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USSR COAL INDUSTRY EXPERIMENTS WITH GASIFICATION OF COAL

PECHORA BASIN

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Moscow, Za Ekonomiyu Topliva, No 4, Apr 51

The first attempts to gasify Pechora basin coals in ordinary semimechanized gas generators were unsuccessful because the coals used for the experiments had highly caking properties. A better acquaintanceship with the coals of the region led to the discovery of certain ones among them which were well adapted to gasification. These included long-flame coal. Supporting evidence has been assembled as a result of experiments performed in VNIIT (All-Union Scientific Research Institute of Fuel Utilization) in an enlarged laboratory installation.

This installation consisted of a gas generator and a condensation system to separate out and determine the moisture and resin content of the gas. The gas generator was a well insulated shaft with an inner diameter of 200 millimeters. The condensation system consisted of two independently operating lines, each with a cyclone, the first having a tubular cooler to bring the temperature of the gas down to 50-60 degrees Centigrade and an electric filter to separate out the resin, and the second having a tubular cooler to reduce the temperature of the gas to 15-18 degrees Centigrade. At the start of operations in the gas generator, the products of gasification were conducted along one line of the condensation system and then, when a steady rate of operation had been achieved, the gas was directed along the second line.

Samples of coal taken from five different sections were selected for tests in the laboratory gas generator. These sections were located as follows: Seam XI, Mine No 1; Seam X, same mine; Seam V, Mine No 2; Seam IX, Mine No 5; Seam VIII, Mine No 10. Each sample, weighing about 2 tons, was selected from current mining; in all cases, the coal taken consisted of lumps more than 15-20 millimeters in size.

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A technical analysis of the coal according to different mines and seams is given in Table 1. Material from other sources is also included for purposes of comparison. The coal selected for the experiments was in no way different from ordinary coal shipped to consumers. All estimates indicated a high ash content in the coal.

Table 1

	Seam XI, Mine No 1	Seam X, Mine No 1	Coal from Seam V, Mine No 2	Seam VIII, Mine No 10	Seam IX, Mine No 5
Technical analysis of coal					
Based on samples taken during experiments, %					
Moisture	7.48	7.34	8.08	8.45	7.9
Ash	30.9	31.6	20.4	25.5	22.9
Sulfur	3.64	3.98	1.79	3.63	3.27
Volatile substances	37.9	39.6	37.8	34.8	32.6
Based on data from other sources (including OTK* data), %					
Ash	33.7	28.1	24.5	28.5	25.5
Sulfur	3.34	3.16	1.67	2.53	3.44
Volatile substances	41.4	40.6	38.4	39.5	38.7
Element content of coal (disregarding sulfur), %					
H^g	5.07	4.88	4.93	5.20	5.38
C^g	73.7	76.2	75.7	74.5	76.4
N^g	2.34	2.06	1.94	1.93	1.90
O^g	18.89	16.86	17.43	18.37	16.32
Q^g_b, kcal/kg	7,325.00	7,440.00	7,168.00	7,455.00	7,617.00
Q^r_n, kcal/kg	4,365.00	4,406.00	4,952.00	4,759.00	5,063.00
Content of dry mass, %					
Semicoke	81.0	80.0	81.0	81.7	78.8
Resin	7.75	7.32	8.1	10.1	10.7
Moisture	4.3	5.56	5.72	5.21	3.0
Gas, lit/kg	45.06	61.36	52.06	51.0	56.37
Analysis of gas, %					
CO_2	29.49	30.45	21.66	27.17	25.53
C_nH_m	2.96	2.85	2.75	2.95	3.54
CO	9.46	9.25	12.71	9.84	10.32
H_2	10.89	11.45	13.71	10.46	11.06
CH_4	39.35	38.65	40.71	37.51	39.74
C_2H_6	6.49	7.14	7.31	8.48	7.93
N_2	1.36	0.21	1.15	3.59	1.88
Q, kcal/kg	5,339.00	5,367.00	5,712.00	5,479.00	5,671.00
Mineral content of ash, %					
SiO_2	45.9	46.72	47.34	52.2	51.8
CaO	11.5	11.5	12.0	5.32	8.6
MgO	1.93	1.66	1.86	1.89	1.53
Fe_2O_3	11.66	13.69	9.18	14.49	13.98
Al_2O_3	16.99	18.11	22.12	21.35	19.14
SO_3	11.32	7.87	7.17	4.53	4.95

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Table 1 (Contd)

	Seam XI, Mine No 1	Seam X, Mine No 1	Coal from Seam V, Mine No 2	Seam VIII, Mine No 10	Seam IX, Mine No 5
Fusibility of ash					
t_1	1,050	1,090	1,110	1,115	1,075
t_2	1,135	1,180	1,180	1,210	1,185
t_3	1,185	1,210	1,200	1,235	1,225

* Technical Tests Division /of Pechora Basin Mine Administration./

The types of coal received for the experiments did not differ very much in sulfur content from commercial coal shipped by the mines. The volatile substance content of the samples ranged from 30.5 to 40.0 percent. The moisture content of the coal used for the experiments was actually less than that of newly mined coal since more than 20 days had elapsed between the mining of the coal and the tests in the laboratory gas generator, and it was at that time that the moisture content was determined. In these tests, the moisture content ranged from 6.7 to 9.05 percent, whereas data from other chemical laboratories give the moisture content of the coal in question as 11-15 percent.

Regarding the elements entering into the composition of the coal, the oxygen content of 16-18 percent arouses the chief interest since in Type D coal of the Kuzbass, Siberia, and the Donbass, the oxygen content does not exceed 12.5-13.0 percent. In this respect, the coal must be assigned to a younger coal type than long-flame coal, to old lignite, or, more accurately, to a transitional type of coal, very close to lignite. Chelyabinsk lignite, for example, has an oxygen content ranging from 18.5 to 21.3 percent. Another point in support of the above classification of Pechora coals is the fact that samples distilled in an aluminum retort yielded 30.45 percent CO_2. Gas from Chelyabinsk coal contains 32-33 percent CO_2, but long-flame coals of the Zhurinskiy or Minusinsk types yield gas with only 14-17 percent CO_2.

When Pechora coal is left exposed to the open air, it has a marked tendency to lose its mechanical toughness. As it dries out, cracks appear in the coal lumps and fines are formed. Experiments made it possible to give an approximate estimate of the mechanical toughness of this coal, although more than $1\frac{1}{2}$ months had elapsed between the mining of the coal and the test. The experiments were carried out with 5 kilograms of coal in a VNIIT drum. The drum was rotated, and the amount of coal remaining in it after rotation expressed in percent of the amount put into the drum was taken as the index of mechanical toughness.

Table 2 gives the mechanical toughness of Pechora basin D coal in comparison with other coals:

Table 2

Source of Coal	Residue in Drum (index of toughness)
Seam V, Mine No 2	51
Seam IX, Mine No 5	51
Seam VIII, Mine No 10	58
Seam X, Mine No 1	65
Seam XI, Mine No 1	70
Krasnoarmeyskiy (Donbass, Type G coal)	72
Zhurinskiy (Kuzbass, Type D coal)	73
Grodovka (Donbass, Type G coal)	75
Bogoslovskiy (Urals, lignite)	75
Cheremkovo (East Siberia, Type D coal)	76
Chernogorsk (Khakassiya, Type D coal)	78-82
Nesvetayevskiy anthracite (Donbass)	82-82

From this data it is evident that Pechora Type D coals have even less mechanical toughness than the relatively unstable Krasnoarmeyskiy, Zhurinskiy, and other coals. This characterization of the mechanical toughness of Pechora coals is, of course, only a preliminary one; detailed tests on freshly mined Pechora coal are necessary to verify it.

Although the Pechora coal examined shows some similarity to lignite of the Chelyabinsk type, nevertheless it behaves differently when heated. Separate pieces of coal do not show a tendency to cake when heated, but each lump of coal forms a rather tough lump of coke.

The mineral content of the ash and its fusibility are indicated in Table 1. There was a little differenc in the ash content of individual coal seams, but, regardless of differences, the temperature at which the ash is fusible is practically uniform for all the coals in question.

With the five samples of Pechora basin coal, 17 experiments in gasification were carried out, leading to the following results:

Table 3

	Seam XI, Mine No 1	Seam X, Mine No 1	Seam V, Mine No 2	Seam VIII, Mine No 10	Seam IX. Mine No 5
Technical analysis of coal, %					
Moisture	7.48	7.34	8.08	8.45	7.9
Ash	30.9	31.6	20.4	25.5	22.9
Volatile substances	37.9	39.6	37.8	34.8	32.6
Size of coal, mm	15-20	15-20	15-20	15-20	15-20
Rate of process in working fuel, kg-sq m/hr	332-492	348-442	266-380	283-360	282-378
Rate of process in standard fuel kg/sq m/hr	207-308	219-266	189-269	193-245	204-274
Temperature of exhaust mixture, °C	50.0	50.1	50.0	50.0	50.1
Temperature of gas, °C	314	285	300	294	320
Content of gas, %					
CO_2	4.91	5.04	4.05	4.44	4.1
H_2S	0.51	0.55	0.16	0.67	0.48
C_nH_m	0.09	0.11	0.04	0.14	0.08
O_2	0.2	0.23	0.2	0.2	0.23
CO	28.75	28.46	29.85	28.49	29.1
H_2	13.74	13.14	14.04	13.05	13.43
CH_4	1.75	1.93	1.83	2.01	1.71
N_2	50.05	50.54	49.83	51.00	50.87
Calorific value of dry gas, Q_n^s cal/cu m (compressed)	1,386	1,376	1,426	1,386	1,388
Resin in dry fuel, %	8.19	8.27	8.34	8.73	9.11
Resin in gas, gr/cu m (compressed)	38.9	40.4	34.3	37.0	38.4
Moisture in gas, gr/cu m (compressed)	101.2	104.1	88.7	101.9	90.5
Dry fuel dust, %	1.7	1.0	1.6	0.8	1.1
Working calorific value of gas, Q_n^r, kcal/cu m (compressed)	1,507	1,500	1,527	1,492	1,520

Table 3 (Contd)	Seam XI, Mine No 1	Seam X, Mine No 1	Seam V, Mine No 2	Seam VIII, Mine No 10	Seam IX, Mine No 5
Screening properties of dust (residue in screen), %					
No 6	14.0	10.6	9.12	18.63	17.30
No 12	8.66	9.39	8.53	11.16	8.86
No 20	10.17	10.39	10.54	12.39	12.57
No 30	9.22	10.26	8.86	10.86	10.33
No 40	7.91	8.17	7.42	8.17	7.23
No 50	7.76	7.63	6.79	6.88	6.93
No 70	25.42	28.76	21.96	14.36	16.23
No 100	7.02	6.71	6.99	5.25	5.27
No 100 going through screen	9.84	8.09	19.79	12.3	15.28
Air consumption, cu m/kg dry (compressed)	1.36	1.31	1.59	1.58	1.54
Gas yield, cu m/kg (compressed)	2.10	2.04	2.43	2.37	2.37
Combustible material content in slag, %	10.59	13.93	13.6	13.3	16.98
Amount of air for blast cu m/sq m/hr	418-656	418-520	410-525	422-520	416-515

Each experiment lasted 4 hours except for one, which lasted only one hour and 25 minutes. The results of the experiments indicate quite clearly the characteristics of Pechora Type D coals as gas-generator fuel. The chief results are listed as follows:

1. Coal from all sampled seams is excellent gas-generator fuel, with high reaction capabilities and with adequate thermal toughness. During the process, the coal is not pulverized and it shows no tendency to cake in a layer.

2. When the coal is gasified in lumps 15-20 millimeters in size, intensifying the process from 266 to 492 kilograms of the working fuel, that is, from 189 to 308 kilograms of standard fuel, gas is obtained with a CO content up to 30 percent, and an H_2 content up to 14.3 percent. The calorific value of the dry gas Q^s_n is approximately 1,380-1,420. The average resin content of the gas is 37.8 grams per cubic meter (compressed) and the average moisture content is 97.8 grams per cubic meter (compressed).

3. Coal from Seam V, which had an ash content of 20.43 percent, was better for gasification purposes than the other coals sampled. Some difficulties caused by the formation of slag were experienced with coal from Seam XI, which had an ash content of 30.9 percent, and from Seam X, with an ash content of 31.63 percent. Evidently the chief reason for a different procedure in gasifying coal from different seams consists in their different ash content. It is possible that the difference in procedure will be less marked when gasification is carried out in an industrial gas generator and all required conditions have been met.

4. The high sulfur content of these coals and, in particular, coals from seams XI, X, IX, and VIII resulted in an up-to-0.7-percent hydrogen sulfide content in the gas. Seam V contains considerably less sulfur, accordingly, the gas from this coal contained only 0.15-0.18 percent of hydrogen sulfide.

5. Pechora basin Type D coal should receive widespread use in gas generators in a number of enterprises in Kirov, Leningrad, Arkhangel'sk, and Gor'kiy oblasts, Udmurt ASSR, and other areas dependent on the Pechora basin.

GEORGIAN SSR

Tbilisi, Zarya Vostoka, 10 Mar 51

It is extremely important to the national economy that local fuels such as Georgian coals be used as extensively as possible. However, burning Georgian coals, in particular Akhaltsikhe coal, presents a number of difficulties. These difficulties could be solved by gasifying the coal.

Scientific work on the gasification of local fuels has been started by the Chair of Thermotechnics of the Tbilisi Institute of Railroad Transport Engineers and the Power Engineering Institute of the Academy of Sciences Georgian SSR.

In 1947, the Ministry of Local Industry Georgian SSR installed a special, simplified gas generator together with a heating furnace in a precision-instrument plant. Successful experiments were made with both Akhaltsikhe and Tkibuli coal in 1950 by the Chair of Thermodynamics and Thermotechnics of the Georgian Polytechnical Institute. It was established that Akhaltsikhe coal with a high ash and moisture content yields excellent generator gas.

Georgia is rich in types of local fuel that could be gasified and the Ministry of Local Industry should introduce gas-generating installations into its own enterprises and assist enterprises of other industries in doing the same.

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