APPENDIX

Experimental data and calculated results of primary interest for runs 14, 15, 16, and 17 have been included in the Appendix, tables 16 through 19. Additional detailed experimental data and calculated results are available upon request from the Charles R. Robertson Lignite Research Laboratory, Grand Forks, N. Dak. A listing of summary tables that are available follows:

1. Analyses of product gas.
2. Proximate and ultimate analyses of lignites tested.
3. Size distribution of lignites tested.
4. Proximate and ultimate analyses of chars.
5. Size distribution of chars.
6. Retort static pressures.
7. Alloy-tube temperatures measured by optical pyrometer.
8. Temperatures of inner tube.
9. Rate of heat transfer through alloy tube wall.

TABLE 16. - Summary data on gasification of natural lignite, runs 14 through 17

Runs 14-A through 14-O

Run and period number	(1)	14-A	14-B	14-C	14-D	14-E	14-F	14-G	14-H	14-I	14-J	14-K	14-L	14-M	14-N	14-O
Date	(2)	5/3/50	5/5/50	5/7/50	5/10/50	5/12/50	5/14/50	5/16/50	5/18/50	5/20/50	5/22/50	5/24/50	5/26/50	5/28/50	5/30/50	5/1/50
Duration[1] hr.	(3)	21.8	24.0	23.6	22.0	23.6	23.9	22.7	24.0	23.3	24.0	24.3	24.6	22.6	23.9	23.6
Type lignite	(4)	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star
Lignite charged[2] lb. per hr.	(5)	489	464	506	512	506	515	510	507	487	503	485	480	501	504	505
Moisture as charged percent	(6)	36.0	36.8	35.2	35.5	36.4	36.2	36.3	36.0	35.8	35.5	36.1	35.7	35.1	34.4	34.6
Ash as charged do.	(7)	5.2	5.4	5.8	5.9	5.7	5.8	6.1	5.1	5.6	6.0	5.3	5.7	6.4	5.4	5.2
Carbon gasified do.	(8)	62.0	64.6	61.3	57.6	54.6	76.2	66.3	66.9	69.6	64.0	71.8	76.5	73.4	72.0	76.4
Lb. per M c. f. of gas (SCC)	(9)	50.7	48.8	51.5	55.9	49.1	40.4	46.7	42.1	44.1	47.6	41.6	39.7	40.4	40.3	38.3
Dry residue:	(10)															
Char out of bottom lb. per hr.	(11)	90.3	82.0	94.1	102.7	89.4	78.9	80.9	75.5	73.6	81.2	67.0	61.9	63.7	66.9	58.8
Blown over at gas offtake[3] do.	(12)	0.1	0.4	0.7	0.7	0.9	0.9	1.4	0.9	0.6	1.0	1.7	1.3	1.9	2.1	1.9
Dust with gas do.	(13)	0.4	0.4	0.6	1.4	0.9	1.3	0.9	0.8	0.8	1.3	1.1	0.9	1.2	1.3	1.1
Ash in total residue[4] percent	(14)	38.2	36.8	35.9	37.9	37.6	39.3	34.2	37.4	36.9	40.0	39.0	41.5	35.3	40.4	45.7
Gas made, SCC:[5]	(15)															
M c. f. per ton of natural lignite	(16)	39.5	41.0	38.8	37.1	40.7	45.1	42.8	44.0	45.1	49.1	48.1	50.4	49.5	49.6	52.3
M c. f. per hour from displacement meter	(17)	9.7	9.9	9.9	9.5	10.3	11.6	10.9	11.2	11.0	10.6	11.7	12.1	12.4	12.5	13.2
Gross heating value (calc.) B.t.u./cu. ft.	(18)	278	279	280	282	283	277	277	273	274	275	270	269	267	264	268
Net heating value (calc.)[6] do.	(19)	246	248	248	250	251	245	244	241	241	242	237	236	234	232	236
Specific gravity (calc.)[7]	(20)	0.557	0.554	0.554	0.556	0.552	0.555	0.553	0.557	0.554	0.556	0.555	0.554	0.554	0.553	0.549
Ratio H_2-CO	(21)	3.20	3.08	3.05	3.16	3.01	3.47	3.78	3.59	3.69	3.61	4.50	4.29	4.36	4.47	4.12
Process steam used:	(22)															
With lignite lb. per hr.	(23)	50	52	50	50	51	150	150	150	150	150	237	237	237	237	237
In char zone do.	(24)	150	150	150	150	150	165	165	165	165	165	288	288	288	288	288
Undecomposed steam[8] lb./M c.f. dry gas	(25)	22.9	21.0	24.1	23.9	21.4	26.3	28.7	27.7	26.7	25.6	31.4	30.5	37.3	37.3	29.2
Heating-system data:	(26)															
Wet B.t.u. used per cu. ft. product gas	(27)	136	135	132	135	130	129	128	122	127	130	126	124	121	118	116
Heat released[9] M B.t.u./(cu.ft.)(hr.)	(28)	11.1	11.6	11.4	11.2	11.7	12.1	12.1	11.9	12.2	11.9	12.8	13.1	13.2	12.9	13.6
Product gas used M c.f./hr.	(29)	5.4	5.4	5.3	5.2	5.3	5.8	5.7	5.7	5.8	5.7	6.2	6.4	6.4	6.4	6.6
CO_2 in SCC[10] percent	(30)	14.0	15.2	15.8	15.2	15.8	15.9	15.1	14.6	14.4	14.3	13.9	13.8	14.7	14.4	14.2
Primary air M c.f./hr.	(31)	13.5	13.2	13.1	13.1	13.3	14.2	14.2	14.0	14.9	13.9	15.1	15.4	15.5	15.5	16.0
SCC recirculated do.	(32)	29.6	29.8	30.5	31.5	31.2	29.4	30.6	28.6	29.3	28.9	28.9	28.3	27.7	27.9	27.5
Temperatures, °F.:	(33)															
Average combustion chamber[11]	(34)	1,783	1,770	1,769	1,726	1,777	1,779	1,725	1,741	1,756	1,732	1,732	1,757	1,746	1,729	1,781
Bottom of combustion chamber No. 1	(35)	1,750	1,840	1,841	1,842	1,925	1,925	1,842	1,841	1,840	1,752	1,750	1,841	1,841	1,810	1,926
Middle of combustion chamber.... 2	(36)	1,850	1,891	1,802	1,745	1,850	1,849	1,750	1,901	1,851	1,850	1,851	1,919	1,800	1,750	1,851
Top of combustion chamber..... 3	(37)	1,781	1,791	1,806	1,711	1,733	1,727	1,703	1,720	1,731	1,725	1,729	1,736	1,720	1,732	1,748
Outlet from combustion chamber.. 4	(38)	1,596	1,590	1,599	1,601	1,599	1,600	1,601	1,600	1,590	1,598	1,601	1,598	1,595	1,595	1,601
Inlet to fan 5	(39)	886	880	883	884	882	882	881	879	878	878	877	873	872	872	870
Air and PGC to recuperator 7	(40)	631	628	634	645	637	615	622	606	602	614	589	577	570	568	564
Air and PGC to furnace 8	(41)	1,285	1,273	1,275	1,273	1,270	1,272	1,271	1,272	1,271	1,274	1,267	1,268	1,267	1,265	1,266
Steam 5a	(42)	664	550	651	653	646	615	611	614	527	613	588	587	586	594	595
Gas leaving offtake 9	(43)	1,160	1,183	1,159	1,145	1,164	1,164	1,143	1,165	1,180	1,162	1,158	1,160	1,159	1,159	1,173
Gas leaving retort 12	(44)	650	641	633	623	638	675	671	678	691	670	709	712	714	712	725
Steam supply for process[12]	(45)	246	246	248	247	247	246	246	244	244	244	258	260	261	261	261
Superheated steam fed with lignite 17	(46)	500	483	501	445	483	577	576	575	576	575	585	582	587	586	585
Superheated steam to char zone[13]	(47)	1,067	1,065	1,056	1,051	1,064	1,058	1,048	1,053	1,059	1,044	992	962	965	964	979
Inner tube opposite A[14]	(48)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inner tube opposite D	(49)	1,056	1,080	1,040	1,014	1,048	1,063	1,053	1,066	1,090	1,066	1,079	1,082	1,083	1,005	1,095
Inner tube opposite F	(50)	767	756	743	676	795	733	720	732	769	736	737	727	727	793	815
Inner tube opposite G[14]	(51)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Center of inner tube opposite A[15]	(52)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Center of inner tube opposite G[15]	(53)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

See footnotes at end of table.

TABLE 16. - Summary data on gasification of natural lignite, runs 14 through 17 (Con.)

Runs 15-A through 16-G

Run and period number	(1)	15-A	15-B	15-C	15-D	15-E	15-F	15-G	15-H	16-A	16-B	16-C	16-D	16-E	16-F	16-G
Date	(2)	11/11/50	11/13/50	11/15/50	11/17/50	11/19/50	11/21/50	11/23/50	11/25/50	4/23/51	4/25/51	4/27/51	4/29/51	5/1/51	5/3/51	5/5/51
Duration[1] hr.	(3)	25.2	23.8	24.4	23.5	23.7	23.9	24.3	24.3	23.6	24.3	24.8	24.0	24.5	23.4	22.4
Type lignite	(4)	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star
Lignite charged[2] lb. per hr.	(5)	478	566	638	627	593	624	591	668	454	540	681	637	537	427	440
Moisture as charged percent	(6)	36.3	35.5	36.9	36.7	35.2	34.2	35.1	36.4	36.6	37.2	37.6	36.8	36.8	35.8	35.8
Ash as charged do.	(7)	5.1	5.8	5.5	6.4	5.7	7.0	5.5	6.3	6.2	5.7	5.7	5.6	5.6	5.5	5.8
Carbon gasified do.	(8)	72.0	67.6	69.9	65.0	61.0	58.6	47.7	47.2	61.9	78.1	68.3	66.5	66.7	75.5	73.0
Lb. per M c. f. of gas (SCG)	(9)	43.9	46.4	48.5	49.4	52.9	55.3	57.2	68.9	30.6	42.2	48.3	48.2	46.9	41.7	40.5
Dry residue:	(10)															
Char out of bottom lb. per hr.	(11)	70.5	91.3	103.7	110.6	115.1	120.0	149.7	172.1	53.0	71.5	113.2	111.6	88.8	66.9	68.8
Blown over at gas offtake[3] do.	(12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dust with gas do.	(13)	0.4	0.7	1.2	1.1	0.9	0.9	1.0	0.6	0.1	0.8	1.1	1.0	0.5	0.2	1.1
Ash in total residue[4] percent	(14)	43.1	37.8	36.7	33.6	32.6	31.2	22.3	26.4	68.0	58.3	40.9	41.3	44.5	54.2	39.2
Gas made, SCG:[2]	(15)															
M c. f. per ton of natural lignite	(16)	45.6	43.1	41.4	40.5	37.3	36.2	25.8	29.0	51.2	47.4	41.4	41.5	42.6	46.0	49.4
M c. f. per hour from displacement meter	(17)	10.9	12.2	13.2	12.7	11.2	11.1	8.8	9.7	11.6	12.8	14.1	13.2	11.4	10.2	10.9
Gross heating value (calc.) B.t.u./cu.ft.	(18)	289	290	289	294	294	300	306	301	285	287	287	284	288	269	269
Net heating value (calc.)[6] do.	(19)	257	257	257	262	262	268	274	268	254	254	255	255	252	236	236
Specific gravity (calc.)[7]	(20)	0.538	0.541	0.539	0.533	0.542	0.539	0.536	0.538	0.539	0.533	0.534	0.550	0.543	0.545	0.555
Ratio H_2-CO	(21)	2.54	2.76	2.93	2.77	2.52	2.40	2.06	2.36	2.41	2.53	2.60	2.82	2.86	2.52	4.64
Process steam used:	(22)															
With lignite lb. per hr.	(23)	180	220	250	190	130	60	-	-	185	225	260	260	225	185	420
In char zone do.	(24)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undecomposed steam[8] lb./M c.f. dry gas	(25)	13.9	16.7	18.7	15.2	12.9	12.0	8.8	11.2	10.8	13.8	18.0	19.6	17.9	14.7	31.3
Heating-system data:	(26)															
Net B.t.u. used per cu. ft. product gas	(27)	132	127	124	126	137	138	156	150	126	125	125	123	128	132	119
Heat released[9] M B.t.u./(cu.ft.)(hr.)	(28)	12.5	13.4	14.2	14.3	13.4	13.3	12.0	12.7	12.7	13.9	15.3	14.1	12.7	11.8	11.2
Product gas used M c.f./hr.	(29)	5.6	6.0	6.4	6.2	5.9	5.7	5.0	5.4	5.8	6.3	6.9	6.4	5.8	5.3	5.5
CO_2 in POC[10] percent	(30)	13.5	14.2	15.6	15.9	15.4	14.9	15.2	16.0	14.9	16.0	15.7	16.9	15.5	14.9	14.7
Primary air M c.f./hr.	(31)	13.2	14.0	14.7	15.1	14.4	14.1	12.6	13.5	14.2	15.4	16.7	15.7	14.2	13.2	13.6
POC recirculated do.	(32)	26.0	25.3	26.7	26.7	28.2	28.0	31.6	30.1	29.1	27.5	26.3	27.4	28.5	29.5	32.7
Temperatures, °F.:	(33)															
Average combustion chamber[11]	(34)	1,776	1,780	1,775	1,762	1,700	1,780	1,780	1,782	1,780	1,768	1,765	1,727	1,727	1,720	1,621
Bottom of combustion chamber No. 1	(35)	1,922	1,924	1,924	1,925	1,925	1,925	1,924	1,927	1,926	1,924	1,926	1,651	1,945	1,850	1,747
Middle of combustion chamber 2	(36)	1,852	1,853	1,850	1,850	1,850	1,849	1,848	1,851	1,901	1,899	1,897	1,856	1,855	1,851	1,765
Top of combustion chamber 3	(37)	1,735	1,742	1,730	1,755	1,747	1,744	1,749	1,750	1,692	1,650	1,634	1,602	1,598	1,579	1,545
Outlet from combustion chamber 4	(38)	1,538	1,530	1,602	1,599	1,600	1,604	1,599	1,600	1,601	1,600	1,602	1,598	1,605	1,593	1,427
Inlet to fan 5	(39)	893	878	881	884	859	875	874	870	876	877	855	868	869	880	813
Air and POC to recuperator 7	(40)	608	582	577	570	575	580	615	599	645	631	598	624	639	652	685
Air and POC to furnace 8	(41)	1,287	1,290	1,287	1,265	1,255	1,273	1,243	1,255	1,275	1,266	1,256	1,258	1,280	1,130	1,130
Stack 50	(42)	628	624	620	617	624	637	648	665	607	603	581	568	565	604	513
Gas leaving offtake 9	(43)	1,262	1,269	1,318	1,299	1,278	1,282	1,273	1,239	1,237	1,220	1,165	1,163	1,178	1,229	1,160
Gas leaving retort 12	(44)	723	735	727	718	710	701	675	615	735	734	720	715	708	742	735
Steam supply for process[12]	(45)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Superheated steam fed with lignite 17	(46)	567	585	585	572	596	502	-	-	565	569	556	557	538	561	517
Superheated steam to char zone[13]	(47)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inner tube opposite A[14]	(48)	1,223	1,209	1,218	1,201	1,210	1,223	1,214	1,150	1,232	1,225	1,192	1,186	1,181	1,235	1,171
Inner tube opposite D	(49)	1,099	1,023	1,023	977	1,010	1,028	1,000	846	1,107	1,135	1,114	1,101	1,091	1,146	1,091
Inner tube opposite F	(50)	865	770	744	731	735	735	728	624	1,005	976	920	899	913	1,015	945
Inner tube opposite G[14]	(51)	752	680	654	641	645	637	635	533	847	802	719	698	762	869	804
Center of inner tube opposite A[15]	(52)	-	-	-	-	-	-	-	-	1,235	1,234	1,199	1,191	1,199	1,240	1,172
Center of inner tube opposite G[15]	(53)	-	-	-	-	-	-	-	-	940	921	871	874	899	959	911

See footnotes at end of table.

TABLE 16. - Summary data on gasification of natural lignite, runs 1A through 17 (Con.)

Runs 16-H through 17-J

Run and period number:	(1)	16-H	16-I	16-J	16-K	16-L	17-A	17-B	17-C	17-D	17-E	17-F	17-G	17-H	17-I	17-J
Date	(2)	5/8/51	5/10/51	5/12/51	5/14/51	5/15/51	8/14/51	8/16/51	8/9/51	8/21/51	8/24/51	8/25/51	8/31/51	9/2/51	9/4/51	9/6/51
Duration1/ hr.	(3)	24.2	23.4	24.9	24.0	24.1	23.5	24.3	24.6	22.4	23.6	24.2	24.6	16.6	23.7	15.4
Type lignite	(4)	Baukol-Noonan	Baukol-Noonan	Baukol-Noonan	Baukol-Noonan	Baukol-Noonan	Kincaid	Kincaid	Baukol-Noonan	Baukol-Noonan	Zap	Zap	Beulah	Beulah	Dickinson	Dickinson
Lignite charged2/ lb. per hr.	(5)	309	343	536	663	586	483	552	431	556	436	542	464	589	437	555
Moisture as charged percent	(6)	33.4	34.6	35.4	36.2	35.2	35.2	34.2	35.4	36.8	35.0	35.0	35.2	35.8	40.6	37.6
Ash as charged do.	(7)	7.5	7.1	7.2	5.8	5.6	6.2	5.9	7.0	6.9	6.7	5.6	9.7	8.4	7.3	7.6
Carbon gasified do.	(8)	79.3	65.2	60.3	54.0	68.4	86.1	79.4	82.4	75.7	80.2	74.1	66.5	60.7	56.8	58.2
Lb. per M c. f. of gas (DGS)	(9)	37.6	46.8	51.3	56.7	46.0	36.3	38.6	38.4	42.4	38.6	42.1	49.2	52.1	52.1	48.1
Dry residue:	(10)															
Char out of bottom lb. per hr.	(11)	47.7	90.0	117.4	199.0	108.2	56.9	76.0	58.8	97.9	94.0	83.7	97.5	115.5	78.9	117.8
Blown over at gas offtake2/ do.	(12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dust with gas do.	(13)	0.4	0.7	1.8	2.1	1.5	0.6	0.5	0.4	1.0	0.3	0.6	0.6	1.1	0.6	1.0
Ash in total residue4/ percent	(14)	49.2	40.4	39.1	25.6	29.4	63.3	51.5	60.3	41.4	49.7	42.9	44.4	42.9	46.2	38.2
Gas made, DGS:3/	(15)															
M c. f. per ton of natural lignite	(16)	53.2	42.8	39.0	35.3	41.7	55.2	51.8	52.0	47.2	51.9	48.7	43.7	38.4	38.4	34.4
M c. f. per hour from displacement meter	(17)	8.2	9.5	10.5	11.7	12.3	13.3	14.3	11.2	13.1	11.3	13.2	9.5	10.1	8.4	9.5
Gross heating value (calc.) B.t.u./cu.ft.	(18)	289	285	286	286	288	289	289	290	285	282	282	274	273	275	277
Net heating value (calc.)5/ do.	(19)	236	252	253	253	256	256	258	258	253	251	250	242	241	242	244
Specific gravity (calc.)7/	(20)	0.548	0.544	0.542	0.541	0.533	0.538	0.531	0.528	0.551	0.540	0.542	0.552	0.558	0.556	0.562
Ratio H_2-CO	(21)	4.39	3.05	3.40	3.11	2.66	2.12	2.27	2.36	2.63	2.59	2.72	3.38	3.02	3.71	3.99
Process steam used:	(22)															
With lignite lb. per hr.	(23)	270	186	235	330	250	203	237	189	237	196	242	198	238	169	193
In char zone do.	(24)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undecomposed steam6/ lb./M c.f. dry gas	(25)	26.5	16.6	27.9	24.1	17.3	10.2	11.2	12.3	15.1	13.5	15.0	14.7	20.6	23.5	25.0
Heating-system data:	(26)															
Net B.t.u. used per cu. ft. product gas	(27)	134	133	-33	130	132	115	115	135	123	124	118	132	131	142	137
Heat released2/ M B.t.u./(cu.ft.)(hr.)	(28)	9.6	11.0	12.1	13.8	14.0	13.3	14.3	13.1	14.0	12.2	13.5	11.0	11.6	10.3	12.5
Product gas used M c.f./hr.	(29)	4.7	5.0	5.5	6.0	6.3	5.9	6.4	5.6	6.4	5.6	6.2	5.5	4.9	5.3	5.3
CO_2 in POC8/ percent	(30)	12.9	14.2	15.8	16.0	15.7	17.0	15.1	14.7	15.8	15.9	16.4	14.7	14.2	15.0	15.6
Primary air M c.f./hr.	(31)	12.0	12.7	13.8	14.8	15.8	14.5	15.5	13.8	15.3	14.2	15.5	13.5	14.1	12.6	13.7
POC recirculated do.	(32)	33.8	30.7	30.0	29.6	29.1	27.7	27.5	28.0	27.9	29.1	27.3	29.4	28.5	29.7	28.5
Temperatures, °F.:	(33)															
Average combustion chamber11/	(34)	1,668	1,752	1,750	1,744	1,763	1,780	1,783	1,787	1,786	1,794	1,732	1,769	1,789	1,732	1,793
Bottom of combustion chamber No. 1	(35)	1,750	1,850	1,852	1,850	1,921	1,924	1,923	1,924	1,921	1,926	1,925	1,923	1,924	1,926	1,925
Middle of combustion chamber 2	(36)	1,778	1,851	1,851	1,846	1,851	1,900	1,893	1,900	1,898	1,902	1,899	1,898	1,899	1,900	1,900
Top of combustion chamber 3	(37)	1,558	1,707	1,695	1,682	1,719	1,715	1,724	1,718	1,748	1,741	1,735	1,732	1,738	1,748	1,745
Outlet from combustion chamber 4	(38)	1,033	1,599	1,600	1,599	1,600	1,600	1,597	1,600	1,598	1,599	1,601	1,601	1,600	1,600	1,601
Inlet to fan 5	(39)	829	870	865	860	858	875	876	877	852	849	847	863	867	868	868
Air and POC to recuperator 7	(40)	643	660	638	625	620	586	576	583	577	563	572	580	584	586	580
Air and POC to furnace 8	(41)	1,145	1,272	1,263	1,263	1,262	1,277	1,265	1,282	1,249	1,237	1,241	1,257	1,259	1,259	1,257
Stack 9	(42)	536	579	561	574	577	618	600	614	577	570	570	581	582	587	586
Gas leaving offtake 9	(43)	1,776	1,189	1,152	1,105	1,176	1,302	1,297	1,305	1,263	1,201	1,219	1,213	1,191	1,235	1,198
Gas leaving recuperator 10	(44)	719	729	704	719	741	744	740	737	722	726	743	695	702	704	704
Steam supply for process12/	(45)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Superheated steam fed with lignite 37	(46)	536	555	554	564	565	589	585	577	564	543	550	551	567	549	559
Superheated steam to char zone13/	(47)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inner tube opposite A14/	(48)	1,169	1,191	1,193	1,180	1,181	1,252	1,245	1,270	1,217	1,224	1,212	1,164	1,141	1,183	1,141
Inner tube opposite D	(49)	1,008	1,056	1,061	1,034	1,037	1,120	1,104	1,145	1,047	1,125	1,081	1,029	984	1,035	967
Inner tube opposite F	(50)	946	930	870	805	698	877	844	880	779	805	801	785	731	805	715
Inner tube opposite G14/	(51)	809	775	701	634	698	767	740	772	686	755	700	698	659	701	627
Center of inner tube opposite A15/	(52)	1,174	1,197	1,167	1,132	1,191	1,267	1,251	1,279	1,229	1,232	1,226	1,185	1,179	1,209	1,177
Center of inner tube opposite G15/	(53)	984	916	879	835	880	945	931	950	890	940	921	875	865	897	859

See footnotes at end of table.

TABLE 16. - Summary data on gasification of natural lignite, runs 14 through 17 (Con.)

Runs 17-K_2 through 17-O

Run and period number	(1)	17-K_2	17-L	17-M	17-N	17-O
Date	(2)	9/9/51	9/11/51	9/14/51	9/16/51	9/19/51
Duration[1/] hr.	(3)	20.2	22.0	23.3	24.0	25.2
Type lignite	(4)	Custer	Custer	Dienfait	Dienfait	Kincaid
Lignite charged[2/] lb. per hr.	(5)	446	556	452	542	434
Moisture as charged percent	(6)	40.0	40.4	36.6	35.0	34.6
Ash as charged do.	(7)	4.5	4.2	4.9	5.7	7.0
Carbon gasified do.	(8)	72.3	68.4	68.1	65.6	76.6
Lb. per M c. f. of gas (SGG)	(9)	45.1	47.0	43.7	46.0	39.5
Dry residue:	(10)					
Char out of bottom lb. per hr.	(11)	60.9	81.0	76.9	99.3	60.4
Blown over at gas offtake[3/] do.	(12)	-	-	-	-	-
Dust with gas do.	(13)	0.5	0.8	0.7	0.7	0.6
Ash in total residue[4/] percent	(14)	45.6	34.3	35.9	35.3	40.4
Gas made, SGG:[5/]	(15)					
M c. f. per ton of natural lignite	(16)	44.1	42.5	45.8	43.5	50.6
M c. f. per hour from displacement meter	(17)	9.9	12.0	10.3	11.8	11.0
Gross heating value (calc.) B.t.u./cu.ft.	(18)	280	280	283	285	281
Net heating value (calc.)[6/] do.	(19)	248	248	250	252	252
Specific gravity (calc.)[7/]	(20)	0.545	0.547	0.539	0.542	0.538
Ratio H_2-CO	(21)	3.10	3.17	3.13	3.30	2.81
Process steam used:	(22)					
With lignite lb. per hr.	(23)	199	198	188	240	223
In char zone do.	(24)	-	-	-	-	-
Undecomposed steam[8/] lb./M c.f. dry gas	(25)	15.6	17.2	16.2	18.2	18.5
Heating-system data:	(26)					
Net B. t. u. used per cu. ft. product gas	(27)	128	120	127	128	124
Heat released[9/] M B.t.u./(cu.ft.)(hr.)	(28)	11.0	12.6	11.4	13.5	11.9
Product gas used M c.f./hr.	(29)	5.2	5.8	5.3	5.7	5.4
CO_2 in POC[10/] percent	(30)	14.8	16.1	15.1	16.6	15.7
Primary air M c.f./hr.	(31)	12.9	14.6	13.7	14.2	13.4
POC recirculated do.	(32)	27.9	26.6	29.1	27.7	28.3
Temperatures, °F.:	(33)					
Average combustion chamber[11/]	(34)	1,793	1,789	1,790	1,794	1,792
Bottom of combustion chamber No. 1	(35)	1,924	1,923	1,926	1,925	1,925
Middle of combustion chamber.... 2	(36)	1,899	1,901	1,898	1,899	1,900
Top of combustion chamber 3	(37)	1,746	1,731	1,736	1,752	1,742
Outlet from combustion chamber.. 4	(38)	1,601	1,600	1,600	1,600	1,600
Inlet to fan 5	(39)	874	862	868	861	862
Air and POC to recuperator 7	(40)	591	577	597	590	584
Air and POC to furnace 8	(41)	1,258	1,258	1,260	1,251	1,247
Stack 5a	(42)	521	520	521	572	561
Gas leaving offtake 9	(43)	1,217	1,205	1,207	1,250	1,229
Gas leaving retort 10	(44)	737	716	716	721	732
Steam supply for process[12/]	(45)	-	-	-	-	-
Superheated steam fed with lignite 17	(46)	553	550	552	562	544
Superheated steam to char zone[13/]	(47)	-	-	-	-	-
Inner tube opposite A[14/]	(48)	1,184	1,165	1,172	1,197	1,184
Inner tube opposite D	(49)	1,058	986	1,039	996	1,082
Inner tube opposite F	(50)	756	601	758	692	823
Inner tube opposite G[14/]	(51)	649	993	943	588	600
Center of inner tube opposite A[15/]	(52)	1,195	1,182	1,186	1,175	1,201
Center of inner tube opposite G[15/]	(53)	897	870	906	880	936

Footnotes

1/ The testing periods were nominally for 24 hours, but some runs, as indicated, were actually for slightly longer or shorter periods.

2/ Representative lignite samples consisting of approximately 3 percent of total weight charged were taken for each official period.

3/ Run 14 was only run in which divided annulus was used and blowover dust could be measured.

4/ These figures are the percentage ash in a representative sample of total residue as determined by ASTM methods at the Pittsburgh laboratory; no correction has been made for sulfates or carbonates retained in ash during analysis.

5/ Gas volume measured by displacement meter; standard gas conditions, saturated gas at 60° F. and 30 inches of mercury.

6/ Calculated net B.t.u. determined by deducting 9/11ths of total hydrogen times 45.5 from calculated gross B.t.u.

7/ Specific gravity was calculated from average gas analysis.

8/ Dry gas, 60° F. and 30 inches of mercury.

9/ This figure is based upon a furnace volume of 115 cu. ft. and the net heating value of the gas.

10/ Carbon dioxide percentage is average value taken from record chart of Republic meter.

11/ Average of points No. 1, 2, 3, and 4.

12/ Temperature of process steam not measured when continuous annulus was used during runs 15, 16, and 17.

13/ All process steam added with lignite when continuous annulus was used during runs 15, 16, and 17.

14/ Temperature at this point not measured before run 15.

15/ Temperature at this point not measured before run 16.

TABLE 17. - Experimental data and calculations converted to moisture- and ash-free basis, runs 14 through 17

Run and period	(1)	14-A	14-B	14-C	14-D	14-E	14-F	14-G	14-H	14-I	14-J	14-K	14-L	14-M
Type lignite	(2)	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star
Lignite charged ..... lb./hr.	(3)	288	280	296	300	293	299	294	299	287	294	286	283	293
Carbon gasified ..... percent	(4)	62.0	65.6	61.3	57.6	64.8	70.2	66.0	66.9	69.6	64.0	71.8	76.5	73.4
Gas made:[1]														
M c. f. per hour	(5)	9.5	9.8	9.7	9.3	10.1	11.4	10.7	11.0	10.8	10.4	11.5	12.0	12.2
M c. f. per ton of lignite	(6)	66.0	70.3	65.8	62.2	69.2	76.2	73.0	73.4	76.4	70.6	80.2	84.6	83.2
Dry residue:														
Out at bottom ..... lb./hr.	(7)	58.8	50.3	59.0	72.8	51.2	44.3	54.0	48.3	45.0	47.3	39.7	35.6	37.4
With gas[2] ..... do.	(8)	0.3	0.5	0.8	1.5	1.1	1.3	1.6	1.0	0.8	1.3	1.7	1.3	1.8
Process steam used:														
With lignite ..... lb./lb. lignite	(9)	0.17	0.19	0.17	0.17	0.17	0.50	0.51	0.50	0.52	0.51	0.83	0.84	0.81
In char zone ..... do.	(10)	0.52	0.54	0.51	0.50	0.51	0.55	0.56	0.55	0.57	0.56	1.01	1.02	0.98
Moisture + water of formation[3] ..... do.	(11)	0.87	0.89	0.87	0.84	0.88	0.88	0.87	0.86	0.86	0.85	0.87	0.87	0.84
Total water vapor:[4] do.	(12)	1.56	1.61	1.55	1.51	1.56	1.93	1.94	1.91	1.96	1.92	2.70	2.72	2.63
lb./M c.f. of gas	(13)	47.4	45.9	47.1	48.6	45.2	50.3	53.1	52.1	51.8	54.5	67.4	64.3	63.2
Undecomposed steam: lb./lb. lignite	(14)	0.76	0.74	0.79	0.74	0.74	1.01	1.05	1.02	1.01	1.05	1.66	1.63	1.55
mol/mol of gas	(15)	0.48	0.44	0.51	0.50	0.45	0.56	0.60	0.58	0.56	0.62	0.87	0.81	0.78
mol/mol of carbon gasified	(16)	1.16	1.06	1.22	1.20	1.07	1.33	1.47	1.42	1.38	1.52	2.18	2.02	1.99
Hydrogen ..... M c.f./ton of lignite	(17)	37.2	39.6	37.0	34.8	38.9	43.7	42.2	42.2	44.2	40.7	47.2	49.7	48.9
(H_2 + CO) ..... do.	(18)	48.8	52.4	48.4	45.9	51.9	56.2	53.4	53.9	56.2	51.3	57.8	61.3	60.2

Run and period	(1)	14-N	14-O	15-A	15-B	15-C	15-D	15-E	15-F	15-G	15-H	16-A	16-B	16-C
Type lignite	(2)	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Dakota Star
Lignite charged ..... lb./hr.	(3)	303	304	280	332	368	357	344	361	351	383	260	308	386
Carbon gasified ..... percent	(4)	72.0	76.4	72.0	67.6	65.9	65.0	61.0	58.6	47.7	47.2	81.9	75.1	68.3
Gas made:[1]														
M c. f. per hour	(5)	12.3	13.0	10.7	12.0	12.9	12.5	11.0	10.9	8.7	9.5	11.4	12.6	13.9
M c. f. per ton of lignite	(6)	81.0	85.4	76.8	72.1	70.3	70.0	63.9	60.5	49.4	49.7	88.0	81.6	71.8
Dry residue:														
Out at bottom ..... lb./hr.	(7)	38.7	30.9	39.8	55.9	65.0	72.8	76.5	81.6	115.7	126.0	16.7	29.3	65.9
With gas[2] ..... do.	(8)	2.1	1.6	0.2	0.5	0.7	0.8	0.6	0.6	0.7	0.5	0.1	0.4	0.7
Process steam used:														
With lignite ..... lb./lb. lignite	(9)	0.78	0.78	0.64	0.66	0.68	0.53	0.38	0.17	-	-	0.71	0.74	0.67
In char zone ..... do.	(10)	0.95	0.95	-	-	-	-	-	-	-	-	-	-	-
Moisture + water of formation[3] ..... do.	(11)	0.83	0.83	0.86	0.84	0.87	0.88	0.86	0.81	0.83	0.87	0.88	0.91	0.93
Total water vapor:[4] do.	(12)	2.56	2.56	1.50	1.50	1.55	1.41	1.24	0.98	0.83	0.87	1.59	1.66	1.60
lb./M c.f. of gas	(13)	63.3	59.9	39.3	41.7	44.2	40.2	38.8	32.4	33.5	34.9	36.2	40.6	44.6
Undecomposed steam: lb./lb. lignite	(14)	1.55	1.50	0.53	0.60	0.66	0.53	0.41	0.36	0.22	0.27	0.48	0.56	0.65
mol/mol of gas	(15)	0.78	0.74	0.29	0.35	0.39	0.32	0.27	0.25	0.18	0.23	0.23	0.29	0.38
mol/mol of carbon gasified	(16)	2.00	1.86	0.69	0.82	0.94	0.76	0.63	0.58	0.42	0.54	0.55	0.70	0.90
Hydrogen ..... M c.f./ton of lignite	(17)	47.8	50.3	43.2	41.0	40.4	40.1	35.7	33.5	26.7	27.6	49.3	46.3	40.6
(H_2 + CO) ..... do.	(18)	58.4	62.5	60.2	55.8	54.2	54.6	49.9	47.5	39.6	39.3	69.8	64.5	56.3

See footnotes at end of table.

TABLE 17. - Experimental data and calculations converted to moisture- and ash-free basis, runs 14 through 17 (Con.)

Run and period	(1)	Runs 16-D through 17-C											
		16-D	16-E	16-F	16-G	16-H	16-I	16-J	16-K	16-L	17-A	17-B	17-C
Type lignite	(2)	Dakota Star	Dakota Star	Dakota Star	Dakota Star	Baukol-Noonan	Baukol-Noonan	Baukol-Noonan	Baukol-Noonan	Baukol-Noonan	Kincaid	Kincaid	Baukol-Noonan
Lignite charged, lb./hr.	(3)	367	309	251	257	283	257	308	388	349	285	331	244
Carbon gasified, percent	(4)	66.5	66.7	75.5	73.0	75.3	65.2	60.3	54.0	63.4	86.4	79.4	82.4
Gas made: 1/													
M c. f. per hour	(5)	13.0	11.2	10.1	10.7	8.1	9.3	10.3	11.5	12.1	13.1	14.1	11.0
M c. f. per ton of lignite	(6)	70.7	72.7	80.2	83.0	88.4	72.5	66.8	59.2	69.2	92.4	84.9	90.3
Dry residue:													
Out at bottom, lb./hr.	(7)	64.6	48.6	50.2	41.1	23.9	53.1	75.0	116.9	75.3	20.4	36.4	22.9
With gas 2/, do.	(8)	0.6	0.2	0.1	0.6	0.2	0.4	0.1	1.3	0.9	0.2	0.2	0.1
Process steam used:													
With lignite, lb./lb. lignite	(9)	0.71	0.73	0.74	1.62	1.48	0.72	0.76	0.64	0.72	0.72	0.72	0.78
In char zone, do.	(10)	-	-	-	-	-	-	-	-	-	-	-	-
Moisture + water of formation 3/, do.	(11)	0.89	0.86	0.85	0.85	0.79	0.82	0.84	0.86	0.84	0.85	0.82	0.87
Total water vapor: 4/, do.	(12)	1.60	1.61	1.59	2.49	2.27	1.54	1.60	1.51	1.55	1.56	1.53	1.65
Undecomposed steam: lb./M c.f. of gas	(13)	45.3	44.3	39.7	59.9	51.4	42.6	48.0	30.9	44.9	33.8	36.1	36.5
lb./lb. lignite	(14)	0.69	0.65	0.59	1.30	1.17	0.60	0.77	0.71	0.60	0.47	0.48	0.56
mol/mol of gas	(15)	0.41	0.38	0.31	0.66	0.56	0.35	0.48	0.51	0.36	0.21	0.24	0.26
mol/mol of carbon gasified	(16)	0.98	0.91	0.73	1.66	1.42	0.85	1.16	1.23	0.88	0.51	0.56	0.62
Hydrogen, M c.f./ton of lignite	(17)	40.2	41.2	44.9	49.6	51.8	40.9	38.1	33.7	39.4	50.7	47.6	51.0
(H_2 + CO), do.	(18)	54.5	55.6	62.1	60.4	63.8	54.4	49.4	44.5	54.2	74.6	68.6	72.5

Run and period	(1)	Runs 17-D through 17-O											
		17-D	17-E	17-F	17-G_3	17-H	17-I	17-J	17-K_2	17-L	17-M	17-N	17-O
Type lignite	(2)	Baukol-Noonan	Zap	Zap	Beulah	Beulah	Dickinson	Dickinson	Custer	Custer	Bienfait	Bienfait	Kincaid
Lignite charged, lb./hr.	(3)	313	254	332	256	295	228	301	248	314	264	321	253
Carbon gasified, percent	(4)	73.7	80.2	74.1	56.5	60.7	66.8	58.2	72.3	68.4	68.4	65.0	76.6
Gas made: 1/													
M c.f. per hour	(5)	12.9	11.1	13.0	9.3	10.0	8.2	9.3	9.7	11.8	10.2	11.6	10.8
M c. f. per ton of lignite	(5)	82.4	87.5	80.6	72.6	67.5	72.3	62.0	78.4	75.3	77.0	72.1	85.4
Dry residue:													
Out at bottom, lb./hr.	(7)	56.5	31.7	47.7	53.1	64.6	40.8	71.7	32.7	52.6	48.7	66.4	32.9
With gas 2/, do.	(8)	0.6	0.2	0.4	0.3	0.6	0.3	0.6	0.3	0.6	0.4	0.4	0.4
Process steam used:													
With lignite, lb./lb. lignite	(9)	0.76	0.78	0.75	0.77	0.79	0.74	0.66	0.63	0.63	0.71	0.75	0.88
In char zone, do.	(10)	-	-	-	-	-	-	-	-	-	-	-	-
Moisture + water of formation 3/, do.	(11)	0.88	0.83	0.83	0.86	0.87	1.01	0.92	0.97	0.98	0.86	0.82	0.83
Total water vapor: 4/, do.	(12)	1.64	1.61	1.58	1.63	1.66	1.75	1.58	1.60	1.61	1.57	1.57	1.71
Undecomposed steam: lb./M c.f. of gas	(13)	39.8	36.8	39.2	45.0	49.1	27.7	30.9	40.7	42.7	40.8	43.5	40.1
lb./lb. lignite	(14)	0.62	0.59	0.60	0.53	0.70	0.85	0.90	0.61	0.65	0.62	0.66	0.62
mol/mol of gas	(15)	0.32	0.28	0.32	0.31	0.44	0.49	0.61	0.33	0.36	0.34	0.38	0.30
mol/mol of carbon gasified	(16)	0.78	0.68	0.76	0.74	1.07	1.21	1.47	0.80	0.89	0.84	0.95	0.74
Hydrogen, M c.f./ton of lignite	(17)	47.1	49.3	45.5	40.9	38.7	41.3	35.3	44.7	42.9	44.0	41.4	49.2
(H_2 + CO), do.	(18)	63.8	68.4	62.3	53.0	48.6	52.4	44.3	59.1	56.5	58.1	53.9	66.7

1/ Gas measured dry at 60° F. and 30 inches of mercury.
2/ Residue with gas includes blowover dust, sump residue, and dust with waste water.
3/ Calculated from oxygen and equivalent hydrogen from ultimate analysis.
4/ Includes process steam, moisture, and water of formation.

TABLE 18. - Material balances for runs 14 through 17 1/

Runs 14-A through 14-O

Run and period	14-A		14-B		14-C		14-E		14-E		14-F		14-G		14-H		14-I		14-J		14-K		14-L		14-M		14-N		14-O	
	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent
Material in:																														
Natural lignite, as charged	489	68.0	488	67.6	509	68.9	512	69.0	506	68.7	515	59.9	370	59.7	507	59.5	487	58.5	303	59.3	485	46.6	482	46.5	501	47.4	504	47.6	506	47.7
Process steam	200	27.8	202	28.2	200	27.1	203	27.6	201	27.3	315	36.6	215	36.8	315	37.0	315	37.9	215	37.2	525	50.5	505	50.6	525	49.7	525	49.6	525	49.5
Purge gas 2/	30	4.2	30	4.2	30	4.0	30	4.0	30	4.0	30	3.5	30	3.5	30	3.5	30	3.6	30	3.5	30	2.9	30	2.9	30	2.9	30	2.8	30	2.8
Total in	719	100.0	720	100.0	739	100.0	742	100.0	737	100.0	860	100.0	655	100.0	852	100.0	832	100.0	548	100.0	1040	100.0	1037	100.0	1056	100.0	1059	100.0	1061	100.0
Material out:																														
Char and dusts	91	12.7	83	11.6	96	13.0	105	14.2	86	11.7	77	9.0	63	9.7	81	9.5	75	9.0	84	9.9	70	6.7	60	6.2	57	6.3	71	6.7	58	5.8
Undecomposed steam	217	30.2	207	28.9	234	31.7	223	30.1	217	29.4	305	35.2	206	36.1	301	35.7	290	34.9	307	36.2	474	45.6	460	44.4	455	43.1	458	43.3	458	43.2
Product gas	405	56.5	418	58.4	406	54.9	398	53.6	428	58.1	480	56.5	455	53.2	469	55.0	461	55.4	443	52.2	486	46.9	508	49.0	518	49.1	521	49.2	547	51.6
Total out 3/	714	99.4	708	98.9	736	99.6	726	97.9	731	99.2	866	100.7	846	99.0	854	100.2	826	99.3	834	98.3	1030	99.2	1030	99.6	1040	98.5	1050	99.2	1057	100.6

Runs 15-A through 15-H

	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent
Material in:																		
Natural lignite, as charged	478	69.5	566	69.4	598	69.5	627	74.0	593	78.7	614	87.2	391	95.2	668	95.7		
Process steam	180	26.2	220	27.0	250	27.2	190	22.4	130	17.3	60	8.5	-	-	-	-		
Purge gas 2/	30	4.3	30	3.6	30	3.3	30	3.6	30	4.0	30	4.3	30	4.8	30	4.3		
Total in	688	100.0	816	100.0	919	100.0	847	100.0	753	100.0	704	100.0	621	100.0	698	100.0		
Material out:																		
Char and dusts	70.9	10.3	92.0	11.3	104.9	11.4	111.9	13.2	116.0	15.4	120.9	17.2	150.7	24.3	172.7	24.7		
Undecomposed steam	149.4	21.7	200.0	24.5	241.6	26.3	189.9	22.4	142.1	18.9	131.0	18.6	76.3	12.3	105.6	15.1		
Product gas	443.6	64.5	497.2	60.9	534.4	58.2	510.9	60.3	427.9	56.8	451.3	64.1	356.4	57.4	389.8	55.8		
Total out 3/	663.9	96.5	789.2	96.7	880.9	95.9	812.7	95.9	716	95.1	703.2	99.9	583.4	94.0	668.1	95.6		

Runs 16-A through 16-L

Run and period	16-A		16-B		16-C		16-D		16-E		16-F		16-G		16-H		16-I		16-J		16-K		16-L	
	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent
Material in:																								
Natural lignite, as charged	151	67.9	540	67.5	681	70.1	636	68.7	537	67.8	427	66.5	440	69.4	309	50.7	445	67.3	535	66.9	663	70.3	589	67.8
Process steam	165	27.6	225	28.3	260	26.8	260	28.1	225	28.4	165	28.8	120	47.9	270	44.3	185	28.1	235	29.5	250	25.5	250	28.8
Purge gas 2/	30	4.5	30	3.8	30	3.1	30	3.2	30	3.8	30	4.7	30	5.0	30	5.0	30	4.6	30	3.8	30	3.2	30	3.4
Total in	509	100.0	795	100.0	971	100.0	926	100.0	792	100.0	642	100.0	590	100.0	609	100.0	658	100.0	801	100.0	943	100.0	869	100.0
Material out:																								
Char and dusts	53	8.0	72	9.1	110	11.6	113	12.1	89	11.3	67	10.4	70	7.6	48	7.9	91	13.8	110	58.2	162	50.6	110	12.6
Undecomposed steam	165	18.4	175	21.8	250	25.7	255	27.5	202	25.5	148	23.0	336	37.5	214	35.1	154	23.4	235	29.4	277	29.4	205	24.0
Product gas	109	73.0	514	64.7	588	58.2	547	59.1	469	59.2	420	65.5	454	51.0	339	55.7	388	59.0	419	54.6	477	47.4	498	56.7
Total out 3/	345	98.4	759	95.6	932	96.0	915	98.7	760	96.0	635	98.9	860	96.3	601	98.7	633	96.2	773	96.4	915	97.1	812	93.3

Runs 17-A through 17-O

Run and period	17-A		17-B		17-C		17-D		17-E		17-F		17-G		17-H		17-I		17-J		17-K		17-L		17-M		17-N		17-O	
	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent	Pound	Percent
Material in:																														
Natural lignite, as charged	483	67.4	552	67.0	435	66.3	556	67.6	436	65.7	582	66.7	464	67.1	528	66.8	437	68.7	553	70.8	446	70.7	566	71.3	492	67.5	542	66.7	434	53.2
Process steam	203	28.3	237	28.9	189	28.1	237	28.8	198	29.8	232	28.6	198	28.6	232	29.4	169	26.6	198	25.4	155	24.5	198	24.9	188	25.8	240	29.5	223	32.4
Purge gas 2/	30	4.2	30	3.7	30	4.6	30	3.6	30	4.5	30	3.7	30	4.3	30	3.8	30	4.7	30	3.8	30	4.8	30	3.8	30	4.2	30	3.7	30	4.4
Total in	716	100.0	819	100.0	650	100.0	823	100.0	664	100.0	813	100.0	692	100.0	790	100.0	636	100.0	781	100.0	631	100.0	794	100.0	670	100.0	812	100.0	687	100.0
Material out:																														
Char and dusts	58	8.1	76	9.3	59	9.0	97	12.0	61	9.6	81	10.3	98	14.2	117	14.8	79	12.4	119	15.2	61	9.7	82	10.3	78	11.6	100	12.3	61	8.9
Undecomposed steam	134	18.7	157	19.2	121	19.1	191	23.6	150	22.6	191	23.9	137	19.8	207	26.2	194	30.5	271	34.7	150	24.1	201	25.7	151	24.5	210	25.9	156	22.7
Product gas	540	75.4	572	69.8	447	68.8	525	63.8	460	69.3	539	66.3	401	57.9	427	54.0	352	55.4	403	52.0	407	64.5	495	62.5	420	62.7	491	59.2	441	64.2
Total out 3/	732	102.2	805	98.3	630	96.9	813	99.4	671	101.5	811	100.5	636	91.9	751	95.0	625	98.3	793	101.9	620	98.3	788	98.5	649	98.8	791	97.4	658	95.8

1/ Hourly basis, material entering and leaving mine-fan.
2/ Calculated as an average 30 lb./hr.
3/ Percent of total input.

TABLE 19. - Heat balances for runs 14 through 17[1/]

Run and period	14-A		14-B		14-C		14-D		14-E		14-F		14-G		14-H	
	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent
Heat in:																
Potential heat, natural lignite, as charged	3,419	65.5	3,315	64.5	3,551	67.4	3,616	68.0	3,488	66.5	3,386	64.4	3,535	64.4	3,586	65.1
Potential heat, product gas used	1,557	29.5	1,506	29.7	1,473	28.0	1,453	27.4	1,513	28.8	1,509	28.9	1,584	28.8	1,550	28.2
Sensible and latent heat in process steam[2/]	228	4.4	230	4.5	226	4.3	228	4.3	229	4.4	358	6.4	358	6.5	358	6.5
Sensible heat in purge gas, air, lignite and product gas used[3/]	15	.3	15	.3	15	.3	15	.3	15	.3	15	.3	15	.3	15	.3
Total in	5,219	100.0	5,066	100.0	5,267	100.0	5,312	100.0	5,245	100.0	5,550	100.0	5,492	100.0	5,509	100.0
Heat out:																
Potential heat, product gas	2,684	51.4	2,768	54.7	2,661	52.6	2,680	50.5	2,814	55.5	3,218	57.6	3,024	55.1	3,047	55.3
Potential heat, char and dusts	900	17.4	785	15.4	888	17.6	1,134	21.4	820	15.8	712	12.8	842	15.3	762	13.8
Sensible and latent heat, undecomposed steam[2/]	289	5.5	274	5.4	311	6.2	300	5.6	287	5.5	406	7.3	414	7.5	409	7.4
Sensible heat, char and dusts[4/]	21	.4	19	.4	22	.4	25	.5	20	.4	18	.3	20	.4	19	.3
Sensible heat, product gas, dry	116	2.2	117	2.3	116	2.2	120	2.3	120	2.3	146	2.6	137	2.5	142	2.6
Sensible heat, stack gas, dry	166	3.2	153	3.0	151	2.9	152	2.9	153	2.9	155	2.7	152	2.9	152	2.8
Sensible and latent heat, water in stack gas	236	4.5	236	4.7	234	4.4	229	4.3	235	4.5	254	4.6	252	4.6	247	4.4
Radiation, convection, and unaccounted for	807	15.4	716	14.1	734	14.0	672	12.5	690	13.1	661	11.9	651	11.8	731	13.4
Total out	5,219	100.0	5,066	100.0	5,267	100.0	5,312	100.0	5,245	100.0	5,508	100.0	5,492	100.0	5,509	100.0

Run and period	14-I		14-J		14-K		14-L		14-M		14-N		14-O	
	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent
Heat in:														
Potential heat, natural lignite, as charged	3,416	63.5	3,538	64.7	3,454	59.9	3,400	59.4	3,520	60.2	3,623	61.2	3,621	60.3
Potential heat, product gas used	1,535	28.5	1,550	28.4	1,677	29.3	1,712	29.0	1,710	29.2	1,684	28.4	1,772	29.5
Sensible and latent heat in process steam[2/]	356	6.7	358	6.6	601	10.5	601	10.4	601	10.3	601	10.1	602	10.0
Sensible heat in purge gas, air, lignite and product gas used[3/]	15	.3	15	.3	15	.3	15	.3	15	.3	15	.3	11	.2
Total in	5,378	100.0	5,466	100.0	5,727	100.0	5,728	100.0	5,846	100.0	5,923	100.0	6,009	100.0
Heat out:														
Potential heat, product gas	3,025	56.3	2,906	53.2	3,148	55.0	3,272	57.1	3,314	56.7	3,288	55.7	3,502	58.9
Potential heat, char and dusts	702	13.1	772	14.1	633	11.1	565	9.9	604	10.3	614	10.4	496	8.3
Sensible and latent heat, undecomposed steam[2/]	395	7.3	415	7.6	645	11.3	627	10.9	620	10.6	624	10.5	626	10.4
Sensible heat, char and dusts[4/]	18	.3	19	.3	16	.3	15	.3	16	.3	17	.3	14	.2
Sensible heat, product gas, dry	143	2.7	130	2.4	157	2.7	151	2.9	168	2.9	168	2.8	180	3.0
Sensible heat, stack gas, dry	160	3.0	140	2.6	156	2.7	158	2.8	160	2.7	162	2.7	167	2.8
Sensible and latent heat, water in stack gas	255	4.7	249	4.5	270	4.7	278	4.8	279	4.8	279	4.7	288	4.8
Radiation, convection, and unaccounted for	679	12.6	852	15.3	702	12.2	649	11.3	684	11.7	762	12.9	696	11.6
Total out	5,379	100.0	5,486	100.0	5,727	100.0	5,778	100.0	5,846	100.0	5,923	100.0	6,009	100.0

Run and period	15-A		15-B		15-C		15-D		15-E		15-F		15-G		15-H	
	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent
Heat in:																
Potential heat, natural lignite, as charged	3,375	64.8	4,024	66.7	4,440	67.4	4,358	68.0	4,151	68.6	4,390	71.0	4,643	73.3	4,663	71.0
Potential heat, product gas used	1,640	31.0	1,749	28.9	1,850	28.1	1,823	28.4	1,733	28.7	1,710	27.7	1,530	26.1	1,625	25.8
Sensible and latent heat in process steam[2/]	205	3.9	251	4.2	285	4.3	217	3.4	148	2.5	68	1.1	(5)	-	(5)	-
Sensible heat in purge gas, air, lignite and product gas used[3/]	15	.3	15	.2	15	.2	15	.2	15	.2	15	.2	15	.3	15	.2
Total in	5,213	100.0	6,039	100.0	6,590	100.0	6,413	100.0	6,049	100.0	6,183	100.0	5,788	100.0	6,303	100.0
Heat out:																
Potential heat, product gas	3,150	60.4	3,538	58.7	3,825	57.9	3,734	58.2	3,293	54.5	3,330	53.8	2,693	46.5	2,920	46.3
Potential heat, char and dusts	668	12.9	926	15.4	1,060	16.1	1,250	19.5	1,219	20.2	1,305	21.1	1,758	30.4	1,943	30.8
Sensible and latent heat, undecomposed steam[2/]	204	3.9	275	4.6	332	5.0	259	4.0	193	3.2	179	2.9	102	1.8	139	2.2
Sensible heat, char and dusts[4/]	17	.3	21	0.3	25	.4	26	.4	27	.4	29	.5	35	.6	47	.7
Sensible heat, product gas, dry	145	2.8	167	2.8	177	2.7	169	2.6	146	2.4	145	2.3	107	1.8	107	1.7
Sensible heat, stack gas, dry	147	2.8	154	2.6	161	2.4	161	2.5	159	2.6	158	2.6	145	2.5	159	2.5
Sensible and latent heat, water in stack gas	241	4.6	262	4.3	282	4.3	279	4.3	257	4.2	249	4.0	216	3.7	220	3.5
Radiation, convection, and unaccounted for	641	12.3	681	11.3	739	11.2	540	8.5	715	11.5	780	12.8	732	12.7	774	12.3
Total out	5,213	100.0	6,039	100.0	6,590	100.0	6,413	100.0	6,049	100.0	6,183	100.0	5,788	100.0	6,308	100.0

[1/] See footnotes at end of table.

TABLE 19. - Heat balances for runs 14 through 17[1/] (Con.)

Run and period	16-A		16-B		16-C		16-D		16-E		16-F	
	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent
Heat in:												
Potential heat, natural lignite, as charged	3,164	62.9	3,744	64.6	4,670	67.1	4,446	67.5	3,738	66.0	3,027	63.4
Potential heat, product gas used	1,639	32.5	1,797	30.9	1,581	28.4	1,838	27.8	1,650	29.2	1,520	31.8
Sensible and latent heat in process steam[2/]	212	4.2	257	4.4	297	4.3	297	4.5	257	4.5	211	4.4
Sensible heat in purge gas, air, lignite and product gas used[3/]	15	.3	15	.3	15	.2	15	.2	15	.3	15	.3
Total in	5,030	100.0	5,813	100.0	6,963	100.0	6,598	100.0	5,660	100.0	4,773	100.0
Heat out:												
Potential heat, product gas	3,255	64.7	3,583	61.6	3,976	57.1	3,722	56.5	3,192	56.4	2,891	60.6
Potential heat, char and dusts	348	6.8	544	9.4	1,074	15.4	1,005	15.3	796	14.1	534	11.2
Sensible and latent heat, undecomposed steam[2/]	169	3.4	238	4.1	341	4.9	347	5.3	274	4.8	203	4.3
Sensible heat, char and dusts[4/]	13	.3	17	.3	26	.4	25	.4	21	.4	16	.3
Sensible heat, product gas, dry	156	3.1	158	2.7	186	2.7	154	2.5	150	2.7	141	3.0
Sensible heat, stack gas, dry	155	3.1	165	2.8	173	2.5	158	2.4	142	2.5	143	3.0
Sensible and latent heat, water in stack gas	241	4.8	268	4.6	292	4.2	266	4.0	240	4.2	226	4.7
Radiation, convection, and unaccounted for	697	13.8	840	14.5	895	12.8	901	13.6	846	14.9	619	12.9
Total out	5,030	100.0	5,813	100.0	6,963	100.0	6,589	100.0	5,660	100.0	4,773	100.0

Run and period	16-G		16-H		16-I		16-J		16-K		16-L	
	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent
Heat in:												
Potential heat, natural lignite, as charged	3,106	61.2	2,280	59.1	3,185	65.9	3,822	67.4	4,774	70.3	4,276	67.0
Potential heat, product gas used	1,472	29.0	1,255	32.5	1,423	29.4	1,568	27.6	1,717	25.3	1,804	28.3
Sensible and latent heat in process steam[2/]	478	9.5	308	8.0	211	4.4	268	4.7	285	4.2	285	4.5
Sensible heat in purge gas, air, lignite and product gas used[3/]	15	.3	15	.4	15	.3	15	.3	15	.2	15	.2
Total in	5,071	100.0	3,858	100.0	4,834	100.0	5,673	100.0	6,791	100.0	6,380	100.0
Heat out:												
Potential heat, product gas	2,875	56.7	2,172	56.3	2,652	54.8	2,942	51.9	3,281	48.3	3,469	54.4
Potential heat, char and dusts	627	12.4	371	9.6	853	17.7	1,162	20.5	1,745	25.7	1,132	17.7
Sensible and latent heat, undecomposed steam[2/]	458	9.0	291	7.6	215	4.4	321	5.7	379	5.6	287	4.5
Sensible heat, char and dusts[4/]	17	.3	11	.3	22	.5	28	.5	38	.6	26	.4
Sensible heat, product gas, dry	151	3.0	111	2.9	129	2.7	142	2.5	156	2.3	166	2.6
Sensible heat, stack gas, dry	121	2.4	112	2.9	130	2.7	135	2.4	150	2.2	161	2.5
Sensible and latent heat, water in stack gas	234	4.6	202	5.2	217	4.4	240	4.2	262	3.9	268	4.2
Radiation, convection, and unaccounted for	588	11.6	588	15.2	620	12.8	703	12.3	781	11.4	869	13.7
Total out	5,071	100.0	3,858	100.0	4,834	100.0	5,673	100.0	6,791	100.0	6,380	100.0

See footnotes at end of table.

TABLE 19. - Heat balances for runs 14 through 17[1] (Con.)

Run and period	17-A		17-B		17-C		17-D		17-E		17-F		17-G		17-H	
Heat in:	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent
Potential heat, natural lignite, as charged	3,429	63.7	3,980	65.1	2,955	61.8	3,853	64.6	3,091	62.9	3,875	65.5	3,086	64.9	3,534	66.5
Potential heat, product gas used	1,705	31.7	1,850	30.2	1,624	33.5	1,824	30.6	1,579	32.2	1,748	29.6	1,425	30.0	1,502	28.2
Sensible and latent heat in process steam[2]	232	4.3	271	4.4	216	4.4	271	4.5	227	4.6	276	4.6	227	4.8	265	5.0
Sensible heat in purge gas, air, lignite and product gas used[3]	15	.3	15	.3	15	.3	15	.3	15	.3	15	.3	15	.3	15	.3
Total in	5,381	100.0	6,116	100.0	4,850	100.0	5,963	100.0	4,912	100.0	5,914	100.0	4,753	100.0	5,316	100.0
Heat out:																
Potential heat, product gas	3,844	71.4	4,133	67.6	3,248	67.0	3,734	62.6	3,187	64.9	3,722	62.9	2,603	54.8	2,757	51.9
Potential heat, char and dusts	325	6.0	555	9.1	361	7.4	841	14.1	529	10.8	770	13.0	852	17.9	1,021	19.2
Sensible and latent heat, undecomposed steam[2]	184	3.4	217	3.5	170	3.5	266	4.5	206	4.2	268	4.5	185	3.9	283	5.3
Sensible heat, char and dusts[4]	14	.3	18	.3	14	.3	23	.4	15	.3	20	.3	23	.5	27	.5
Sensible heat, product gas, dry	181	3.4	193	3.2	150	3.1	174	2.9	150	3.1	182	3.1	122	2.6	131	2.5
Sensible heat, stack gas, dry	159	2.9	164	2.7	149	3.1	153	2.6	141	2.9	155	2.7	138	2.9	144	2.7
Sensible and latent heat, water in stack gas	240	4.5	253	4.3	235	4.8	267	4.4	218	4.4	262	4.4	221	4.6	237	4.4
Radiation, convection, and unaccounted for	434	8.1	573	9.3	525	10.8	505	8.5	466	9.4	535	9.1	609	12.8	716	13.5
Total out	5,381	100.0	6,116	100.0	4,850	100.0	5,963	100.0	4,912	100.0	5,914	100.0	4,753	100.0	5,316	100.0

Run and period	17-I		17-J		17-K		17-L		17-M		17-N		17-O	
Heat in:	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent	B.t.u., thousands	Percent
Potential heat, natural lignite, as charged	2,748	63.8	3,600	67.8	2,961	64.6	3,764	66.9	3,241	65.3	3,946	67.3	3,068	63.0
Potential heat, product gas used	1,348	31.4	1,468	27.6	1,428	31.2	1,624	28.8	1,495	30.1	1,625	27.7	1,534	31.5
Sensible and latent heat in process steam[2]	193	4.5	227	4.3	177	3.9	227	4.0	215	4.3	275	4.7	255	5.2
Sensible heat in purge gas, air, lignite and product gas used[3]	15	.3	15	.3	15	.3	15	.3	15	.3	15	.3	15	.3
Total in	4,296	100.0	5,310	100.0	4,581	100.0	5,630	100.0	4,966	100.0	5,861	100.0	4,872	100.0
Heat out:														
Potential heat, product gas	2,310	53.8	2,632	49.6	2,772	60.5	3,360	59.7	2,905	58.5	3,363	57.4	3,124	64.1
Potential heat, char and dusts	762	17.7	1,230	23.2	450	9.8	790	14.0	735	14.8	982	16.1	486	10.0
Sensible and latent heat, undecomposed steam[2]	262	6.1	367	6.9	205	4.5	277	4.9	223	4.5	288	4.9	215	4.4
Sensible heat, char and dusts[4]	19	.4	26	.5	14	.3	19	.3	18	.4	22	.4	14	.3
Sensible heat, product gas, dry	109	2.5	125	2.4	128	2.8	159	2.8	137	2.8	158	2.7	149	3.1
Sensible heat, stack gas, dry	130	3.0	140	2.6	139	3.0	151	2.7	135	2.7	140	2.4	130	2.7
Sensible and latent heat, water in stack gas	213	5.0	232	4.4	220	4.9	253	4.5	228	4.6	247	4.2	228	4.7
Radiation, convection, and unaccounted for	492	11.5	556	10.4	653	14.3	621	11.1	585	11.7	699	11.9	526	10.7
Total out	4,296	100.0	5,310	100.0	4,581	100.0	5,630	100.0	4,966	100.0	5,861	100.0	4,872	100.0

1/ Gross heat basis, hourly average and above 60° F.
2/ Calculated as 1,020 - 0.48 t. B.t.u. per lb.; temperature of process steam in °F. Process steam temperature taken as 250° F. for runs 15, 16, and 17.
3/ Approximate figure of 15,000 B.t.u. per hr. used.
4/ Temperature of char assumed at 1,000° F.
5/ No process steam added.

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