluoride impregnated roasted pyrites variety, having the following properties:

	LOT 1 Runs 1 through 7	LOT 2 Runs 8 through 11
Chemical Analysis:		
Wt. % Fe	67.3	
Wt. % KF	2.0	
X-Ray Diffraction Analysis- %		
Fe_2O_3	50	
Fe_3O_4	50	
Screen Analysis:		
meshes per inch	% Retained	
35	0.0	26.2
100	9.6	17.2
150	12.9	12.6
200	14.8	8.8
250	1.9	7.3
325	14.4	5.2
To Pan	46.4	22.2

DISCUSSION

To date eleven runs have been made. The principal operating conditions are summarized in the following table:

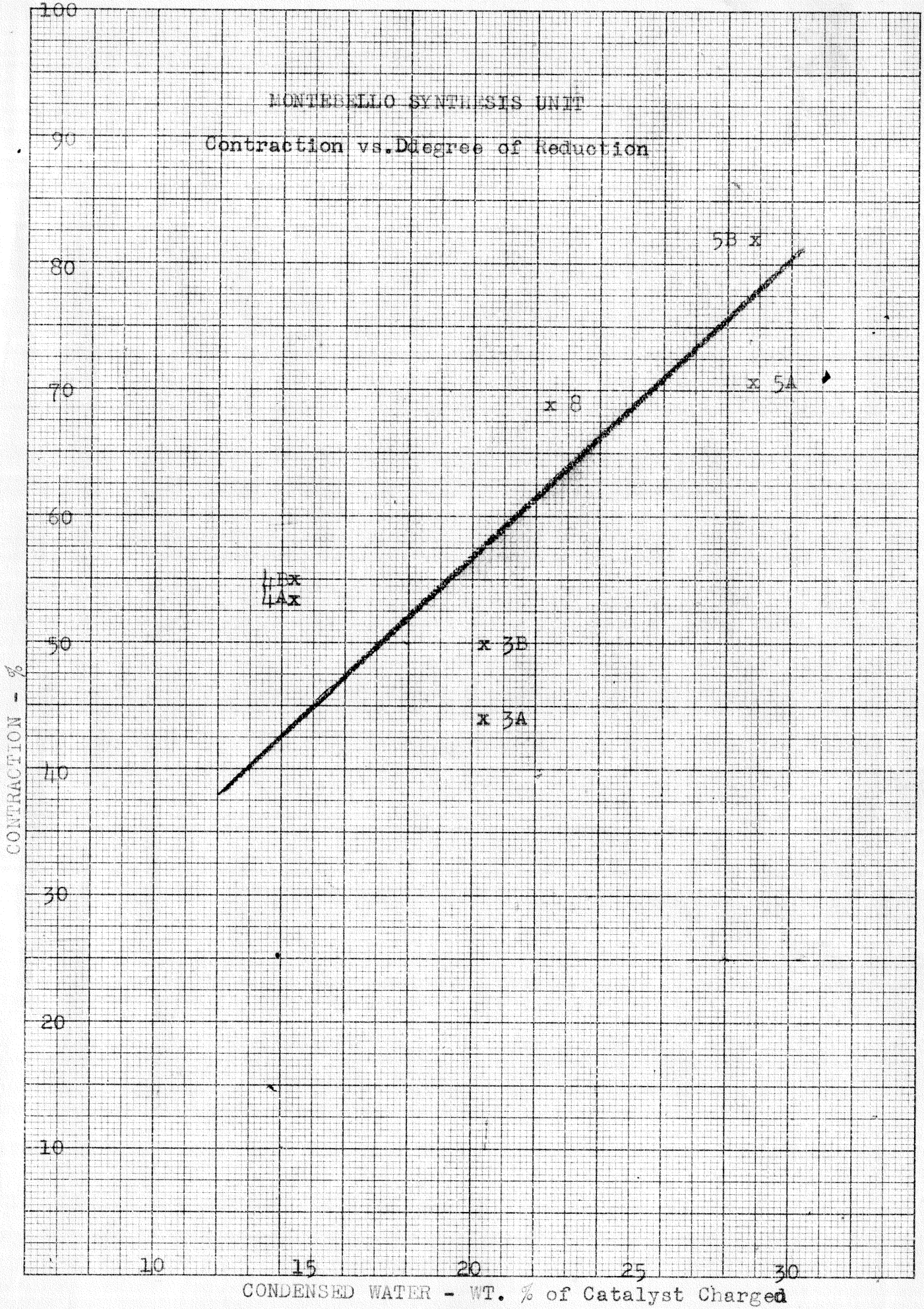
MONTEBELLO EXPERIMENT STATION
SUMMARY OF SYNTHESIS DATA

RUN NO.	DATE	HOURS RUN	HOURS CAT	BED TEMP.	REACTOR VELOCITY	RECYCLE RATIO	CONTRACTION- %	CO CONVERTED: CO_2	C_1C_2	C_{3+}	REASON FOR SHUTDOWN
1	7/9	16	16		1.3	1.3	23				Cat. Transfer Line
2A	8/1	18	18	570	1.2	4.7	66	18	16	63	
2B		14	32	595	0.6	0.0	33				Cat. Transfer Line
3A	10/13	16	16	610	1.4	1.4	44	34	10	46	
3B		18	34	600	1.4	1.3	50	31	11	47	Burner Failure
4A	10/28	12	12	650	1.8	1.5	54	26	7	57	
4B	10/29	16	28	650	1.7	1.5	56	24	9	57	Gen.Transf.Line
5A	11/22	10	10	625	1.5	1.6	70	20	8	64	(Well reduced
5B		16	26	625	1.5	1.5	82	7	6	84	Slide Valve
6	11/30	12	39	600	1.4	1.3	67	18	11	66	Boiler Feed Pump
7A	12/5	28	55	610	1.3	1.3	56	25	10	59	
7B		2	57	800	1.4	1.3	68	14	22	59	Slide Valve
8	1/13	23	23	670	1.4	1.4	69	10	5	73	Slide Valve
9A	1/27	23	23	635	1.8	1.0	64				
9B		11	34	610	2.2	1.5	69				Quench Failure
10	2/1	9	9	620	1.6	1.3	76				Transfer Line
11	2/3	33	33	635	2.2	1.7	62				Slide Valve

It will be noted that the principal operating problems have been connected with the operation of the standpipe-slide valve system which has proved very difficult to control satisfactorily over extended periods. This is, of course, associated with the use of small lines as required on equipment of this size, the standpipe being 3 inch pipe and the slide valve having an opening of about 1 inch. These small sizes lead to easy plugging particularly if the catalyst is at all wet. The other principal operating problem has been the training of new operating personnel.

A study of the results obtained to date has shown that the activity of the catalyst is strongly influenced by the degree of reduction. This is illustrated in the attached plot which indicates that the % contraction increases from about 40% when the yield of water on reduction is 10% by weight of the catalyst charged, to about 75 % when the water yield is in the range of 30% There is also a consistent improvement in results between the first and second operating periods of the runs made. Although it is possible that runs of longer duration with poorly reduced catalyst might eventually reach contraction levels as high as those obtained with fully reduced catalyst, this does not appear likely with the data at hand.

A comparison of the present data with the Gaucher correlation is shown in the following tabulation. It is evident that this correlation agrees well with the present data, particularly in view of the fact that the only data used in entering the correlation were contraction, H_2/CO ratio in the fresh feed, and recycle ratio.



KEUFFEL & ESSER CO.
NO. 359-11 10 × 10 to the half inch, 5th lines accented.
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MONTEBELLO SYNTHESIS UNIT

COMPARISON OF OBSERVED DATA WITH GAUCHER CORRELATION

RUN NUMBER	2A		3A		3B		4A		4B	
	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.
Contraction, %	66.1		44.1		50.0		53.5		56.0	
Conversion of H_2, %	75.6	72	49.5	48	55.4	55	58.5	58	61.0	61
Conversion of CO, %	97.2	98	88.8	80	89.3	88	89.5	90	89.7	93
% CO Converted to:										
CO_2	18.3	22	37.9	35	35.2	30	29.0	29	26.8	28
C_1 & C_2	16.6	21	10.7	12	12.1	11	7.7	11	9.6	11
C_3 & Heavier	65.1	57	51.4	53	52.7	59	63.4	60	63.6	61

RUN NUMBER	5A		5B		6		7		8	
	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.
Contraction, %	70.2		82.1		66.7		68.5		69.1	
Conversion of H_2, %	82.1	78	88.3	90	72.1	73	81.0	75	71.9	76
Conversion of CO, %	92.8	99	97.0	99	95.3	98	94.5	98	87.9	99
% CO Converted to:										
CO_2	21.4	19	7.0	9	18.5	22	14.3	20	11.5	20
C_1 & C_2	9.1	10	6.3	4	12.0	13	23.2	12	6.0	11
C_3 & Heavier	69.5	71	86.7	87	69.5	65	62.5	68	82.5	69

Run 7B is of unusual interest since it was made at a temperature of 800 F. in place of the 600-650 F. range used in the remaining runs. This higher temperature resulted from the failure of the boiler feed pump, the run being continued without cooling and with cold fresh feed and recycle. This operation was apparently staisfactory from an operations standpoint and as compared with Run 7A gave the same yield of C_3 and heavier but more methane and less carbon dioxide and a somewhat higher contraction. The run was only continued long enough to obtain representative gas samples.

Heat transfer data have not yet been analyzed in sufficient detail to draw conclusions as to all the relations existing, but it is clear that over-all heat transfer coefficients are well above 100 B.t.u./hr./sq.ft./ F. based on the total cooling surface in the reactor, and that the coefficients are on the order of 300 based on the dense phase only. Runs 9A and 9B which were made with the same fresh feed rates but with different recycle rates show that the transfer coefficient varies with reactor velocity.

In the runs reported here there has been no sign of the decrease in bed density which has been troublesome in other operations. This is believed to result from the ability of the cyclone system to reject excessively fine catalyst and maintain a bed density of some 60 to 80 lbs./cu. ft. It is found in this operation that there is an appreciable loss of catalyst to the second cyclone soon after fresh catalyst is charged and that the rate of loss then falls to a value on the order of one pound per hour.

MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	1	2A	2B	3A	3B
Start	16:00 7/9	17:00 8/1	11:00 8/2	15:00 10/13	7:00 10/14
End	8:00 7/10	11:00 8/2	1:00 8/3	7:00 10/14	1:00 10/15
Duration	16:00	16:00	14:00	16:00	18:00
GENERATOR DATA					
Pressure-psig	210	210	210	215	215
Gas Rate-scfh	2910	2400	2400	2120	2140
Oxygen Rate-scfh	2200			1820	1840
Product Rate-scfh	8600	7300	6780	6350	6700
Product Composition-Corrected Explosion Orsat-mol %					
CO + .7	35.7	35.5	35.3	34.2	34.0
H_2	56.4	57.2	56.9	58.9	58.4
CO_2	2.4	2.2	2.6	2.3	2.0
N_2 - .6	1.4	3.3	0.6	1.0	3.3
CH_4 - 1.1	4.1	1.8	4.6	3.6	2.3
SYNTHESIS DATA					
Pressure-psig	200	200	200	200	200
Recycle Rate-scfh	10520	8515	0	8815	8732
Fresh Feed Rate-scfh	8050	1800	6780	6350	6700
Wet Gas Rate-scfh	6200	610	4930	3550	3350
Catalyst Temperature- F.		570	585	610	600
Catalyst Density-#/cu.ft.		87	76	81	
Catalyst Fluidized-#		197	210	265	
Depth of Bed-ft.			6.3	6.3	
Space Velocity-CFH/# Cat.		9	35	24	
Inlet Velocity-ft./sec.		1.2	0.6	1.4	1.4
Recycle Ratio	1.3	4.7	0	1.4	1.3
Contraction- %	23	66	33	44	50
Recovered Oil-gal./hr.	1.2	0.7	0.8	---2.04---	
Condensed Water-gal./hr.	6.2	3.8	4.4	---9.65---	
Steam Pressure-psig	500	800	850	900	900
Steam Rate-#/hr.	217		250		206
Wet Gas Composition by Mass Spectrometer-mol %					
CO		2.9		6.85	7.3
H_2		41.1		53.3	52.1
CO_2		25.1		24.7	25.3
N_2		7.0		1.4	1.3
CH_4		16.4		8.7	8.5
C_2H_4		1.9		1.25	1.3
C_2H_6		1.0		0.5	0.4
C_3H_6		1.7		1.25	0.7
C_3H_8		0.6		0.15	0.2
C_4H_8		1.3		1.05	1.4
C_4H_{10}		0.2		0.2	0.4
C_5H_{10}		0.5		0.5	0.8
C_5H_{12}		0.3		0.15	0.3
Conversion of CO- %		97.2		88.8	89.3
Conversion of H_2- %		75.6		49.5	55.4
CO Fed Converted to:					
CO_2		17.8		33.7	31.4
C_1 & C_2		16.1		9.5	10.8
C_3 & Heavier		63.3		45.6	47.1

MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	4A	4B	5A	5B
Start	19:00 10/28	7:00 10/29	21:00 11/22	7:00 11/23
End	7:00 10/29	23:00 10/29	7:00 11/23	23:00 11/23
Duration	12:00	16:00	10:00	16:00
GENERATOR DATA				
Pressure-psig	210	210	210	210
Gas Rate-scfh	2350	2350	2040	2040
Oxygen Rate-scfh	1920	1920	1680	1680
Product Rate-scfh	7060	7150	5940	6180
Product Composition-Corrected Explosion Orsat-mol %				
CO	34.1	34.4	35.0	35.0
H_2	58.5	59.0	58.1	58.2
CO_2	2.2	2.4	1.9	1.8
N_2	1.6	1.5	0.7	2.2
CH_4	3.6	2.7	4.3	2.8
SYNTHESIS DATA				
Pressure-psig	210	210	200	200
Recycle Rate-scfh	10780	10640	9512	9580
Fresh Feed Rate-scfh	7060	7150	5940	6180
Wet Gas Rate-scfh	3280	3150	1770	1100
Catalyst Temperature- F.	650	650	625	625
Catalyst Density-#/cu.ft.	81	66	92	90
Catalyst Fluidized-#	315	270	315	345
Depth of Bed-ft.	9.2	9.6	8.0	9.0
Space Velocity-cfh/# Cat	23	26	19	18
Inlet Velocity-ft./sec.	1.8	1.7	1.5	1.5
Recycle Ratio	1.5	1.5	1.6	1.5
Contraction- %	54	55	71	82
Recovered Oil-gal/hr	4.1	3.7	4.0	5.6
Condensed Water-gal/hr	10.1	9.5	7.8	8.8
Steam Pressure-psig	960	960	980	980
Steam Rate-#/hr.	227	227	136	220
Wet Gas Composition by Mass Spectrometer-mol %				
CO	7.7	8.0		
H_2	51.4	52.0		
CO_2	23.8	24.2		
N_2	1.7	1.4		
CH_4	9.3	9.7		
C_2H_4	1.3	1.2		
C_2H_6	0.4	0.4		
C_3H_6	1.2	1.2		
C_3H_8	0.1	0.2		
C_4H_8	1.0	0.9		
C_4H_{10}	0.4	0.3		
C_5H_{10}	0.7	0.5		
Conversion of CO- %	89.5	89.7		
Conversion of H_2- %	58.5	61.0		
CO Fed Converted to:				
CO_2	25.9	24.0		
C_1 & C_2	6.9	8.7		
C_3 & Heavier	56.7	57.0		

THE TEXAS COMPANY
MONTEBELLO SYNTHESIS UNIT
Summary of Preliminary Data

RUN NUMBER	6A	6B	7A	7B
Start	17:00	3:00	9:30	13:00
	11/30	12/1	12/5	12/6
End	3:00	5:00	13:00	18:30
	12/1	12/1	12/6	12/6
Duration	10:00	2:00	27:30	2:00
GENERATOR DATA				
Pressure-psig	210		210	
Gas Rate-scfh	2110		2190	
Oxygen Rate-scfh	1730		1810	
Product Rate-scfh	6600		6770	
Product Composition by Explosion Orsat-mol %				
CO	33.2		32.4	
H_2	59.2		58.6	
CO_2	1.8		2.0	
N_2	2.5		2.5	
CH_4	3.3		4.5	
SYNTHESIS DATA				
Pressure-psig	200		200	200
Fresh Feed Rate-scfh	6600		6770	6770
Recycle Rate-scfh	8376		8660	8660
Net Gas Rate-scfh	2200		3000	2140
Catalyst Temperature- F.	600		610	800
Catalyst Density-#/cu.ft.	81		78	
Catalyst Fluidized-#	610		500	
Depth of Bed-ft.	17.2		14.9	
Space Velocity-cfh/# Cat.	11		13	
Inlet Velocity-ft./sec.	1.4		1.3	1.4
Recycle Ratio	1.3		1.3	1.3
Contraction-%	67		56	68
Recovered Oil-gal./hr.	1.9	3.5	2.8	
Condensed Water-gal./hr.	6.5	11.0	5.4	
Steam Pressure-psig	1000		1000	
Steam Rate-#/hr.	188		149	
% CO_2 in Net Gas by Orsat	27.5		22.3	24.3

MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	1	2A	2B	3A	3B
Start	16:00 7/9	17:00 8/1	11:00 8/2	15:00 10/13	7:00 10/14
End	8:00 7/10	11:00 8/2	1:00 8/3	7:00 10/14	1:00 10/15
Duration	16	18	14	16	18
GENERATOR DATA					
Pressure-psig	210	210	210	215	215
Gas Rate-scfh	2910	2400	2400	2120	2140
Oxygen Rate-scfh	2200			1820	1840
Product Rate-scfh	8600	7300	6780	6450	6700
Product Composition by Corrected Explosion Orsat- mol %					
CO	35.7	35.5	35.3	34.2	34.0
H_2	56.4	57.2	56.9	58.9	58.4
CO_2	2.4	2.2	2.6	2.3	2.0
N_2	1.4	3.3	0.6	1.0	3.3
CH_4	4.1	1.8	4.6	3.6	2.3
SYNTHESIS DATA					
Pressure-psig	200	200	200	200	200
Recycle Rate-scfh	10520	8515	0	8815	8732
Fresh Feed Rate-scfh	8050	1800	6780	6350	6700
Wet Gas Rate-scfh	6200	610	4930	3550	3350
Catalyst Temperature- F.		570	585	610	600
Catalyst Density-#/cu.ft.		87	76	81	
Catalyst Fluidized-#		197	210	265	
Depth of Dense Phase-ft.			6.3	6.5	
Fresh Feed-cfh/# cat.		9	35	24	
Inlet Velocity-ft./sec.	1.3	1.2	0.6	1.4	1.4
Recycle Ratio-	1.3	4.7	0	1.4	1.3
Contraction- %	23	66	33	44	50
Measured Oil-gal./hr.	1.2	0.7	0.8	--2.04--	
Measured Water-gal./hr.	6.2	3.8	4.4	--9.65--	
Steam Pressure-psig	1	800	850	900	900
Steam Rate-#/hr.	217		250		206
Wet Gas Composition by Mass Spectrometer- mol %					
CO		2.9		6.8	7.3
H_2		41.1		53.3	52.1
CO_2		25.1		24.7	25.3
N_2		7.0		1.4	1.3
CH_4		16.4		8.7	8.5
C_2H_4		1.9		1.3	1.3
C_2H_6		1.0		0.5	0.4
C_3H_6		1.7		1.2	0.7
C_3H_8		0.6		0.2	0.2
C_4H_8		1.3		1.0	1.4
C_4H_{10}		0.2		0.2	0.4
C_5H_{10}		0.5		0.5	0.8
C_5H_{12}		0.3		0.2	0.3
Conversion of CO- %		97.2		88.8	89.3
Conversion of H_2- %		75.6		49.5	55.4
CO Converted to:					
CO_2		17.8		33.7	31.4
C_1 & C_2		16.1		9.5	10.8
C_3 & Heavier		63.3		45.6	47.1
Unconverted		2.8		11.2	10.7

MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	4A	4B	5A	5B
Start	19:00 10/28	7:00 10/29	21:00 11/22	7:00 11/23
End	7:00 10/29	23:00 10/29	7:00 11/23	23:00 11/23
Duration	12	16	10	16
GENERATOR DATA				
Pressure-psig	210	210	210	210
Gas Rate-scfh	2350	2350	2040	2040
Oxygen Rate-scfh	1920	1920	1680	1680
Product Rate-scfh	7060	7150	5940	6180
Product Composition-Corrected Explosion Orsat- mol %				
CO	34.1	34.4	35.0	35.0
H_2	58.5	59.0	58.1	58.2
CO_2	2.2	2.4	1.9	1.8
N_2	1.6	1.5	0.7	2.2
CH_4	3.6	2.7	4.3	2.8
SYNTHESIS DATA				
Pressure-psig	210	210	200	200
Recycle Rate-scfh	10780	10640	9512	9580
Fresh Feed Rate-scfh	7060	7150	5940	6180
Wet Gas Rate-scfh	3280	3150	1770	1100
Catalyst Temperature- F.	650	650	625	625
Catalyst Density- #/cu.ft.	81	66	92	90
Catalyst Fluidized- #	315	270	315	345
Depth of Dense Phase-ft.	9.2	9.6	8.0	9.0
Fresh Feed- cfh/# catalyst	23	26	19	18
Inlet Velocity-ft./sec.	1.8	1.7	1.5	1.5
Recycle Ratio	1.5	1.5	1.6	1.5
Contraction- %	54	56	70	82
Measured Oil-gal/hr	4.1	3.7	4.0	5.6
Measured Water-gal/hr	10.1	9.5	7.8	8.8
Steam Pressure-psig	960	960	980	980
Steam Rate- #/hr.	227	227	136	220
Wet Gas Composition by Mass Spectormeter- mol %				
CO	7.7	8/0	8.6	5.6
H_2	52.4	52.0	35.0	38.5
CO_2	23.8	24.2	29.7	23.4
N_2	1.7	1.4	0.0	1.9
CH_4	9.3	9.7	16.9	19.6
C_2H_4	1.3	1.2	2.7	2.6
C_2H_6	0.4	0.4	1.1	1.4
C_3H_6	1.2	1.2	2.9	3.3
C_3H_8	0.1	0.2	0.5	0.4
C_4H_8	1.0	0.9	1.9	2.1
C_4H_{10}	0.4	0.3	0.0	0.3
C_5H_{10}	0.7	0.5	0.8	0.9
Conversion of CO- %	89.5	89.7	92.8	97.0
Conversion of H_2- %	58.5	61.0	88.3	82.1
CO Converted to:				
CO_2	25.9	24.0	19.8	6.8
C_1 & C_2	6.9	8.7	8/4	6.1
C_3 & Heavier	56.7	57.0	64.5	84.3
Unconverted	10.5	10.3	7.3	2.8

from batch coal

MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	6A	6B	7A	7B	8
Start	17:00 11/30	3:00 12/1	9:30 12/5	13:00 12/6	10:00 1/13
End	3:00 12/1	5:00 12/1	13:00 12/6	18:30 12/6	22:00 1/13
Duration	10	2	27½	2	12
GENERATOR DATA					
Pressure-psig	210	210	210	210	210
Gas Rate-scfh	2110	2110	2190	2190	2063
Oxygen Rate-scfh	1730	1730	1810	1810	1584
Product Rate-scfh	6600	6600	6770	6770	6350
Product Composition by Corrected Explosion Orsat- mol %					
CO	34.9	34.9	34.1	34.1	35.3
H_2	59.2	59.2	58.6	58.6	58.7
CO_2	1.8	1.8	2.0	2.0	2.5
N_2	1.9	1.9	1.9	1.9	2.3
CH_4	2.2	2.2	3.4	3.4	1.2
SYNTHESIS DATA					
Pressure-psig	200	2002	200	200	200
Fresh Feed Rate-scfh	6600	6600	6770	6770	6350
Recycle Rate-scfh	8376	8376	8660	8660	8620
Wet Gas Rate-scfh	2200	2200	3000	2140	1960
Catalyst Temperature- F.	600	600	610	800	670
Catalyst Density-#/cu.ft.	81	81	78		112
Catalyst Fluidized-#	610		500		241
Depth of Dense Phase-ft.	17.2		14.9		5.0
Fresh Feed-cfh/# cat.	11		13		26
Inlet Velocity-ft./sec.	1.4		1.3	1.4	1.4
Recycle Ratio	1.3		1.3	1.3	1.4
Contraction- %	67		56	68	69
Measured Oil-gal./hr.	1.9	3.5	2.8		
Measured Water-gal./hr.	6.5	11.0	5.4		
Steam Pressure-psig	1000	1000	1000		
Steam Rate-#/hr.	188		189		
% CO_2 in Wet Gas by Orsat	27.5		22.3	24.3	20.0
Wet Gas Composition by Mass Spectrometer- mol %					
CO	5.1		11.6	6.1	13.8
H_2	49.7		46.9	35.2	53.4
CO_2	23.8		23.5	20.9	19.7
N_2	0.9		0.5	2.3	2.4
CH_4	12.4		10.6	25.9	6.7
C_2H_4	2.2		1.8	2.5	1.1
C_2H_6	0.9		0.7	1.8	0.5
C_3H_6	2.3		1.8	2.3	0.8
C_3H_8	0.4		0.3	0.6	0.2
C_4H_8	1.5		1.4	1.5	0.8
C_4H_{10}	0.2		0.2	0.3	0.2
C_5H_{10}	0.7		0.7	0.7	0.4
Conversion of CO- %	95.3		84.9	94.5	87.9
Conversion of H_2- %	72.1		64.6	81.0	71.9
CO Converted to:					
CO_2	17.6		24.6	13.5	10.2
C_1 & C_2	11.4		10.5	21.9	5.2
C_3 & Heavier	66.2		49.8	59.0	72.5
Unconverted	4.8		15.1	5.6	12.1

MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	9A	9B	10	11A	11B
Start	10:00 1/27	9:00 1/28	10:00 2/1	11:00 2/3	8:00 2/4
End	9:00 1/28	20:00 1/28	19:00 2/1	8:00 2/4	20:00 2/4
Duration	23	11	9	21	12
Catalyst Age	23	34	43	64	76
Generator Data					
Pressure-psig	205	205	200	200	200
Gas Rate-scfh	3000	2950		2790	3200
Oxygen Rate-scfh	2150	2100		1940	2200
Product Rate-scfh	9400	9200		8300	9400
Product Composition-Corrected Explosion Orsat- mol %					
CO	34.0	34.2	35.7	34.9	35.1
H_2	59.9	58.2	59.7	58.0	59.5
CO_2	1.9	1.7	2.3	2.0	2.1
N_2	1.9	2.5	0.9	2.3	0.7
CH_4	2.3	3.4	1.4	2.8	2.0
Synthesis Data					
Pressure-psig	205	205	200	200	200
Recycle Rate-scfh	9135	13940	10270	14357	14357
Fresh Feed Rate-scfh	9400	9200	7700	8300	9400
Wet Gas Rate-scfh	3390	2850	1850	3160	
Catalyst Temperature- F.	635	610	620	635	635
Catalyst Density-#/cu.ft.	84	90			
Catalyst Fluidized	347	475			
Depth of Dense Phase-ft.	9.6	12.4			
Fresh Feed-cfh/# cat.	27	20			
Inlet Velocity-ft./sec.	1.8	2.2	1.6	2.2	
Recycle Ratio	1.0	1.5	1.3	1.7	1.5
Contraction- %	64	69	76	62	
Measured Oil-gph	4.8	8.5			
Measured Water-gph	11.5	20.0			
Steam Pressure-psig	1000	1000	1000	1000	
Steam Rate-#/hr.	465	465		435	
% CO_2 in Wet Gas	27.7	30.0		21.7	

MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	9A	9B	10	11A	11B
Start	10:00 1/27	9:00 1/28	10:00 2/1	11:00 2/3	8:00 2/4
End	9:00 1/28	20:00 1/28	19:00 2/1	8:00 2/4	20:00 2/4
Duration	23	11	9	21	12
Catalyst age	23	34	43	64	76
GENERATOR DATA					
Pressure-psig	205	205	200	200	200
Gas Rate-scfh	3000	2950		2790	3200
Oxygen Rate-scfh	2150	2100		1940	2200
Product Rate-scfh	9400	9200		8300	9400
Product Composition-Corrected Explosion Orsat- mol %					
CO	34.0	34.2	35.7	34.9	35.1
H2	59.9	58.2	59.7	58.0	59.5
CO2	1.9	1.7	2.3	2.0	2.1
N2	1.9	2.5	0.9	2.3	0.7
CH4	2.3	3.4	1.4	2.8	2.0
SYNTHESIS DATA					
Pressure-psig	205	205	200	200	200
Recycle Rate-scfh	9135	13940	10270	14357	14357
Fresh Feed Rate-scfh	9400	9200	7700	8300	9400
Wet Gas Rate-scfh	3390	2850	1850	3160	3900
Catalyst Temperature- F	635	610	620	635	635
Catalyst Density-#/cu.ft.	84	90			
Catalyst Fluidized-#	347	475			
Depth of Dense Phase-ft.	9.6	12.4			
Fresh Feed-cfh/# cat.	27	20			
Inlet Velocity-ft./sec.	1.8	2.2	1.6	2.2	
Recycle Ratio	1.0	1.5	1.3	1.7	1.5
Contraction- %	64	69	76	62	59
Measured Oil-gph	4.8	8.5			
Measured Water-gph	11.5	20.0			
Steam Pressure-psig	1000	1000	1000	1000	1000
Steam Rate-#/hr	465	465		435	
% CO2 in Wet Gas by Orsat	27.7	30.0		21.7	
Wet Gas Composition by Mass Spectrometer- mol %					
CO	3.9	3.0	4.4	7.0	7.3
H2	46.4	41.5	50.5	50.0	46.8
CO2	21.9	24.2	26.8	22.0	20.1
N2	3.5	2.5	4.7	3.2	3.3
CH4	14.6	16.1	10.1	10.6	14.2
C2H4	2.5	2.9	1.4	1.9	2.0
C2H6	1.0	1.6	0.2	0.7	1.4
C3H6	2.5	3.4	0.5	1.7	1.6
C3H8	0.3	0.5	0.0	0.2	0.4
C4H8	2.4	2.6	0.5	1.5	1.5
C4H10	0.0	0.4	0.3	0.3	0.4
C5H10	1.0	1.3	0.6	0.9	1.0
Conversion of CO- %	95.8	97.3	97.0	92.2	91.3
Conversion of H2- %	72.0	77.9	79.7	67.2	67.4
CO Converted to:					
CO2	17.6	17.0	11.6	18.3	17.7
C1 & C2	16.0	12.9	4.9	9.2	19.1
C3 & Heavier	62.2	67.4	80.5	64.8	54.5
Unconverted	4.2	2.7	3.0	7.7	8.7

RUN NUMBER 2 A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE	C	H	O	MW	#/hr	#/gal	gal/hr
CO	35.5	1.687	2.9	0.047	-1.640	-1.640		-1.640				
H_2	57.2	2.716	41.1	0.661	-2.055		-4.110					
CO_2	2.2	0.104	25.1	0.404	0.300	0.300		0.600				
N_2	3.3	0.157	7.0	0.113								
CH_4	1.8	0.086	16.4	0.264	0.178	0.178	0.712					
C_2H_4			1.9	0.031	0.031	0.062	0.124					
C_2H_6			1.0	0.016	0.016	0.032	0.096					
C_3H_6			1.7	0.027	0.027	0.081	0.162		0.90 x 42	1.02	6.25	0.163
C_3H_8			0.6	0.010	0.010	0.030	0.080					
C_4H_8			1.3	0.021	0.021	0.084	0.168		0.95 x 56	1.12	6.1	0.184
C_4H_{10}			0.2	0.003	0.003	0.012	0.030		58	0.17	4.86	0.035
C_5H_{10}			0.5	0.008	0.008	0.040	0.080		70	0.56	5.4	0.104
C_5H_{12}			0.3	0.005	0.005	0.025	0.060		72	0.36	5.25	0.069
OIL						0.796*	1.592		14	11.14	6.5	1.71
WATER							1.006*	1.040				
								503				
TOTAL		4.75		1.610				1543		14.37		2.265

Contraction: 4.75 - 1.61 / 4.75 = 66.1%
Conversion of CO: 1.640 / 1.687 = 97.2%
Conversion of H_2: 2.055 / 2.716 = 75.6%

Entering CO Converted to:

	m/hr	%
CO_2	0.300	17.8
C_1 & C_2	0.272	16.1
C_3 & Heavier	1.068	63.3
Unconverted	0.047	2.8

2A

Natural Gas Fed: 1800 x 0.395 / 1.20 = 592 SCFH

Oil Yields: 1.71 / 0.592 = 2.88 gal. recovered oil per MCF natural gas fed to generator
2.265/ 0.592 = 3.82 gal. ultimate oil per MCF natural gas
= 91 Bbl. ultimate oil per MMcf

RUN 3 A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	34.2	5.720	6.85	0.641	-5.079	-5.079		-5.079					
H_2	58.9	9.856	53.3	4.988	-4.868		-9.736						
CO_2	2.3	0.385	24.7	2.312	1.927	1.927		3.854					
N_2	1.0	0.167	1.4	0.131									
CH_4	3.6	0.602	8.7	0.815	0.213	0.213	0.852						
C_2H_4			1.25	0.117	0.117	0.234	0.468						
C_2H_6			0.5	0.047	0.047	0.094	0.282						
C_3H_6			1.25	0.117	0.117	0.351	0.702		0.90 x 42		4.42	6.25	0.708
C_3H_8			0.15	0.014	0.014	0.042	0.112						
C_4H_8			1.05	0.098	0.098	0.392	0.784		0.95 x 56		5.21	6.1	0.855
C_4H_{10}			0.2	0.019	0.019	0.076	0.190			58	1.10	4.86	0.226
C_5H_{10}			0.5	0.047	0.047	0.235	0.470			70	3.29	5.4	0.610
C_5H_{12}			0.15	0.014	0.014	0.070	0.168			72	1.01	5.24	0.192
OIL						1.445*	2.890			14	20.23	6.5	3.12
WATER							2.648*	1.225*					
								vs.1.424 from H_2 balance					
TOTAL		16.73		9.36							35.26		5.711

Fresh feed rate: 2120 x 1.20 / 0.401 = 6350 SCFH or 16.73 mols per hour
Wet gas rate: 3550 SCFH or 9.36 mols per hour

Contraction: 16.73 - 9.36 / 16.73 = 44.1 %
Conversion of CO: 5.079 / 5.720 = 88.8 %
Conversion of H_2: 4.868 / 9.856 = 49.5 %

Entering CO converted to:

	m/hr	%
CO_2	1.927	33.7
C_1 & C_2	0.541	9.5
C_3 & Heavier	2.611	45.6
Unconverted	0.641	11.2

3A

Oil yields: 3.12 / 2.12 = 1.47 gal. recovered oil per MCF natural gas fed to generator
5.71 / 2.12 = 2.7 gal. ultimate oil per MCF natural gas fed to generator
= 64 bbl. ultimate oil per MMCF

RUN NUMBER 3 B

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	34.0	6.01	7.3	0.645	-5.365	-5.365		-5.365					
H_2	58.4	10.325	52.1	4.600	-5.725		-11.450						
CO_2	2.0	0.354	25.3	2.240	1.886	1.886		3.772					
N_2	3.3	0.584	1.3	0.115									
CH_4	2.3	0.407	8.5	0.753	0.346	0.346	1.384						
C_2H_4			1.3	0.115	0.115	0.230	0.460						
C_2H_6			0.4	0.35	0.35	0.70	0.210						
C_3H_6			0.7	0.062	0.062	0.186	0.372		0.90 x	42	2.34	6.25	0.375
C_3H_8			0.2	0.18	0.18	0.54	0.144						
C_4H_8			1.4	0.124	0.124	0.496	0.992		0.95 x	56	6.60	6.1	1.082
C_4H_{10}			0.4	0.035	0.035	0.140	0.350			58	2.03	4.86	0.418
C_5H_{10}			0.8	0.071	0.071	0.355	0.710			70	4.96	5.4	0.920
C_5H_{12}			0.3	0.027	0.027	0.135	0.324			72	1.94	5.25	0.370
OIL						1.467*	2.934			14	20.52	6.5	3.16
WATER							3.570*	1.593*					
								vs 1.785 from H_2					
TOTAL		17.68		8.84							38.39		6.325

Fresh Feed Rate: 2140 x 1.20 / 0.383 = 6700 SCFH or 17.68 mols per hour
Wet Gas Rate: 3350 SCFH or 8.84 mols per hour

Contraction: 17.68 - 8.84 / 17.68 = 50.0 %
Conversion of CO: 5.365 / 6.01 = 89.3 %
Conversion of H_2: 5.725 / 10.325 = 55.4 %

Entering CO Converted to:

	m/hr	%
CO_2	1.886	31.4
C_1 & C_2	0.646	10.8
C_3 & Heavier	2.833	47.1
Unconverted	0.645	10.7

3B

Oil Yields: 3.16 / 2.14 = 1.48 gal. recovered oil per MCF natural gas fed to generator
6.325/ 2.14 = 2.96 gal. ultimate oil per MCF natural gas fed to generator
or 70.5 bbl. ultimate oil per MMCF natural gas fed to generator

* these items by difference

RUN NUMBER 4 A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY	MW	#/hr	#/gal	gal/hr
									YIELD				
CO	34.1	6.355	7.7	0.666	-5.689	-5.689		-5.689					
H_2	58.5	10.898	52.35	4.534	-6.364		-12.728						
CO_2	2.2	0.410	23.75	2.055	1.645	1.645		3.290					
N_2	1.6	0.298	1.75	0.152									
CH_4	3.6	0.671	9.3	0.806	0.135	0.135	0.540						
C_2H_4			1.3	0.113	0.113	0.226	0.452						
C_2H_6			0.45	0.039	0.039	0.078	0.234						
C_3H_6			1.15	0.100	0.100	0.300	0.600		0.90 x	42	3.78	6.25	0.605
C_3H_8			0.15	0.013	0.013	0.039	0.104						
C_4H_8			1.05	0.091	0.364	0.364	0.728		0.95 x	56	4.84	6.1	0.794
C_4H_{10}			0.35	0.030	0.030	0.120	0.300			58	1.74	4.86	0.358
C_5H_{10}			0.7	0.061	0.061	0.305	0.610			70	4.27	5.3	0.806
C_5H_{12}													
Oil						2.477*	4.954			14	34.62	6.5	5.33
Water							4.206*	2.399*					
								vs.2.103 from H_2 balance					
TOTAL		18.632		8.66							49.25		7.893

Fresh feed rate: 2350 x 1.20 / 0.399 = 18.62 mols per hour
Net gas rate: 3280 SCFH or 8.66 mols per hour

Contraction: 18.632 - 8.66 / 18.632 = 53.5 %
Conversion of CO: 5.689 / 6.355 = 89.5 %
Conversion of H_2: 6.364 / 10.898 = 58.5 %

Entering CO converted to:

	m/hr	%
CO_2	1.645	25.9
C_1 & C_2	0.439	6.9
C_3 & Heavier	3.605	56.7
Unconverted	0.666	10.5

4A

Oil yields: 5.33 / 2.35 = 2.26 gal. recovered oil per MCF natural gas fed to generator
7.893/ 2.35 = 3.36 gal. Ultimate oil per MCF natural gas fed to generator
= 80 bbl. ultimate oil per MMCF natural gas fed to generator

* These items by difference

RUN NUMBER 4 B

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	34.4	6.485	8.0	0.665	-5.820	-5.820		-5.820					
H_2	59.0	11.121	52.0	4.322	-6.799		-13.598						
CO_2	2.4	0.452	24.2	2.010	1.558	1.558		3.116					
N_2	1.5	0.283	1.4	0.116									
CH_4	2.7	0.509	9.7	0.805	0.296	0.296	1.184						
C_2H_4			1.2	0.100	0.100	0.200	0.400						
C_2H_6			0.4	0.033	0.033	0.066	0.198						
C_3H_6			1.2	0.100	0.100	0.300	0.600		0.90 x	42	3.78	6.25	0.605
C_3H_8			0.2	0.017	0.017	0.051	0.136						
C_4H_8			0.9	0.075	0.075	0.300	0.600		0.95 x	56	3.99	6.1	0.654
C_4H_{10}			0.3	0.025	0.025	0.100	0.250			58	1.45	4.86	0.298
C_5H_{10}			0.5	0.042	0.042	0.200	0.420			70	2.94	5.3	0.555
OIL						2.749*	5.498			14	38.5	6.5	5.92
WATER							4.312*	2.704*					
								vs.2.156 from H_2 balance					
TOTAL		18.85		8.31							50.66		8.032

Fresh feed rate: 2350 x 1.20 / 0.395 = 7150 SCFH or 18.85 mols per hour
Wet gas rate: 3150 SCFH or 8.31 mols per hour

Contraction: 18.85 - 8.31 / 18.85 = 56.0 %
Conversion of CO: 5.820 / 6.485 = 89.7 %
Conversion of H_2: 6.799 /11.121 = 61.0 %

Entering CO converted to:

	m/hr	%
CO_2	1.558	24.0
C_1 & C_2	0.562	8.7
C_3 & Heavier	3.700	57.0
Unconverted	0.665	10.3

40

Oil Yields: 5.92 / 2.35 = 2.52 gal. recovered oil per MCF of natural gas fed to generator
8.032/ 2.35 = 3.42 gal. ultimate oil per MCF of natural gas fed to generator
= 81.4 bbl. ultimate oil per MMCF of natural gas fed to generator

* These items by difference

MONTEBELLO SYNTHESIS UNIT

Comparison of Observed Data
With Gaucher Correlation

Run Number	2A		3A		3B		4A		4B	
	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.
Contraction, %	66.1		44.1		50.0		53.5		56.0	
Conversion of H_2, %	75.6	72	49.5	48	55.4	55	58.5	58	61.0	61
Conversion of CO, %	97.2	98	88.8	80	89.3	88	89.5	90	89.7	93
% CO Converted to:										
CO_2	18.3	22	38.0	28	35.2	30	28.9	29	26.8	28
C_1 & C_2	21.6	21	20.7	10	12.1	11	7.7	11	9.7	11
C_3 & Heavier	60.1	57	51.3	62	52.7	59	63.4	60	63.5	61

Run Number	5A		5B		6		7		8	
	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.
Contraction, %	70.9		82.5		51.1		55.6		69.1	
Conversion of H_2, %		78		90		56		60		76
Conversion of CO, %		99		99		89		92		99
% CO Converted to:										
CO_2		19		9		30		29		20
C_1 & C_2		10		4		11		13		11
C_3 & Heavier		71		87		59		58		69

RUN NUMBER 2 A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	35.5	1.687	2.9	0.047	-1.640	-1.640		-1.640					
H_2	57.2	2.716	41.1	0.661	-2.055		-4.110						
CO_2	2.2	0.104	25.1	0.404	0.300	0.300		0.600					
N_2	3.3	0.157	7.0	0.113									
CH_4	1.8	0.086	16.4	0.264	0.178	0.178	0.712						
C_2H_4			1.9	0.031	0.031	0.062	0.124						
C_2H_6			1.0	0.016	0.016	0.032	0.096						
C_3H_6			1.7	0.027	0.027	0.081	0.162		0.90 x	42	1.02	6.25	0.163
C_3H_8			0.6	0.010	0.010	0.030	0.080						
C_4H_8			1.3	0.021	0.021	0.084	0.168		0.95 x	56	1.12	6.1	0.184
C_4H_{10}			0.2	0.003	0.003	0.012	0.030			58	0.17	4.86	0.035
C_5H_{10}			0.5	0.008	0.008	0.040	0.080			70	0.56	5.4	0.104
C_5H_{12}			0.3	0.005	0.005	0.025	0.060			72	0.36	5.25	0.069
OIL						0.796*	1.592			14	11.14	6.5	1.71
WATER							1.006*	1.040*					
								vs 0.503 from H_2					
TOTAL		4.75	1.610								14.37		2.265

Contraction: 4.75 - 1.61 / 4.75 = 66.1 %
Conversion of CO: 1.640 / 1.687 = 97.2 %
Conversion of H_2: 2.055 / 2.716 = 75.6 %

CO Converted to:	mols/hr	%	%
CO_2	0.300	17.8	18.3
C1 & C2	0.272	16.1	16.6
C_3 & Heavier	1.068	63.3	65.1
Unconverted	0.047	2.8	
	1.687		

Oil Yield: 1.71 / 0.592 = 2.88 gal."recovered" oil per MCF natural gas fed to generator
2.265/ 0.592 = 3.82 gal. ultimate oil per MCF natural gas fed to generaotr
= 91.0 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 3 A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	34.2	5.720	6.85	0.641	-5.079	-5.079		-5.079					
H_2	58.9	9.856	53.3	4.988	-4.868		-9.736						
CO_2	2.3	0.385	24.7	2.312	1.927	1.927		3.854					
N_2	1.0	0.167	1.4	0.131									
CH_4	3.6	0.602	8.7	0.815	0.213	0.213	0.852						
C_2H_4			1.25	0.117	0.117	0.234	0.468						
C_2H_6			0.5	0.047	0.047	0.094	0.282						
C_3H_6			1.25	0.117	0.117	0.351	0.702		0.90 x	42	4.42	6.25	0.708
C_3H_8			0.15	0.014	0.014	0.042	0.112						
C_4H_8			1.05	0.098	0.098	0.392	0.784		0.95 x	56	5.21	6.1	0.855
C_4H_{10}			0.2	0.019	0.019	0.076	0.190			58	1.10	4.86	0.226
C_5H_{10}			0.5	0.047	0.047	0.235	0.470			70	3.29	5.4	0.610
C_5H_{12}			0.15	0.014	0.014	0.070	0.168			72	1.01	5.24	0.192
OIL						1.445*	2.890			14	20.23	6.5	3.12
WATER							2.848*	1.225*					
							vs 1.424 from H_2						
TOTAL		16.73		9.36							35.26		5.711

Contraction: 16.73 - 9.36 / 16.73 = 44.1 %
Conversion of CO: 5.079 / 5.720 = 88.8 %
Conversion of H_2: 4.868 / 9.856 = 49.5 %

CO Converted to:

	mols/hr	%	%
CO_2	1.927	33.7	37.9
C_1 & C_2	0.541	9.5	10.7
C_3 & Heavier	2.611	45.6	51.4
Unconverted	0.641	11.2	
	5.720		

Oil Yields: 3.12 / 2.12 = 1.47 gal."recovered" oil per MCF natural gas fed to generator
5.71 / 2.12 = 2.7 gal. ultimate oil per MCF natural gas fed to generator
= 64.1 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 3 B

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/gal	#/gal	gal/hr
CO	34.0	6.010	7.3	0.645	-5.365	-5.365		-5.365					
H_2	58.4	10.325	52.1	4.600	-5.725		-11.450						
CO_2	2.0	0.354	25.3	2.240	1.886	1.886		3.772					
N_2	3.3	0.584	1.3	0.115									
CH_4	2.3	0.407	8.5	0.753	0.346	0.346	1.384						
C_2H_4			1.3	0.115	0.115	0.230	0.460						
C_2H_6			0.4	0.035	0.035	0.070	0.210						
C_3H_6			0.7	0.062	0.062	0.186	0.372		0.90 x	42	2.34	6.25	0.375
C_3H_8			0.2	0.018	0.018	0.054	0.144						
C_4H_8			1.4	0.124	0.124	0.496	0.992		0.95 x	56	6.60	6.1	1.082
C_4H_{10}			0.4	0.035	0.035	0.140	0.350			58	2.03	4.86	0.418
C_5H_{10}			0.8	0.071	0.071	0.355	0.710			70	4.96	5.4	0.920
C_5H_{12}			0.3	0.027	0.027	0.135	0.324			72	1.94	5.25	0.370
OIL						1.467*	2.934			14	20.52	6.5	3.16
WATER							3.570*	1.593*					
							vs	1.785 from H_2					
TOTAL		17.68		8.84							38.39	6.1	6.325

Contraction: 17.68 - 8.84 / 17.68 = 50.0 %
Conversion of CO: 5.365 / 6.01 = 89.3 %
Conversion of H_2: 5.725 /10.325 = 55.4 %

CO Converted to:

	mols/hr	%	%
CO_2	1.886	31.4	35.2
C_1 & C_2	0.646	10.8	12.1
C_3 & Heavier	2.833	47.1	52.7
Unconverted	0.645	10.7	
	6.010		

Oil Yields: 3.16 / 2.14 = 1.48 gal."recovered" oil per MCF natural gas fed to generator
6.325/ 2.14 = 2.96 gal. ultimate oil per MCF natural gas fed to generator
= 70.5 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 4 A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	34.1	6.355	7.7	0.666	-5.689	-5.689		-5.689					
H_2	58.5	10.898	52.35	4.534	-6.364		-12.728						
CO_2	2.2	0.410	23.75	2.055	1.645	1.645		3.290					
N_2	1.6	0.298	1.75	0.152									
CH_4	3.6	0.671	9.3	0.806	0.135	0.135	0.540						
C_2H_4			1.3	0.113	0.113	0.266	0.452						
C_2H_6			0.45	0.039	0.039	0.078	0.234						
C_3H_6			1.15	0.100	0.100	0.300	0.600		0.90 x	42	3.78	6.25	0.605
C_3H_8			0.15	0.013	0.013	0.039	0.104						
C_4H_8			1.05	0.091	0.091	0.364	0.728		0.95 x	56	4.84	6.1	0.794
C_4H_{10}			0.35	0.030	0.030	0.120	0.300			58	1.74	4.86	0.358
C_5H_{10}			0.7	0.061	0.061	0.305	0.610			70	4.27	5.3	0.806
OIL						2.477*	4.954			14	34.62	6.5	5.33
WATER							4.206*	2.399*					
								vs 2.103 from H_2					
TOTAL		18.632		8.66							49.25		7.893

Contraction: 18.632 - 8.66 / 18.632 = 53.5 %
Conversion of CO: 5.689 / 6.355 = 89.5 %
Conversion of H_2: 6.364 / 10.898 = 58.5 %

CO Converted to:

	mols/hr	%	%
CO_2	1.645	25.9	29.0
C_1 & C_2	0.439	6.9	7.7
C_3 & Heavier	3.605	56.7	63.3
Unconverted	0.666	10.5	
	6.355		

Oil Yields: 5.33 / 2.35 = 2.26 gal."recovered"oil per MCF natural gas fed to reactor
7.893/2.35 = 3.36 gal. ultimate oil per MCF natural gas fed to reactor
= 80.0 bbl. ultimate oil per MMCF natural gas fed to reactor

RUNNNUMBER 4 B

MONTEBELLO SYNTHESIS UNIT
CALCUALTION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	34.4	6.485	8.0	0.665	-5.820	-5.820		-5.820					
H_2	59.0	11.121	52.0	4.322	-6.799		-13.598						
CO_2	2.4	0.452	24.2	2.010	1.558	1.558		3.116					
N_2	1.5	0.283	1.4	0.116									
CH_4	2.7	0.509	9.7	0.805	0.296	0.296	1.184						
C_2H_4			1.2	0.100	0.100	0.200	0.400						
C_2H_6			0.4	0.033	0.033	0.066	0.198						
C_3H_6			1.2	0.100	0.100	0.300	0.600		0.90 x 42		3.78	6.25	0.605
C_3H_8			0.2	0.017	00017	0.051	0.136						
C_4H_8			0.9	0.075	0.075	0.300	0.600		0.95 x 56		3.99	6.1	0.654
C_4H_{10}			0.3	0.025	0.025	0.100	0.250			58	1.45	4.86	0.298
C_5H_{10}			0.5	0.042	0.042	0.200	0.420			70	2.94	5.3	0.555
OIL						2.749*	5.498			14	38.5	6.5	5.92
WATER							4.312*	2.704*					
							vs 2.156 from H_2						
TOTAL		18.85		8.31							50.66		8.032

Contraction: 18.85 - 8.31 / 18.85 = 56.0 %
Conversion of CO: 5.820 / 6.485 = 89.7 %
Conversion of H_2: 6.799 /11.121 = 61.0 %

CO Converted to:

	mols/hr	%	%
CO_2	1.558	24.0	26.8
C_1 & C_2	0.562	8.7	9.6
C_3 & Heavier	3.700	57.0	63.6
Unconverted	0.665	10.3	
	6.485		

Oil Yields: 5.92 / 2.35 = 2.52 gal."recovered" oil per MCF natural gas fed to reactor
8.03 / 2.35 = 3.42 gal. ultimate oil per MCF natural gas fed to reactor
= 81.4 bbl. ultimate oil per MMCF natural gas fed to reactor

RUN NUMBER 5 A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANCE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	35.0	5.485	8.56	0.400	-5.085	-5.085		-5.085					
H_2	58.1	9.110	35.03	1.636	-7.474		-14.948						
CO_2	1.9	0.298	29.66	1.385	1.087	1.087		2.174					
N_2	0.7	0.110	0.0										
CH_4	4.3	0.674	16.86	0.787	0.113	0.113	0.452						
C_2H_4			2.67	0.125	0.125	0.250	0.500						
C_2H_6			1.07	0.050	0.050	0.100	0.300						
C_3H_6			2.94	0.137	0.137	0.411	0.822		0.90 x 42		5.19	6.23	0.830
C_3H_8			0.54	0.025	0.025	0.075	0.200						
C_4H_8			1.87	0.088	0.088	0.352	0.704		0.95 x 56		4.69	6.1	0.770
C_4H_{10}			0.0										
C_5H_{10}			0.80	0.037	0.037	0.185	0.370			70	2.59	5.3	0.488
OIL						2.512*	5.024			14	35.20	6.5	5.420
WATER							6.576*	2.911*					
							vs.	3.288					
TOTAL		15.68		4.67							47.67		7.508

Contraction: 15.68 - 4.67 / 15.68 = 70.2 %
Conversion of CO: 5.085 / 5.485 = 92.8 %
Conversion of H_2: 7.474 / 9.110 = 82.1 %

CO Converted to:

	mols/hr	%	%
CO_2	1.087	19.8	21.4
C_1 & C_2	0.463	8.4	9.1
C_3 & Heavier	3.535	64.5	69.5
Unconverted	0.400	7.3	
	5.485	100.0	100.0

Oil Yields: 5.42 / 2.04 = 2.66 gal. "recovered" oil per MCF natural gas fed to generator
7.51 / 2.04 = 3.67 gal. ultimate oil per MCF natural gas fed to generator
= 87.5 bbl. ultimate Oil per MMCF natural gas fed to generator

5A

RUN NUMBER 5 B

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	35.0	5.705	5.56	0.161	-5.544	-5.544		-5.544					
H_2	58.2	9.486	38.46	1.113	-8.373		-16.746						
CO_2	1.8	0.294	23.44	0.680	0.386	0.386		0.772					
N_2	2.2	0.359	1.88	0.055									
CH_4	2.8	0.456	19.62	0.570	0.114	0.114	0.456						
C_2H_4			2.62	0.076	0.076	0.152	0.304						
C_2H_6			1.40	0.041	0.041	0.082	0.246						
C_3H_6			3.30	0.096	0.096	0.288	0.576		0.90 x 42		3.63	6.25	0.581
C_3H_8			0.42	0.012	0.012	0.036	0.096						
C_4H_8			2.10	0.061	0.061	0.244	0.488		0.95 x 56		3.25	6.1	0.534
C_4H_{10}			0.26	0.008	0.008	0.032	0.080			58	0.46	4.86	0.095
C_5H_{10}			0.94	0.027	0.027	0.135	0.270			70	1.89	5.4	0.350
OIL						4.075*	8.150			14	57.05	6.5	8.77
WATER							6.080*	4.772*					
							vs.	3.040	from H_2				
TOTAL		16.30		2.90							66.28		10.33

Contraction: 16.30 - 2.90 / 16.30 = 82.1 %
Conversion of CO: 5.544 / 5.705 = 97.0 %
Conversion of H_2: 8.373 / 9.486 = 88.3 %

CO Converted to:

	mols/hr	%	%
CO_2	0.386	6.8	7.0
C_1 & C_2	0.348	6.1	6.3
C_3 & Heavier	4.810	84.3	86.7
Unconverted	0.161	2.8	
	5.705		

58

OIL YIELDS: 8.77 / 2.04 = 4.30 gal."recovered" oil per MCF natural gas fed to generator
10.33 / 2.04 = 5.06 gal. ultimate oil per MCF natural gas fed to generator
=121 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 6

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	34.9	6.075	5.07	0.294	-5.781	-5.781		-5.781					
H_2	59.2	10.307	49.73	2.884	-7.423		-14.846						
CO_2	1.8	0.314	23.82	1.383	1.069	1.069		2.138					
N_2	1.9	0.331	0.88	0.051									
CH_4	2.2	0.383	12.43	0.721	0.338	0.338	1.352						
C_2H_4			2.19	0.127	0.127	0.254	0.508						
C_2H_6			0.88	0.051	0.051	0.102	0.306						
C_3H_6			2.28	0.132	0.132	0.396	0.792		0.90 x	42	5.03	6.25	0.804
C_3H_8			0.35	0.020	0.020	0.060	0.160						
C_4H_8			1.49	0.086	0.086	0.344	0.688		0.95 x	56	4.58	6.1	0.750
C_4H_{10}			0.18	0.010	0.010	0.040	0.100			58	0.58	4.86	0.119
C_5H_{10}			0.70	0.041	0.041	0.205	0.410			70	2.87	5.4	0.531
OIL						2.973*	5.946			14	41.58	6.5	6.40
WATER							4.584*	3.643*					
								vs.2.294 from H_2					
TOTAL		17.41		5.80							54.64		8.60

Contraction: 17.41 - 5.80 / 17.41 = 66.7 %
Conversion of CO: 5.781 / 6.075 = 95.3 %
Conversion of H_2: 7.423 /10.307 = 72.1 %

CO Converted to:

	mols / hr	%	%
CO_2	1.069	17.6	18.5
C_1 & C_2	0.694	11.4	12.0
C_3 & Heavier	4.018	66.2	69.5
Unconverted	0.294	4.8	
	6.075		

Oil Yields: 6.40 / 2.11 = 3.04 gal."recovered"oil per MCF natural gas fed to generator
8.60 / 2.11 = 4.07 gal. ultimate oil per MCF natural gas fed to generator
= 97.1 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 7 A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	34.1	6.095	11.57	0.916	5.179	-5.179		-5.179					
CO_2	2.0	0.358	23.50	1.861	1.503	1.503		3.006					
H_2	58.6	10.478	46.86	3.708	6.770		-13.540						
N_2	1.9	0.340	0.52	0.041									
CH_4	3.4	0.609	10.65	0.844	0.235	0.235	0.940						
C_2H_4			1.84	0.146	0.146	0.292	0.584						
C_2H_6			0.70	0.055	0.055	0.110	0.330						
C_3H_6			1.84	0.146	0.146	0.438	0.876		0.90 x 42		5.52	6.25	0.884
C_3H_8			0.32	0.025	0.025	0.075	0.200						
C_4H_8			1.37	0.108	0.108	0.432	0.864		0.95 x 56		5.75	6.1	0.942
C_4H_{10}			0.17	0.013	0.013	0.052	0.130			58	0.75	4.86	0.155
C_5H_{10}			0.66	0.052	0.052	0.260	0.520			70	3.64	5.4	0.674
OIL						1.782*	3.564			14	24.95	6.5	3.838
WATER							5.532*	2.173*					
								vs.2.766 from H_2					
TOTAL		17.88		7.915							40.61		6.493

Contraction: 17.88 - 7.915 / 17.88 = 55.8 %
Conversion of H_2: 6.770 /10.478 = 64.6 %
Conversion of CO: 5.179 / 6.095 = 84.9 %

CO Converted to:

	mols/hr	%	%
CO_2	1.503	24.6	29.0
C_1 & C_2	0.637	10.5	12.4
C_3 & Heavier	3.039	49.8	58.6
Unconverted	0.916	15.1	
	6.095		

Oil Yields: 3.84 / 2.19 = 1.75 gal."reconvered"oil per MCF natural gas fed to generator
6.49 / 2.19 = 2.96 gal. ultimate oil per MCF natural gas fed to generator
= 70.5 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 7 B

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal.gal/hr
CO	34.1	6.095	6.05	0.342	-5.753	-5.753		-5.753				
H_2	58.6	10.478	35.16	1.985	-8.493		-16.986					
CO_2	2.0	0.358	20.90	1.182	0.824	0.824		1.648				
N_2	1.9	0.340	2.34	0.132								
CH_4	3.4	0.609	25.90	1.463	0.854	0.854	3.416					
C_2H_4			2.49	0.141	0.141	0.282	0.564					
C_2H_6			1.78	0.101	0.101	0.202	0.606					
C_3H_6			2.34	0.132	0.132	0.396	0.792		0.90 x 42		4.99	6.25 0.799
C_3H_8			0.55	0.031	0.031	0.093	0.248					
C_4H_8			1.50	0.85	0.085	0.340	0.680		0.95 x 56		4.52	6.1 0.742
C_4H_{10}			0.28	0.016	0.016	0.640	0.160			58	0.93	4.86 0.191
C_5H_{10}			0.71	0.040	0.040	0.200	0.400			70	2.80	5.4 0.519
OIL						2.498*	4.996			14	35.0	6.5 5.38
WATER							5.124*	2.562*				
							vs	4.105				
TOTAL		17.88		5.65							38.24	7.63

Contraction: 17.88 - 5.65 / 17.88 = 68.5 %
Conversion of CO: 5.753 / 6.095 = 94.5 %
Conversion of H_2: 8.493 / 10.478 = 81.0 %

CO Converted to:

	mols/hr	%	%
CO_2	0.824	13.5	14.3
C_1 & C_2	1.338	21.9	23.2
C_3 & Heavier	3.591	59.0	62.5
Unconverted	0.342	5.6	
	6.095		

Oil Yields: 5.38 / 2.19 = 2.46 gal."recovered"oil per MCF Natural Gas fed to generator
7.63 / 2.19 = 3.48 gal. ultimate oil per MCF Natural Gas fed to generator
= 82.9 bbl. ultimate oil per MMCF Natural Gas fed to generator

RUN NUMBER 8

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	WET GAS %	WET GAS m/hr	CHANGE mols	C	H	O	POLY YIELD	MW	#/hr	#/gal	gal/hr
CO	35.3	5.905	13.78	0.712	-5.193	-5.193		-5.193					
H_2	58.7	9.820	53.37	2.795	-7.061		-14.122						
CO_2	2.5	0.419	19.73	1.021	0.602	0.602		1.204					
N_2	2.3	0.385	2.42	0.125									
CH_4	1.2	0.201	6.70	0.346	0.145	0.145	0.580						
C_2H_4			1.12	0.058	0.058	0.116	0.232						
C_2H_6			0.46	0.024	0.024	0.048	0.144						
C_3H_6			0.84	0.043	0.043	0.129	0.258		0.90 x	42	1.625	6.25	0.260
C_3H_8			0.19	0.010	0.010	0.030	0.080						
C_4H_8			0.84	0.043	0.043	0.172	0.344		0.95 x	56	2.185	6.1	0.375
C_4H_{10}			0.19	0.010	0.010	0.040	0.100			58	0.580	4.86	0.119
C_5H_{10}			0.37	0.019	0.019	0.095	0.190			70	1.330	5.4	0.246
OIL						3.816*	7.632			14	53.40	6.5	8.21
WATER							4.562*	3.989*					
								vs. 2.281 from H_2					
TOTAL		16.73		5.17							59.12		9.21

Contraction: 16.73 - 5.17 / 16.73 = 69.1 %
Conversion of CO: 5.193 / 5.905 = 87.9 %
Conversion of H_2: 7.061 / 9.820 = 71.9 %

Co Converted to:

	mols/hr	%	%
CO_2	0.602	10.2	11.5
C1 & C2	0.309	5.2	6.0
C_3 & Heavier	4.282	72.5	82.5
Unconverted	0.342	12.1	
	5.905		

Oil Yields: 8.21 / 2.06 = 3.98 gal. "recovered" oil per MCF natural gas fed to generator
9.21 / 2.06 = 4.46 gal. ultimate oil per MCF natural gas fed to generator
106.1 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 9 A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS m/hr	WET GAS #/hr	CHANGE mols	C	H	O	POLY	#/hr	gal/hr
CO	34.0	8.432	236.1	3.9	0.350	13.3	-8.082	-8.082	-[illegible]	-8.082			
H2	59.9	14.856	29.7	46.4	4.154	8.3	-10.702		-21.404				
CO2	1.9	0.471	20.7	21.9	1.957	96.4	1.486	1.486		2.972			
N2	1.9	0.471	13.2	3.5	0.315	8.8	-0.156						
CH4	2.3	0.570	9.1	14.6	1.307	20.9	0.737	0.737	2.972				
C2H4				2.5	0.224	6.3	0.224	0.448	0.896				
C2H6				1.0	0.084	2.5	0.084	0.168	0.504				
C3H6				2.5	0.224	9.4	0.224	0.672	1.344		0.90	8.5	1.35
C3H8				0.3	0.028	1.2	0.028	0.074	0.224				
C4H8				2.4	0.216	12.1	0.216	0.864	1.728		0.95	11.5	1.88
C4H10				1									
C5H10				1.0	0.091	6.4	0.091	0.455	0.910			6.4	1.18
OIL								3.178*	6.356			44.5	7.12
WATER									6.494*	5.110*			
TOTAL		24.80	308.8		8.95	185.6-15.850				3.247		92.1	11.53

Contraction: 15.85/24.80 = 64.0 %
Conversion of CO: 8.082/8.432 = 95.8 %
Conversion of H2: 10.702/14.856 = 72.0 %

9A

CO Converted to:

	mols/hr	%	%
CO2	1.486	17.6	18.4
C1 & C2	1.353	16.0	16.8
C3 & Heavier	5.243	62.2	64.8
Unconverted	0.350	4.2	

WEIGHT BALANCE

Measured Oil	4.8 gal/hr	31.2	#/hr
Measured Water	11.5 gal/hr	95.9	#/hr
Wet gas		185.6	#/hr
		312.7	
	or	101.2	%

Oil Yield: 7.12 /3.0 = 2.37 gal. "recovered" oil per MCF natural gas fed to generator
11.53 /3.0 = 3.84 gal. ultimate oil per MCF natural gas fed to generator
= 91.5 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 9 B

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	m/hr	#/hr	WET GAS %	m/hr	#/hr	CHANGE mols	C	H	O	POLY Y'LD	#/hr	gal/hr
CO	34.2	8.300	232.4	3.0	0.224	6.3	-8.076	-8.076		-8.076			
H2	58.2	14.104	28.2	41.5	3.125	6.2	-10.979		-21.958				
CO2	1.7	0.413	18.2	24.2	1.820	80.2	1.407	1.407		2.814			
N2	2.5	0.607	17.0	2.5	0.189	5.1	-0.418						
CH4	3.4	0.826	13.2	16.1	1.211	19.4	0.385	0.385	1.540				
C2H4				2.9	0.218	6.1	0.218	0.436	0.872				
C2H6				1.6	0.124	3.7	0.124	0.248	0.744				
C3H6				3.4	0.254	10.7	0.254	0.762	1.524		0.90	9.60	1.54
C3H8				0.5	0.035	1.5	0.035	0.105	0.280				
C4H8				2.6	0.195	10.9	0.195	0.780	1.560		0.95	10.38	1.70
C4H10				0.4	0.030	1.7	0.030	0.120	0.300			1.74	0.36
C5H10				1.3	0.095	6.6	0.095	0.475	0.950			6.65	1.23
OIL								3.358*	6.716			47.0	7.24
WATER									7.572*	5.262*			
TOTAL		24.25	309.0		7.52	158.3	16.73			3.786		75.37	12.07

Contraction: 16.73/24.25 = 69.0 %
Conversion of CO: 8.076/8.300 = 97.3 %
Conversion of H2: 10.979/14.104 = 77.9 %

96

CO Converted to:

	mols/hr	%	%
CO2	1.407	17.0	17.4
C1 & C2	1.069	12.9	13.2
C3 & Heavier	5.600	67.4	69.4
Unconverted	0.224	2.7	

WEIGHT BALANCE:

Measured Oil	8.5 gal/hr	55.3	#/hr
Measured water	20.0 gal/hr	166.0	#/hr
Wet Gas		158.3	#/hr
		379.6	
	or	122.9	%

Oil Yield: 7.24/2.95 = 2.46 gal."recovered" oil per MCF natural gas fed to generator
12.07/2.95 = 4.09 gal. ultimate oil per MCF natural gas fed to generator
= 97.4 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 10

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS m/hr	WET GAS #/hr	CHARGE mols	C	H	O	POLY Y'LD	#/hr	gal/hr
CO	35.7	7.255	203.1	4.4	0.214	6.0	-7.041	-7.041		-7.041			
H2	59.7	12.161	24.3	50.5	2.470	4.9	-9.691		-19.382				
CO2	2.3	0.467	20.6	26.8	1.311	57.7	0.844	0.844		1.688			
N2	0.9	0.183	5.1	4.7	0.230	6.4	0.047						
CH4	1.4	0.284	4.5	10.1	0.491	7.9	0.207	0.207	0.828				
C2H4				1.4	0.066	1.9	0.066	0.132	0.264				
C2H6				0.2	0.008	0.2	0.008	0.016	0.048				
C3H6				0.5	0.023	1.0	0.023	0.069	0.138		0.90	0.87	0.14
C3H8				0.0									
C4H8				0.5	0.024	1.4	0.024	0.096	0.192		0.95	1.23	0.27
C5H10				0.3	0.016	0.9	0.016	0.064	0.160			0.93	0.19
C5H10				0.6	0.027	1.9	0.027	0.135	0.270			1.89	0.35
OIL								5.478*	10.956			76.85	11.11
WATER									6.526*	5.353			
TOTAL		20.35	257.6		4.88	90.2	15.47			3.263		81.8	12.7

Contraction: 15.47/20.35 = 76.0 %
Conversion of CO: 7.041/7.255 = 97.0 %
Conversion of H2: 9.691/12.161 = 79.7 %

CO Converted to:

	mols/hr	%	%
CO2	0.844	11.6	12.0
C1 & C2	0.355	4.9	5.0
C3 & Heavier	5.842	80.5	83.0
Unconverted	0.214	3.0	

10

Oil Yield: 11.8 / 2.45 = 4.81 gal. "recovered" oil per MCF natural gas fed to generator
12.7 / 2.45 = 5.19 gal. ultimate oil per MCF natural gas fed to generator
= 123.2 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 11A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS m/hr	WET GAS #/hr	CHANGE mols	C	H	O	POLY Y'LD	#/hr	gal/hr
CO	34.9	7.629	213.8	7.0	0.586	16.4	-7.043	-7.043		-7.043			
H2	58.0	12.679	25.3	50.0	4.165	8.3	-8.514		-17.028				
CO2	2.0	0.438	19.3	22.0	1.835	80.8	1.397	1.397		2.794			
N2	2.3	0.504	14.1	3.2	0.267	7.5	-0.237						
CH4	2.8	0.614	9.8	10.6	0.886	14.2	0.272	0.272	1.088				
C2H4				1.9	0.156	4.4	0.156	0.312	0.624				
C2H6				0.7	0.059	1.8	0.059	0.118	0.354				
C3H6				1.7	0.143	6.0	0.143	0.429	0.858		0.90	5.41	0;86
C3H8				0.2	0.020	0.9	0.020	0.060	0.160				
C4H8				1.5	0.124	6.9	0.124	0.496	0.992		0.95	6.07	0.99
C4H10				0.3	0.026	1.5	0.026	0.104	0.260			1.51	0.31
C5H10				0.9	0.073	5.1	0.073	0.365	0.730			5.11	-0.95
OIL								3.490*	6.980			48.85	7.52
WATER									4.982*	4.249*			
TOTAL		21.864	282.3		8.34	153.8	13.524			2.491		66.95	10.63

Contraction: 13.52/21.86 = 61.9 %
Conversion of CO: 7.043/7.629 = 92.2 %
Conversion of H2: 8.514/12.679 = 67.2 %

CO Converted to:

	mols/hr	%	%
CO2	1.397	18.3	19.8
C1 & C2	0.702	9.2	10.0
C3 and Heavier	4.944	64.8	70.2
Unconverted	0.586	7.7	

11A

Oil Yield: 7.52 / 2.79 = 2.70 gal."recovered"oil per MCF natural gas fed to generator
10.63 / 2.79 = 3.82 gal. ultimate oil per MCF natural gas fed to generator
= 90.9 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 11 B

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS m/hr	WET GAS #/hr	CHANGE mols	C	H	O	POLY WILD	#/hr	gal/hr
CO	35.1	8.705	244.0	7.3	0;757	21.2	-7.948	-7.948		-7.948			
H2	59.5	14.756	29.5	46.8	4.824	9.6	-9.932		-19.864				
CO2	2.1	0.521	22.9	20.1	2.063	90.9	1.542	1.542		3.084			
N2	1.3	0.322	9.0	3.3	0.337	9.4	0.015						
CH4	2.0	0.496	7.9	14.2	1.462	23.4	0.966	0.966	3.864				
C2H4				2.0	0.206	5.8	0.206	0.412	0.824				
C2H6				1.4	0.140	4.2	0.140	0.280	0.840				
C3H6				1.6	0.164	6.9	0.164	0.492	0.984		0.90	6.20	0.99
C3H8				0.4	0.041	1.8	0.041	0.123	0.328				
C4H8				1.5	0.156	8.7	0.156	0.624	1.248		0.95	8.30	1.36
C4H10				0.4	0.041	2.4	0.041	0.164	0.410			2.38	0.49
C5H10				1.0	0.099	6.9	0.099	0.495	0.990			6.93	1.28
OIL								2.850*	5.700			39.9	5.26
WATER									4.676*	4.864*			
TOTAL		24.80	313.3		10.29	191.2	14.51			2338		63.71	9.38

Contraction: 14.51/24.80 = 58.5 %
Conversion of CO: 7.948/8.705 = 91.3 %
Conversion of H2: 9.932/14.756 = 67.4 %

CO Converted to:

	mols/hr	%	%
CO2	1.542	17.7	19.4
C1 & C2	1.658	19.1	20.9
C3 & Heavier	4.748	54.5	59.7
Unconverted	0.757	8.7	

11 B

Oil Yield: 5.26 / 3.2 = 1.65 gal."recovered"oil per MCF natural gas fed to generator
9.38 / 3.2 = 2.93 gal. ultimate oil per MCF natural gas fed to generator
= 69.7 bbl. ultimate oil per MMCF natural gas fed to generator

THE TEXAS COMPANY
MONTEBELLO EXPERIMENT STATION

REPORT ON SYNTHESIS RUN NUMBER 12

February 27, 1947

THE TEXAS COMPANY
MONTEBELLO EXPERIMENT STATION

PRELIMINARY REPORT ON SYNTHESIS RUN NUMBER 12

INTRODUCTION

Run Number 12 was made on the Montebello Synthesis Unit over the period February 21 - February 26 covering a total of 120 hours operation. The run was terminated by the failure of the recycle gas compressor.

EQUIPMENT CHANGES

Following Synthesis Run Number 11, which was ended by a slide valve failure, a new slide valve was constructed and installed. This valve contains a flat plate slide which is 3-3/8" wide, 4-3/4" long and 1/2" thick. The slide has a V-notch which is 1-1/2" wide at the base and has an altitude of 1-1/2". The slide moves across a 3" opening in the base of the 3" standpipe and discharges into a conical hopper which is 8" in diameter at the top and 10" high. The hopper converges into the 1" transfer line which returns catalyst to the reactor. The transfer line is bent through a 90 degree angle on a radius of about 10 feet. The transfer gas which carries the catalyst through the line is introduced at the top of the hopper just below the slide.

OPERATIONS

During the initial attempt to operate the new slide valve, transfer gas was inadvertently allowed to flow up through the slide valve for a considerable period after the catalyst was charged and before the catalyst was reduced. When this was corrected it was found that the valve was

leaking badly and inspection showed that the slide was eroded to a depth of about 1/4" on the upper surface of the slide, the principal erosion being at the edge of the 3" opening in the standpipe. During this same period a small leak developed in the transfer line due to erosion at the bend which at that time was considerably sharper than the present 10 ft. radius bend. The carbon steel slide was replaced at this time with 18-8 stainless steel and an inspection after Run 12 showed no detectable erosion.

Catalyst reduction was started on February 19 and continued at a temperature of about 700 F. for 12 hours at which time the supply of 100 cylinders of hydrogen was exhausted. The loss in weight of the contents of the reactor as estimated from the reactor differential pressure meter was 170#, 31# of catalyst were recovered from the second cyclone and 107# of water were recovered from the condenser. The water measurement is thought to have been in error and it is thought that the apparent loss of 32# was probably water that was not measured. On this basis the water produced was 22 wt.% of the catalyst charged and the reduction in any case can be regarded as a relatively poor one.

Fresh feed was introduced into the reactor at 9:00 on February 21 and synthesis operations continued until 9:00 on February 26 when it was necessary to shut down to replace a broken valve in the recycle gas compressor. Operations were comparatively steady for the first 100 hours of the run, but at that time the level of catalyst in the standpipe reached the cyclone and the loss of catalyst from the reactor

started to increase rapidly. Since the slide valve was being operated with a minimum differential pressure as limited by the combined pressure surges in the reactor and the standpipe, the slide valve could not be opened further without causing reverse flow in the standpipe at the peaks of the surges, and it was therefore impossible to lower the standpipe level.

An attempt was then made to increase the density of the catalyst in the system by adding fresh, unreduced catalyst. Over a two hour period 240# of catalyst were added and this resulted in a reduction in standpipe temperature from about 660 F. to about 480 F. and a reduction in bed temperature from about 625 F. to about 610 F. The bed density rose sharply from 35 lbs./cu.ft. at 14:00 to about 90 lbs./cu.ft. at 24:00 and there was a steady increase in wet gas rate, together with a steady increase in bed temperatures from 610 F. to 660 F. at the bottom and from 610 F. to 640 F. at the top. Conditions may have been stabilized at this time but operations were not continued long enough to show this point clearly. When the reactor was drained after the run it was found that most of the catalyst in the reactor was in the form of spherical pellets 1/16" to 1/8" in diameter.

DISCUSSION

It is apparent that this run should be considered as made up of a period of 100 hours of comparatively steady operation which had approached rather closely to an equilibrium condition, followed by a 24 hour period of very unsettled operation which followed the addition of fresh

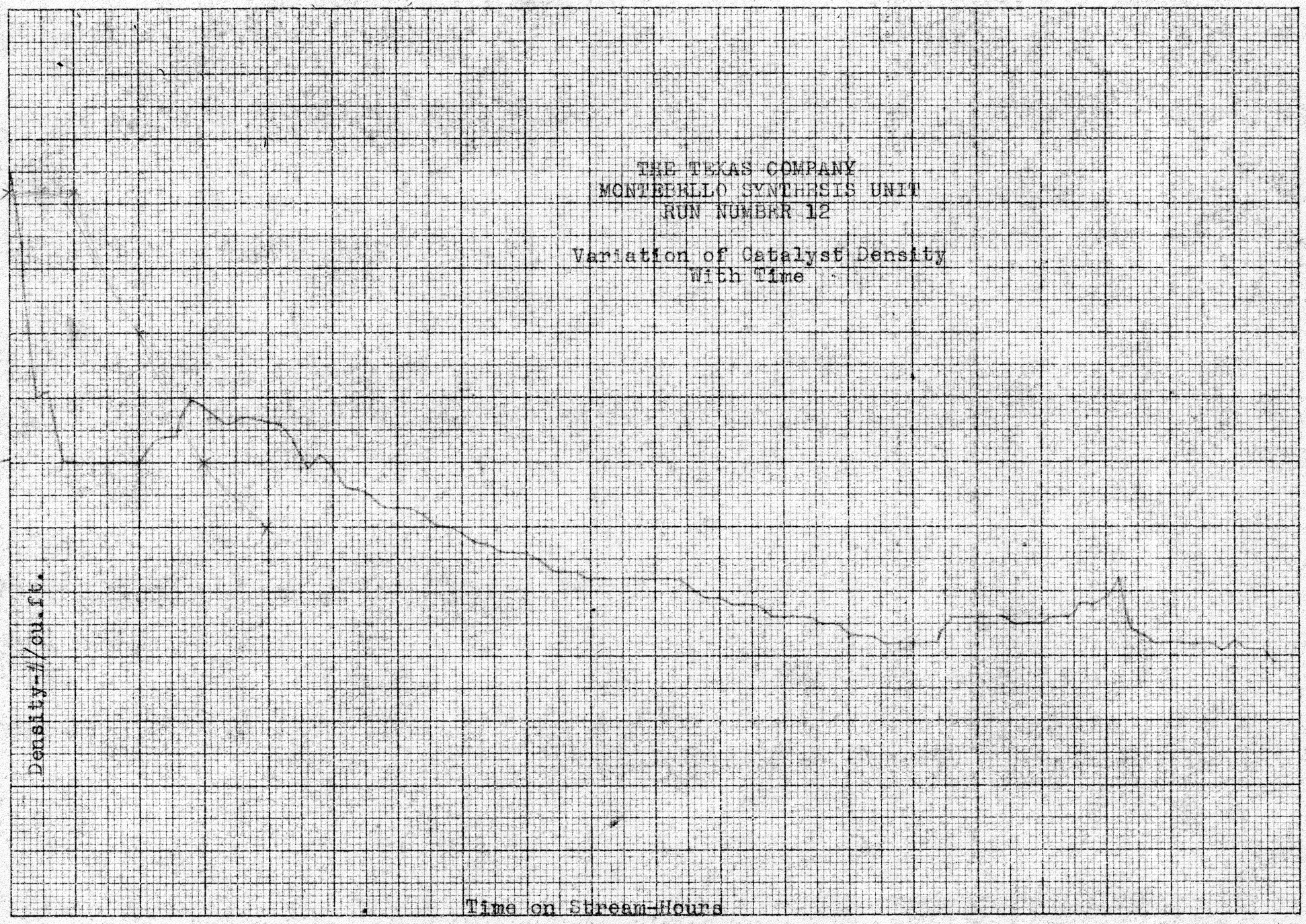
catalyst. In the first period, the density of the catalyst in the reactor fell rapidly at first from the initial density of 115 #/cu.ft., and then more slowly and appeared to be reaching an equilibrium value of about 35#/cu.ft. During this period the depth of the catalyst bed increased from about 16 ft. to about 22 ft. and the catalyst inventory dropped from about 500 lbs. to about 270 lbs. The conversion as measured by contraction increased from 60% contraction to 69% contraction in spite of the decrease in catalyst inventory. The steam pressure in the reactor cooling system was maintained at 1100 p.s.i.g. throughout the run and there was no change in bed temperatures, indicating that there was a slight improvement in over-all heat transferred, in spite of the decreased catalyst density.

The failure of the conversion level to go beyond about 70% contraction indicates that a poorly reduced catalyst does not reach the activity level corresponding to a well reduced catalyst even over an extended period of operation. It was also evident during this run that the product contained a very much larger proportion of wax than is produced with a well reduced catalyst. No numerical data are yet available on this point.

FUTURE OPERATION

An additional 30 ft. in standpipe height are now being installed and an attempt will be made to secure a very completely reduced catalyst for the next run.

NO. 359-11 10 × 10 to the half inch, 5th lines accented.
Engraving, 7 × 10 in.
MADE IN U. S. A.
KEUFFEL & ESSER CO.



MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	12A	12B	12C	12D	12E
Start	8:00 2/21	8:00 2/22	8:00 2/23	8:00 2/24	8:00 2/25
End	8:00 2/22	8:00 2/23	8:00 2/24	8:00 2/25	8:00 2/26
Duration	24	24	24	24	24
GENERATOR DATA					
Pressure-psig	220	230	227	221	221
Gas Rate-scfh	2830	2880	2890	2930	2930
Oxygen Rate-scfh	2210	2260	2120	2120	2120
Product Rate-scfh	8880	9000	9000	8970	8970
Product Composition by Corrected Orsat- mol %					
CO	35.1	34.2	34.7	33.9	33.9
H_2	58.9	59.2	59.0	60.0	60.0
CO_2	2.3	2.6	2.0	2.0	2.0
N_2	1.8	2.7	2.6	3.3	3.3
CH_4	1.9	1.3	1.7	0.8	0.8
SYNTHESIS DATA					
Pressure-psig	200	200	200	200	200
Recycle Rate-scfh	13130	13480	12865	12660	13370
Fresh Feed Rate-scfh	8880	9000	9000	8970	8970
Wet Gas Rate-scfh	3370	3050	2940	2830	3650
Catalyst Temperature- F.	617	619	616	622	650
Catalyst Density-#/cu.ft.	71	52	46	42	85
Cat. Fluidized-#	495	505	411	268	220
Depth of Bed-ft.	16	22	21	15	9
Fresh Feed-cfh/# cat.	18	18	22	33	41
Inlet Velocity-ft./sec/	2.0	2.0	2.0	2.0	2.0
Recycle Ratio	1.5	1.5	1.4	1.4	1.5
Contraction- %	60.5	66.1	67.5	69.5	55
Measured Oil-gph	3.3	3.3	2.4	3.7	3.0
Measured Water-gph	5.3	10.4	8.2	8.8	4.5
Steam Pressure-psig	1100	1100	1100	1100	1100
Steam Rate-#/hr.	376	452	435	435	
CO_2 in Wet Gas-%	24.5	28.0	27.9	27.2	21*
CO Converted to CO_2-%	21	20	20	19	
Yields Estimated From Gaucher Correlation and Observed Contraction					
Conversion of CO	95	98	98	98	
Conversion of H_2	66	72	74	75	
CO Converted to:					
CO_2	26	23	22	21	
C_1 & C_2	13	13	13	13	
C_3 & Heavier	61	64	65	66	

* During the period immediately following the charging of fresh catalyst the CO_2 content of the wet gas fell to about 10%

STRATFORD ENGINEERING CORPORATION

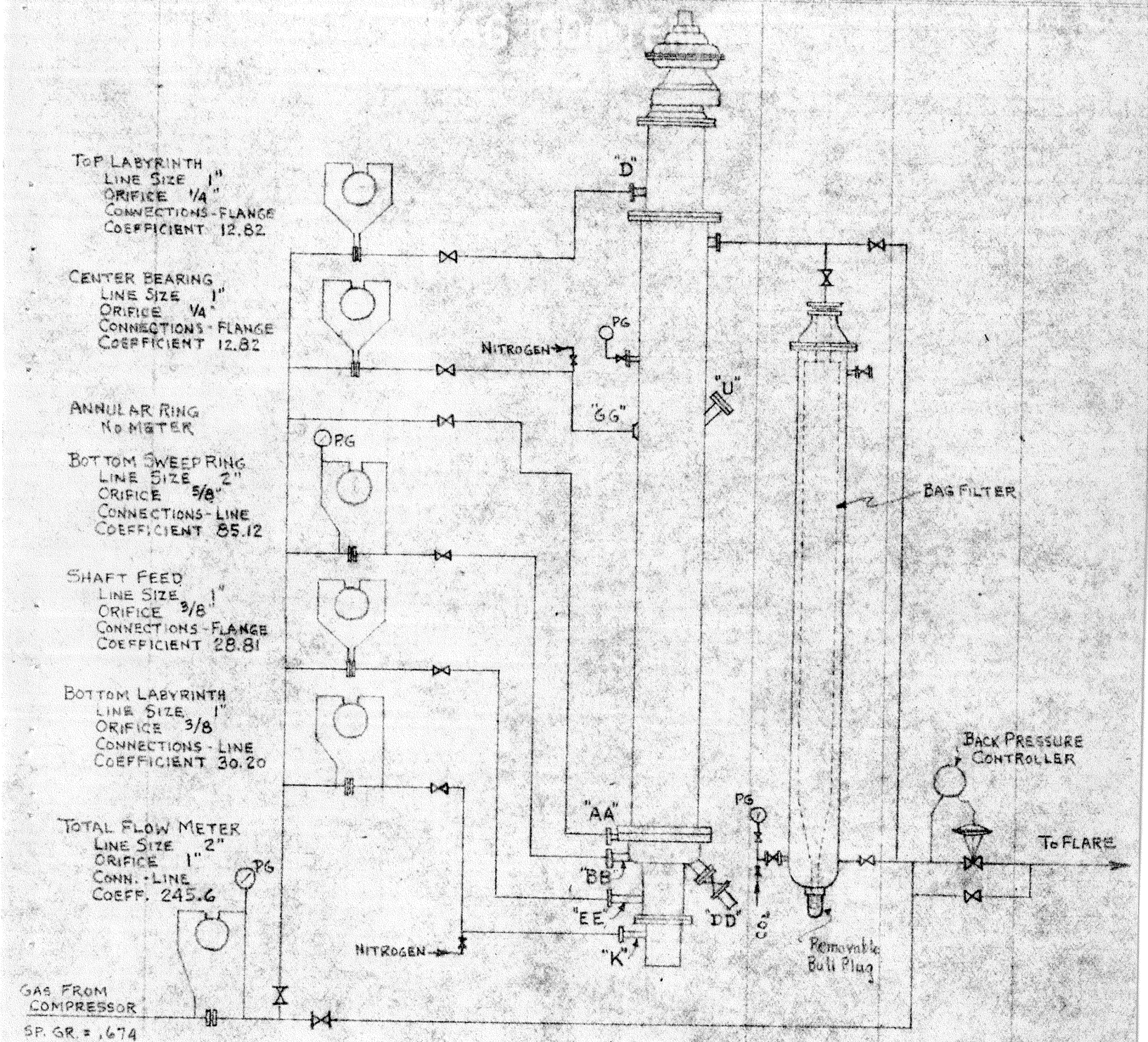
COMPANY

JOB NO. J-1814

SUBJECT ENTRAINMENT CARRYOVER TESTS AT MONTEBELLO, CAL

SHEET NO. 1 BY

DATE



FLOW DIAGRAM AND METER ARRANGEMENT

FORM 35

STRATFORD ENGINEERING CORPORATION

COMPANY

JOB NO. J-1814

SUBJECT ENTRAINMENT CARRYOVER TESTS AT MONTEBELLO, CAL.

SHEET NO. 2 BY

DATE

TEST NO	A	B	C	D	E	1	2	3	4	5	6	7	8
DATE (1947)	3/7	3/7	3/7	3/7	3/7	3/8	3/8	3/8	3/8	3/8	3/8	3/9	3/9
TOTAL FLOW "H_2O	29.5	✓	36.0	✓	✓	36.0	✓	✓	✓	✓	✓	✓	✓
COEF $\times\sqrt{\frac{I}{G}}$	299.1		299.1			299.1							
DWNSTREAM PRESS #G	235	✓	178	✓	✓	178	✓	✓	✓	✓	✓	✓	✓
$\sqrt{P}$ abs. UPSTREAM	15.4		13.9			13.9							
FLOW STD. C.F./HR	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000	25000
TOP LABYRINTH "H_2O	15.0	✓	19.0			19.0	✓	✓	✓			✓	✓
COEF $\times\sqrt{\frac{I}{G}}$	15.6		15.6			15.6							
UPSTREAM PRESS #G	220	✓	168	✓	✓	168	✓	✓	✓	✓	✓	✓	✓
$\sqrt{P}$ abs. DOWNSTREAM	15.3		13.5			13.5							
FLOW STD. C.F./HR	923	923	920	920	920	920	920	920	920	920	920	920	920
MIDDLE BEARING "H_2O	15.0	✓	19.0	✓	✓	19.0	✓	✓	✓	✓	✓	✓	✓
COEF $\times\sqrt{\frac{I}{G}}$	15.6		15.6			15.6							
UPSTREAM PRESS #G	220	✓	168	✓	✓	168	✓	✓	✓	✓	✓	✓	✓
$\sqrt{P}$ abs. DOWNSTREAM	15.3		13.5			13.5							
FLOW STD. C.F./HR	923	923	920	920	920	920	920	920	920	920	920	920	920
BOTTOM LABYRINTH "H_2O	10.8	✓	14.0	✓	✓	14.0	✓	✓	✓	✓	✓	✓	✓
COEF $\times\sqrt{\frac{I}{G}}$	36.8		36.8			36.8							
UPSTREAM PRESS #G	220	✓	168	✓	✓	168	✓	✓	✓	✓	✓	✓	✓
$\sqrt{P}$ abs. UPSTREAM	15.3		13.53			13.53							
FLOW STD. C.F./HR	1855	1855	1860	1860	1860	1860	1860	1860	1860	1860	1860	1860	1860
SHAFT FEED "H_2O	11.8	✓	15.5	✓	✓	15.5	✓	✓	✓	✓	✓	✓	✓
COEF $\times\sqrt{\frac{I}{G}}$	35.1		35.1			35.1							
UPSTREAM PRESS #G	220	✓	168	✓	✓	168	✓	✓	✓	✓	✓	✓	✓
$\sqrt{P}$ abs. DOWNSTREAM	15.3		13.50			13.5							
FLOW STD C.F./HR	1845	1845	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875
BOTTOM SWEEP "H_2O	16.2	✓	21.5	✓	✓	21.5	✓	✓	✓	✓	✓	✓	✓
COEF $\times\sqrt{\frac{I}{G}}$	103.7		103.7			103.7							
UPSTREAM PRESS #G	220	✓	168	✓	✓	168	✓	✓	✓	✓	✓	✓	✓
$\sqrt{P}$ abs. UPSTREAM	15.3		13.53			13.53							
FLOW STD. C.F./HR	6380	6380	6500	6500	6500	6500	6500	6500	6500	6500	6500	6500	6500
ANNULAR RING (BY DIFF.) C.F./H.	13074	13074	12925	12925	12925	12925	12925	12925	12925	12925	12925	12925	12925

FORM 35

STRATFORD ENGINEERING CORPORATION

COMPANY

JOB NO. J-1814

SHEET NO. 3 BY

SUBJECT ENTRAINMENT CARRYOVER TESTS AT MONTEBELLO, CAL

DATE

TEST No	9	10	11	12	13	14	15	16	17	18
DATE (1943)	3/10	3/10	3/10	3/10	3/11					
TOTAL FLOW "H_2O	36	″	″	″	″					
COEF. x $\sqrt{\frac{I}{G}}$	299.1									
DOWNSTREAM PRESS #G	178	″	″	″	″					
$\sqrt{P}$ abs UPSTREAM	139									
FLOW - STD CU.FT/HR	25000	25000	25000	25000	25000					
TOP LABYRINTH "H_2O	19.0	″	″	″	″					
COEF. x $\sqrt{\frac{I}{G}}$	15.6									
UPSTREAM PRESS #G	168.0	″	″	″	″					
$\sqrt{P}$ abs. DOWNSTREAM	13.5									
FLOW - STD CU.FT./HR	920	920	920	920	920					
MIDDLE BEARING "H_2O	19.0	″	″	″	″					
COEF. x $\sqrt{\frac{I}{G}}$	15.6									
UPSTREAM PRESS #G	168.0	″	″	″	″					
$\sqrt{P}$ abs. DOWNSTREAM	13.5									
FLOW - STD. CU.FT./HR	920	920	920	920	920					
BOTTOM LABYRINTH "H_2O ,	14.0	″	″	″	″					
COEF x $\sqrt{\frac{I}{G}}$	36.8									
UPSTREAM PRESS. #G	168.0	″	″	″	″					
$\sqrt{P}$ abs UPSTREAM	13.53									
FLOW - STD. CU.FT./HR	1860	1860	1860	1860	1860					
SHAFT FEED "H_2O	15.5	″	″	″	″					
COEF. x $\sqrt{\frac{I}{G}}$	35.1									
UPSTREAM PRESS #G	168.0	″	″	″	″					
$\sqrt{P}$ abs. DOWNSTREAM	13.50									
FLOW - STD. CU.FT./HR.	1875	1875	1875	1875	1875					
BOTTOM SWEEP "H_2O	21.5	″	″	″	″					
COEF. x $\sqrt{\frac{I}{G}}$	103.7									
UPSTREAM PRESS. #G	168.0	″	″	″	″					
$\sqrt{P}$ abs. UPSTREAM	13.53									
FLOW - STD CU.FT/HR	6500	6500	6500	6500	6500					
NULAR RING (BY DIFF.) C.F./HR	12925	12925	12925	12925	12925					

FORM 35

STRATFORD ENGINEERING CORPORATION

COMPANY

JOB NO. J-1814

SHEET NO. 4 BY

SUBJECT ENTRAINMENT CARRYOVER TESTS AT MONTEBELLO, CAL

DATE

TEST NO.	A	B	C	D	E	1	2	3	4	5	6	7	8
DATE (1947)	3/7	3/7	3/7	3/7	3/7	3/7	3/8	3/8	3/8	3/8	3/8	3/9	3/9
R.P.M. SHAFT SPEED	0	0	0	0	1000	1000	1000	1000	1000	1000	1000	1000	1000
CONTACTOR PRESS. #G	51	51	28	28	28	28	28	28	28	28	28	28	28
FLOW RATES - STD C.F.M.													
TOTAL FEED	416.6	416.6	416.6	"	"	"	"	"	"	"	"	"	"
TOP LABYRINTH	15.4	15.4	15.3	"	"	"	"	"	"	"	"	"	"
MIDDLE BEARING	15.4	15.4	15.3	"	"	"	"	"	"	"	"	"	"
BOTTOM LABYRINTH	30.9	30.9	31.0	"	"	"	"	"	"	"	"	"	"
SHAFT FEED	30.8	30.8	31.3	"	"	"	"	"	"	"	"	"	"
BOTTOM SWEEP	106.3	106.3	108.3	"	"	"	"	"	"	"	"	"	"
ANNULAR RING (BY DIFF.)	217.6	217.6	215.4	"	"	"	"	"	"	"	"	"	"
TOTAL TO CENTER	168.0	168.0	170.9	"	"	"	"	"	"	"	"	"	"
TOTAL TO ANNULUS	217.6	217.6	215.4	"	"	"	"	"	"	"	"	"	"
TOTAL TO WHEEL	401.2	401.2	401.3	"	"	"	"	"	"	"	"	"	"
FLOW RATES - ACTUAL C.F.M.													
TOTAL TO CENTER	37.6	37.6	58.8	58.8	58.8	58.8	58.8	58.8	58.8	58.8	58.8	58.8	58.8
TOTAL TO ANNULUS	48.7	48.7	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2
TOTAL TO WHEEL	89.7	89.7	138.0	138.0	138.0	138.0	138.0	138.0	138.0	138.0	138.0	138.0	138.0
VELOCITIES - SUPERFICIAL													
CENTER TUBE Ft/sec.	1.93	1.93	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01
ANNULUS	1.92	1.92	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93
DILUTE PHASE	1.36	1.36	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09	2.09
IN SEPARATOR WHEEL	2.05	2.05	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
TEST PERIOD - MINUTES	2	4	4	4		60	120	180	240	184	215	255	252
TOTAL GAS RUN - CU.FT.	179.4	358.8	558.0	558.0		8280	16560	24840	33180	25392	29670	35190	34776
BAG WEIGHT FINAL LBS-OZ	5-9½	6-3	9-11	9-12½		10 3½	11-15	14-13	16-14½	12-14	8-13	9-11	7-8
BAG WEIGHT START	5-5	5-9½	6-3	6-4		8-1	8-10	8-13	8-9	7-12	6-11	7-9	6-8½
DIFF. WEIGHT LBS-OZ	0-4½	0-9½	3-8	3-8½		2-2½	3-5	6-0	8-5½	5-2	2-2	2-2	0-15½
CARRYOVER - GRAINS/CU.FT.	11.0	11.6	44.0	44.3		1.82	1.40	1.69	1.76	1.42	0.50	0.42	0.195
FINES DENSITY - AERATED						—	—	44.5	45.7		51.0	50.5	51.8
" " SETTLED						—	46.0	46.2	47.3		52.8	51.8	53.9
" " PACKED						79.2	81.0	85.5	92.2		91.0	95.0	98.0
RESIDUE DENSITY - AERATED							137.0		137.5		140.0		139.0
" " SETTLED							138.0		146.0		145.5		144.0
" " PACKED							178.0		179.0		176.0		175.0
CATALYST INVENTORY AT START	425	424.7	424.1	424.1		424.0	421.85	418.54	412.54	404.20	399.07	397.95	395.82
CUMULATIVE OVER - WT %						0.74	1.52	2.92	4.88	6.10	6.60	7.10	7.35

FORM 38

End of Run Filter sucked into effluent line. Shut Down and returned Fines. Run Void

N.G. - Trouble Stopped

N.G. - Trouble Stopped

STRATFORD ENGINEERING CORPORATION

COMPANY

JOB NO. J-1814

SHEET NO. 5 BY

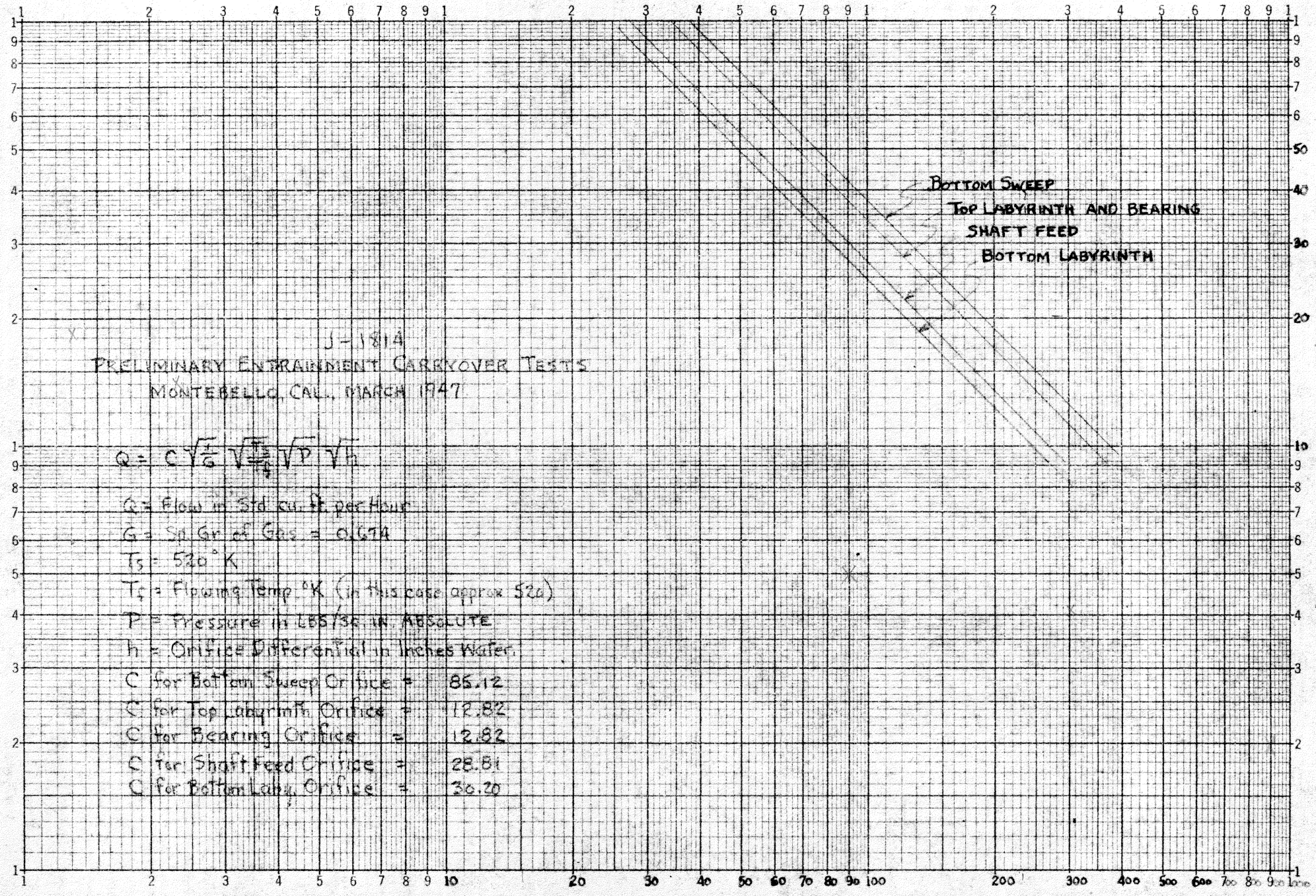
SUBJECT ENTRAINMENT CARRYOVER TESTS AT MONTEBELLO, CAL

DATE

TEST NO	9	10	11	12	13					
DATE (1947)	3/10	3/10	3/10	3/10	3/11					
R.P.M. SHAFT SPEED	1000	1000	1000	1000	1000					
CONTACTOR PRESS. #G	28	16	16	16	16					
FLOW RATES - STD. C.F.M.										
TOTAL FEED	416.6	"	"	"	"					
TOP LABYRINTH	15.3	"	"	"	"					
MIDDLE BEARING	15.3	"	"	"	"					
BOTTOM LABYRINTH	31.0	"	"	"	"					
SHAFT FEED	31.3	"	"	"	"					
BOTTOM SWEEP	108.3	"	"	"	"					
ANNULAR RING (BY DIFF.)	215.4	"	"	"	"					
TOTAL TO CENTER	170.9	"	"	"	"					
TOTAL TO ANNULUS	215.4	"	"	"	"					
TOTAL TO WHEEL	401.3	"	"	"	"					
FLOW RATES - ACTUAL C.F.M.										
TOTAL TO CENTER	58.8	81.5	81.5	81.5	81.5					
TOTAL TO ANNULUS	74.2	103.0	103.0	103.0	103.0					
TOTAL TO WHEEL	138.0	192.0	192.0	192.0	192.0					
VELOCITIES - SUPERFICIAL										
CENTER TUBE FT./SEC.	3.01	4.18	4.18	4.18	4.18					
ANNULUS	2.93	4.06	4.06	4.06	4.06					
DILUTE PHASE	2.09	2.90	2.90	2.90	2.90					
IN SEPARATOR WHEEL	3.15	4.40	4.40	4.40	4.40					
TEST PERIOD - MINUTES	120	181	240	360	490					
TOTAL GAS RUN - CU. FT.	16560	34750	46080	69120	94080					
BAG WEIGHT FINAL, LBS. - OZ.	6-13	8-1½	9-8¼	9-15	8-7½					
BAG WT. AT START	6-7	6-6	6-12½	6-6¾	6-10					
DIFF. WEIGHT, LBS. - OZ.	0-6	1-11½	2-11¾	3-8¾	1-13½					
CARRYOVER, GRAINS/CU.FT.	0.158	0.347	0.915	0.359	0.137					
FINES DENSITY - AERATED		56.0	60.0	55.2	52.5					
" " SETTLED		59.5	61.8	58.0	53.8					
" " PACKED		105.0	106.2	104.0	103.5					
RESIDUE DENSITY - AERATED		140.5		141.0	142.0					
" " SETTLED		144.0		146.5	146.0					
" " PACKED		175.0		173.0	162.0					
CATALYST INVENTORY AT START	394.84	394.47	393.75	389.01	385.46	383.62				
CUMULATIVE OVER - WT %	7.42	7.82	8.45	9.30	9.74					

FORM 35

KEUFFEL & ESSER CO., N. Y. NO. 359-112
Logarithmic, 3 × 2 Cycles.
MADE IN U. S. A.



J-1814

PRELIMINARY ENTRAINMENT CARRYOVER TESTS
MONTEBELLO, CALIF., MARCH 1947

$$Q = C\sqrt{\frac{1}{G}}\sqrt{\frac{T_s}{T_f}}\sqrt{P}\sqrt{h}$$

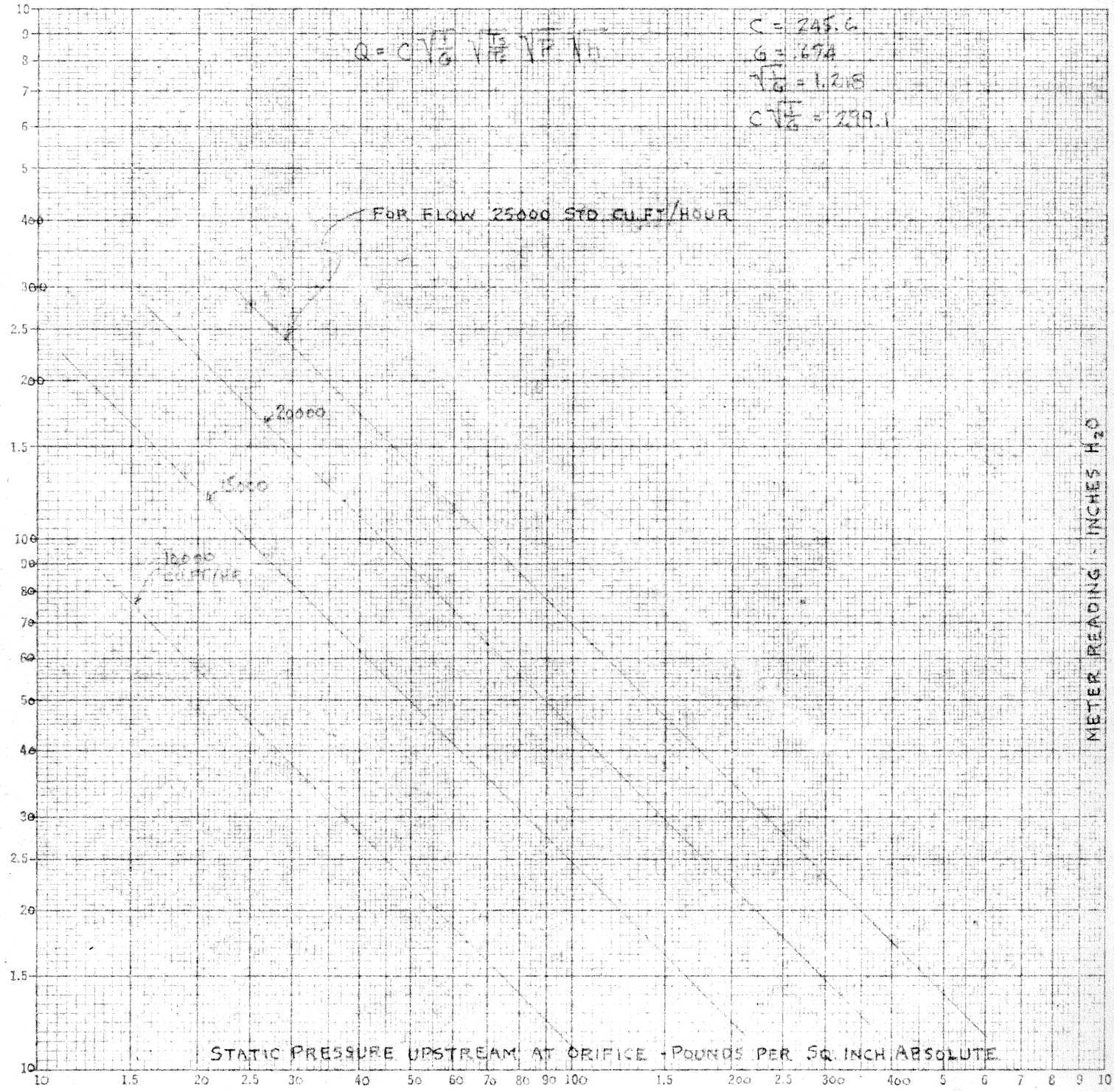
Q = Flow in Std. cu. ft. per Hour
G = Sp. Gr. of Gas = 0.674
T_s = 520° K
T_f = Flowing Temp °K (in this case approx 520)
P = Pressure in LBS/SQ. IN. ABSOLUTE
h = Orifice Differential in Inches Water

C for Bottom Sweep Orifice	=	85.12
C for Top Labyrinth Orifice	=	12.82
C for Bearing Orifice	=	12.82
C for Shaft Feed Orifice	=	28.84
C for Bottom Lab. Orifice	=	36.20

J-1814

TOTAL FLOW METER - IN 2" LINE

1" ORIFICE - LINE CONNECTED.



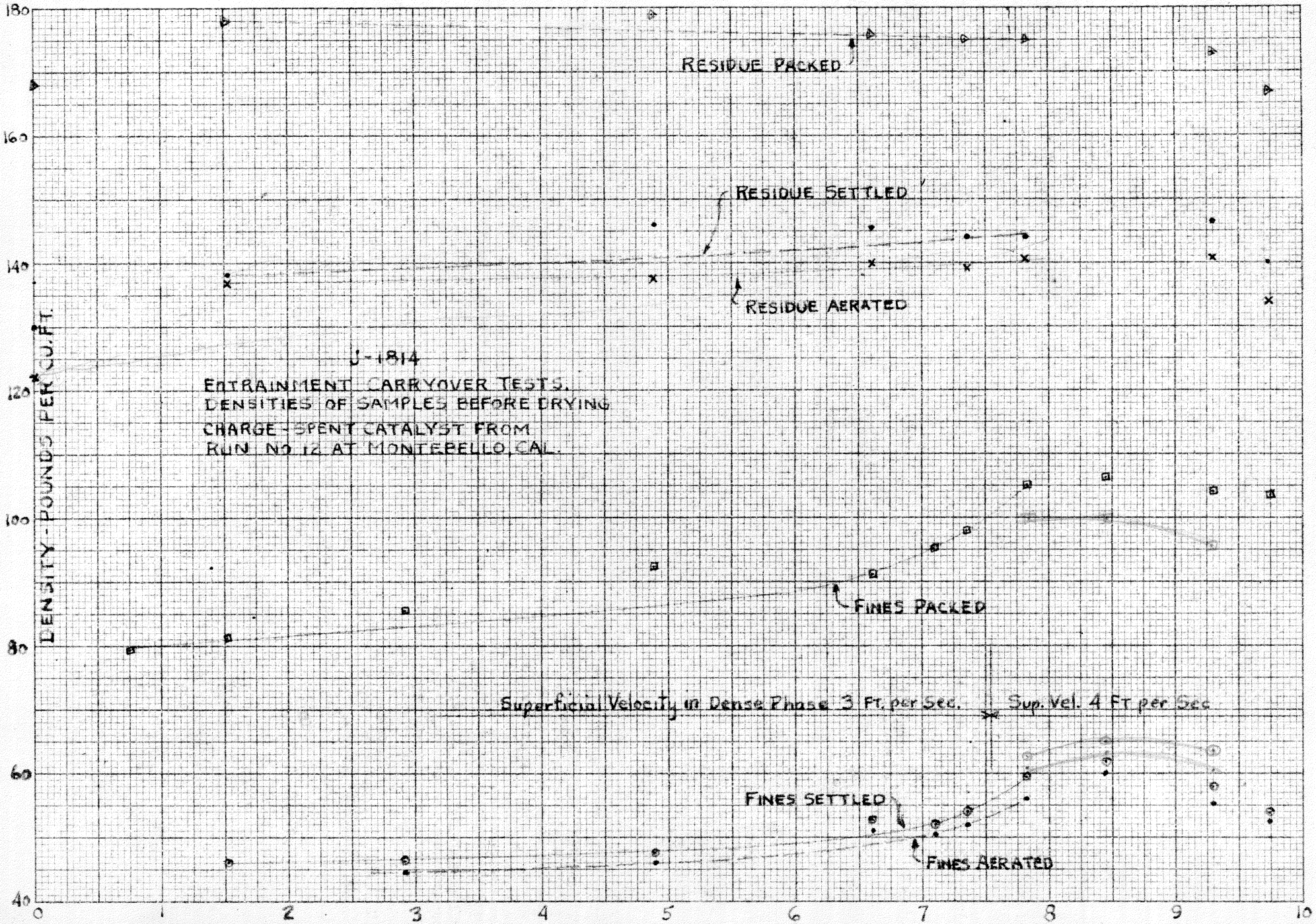
J-1814

PRELIMINARY ENTRAINMENT CARRYOVER TESTS

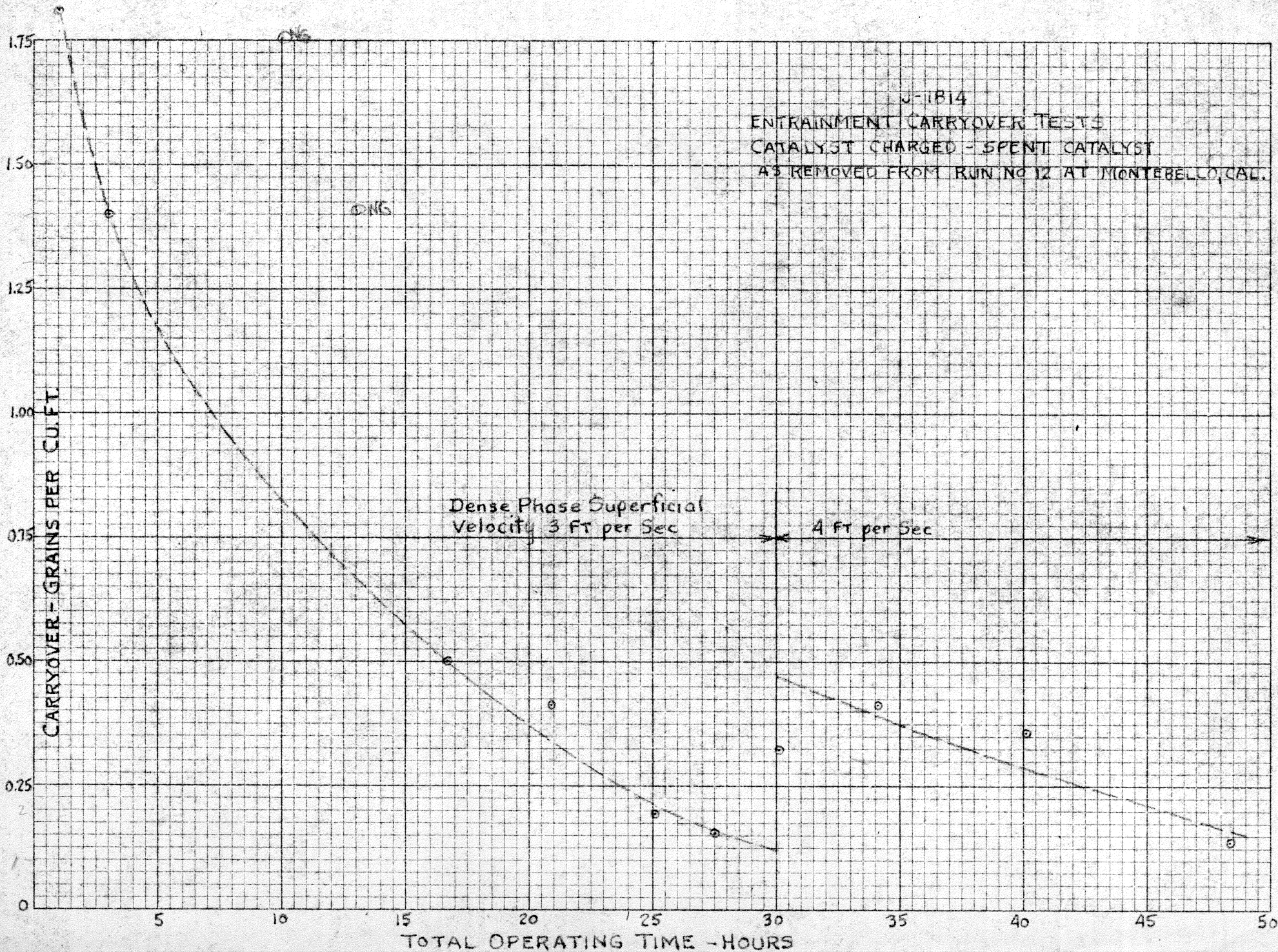
MONTEBELLO, CAL MCH 1947

CHARLES BRUNING COMPANY, INC. NO. 700-24
DATA SHEETS
PRINTED IN U.S.A.

KEUFFEL & ESSER CO., N. Y. NO. 359-11
10 × 10 to the ½ inch, 5th lines accented.
Engraving 7 × 10 in.
MADE IN U. S. A.



KEUFFEL & ESSER CO., N. Y. NO. 359-5
10 × 10 to the inch. 10th lines heavy.
MADE IN U. S. A.



MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	13A	13B
Start	10:00 3/20	10:00 3/21
End	10:00 3/21	10:00 3/22
Duration	24	24
GENERATOR DATA		
Pressure-psig	214	212
Gas Rate-scfh	2790	2785
Oxygen Rate-scfh	2005	2000
Product Rate-scfh	8450	8250
Product Composition by Corrected Orsat- mol %		
CO	35.1	34.7
H2	58.4	57.9
CO2	2.0	2.1
N2	2.0	1.5
CH4	2.5	3.8
SYNTHESIS DATA		
Pressure-psig	200	200
Recycle Rate-scfh	12740	12830
Fresh Feed Rate-scfh	8450	8250
Wet Gas Rate-scfh	3310	2920
Catalyst Temperature- F	674	645
Catalyst Density-#/cu.ft.	49	28
Depth of Bed-ft.	10	11
Fresh Feed Rate-cfh/# Cat.	~~546~~	465
Cat. Fluidized - #	546	465
Inlet Velocity-ft./sec.	2.0	2.0
Recycle Ratio	1.5	1.6
Contraction- %	61.0	64.5
Measured oil - gph	2.5	3.9
Measured Water - gph	6.1	9.5
Steam Pressure - psig	1050	1050
Steam Rate - #/hr.	431	400
% CO2 in Wet Gas	27.7	25.7
% CO Converted to CO2	25.8	20.1

MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	12A	12B	12C	12D	12E
Start	8:00 2/21	8:00 2/22	8:00 2/23	8:00 2/24	8:00 2/25
End	8:00 2/22	8:00 2/23	8:00 2/24	8:00 2/25	8:00 2/26
Duration	24	24	24	24	24
GENERATOR DATA					
Pressure-psig	220	230	227	221	221
Gas Rate-scfh	2830	2880	2890	2930	2930
Oxygen Rate-scfh	2210	2260	2120	2120	2120
Product Rate-scfh	8880	9000	9000	8970	8970
Product Composition by Corrected Orsat- mol %					
CO	35.1	34.2	34.7	33.9	33.9
H2	58.9	59.2	59.0	60.0	60.0
CO2	2.3	2.6	2.0	2.0	2.0
N2	1.8	2.7	2.6	3.3	3.3
CH4	1.9	1.3	1.7	0.8	0.8
SYNTHESIS DATA					
Pressure-psig	200	200	200	200	200
Recycle Rate-scfh	13130	13480	12865	12660	13370
Fresh Feed Rate-scfh	8880	9000	9000	8970	8970
Wet Gas Rate-scfh	3370	3050	2940	2830	3650
Catalyst Temperature- F.	617	619	616	622	650
Catalyst Density-#/cu.ft.	71	52	46	42	85
Cat. Fluidized-#	495	505	411	268	220
Depth of Bed-ft.	16	22	21	15	9
Fresh Feed-cfh/# Cat.	18	18	22	33	41
Inlet Velocity-ft./sec.	2.0	2.0	2.0	2.0	2.0
Recycle Ratio	1.5	1.5	1.4	1.4	1.5
Contraction-%	60.5	66.1	67.5	68.5	57.0
Measured Oil-gph	3.3	3.3	2.4	3.7	3.0
Measured Water-ph	5.3	10.4	8.2	8.8	4.5
Steam Pressure-psig	1100	1100	1100	1100	1100
Steam Rate-#/hr.	376	452	435	435	
Wet Gas Composition by Mass Spectrometer- mol%					
CO	7.6	5.7	5.8	6.1	7.1
H2	49.1	46.0	45.3	45.7	46.8
CO2	28.1	30.2	27.3	27.6	25.6
N2	3.1	3.2	3.3	2.9	5.0
CH4	5.1	6.4	9.8	9.4	8.3
C2H4	1.9	2.2	2.3	2.2	2.0
C2H6	0.7	1.0	0.9	0.9	0.7
C3H6	1.6	2.0	1.9	1.9	1.6
C3H8	0.2	0.3	0.3	0.4	0.2
C4H8	1.5	1.8	1.9	1.8	1.5
C4H10	0.3	0.3	0.3	0.3	0.2
C5H10	0.8	1.0	1.0	0.9	0.8
CO Converted to:					
CO2	24.2	22.3	19.9	19.6	24.8
C1 & C2	5.7	9.0	10.2	12.2	14.2
C3 & Heavier	6.19	63.0	64.4	62.5	52.4
Unconverted	8.2	5.6	5.5	5.7	8.6
CO Conversion %	91.8	94.4	94.5	94.3	91.4
H2 Conversion %	68.5	73.6	75.0	76.0	68.4

RUN NUMBER 12 A

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS m/hr	WET GAS #/hr	CHANGE mols	C	H	O	POLY Y'LD	#/hr	gal/hr
CO	35.1	8.217	230.1	7.63	0.678	19.0	-7.539	-7.539	-7.539	-7.539			
H2	58.9	13.788	27.5	49.06	4.353	8.7	-9.435		-18.870				
CO2	2.3	0.539	23.7	28.05	2.497	109.9	1.958	1.958		3.970			
N2	1.8	0.421	11.8	3.10	0.276	7.7	-0.145						
CH4	1.9	0.445	7.1	5.11	0.455	7.3	0.010	0.010	0.040				
C2H4				1.87	0.166	4.7	0.166	0.332	0.664				
C2H6				0.72	0.064	1.9	0.064	0.128	0.384				
C3H6				1.65	0.147	6.2	0.147	0.441	0.882		0.90	5.6	0.90
C3H8				0.22	0.020	0.9	0.020	0.060	0.160				
C4H8				1.51	0.134	7.5	0.134	0.536	1.072		0.95	7.1	1.17
C4H10				0.29	0.030	1.7	0.030	0.120	0.300			1.7	0.35
C5H10				0.79	0.070	4.9	0.070	0.350	0.700			4.9	0.91
OIL								3.577*	7.154			50.1	7.70
WATER									7.514*	3.569*			
						65.9				3.757 from H2			
ToTal	23.41	300.2		8.89	180.4	14.52						69.4	11.03

22.005 20.13 3.326 3.663

Contraction: 14.52 / 23.41 = 62.0 %
Conversion of CO: 7.539 / 8.217 = 91.8 %
Conversion of H2: 9.435 / 13.788 = 68.5 %

Weight Balance:

Wet Gas	180.4	
Oil; 3.3 gph	21.5	
Water; 5.3 gph	44.2	
	246.1	82.1 %

8.321 #/MCF H2+CO
1.322 gal/MCF

CO Converted to:

	mols/hr	%	%
CO2	1.985	24.2	26.4
C1 & C2	0.470	5.7	6.2
C3 & Heavier	5.084	61.9	67.4
Unconverted	0.678	8.2	

H2+CO = 8.340
= 2.95 × N.G.

	#/R	#/MMSCF	#/M³
H2O	65.9%	7.91	126.6
CO2	86.2	10.34	165.4
C3+	71.3	8.55	136.8
C1+C2	6.8	0.82	13.1

Oil Yield: 7.70 / 2.83 - 2.72 gal. "recovered" oil per MCF natural gas fed to generator
11.03 / 2.83 - 3.89 gal. ultimate oil per MCF natural gas fed to generator
92.5 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 12 B

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS m/hr	WET GAS #/hr	CHANGE mols	C	H	O	POLY Y'LD	#/hr	gal/hr
CO	34.2	8.112	227.5	5.66	0.455	12.7	-7.657	-7.657		-7.657			
H2	59.2	14.073	28.2	46.02	3.707	7.4	-10.366		-20.732				
CO2	2.6	0.616	27.2	30.15	2.426	108.0	1.810	1.810		3.620			
N2	2.7	0.641	17.9	3.21	0.258	7.2	-0.383						
CH4	1.3	0.308	4.9	6.43	0.517	8.3	0.209	0.209	0.836				
C2H4				2.24	0.180	5.0	0.180	0.360	0.720				
C2H6				0.98	0.079	2.4	0.079	0.158	0.474				
C3H6				2.02	0.162	6.8	0.162	0.486	0.972		0.90	6.11	0.98
C3H8				0.28	0.023	1.0	0.023	0.069	0.184				
C4H8				1.75	0.141	7.9	0.141	0.564	1.128		0.95	7.51	1.23
C4H10				0.28	0.023	1.3	0.023	0.092	0.230			1.3	0.27
C5H10				0.98	0.079	5.5	0.079	0.395	0.790			5.5	1.02
OIL								3.514*	7.028			49.15	7.57
WATER									8.370*	4.037*			
							4.111			4.185 from H2			
TOTAL	23.75	305.7		8.05	173.5	15.70						69.57	11.07

22.185 21.6 22.2

Contraction: 15.70 / 23.75 = 66.1 %
Conversion of CO: 7.657 / 8.112 = 94.4 %
Conversion of H2: 10.366 / 14.073 = 73.6 %

Weight Balance:

Wet Gas	173.5
Oil; 3.3 gph	21.5
Water; 10.4 gph	86.7
	281.7

92.1 %

8.27 #/m 1.32 gal/m

CO Converted to:

	mols/hr	%	%
CO2	1.810	22.3	23.6
C1 & C2	0.727	9.0	9.5
C3 & Heavier	5.120	63.1	66.9
Unconverted	0.455		

8.408

	#/l	g/m	g/m³
H2O	74.00	8.801	140.8
CO2	79.64	9.472	151.6
C3+	71.65	8.521	136.3
C1+C2	10.8	1.284	20.5

Oil Yield: 7.57 / 2.88 = 2.63 gal."recovered" oil per MCF natural gas fed to generator
11.07 / 2.88 = 3.84 gal. ultimate oil per MCF natural gas fed to generator
= 91.4 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 12 C

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS m/hr	WET GAS #/hr	CHANGE mols	C	H	O	POLY Y'LD	#/hr	gal/hr
CO	34.7	8.241	230.7	5.81	0.451	12.6	-7.790	-7.790		-7.790			
H2	59.0	14.013	28.0	45.28	3.505	7.0	-10.508		-21.016				
CO2	2.0	0;475	20.9	27.30	2.116	93.1	1.641	1.641		3.282			
N2	2.6	0.617	17.3	3.27	0.254	7.1	-0.363						
CH4	1.7	0.404	6.5	9.83	0.762	12.2	0.358	0.358	1.432				
C2H4				2.26	0.175	4.9	0.175	0.350	0.700				
C2H6				0.87	0.068	2.0	0.068	0.136	0.408				
C3H6				1.89	0.147	6.0	0.147	0.441	0.882		0.90	5.7	0.86
C3H8				0.29	0.023	1.0	0.023	0.069	0.184				
C4H8				1.89	0.147	8.1	0.147	0.588	1.176		0.95	7.7	1.27
C4H10				0.29	0.023	1.3	0.023	0.092	0.230			1.3	0.27
C5H10				1.02	0.079	5.5	0.079	0.395	0.790			5.5	1.02
OIL								3.720*	7.440			52.1	8.01
WATER									7.774*	4.508*			
										3.887			
TOTAL		23.75	303.4		7.75	160.8	16.00					72.2	11.41

22.254 20.75 3.395 4.198

8.572 #/M

Contraction: 16.00 / 23.75 = 67.4 %
Conversion of CO: 7.79 / 8.24 = 94.5 %
Conversion of H2: 10.508/14.013 = 75.0 %

Weight balance:

Wet Gas		160.8	1.352 8
Oil: 2.4 gph		15.6	
Water: 8.2 gph		68.5	
		244.9	81.0 %

#/hr #/M

H2O	75.6	8.963	143.4
CO2	72.2	8.560	137.0
C3+	76.0	9.011	144.2
C4+	12.6	1.494	23.9

8.434

Co Converted to:

	mols/hr	%	%
CO2	1.641	19.9	21.1
C1 & C2	0.844	10.2	10.8
C3 & Heavier	5.305	64.4	68.1
Unconverted	0.451	5.5	

Oil Yield: 8.01 / 2.89 = 2.77 gal."recovered"oil per MCF natural gas fed to generator
11.41 / 2.89 = 3.96 gal. ultimate oil per MCF natural gas fed to generator
= 94.1 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 12 D

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS m/hr	WET GAS #/hr	CHANGE mols	C	H	O	POLY Y'LD	#/hr	gal/hr
CO	33.9	8.023	224.4	6.09	0.455	12.7	-7.568	-7.568		-7.568			
H2	60.0	14.200	28.4	45.70	3.420	6.8	-10.780		-21.560				
CO2	2.0	0.474	20.8	27.55	2.047	90.1	1.573	1.573		3.146			
N2	3.3	0.781	21.9	2.90	0.217	6.1	-0.564						
CH4	0.8	0.190	3.0	9.36	0.700	11.2	0.510	0.510	2.040				
C2H4				2.18	0.163	4.6	0.163	0.326	0.652				
C2H6				0.94	0.070	2.1	0.070	0.140	0.420				
C3H6				1.88	0.141	5.9	0.141	0.423	0.846		0.90	5.3	0.85
C3H8				0.36	0.027	1.2	0.027	0.081	0.216				
C4H8				1.81	0.135	7.6	0.135	0.540	1.080		0.95	7.2	1.07
C4H10				0.29	0.022	1.3	0.022	0.088	0.220			1.3	0.27
C5H10				0.94	0.070	4.9	0.070	0.350	0.700			4.9	0.91
OIL								3.537*	7.074			49.52	7.64
WATER									8.312*	4.422*		79.6	
										4.156 from H2			
TOTAL		23.668	298.5		7.467	154.4	16.201			8.578		68.22	10.74

22,223 20.67

Contraction: 16.201 / 23.668 = 68.5 %
Conversion of CO: 7.568 / 8.023 = 94.3 %
Conversion of H2: 10.780 / 14.200 = 76.0 %

Weight Balance:

Wet Gas	154.4	
Oil; 3.7 gph	24.1	
Water; 8.8 gph	73.4	
	251.9	84.4 %

8.10 #/m 1.275 gal/m

CO CONVERTED TO:

	mols/hr	%	%
CO2	1.573	19.6	20.8
C1 & C2	0.976	12.2	12.9
C3 & Heavier	5.019	62.5	66.3
Unconverted	0.455	5.7	

8.423

	#/h	#/m	s/m³
H2O	77.20	91.66	146.6
CO2	69.30	82.28	131.6
C3+	70.42	83.61	133.8
C+R	14.90	17.69	28.3

Oil Yield: 7.64 / 2.93 = 2.60 gal."recovered"oil per MCF natural gas fed to generator
10.74 / 2.93 = 3.80 gal. ultimate oil per MCF natural gas fed to generator
= 90.5 bbl. ultimate oil per MMCF natural gas fed to generator

RUN NUMBER 12 E

MONTEBELLO SYNTHESIS UNIT
CALCULATION OF YIELDS

	FRESH FEED %	FRESH FEED m/hr	FRESH FEED #/hr	WET GAS %	WET GAS m/hr	WET GAS #/hr	CHANGE mols	C	H	O	POLY Y'LD	#/hr	gal/hr
CO	33.9	8.023	224.4	7.14	0.687	19.2	-7.336	-7.336		-7.336			
H2	60.0	14.200	28.4	46.80	4.502	9.0	-9.698		-19.396				
CO2	2.0	0.474	20.8	25.60	2.464	108.4	1.990	1.990		3.980			
N2	3.3	0.781	21.9	4.99	0.480	13.4	-0.301						
CH4	0.8	0.190	3.0	8.33	0.801	12.8	0.611	0.611	2.444				
C2H4				2.01	0.193	5.4	0.193	0.386	0.772				
C2H6				0.74	0.071	2.1	0.071	0.142	0.426				
C3H6				1.64	0.158	6.7	0.158	0.474	0.948		0.90	6.1	0.97
C3H8				0.22	0.021	0.9	0.021	0.063	0.168				
C4H8				1.49	0.143	8.0	0.143	0.572	1.144		0.95	7.6	1.24
C4H10				0.22	0.021	1.2	0.021	0.084	0.210			1.2	0.25
C5H10				0.82	0.079	5.5	0.079	0.395	0.790			5.5	1.02
OIL								2.619*	5.238			36.6	5.87
WATER									7.256*	3.366*			
										3.628 from H2			
TOTAL	23.668	298.5		9.62	192.6	13.848						57.0	9.35

Contraction: 13.848 / 23.668 = 57.0%

Conversion of CO: 7.336/ 8.023 = 91.4%

Conversion of H2: 9.698/14.200 = 68.4%

CO Converted to:	mols/hr	%	%
CO2	1.990	24.8	27.3
C1 & C2	1.139	14.2	15.4
C3 & Heavier	4.207	52.4	57.3
Unconverted	0.687		

Weight Balance

Wet Gas	192.6
Oil; 5.6 gph	36.6
Water; 7.3 gph	60.6
	289.8 #/hr

Oil Yield: 5.87 / 2.93 = 2.01 gal."recovered"oil per MCF natural gas fed to generator

9.35 / 2.93 = 3.18 gal. ultimate oil per MCF natural gas fed to generator

= 75.9 bbl. ultimate oil per MMCF natural gas fed to generator

THE TEXAS COMPANY
MONTEBELLO LABORATORY

TEST OF STRATCO SEPARATING WHEEL

March 15, 1947

THE TEXAS COMPANY
MONTEBELLO LABORATORY

TEST OF STRATCO SEPARATING WHEEL
March 15, 1947

INTRODUCTION

During the past two week period the Montebello synthesis reactor has been out of service for the purpose of adding 30 feet to the height of the standpipe system, a change required to permit the use of low density catalyst. During this period a preliminary test of the separating performance of the Stratco separating wheel was carried out. The present report presents the results of this test.

EQUIPMENT

The Stratco reactor at Montebello consists of a 16 inch diameter tube 20 feet long, provided with a contacting section at the bottom and a separating section at the top. The contacting section is 12 feet long and contains an annular space around a central draft tube. The draft tube is 9 inches in internal diameter and 12 inches in external diameter. A central shaft carries 17 pumping impellers which, together with 17 corresponding baffles fitted to the inside of the draft tube, serves to pump the catalyst up through the draft tube from bottom to top, the catalyst returning to the bottom through the annular space. Feed gas is introduced at the bottom and gas oil cooling jackets are provided around the contacting section both on the external shell and on the draft tube.

The separating section contains a separating wheel which is 12 inches in diameter and 43 inches long. This wheel is made up of a shaft $4\frac{1}{2}$ inches in diameter to

which 12 rectangular blades are welded axially to make a star wheel. This wheel is contained in a sleeve 13 inches in diameter in which a series of tangential slots are cut to permit the passage of catalyst. There are five rows of slots with 4 slots per row. The lower two rows of slots are 1/4" wide and the upper three rows are 1/8" wide, the length of the slots being 7 inches in all cases. Catalyst laden gas enters the separating wheel at the bottom and the entrained catalyst is thrown to the outside of the wheel by centrifugal force. The separated catalyst escapes through the slots in the sleeve and falls through the annular space and returns to the dense phase. The present tests were carried out with a bag filter attached to the outlet, the amount of catalyst lost from the wheel being determined by weighing the filter bag and its contents.

OPERATIONS

The reactor was charged with 425 pounds of catalyst from Montebello Run 12. This catalyst had been in service for 120 hours and showed a final density of 91 #/cu.ft. in the synthesis reactor. As charged to the Stratco, it showed an aeriated density of 122½ #/cu.ft., a settled density of 130 #/cu.ft. and a packed density of 168 #/cu.ft.

Two loading tests were made with a stationary wheel at gas velocities of 1.36 ft./sec. and 2.09 ft./sec. in the dilute phase, the corresponding velocities in the wheel being 2.05 ft./sec. and 3.15 ft./sec.

The wheel was then operated at a speed of 1000 R.P.M. with a gas velocity of 2.09 ft./sec. in the dilute phase and 3.15 ft./sec. in the wheel for a period of 30 hours.

At the end of this period the carry-over had fallen to 0.16 grains per cubic foot and the gas velocity was increased to 2.90 ft./sec. in the dilute phase and 4.40 ft./sec. in the wheel. The test was continued at these conditions until the loading had fallen to 1.37 grains per cubic foot.

DISCUSSION

The attached Figure 1 shows the variation of the aeriated densities of the dense and dilute phases plotted against the quantity of catalyst carried out of the reactor. It will be noted that the first 1½% of catalyst lost gave an increase in dense phase density from 122 to 140 #/cu.ft. and that further loss had no material effect on bed density. This result is not unexpected in that the catalyst used had been used in the Montebello reactor which is fitted with cyclones and the catalyst had therefore already been fairly well fractionated. Future tests to be made with a sample of catalyst from the Tulsa unit which is equipped with filters may be expected to whow a marked effect of fines removal on the density of the residual dense phase.

Figure 2 is a plot of the variation of loss with time, the loss being expressed in grains per cubic foot of gas. As might be expected, the loss declined logarithmically with time from an initial value of 2 gr./cu.ft. to a final value of 0.16 gr./cu.ft. at the end of 27½ hours. The gas rate was then increased and a further period of 20 hours of operation obtained. Although there is some irregularity in the loading figures immediately following the increase in gas rate, the indicated initial carry-over at the higher gas rate is about 0.8 gr./cu.ft. The increase in quantity of catalyst

carried over was therefore 0.8 x 2.90 / 2.09 x 0.16 or 7 fold. This corresponds satisfactorily with the 7.2 fold increase which would be expected on the basis of the sixth power of the velocity, the theoretical value.

Since the carry-over measured with the wheel rotated at 1000 R.P.M is indicated to be 2 gr./cu.ft., and since the loading test made with the stationary wheel showed a carry-over of 44 gr./cu.ft. the separating power of the wheel is indicated to be 42/44 or 95.5%

The Stratco reactor performed satisfactorily from a mechanical standpoint during these tests showing no signs of severe vibration, or of undue difficulty with the sealing system. There was no evidence of erosion at the end of the test.

Particle size anahyses are now being obtained on the catalyst samples from these tests.

THE TEXAS COMPANY
MONTEBELLO LABORATORY
STRATCO SEPARATOR TESTS

TEST NUMBER	5	6	7	8	9	10	11	12	13
DATE	3/8	3/8	3/9	3/9	3/10	3/10	3/10	3/10	3/11
R.P.M.	1000	1000	1000	1000	1000	1000	1000	1000	1000
PERIOD-Min.	184	215	255	252	120	181	240	360	490
PRESSURE-psig	28	28	28	28	28	16	16	16	16
FLOW RATES-scf/min.									
Total Feed	416.6								
Top Labyrinth	15.4								
Middle Bearing	15.3								
Bottom Labyrinth	31.0								
Shaft Feed	31.3								
Bottom Sweep	108.3								
Annular Ring	215.4								
Total to Center	170.9								
Total to Annulus	215.4								
Total to Wheel	401.3								
FLOW RATES-Actual cfm									
Total to Center	58.8	58.8	58.8	58.8	81.5	81.5	81.5	81.5	81.5
Total to Annulus	74.2	74.2	74.2	74.2	74.2	103.0	103.0	103.0	103.0
Total to Wheel	138.0	138.0	138.0	138.0	138.0	192.0	192.0	192.0	192.0
SUPERFICIAL VELOCITIES- ft./sec.									
Center Tube	3.01	3.01	3.01	3.01	3.01	4.18	4.18	4.18	4.18
Annulus	2.93	2.93	2.93	2.93	2.93	4.06	4.06	4.06	4.06
Dilute Phase	2.09	2.09	2.09	2.09	2.09	2.90	2.90	2.90	2.90
Wheel	3.15	3.15	3.15	3.15	3.15	4.40	4.40	4.40	4.40
Total Gas Flow- cu.ft.	25392	29670	25190	34776	16560	34750	46080	69120	94080
Bag Weight, Final-Lbs.-Oz	12-14	8-13	9-11	7-8	6-13	8-1½	9-8¼	9-15	8-7½
Initial	7-12	6-11	7- 9	6-8½	6- 7	6-6	6-12½	6-6¼	6-10
Contents	5- 2	2- 2	2- 2	0-15½	0- 6	1-11½	2-11¾	3-8¾	1-13½
Carry-over-Grains/cu.ft.	1.42	0.50	0.42	0.195	0.158	0.347	0.415	0.35	0.139
Fines Density-#/cu.ft.									
Aerated		51.0	50.5	51.8		56.0	60.0	55.2	52.5
Settled		5.28	51.8	53.9		59.5	61.8	58.0	53.5
Packed		91.0	95.0	98.0		105.0	106.2	104.0	103.5
Residue Density-#/cu.ft.									
Aerated		140.0		139.0		140.5		141.0	142.0
Settled		145.5		144.0		144.0		146.5	146.0
Packed		176.0		175.0		175.0		173.0	162.0
Inventory at Start	404.2	399.07	397.08	395.82	394.84	394.47	391.75	389.01	385.46
Cumulative Wt.% Over	6.10	6.60	7.10	7.35	7.42	7.82	8.45	9.30	9.74

Note: Turbine stopped during Run 5 - Results unreliable

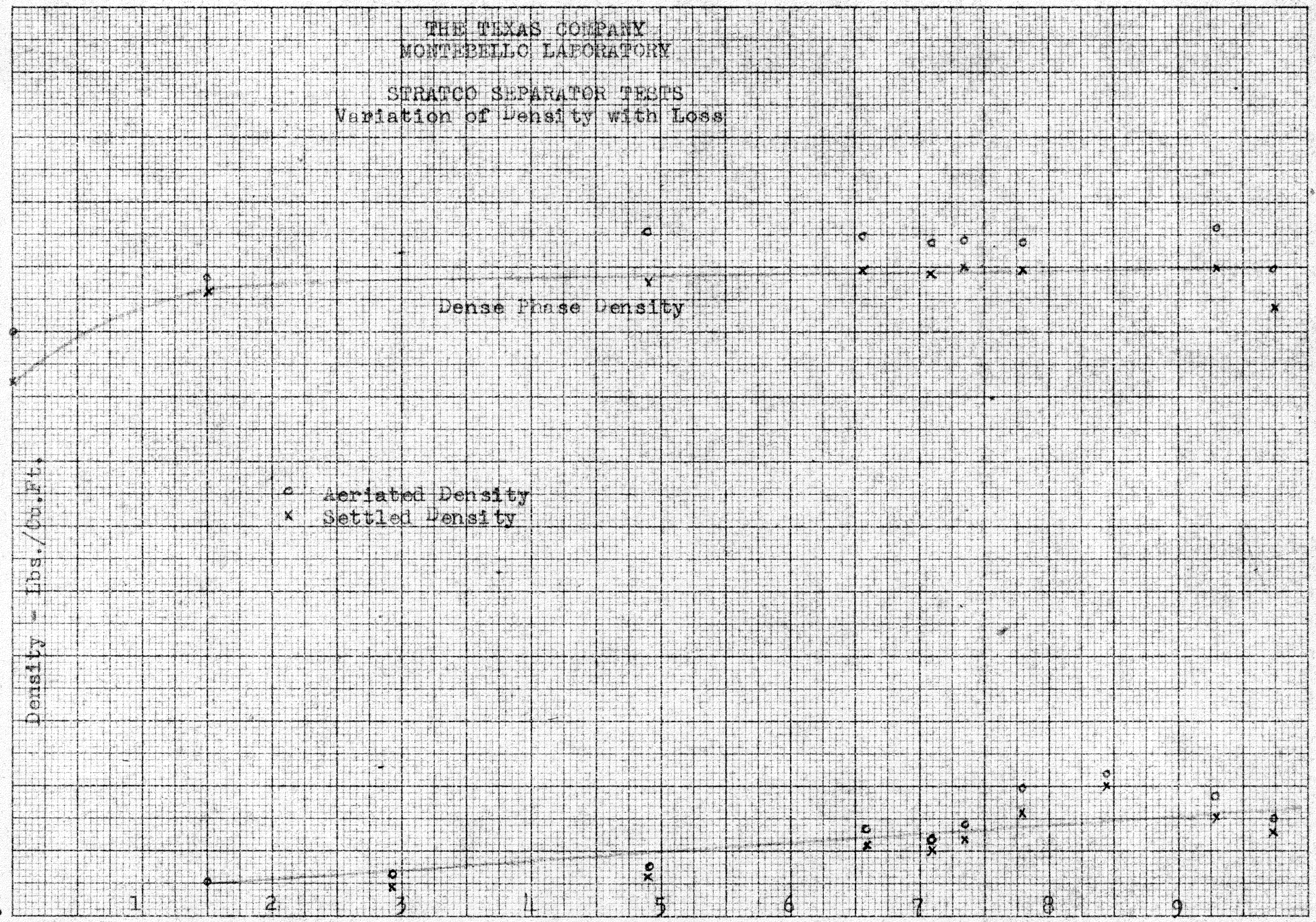
THE TEXAS COMPANY
MONTEBELLO LABORATORY
STRATCO SEPARATOR TESTS

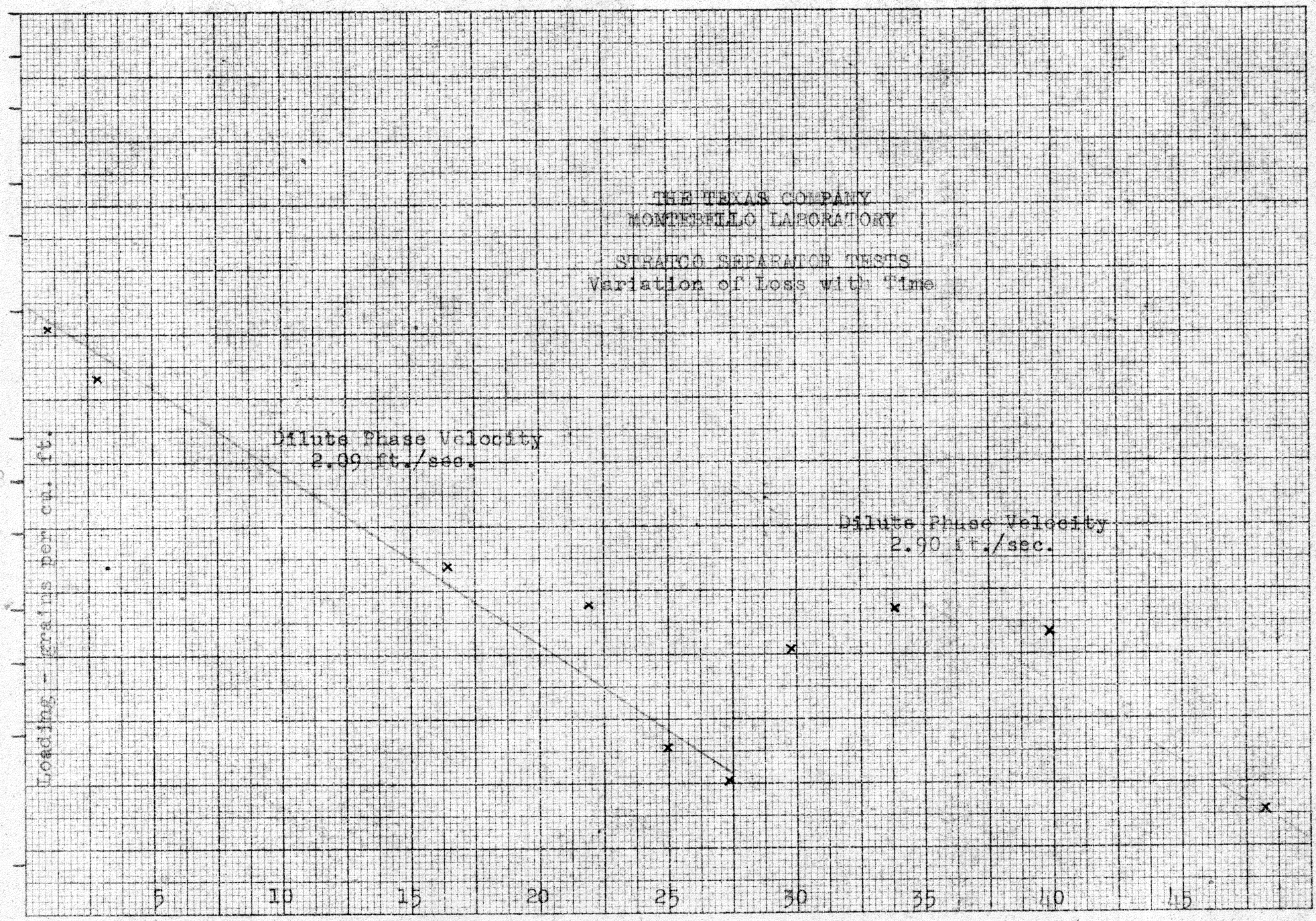
TEST NUMBER	A	B	C	D	E	1	2	3	4
DATE	3/7	3/7	3/7	3/7	3/7	3/7	3/8	3/8	3/8
R.P.M.	0	0	0	0	0	1000	1000	1000	1000
PERIOD-Min.	2	4	4	4	4	60	120	180	240
PRESSURE-psig	51	51	28	28	28	28	28	28	28
FLOW RATES-scf/min									
Total Feed	416.6	416.6	416.6						
Top Labyrinth	15.4	15.4	15.3						
Middle Bearing	15.4	15.4	15.3						
Bottom Labyrinth	30.9	30.9	31.0						
Shaft Feed	30.8	30.8	31.3						
Bottom Sweep	106.3	106.3	108.3						
Annular Ring	217.6	217.6	215.4						
Total to Center	168.0	168.0	170.9						
Total to Annulus	217.6	217.6	215.4						
Total to Wheel	401.2	401.2	401.3						
FLOW RATES-Actual cfm									
Total to Center	37.6	37.6	58.8	58.8	58.8	58.8	58.8	58.8	58.8
Total to Annulus	48.7	48.7	74.2	74.2	74.2	74.2	74.2	74.2	74.2
Total to Wheel	89.7	89.7	138.0	138.0	138.0	138.0	138.0	138.0	138.0
SUPERFICIAL VELOCITIES- ft./sec.									
Center Tube	1.93	1.93	3.01	3.01	3.01	3101	3.01	3.01	3.01
Annulus	1.92	1.92	2.93	2.93	2.93	2.93	2.93	2.93	2.93
Dilute Phase	1.36	1.36	2.09	2.09	2.09	2.09	2.09	2.09	2.09
Wheel	2.05	2.05	3.15	3.15	3.15	3.15	3.15	3.15	3.15
Total Gas Flow- cu.ft.	179.4	358.8	558.0	558.0		8280	16560	24840	33120
Bag Weight,Final-Lbs.Oz.	5-9½	6-3	9-11	9-12½		10-3½	11-15	14-13	16-14½
Initial	5-5	5-9½	6-4	6- 4		8-1	8-10	8-13	8- 9
Contents	0-4½	0-9½	3- 8	3-8½		2-2½	3-5	6- 0	8- 5½
Carry-over- grains/cu.ft	11.0	11.6	44.0	44.3		1.82	1.40	1.69	1.76
Fines Density-#/cu.ft.									
Aeriated								44.5	45.7
Settled							46.0	46.2	47.3
Packed						79.2	81.0	85.5	92.2
Residue Density-#/cu.ft.									
Aeriated							137.0	137.5	137.5
Settled							138.0		146.0
Packed							178.0		179.0
Inventory at Start	425	424.7	424.1	424.1		424.0	421.85	418.54	412.54
Cumulative Wt.% Over						0.74	1.52	2.92	4.88

Note: Turbine stopped during Run 4 - Results unreliable

THE TEXAS COMPANY
MONTEBELLO LABORATORY

STRATCO SEPARATOR TESTS
Variation of Density with Loss




THE TEXAS COMPANY
MONTEBELLO LABORATORY
STRATCO SEPARATOR TESTS
Variation of Loss with Time
Dilute Phase Velocity
2.09 ft./sec.
Dilute Phase Velocity
2.90 ft./sec.
Loading - grains per cu. ft.
5
10
15
20
25
30
35
40
45
Durationof Test - Hours

THE TEXAS COMPANY
MONTEBELLO EXPERIMENT STATION

HEAT TRANSFER DATA

April 7, 1947

THE TEXAS COMPANY
MONTEBELLO LABORATORY

HEAT TRANSFER DATA

INTRODUCTION

The following report summarizes heat transfer data for Montebello synthesis operations, Runs 3 through 12.

EQUIPMENT

The Montebello synthesis reactor consists of a vertical 10 inch I.D. tube 30 ft. long which contains three 2 inch extra heavy cooling tubes with centers on a 5 inch circle, which extend through the full length of the reactor, These cooling tubes are connected to a steam drum at the top and a blow-down drum at the bottom. The steam drum and the blow-down drum are, also, connected by means of a 6 inch down-commer which completes the thermo-syphon circulating system. The cooling system is designed for operation at a maximum pressure of 1100 psig. The cooling tubes have an external surface area of 56 sq. ft. and an internal surface area of 46 sq. ft. and a mean area of 51 sq. ft.

OPERATION

Two methods of start-up have been used. In the early operation the boiler system was blocked off at the inlet to the cooling tubes and thetubes allowed to boil dry, a water level established in the steam drum and the reactor and catalyst preheated to 600 to 625 F. with natural gas circulation. Fresh feed was then introduced and, as the temperature rose in thereactor, slugs of water were allowed to enter the

cooling tubes. By alternately increasing the fresh feed rate and opening the water valve the reactor was brought on stream in an interval of about an hour. During this start-up period, catalyst bed temperatures varied widely; in a typical start-up ranging from about 500 F to about 750 F. This did not seem to cause any difficulty with loss of fluidization and seemed to be entirely satisfactory from an operating standpoint but the range of temperature seemed to be rather large. The method then adopted consisted in preheating the reactor to a temperature of about 500 F with the water in the tubes. This gives a steam pressure of about 400 psig and can be reached over a reasonable period with natural gas circulation and the preheaters available. Under this plan, there is no tendency toward a violent swing in temperature when fresh feed is introduced.

RESULTS

The calculated heat loss from the system is as follows:

1) Reactor, Cyclone, Standpipe and Feed Lines
   421 sq. ft. at 100 Bty-hr/sq.ft. or 42,000 Btu/hr
2) Bare metal-slide valve and transfer line connection.
   5 sq.ft. at 3000 Btu/hr/sq.ft. 15,000 Btu/hr
   Total Reactor Loss 57,000 Btu/hr
3) Steam System
   155 sq. ft. at 135 Btu/hr/sq.ft. 21,000 Btu/hr
   Total Loss 78,000 Btu/hr

Heat release rates were calculated on the following basis:

	Btu/mol CO Converted
CO2	16,650
CH_4	94,300
C_2, C_3, & C_4 olefins	68,200
C_2, C_3, & C_4 paraffins	72,500
Oil	68,200

The following tabulations summarize the heat balances and heat transfer coefficients for Runs 3 through 12.

It will be noted that during the earlier runs, 3 through 7, the unaccounted-for heat loss was considerably higher than in the latter runs. This reduction corresponded to the installation of better insulation at this time. Some difficulty has also been experienced from time to time in the measurement of steam production due to surges in steam rate. These surges have resulted from the combined action of the boiler water level controller and the steam back pressure regulator and have now been brought under control.

Figure 1 shows the relation between overall heat transfer coefficient and reactor inlet velocity. It is apparent that the heat transfer rate is very strongly influenced by velocity, no doubt as a result of the scrubbing action of the turbulent catalyst on the gas film on the cooling tubes and also as a result of the greater turbulence of the catalyst bed itself. It may also be noted that thecurve extrapolates approximately to a gas film heat transfer coefficient at zero inlet velocity.

It should be noted that nearly all of the runs made at Montebello have been in the ramge of 1.5 recycle ratio and that inlet velocity is directly related to heat input.

Figure 2 shows a corresponding relation of inlet velocity to the dense phase heat transfer coefficient. These values were calculated on the assumption that all heat is transferred in the dense phase region of the reactor. There is considerable doubt that this is the case and there is, also, some uncertainty as to the extent of the dense phase, since this, in turn, is calculated on the assumption that the pressure drop measured over the bottom 44.4 inches of the reactor is a true measure of the density of the catalyst throughtout the reactor. It is, therefore, not surprising that the correlation shown in Figure 2 is poorer than that shown in Figure 1.

It should, also, be noted that there is no apparent effect of catalyst density on the overall heat transfer coefficient. This is shown most clearly by a comparison of the successive periods of Run 12 where the catalyst density dropped from 117 lbs./cu.ft. initial density and 71 lbs/cu.ft. in Run 12-D.

Although no data are available to establish the point clearly it is the impression of those who have operated the Montebello Unit that the variation of steam pressure is not a very effective means of controlling bed temperature over wide ranges. Over narrow ranges steam pressure variation appears to be an effective means of control, but over wide ranges it is believed that the ability to change the amount of cooling surface will be required. This should not be difficult to accomplish in a commercial reactor, will provide a reasonable steam pressure,

over wide ranges of cooling rate, and will not introduce excessive temperature differentials between cooling tubes and catalyst bed.

Frequent inspections of the condition of the cooling tubes have been made and no accumulation of oil, wax or catalyst has ever been observed. The tubes are usually coated with a very thin film of sooty material which appears to be catalyst.

MONTEBELLO SYNTHESIS UNIT
HEAT BALANCE DATA
Thousands of Btu per Hour

RUN NO.	HEAT CONTENT OF FEED	HEAT OF REACTION	TOTAL INPUT	HEAT CONTENT OF PRODUCTS	HEAT IN STEAM	TOTAL OUTPUT	HEAT LOST	UNACCOUNTED FOR
3B	199	280	479	179	224	403	76	-2
4A	304	310	615	186	248	434	181	83
4B	262	326	588	187	248	435	153	75
5A	194	294	489	168	148	316	173	95
5B	198	362	560	165	240	405	155	77
7A	238	283	521	162	206	368	153	75
7B	25	374	399	224	0	224	175	97
9A	270	495	765	186	507	694	71	-6
9B	358	504	862	250	507	757	105	27
11A	370	417	787	204	475	679	108	30
12A	354	414	768	243	437	680	88	10
12B	358	435	793	247	497	744	49	-29
12C	357	458	815	241	490	731	84	6
12D	334	449	783	237	490	727	56	-22
12E	359	415	774	238	420	678	96	18

MONTEBELLO SYNTHESIS UNIT
HEAT TRANSFER DATA

RUN NO.	AVERAGE BED TEMP F.	STEAM TEMP F	TEMPERATURE DEFFERENCE F	HEAT CONTENT OF STEAM M Btu/hr	BOILER LOSS	TOTAL TO STEAM	HEAT TRANSFER COEF. Btu/Hr/SqFt/ F/ OVERALL	DENSE PHASE
3B	605	535	70	224	21	245	69	318
4A	591	542	49	248	21	269	108	352
4B	597	542	55	248	21	269	96	300
5A	588	544	44	148	21	169	75	282
5B	597	544	53	240	21	261	96	320
7A	586	546	40	206	21	227	111	224
9A	601	546	55	507	21	528	188	368
9B	592	546	46	507	21	528	225	545
11A	605	546	59	475	21	496	165	
11B	625	546	79	437	21	458	272	
12A	603	558	45	437	21	458	200	375
12B	608	558	50	497	21	518	203	277
12C	602	558	44	490	21	511	228	325
12D	610	558	52	490	21	511	193	258

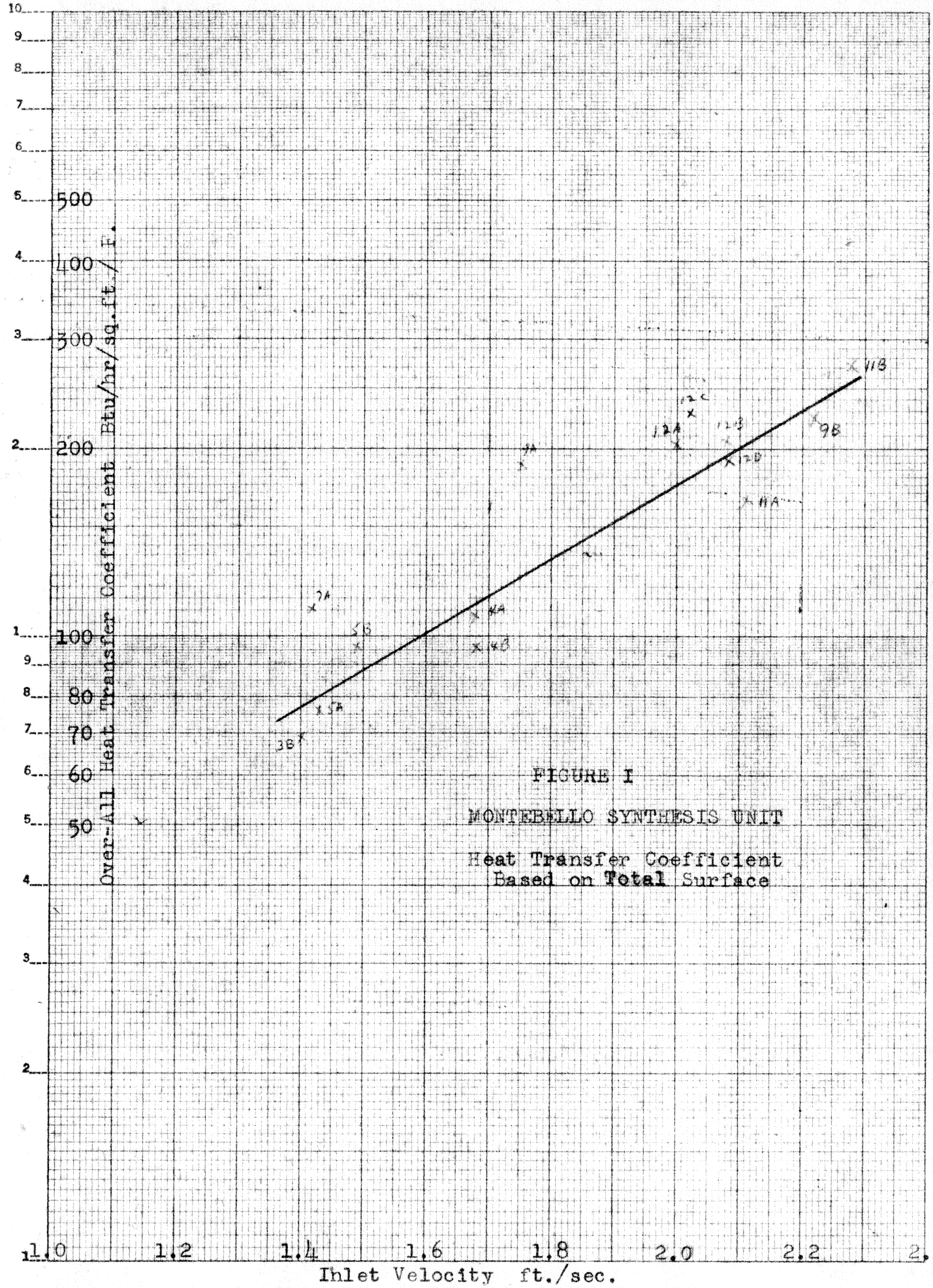


FIGURE I

MONTEBELLO SYNTHESIS UNIT

Heat Transfer Coefficient
Based on **Total** Surface

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Semi-Logarithmic, 2 cycles × 10 to the ½ inch,
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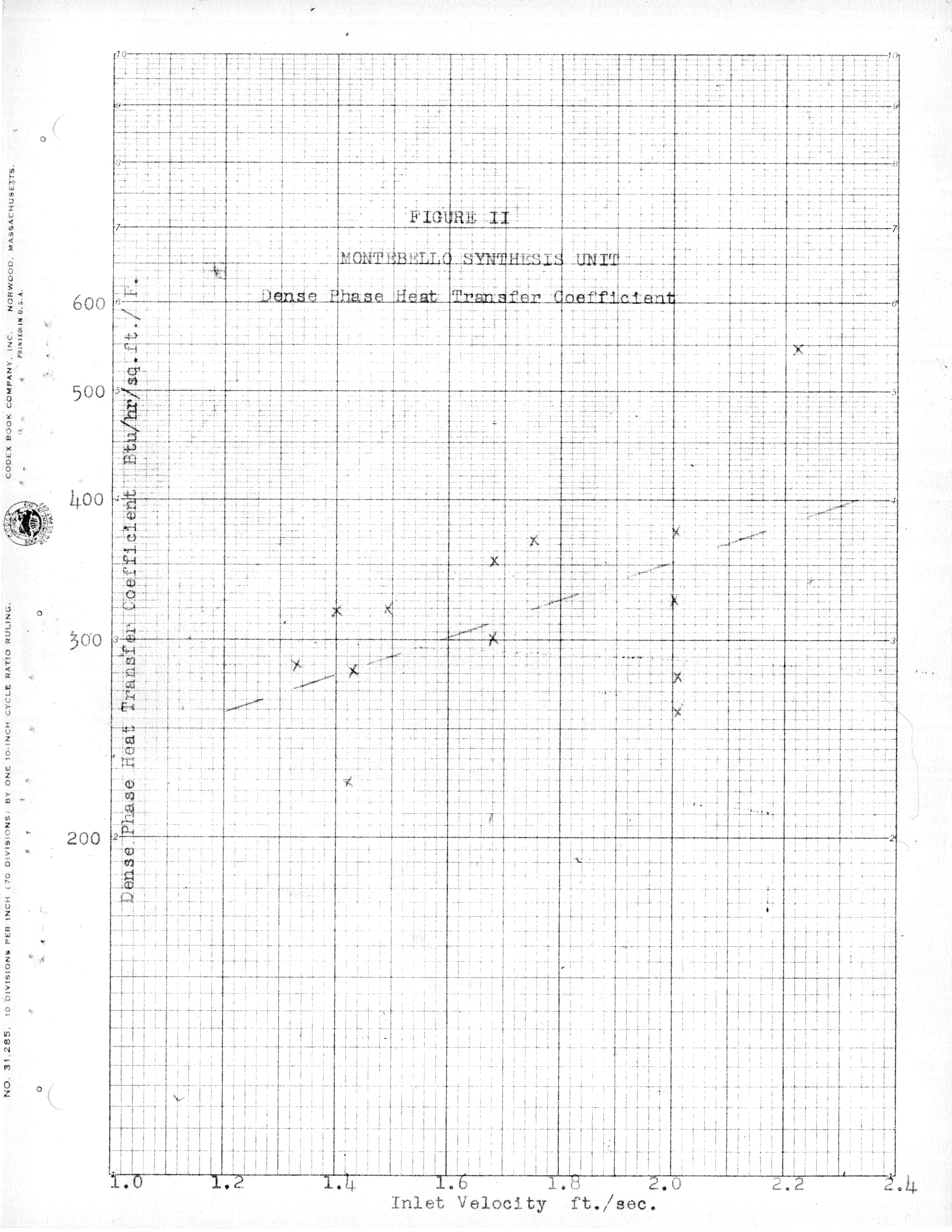

NO. 31.285. 10 DIVISIONS PER INCH (70 DIVISIONS) BY ONE 10-INCH CYCLE RATIO RULING.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.
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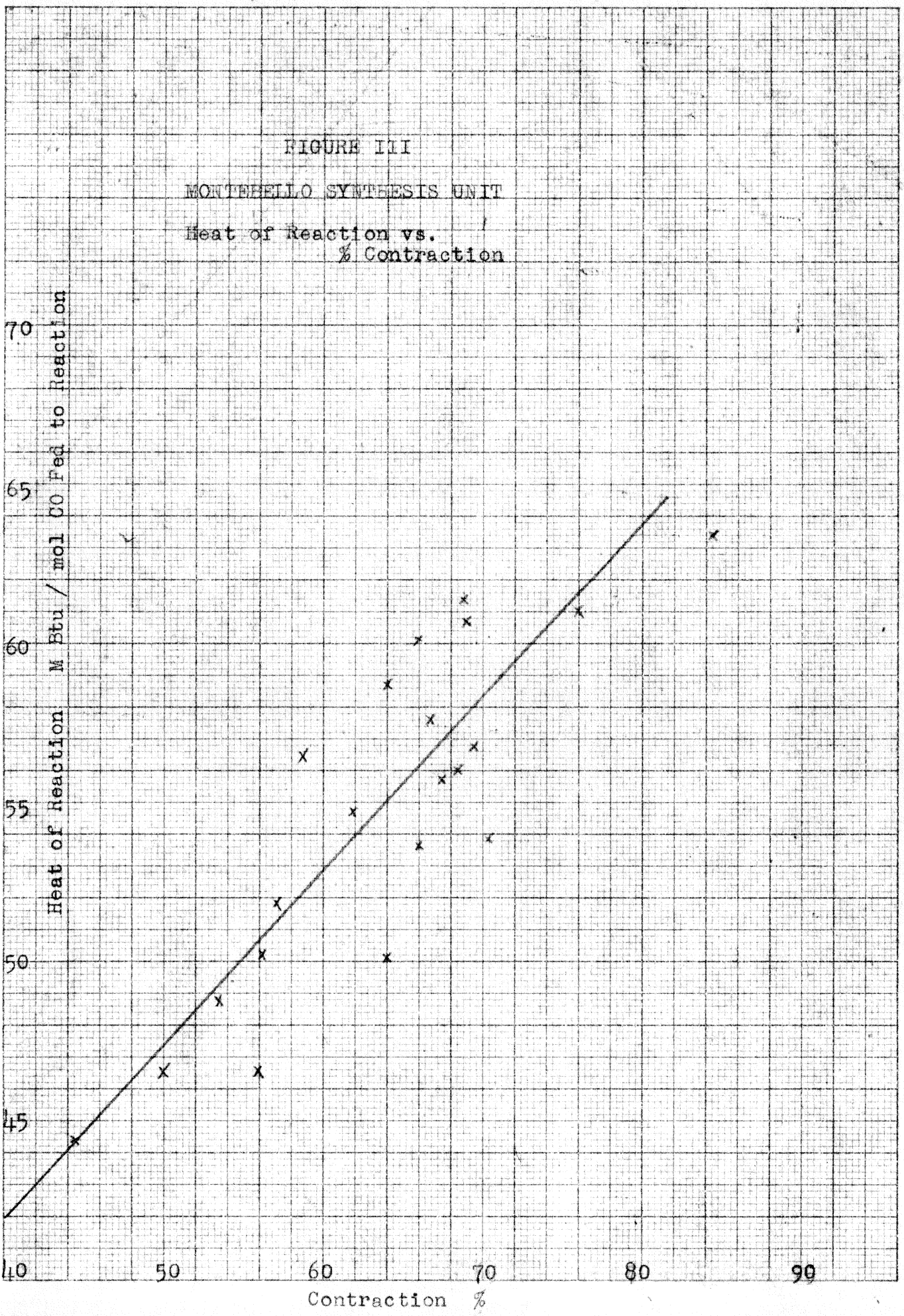
FIGURE III

MONTEBELLO SYNTHESIS UNIT

Heat of Reaction vs.
% Contraction



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THE TEXAS COMPANY
MONTEBELLO EXPERIMENT STATION

Preliminary Correlation of Synthesis Data

April 7, 1947

THE TEXAS COMPANY
MONTEBELLO LABORATORY

Preliminary Correlation of Synthesis Data

INTRODUCTION

The following report presents a series of correlations of synthesis data obtained at Montebello. In general, these correlations follow the form of earlier correlations prepared by the New York Engineering group which were based on results obtained at Olean and Beacon.

CORRELATIONS AND DISCUSSION

Figure I shows the relation of Contraction to Hydrogen Conversion and it will be noted that the present data are in excellent agreement with the previous correlation.

Figure II is a similar correlation of Hydrogen Conversion to CO Conversion. In this plot the data are somewhat more widely scattered due to the enlargement of the CO Conversion scale.

Figure III shows the relation of Hydrogen Conversion to the yield of CO2 expressed as a percentage of the CO fed to the reactor. In this plot it will be noted that the yield of CO is lower than called for by the correlation either at 1.5 or 2.0 H2/CO ratio. Since the Montebello H2/CO ratio is between 1.6 and 1.7, it is apparent that less CO2 is being produced at Montebello than at Beacon or Olean. This is believed to result from the higher CO2 content of the Montebello generator product which contains about 2% CO2.

Figure IV shows the yields of Methane, C2's and C3's expressed as percentages of the CO fed to the reactor. The scatter of the Methane points is so great that no curve has been drawn. This scatter is believed to result from the uncertainty of the explosion analyses on the generator product. There is no observable trend in the C2 or C3 yields with conversion.

Figure V shows the unsaturation of the C2, C3 and C4 fractions as a function of Hydrogen Conversion. There appears to be some decline in the unsaturation of the C2 fraction and some rise in the unsaturation of the C4 fraction and no change in the unsaturation of the C3 fraction.

Figure VI shows the relation of C3 and Heavier yield to Hydrogen Conversion for the Montebello data. The curve drawn lies directly on the Beacon curve for 2.0 H2/CO ratio. Since the Montebello generator gas is in the range of 1.6 to 1.7 and since the C3 and Heavier yield increases with H2/CO ratio, the Montebello yields are higher than the corresponding yields at Beacon. This is of course a reflection of the lower CO2 yields experienced at Montebello and is in turn a reflection of the higher CO2 content of the Montebello generator gas.

Figure VII is a plot of the ultimate oil yields as a function of Hydrogen conversion. These ultimate oil yields are calculated on the basis of 90% C3 olefin polymerization and 95% C4 olefin polymerization. A scale has, also, been shown for the corresponding yields to be expected from Brownsville gas which has an average carbon content of 1.074 atoms per mol against the 1.189 atoms per mol for the Montebello gas. Since

this function does not depend on the explosion analyses, it is believed to be somewhat more general than the others shown.

It should be borne in mind that the correlations presented are based on preliminary data from runs which have been shorter thandesired and which have, in many cases, given poor weight balances. The agreement with the correlations of earlier data from Olean and Beacon is thought to be quite good, however, and this together with the internal consistency of the data, indicates that the data,can be relied upon to a greater extent than would otherwise be the case.

In studying the data no general relationship has been found relating the CO Conversion, H2 Conversion or Contraction to operating conditions. As pointed out in an earlier report, the degree of initial catalyst reduction appears to be the principal factor in the observed variations in these relations. In the study so far made, the effects of temperature, bed density, feed rate, and catalyst inventory have not been apparent.

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FIGURE I

MONTEBELLO SYNTHESIS UNIT

Comparison of Montebello Data
With Gaucher Correlation

Contraction Vs. H2 Conversion

H2/CO Ratio for Montebello 1.6 - 1.7

Gaucher Correlation
H2/CO = 2.0

Correlation
H2/CO = 1.5

Contraction %

Hydrogen Conversion %

85
80
75
70
65
60
55
50
45
40
50
60
70
80
90

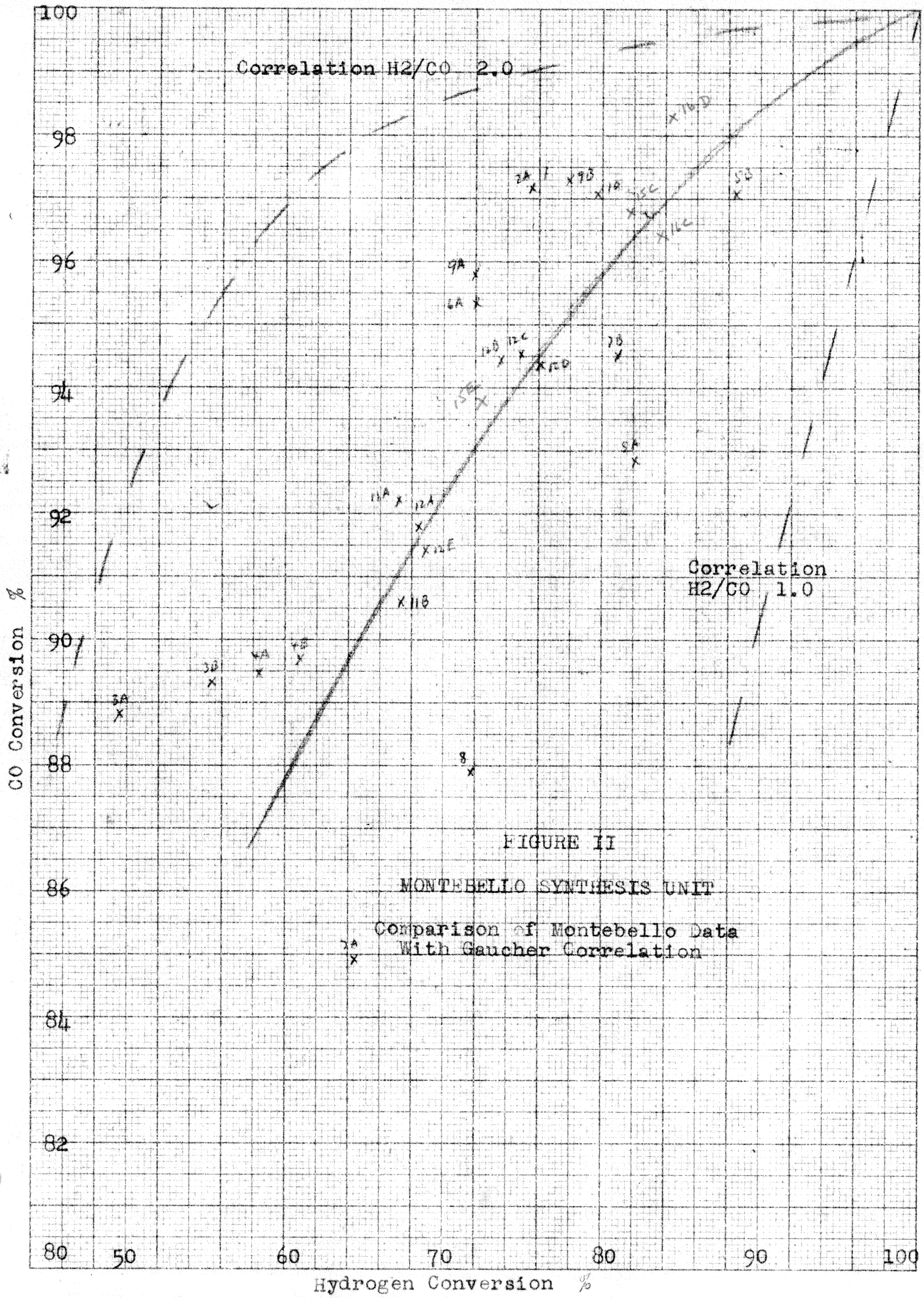

FIGURE II

MONTEBELLO SYNTHESIS UNIT

Comparison of Montebello Data With Gaucher Correlation

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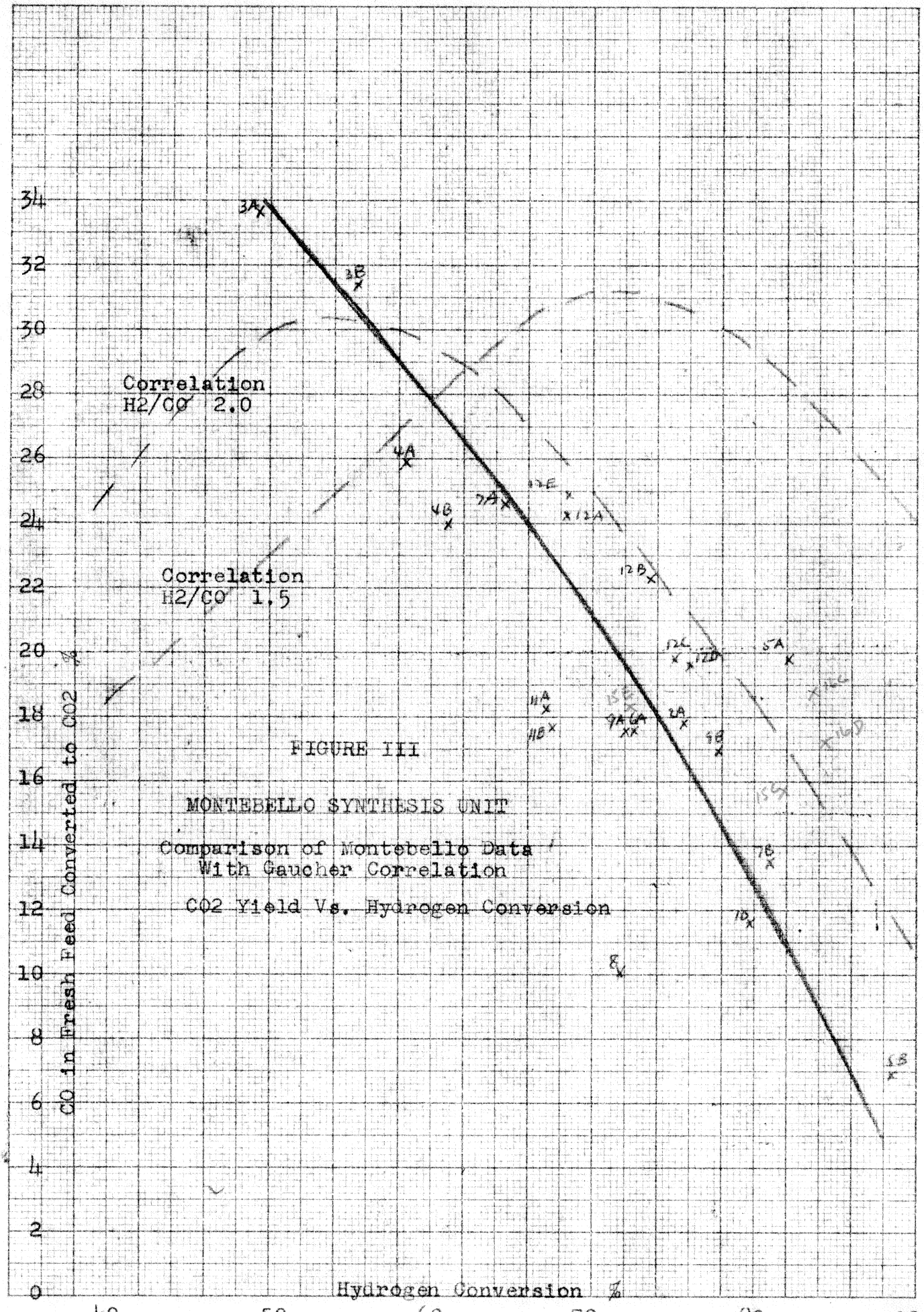

FIGURE III

MONTEBELLO SYNTHESIS UNIT

Comparison of Montebello Data
With Gaucher Correlation

CO2 Yield Vs. Hydrogen Conversion

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FIGURE IV

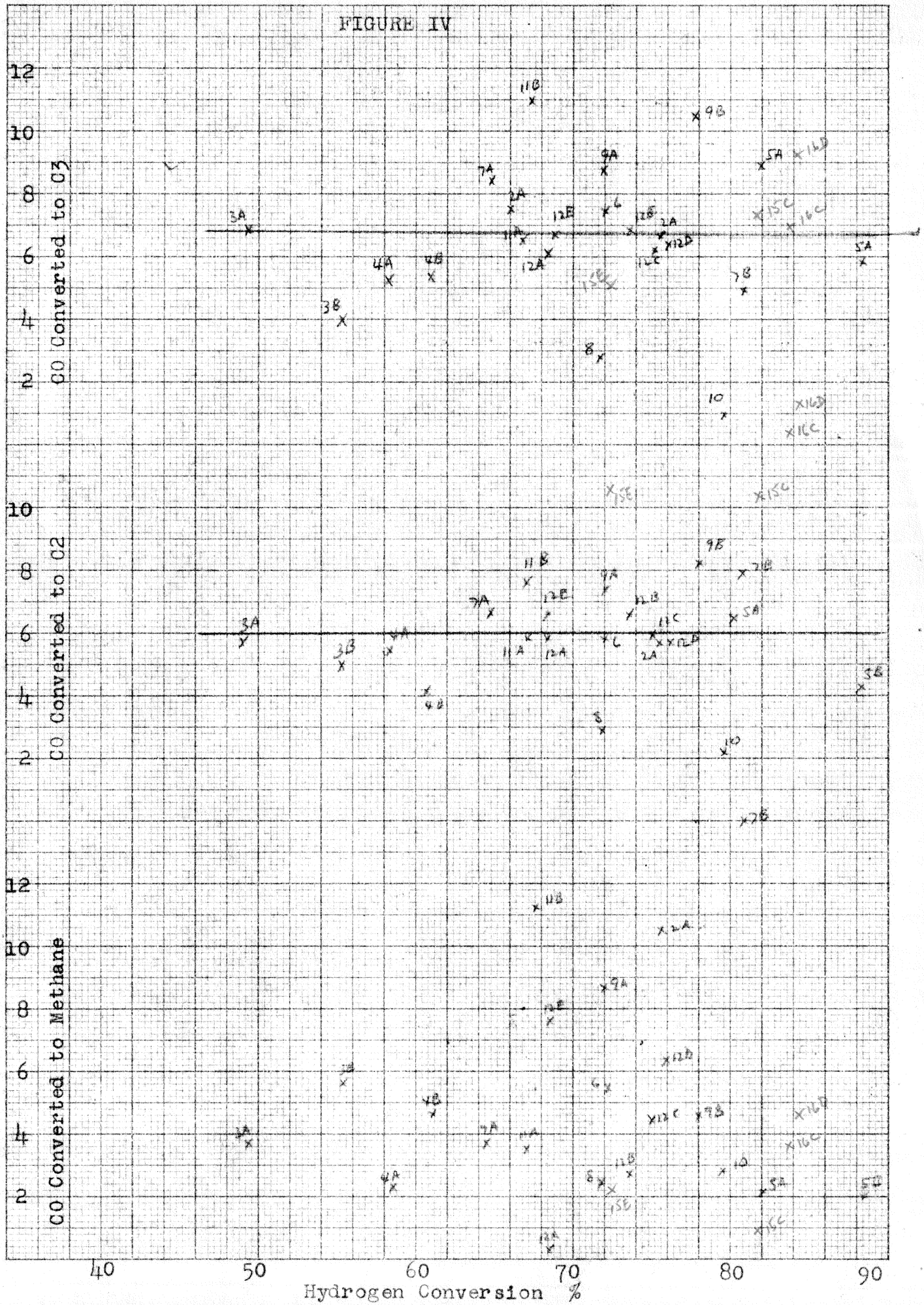

FIGURE V

MONTEBELLO SYNTHESIS UNIT

Unsaturation of C2, C3, & C4 Fractions

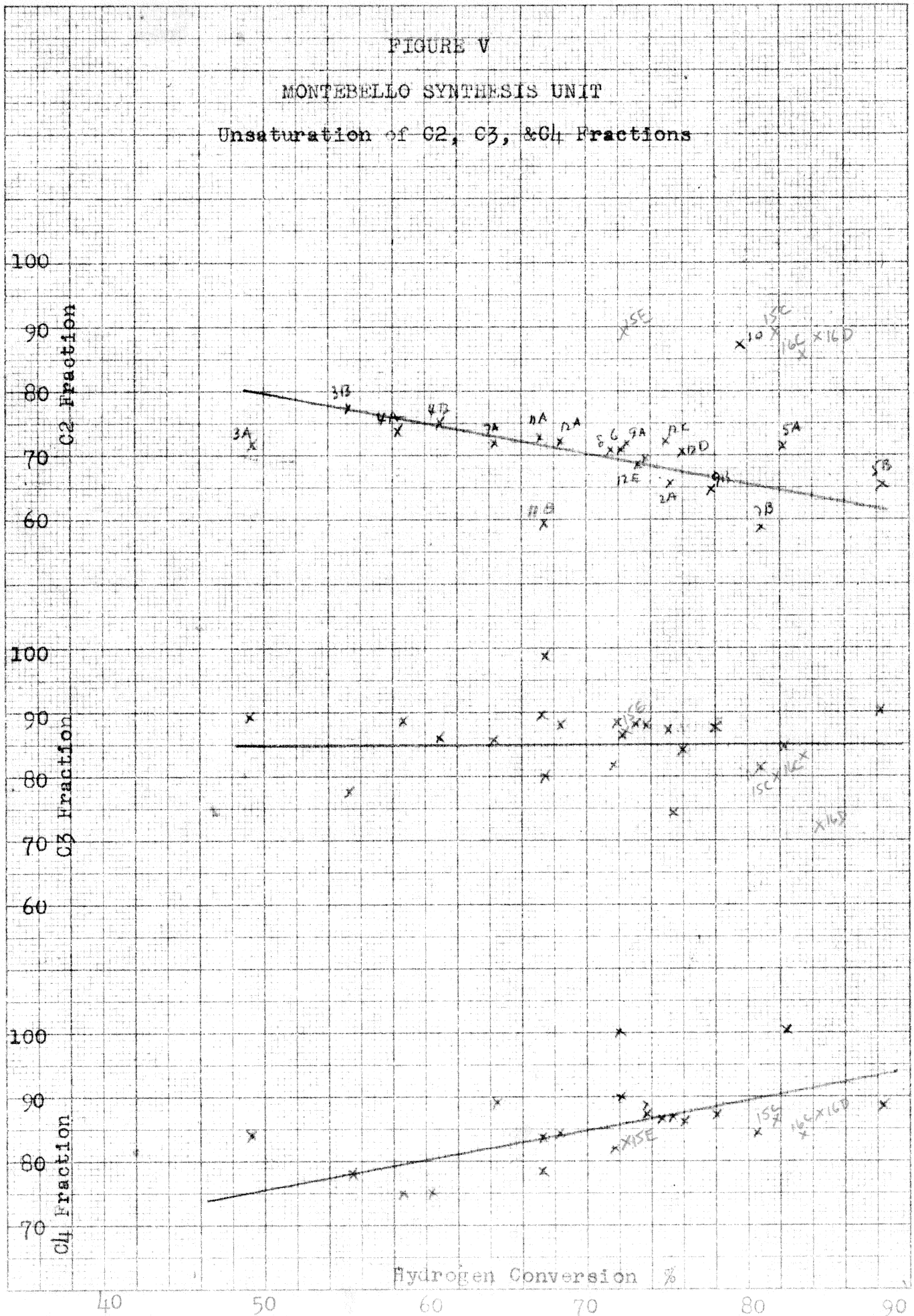

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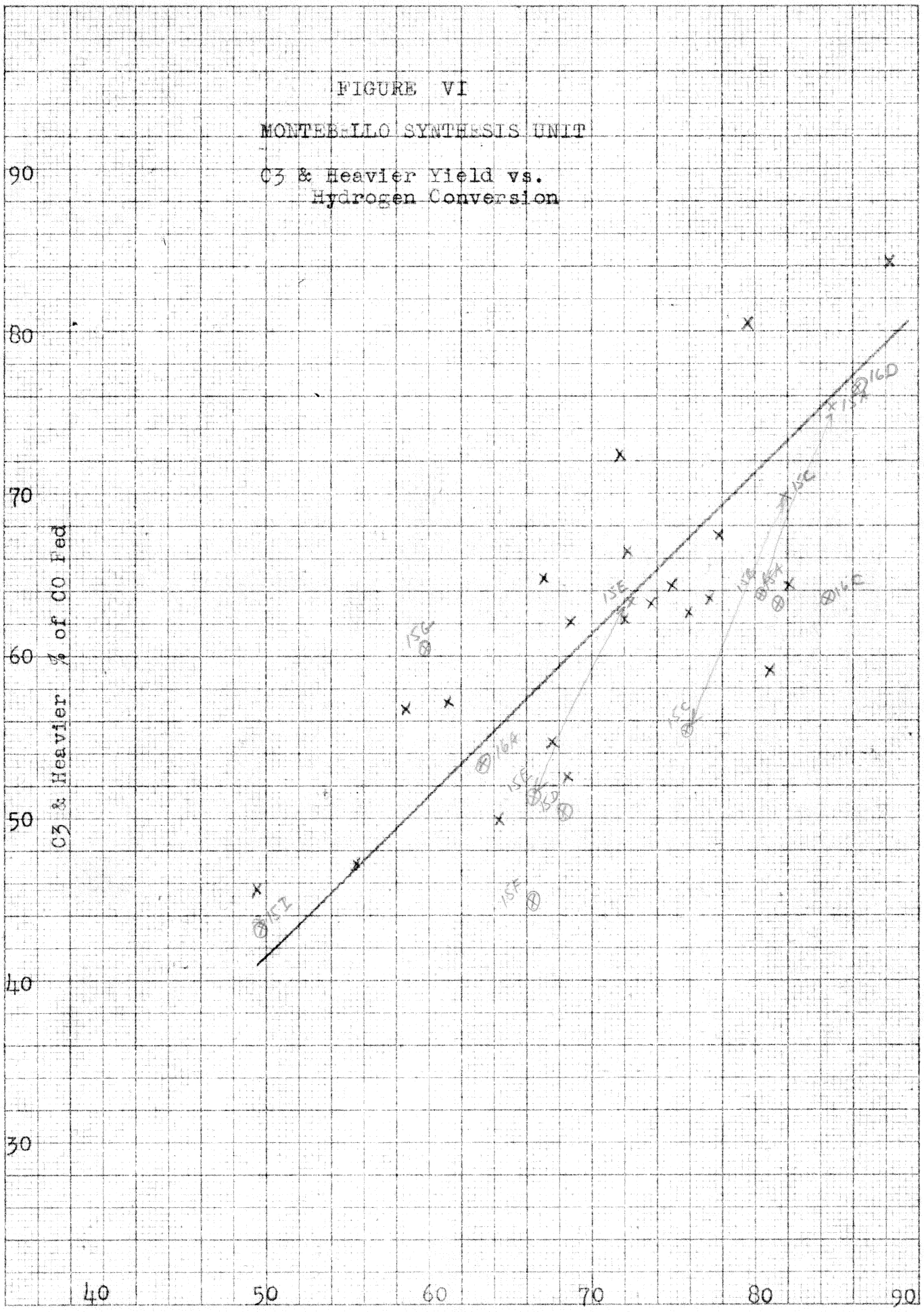
FIGURE VI

MONTEBELLO SYNTHESIS UNIT

C3 & Heavier Yield vs.
Hydrogen Conversion



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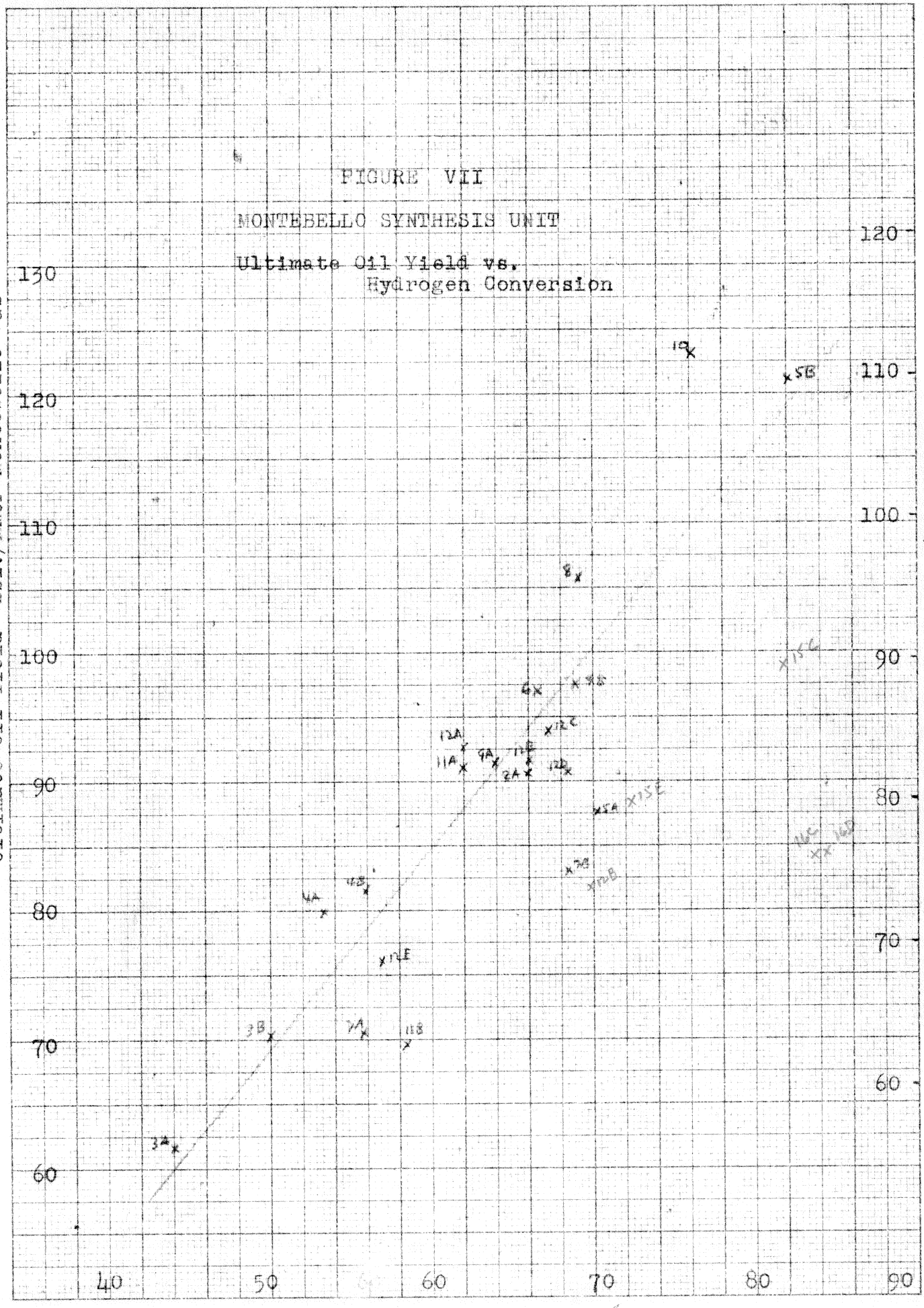

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THE TEXAS COMPANY
MONTEBELLO LABORATORY

PRELIMINARY REPORT ON SYNTHESIS RUN NUMBER 15

April 18, 1947

THE TEXAS COMPANY
MONTEBELLO LABORATORY

PRELIMINARY REPORT ON SYNTHESIS RUN NUMBER 15

INTRODUCTION

Run Number 15 was made on the Montebello Synthesis Unit over the period April 7 - April 12, covering a total of 226 hours operation. The run was terminated by a sudden loss of bed temperature and a simultaneous rise in wet gas rate.

EQUIPMENT CHANGES

Following Run Number 12, the standpipe system was elevated 30 feet in order to provide additional static head so that catalyst circulation could be maintained through the slide valve with low density catalyst. It had been established that the slide valve had to be restricted to about 75 inches of water differential to prevent reverse flow with the existing pressure surges in the reactor and standpipe. With catalyst of less than about 30 lbs./cu.ft. density insufficient static head was available with the previous cyclone elevation.

OPERATIONS

In attempting to start Run 13, repeated difficulty was experienced with restrictions in the standpipe gas preheater system. Runs 13 and 14 suffered from an almost continuous series of interruptions for this reason and were accordingly very short and of little interest. In an effort to improve this situation, the transfer line from the slide valve to the reactor was changed after Run 14 from 1" to 1½" and an orifice run

for the standpipe gas was installed on the outlet side of the preheater. These changes were made because of the presence of catalyst in the standpipe gas heater outlet line, with the thought that cycling of the rate of flow controller may have resulted in reverse flow on some ocassions. Part of the standpipe gas was also introduced a short distance above the slide valve.

In order to determine whether these changes had been effective, the unit was again started up and it was found that plugging was again prevalent in the standpipe gas preheater. With the thought that the difficulty may have been due to coking of the recycle gas in the standpipe gas heater which had suffered from repeated stoppage of flow, the heater was by-passed and the unit again put on stream. No further plugging of the standpipe gas system was experienced but at about this time it was found that a pressure balance could no longer be obtained around the reactor and standpipe by taking the sum of the differential pressure meters, and that a substantial differential pressure had built up across the transfer line from the reactor to the cyclone. After clearing all meter leads and again establishing a pressure balance, it was found that there was no flow through the slide valve and that the standpipe had plugged. Since catalyst carry-over into the second cyclone was small, and reactor inventory reasonably constant, the run was continued under these conditions.

CATALYST HISTORY

It is apparent from the above, that the history of the catalyst used in Run 15 is not clear cut. The inventory record is as follows:

Fresh catalyst charged to Run 14	1129	lbs.
Water recovered during reduction	289	
Net reduced catalyst	840	
Catalyst removed during Run 14	299	
Inventory at start of Run 15	541	
Catalyst removed during Run 15	144	
Inventory at end of Run 15	397	
Catalyst removed after Run 15		
From standpipe	138	
From reactor	50	
Total	188	
Unaccounted for	109	

209

Since a substantial quantity of catalyst was removed from the standpipe by steaming and washing with water at the end of Run 15, it may be assumed that the unaccounted for catalyst was largely lost in this operation. The catalyst inventory in the reactor at the start of Run 15 would be on this basis:

Total inventory	541
Standpipe inventory	
Recovered at end of run	138
Lost in washing	109
Total	247
Net reactor inventory at start of run	294

188 ? - 209 ?

This figure is, of course, quite uncertain but is in reasonable agreement with the reading of the differential gage across the reactor which indicated a catalyst inventory of 268 lbs. Since this gage agreed well with the quantity of catalyst removed from the reactor at the end of the run, the 268 lb. inventory figure has been used.

RESULTS

The most striking feature of Run 15 is the demonstration that catalyst carry-over can ve very small in an open reactor with no catalyst return from the cyclone. This is particularly notable in view of the fact that the catalyst density in the reacotr fell to about 3 lbs./cu.ft. at the end of the run and that the inlet velocity at this time was about 1.8 ft./sec.

Figure 1 is a plot of reactor catalyst density against time and shows that after 60 to 70 hours the decline of density with time was substantially linear.

Figure 2 is a plot of reactor inventory with time, which is also linear except for the early portion of the run where some rise was noted, no doubt due to carbide accumulation.

Figure 3 is a plot of apparent bed depth calculated from the data of Figures 1 and 2. The curve is rather irregular due to the sensetivity of this function to small errors in bed density and inventory. The general reliability of these measurements is demonstrated by the agreement of bed depth measured in this way with the penetron measurement made at 82 hours.

Figure 4 shows the relation of percent contraction with time. Although a straight line has been drawn, it seems likely that the invrease in conversion noted in previous runs may have been experienced in this case during Run 14 and that conversion passes through a maximum at 50 to 75 hours catalyst life.

Figure 5 shows the ultimate oil yields estimated

from the correlations for the observed contractions, both on the basis of Montebello gas and for Brownsville gas. Values are plotted both for the yields of the individual test periods, and for the cumulative yields for the entire run.

Figure 6 shows the cumulative oil yield expressed in terms of gallons of oil produced per pound of catalyst charged. These values were calculated on the basis of 268 lbs. of catalyst.

DISCUSSION

The data obtained in Run 15 show that a satisfactory oil yield and catalyst life can be obtained when charging catalyst batch-wise and operating with an inlet velocity of 1.8 ft./sec. with an open reactor without catalyst return over a period of 200 to 250 hours. This is not regarded as a particularly desirable method of operation but is considered entirely feasable.

The low carry-over rates are believed to be characteristic of this catalyst and are believed to demonstrate that the high rates of catalyst circulation previously encountered merely show that excessively fine catalyst returned to the reactor is immediately discharged again, setting up a catalyst circulation so that the rates of carry-over in a system equipped for catalyst return are far above those in a system where the fines are not returned. This run shows that satisfactory yield and catalyst life can be obtained without catalyst return. Since rates of carry-over are very sensetive to reactor velocity, longer or shorter catalyst life can be obtained

by varying this factor. This puts a premium on uniformity of flow through the reactor and it is expected that somewhat lower loss rates will be obtained in the future by reducing the pressure surges which have previously been experienced when the secondary cyclone trap is discharged.

Run 15 was terminated by a sudden loss of bed temperature and a correspondingly sudden reduction in steam production and increase in wet gas rate. While it is possible that this effect may have resulted from a leak in the steam cooling system, this is not thought to be the case and the effect is thought to represent a critical space velocity which, for this catalyst, was on the order of 160 cu.ft./hr./lb. of catalyst.

MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

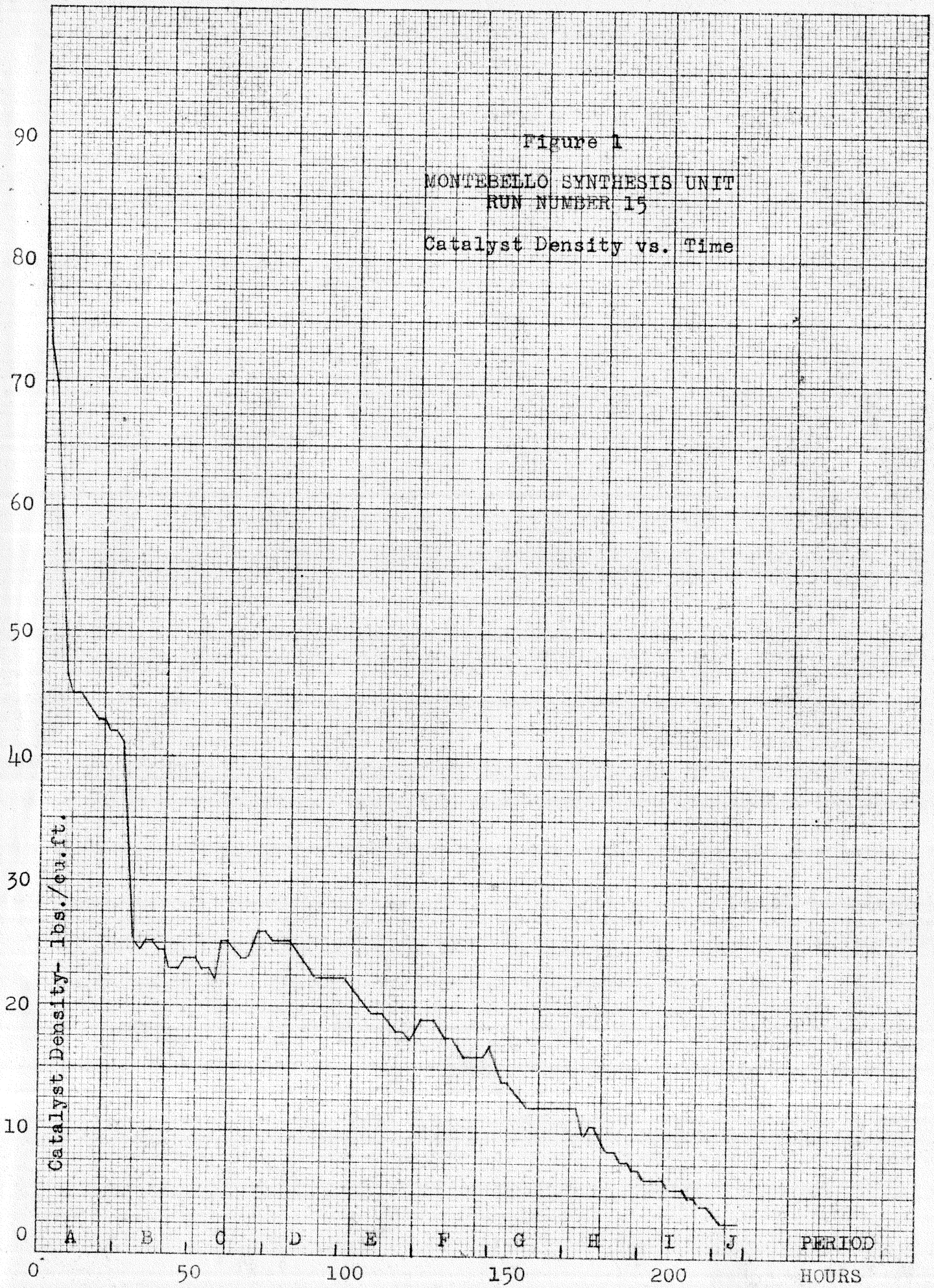
RUN NUMBER	15A	15B	15C	15D	15E
Start	4/7	4/8	4/9	4/10	4/11
End	4/8	4/9	4/10	4/11	4/12
GENERATOR DATA					
Gas Rate-scfh	2620	2600	2520	2520	2455
Oxygen Rate-scfh	1820	1915	1880	1900	1848
Product Rate-scfh	7780	8110	7650	8000	7300
Product Compostion by Corrected Explosion Orsat- mol %					
CO	31.1	31.8	34.8	33.2	34.8
H2	57.4	59.9	58.4	60/0	58.0
CO2	2.4	2.5	2.3	2.1	2.3
N2	2.2	1.7	2.1	2.2	2.2
CH4	6.9	4.1	2.4	2.5	3.3
SYNTHESIS DATA					
Pressure-psig	200	200	200	200	200
Recycle Rate-scfh	12175	11410	11360	10700	12118
Fresh Feed Rate-scfh	7780	8110	7650	8000	7300
Wet Gas Rate-scfh	2080	1855	2005	2120	2550
Catalyst Temperature F.	618	620	623	630	630
Catalyst Denity-#/cu.ft.	45	25	24	22	20
Cat. Fluidized-#	268	255	208	185	166
Depth of Bed-ft.	14	16	18	18	19
Fresh Feed-cfh/# cat.	29	32	37	43	44
Inlet Velocity-ft./sec.	1.7	1.7	1.6	1.5	1.8
Recycle Ratio	1.6	1.4	1.5	1.3	1.7
Contraction-%	73.0	77.0	73.8	73.5	65.0
Measured Oil-gph	4.6	5.9	4.5	5.4	4.2
Measured Water-gph	9.4	10.0	8.9	7.9	7.3
Steam Pressure-psig	925	925	925	925	925
Steam Rate-#/hr. (1)	358	349	284	300	280
YIELDS ESTIMATED FROM CORRELATION					
CO Conversion- %	96.3	97.5	96.6	96.5	93.4
H2 Conversion- %	81.8	86.0	82.7	82.3	72.9
Ultimate Oil Yield bbl./MMCF Gen. Feed	119	125	120	120	105
Cumulative Ultimate Oil bbl./MMCF Gen. Feed	119	122	121	121	118
gal./# cat. charged	1.2	2.4	3.5	4.7	5.7

(1) Sight average from badly pulsating chart

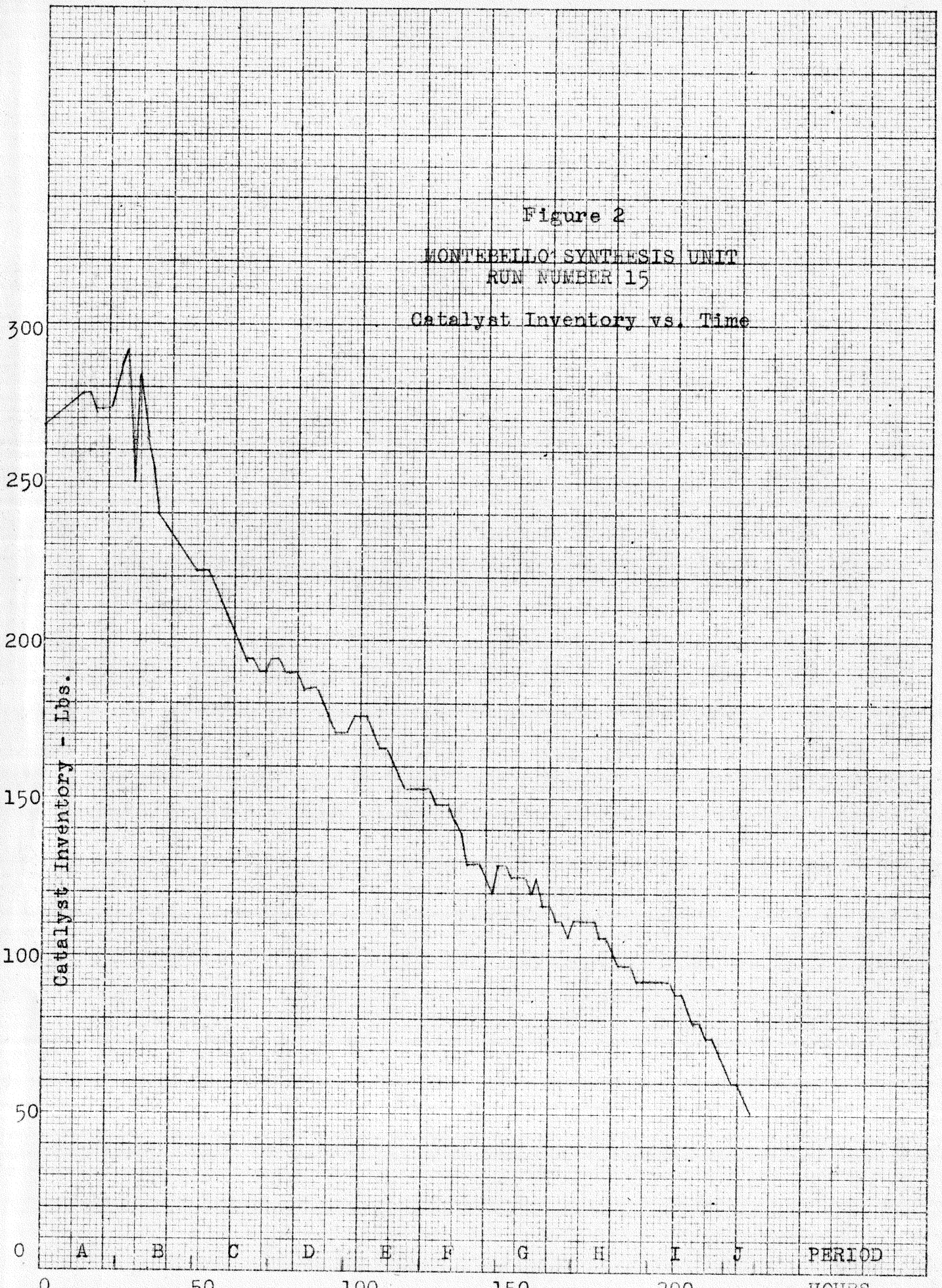
MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	15F	15G	15H	15I	15J
Start	4/12	4/13	4/14	4/15	4/16
End	4/13	4/14	4/15	4/16	4/16
GENERATOR DATA					
Gas Rate-scfh	2510	2560	2540	2550	2560
Oxygen Rate-scfh	1960	1860	1845	1870	1835
Product Rate-scfh	7700	8050	7550	7620	7970
Product Composition by Corrected Explosion Orsat- mol %					
CO	34.1	34.6	35.2	35.6	35.6
H2	58.9	59.4	58.3	58.4	58.4
CO2	2.1	2.2	2.2	2.2	2.1
N2	2.0	3.0	2.0	2.1	2.1
CH_4	2.9	1.4	2.9	2.4	2.4
SYNTHESIS DATA					
Pressure-psig	200	200	200	200	200
Recycle Rate-scfh	12085	12360	12230	12180	12790
Fresh Feed Rate-scfh	7700	8050	7550	7620	7970
Wet Gas Rate-scfh	2830	2625	3160	3040	3340
Catalyst Temperature F.	628	620	635	635	640
Catalyst Density-#/cu.ft.	17	14	10	5	3.5
Cat. Fluidized-#	139	116	102	79	65
Depth of Bed-ft.	19	21	23	30	
Fresh Feed-cfh/# cat.	55	69	74	96	122
Inlet Velocity-ft./sec.	1.9	1.8	1.8	1.8	1.8
Recycle Ratio	1.6	1.5	1.6	1.6	1.6
Contraction- %	63.3	67.5	58.1	60.1	58.2
Measured Oil-gph	3.2	4.3	3.5	3.1	4.3
Measured Water-gph	6.7	5.5	3.9	3.1	4.3
Steam Pressure-psig	925	925	925	925	925
Steam Rate-#/hr. (1)	275	207	264	284	242
YIELDS ESTIMATED FROM CORRELATION					
CO Conversion- %	92.7	94.4	90.2	91.2	90.3
H2 Conversion- %	71.1	75.7	65.2	67.5	65.5
Ultimate Oil Yield					
bbl./MMCF Gen. Feed	102	109	90	97	93
Cumulative Ultimate Oil					
bbl./MMCF Gen. Feed	116	115	111	110	109
gal./# Cat. Charged	6.6	7.6	8.5	9.4	9.7

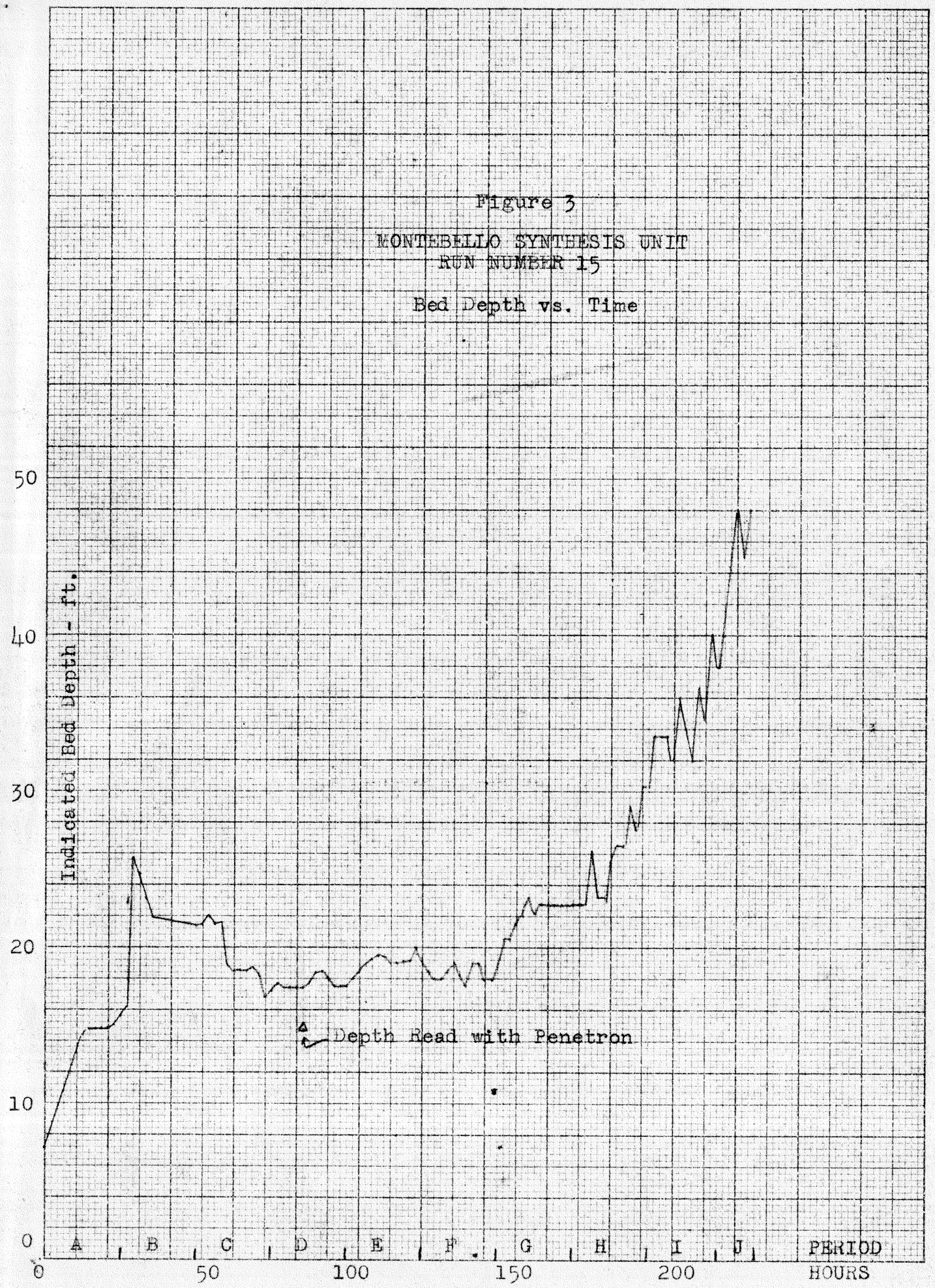
(1) Sight average from badly pulsating chart



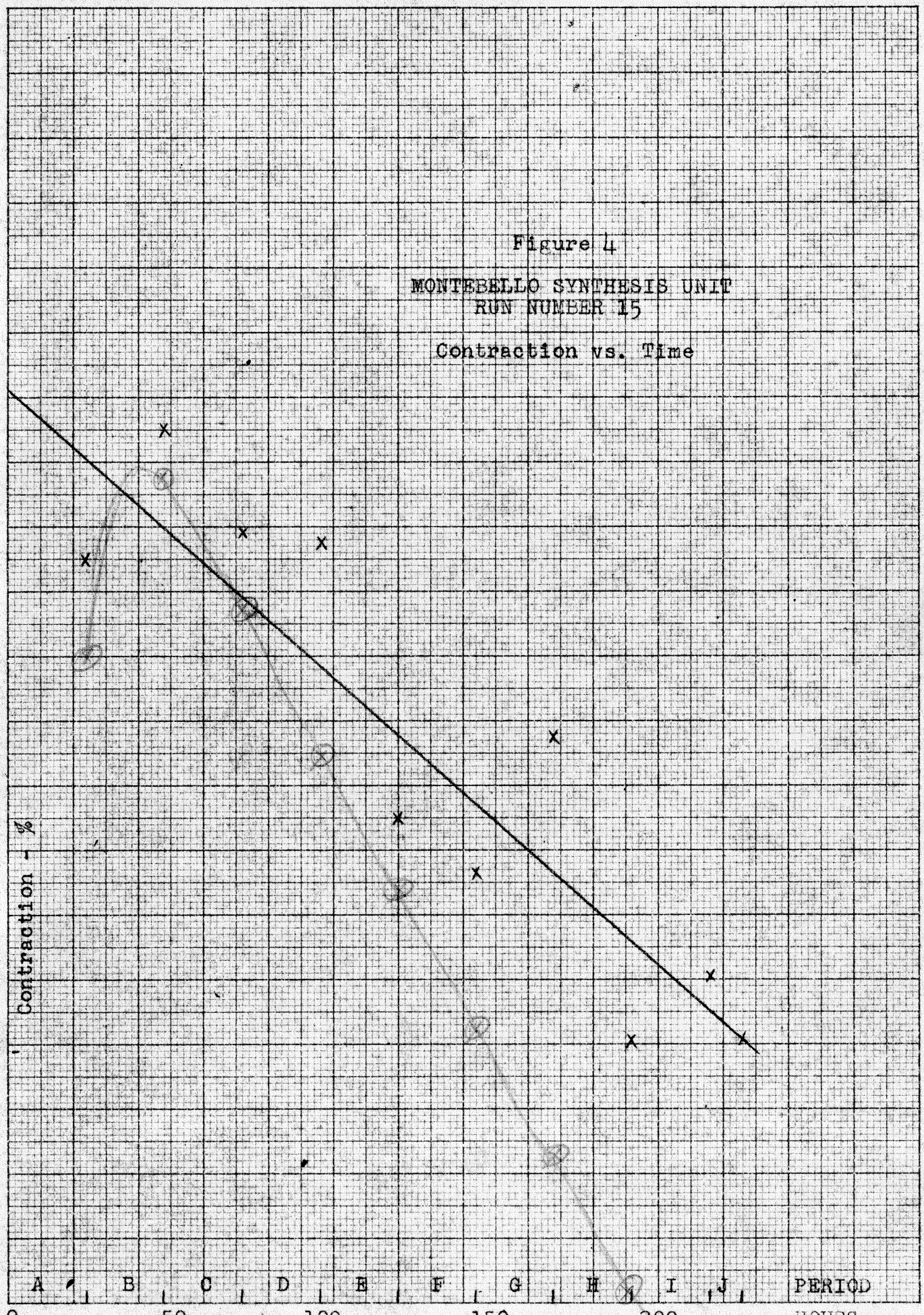
KEUFFEL & ESSER CO.
NO. 359-11, 10 × 10 to the half inch, 5th lines accented.
Engraving, 7 × 10 in.
MADE IN U.S.A.



KEUFFEL & ESSER CO.
NO. 359-11. 10 × 10 to the half inch, 5th lines accented.
Engraving, 7 × 10 in.
MADE IN U.S.A.



KEUFFEL & ESSER C
NO. 359-11. 10 × 10 to the half inch, 5th lines accented.
Engraving, 7 × 10 in.
MADE IN U.S.A.



KEUFFEL & ESSER CO.
NO. 359-11. 10 × 10 to the half inch, 5th lines accented.
Engraving, 7 × 10 in.
MADE IN U.S.A.

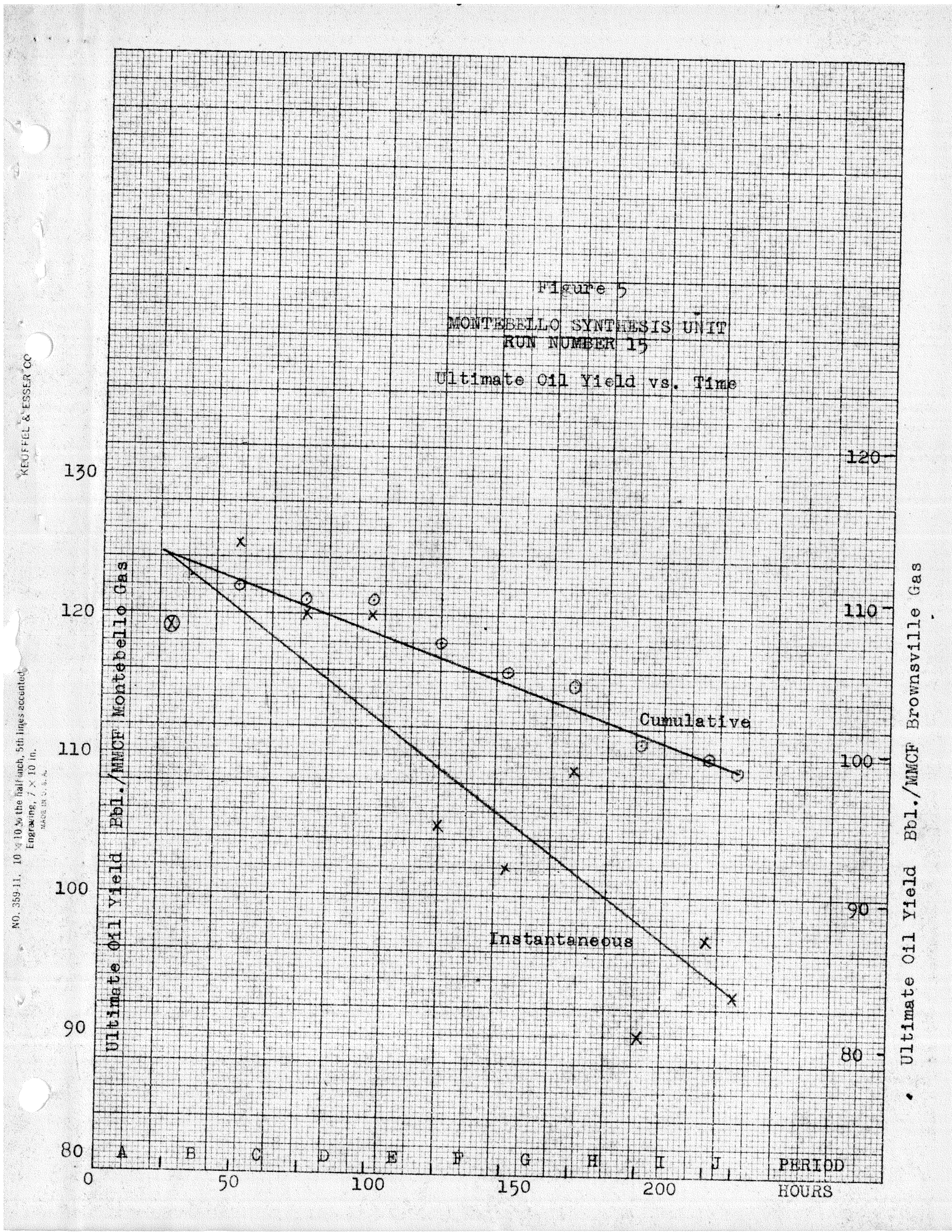
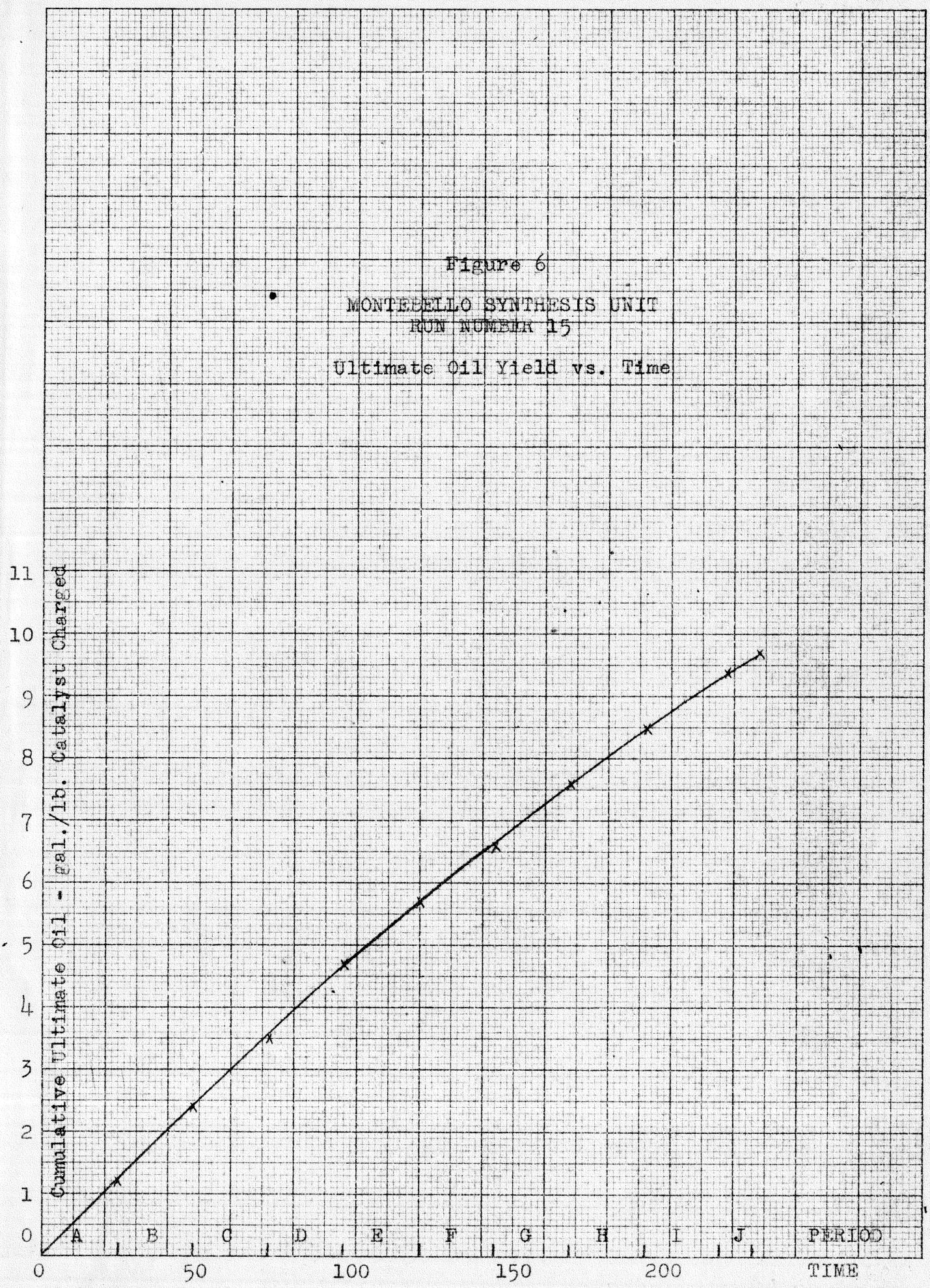


Figure 5
MONTEBELLO SYNTHESIS UNIT
RUN NUMBER 15
Ultimate Oil Yield vs. Time
Ultimate Oil Yield Bbl./MMCF Montebello Gas
Ultimate Oil Yield Bbl./MMCF Brownsville Gas
Cumulative
Instantaneous
130
120
110
100
90
80
120
110
100
90
80
A
B
C
D
E
F
G
H
I
J
PERIOD
0
50
100
150
200
HOURS



KEUFFEL & ESSER CO.
NO. 359-11. 10 to the half inch, 5th lines accented.
Engraving, 7 × 10 in.
MADE IN U.S.A.

THE TEXAS COMPANY

MONTEBELLO LABORATORY

Review of Operations

Synthesis Runs 17 through 21

July 28, 1947

THE TEXAS COMPANY
MONTEBELLO LABORATORY

Review of Operations
Synthesis Runs 17, 19, and 21

It will be recalled that early operations at Montebello were carried out with a dual cyclone system in which the catalyst recovered in the primary cyclone was discharged into a standpipe which was provided with a slide valve and transfer line by means of which catalyst recovered in the primary cyclone could be returned to the base of the synthesis reactor. This arrangement proved very difficult to operate, due principally to difficulties in bridging and plugging of the small lines required in pilot plant operation. In Run 12, the longest run made with this system, it was estimated that the rate of catalyst circulation was on the order of 500 lbs. per hour.

In Run 15 the meter system was seriously upset in the early part of the run and when these difficulties had been straightened out, it was found that there was no circulation in the cyclone-standpipe system, and the rate of carry-over to the secondary cyclone was only on the order of one pound per hour, indicating that the circulation of catalyst was not necessary for good results.

Run 16 was then made, with all catalyst withdrawn from both primary and secondary cyclones. In an attempt to attain higher conversion levels, however, catalyst temperatures were raised from the 620 - 630°F. level of Runs 12 and 15, to about 690°F and catalyst carry-over increased from about one

pound per hour in Run 15 to about 20 pounds per hour in Run 16. Due to this high rate of catalyst loss, the inventory of catalyst in the reactor fell rapidly and it was soon necessary to recharge catalyst fines from the cyclone system in order to continue operation.

In subsequent runs, 17 through 21, repeated attempts have been made to operate without the return of any catalyst from the cyclone system, at temperatures below 650°F. These runs have been quite satisfactory from a mechanical standpoint, extending over periods as long as 319 hours, but have been uniformly low in conversion.

It will be recalled that the Montebello method of operation is similar to that used in other pilot plants and consists in the reduction of a substantial batch of catalyst in the reactor prior to synthesis operations, reduction being obtained by circulating hydrogen through the synthesis system at a pressure on the order of 200 psig. When reduction is complete or the supply of hydrogen is exhausted, the supply of hydrogen is cut off, and pressure maintained on the system by the addition of natural gas until the generator system is in operation. Fresh feed is then introduced over a period of about one hour and no other conditioning is employed. Runs made in this way have invariably shown a time lag or induction period of one or more days duration in which the conversion has increased, this early rise in conversion being followed by a decline extending over the remainder of the run. This behavior is in contrast to the experience of the Beacon Laboratory where

the catalyst is conditioned by treatment with synthesis gas at atmospheric pressure for an extended period, a practice which apparently eliminates the induction period and results in maximum yields at the start of operations. This conditioning step has not been feasable at Montebello since the only source of heat in the synthesis reactor is the recycle gas heater and the recycle gas has insufficient heat capacity to overcome heat loss and bring the reactor up to temperature with the very small weight of gas which can be circulated with a reactor velocity of one or two feet per second at atmospheric pressure.

In the runs which have been made without catalyst circulation at Montebello, no induction period has been observed, and conversion has remained at the low initial level throughout the duration of the run. This behavior has led to the opinion that operations have been such that the most active fraction of the catalyst has been discarded from the cyclone system and that catalyst circulation will be required in order to retain this material in the reactor, and future runs will be made in this way.

There are two other possible explanations for the performance of the last few runs which may be important and which will also be examined. Following Run 16, operations have been carried out on a new batch of pyrites catalyst which was obtained from the same source as previous batches, but which may differ in activity. In the recent runs greater pains have been taken to secure complete reduction of the catalyst and it is possible that this may have had some bearing on the results.

THE TEXAS COMPANY
MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	17A	17B	17C	17D	17E	17F	17G	17H	17I
Start	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15
End	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	5/16
GENERATOR DATA									
Pressure - psig	213	215	215	215	220	225	220	218	218
Gas Rate - SCFH	2405	2370	2480	2470	2490	2480	2425	2450	2440
Oxygen Rate - SCFH	1845	1820	1860	1930	1910	1845	1775	1790	1795
Product Rate - SCFH	7020	7440	7790	7540	7800	7520	7280	7390	7390
Product Composition									
*CEO / **MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS
CO / CO	35.0-	34.4-	34.3-	36.0-	34.9-	34.4-	35.5-	35.5-	35.7-
H_2 / H_2	58.2-	61.4-	60.6-	59.8-	59.2-	59.2-	58.5-	59.1-	59.4-
CO_2 / CO_2	2.0-	1.7-	1.8-	1.8-	2.3-	2.3-	2.1-	2.1-	2.0-
N_2 / N_2	0.7-	0.4-	1.2-	0.9-	1.2-	1.2-	1.6-	1.1-	0.9-
CH_4 / CH_4	4.1-	2.1-	2.1-	1.5-	2.9-	2.9-	2.3-	2.2-	2.0-
SYNTHESIS DATA									
Pressure - psig	200	200	200	200	200	200	200	200	200
Recycle Rate - SCFH	10265	9200	10400	10980	11500	11470	11028	11540	11560
Fresh Feed - SCFH	7020	7440	7790	7540	7800	7520	7280	7390	7390
Wet Gas Rate - SCFH	3185	3240	3410	3115	3210	3170	3085	3015	3000
Catalyst Temperature - °F	625	610	610	608	620	618	624	620	620
Catalyst Density - #/cu ft	132	126	131	140	109	104	99.5	89.5	80
Catalyst Fluidized - #	445	402	418.5	418	321	306	302.5	246	227
Cat. Bed Ht. Depth of Catalyst Bed - ft	5.7	5.1	5.2	4.7	4.4	4.6	4.9	4.1	4.4
Fresh Feed - SCFH/#Cat	15.8	18.5	18.6	18.0	24.3	24.6	24.1	30.0	32.6
Inlet Velocity - ft/sec	1.5	1.4	1.6	1.6	1.7	1.6	1.6	1.6	1.6
Recycle Ratio	1.5	1.2	1.3	1.5	1.5	1.5	1.5	1.6	1.6
Contraction - %	55	56.5	56.3	58.8	58.9	57.9	57.6	59.2	59.4
Measured Oil - gph	3.4	4.4	3.9	4.1	3.7	3.9	2.9	3.5	3.5
Measured Water - gph	6.9	6.2	6.0	6.9	6.4	6.3	6.3	6.2	5.6
Steam Pressure - psig	710	700	700	890	900	900	870	860	860
Steam Rate - #/hr	376	225	191	144	147				
% CO_2 in Wet Gas by Orsat	20.6	18.0	18.6	21.8	21.6	21.0	22.1	22.3	21.8
Weight Balance - %	99	102	99	97	92	96	91	93	91
WET GAS COMPOSITION ~~BY~~ ~~~~ ~~MS~~**									
CO	11.69	16.25	16.78	13.06	14.51	15.48	15.78	15.03	15.22
H_2	54.23	48.87	57.03	50.14	52.25	52.28	47.94	45.97	48.55
CO_2	14.59	19.08	15.43	22.97	21.63	17.64	20.68	19.37	13.63
N_2	.63	1.76	1.42	.94	1.08	1.25	3.14	2.84	1.63
CH_4	12.62	4.83	6.22	5.00	4.40	5.91	5.78	5.49	5.96
C_2H_4	1.00	4.77	1.22	2.17	1.39	1.48	1.48	1.78	1.91
C_2H_6	.68	.50	.63	.81	.62	.70	.61	.61	.64
C_3H_6	1.18	1.21	1.33	1.67	1.27	1.85	1.24	1.21	1.16
C_3H_8	.32	.23	.27	.44	.22	.43	.33	.32	.20
C_4H_8	1.23	1.52	1.06	1.31	1.21	1.13	1.28	3.69	2.12
C_4H_{10}	.29	.24	.72	.39	.27	.45	.31	.37	.46
C_5H_{10}	.48	.51	.37	.72	.66	.36	.57	.70	.73
C_5H_{12}				.14	.15				.21
C_6H_{12}	.17	.17	.10	.25	.27	.25	.28	.22	.32

* CEO - CORRECTED EXPLOSION ORSAT
** MS - MASS SPECTROMETER

THE TEXAS COMPANY
MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	17J	17K	17L	17M	18A	18B	18C	18D	18E
Start	5/16	5/17	5/18	5/19	6/4	6/5	6/6	6/7	6/8
End	5/17	5/18	5/19	5/20	6/5 (15 hrs)	6/6	6/7	6/8	6/9
GENERATOR DATA									
Pressure - psig	218	215	218	218	210	210	210	205	207
Gas Rate - SCFH	2440	2440	2445	2470	2465	2420	2445	2440	2480
Oxygen Rate - SCFH	1830	1783	1780	1800	1825	1810	1793	1785	1810
Product Rate - SCFH	7320	7430	7550	7490	7060	6950	6920	7510	7610
Product Composition									
*CEO / **MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS
CO / CO	34.8-	35.3-	34.0-	34.7-	35.0-	35.3-	34.1-	34.2-	34.9-
H_2 / H_2	59.0-	59.2-	59.1-	59.0-	59.7-	59.0-	59.2-	60.1-	59.5-
CO_2 / CO_2	2.0-	2.0-	2.1-	1.9-	2.1-	1.9-	1.9-	1.7-	1.8-
N_2 / N_2	1.0-	1.4-	2.0-	1.4	0.0-	1.0-	0.7-	0.9-	1.4-
CH_4 / CH_4	3.2-	2.0-	2.8-	3.0-	3.2-	2.8-	4.1-	3.1-	2.4-
SYNTHESIS DATA									
Pressure - psig	200	200	200	200	200	200	200	200	200
Recycle Rate - SCFH	11400	10960	11290	12070	12200	12400	12450	12490	12130
Fresh Feed - SCFH	7320	7430	7550	7490	7340	7250	7325	7510	7610
Wet Gas Rate - SCFH	3130	3170	3100	3530	3930	4320	4500	4330	4280
Catalyst Temperature - °F	622	621	625	621	616	600	610	620	619
Catalyst Density - #/cu ft	66	60	48	40	89.6	(30)	(30)	(40)	(50)
Catalyst Fluidized - #	213	197	223	192	218.6	(60)	(60)	(100)	(200)
Depth of Catalyst Bed - ft	5.3	5.5	9.5	9.0					
Fresh Feed - SCFH/#Cat	34.4	37.7	33.8	39.0	30.4	30.5	31	32.5	25.4
Inlet Velocity - ft/sec	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.7
Recycle Ratio	1.6	1.5	1.5	1.6	1.7	1.7	1.7	1.7	1.6
Contraction - %	57.3	57.4	59.0	53	46	40.4	38.5	42.4	43.8
Measured Oil - gph	3.3	3.6	3.4	2.6	1.5	1.6	2.7	2.3	2.3
Measured Water - gph	6.0	5.8	5.6	4.9	7.9	4.0	3.9	3.9	3.7
Steam Pressure - psig	900	900	750	650	880	900	870	840	800
Steam Rate - #/hr	240	235	238	228					
% CO_2 in Wet Gas by Orsat	21.2	21.3	21.2	19.5	14.9	14.4	14.5	15.1	14.9
Weight Balance - %	95	95	91	91	107	101	105	103	99.3
WET GAS COMPOSITION BY ** MS									
CO	9.07	15.22	11.80	14.80		20.06	16.64	17.69	18.10
H_2	49.85	50.42	48.15	52.84		53.49	43.81	56.82	35.41
CO_2	24.65	17.67	22.44	18.26		13.01	10.17	14.27	11.45
N_2	.26	3.32	3.99	3.57		1.52	12.23	1.25	21.61
CH_4	7.14	6.85	6.49	6.11		6.35	5.54	5.73	4.67
C_2H_4	2.21	1.49	1.89	1.40		2.36	.67	.97	.78
C_2H_6	.75	.64	.62	.57		1.13	.41	.18	.25
C_3H_6	2.07	1.18	1.36	.89		.63	.35	.45	.35
C_3H_8	1.68	.78	.33	.12		.11	.31	.88	.44
C_4H_8	1.05	1.19	1.19	.03		.56	.77	.62	.34
C_4H_{10}	.32	.20	.27	.21		.18	.21	.19	.23
C_5H_{10}	.77	.54	.95	.54		.42	.52	.43	.41
C_5H_{12}				.36				.08	.04
C_6H_{12}	.25	.16	.16	.30		.18	.16	.18	.17

* CEO - CORRECTED EXPLOSION ORSAT
** MS - MASS SPECTROMETER

THE TEXAS COMPANY
MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	18F	18G	18H	19A	19B	19C	19D	21A	21B
Start	6/9	6/10	6/11	6/30	7/1	7/2	7/3	7/8	7/9
End	6/10	6/11	6/11 (5hrs)	7/1 (26hrs)	7/2 (8hrs)	7/3	7/4	7/9 (13hrs)	7/10
GENERATOR DATA									
Pressure - psig	209	205	205	213	210	210	210	310	315
Gas Rate - SCFH	2510	2505	2500	2240	2325	2280	2245	2260	2250
Oxygen Rate - SCFH	1820	1830	1830	1670	1710	1780	1777	1750	1750
Product Rate - SCFH	7610	7650	7400	6410	6450	6710	6750	7000	6500
Product Composition									
*CEO **MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS
CO CO	35.1-	35.1-	34.7-	34.6-	32.8-	35.3-34.0	35.6-36.5	34.9-	35.4-34.7
H_2 H_2	59.8-	60.1-	59.2-	57.4-	56.4-	57.8-61.6	59.1-58.9	58.0-	57.9-55.6
CO_2 CO_2	1.7-	1.7-	1.6-	2.3-	2.4-	2.0- 1.9	1.9- 1.7	2.0-	2.1- 2.0
N_2 N_2	0.6-	0.6-	0.2-	0.7-	0.3-	1.5- 0.8	1.0- 1.3	1.2-	0.5- 3.0
CH_4 CH_4	2.8-	2.5-	4.3-	5.0-	8.1-	3.4- 1.7	2.4- 1.6	3.9-	4.1- 4.7
SYNTHESIS DATA									
Pressure - psig	200	200	200	200	200	200	200	200	200
Recycle Rate - SCFH	11580	11540	10120	9240	9540	9410	9268	10100	8640
Fresh Feed - SCFH	7610	7650	7400	6410	6450	6710	6750	7000	6500
Wet Gas Rate - SCFH	4500	3920	3860	2820	3000	3360	3230	2830	3430
Catalyst Temperature - °F	647	685	655	660	665	641	657	675	635
Catalyst Density - #/cu ft	(70)	(112)	(90)	119	95	91		115	117
Catalyst Fluidized - #	(200)	(170)	(165)	473	324	174	79.5	316	307
Depth of Catalyst Bed - ft				8.5	6.8	3.5	(3.6)	5.4	5.0
Fresh Feed - SCFH/#Cat	26.0	45		14.8	19.9	38.5	85	22.1	21.1
Inlet Velocity - ft/sec	1.7	1.8	1.6	1.4	1.5	1.4	1.4	1.2	0.9
Recycle Ratio	1.5	1.5	1.3	1.4	1.4	1.4	1.3	1.4	1.3
Contraction - %	40.9	48.8	46.3	56	53.5	50.0	52.2	59.6	47.2
Measured Oil - gph	2.1	3.2	4.5	3.4	3.0	3.0	2.7	3.8	2.9
Measured Water - gph	3.7	5.1	6.9	6.5	7.7	4.7	4.9	7.6	3.3
Steam Pressure - psig	610	900	750	880	880	700	500	610	450
Steam Rate - #/hr	101	71							117
% CO_2 in Wet Gas by Orsat	13.5	16.1	23.0	22.8	21.6	20.3	19.5	24.7	20.2
Weight Balance - %	101	103	111	101	108	100	100.2	98.5	95
WET GAS COMPOSITION BY ** MS									
CO	19.09	5.27	11.19	6.47	9.15	17.30	9.16	6.39	14.06
H_2	55.25	45.49	57.05	34.49	44.47	52.20	58.25	30.87	48.42
CO_2	14.00	.38	19.10	21.30	22.71	15.29	10.52	16.04	14.77
N_2	1.27	30.11	1.88	14.07	.60	2.04	5.15	18.47	2.54
CH_4	6.34	7.98	6.78	12.53	14.92	6.82	10.57	16.91	13.83
C_2H_4	.97	.79	.97	2.41	2.65	1.95	2.17	1.30	1.28
C_2H_6	.45	.67	.34	.82	.82	.71	.93	1.39	.80
C_3H_6	.59	.78	.89	1.38	.98	1.33	1.32	1.69	1.51
C_3H_8	.11	.46	.14	.41	.35	.56	.57	.78	.68
C_4H_8	.69	.57	.69	1.31	1.51	.94	.73	1.13	1.06
C_4H_{10}	.33		.12	.33	.35		.12		.14
C_5H_{10}	.51	.31	.42	.72	.91	.53	.39	.48	.57
C_5H_{12}	.08			.17	.28				
C_6H_{12}	.25		.14	.27	.28	.21	.17		.17

* CEO - CORRECTED EXPLOSION ORSAT
** MS - MASS SPECTROMETER

THE TEXAS COMPANY
MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER		21C	21D	21E	21F	21G	21H	21I	21J	21K
Start		7/10	7/11	7/12	7/13	7/14	7/15	7/16	7/17	7/18
End		7/11	7/12	7/13	7/14	7/15 (15hrs)	7/16	7/17	7/18	7/19
GENERATOR DATA										
Pressure - psig		310	313	308	303	304	304	303	306	313
Gas Rate - SCFH		2290	2330	2314	2280	2280	2360	2380	2380	2328
Oxygen Rate - SCFH		1790	1920	1800	1780	1760	1830	1830	1800	1783
Product Rate - SCFH		6970	7260	7020	6850	6670	7250	7240	7320	7040
Product Composition										
*CEO	**MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS	CEO MS
CO	CO	34.0-36.8	34.3-36.3	35.2-33.8	34.2-	31.7-31.8	34.5-34.4	34.9-34.0	34.9-	34.5-30.4
H_2	H_2	60.0-57.6	60.3-58.3	59.1-58.4	59.0-	57.7-52.5	58.4-58.5	59.4-58.5	59.7-	59.2-62.5
CO_2	CO_2	1.8- 1.7	2.0- 1.5	1.8- 2.5	2.7-	4.4- 5.8	2.3- 1.9	2.3- 2.9	2.1-	2.2- 1.8
N_2	N_2	0.6- 1.9	1.2- 3.1	1.3- 3.1	1.1-	1.1- 1.9	2.5- 3.1	1.0- 2.8	1.2-	1.1- 1.3
CH_4	CH_4	3.6- 2.0	2.2- 0.8	2.6- 2.2	3.0-	5.1- 8.0	2.3- 2.1	2.4- 1.8	2.1-	3.0- 3.5
										C_2H_6-.5
SYNTHESIS DATA										
Pressure - psig		285	300	301	299	299	300	300	300	298
Recycle Rate - SCFH		10010	10452	10590	10638	10356	10110	9914	9874	10008
Fresh Feed - SCFH		6970	7260	7020	6850	6670	7250	7240	7320	7320
Wet Gas Rate - SCFH		3600	3520	3420	3520	3440	3700	3600	3380	3640
Catalyst Temperature - °F		630	650	660	640	640	560	650	635	655
Catalyst Density - #/cu ft		120	115	95	98	(94)	(53)	(98)	(70)	(67.2)
Catalyst Fluidized - #		290	241	223	233	187	210	233	273	254.6
Depth of Catalyst Bed - ft		4.5	3.8	4.4	4.5	(3.6)	(5.8)	(4.5)	(8.1)	(7.7)
Fresh Feed - SCFH/#Cat		24.0	30.1	31.5	29.4	35.6	34.5	31.0	26.8	28.7
Inlet Velocity - ft/sec		1.0	1.1	1.1	1.1	1.0	1.0	1.1	1.0	1.0
Recycle Ratio		1.4	1.4	1.5	1.5	1.5	1.3	1.3	1.3	1.4
Contraction - %		48.3	51.5	51.2	48.7	45.5	56.5	50.5	53.5	50.3
Measured Oil - gph		3.3	2.9	2.8	2.8	2.1	2.9	3.0	3.1	2.4
Measured Water - gph		4.8	6.4	5.6	2.3	5.2	5.0	5.8	6.4	5.6
Steam Pressure - psig		450	500	600	700	625	700	600	660	694
Steam Rate - #/hr		131	140.5		102				161	132.3
% CO_2 in Wet Gas by Orsat		19.1	21.1	19.2	20.2	20.5	17.7	20.5	22.2	21.6
Weight Balance - %		102	103	104	104	96.5	99.8	106	99	100.2
WET GAS COMPOSITION BY ** MS										
CO			12.45	9.23	12.11	12.16	12.01	13.76	9.23	
H_2			54.27	45.56	49.60	46.14	55.80	56.32	53.91	
CO_2			16.19	18.71	19.16	20.17	15.36	13.79	16.01	
N_2			2.65	1.78	1.58	2.03	2.06	2.49	4.88	
CH_4			6.29	16.36	8.63	13.20	8.18	7.47	9.05	
C_2H_4			1.77	1.87	1.45	1.33	1.35	1.34	1.69	
C_2H_6			.90	1.36	1.03	.65	.85	.66	.74	
C_3H_6			2.18	2.06	1.64	1.78	1.59	1.64	1.86	
C_3H_8			.81	.57	.32	.41	.79	.43	.44	
C_4H_8			1.46	1.30	1.03	.95	1.09	1.41	1.21	
C_4H_{10}			.16	.22	.29	.16	.15		.15	
C_5H_{10}			.68	.70	.52	.87	.56	.69	.62	
C_5H_{12}										
C_6H_{12}			.19	.29	.23	.18	.21		.21	

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THE TEXAS COMPANY
MONTEBELLO SYNTHESIS UNIT
SUMMARY OF PRELIMINARY DATA

RUN NUMBER	21L	21M	21N
Start	7/19	7/20	7/21
End	7/20	7/21	7/22
GENERATOR DATA			
Pressure - psig	313	310	304
Gas Rate - SCFH	2320	1840	1820
Oxygen Rate - SCFH	1795	1440	1470
Product Rate - SCFH	7020	5460	5400
Product Composition			
*CEO **MS	CEO MS	CEO MS	CEO MS
CO CO	34.6-32.9	34.5-38.7	34.3-33.9
H_2 H_2	59.0-57.3	57.8-53.7	58.0-57.2
CO_2 CO_2	2.1- 2.9	2.4- 2.6	2.3- 2.2
N_2 N_2	1.3- 4.7	1.7- 2.1	1.2- 4.1
CH_4 CH_4	3.0- 2.2	3.6- 2.6	4.2- 2.6
		C2H6-.3	
SYNTHESIS DATA			
Pressure - psig	300	298	298
Recycle Rate - SCFH	10474	8798	8832
Fresh Feed - SCFH	7550	5600	5630
Wet Gas Rate - SCFH	4170	2840	3040
Catalyst Temperature - °F	673	670	650
Catalyst Density - #/cu ft	(63)	(36.4)	(16.8)
Catalyst Fluidized - #	170	82.7	72.9
Depth of Catalyst Bed - ft	(5.2)		
Fresh Feed - SCFH/#Cat	44.5	47.9	77.3
Inlet Velocity - ft/sec	1.1	1.1	1.0
Recycle Ratio	1.4	1.6	1.6
Contraction - %	40.7	49.4	46.0
Measured Oil - gph	1.8	1.8	1.0
Measured Water - gph	5.5	4.0	3.9
Steam Pressure - psig	707	890	980
Steam Rate - #/hr	91.8	76.5	79.5
% CO_2 in Wet Gas by Orsat	18.5	21.2	14.6
Weight Balance - %	103	97	102
WET GAS COMPOSITION BY ** MS			
CO	11.47	11.31	16.72
H_2	62.25	52.45	51.40
CO_2	12.75	15.82	12.50
N_2		4.07	4.22
CH_4	8.71	10.38	9.00
C_2H_4	1.14	1.49	1.15
C_2H_6	.57	.53	2.36
C_3H_6	1.21	1.46	1.15
C_3H_8	.21	.40	.06
C_4H_8	1.14	1.09	.90
C_4H_{10}		.16	.16
C_5H_{10}	.57	.59	.40
C_5H_{12}			
C_6H_{12}		.25	

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