Figure 16 is a view of the slag-tap opening in the primary zone after test 34. This shows the comparatively small amount of erosion of the base refractory and slag-tap hole.

Figures 17 and 18 are views of the sidewall refractory in that zone after the same test. The eroded areas in the northeast sector of figure 17 and the southwest sector of figure 18 correspond to those shown in the cross section (fig. 10).

Figure 19 is a view of the bottom side of the throat between the primary and secondary zones. The reactant-injection burners are shown in the southwest and northeast sectors. It will be noted that the support coil in the throat is uniformily covered with refractory and slag and that no erosion occurred in the refractory at the points of burner entrance.

The buildup of fluffy fly ash on the platen coils in the upper part of the gasifier is shown in figure 20. This material was easily blown off and in large plant equipment, steam lances or soot blowers would keep the tubes clean. The deposit of ash on the sidewalls of the secondary zone has shown no tendency to build up past 1- or 2-inch thickness.

RESULTS

Principal results

Table 1 presents, in chronological order, the principal results through run 34 on atmospheric gasifier 4. Runs 1, 2, 3, 8, 27, and 32 have been omitted from the table because operating conditions were not satisfactory, and the numerical data obtained were of no value for design purposes. The first three (through run 3) proved useful for training personnel and testing equipment operation, especially for indicating advantages of two reactant burners over one, but were regarded as preliminary rather than data runs. Runs 8 and 32 were ended prematurely by failure of a reactant burner and a heat-trap coil, respectively, and run 27 was short because operation was not satisfactory with that burner design.

Sewickley-bed coal was used for all test runs, the finer size (90 percent minus-200-mesh) through run 18 and the coarser size (70 percent minus-200-mesh) beginning with run 19. The other reactants were steam and oxygen. The steam was superheated to about 1,000° F. through run 9 (except run 5), and again for runs 33 and 34, steam and oxygen were heated together to about 600° F. for runs 10 through 31, and the coal was heated to about 300° F. commencing with run 10. One reactant burner was used for runs 1 and 2 (not reported), and two reactant burners were used for all runs reported.

Column 1 gives the run number and the basis for calculating results. Single-period runs are designated by Arabic numerals, such as 7 for run 7. Separate lines are shown for individual periods and the overall averages of multiperiod runs, for example, lines 14A, 14B, 14C, and 14 for the three-period run 14, F indicates that items in columns 16, 18, 29 to 34, 47 to 52, and 62 are calculated from (or based on) carbon balances using product-gas flow data, R indicates that these items are calculated from carbon balances using residue data, and A indicates an average of flow and residue data. Except where only one basis was available, the method of selection, explained in footnote 1 to the table, depends on which basis gives the best agreement between calculated and reported coal requirements. For further details see footnote 1 under table 1.

TABLE 1. - Principal results on pilot-plant atmospheric gasifier 4, runs 4 through 34*

Run No. (with basis for calculating results)1/	Date of run (or period)	Reactant burner design2/	Duration of run (or period), hr.	Raw-coal feed rate, lb./hr.	Process-steam input, lb./hr.3/	Process-oxygen input (100% std. c.f./hr.3/	Coal inlet temperature °F.	Steam inlet temperature °F.	Oxygen inlet temperature °F.	Process steam, lb./lb. raw coal	Process oxygen (100%), std. c.f./lb. raw coal	Process steam, lb./lb. carbon in coal	Process oxygen (100%), std. c.f./lb. carbon in coal	Gasifier temperature, T.C. 13, below heat recovery zone, in gas stream °F.
	Conditions											Input ratios		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4 A	10/10/51	2	3.63	474	288	4,950	77	963	70	0.61	10.45	0.89	15.31	-
5 F	10/25/51	2	2.00	485	479	4,615	68	320	68	.99	9.51	1.36	13.16	-
6 F	10/30/51	2	5.83	491	500	4,480	78	875	70	1.02	9.12	1.41	12.62	-
7 A	12/11/51	2	6.00	516	478	4,540	75	1,055	69	.93	8.99	1.28	12.44	-
9 A	12/18/51	2	6.56	500	474	4,260	63	1,080	63	.95	8.52	1.31	11.80	1,905
10 A	2/29/52	3	6.00	462	448	4,345	315	530	530	.97	9.40	1.38	13.38	1,700
11 A	3/4/52	4	7.56	540	400	4,370	309	566	566	.74	8.09	1.05	11.51	1,860
12 A	3/7/52	4	6.00	521	300	4,110	297	562	562	.58	7.89	.82	11.22	1,800
13 A	4/22/52	5	6.00	490	558	4,980	311	678	678	1.14	10.16	1.60	14.25	Out
14A F	4/24/52	5	2.00	471	450	4,620	304	622	622	.96	9.81	1.34	13.76	2,260
14B F	do.	5	2.00	471	500	4,580	302	618	618	1.06	9.72	1.49	13.64	2,370
14C F	do.	5	2.00	471	550	4,580	300	624	624	1.17	9.72	1.64	13.64	2,365
14 A	do.	5	6.00	471	500	4,590	302	622	622	1.06	9.75	1.49	13.67	2,315
15A F	4/29/52	5	2.00	329	350	3,490	297	591	591	1.06	10.61	1.49	14.68	2,360
15B F	do.	5	2.00	329	385	3,490	295	594	594	1.17	10.61	1.64	14.88	2,380
15C F	do.	5	2.00	329	370	3,300	296	603	603	1.12	10.03	1.57	14.07	2,390
15 A	do.	5	6.50	329	365	3,430	296	589	589	1.11	10.43	1.56	14.52	2,355
16A F	4/30/52	5	2.00	464	400	4,480	286	594	594	.86	9.66	1.21	13.54	2,400
16B F	do.	5	2.00	464	350	4,230	286	597	597	.75	9.12	1.06	12.79	2,400
16 A	do.	5	4.07	464	379	4,380	286	592	592	.82	9.44	1.15	13.24	2,385
17 R	4/30/52	5	2.37	342	256	2,990	297	565	565	.75	8.74	1.05	12.26	2,290
18 A	4/30/52	5	2.50	598	333	4,680	287	594	594	.56	7.83	.78	10.98	2,325
19A F	5/13/52	5	3.00	355	280	3,110	304	618	618	.79	8.76	1.11	12.36	2,140
19B F	do.	5	3.00	355	210	3,455	304	616	616	.59	9.73	.83	13.73	2,340
19C F	do.	5	3.00	355	280	3,455	290	625	625	.79	9.73	1.11	13.73	2,330
19D F	do.	5	3.00	355	210	3,110	302	612	612	.59	8.76	.83	12.36	2,310
19 F	do.	5	12.00	355	245	3,280	300	618	618	.69	9.24	.97	13.03	2,280
20A F	5/14/52	5	4.00	358	280	3,375	307	620	620	.78	9.43	1.10	13.30	2,285
20B F	do.	5	3.00	358	210	2,790	295	598	598	.59	7.79	.83	10.99	2,080
20C F	do.	5	3.00	358	210	3,135	300	615	615	.59	8.76	.83	12.35	2,230
20D F	5/15/52	5	1.20	365	280	2,710	297	619	619	.77	7.42	1.08	10.47	2,000
20 F	5/14-15	5	11.20	360	245	3,000	300	613	613	.68	8.33	.96	11.76	2,170
21 A	5/28/52	6	7.00	355	280	3,215	300	618	618	.79	9.05	1.11	12.79	2,045
22A F	6/3/52	6	4.00	545	330	4,380	291	614	614	.61	8.04	.86	11.35	2,060
22B F	do.	6	4.00	357	210	3,040	303	620	620	.59	8.52	.83	12.02	2,050
22C F	do.	6	4.00	562	330	4,730	297	644	644	.59	8.42	.83	11.89	2,315
22D F	6/4/52	6	4.00	352	210	2,840	307	621	621	.60	8.07	.84	11.40	2,180
22E F	do.	6	3.50	352	210	2,940	304	628	628	.60	8.35	.84	11.80	2,185
22F F	do.	6	3.50	549	330	4,660	290	645	645	.60	8.49	.85	11.99	2,320
22G F	do.	6	3.50	549	330	4,400	290	636	636	.60	8.01	.85	11.32	2,295
22H F	do.	6	2.70	362	210	2,820	308	613	613	.58	7.79	.82	11.00	2,190
22A-H F	6/3-4	6	29.20	454	270	3,725	299	628	628	.59	8.20	.84	11.59	2,200
22I F	6/5/52	6	3.00	568	275	4,470	302	622	622	.48	7.87	.68	11.12	2,300
23A F	6/17/52	6	6.00	600	300	5,385	285	613	613	.50	8.98	.70	12.50	2,495
23B F	do.	6	6.00	597	240	5,110	278	630	630	.40	8.56	.56	11.92	2,435
23C F	6/18/52	6	6.00	597	300	5,125	285	667	667	.50	8.58	.70	11.95	2,390
23D R	do.	6	5.00	600	240	5,360	285	633	633	.40	8.93	.56	12.44	2,485
23E F	do.	6	7.00	624	240	5,110	282	644	644	.38	8.19	.54	11.41	2,270
23F R	6/19/52	6	6.00	624	300	5,090	281	671	671	.48	8.16	.67	11.36	2,345
23G R	do.	6	6.00	627	300	5,035	285	642	642	.48	8.06	.67	11.25	2,360
23 F	6/17-19	6	42.00	610	274	5,170	283	644	644	.45	8.48	.63	11.82	2,395
24 F	7/29/52	7	2.00	637	195	5,080	269	584	584	.31	7.97	.43	11.31	2,310
25A F	7/31/52	7	2.00	479	300	4,475	273	609	609	.63	9.34	.99	13.25	2,230
25B F	do.	7	1.25	399	211	3,570	277	599	599	.53	8.95	.75	12.69	2,180
25C F	do.	7	1.25	499	250	4,480	267	617	617	.50	8.98	.71	12.73	2,250
25D F	do.	7	2.00	549	275	4,925	267	651	651	.50	8.97	.71	12.73	2,340
25 F	do.	7	6.50	489	266	4,440	271	619	619	.54	9.08	.77	12.88	2,250
26A F	8/6/52	7	2.00	594	356	5,270	280	663	663	.60	8.87	.85	12.58	2,280
26B F	do.	7	1.00	594	300	5,170	280	615	615	.51	8.70	.72	12.34	2,295
26C F	do.	7	1.00	594	240	5,340	278	620	620	.40	8.99	.57	12.75	2,280
26D F	do.	7	.50	495	394	4,980	285	589	589	.80	10.05	1.13	14.27	2,280
26E F	do.	7	1.00	396	200	3,600	297	585	585	.51	9.09	.72	12.89	2,190
26 F	do.	7	5.50	549	301	4,930	284	626	626	.55	8.98	.78	12.74	2,265
28A R	8/14/52	6	1.75	399	230	3,330	298	585	585	.58	8.35	.82	11.84	2,180
28B R	do.	6	2.50	599	300	5,040	283	627	627	.50	8.41	.71	11.93	2,280
28C R	do.	6	2.00	399	320	3,615	301	630	630	.80	9.06	1.13	12.81	2,220
28D R	do.	6	2.50	598	480	5,380	295	662	662	.80	9.00	1.13	12.57	2,325
28 R	do.	6	8.75	513	342	4,470	294	629	629	.67	8.71	.94	12.32	2,245
29A F	8/21/52	6	3.00	599	300	4,835	282	618	618	.50	8.07	.71	11.37	2,275
29B F	do.	6	1.50	399	160	3,390	285	564	564	.40	8.50	.56	11.97	2,210
29C F	do.	6	3.37	600	240	4,985	260	525	525	.40	8.31	.56	11.70	2,315
29D F	do.	6	3.08	400	160	3,360	310	580	580	.40	8.40	.56	11.83	2,245
29 F	do.	6	10.75	514	223	4,255	285	572	572	.43	8.28	.61	11.66	2,270
30A R	10/3/52	9	2.00	405	280	3,565	282	541	541	.69	8.80	.95	12.14	2,215
30B R	do.	9	2.00	405	240	3,560	296	556	556	.59	8.79	.82	12.12	2,210
30C R	do.	9	1.96	405	200	3,360	304	566	566	.49	8.30	.68	11.44	2,220
30 R	do.	9	5.96	405	240	3,495	294	555	555	.59	8.64	.82	11.90	2,215
31 A	10/7/52	9	5.80	407	160	3,390	304	563	563	.39	8.33	.54	11.49	2,260
33 A	11/10/52	9	5.00	457	229	4,055	236	485	485	.50	8.87	.71	12.60	2,125
34C-H F	11/13/52	9	66.00	466	225	4,090	284	474	474	.48	8.77	.69	12.45	2,110
34I-N,T F		9	65.00	466	270	4,085	293	514	514	.58	8.76	.82	12.37	2,135
34O,P,R,S F	to	9	34.00	462	315	4,085	289	561	561	.68	8.84	.96	12.46	2,200
34Q F		9	10.00	466	360	4,105	292	578	578	.77	8.60	1.10	12.50	2,215
34U F	11/25/52	9	27.00	466	225	3,785	288	508	508	.48	8.11	.68	11.51	2,215
34C-U F		9	202.00	466	261	4,050	289	511	511	.56	8.69	.79	12.31	2,160

*See end of table for footnotes.

3785

TABLE 1. - Principal results on pilot-plant atmospheric gasifier 4, runs 4 through 34 - Coal.

Run No. (with basis for calculating results)		Product-gas output, thousands of std. c.f./hr.4/	Inert-gas input, thousands of std. c.f./hr.5/	Product-gas flow through slag throat, thousands of std. c.f./hr.	$(CO + H_2)$ output thousands of std. c.f./hr.	Product-gas analysis (as analyzed), percent4/					Calculated net heating value of product gas, B.t.u./std. c.f.	H_2-CO ratio	Carbon in coal gasified, percent6/		
						CO_2	H_2	CO	CH_4 ill.	N_2			Flow data	Residue data	Average of flow and residue data
1		16	17	18	19	20	21	22	23	24	25	26	27	28	29
4	A	14.80	-	-	11.93	16.4	34.6	46.0	0.9	2.0	252.9	0.75	92.5	92.1	92.3
5	F	14.14	-	2.33	10.14	23.6	38.7	33.0	1.4	3.1	229.2	1.17	75.0	86.0	80.5
6	F	14.35	-	2.55	10.79	20.7	40.0	35.3	1.4	2.4	240.2	1.13	74.3	80.5	77.4
7	A	16.89	-	2.13	12.68	19.2	38.2	36.9	1.5	4.0	240.1	1.04	80.5	86.2	83.4
9	A	15.02	-	3.76	11.16	19.8	39.3	35.0	1.6	4.1	239.8	1.12	76.2	74.7	75.4
10	A	14.44	0.20	2.73	10.82	22.5	37.4	37.5	1.2	1.1	236.5	1.00	85.5	84.1	84.8
11	A	15.22	.19	2.40	11.96	18.2	40.0	38.6	1.3	1.9	247.4	1.04	71.9	76.0	73.9
12	A	14.08	.42	2.73	11.23	14.9	39.3	40.8	1.5	3.2	255.7	.96	68.9	70.7	69.8
13	A	16.12	.18	1.88	12.11	22.2	38.3	35.8	1.1	1.4	237.6	1.04	86.5	90.9	88.7
14A	F	15.30	.17	2.42	11.75	19.6	38.0	38.8	1.2	2.3	243.6	.98	86.7	-	-
14B	F	15.83	.16	2.17	12.19	19.6	38.7	38.3	1.1	2.2	243.6	1.01	89.0	-	-
14C	F	15.90	.17	1.80	12.09	20.7	39.7	37.0	1.2	1.9	241.9	1.05	89.4	-	-
14	A	15.84	.17	2.15	12.13	20.0	38.6	38.0	1.2	2.1	243.3	1.02	88.6	90.2	89.4
15A	F	11.48	.13	.29	8.43	21.9	35.8	37.6	.8	3.7	229.4	.95	94.1	-	-
15B	F	11.34	.13	.56	8.29	23.2	35.9	37.2	.7	2.9	226.8	.96	94.9	-	-
15C	F	11.26	.12	1.82	8.19	23.1	35.2	36.5	.8	3.2	226.2	.99	92.2	-	-
15	A	11.26	.13	.70	8.23	22.9	36.3	37.6	.7	3.3	226.6	.96	92.9	92.0	92.4
16A	F	15.80	.15	2.15	12.13	17.9	37.4	40.1	.8	4.2	239.1	.94	88.8	-	-
16B	F	15.44	.14	2.17	12.24	16.3	38.4	41.7	.9	3.4	248.3	.92	87.0	-	-
16	A	15.62	.14	2.11	12.03	17.3	37.8	40.8	.8	3.6	242.5	.93	87.8	85.9	86.9
17	R	10.63	.14	2.10	8.50	15.3	36.9	44.2	.9	2.4	251.9	.84	88.2	83.2	85.7
18	A	16.94	.15	2.51	13.72	14.5	39.1	42.6	.9	2.7	253.4	.92	73.6	72.4	73.0
19A	F	10.70	.17	2.17	8.40	18.1	38.0	39.7	1.3	1.7	249.6	.98	80.2	84.9	82.5
19B	F	11.50	.17	-	9.35	15.9	36.0	45.3	1.2	1.3	257.2	.80	90.5	89.6	90.0
19C	F	11.46	.17	2.11	8.93	17.7	37.2	40.8	1.0	3.0	246.0	.91	86.5	89.3	87.9
19D	F	10.74	.17	2.49	8.67	15.7	37.0	43.7	.8	2.6	252.4	.85	81.8	87.4	84.6
19	F	11.10	.17	2.30	8.85	16.8	37.3	42.4	1.1	2.1	251.7	.88	84.7	87.8	86.3
20A	F	10.89	.23	2.15	8.45	18.3	37.8	39.8	1.0	2.6	244.4	.95	80.6	88.7	84.8
20B	F	9.92	.28	2.04	7.93	15.4	39.0	40.9	1.0	3.5	250.6	.95	71.2	77.5	74.4
20C	F	10.82	.20	2.33	8.88	14.8	37.9	44.2	.9	2.0	256.4	.86	81.2	84.9	83.0
20D	F	9.20	.26	1.66	6.96	19.1	40.4	34.6	1.3	3.5	243.6	1.16	53.6	69.6	66.6
20	F	10.22	.24	2.12	8.05	16.9	38.8	39.9	1.2	2.9	246.8	.97	73.5	80.1	77.0
21	A	11.61	.32	1.67	9.06	17.2	38.4	39.4	.8	3.9	242.3	.98	85.6	83.2	84.5
22A	F	15.17	.34	2.72	12.30	14.9	39.4	41.7	.7	3.0	251.6	.94	71.7	76.0	73.6
22B	F	10.86	.45	2.67	8.70	14.4	37.9	42.2	.7	4.6	248.4	.90	77.9	82.0	80.0
22C	F	17.52	.16	4.13	14.56	14.1	38.4	44.7	.8	1.8	259.4	.86	83.7	82.2	83.0
22D	F	10.40	.43	3.96	8.27	14.9	38.4	41.1	.8	4.6	247.8	.93	75.2	77.3	76.2
22E	F	10.85	.72	2.36	8.46	14.1	37.2	40.8	.9	6.8	245.1	.91	76.7	76.0	76.4
22F	F	16.75	.29	3.45	13.85	13.8	39.1	43.6	.8	2.5	257.2	.90	79.8	79.8	79.8
22G	F	15.95	.35	.50	12.95	14.8	39.3	41.9	.9	2.9	254.4	.94	75.4	81.8	78.6
22H	F	10.14	.44	1.22	7.95	15.7	38.1	40.3	.9	4.8	245.9	.94	71.4	83.5	77.4
22A-H	F	13.46	.40	2.61	10.83	14.6	38.5	42.0	.8	3.9	251.0	.92	76.7	79.9	78.3
22I	F	16.82	.25	2.23	14.20	12.2	39.1	45.3	.9	2.3	264.6	.86	78.6	77.4	78.0
23A	F	19.50	.36	3.29	16.52	11.8	36.9	47.8	.8	2.6	265.3	.80	86.1	88.6	87.4
23B	F	18.28	.34	2.98	15.67	10.6	37.1	48.6	.8	2.8	258.4	.74	83.5	88.5	86.0
23C	F	18.58	.35	2.69	15.77	11.8	38.6	46.1	.9	2.4	264.8	.84	81.0	79.9	80.4
23D	R	19.08	.48	2.80	16.22	10.1	35.9	49.1	1.0	2.7	269.2	.73	81.5	84.5	83.2
23E	F	18.62	.44	2.97	16.05	10.2	37.4	48.7	1.0	2.5	272.6	.77	79.2	84.2	81.8
23F	R	19.79	.31	2.42	16.62	11.7	38.6	45.4	1.0	3.1	264.8	.85	76.6	81.9	79.2
23G	R	19.33	.47	2.97	15.93	12.4	37.6	44.8	1.2	3.8	263.1	.84	81.1	80.6	80.8
23	F	18.76	.39	2.91	15.54	11.2	37.4	47.2	1.0	3.0	270.5	.79	81.6	83.7	82.6
24	F	17.22	.24	2.20	14.72	10.8	35.8	49.7	1.5	2.2	276.1	.72	76.1	-	-
25A	F	14.54	.32	2.14	11.56	16.3	37.3	42.2	1.1	2.9	252.9	.88	82.1	82.7	82.4
25B	F	12.09	.24	2.05	9.84	14.5	37.3	44.1	1.1	2.8	259.7	.85	82.2	80.7	81.4
25C	F	15.22	.25	1.89	12.67	13.5	36.6	46.8	.9	1.9	261.5	.78	84.1	80.3	82.2
25D	F	17.16	.25	2.10	14.29	13.2	36.5	46.8	1.0	2.3	264.7	.78	86.6	84.0	85.3
25	F	15.26	.27	2.10	12.48	14.5	36.9	44.9	1.0	2.5	258.9	.82	85.5	82.3	83.9
26A	F	17.00	.35	1.89	13.66	16.1	36.8	43.6	.7	2.6	249.9	.84	79.9	-	-
26B	F	16.86	.33	1.97	13.77	14.7	36.1	45.6	.6	2.8	252.9	.79	77.0	-	-
26C	F	17.01	.37	2.08	14.39	12.3	36.4	48.2	.5	2.4	260.0	.76	78.4	-	-
26D	F	15.63	.37	1.78	12.15	17.8	36.2	41.5	.5	3.9	239.1	.87	84.9	-	-
26E	F	12.11	.39	1.64	9.85	13.9	36.6	44.7	.6	3.9	251.1	.82	81.3	-	-
26	F	16.22	.36	1.67	13.14	15.0	36.4	44.6	.6	3.2	250.5	.82	80.0	-	-
28A	R	11.72	.27	3.13	9.36	15.8	38.3	41.6	1.2	2.9	254.7	.92	74.6	78.4	76.5
28B	R	18.46	.29	2.45	15.17	14.4	37.5	44.7	.9	2.3	258.4	.84	76.8	83.6	80.2
28C	R	11.72	.30	2.45	8.99	18.0	37.5	39.2	1.4	3.4	247.2	.96	78.0	78.0	78.0
28D	R	17.81	.31	1.61	13.61	19.3	37.9	38.5	1.5	2.4	247.6	.98	77.5	75.9	78.7
28	R	15.39	.29	2.45	12.14	16.9	37.9	41.1	1.2	2.7	252.0	.92	76.8	80.2	78.5
29A	F	17.45	.34	1.98	14.17	15.1	36.8	44.4	1.2	2.4	259.6	.83	79.7	80.8	80.2
29B	F	11.72	.48	2.05	9.58	12.9	35.7	46.1	1.2	4.0	262.7	.77	79.8	81.7	80.8
29C	F	17.61	.26	1.91	15.02	11.5	37.3	48.0	1.1	2.0	271.6	.78	80.2	80.5	80.4
29D	F	11.69	.29	2.06	9.76	12.2	36.1	47.4	1.1	3.0	266.4	.75	79.6	79.7	79.8
29	F	15.04	.32	1.98	12.52	12.9	36.6	46.6	1.1	3.0	265.1	.78	79.9	80.5	80.2
30A	R	12.25	.27	2.51	9.32	19.7	37.4	38.7	1.3	2.6	243.1	.97	77.9	79.5	78.7
30B	R	11.41	.20	2.17	9.17	16.1	36.8	44.3	1.1	2.0	255.5	.84	80.0	75.5	77.8
30C	R	11.01	.34	2.95	9.02	14.6	36.6	45.3	1.1	3.2	260.4	.81	77.7	72.1	74.9
30	R	11.56	.27	2.54	9.17	16.8	36.9	42.5	1.2	2.6	253.0	.87	78.5	75.7	77.1
31	A	12.56	.30	2.81	10.49	12.7	35.6	47.9	.9	2.7	253.5	.74	84.2	82.5	83.4
33	A	13.84	.16	1.20	11.40	14.4	37.5	44.9	1.1	2.0	250.5	.84	85.9	83.2	83.0
34C-H	F	14.36	.37	2.94	12.09	13.1	38.5	45.7	.9	1.6	265.3	.84	83.7	79.1	81.4
34I-N,T	F	14.47	.31	2.32	12.02	14.6	39.1	44.0	.9	1.3	258.2	.89	83.5	81.1	82.3
34O,P,R,S	F	14.44	.31	2.04	11.80	16.8	39.7	42.0	.6	.8	254.3	.94	83.6	82.4	83.0
34Q	F	14.58	.34	1.92	11.70	17.8	40.2	40.0	1.0	.9	251.6	1.00	83.5	82.1	82.8
34U	F	13.63	.37	2.03	11.49	14.0	39.1	45.2	.9	.7	264.5	.86	79.7	82.6	81.2
34C-U	F	14.29	.33	2.40	11.90	14.5	39.1	44.2	.9	1.1	260.4	.89	82.9	81.0	82.0

TABLE 1. - Principal results on pilot-plant atmospheric gasifier 4, runs 4 through 34 - Cont.

Run No. (with basis for calculating results)	Steam decomposed, percent of process-steam input 7/	Material requirements per 1,000 std. c.f. of CO + H_2: Raw coal, lb.	Process oxygen (100%), std. c.f.	Process steam, lb.	Computed equilibrium temperature, water-gas shift reaction, °F.	Calculated residence time in gasifier, seconds 8/	Gasifier temperatures, °F.: Product-gas outlet, crossover level, in gas stream TC 1	Secondary reaction zone, 1 in. from inner face TC 4	Upper throat, 8 in. above top of support coil, 1.5 in. from inner face TC 5, 6	Primary reaction zone, 19.5 in. above lower throat, 1 to 4 in. from inner face 9/ TC 9	Slag tap 1 to 9 in. from inner face 9/ TC 10, 11
1	30	31	32	33	34	35	36	37	38	39	40
4 A	13.4	39.7	415	24.2	2,310	-	-	2,060	2,160	2,230	2,040
5 F	12.6	47.8	455	47.2	2,050	-	1,925	1,665	1,975	2,110	2,020
6 F	12.6	45.5	515	46.3	1,910	-	1,590	1,940	2,010	2,090	2,060
7 A	22.5	40.7	366	37.7	2,085	-	1,565	1,895	1,755	2,085	2,040
9 A	18.4	44.8	381	42.5	2,130	1.45	1,650	2,035	2,115	2,125	2,030
10 A	20.3	42.7	402	41.4	2,085	1.60	1,605	1,835	2,265	2,060	2,000
11 A	20.7	45.2	365	33.4	2,065	1.21	1,630	1,950	2,310	2,150	2,180
12 A	18.0	46.2	364	22.6	2,190	1.69	1,605	1,920	2,320	2,465	2,095
13 A	18.9	40.5	401	46.1	2,180	-	Out	1,960	2,255	2,240	2,250
14A F	20.2	40.1	393	38.3	2,185	1.19	1,735	1,850	2,260	2,110	2,225
14B F	20.6	38.6	376	41.0	2,205	1.08	1,780	2,080	2,360	2,215	2,325
14C F	21.1	39.0	379	45.5	2,210	.99	1,825	2,150	2,355	2,275	2,350
14 A	21.7	38.9	378	41.2	2,180	1.08	1,780	2,025	2,325	2,200	2,300
15A F	21.9	39.0	414	41.5	2,110	1.32	1,505	2,020	2,335	2,325	2,445
15B F	19.9	39.7	421	46.4	2,180	1.29	1,590	2,145	2,405	2,395	2,510
15C F	22.7	40.2	403	45.2	2,075	1.47	1,620	2,185	2,410	2,400	2,530
15 A	21.1	39.9	417	44.3	2,130	1.36	1,540	2,100	2,435	2,360	2,515
16A F	25.5	38.3	369	33.0	2,100	1.10	1,690	2,025	2,235	2,270	2,365
16B F	29.1	37.9	346	28.6	2,050	1.23	1,725	2,130	2,245	2,285	2,400
16 A	25.3	38.6	304	31.5	2,120	1.19	1,670	2,050	2,225	2,275	2,370
17 R	22.5	40.2	352	30.1	2,400	1.90	1,465	2,115	2,180	2,320	2,375
18 A	24.1	43.6	341	24.3	2,100	1.18	1,780	2,105	2,145	2,290	2,345
19A F	22.5	42.3	370	33.3	2,130	1.83	1,350	1,805	1,920	2,230	2,345
19B F	30.7	38.0	370	22.5	1,990	1.53	1,610	2,060	2,305	2,400	2,350
19C F	22.5	39.6	387	31.4	2,140	1.72	1,615	2,170	2,335	2,430	2,445
19D F	26.0	40.9	357	24.2	2,070	2.09	1,585	2,180	2,275	2,440	2,440
19 F	25.2	40.1	371	27.7	2,090	1.91	1,540	2,055	2,220	2,375	2,400
20A F	18.5	42.4	399	33.1	2,175	1.66	1,510	2,025	2,200	2,325	2,450
20B F	21.2	45.1	352	26.5	2,110	2.37	1,445	1,920	2,020	2,245	2,335
20C F	25.8	40.3	353	23.6	2,110	2.03	1,595	2,040	2,105	2,370	2,460
20D F	14.3	52.4	389	40.2	2,150	2.16	1,470	1,950	1,950	2,160	2,270
20 F	19.5	44.7	373	30.4	2,170	2.05	1,505	1,965	2,070	2,275	2,380
21 A	25.3	39.2	355	30.9	2,060	1.71	1,625	2,075	2,140	2,010	2,145
22A F	18.4	44.3	356	26.8	2,215	1.44	1,715	1,960	2,090	1,950	2,020
22B F	23.5	41.0	349	24.1	2,110	2.29	1,610	1,995	2,070	1,990	2,030
22C F	31.3	38.6	325	22.7	2,040	1.32	1,765	2,030	2,170	2,045	2,105
22D F	23.2	42.6	343	25.4	2,080	2.75	1,605	2,040	2,025	2,130	2,125
22E F	22.2	41.6	348	24.8	2,130	2.10	1,685	2,015	2,010	2,025	2,165
22F F	25.5	39.6	336	23.9	2,160	1.36	1,830	2,050	2,090	2,035	2,205
22G F	23.7	42.4	340	25.5	2,110	1.10	1,805	2,085	2,110	2,045	2,150
22H F	20.1	45.5	355	26.4	2,090	1.54	1,630	2,020	2,055	2,010	2,175
22A-H F	23.7	41.9	344	24.9	2,120	1.63	1,705	2,030	2,060	2,030	2,025
22I F	30.5	40.0	315	19.1	2,040	2.25	1,785	2,020	2,090	2,045	2,300
23A F	33.5	36.3	326	18.2	2,060	1.07	1,740	2,155	2,315	2,170	2,355
23B F	32.1	38.1	326	15.3	2,080	1.19	1,750	2,175	2,200	2,185	2,390
23C F	30.9	37.9	325	19.0	2,100	1.11	1,760	2,170	2,275	2,155	2,395
23D R	32.9	37.0	330	15.8	2,090	1.10	1,750	2,155	2,250	2,170	2,355
23E F	33.4	38.9	319	15.0	2,050	1.23	1,830	2,155	2,220	2,155	2,385
23F R	38.5	37.5	306	10.1	1,950	1.07	1,810	2,125	2,175	2,125	2,315
23G R	35.2	39.4	316	18.8	1,950	1.11	1,805	2,095	2,160	2,100	2,320
23 F	31.3	39.3	334	17.6	2,100	1.14	1,790	2,145	2,245	2,150	2,350
24 F	26.9	43.3	345	24.5	2,080	1.27	1,635	1,980	2,190	2,200	2,625
25A F	20.7	41.4	387	26.0	2,120	1.39	1,445	2,000	2,160	2,205	2,435
25B F	25.9	40.5	363	21.4	2,040	1.84	1,455	2,040	2,140	2,275	2,505
25C F	22.2	39.4	354	19.7	2,060	1.36	1,655	2,055	2,175	2,305	2,535
25D F	30.8	38.4	345	19.2	2,070	1.20	1,730	2,100	2,240	2,340	2,570
25 F	28.5	39.2	356	21.3	2,035	1.38	1,570	2,040	2,180	2,280	2,510
26A F	17.5	43.5	386	26.2	2,240	1.10	1,595	2,040	2,130	1,700	880
26B F	19.0	43.1	375	21.8	2,200	1.17	1,630	2,075	2,175	1,760	960
26C F	16.3	43.1	388	17.4	2,430	1.22	1,615	2,095	2,195	1,790	1,000
26D F	16.0	40.8	410	32.4	2,390	1.13	1,665	2,100	2,185	1,815	1,020
26E F	23.8	40.2	366	20.3	2,090	1.80	1,515	2,090	2,115	1,820	1,055
26 F	20.0	41.8	376	23.0	2,175	1.20	1,595	2,070	2,150	1,760	970
28A R	26.3	42.6	356	24.5	1,980	2.17	1,500	2,010	2,065	1,845	1,170
28B R	35.3	38.1	332	19.8	1,880	1.16	1,770	2,060	2,165	1,895	1,225
28C R	15.8	44.3	402	35.6	2,885	1.69	1,645	2,080	2,130	1,905	1,260
28D R	18.7	44.0	395	35.3	2,130	.94	1,895	2,100	2,125	1,890	1,290
28 R	23.9	42.3	368	28.2	2,065	1.31	1,705	2,065	2,130	1,885	1,240
29A F	27.9	42.3	341	21.1	1,980	1.17	1,730	2,030	2,190	1,955	1,250
29B F	24.0	41.6	354	16.7	2,225	1.97	1,490	2,030	2,040	1,945	1,310
29C F	28.0	39.9	332	16.0	2,075	1.18	1,770	2,090	2,170	2,030	1,410
29D F	25.6	41.0	344	16.4	2,075	1.96	1,615	2,110	2,145	2,065	1,570
29 F	26.0	41.2	343	17.6	2,070	1.41	1,675	2,070	2,130	2,015	1,395
30A R	25.7	43.4	383	30.0	1,900	1.76	1,445	1,980	2,045	1,945	1,235
30B R	17.4	44.2	388	26.2	2,240	1.84	1,515	2,020	2,105	1,950	1,270
30C R	15.0	44.9	373	22.2	2,280	2.17	1,530	2,025	2,060	1,955	1,305
30 R	19.4	44.2	381	26.1	2,140	1.91	1,495	2,010	2,075	1,950	1,270
31 A	40.7	39.8	323	15.3	1,820	2.02	1,590	2,020	2,155	1,910	1,200
33 A	27.9	40.1	356	20.1	1,980	1.62	1,490	2,025	2,075	1,870	1,560
34C-H F	32.0	38.6	338	18.6	1,950	1.72	1,545	2,090	2,130	2,130	2,085
34I-N,T F	30.4	38.8	340	22.5	1,990	1.54	1,485	2,030	2,105	2,155	2,200
34O,P,R,S F	28.9	39.2	346	26.7	1,970	1.41	1,485	1,990	2,080	2,145	2,215
34Q F	26.4	39.9	351	30.8	2,000	1.33	1,465	1,980	2,085	2,135	2,205
34U F	32.4	40.6	329	19.6	1,920	1.62	1,475	1,925	1,990	2,140	2,235
34C-U F	30.6	39.1	340	21.9	1,980	1.57	1,500	2,025	2,090	2,140	2,170

TABLE 1. - Principal results on pilot-plant atmospheric gasifier 4, runs 4 through 34 - Cont.

Run No. (with basis calculating results)		Heat balance across gasifier, thousands of B.t.u./hr. Basis: 1 hour: Datum level: Steam at 60° F. Net heating value of coal	Sensible heat in process steam	Sensible heat in process oxygen	Sensible heat in coal	Total heat input	Net heating value of dry product gas	Sensible heat in dry product gas: At gasifier exit top of gasifier)	Sensible heat in dry product gas: At slag-tap exit	Sensible heat in unreacted steam: At gasifier exit	Sensible heat in unreacted steam: At slag-tap exit	Net heating value of combustibles in residue	Sensible heat in residue and gasifier slag: Residue entrained at gasifier exit	Sensible heat in residue and gasifier slag: Slag tapped from gasifier
1		41	42	43	44	45	46	47	48	49	50	51	52	53
4	A	5,668	126	1	-6	5,789	3,743	707	-	264	-	360	36	10
5	F	6,478	46	1	2	6,527	3,241	387	120	152	53	1,289	52	5
6	F	6,314	194	1	3	6,512	3,442	383	131	264	97	1,431	104	1
7	A	6,636	229	1	2	6,858	4,056	469	110	289	74	924	56	18
9	A	6,360	229	0	1	6,590	3,603	385	194	235	127	1,303	105	0
10	A	5,692	95	39	43	5,869	3,414	397	141	224	87	730	56	15
11	A	6,653	92	42	50	6,837	3,762	499	121	252	60	1,445	107	5
12	A	6,419	69	40	45	6,573	3,595	397	141	163	60	1,560	128	6
13	A	6,140	166	60	47	6,413	3,832	521	97	334	64	566	51	23
14A	F	5,902	116	51	43	6,112	3,727	468	125	257	74	659	59	5
14B	F	5,902	128	50	42	6,122	3,856	511	112	294	71	547	46	20
14C	F	5,902	142	50	42	6,136	3,847	548	98	347	63	526	50	16
14	A	5,902	128	50	42	6,122	3,854	530	108	295	69	529	53	14
15A	F	4,027	85	36	28	4,176	2,634	346	15	192	9	204	20	15
15B	F	4,027	94	36	28	4,185	2,572	349	30	224	21	174	19	12
15C	F	4,027	93	35	28	4,183	2,547	330	61	202	39	267	33	19
15	A	4,027	88	35	28	4,178	2,552	337	36	206	23	261	22	15
16A	F	5,679	98	47	38	5,862	3,778	486	111	192	47	524	52	17
16B	F	5,679	86	41	38	5,847	3,834	457	112	175	41	612	69	20
16	A	5,679	92	45	38	5,854	3,746	452	109	211	49	631	56	19
17	R	4,106	59	29	30	4,304	2,676	252	109	139	49	600	71	12
18	A	7,320	81	48	50	7,500	4,293	528	129	188	47	1,705	137	12
19A	F	4,365	72	34	34	4,505	2,571	229	64	106	29	732	20	12
19B	F	4,365	53	37	34	4,489	2,958	384	-	114	-	349	27	9
19C	F	4,365	72	38	33	4,508	2,618	312	110	138	50	502	38	9
19D	F	4,365	53	33	33	4,484	2,711	266	122	91	45	660	49	22
19	F	4,365	63	36	34	4,498	2,794	289	74	106	39	558	38	13
20A	F	4,402	72	36	32	4,542	2,662	264	128	128	64	712	49	16
20B	F	4,402	51	29	30	4,512	2,486	219	126	86	51	1,071	67	15
20C	F	4,402	53	34	30	4,519	2,774	283	109	94	43	713	51	13
20D	F	4,408	72	29	31	4,620	2,256	227	96	135	50	1,393	115	6
20	F	4,426	63	32	31	4,552	2,543	258	95	116	45	972	59	14
21	A	4,423	72	35	34	4,564	2,822	327	98	139	42	571	43	10
22A	F	6,791	84	47	51	6,973	3,817	437	140	185	60	1,626	107	10
22B	F	4,446	54	33	34	4,569	2,698	268	137	94	50	824	56	9
22C	F	7,003	89	54	53	7,199	4,545	489	212	151	67	955	82	11
22D	F	4,386	54	31	34	4,505	2,577	210	204	73	77	916	67	6
22E	F	4,386	54	33	34	4,507	2,659	284	121	105	44	863	72	8
22F	F	6,841	89	53	51	7,034	4,308	500	176	177	64	1,165	98	3
22G	F	6,841	87	49	51	7,028	4,056	577	26	219	10	1,417	121	2
22H	F	4,511	53	30	36	4,630	2,493	229	63	116	25	1,090	61	37
22A-H	F	5,657	70	41	43	5,811	3,377	379	134	139	50	1,113	93	10
22I	F	7,077	71	48	55	7,251	4,454	531	113	244	32	1,315	107	13
23A	F	7,476	76	58	50	7,660	5,173	572	158	141	43	869	74	33
23B	F	7,439	63	56	48	7,606	4,906	540	150	117	35	1,047	90	20
23C	F	7,439	83	61	50	7,633	4,919	568	136	149	38	1,201	105	20
23D	R	7,476	63	59	50	7,648	5,136	574	142	119	29	954	68	21
23E	F	7,775	64	58	51	7,948	5,076	582	150	122	28	1,367	142	26
23F	R	7,775	84	61	51	7,971	5,240	639	123	146	28	1,200	106	20
23G	R	7,751	80	57	52	7,940	5,096	602	152	147	30	1,293	153	30
23	F	7,540	74	59	54	7,727	5,075	574	145	140	37	1,187	104	24
24	F	7,714	46	52	53	7,869	4,754	507	112	99	23	1,551	111	32
25A	F	5,801	75	47	39	5,962	3,677	354	112	139	44	884	55	25
25B	F	4,832	52	37	36	4,957	3,140	292	106	89	33	763	44	21
25C	F	6,043	61	48	42	6,197	3,790	499	97	137	30	1,014	63	37
25D	F	6,648	74	53	45	6,820	4,542	535	108	145	28	758	63	26
25	F	5,922	68	59	47	6,090	3,951	422	109	124	33	729	51	26
26A	F	7,193	99	62	52	7,406	4,247	493	98	203	42	1,325	-	-
26B	F	7,193	76	56	52	7,377	4,263	495	101	169	37	1,322	-	-
26C	F	7,193	62	58	52	7,365	4,423	483	105	135	30	1,282	-	-
26D	F	5,994	95	51	44	6,184	3,737	497	93	241	48	748	-	-
26E	F	4,796	48	37	38	4,919	3,041	308	94	94	39	743	-	-
26	F	6,648	79	54	50	6,830	4,062	446	96	172	39	1,100	-	-
28A	R	4,836	55	34	35	4,960	2,985	263	163	89	58	907	56	8
28B	R	7,260	78	55	52	7,445	4,770	586	126	247	33	1,018	84	19
28C	R	4,860	84	40	30	5,022	2,897	319	130	170	72	934	70	4
28D	R	7,349	132	63	56	7,600	4,410	634	86	334	45	1,259	106	6
28	R	6,252	89	49	47	6,437	3,882	464	123	183	52	1,045	85	15
29A	F	7,362	77	52	53	7,544	4,530	627	103	162	32	1,264	100	19
29B	F	4,904	37	34	36	5,011	3,077	352	105	72	26	845	56	12
29C	F	7,374	51	44	52	7,521	4,783	636	97	135	34	1,225	98	18
29D	F	4,916	38	34	40	5,008	3,114	303	105	77	26	837	59	9
29	F	6,317	92	42	46	6,457	3,996	514	102	118	29	1,061	63	13
30A	R	5,036	61	33	34	5,164	2,978	366	134	113	55	864	55	7
30B	R	5,036	54	34	36	5,160	2,915	348	113	117	47	1,058	70	10
30C	R	5,036	46	33	39	5,154	2,867	342	152	92	57	1,201	81	6
30	R	5,036	54	33	35	5,159	2,920	354	133	107	53	1,048	68	8
31	A	5,061	37	34	37	5,169	3,308	402	143	57	25	716	53	13
33	A	5,559	45	32	42	5,678	3,611	358	101	104	30	793	42	23
34C-H	F	5,675	43	32	42	5,792	3,910	355	150	90	39	785	53	13
34I-N,T	F	5,720	57	35	43	5,645	3,726	365	120	112	38	801	51	19
34O,P,R,S	F	5,666	72	39	42	5,819	3,672	376	106	136	40	791	52	23
34Q	F	5,675	84	40	43	5,842	3,568	379	100	150	44	792	50	19
34U	F	5,682	47	32	42	5,703	3,605	343	104	91	29	973	62	18
34C-U	F	5,685	55	36	42	5,816	3,721	406	123	108	36	819	55	18

TABLE 1. - Principal results on pilot-plant atmospheric gasifier 4, runs 4 through 34 - Cont.

Run No. (with basis for calculating results)		Heat balance across gasifier - continued: Heat removed by coils at top of gasifier	Heat removed by gasifier support coil	Heat removed by gasifier burner water jackets	Heat removed by vertical and sloping shell coils	Radiation and convection loss from gasifier, shell: Primary reaction zone	Radiation and convection loss from gasifier, shell: Secondary reaction zone	Other heat losses including unaccounted for losses10/	Total heat output (equals heat input)	Thermal efficiency (heat of combustion of prod. gas, B.t.u. per 100 B.t.u. in coal charged), percent	Calculated heat loss through refr., thousands of B.t.u./hr.11/: Primary reaction zone	Calculated heat loss through refr., thousands of B.t.u./hr.11/: Secondary reaction zone	Total preheat, B.t.u./lb. coal charged12/	Total heat loss from gasification section, B.t.u./lb. coal charged13/
1		54	55	56	57	58	59	60	61	62	63	64	65	66
4	A	137	-	-	-	24	45	463	5,709	66.0	29	34	255	435
5	F	225	-	-	-	23	41	959	6,527	50.0	28	32	100	595
6	F	230	-	-	-	28	53	340	6,512	54.5	28	33	405	635
7	A	262	-	-	-	19	34	555	6,868	61.1	28	32	450	610
9	A	198	-	-	-	27	45	368	6,590	65.7	28	36	460	540
10	A	174	-	-	-	16	40	575	5,869	60.0	26	30	385	500
11	A	139	-	-	-	32	56	359	6,837	56.5	28	32	340	420
12	A	96	-	-	-	31	46	350	6,573	56.0	29	32	295	330
13	A	244	94	-	-	25	38	524	6,413	62.4	29	32	555	820
14A	F	191	95	-	-	22	31	309	6,112	63.1	27	31	445	720
14B	F	226	106	-	-	24	37	272	6,122	65.3	29	35	465	655
14C	F	210	102	-	-	24	39	266	6,136	65.2	30	35	500	795
14	A	209	101	-	-	23	35	300	6,122	65.3	29	35	465	830
15A	F	253	122	-	-	21	35	310	4,176	65.4	31	34	455	1,305
15B	F	207	123	-	-	24	41	389	4,185	63.9	31	36	480	1,175
15C	F	198	125	-	-	27	46	289	4,183	63.2	31	37	475	1,205
15	A	207	124	-	-	24	40	331	4,178	64.3	31	36	460	1,205
16A	F	253	111	-	-	25	42	224	5,862	66.5	30	34	395	930
16B	F	212	116	-	-	21	43	132	5,847	67.5	30	35	360	845
16	A	223	111	-	-	23	43	181	5,854	66.0	30	35	375	860
17	R	148	116	-	-	21	42	69	4,304	63.9	30	36	345	955
18	A	118	115	-	-	22	48	158	7,500	59.6	30	35	301	505
19A	F	101	87	-	-	24	36	392	4,505	61.2	29	30	395	700
19B	F	130	82	-	-	29	43	364	4,489	67.8	32	35	350	800
19C	F	139	65	-	-	33	53	241	4,508	64.6	32	37	405	815
19D	F	106	62	-	-	32	58	240	4,484	62.1	32	36	335	765
19	F	120	79	-	-	30	48	310	4,498	64.0	31	34	375	780
20A	F	79	119	-	-	29	52	140	4,542	60.5	31	34	390	1,060
20B	F	70	109	-	-	29	51	131	4,512	56.5	29	32	305	725
20C	F	75	125	-	-	33	56	150	4,519	63.0	31	34	325	805
20D	F	183	109	-	-	29	51	-39	4,620	50.3	29	33	360	1,020
20	F	129	119	-	-	30	52	120	4,552	57.5	32	33	350	915
21	A	143	80	-	-	9	38	242	4,564	63.8	29	35	395	745
22A	F	135	93	-	-	15	36	312	6,973	56.2	27	33	335	510
22B	F	155	101	-	-	12	41	124	4,569	60.7	28	34	340	865
22C	F	146	97	-	-	16	45	383	7,199	64.9	29	35	350	540
22D	F	18	97	-	-	18	46	196	4,505	58.8	29	37	340	510
22E	F	28	91	-	-	22	50	159	4,507	60.6	28	34	345	545
22F	F	152	100	-	-	19	48	284	7,034	63.0	29	35	350	580
22G	F	150	101	-	-	17	46	285	7,028	59.3	29	35	340	570
22H	F	75	99	-	-	15	47	250	4,630	55.3	28	35	330	655
22A-H	F	107	97	-	-	16	45	251	5,811	59.7	28	35	340	585
22I	F	58	99	-	-	21	50	314	7,251	62.9	29	34	305	400
23A	F	187	88	-	-	18	45	259	7,660	69.6	27	36	305	565
23B	F	231	108	-	-	35	69	260	7,606	65.9	26	36	280	740
23C	F	244	121	-	-	32	69	31	7,633	66.1	26	36	325	780
23D	F	160	118	-	-	22	54	251	7,648	68.7	27	36	285	590
23E	F	198	119	-	-	32	66	40	7,940	65.3	25	35	275	665
23F	R	183	118	-	-	31	66	72	7,971	67.4	28	33	325	640
23G	R	171	109	-	-	25	59	75	7,940	65.6	28	32	300	335
23	F	196	112	-	-	27	61	244	7,927	67.3	27	33	305	635
24	F	248	104	-	51	3	31	239	7,865	61.6	27	33	235	685
25A	F	241	99	-	53	3	34	232	5,962	63.4	27	35	335	900
25B	F	191	87	-	58	2	36	95	4,957	65.0	28	35	315	930
25C	F	195	100	-	61	2	36	136	6,197	62.7	28	37	310	790
25D	F	162	99	-	63	2	39	250	6,820	58.3	28	37	315	665
25	F	156	96	-	60	2	35	292	6,090	66.7	28	36	345	770
26A	F	302	114	-	64	2	35	471	7,406	59.0	26	29	360	905
26B	F	239	114	-	62	2	37	516	7,377	59.3	29	30	310	800
26C	F	235	116	-	88	2	37	429	7,365	61.5	28	31	290	805
26D	F	215	117	-	81	2	38	364	6,284	62.3	28	31	385	920
26E	F	73	115	-	85	2	39	286	4,919	63.4	28	32	310	795
26	F	223	114	-	84	2	36	456	6,830	61.0	28	30	330	835
28A	R	131	203	-	85	2	34	124	4,960	61.7	27	33	310	1,140
28B	R	115	201	-	96	2	39	219	7,445	65.7	27	34	310	740
28C	R	61	203	-	86	3	41	32	5,022	59.6	28	34	506	985
28D	R	185	205	-	78	3	44	205	7,600	60.0	28	34	420	860
28	R	126	203	-	86	3	40	130	6,437	62.1	28	34	360	895
29A	F	192	71	-	28	8	35	373	7,544	51.5	27	34	305	560
29B	F	158	72	-	44	6	40	144	5,011	62.7	28	35	270	600
29C	F	227	125	-	-	21	55	67	7,521	64.9	28	35	245	715
29D	F	173	119	-	-	38	71	17	5,028	63.3	28	35	280	1,000
29	F	190	97	-	18									
30A	R	202	113	-	69	6	41	141	5,164	59.1	27	44	315	1,065
30B	R	139	108	-	56	8	46	125	5,160	57.9	27	43	305	880
30C	R	233	86	-	73	10	50	-96	5,154	57.9	27	44	290	1,215
30	R	191	112	-	52	8	45	60	5,159	58.0	27	44	305	1,005
31	A	196	120	-	72	9	45	1	5,169	65.3	27	43	265	1,105
33	A	154	102	65	56	8	43	188	5,678	65.0	25	34	290	1,230
34C-H	F	145	136	71	65	13	46	21	5,792	67.1	28	48	250	1,020
34I-N,T	F	103	106	83	64	13	35	128	5,645	65.4	27	48	290	1,045
34O,P,R,S	F	134	104	85	72	8	36	185	5,819	64.8	26	46	335	950
34Q	F	180	100	78	80	9	35	118	5,842	64.6	26	48	365	1,035
34U	F	148	96	67	78	7	30	50	5,703	63.4	26	49	260	920
34C-U	F	157	114	77	68	9	35	68	5,816	65.5	27	49	285	985

Footnotes for Table 1

1/ F indicates that items in columns 16, 19, 30-34, 56-58, and 62 were calculated from (or based on) carbon balances using product-gas flow data, R indicates that these items were calculated using residue data, and A indicates average of flow and residue data. Except for a few runs were data were available for only one basis of calculation, the basis selected was the one that gave the best material balance, judged by the agreement between the reported coal requirement and the calculated coal requirement according to the following equation:

Lb. coal per 1,000 std. c.f. $(CO + H_2)$

$$= \frac{500\ (\text{lb. coal/lb. carbon})}{31.5\ f - \frac{\text{Std. } O_2}{\text{lb. carbon}} + 1/2\ \frac{\text{Std. net } H_2}{\text{lb. carbon}} - \frac{2\ \text{Std. } (CH_4)}{\text{lb. carbon}} - \frac{3\ \text{Std. } (C_2H_4)}{\text{lb. carbon}}}$$

where f = fraction of carbon in coal gasified and the other quantities are expressed per pound of carbon entering in the coal. Std. O_2 refers to process oxygen introduced (see footnote 3 below), Std. net H_2 refers to net hydrogen in the coal, and Std. CH_4 and Std. C_2H_4 are calculated from the product-gas output and analysis. The derivation of the above equation, and similar ones for oxygen and carbon requirements, may be obtained from the authors.

In those instances where a particular basis gives the best agreement for the majority of periods of a multiperiod run and reasonable agreement for the other periods, that basis has been used throughout the run. In runs 14, 15, and 16, where residues were not separated by periods, flow data have been used for the individual periods and the average data for the overall runs.

2/ The various reactant burners are discussed earlier, and their distinguishing characteristics are summarized in table 7.

3/ Process steam and process oxygen include only quantities metered as such and do not include moisture or combined water in coal or oxygen in coal. The oxygen is expressed on the 100.0 percent basis, calculated from 99.6 percent oxygen for the Cascade storage unit (runs 4 through 32) and 99.6 - 99.8 percent for the new oxygen plant (runs 33 and 34).

4/ The dry product gas output (column 16) and the product-gas analysis (columns 20-24) are as determined, without adjustment for inert feed gas with the coal or purge gas to the gasifier. Material-balance and heat-balance data (appearing later in this table) are based on the as-determined flows and analyses.

5/ The inert gas (column 17) consisted of about 12 percent CO_2 and 88 percent N_2 (from inert-gas generators) for runs 3 through 33, and about 98.5 percent N_2 (from the new oxygen plant) for run 34.

6/ The figures underlined (columns 27-29) indicate the basis selected (flow, residue, or average) for calculating test results. For example, as may be confirmed from column 1, average data were used for runs 4 and flow data for run 5.

7/ The steam decomposition is the average calculated from hydrogen and oxygen balances. The figures shown in column 30 were obtained by dividing the average steam-decomposition values (X 100) by the process-steam inputs of column 6.

8/ Since several assumptions have been used in calculating the residence time, the reported values should be regarded as only approximate.

9/ Columns 39 and 40 show the range of positions for thermocouples 9, 10, and 11. Thermocouple 9 was 1 inch from the inner face for runs 3 through 20, 1.5 inches for the next 3 runs, 3 inches for runs 24 through 30, and 4 inches for runs 31 through 34. Thermocouples 10 and 11 were 1 inch from the inner face through run 20, 3 inches for the next 5 runs, 5.5 inches for runs 26 through 30, and 8.5 inches for the last 4 runs. Thermocouple 6 was out of place (6.5 inches from the inner face) for runs 5 through 12, but thermocouple 5 (instead of the average) has been used as the standard for these runs.

10/ The unaccounted-for heat loss is determined by difference so that the heat output (column 61) will equal the heat input (column 45).

11/ The calculated heat loss through refractory (columns 63 and 64) is based on refractory temperatures and thermal conductivity of refractory.

12/ The total preheat to reactants, B.t.u. per pound of coal, is the sum of the preheats given in columns 42 through 44 divided by the coal input given in column 5.

13/ The total heat loss from the gasification section, B.t.u. per pound of coal, is the sum of the heat losses of columns 55 through 59, divided by the coal input of column 5.

Column 2 gives the date on which the run was made, columns 3 through 10 give run conditions, and columns 11 through 14 give input ratios - expressed per pound of raw coal and per pound of carbon in coal.

Column 15 shows temperatures indicated by thermocouple 13, located within the secondary reaction zone 8 inches below the bottom of the heat-trap coils. This thermocouple is considered of special significance because its temperatures are proportional to the theoretical product-gas outlet temperature, even though the thermocouple is affected by radiation from the reaction zones and radiation to the heat-trap coils.

Column 16 gives the output of dry product gas in thousands of standard cubic feet per hour on the as-determined basis, that is, without adjustment for inert gas used to convey coal to the gasifier or as purge gas at the slag-pot observation ports. Column 17 shows the inert-gas input so that a reader may adjust the product-gas output and analyses (columns 20 to 24) for all or part of the inert gas added. No adjustment has been made here since it is doubtful that the use of conveying gas would be entirely eliminated in a commercial-size process. Material-balance and heat-balance calculations are based on the as-determined (or unadjusted) flows and analyses. The useful output of synthesis gas ($CO + H_2$) is shown in column 19, the product-gas heating value in column 25, and the H_2-CO ratio in column 26.

The conversion of carbon in coal to gases is shown in columns 27 through 29, calculated from flow data, residue data, and average of flow and residue data, respectively, to indicate the degree of agreement by the three methods. The "standard" figure for each run is underlined.

The percentage of process steam decomposed, shown in column 30, is the average obtained from hydrogen and oxygen balances. A comparison of these results with those determined from the water vapor in the gas is given later. Columns 31 to 33 express the comparative economy of the process by showing the coal, process oxygen, and process steam requirements per thousand standard cubic feet of synthesis gas ($CO + H_2$). Column 34 shows computed equilibrium temperatures of the water-gas shift reaction, based on product-gas data of columns 16 and 20 to 24 and steam decomposition data of column 30, using Bureau of Standards equilibrium constants.[19]

Column 35 gives the residence time in the gasifier, calculated from the product-gas quantities in columns 16 and 18, a reactor volume averaging about 35 cubic feet, an outlet temperature proportional to (150° F. higher than that registered by) Thermocouple 13 (column 15), and an estimated temperature of 2,400° F. at the slag throat.

19/ Wagman, D. D., Kilpatrick, J. E., Taylor, W. J., Pilzer, K. S., Rossini, F. D., Heats, Free Energies and Equilibrium Constants of some Reactions Involving O_2, H_2, H_2O, C, CO, CO_2, and CH_4: Nat. Bureau of Standards Research Paper 1634, February 1945, 19 pp.