The average temperatures of the outer and inner retort tubes at different elevations above the bottom of the furnace are shown in table 8. It should be noted that at points C and D, which are the hottest sections of the retort, the gradient across the annular section is 660°F. to 900°F., varying with its thickness.

TABLE 8. - Average temperature gradients across reaction zone, Grand Forks pilot plant.[1]

Run number	1		2		3		4	
Width of annulus, inches[2]	4		3		3		3	
Optical pyrometer observation points		Tube temperatures, °F.						
Point	Location[3]	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner
A	2.25	1,790	740	1,750	1,125	1,915	1,075	1,905	1,090
B	4.25	1,795	800	1,760		1,845		1,870	
C	6.25	1,770		1,860	1,160	1,885	1,215	1,900	1,200
D	8.25	1,740	830	1,780	1,120	1,760	1,100	1,780	1,105
E	10.25	1,700		1,740		1,735		1,695	
F	12.25	1,650	625	1,630	890	1,620	735	1,570	780
G	14.25	1,585	545	1,540		1,520		1,470	

1/ Outside retort tube temperatures measured with optical pyrometer. Inner retort temperatures measured with chromel-alumel thermocouples at similarly located levels.
2/ Width of reaction zone space between outer and inner retort tubes.
3/ Distance, in feet, above bottom of retort shell.

The average static pressures in the reaction zones in relation to flow of materials during runs 1, 2, and 3 are given in table 9. A more detailed record of static pressure in the retort unit is given in table 10, which records the average pressures throughout the system for each period of run 4.

Properties of Chars and Dusts

The proximate and ultimate analyses of chars obtained from the main outlet at the bottom of the lower annulus are given in table 11. As noted in the footnotes of this table, considerable trouble was experienced in determining the true ash content of the higher ash samples because of the formation of sulfates and because of the presence of magnetic material. The ash content reported has not been corrected for sulfates or carbonates.

A study of the analyses of chars and dusts obtained during run 3 is given in table 12. The char is defined as the residue collected from the lower annulus. The blow-over dust is the residue carried through the gas ports at the junction of the upper and lower annuli, and the dust is carried out of the system with the gas. It should be noted that the ash concentrates in the smaller sizes.

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TABLE 9. - Static pressure and flow of materials in the reaction zones, Grand Forks pilot plant.

Run and period	1A	1B	2A	2B	2C	2D	2E	3A	3B	3D	3F	3G	3H
						Gas made							
Mcf per hour	8.5	10.1	11.0	12.3	13.6	14.9	15.8	7.8	15.3	13.0	12.3	12.2	12.6
						Static pressures, inches of water							
Charging dome	9.3	20.8	18.3	24.8	31.3	21.4	18.4	14.7	12.5	13.4	14.7	13.6	14.2
Char discharge	8.4	9.4	5.9	7.3	8.4	7.6	10.0	8.3	10.4	8.5	6.2	5.3	7.6
Gas offtake	1.2	1.7	2.4	2.6	2.6	3.3	2.5	3.6	1.2	2.3	2.8	1.8	2.1
Drop through upper annulus	8.1	19.1	15.9	22.2	28.7	18.1	15.9	11.1	11.3	11.1	11.9	11.8	12.1
Drop through lower annulus	7.2	7.7	3.5	4.7	4.8	4.3	7.5	4.7	9.2	6.2	3.4	3.5	5.5
						Dimensions of retort, inches							
Width of reaction zone	4	4	3	3	3	3	3	3	3	3	3	3	3
Length of upper annulus	153	153	138	138	138	138	128 1/	128	128	128	128	128	128
Length of lower annulus	52	52	60	60	60	60	60	60	60	60	60	60	60
						Steam to reaction zones, lb. per hour							
Process steam to upper annulus	0	165	100	65	65	0	0	500	50	50	50	0	0
Steam from coal in upper annulus	224	258	165	181	202	304	277	150	250	197	202	202	227
Total steam to upper annulus	224	423	265	246	267	304	277	650	300	247	252	202	227
Process steam to lower annulus	400	400	200	200	200	200	250	300	300	300	150	150	200

1/ Gas outlet ports were increased by shortening upper annulus 10 inches.

TABLE 10. - Static pressures in retort unit, inches of water, run 4, Grand Forks pilot plant. 1/

TABLE 10. - Static pressures in retort unit, inches of water, run 4, Grand Forks pilot plant.[1/]

Period number	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Furnace pressure ...		0.025	0.027	0.021	0.025	0.025	0.013	0.025	0.022	0.022	0.019	0.016	0.013	0.016	0.016
Air and Poc to recuperator		1.00	1.04	1.07	1.07	1.04	1.02	1.02	.99	.99	1.00	1.03	1.00	1.00	.97
Air and Poc to furnace	0.50	.50	.55	.58	.58	.60	.55	.49	.46	.46	.46	.52	.50	.55	.47
Outlet of furnace[2/]	.0	.0	-.08	-.52	.85	-1.27	-.16	-.16	-.21	-	-.25	-.11	-.13	-.12	-.08
Poc out of recuperator	-2.50	-2.59	-2.59	-2.52	-2.56	-2.53	-2.48	-2.48	-2.51	-2.61	-2.51	-2.56	-2.59	-2.64	-2.46
Inlet to fan	-2.81	-2.89	-2.81	-2.78	-2.84	-2.78	-2.76	-2.86	-2.86	-2.92	-2.94	-2.90	-2.94	-2.94	-2.73
Outlet of fan	1.24	1.41	1.35	1.45	1.41	1.41	1.43	1.35	1.35	1.29	1.32	1.35	1.29	1.36	1.61
Char discharge	7.13	6.96	6.16	7.50	8.03	7.26	7.46	6.66	5.70	5.16	5.33	4.13	6.56	8.60	9.65
Charging dome	16.93	17.63	17.96	13.83	13.76	13.16	13.36	28.86	17.43	18.20	16.03	29.40	23.60	29.90	27.20
Gas leaving retort .	2.30	2.03	2.03	2.06	2.70	2.06	2.33	2.70	2.13	2.03	2.13	2.00	2.13	3.40	2.40
Drop thru upper annulus	14.63	15.60	15.93	11.77	11.06	11.10	11.03	26.16	15.30	16.17	13.90	27.40	21.47	26.50	24.80
Drop thru lower annulus	4.83	4.93	4.13	5.44	5.33	5.20	5.13	3.96	3.57	3.13	3.20	2.13	4.43	5.20	7.25
After water separator				-.33	.85	-1.18	-1.29	-2.12	-1.00	-1.43	-.80	-2.33	-2.75	-4.4	-1.41

1/ Average of 24-hour period.

2/ Gas sample line connected to this circuit. Pressure data are not reliable.

TABLE 11. - Proximate and ultimate analyses of chars from Grand Forks pilot plant.1/

Run and period	Condition2/	Pittsburgh lab. No.	Proximate, percent				Ultimate, percent					B.t.u. per pound	Softening temp. ash, °F.
			Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur		
Pre.-A	1	C-36716	11.0	14.4	55.0	19.6	3.0	59.7	0.7	16.7	0.3	9,400	2,420
	2			16.2	61.7	22.1	2.0	67.1	.8	7.7	.3	10,570	
	3			20.8	79.2		2.5	86.1	1.0	10.0	.4	13,560	
Pre.-B	1	C-36715	5.5	15.5	56.3	22.7	2.6	61.7	.8	11.8	.4	9,720	2,260
	2			16.3	59.7	24.0	2.1	65.3	.8	7.4	.4	10,280	
	3			21.5	78.5		2.7	85.8	1.0	10.0	.5	13,520	
1-A ...	1	C-44346	2.9	12.8	68.5	15.8	2.1	74.9	.8	5.5	.9	11,820	2,460
	2			13.2	70.5	16.3	1.8	77.1	.8	3.1	.9	12,170	
	3			15.8	84.2		2.2	92.1	1.0	3.6	1.1	14,540	
1-B ...	1	C-44347	2.9	12.8	69.3	15.0	2.3	75.2	.8	5.9	.8	11,930	2,470
	2			13.2	71.4	15.4	2.0	77.4	.8	3.6	.8	12,280	
	3			15.6	84.4		2.4	91.5	1.0	4.1	1.0	14,520	
1-C ...	1	C-44348	2.6	11.5	68.3	17.6	1.9	72.3	.8	7.0	.4	11,240	2,530
	2			11.8	70.2	18.0	1.7	74.2	.8	4.8	.5	11,530	
	3			14.3	85.7		2.0	90.5	1.0	5.9	.6	14,070	
2-A ...	3/	C-52389	1.3	10.3	61.0	27.4	1.4	69.1	0.6		2.0	10,743	2,450
2-B ...	3/	C-52390	1.2	9.7	55.1	34.0	1.2	65.6	.4		3.0	10,232	2,440
2-C ...	3/	C-52391	1.2	8.8	53.7	36.3	1.1	63.6	.4		2.9	9,851	2,430
2-D ...	1	C-52392	1.2	8.8	70.6	19.4	1.5	75.9	.7	1.0	1.5	11,810	2,400
	2			8.9	71.5	19.6	1.4	76.8	.7	.0	1.5	11,950	
	3			11.1	88.9		1.7	95.6	.8	.1	1.8	14,870	

See footnotes on page 39.

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TABLE 11. - Proximate and ultimate analyses of chars from Grand Forks pilot plant.1/ (cont'd.)

Run and period	Condition2/	Pittsburgh lab. No.	Proximate, percent			Ash	Ultimate, percent					B.t.u. per pound	Softening temp. ash, °F.
			Moisture	Volatile matter	Fixed carbon		Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur		
2-E ...	3/	C-52393	1.2	9.1	67.1	22.6	1.4	73.3	.6	.6	1.5	11,380	2,470
3-A ...	4/	C-56892	1.4	10.2	72.8	15.6	1.9	76.6	.7		.5	12,040	2,510
3-G ...	4/	C-56891	1.1	6.3	69.7	22.9	1.1	74.4	.5		1.9	11,390	2,490
4-H ...	5/	C-57636	1.1	7.1	67.6	24.2	1.3	73.1	.5		2.1	11,300	2,560

Note: Proximate analyses of all samples were made by standard A.S.T.M. methods for coal and coke. It has been found in a later study, that more than 95 percent of the sulfur in the char has been retained in the ash as compounds of SO_3. The ash values are subject to correction to the extent of the SO_3 present, else the sulfur values are included twice in the analyses. The true ash in most cases may be estimated by using as the basis of correction, the heating value of the char on the moisture- and ash-free basis, as 14,200 B.t.u. per pound. The fixed carbon value of the char, being determined by difference in the standard method, is subject to correction by the amount of the SO_3 in the as-determined ash.

1/ Composite increment sampling aggregating about 2.75 percent of char removed. Samples from preliminary runs through run 1-C analyzed by standard methods. No corrections were made for sulfates in ash or magnetic residues in ash.

2/ Condition: (1) as received, (2) moisture-free, (3) moisture-and-ash free.

3/ Analyses reported on as-received basis. Fixed carbon, ash, and oxygen values have not been corrected for presence of magnetic iron in the samples. Subsequent tests indicated magnetic material may range from 3 to 7 percent.

4/ Analysis on as-received basis. The sulfur content of the ash was determined as SO_3. In run 3-A, sulfur - 1.4 percent; in 3-G, 4.75 percent. The CO_2 content of sample 3-A - 2.81 percent, and in 3-G, 2.39 percent.

5/ Analysis on as-received basis. The ash was found to contain 5.04 percent sulfur, analyzed as SO_3. Sample contained 2.44 percent CO_2, as-received- basis.

TABLE 12. - Proximate analyses of residues, run 3, Grand Forks pilot plant.[1/]

Run and period	Condition[2/]	Char				Blow-over dust				Dust in gas	
		Proximate, percent			Magnetic material, percent[3/]	Proximate, percent			Magnetic material, percent[3/]	Ash, percent	Magnetic material, percent[3/]
		Volatile matter	Fixed carbon	Ash		Volatile matter	Fixed carbon	Ash			
3-A	2	10.2	72.9	16.9	3.4	14.3	51.7	34.0	3.2	19.1	1.1
	3	12.3	87.7			21.7	78.3				
3-B	2	7.5	72.5	20.0	3.6					33.2	.9
	3	7.9	92.1								
3-C	2	7.3	68.2	24.5	4.4	7.4	33.7	58.9	2.2	28.2	2.1
	3	9.7	90.3			18.0	82.0				
3-D	2	7.6	70.6	21.8	5.2	6.0	24.2	69.8	2.3	31.3	2.1
	3	9.7	90.3			19.9	80.1				
3-E	2					9.0	60.0	31.0	1.1		
	3					13.0	87.0				
3-F	2	7.0	72.2	20.8	5.4	6.4	36.1	57.5	1.6	33.0	1.8
	3	8.8	91.2			15.1	84.9				
3-G	2	6.1	70.9	23.0	6.0	4.9	36.2	58.9	1.6	34.0	1.1
	3	7.9	92.1			11.9	88.1				
3-H	2	7.1	74.1	18.8	4.1	5.7	35.2	59.1	2.5		
	3	8.7	91.3			13.9	86.1				
3-J	2					6.4	32.8	60.8	2.5		
	3					16.3	83.7				

1/ Analyses made at Golden on residues with magnetic material removed.
2/ Condition: (2) moisture-free, (3) moisture and ash free.
3/ Magnetic material was removed by passing over an electromagnet. It is not entirely magnetite and contains an undetermined amount of carbon.

The size consist and proximate analyses of chars and dusts obtained from the runs on the Golden pilot plant are given in table 13. The larger pieces of char are predominantly high in ash, which is probably due to unchanged pieces of slate and shale. With this exception, the ash increases in the smaller sizes. The size consist and ash content of dusts carried out with the gas in the large plant are shown in table 14. This study also shows that the ash concentrates in the smaller sizes.

TABLE 13. - Physical and chemical properties of chars and dusts from Golden gasification runs 10, 11, and 12.

	Char from retort					Dust in gas				
			Proximate analysis percent[1]					Ultimate analysis percent[1]		
Run and period	Size of fraction[2]	Percent of frac. size	Vol. mat.	Fixed carbon	Ash	Size of fraction[2]	Percent of frac. size	Vol. mat.	Fixed carbon	Ash
10-A ...	+0.530	3.0				16 x 30	8.0			
	+.263	28.0				30 x 60	30.6			
	+.131	44.0				60 x 100	13.8			
	+.065	14.0				100 x 200	16.0			
	-.065	11.0				-200	31.6			
	Composite	3/	8.2	76.3	15.5	Composite	4/	25.1	19.1	55.8
10-B ...	+0.530	3.0				16 x 30	12.4			
	+.263	35.0				30 x 60	31.3			
	+.131	30.0				60 x 100	11.7			
	+.065	14.0				100 x 200	12.3			
	-.065	18.0				-200	32.3			
	Composite	4/	11.8	67.3	20.9	Composite	3/	23.0	30.5	46.5
11-A ...	+0.530	4.0	3.4	14.7	82.9	+16	0.3	15.1	62.5	22.4
	+.263	30.0	9.0	57.6	33.4	16 x 30	13.6	17.6	53.8	28.6
	+.131	30.0	10.5	67.9	21.6	30 x 60	28.5	19.1	44.4	36.5
	-.131	36.0	14.6	52.0	33.4	60 x 100	12.9	22.3	30.3	47.4
	Composite	3/	11.0	59.1	29.9	100 x 200	13.5	23.9	21.3	54.8
						-200	31.2	25.8	10.7	63.5
						Composite	4/	22.0	30.4	47.6
12-A ...	+0.530	1.8	4.2	24.6	71.2	16 x 30	3.3	19.4	58.8	21.8
	+.263	30.9	7.0	73.8	19.2	30 x 50	18.6	19.5	60.4	20.1
	+.131	35.2	7.8	78.0	14.2	50 x 100	23.4	21.7	51.0	27.3
	+.065	12.4	8.3	77.3	14.4	100 x 200	18.7	24.0	39.9	36.1
	-.065	19.7	12.9	58.0	29.1	-200	36.0	25.0	26.9	48.1
	Composite	3/	11.3	70.0	18.7	Composite	3/	26.5	38.8	34.7
12-B ...	+0.530	1.8	3.9	15.1	81.0	16 x 30	3.7	18.7	50.7	30.6
	+.263	16.6	7.8	66.1	26.1	30 x 50	24.7	15.9	60.1	24.0
	+.131	53.5	7.8	78.1	14.1	50 x 100	23.6	18.7	48.8	32.5
	+.065	19.9	9.1	76.5	14.4	100 x 200	16.7	22.1	33.7	44.2
	-.065	28.2	13.0	59.4	27.6	-200	31.3	24.8	20.3	54.9
	Composite	3/	10.5	70.0	19.5	Composite	3/	21.1	39.8	39.1

1/ Condition: (2) moisture-free, (3) moisture and ash free.
2/ Magnetic material was removed by passing over an electromagnet. It is not entirely magnetite and contains an undetermined amount of carbon.

TABLE 13. - Physical and chemical properties of chars and dusts from Golden gasification runs 10, 11, and 12. (cont'd.)

Run and period	Char from retort: Size of fraction[2]	Percent of frac. size	Proximate analysis percent[1] Vol. mat.	Fixed carbon	Ash	Dust in gas: Size of fraction[2]	Percent of frac. size	Ultimate analysis percent[1] Vol. mat.	Fixed carbon	Ash
12-C ...	+0.530	0.2	3.9	34.8	61.3					
	+.263	8.5	7.5	74.3	18.2					
	+.131	38.8	10.2	76.5	88.2					
	+.065	21.0	11.0	74.6	14.4					
	-.065	31.5	17.6	52.5	29.9					
	Composite	3/	11.6	72.1	16.2					

1/ Proximate analyses on moisture-free basis. Analyses of sized fractions of char and dust by Golden laboratory.
2/ Standard square-mesh screen opening, in inches. Numbered sieve sizes are U. S. standard series.
3/ Analyses of composite samples by Pittsburgh laboratory.
4/ Analyses of composite samples by Golden laboratory.

TABLE 14. - Size consist and ash content of dusts, Grand Forks plant.

Screen size[1]	8	16	30	50	100	200	-200
	Run 2-E				Blow-over dust		
Percentage retained	3.9	10.1	25.1	30.3	17.6	8.6	4.4
Ash content percent[2]	3/	15.7 3/	34.7	63.6	74.2	76.7	80.5
	Run 2-C				Dust with gas		
Percentage retained	0.0	0.0	0.4	12.2	40.8	27.5	19.1
Ash content percent[2]				39.1	42.2	45.4	56.3
	Run 2-D				Blow-over dust		
Percentage retained	0.8	3.7	25.5	39.5	18.1	8.7	3.7
Ash content percent[2]		18.2	40.7	59.6	64.5	64.2	71.9
	Run 2-D				Dust with gas		
Percentage retained	0.0	0.0	0.8	31.6	31.8	21.2	14.6
Ash content percent[2]			36.3	40.4	42.8	45.0	48.2
	Run 4-H				Blow-over dust		
Percentage retained	5.0	8.2	15.3	32.0	24.3	10.7	4.5
	Run 4-H				Dust with gas		
Percentage retained	0.0	0.2	0.1	4.0	19.8	28.2	47.7

1/ Numbered square-mesh sieve sizes, fine series.
2/ All samples analyzed on moisture-free basis.
3/ Nos. 8 and 16 increments combined for analysis.

Analyses of Make Gases

The gas generator operates continuously and for the plant record, the gross heating value of the gas is determined by a Thomas recording calorimeter, the specific gravity by a Ranarex meter, and the CO_2 by a Republic meter. These instruments indicate constant conditions throughout a balanced period. It was not feasible to collect and store samples of the gases made over the entire 24-hour testing period because of limitations in technical personnel and suitable storage equipment. Representative samples of the gases made were therefore collected during 1- to 4-hour periods, and the analyses of these were considered representative of the entire testing period when static operating conditions were attained.

At Golden, samples of make gas were introduced in a 20-cubic-foot gas holder at a constant rate and stored over water. The gas entering the holder was sampled every 10 minutes for determination of CO_2 content, as some absorption of CO_2 took place in the water-sealed gas holder. The sample for complete gas analysis and for additional tests in the plant instruments was withdrawn from the holder, and corrections were made for any CO_2 absorption.

At Grand Forks, samples of make gas were stored over brine solution in a small sampling system, which received a steady supply of gas from the main gas line leaving the plant exhauster. The CO_2 in the gas was determined at intervals. The sample thus obtained was suitable for gas analysis but insufficient for tests in the plant instruments. This method of sampling was employed for all samples reported up to run 4. Another method of sampling was used for run 4 at Grand Forks, which avoided some of the troubles and manipulative errors encountered with the first sampling system. A stream of gas flowing at a rate of 3 to 5 cubic feet per hour was introduced in a 20-cubic foot receiver. The gas emerging from the receiver was considered a mixture of gases entering for several hours previous to the time of taking the sample. When passing gas through the 20-cubic foot receiver at a rate of 4 cubic feet per hour, the gas emerging can be considered to represent approximately 5 hours of operation. This method of sampling into a large dry receiver eliminated the errors in CO_2 absorption, and it was much simpler than sampling gases into a small receiver employing a confining solution, which absorbed even slight amounts of CO_2.

Table 15 gives the analyses of gases produced during runs 10, 11, and 12 in the small pilot plant, and table 16 gives similar analyses of gases for runs 1 to 4 in the large pilot plant. The footnotes to these tables explain the methods of sampling, and they designate the particular samples reported as representative of the testing period.

TABLE 15. - Analyses of make gases, runs 10, 11, and 12, Golden pilot plant, 1945.

Run and period	Date	Time 1/	Analysis, percent							Sulfur grains per Ccf		Specific gravity (air - 1.0)		B.t.u. per cu. ft.			Remarks
			CO_2	Ill. 2/	CO	H_2	CH_4	C_2H_6	N_2	H_2S	Organic	Ranarex	Calc.	Thomas gross	Calc. gross	Calc. net	
10-A	8-7	10:50A75	10.8	0.2	29.3	56.4	3.3	0.0	0.0			0.551	0.508	313	310	278	3/4/
10-B	8-8	7:50A90	12.0	0.4	28.1	56.2	3.2	.0	.1	0.064	3.33	.581	.518	315	308	277	3/4/
11-A	9-19	8:45A95	13.0	.4	26.2	56.2	3.7	.0	.5	.830	2.46	.558	.522	300	307	275	3/4/
12-A	11-6	8:20P305	13.5	.4	24.9	56.3	4.4	.0	.5	.430	2.32	.557	.520	314	310	278	3/5/
12-A	11-7	8:30A85	10.0	.4	30.3	54.8	4.0	.0	.5	.499		.547	.516	320	318	287	4/
12-B	11-7	4:30P240	13.3	.2	26.2	56.6	3.2	.0	.5	.527	3.00	.551	.521	302	299	268	3/5/
12-B	11-8	9:00A90	12.9	.4	26.5	56.4	3.3	.0	.5	.466	3.11	.550	.520	304	305	273	4/
12-C	11-9	9:30A85	13.6	.4	26.2	55.3	4.0	.0	.5	.280	2.70	.582	.531	309	307	275	3/4/

1/ Samples for analyses were taken at a constant rate, beginning at the time indicated and continuing for the given number of minutes. For example, during period 10-A, designated thus - 10:50A75, the sampling was started at 10:50 A.M. and continued for 75 minutes.

2/ Illuminants are assumed to have the average composition of $C_{2.8}H_{5.6}$. The composition was estimated from heat and material balances of several tests on the small and the large pilot plants.

3/ This analysis is reported as representing the entire testing period.

4/ Sample for analysis was taken at a constant rate into a 20 cu. ft. water-sealed holder. The average CO_2 in the gas was determined before it entered the holder, and the complete analysis was corrected to this CO_2 basis. The H_2S and organic sulfur determinations were made on the gas taken from the holder.

5/ Sample for analysis was taken at a constant rate from the line directly after the scrubber system into a container over a confining solution of saturated brine. The average CO_2 in the gas was determined before it entered the container, and the complete analysis was corrected to this CO_2 basis. The H_2S and organic sulfur determinations were made on the gas from the same source.

TABLE 16. - Analyses of make gases, run 1, Grand Forks pilot plant, June 1945.

Run and period	Date	Time1/	Analysis, percent							Sulfur grains per Ccf		Specific gravity (air = 1.0)		B.t.u. per cu. ft.			Remarks3/
			CO_2	Ill.2/	CO	H_2	CH_4	C_2H_6	N_2	H_2S	Organic	Ranarex	Calc.	Thomas gross	Calc. gross	Calc. net	
1-A	18	9:05A85	22.3	0.4	14.1	56.2	5.0	0.0	2.0			0.580	0.568	275	282	248	P
			22.4	.4	14.4	57.2	5.1	.0	.5			.572	.560	280	287	252	G
												.590	.593	277	278	245	P
1-A	18	1:00P120	22.1	.4	14.8	54.1	3.5	.9	4.2			.570	.572	289	290	256	G 4/
			22.4	.4	15.5	56.6	3.7	.9	.5			.580	.566	278	278	244	P
1-A	19	10:00A110	22.5	.1	15.5	56.7	4.6	.0	.6			.579	.565	278	278	245	G
			22.4	.1	15.5	56.9	4.6	.0	.5			.595	.554	273	276	242	P
1-B	19	7:45P120	23.5	.2	11.1	58.4	5.1	.0	1.7			.587	.548	281	280	246	G 5/
			23.6	.2	11.3	59.2	5.2	.0	.5			.595	.565	270	280	247	P
1-B	19	9:45P35	23.5	.3	13.6	57.5	4.8	.0	.3			.595	.565	270	280	247	G
			23.5	.3	13.6	57.4	4.8	.0	.3			.580	.595	273	265	233	P
1-B	20	9:20A115	24.0	.2	13.6	55.2	3.1	.6	3.3			.589	.582	280	270	238	G 5/
			24.0	.2	14.0	57.0	3.1	.6	.5			.590	.614	281	282	249	P
1-BC	22	8:45A105	25.0	.8	14.2	53.0	5.0	.1	1.9			.592	.602	286	288	255	G 6/
			24.7	.8	14.6	54.2	5.1	.1	0.5			.585	.595	282	281	249	P
1-C	22	7:25P70	24.5	.4	15.2	54.9	4.5	.3	.2			.585	.595	282	281	249	G
			24.5	.4	15.2	54.9	4.5	.3	.2			.580	.558	275	277	243	P
1-C	23	5:20P120	22.4	.3	13.0	58.3	3.3	.6	2.1			.592	.550	279	281	247	G 4/
			22.7	.3	13.2	59.3	3.4	.6	.5								

TABLE 16. - Analyses of make gases, run 2, Grand Forks pilot plant, December 1945.

2-A	9	1:40P25	17.4	0.3	19.6	59.6	3.0	0.0	0.1	0.440	0.966	0.546	0.519	297	288	255	4/7/
2-B	10	3:00P90	15.7	.4	23.4	56.4	3.3	.0	.8	.292	1.35	.541	.556	296	295	263	4/7/
2-C	12	9:50A85	14.0	.4	26.2	56.4	2.9	.0	.1	.470	1.01	.523	.528	303	300	268	4/7/
2-D	13	12:45P95	15.8	.7	23.1	55.6	4.4	.0	.4			.538	.541	309	308	275	4/
2-E	15	3:30P90	15.6	.8	22.9	56.7	3.9	.0	.1	.769	1.54	.536	.533	308	308	275	4/7/

See footnotes on page 48.

TABLE 16. - Analyses of make gases, run 3, Grand Forks pilot plant, March 1946. (cont'd.)

Run and period	Date	Time1/	Analysis, percent							Sulfur grains per Ccf		Specific gravity (air = 1.0)		B.t.u. per cu. ft.			Remarks
			CO_2	Ill.2/	CO	H_2	CH_4	C_2H_6	N_2	H_2S	Organic	Ranarex	Calc.	Thomas gross	Calc. gross	Calc. net	
3-A	9	8:30P60	25.3	0.3	10.7	59.7	2.6	1.0	0.4			0.559	0.563	274	274	240	
3-A	10	9:20A60	25.2	.4	10.9	59.2	3.3	.4	.6	0.216	1.32	.560	.564	271	271	238	4/7/
3-B	14	1:00P60	17.3	.6	21.1	57.2	3.8	.0	.0			.539	.538		299	266	4/
3-BC	15	3:00P90	17.4	.6	21.7	56.2	3.7	.3	.1	.066	2.50		.548	300	302	269	7/
3-C	16	12:35P165	18.6	.3	20.0	57.7	3.2	.2	.0	.105	1.90		.541	288	289	256	7/
3-D	16	7:00P150	18.6	.4	20.0	57.2	3.4	.1	.3				.545	288	289	257	
3-D	17	12:30A195	19.1	.4	18.1	58.2	3.7	.0	.5				.539	287	288	255	
3-D	17	3:00P90	18.5	.2	20.1	57.1	3.1	.3	.7	.158	2.44		.547	287	286	254	4/7/
3-F	18	6:00P260	16.9	.2	22.4	56.2	4.2	.0	.1	.700	5.47		.541	297	296	264	8/
3-F	19	1:45P90	16.5	.2	22.7	55.9	4.1	.0	.6				.543	297	295	263	4/
3-FG	20	10:35P85	14.4	.2	25.5	55.7	3.3	.0	.9				.536	298	296	264	
3-G	21	10:45A60	14.3	.3	25.4	55.4	3.5	.1	1.0	.807	8.51		.538	298	300	268	4/8/
3-GH	22	1:45P105	16.0	.3	23.0	55.9	3.2	.5	1.1				.544	297	298	266	
3-H	23	1:00A270	16.0	.4	22.7	55.7	3.9	.0	1.3			.545	.544	296	297	265	
3-H	23	2:00P60	16.0	.4	23.0	55.7	4.1	.0	.8	.680	8.95	.548	.542	297	299	267	4/8/
3-J	24	1:00A240	15.5	.4	24.2	55.1	4.2	.0	.6	.585	8.15	.544	.543	299	302	270	8/

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TABLE 16. - Analyses of make gases, run 4, Grand Forks pilot plant, April-May 1946. (cont'd.)

TABLE 16. - Analyses of make gases, run 4, Grand Forks pilot plant, April-May 1946. (cont'd.)

Run and period	Date	Time 1/	Analysis, percent							Specific gravity (air = 1.0)		B.t.u. per cu. ft.			Remarks
			CO_2	Ill. 2/	CO	H_2	CH_4	C_2H_6	N_2	Ranarex	Calc.	Thomas gross	Calc. gross	Calc. net	
4-A	17	10:00A	15.9	0.3	22.1	58.9	1.3	0.6	0.9	0.538	0.533	265	287	256	4/
4-3	19	8:30A120	17.8	.3	22.1	56.4	2.8	.4	.2	.545	.551	290	291	260	4/
4-B	19	8:00A	18.2	.4	22.7	55.3	3.3	.0	.1	.545	.560	290	290	259	
4-C	21	1:15P	17.4	.3	20.8	58.5	2.0	.6	.4	.543	.533	292	289	257	4/
4-C	21	8:10A140	17.6	.3	20.7	58.7	2.0	.6	.1	.543	.532	292	290	257	
4-CD	23	6:00P	16.9	.3	19.9	59.6	3.0	.2	.1	.540	.515	294	292	225	
4-D	23	8:20P130	18.1	0.3	20.0	59.3	1.9	0.2	0.2	.542	.530	292	282	250	4/
4-E	25	10:00A	17.7	.3	21.2	58.4	1.7	.4	.3	.540	.537	292	284	252	4/
4-E	25	7:30P5	17.6	.3	20.7	58.8	2.0	.2	.4	.540	.531	296	282	250	
4-EF	27	6.00P	16.4	.4	20.1	60.2	1.7	.7	.5	.536	.513	294	293	260	4/
4-F	28	9:45P	16.3	.3	20.8	59.0	2.5	.6	.5	.530	.520	293	296	263	
4-F	28	8:45A130	16.1	.3	22.6	58.8	1.4	.2	.6	.530	.525	293	283	252	4/
4-FG	29	1:35P	17.0	0.4	20.2	59.6	1.9	0.4	0.5	.540	.521	291	289	256	4/
4-G	30	2:30P135	16.7	.2	21.6	59.3	1.6	.3	.3	.535	.523	294	283	252	4/
4-GH	1	8:10P	18.0	.4	20.8	57.9	1.9	.6	.4	.540	.542	291	289	257	4/
4-H	2	4:20P	18.0	.3	19.4	59.3	2.2	.4	.4	.540	.542	294	286	254	4/
4-H	2	2:45P115	18.0	.3	19.1	59.7	2.0	.4	.5	.540	.526	294	286	253	
4-HI	3	5:05P	16.2	.3	22.5	57.0	3.1	.7	.2	.538	.536	296	303	270	4/
4-I	4	2:45P135	15.8	0.4	23.0	56.8	2.2	1.2	0.6	.535	.539	293	306	273	4/
4-I	4	5:30P	15.9	.4	22.5	56.6	3.1	1.0	.5	.535	.537	293	309	276	
4-IJ	5	2:15P	17.0	.3	21.4	57.4	2.6	.9	.4	.535	.538	290	299	266	4/
4-J	6	2.35P150	17.0	.3	21.4	58.1	2.5	.3	.4	.535	.532	290	290	258	4/
4-J	6	2:00P	17.0	.4	20.4	59.8	1.8	.2	.4	.535	.520	290	286	253	
4-JK	7	4:40P	15.6	.2	23.8	57.5	2.2	.2	.5	.540	.531	292	289	257	4/

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TABLE 16. - Analyses of make gases, run 4, Grand Forks pilot plant, April-May 1946. (cont'd.)

Run and period	Date	Time 1/	Analysis, percent							Specific gravity (air = 1.0)		B.t.u. per cu.ft.			Remarks
			CO_2	Ill. 2/	CO	H_2	CH_4	C_2H_6	N_2	Ranarex	Calc.	Thomas gross	Calc. gross	Calc. net	
4-K	8	2:45P150	15.0	0.2	23.7	58.6	1.8	0.3	0.4	0.540	0.524	292	288	257	4/
4-K	8	5:05P	15.4	.2	23.9	58.1	1.7	.2	.5	.540	.525	292	286	255	
4-KL	9	1:20P	17.3	.3	21.8	57.3	2.5	.3	.5	.540	.542	291	289	257	4/
4-L	10	3:45P	17.1	.3	21.9	57.4	2.6	.2	.5	.540	.538	291	288	257	4/
4-L	10	2:30P130	17.0	.3	21.9	57.6	2.5	.2	.5	.540	.537	291	288	256	
4-LM	11	1:30P	18.6	.3	20.3	58.2	2.1	.2	.3	.540	.541	286	281	249	4/
4-M	12	7:45A130	18.7	0.2	19.5	58.3	2.5	0.3	0.5	.542	.541	285	282	250	4/
4-M	12	7:50A	18.7	.4	19.4	59.2	1.7	.2	.4	.542	.535	285	279	247	
4-N	13	4:20P	19.2	.3	19.0	58.6	2.4	.1	.4	.541	.541	285	279	247	
4-N	13	3:15P155	19.1	.2	18.8	58.7	2.5	.2	.5	.541	.540	285	280	248	4/
4-NO	15	8:00A	17.3	.0	22.6	58.9	.8	.0	.4	.538	.533	252	268	238	4/
4-O	15	10:00A	15.8	.2	23.2	58.7	1.6	.0	.5	.542	.524	268	271	240	4/
4-O	15	10:50A120	16.8	.0	22.9	59.1	.8	.0	.4	.542	.527	268	270	239	
4-O	15	9:00P75	15.0	.1	24.2	59.1	1.2	.1	.3	.542	.516	268	271	241	

1/ Samples for analyses were taken in a container over a confining solution of saturated brine at a constant rate beginning at the time indicated and continuing for the given number of minutes. For example, during period 1-A, designated as 9:05A85, the sampling was started at 9:05 A.M. and continued for 85 minutes. Those samples with only an initial time given are grab samples taken direction into the gas analysis apparatus from the outlet of a 20 cu. ft. dry vessel, through which gas circulated at approximately 5 cu. ft. per hour. Such a sample represents the probable average of the gas for 4 hours prior to the time the sample was taken. The latter method avoids the absorption of CO_2 in the confining solution.

2/ Illuminants are assumed to have the average composition of $C_{2.8}H_{5.6}$. The composition was estimated from heat and material balances of several tests on the small and the large pilot plants.

3/ During run 1, purge gas containing 17 percent CO_2 and 83 percent N_2 was introduced in the top and bottom of the generator to reduce moisture condensation and to avoid explosive mixtures in the charging hopper. Corrections were made for this dilution of the generator gas, the composition of which was calculated, assuming it to contain only 0.5 percent nitrogen. P designates the plant gas containing purge gas; G designated the calculated generator gas. In the subsequent runs, purge gas introduced was insignificant.

4/ This analysis is reported as representing the entire testing period.

5/ Average of these reported as representing the testing period 1-B.

6/ This analysis represents a change-over period between B and C.

7/ Gas samples for H_2S and organic sulfur determinations were taken from line to laboratory.

8/ Gas samples for H_2S and organic sulfur determinations were taken at gas offtake before passing through the water scrubber.