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Plastometric Method in the Identification of Coal from New and Old Deposits

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Abstract—The plastometric method provides useful information regarding the suitability of Russian coking coal for the production of metallurgical coke. The discrepancies between test results in different laboratories are explained. The case is made for trainings in plastometry at laboratories of coke plants and their suppliers.

Keywords: plastometric indices of coal, instrumental discrepancies, coal assessment
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The suitability of coal for coking is currently determined by familiar test methods. Abroad, in regions with large-scale coke production and considerable reserves of good coking coal, the main methods employed are determination of the free expansion in a crucible, the fluidity (Gieseler method), the clinkering properties (Roga and Gray–King methods), and the dilatometric characteristics (Audibert–Arnu equipment).

These methods are also used in Russia, especially when the coal is intended for export. In addition, the swelling is determined in accordance with the method developed by the Institute of Fossil Fuels and OAO VUKhIN.

However, in comparison with foreign coal, the Russian coal available for coking has poorer properties. Therefore, in determining the suitability of Russian coking coal for the production of high-quality coke, the plastometric characteristics y and x are determined in the Sapozhnikov apparatus (State Standard GOST 1186–87), which best simulates the bed-coking process. Many years' experience shows that this method is reliable and reproducible.

Recently, however, some researchers have written that, "regrettably, the thickness of the plastic layer provides little information, especially for coal with poor clinkering properties" [3, 4]. This assertion was made earlier in [1, 2]: "Because y provides little information, producers of coal for the coke industry are able to engage in deceptive rank assignment."

For instance, KSN coal may be assigned the rank KS if the V^{daf} values are the same, and the difference in y is slight, although the standard requires identical values of y. KSN coal may be represented as KO coal if the V^{daf} values are the same, and the difference in y is slight: 9 mm is the maximum possible value for KSN, while 10 mm is the minimum possible value for KO. The difference in y may be ignored in the light of the permissible measurement error of ± 1 mm. A similar situation arises with KS and OS coal for which the V^{daf} values are the same, and the difference in y is slight (9 mm for KS and 10 mm for OS). However, the assertion that y provides little information is debatable.

All coal, including clinkering coal, is separated into ranks, so as to identify groups with similar properties. However, to invent a laboratory method capable of determining the suitability of a particular coal or coal blend for coking and obtaining coke of known quality is an unattainable dream.

In practice, we must use a combination of laboratory methods to establish the suitability of coal for coking. Many such methods have been adopted; the best known have been standardized. The minimum set of characteristics that may be used to divide coal into ranks, groups, and subgroups has been specified. The classification procedures are outlined in State Standard GOST 25543–88.

Coal is a complex organic product. It is very difficult to obtain clearly defined boundaries between ranks. A specific coal may be formally assigned to different ranks on the basis of different characteristics. Therefore, we need to use a combination of methods. In practice, coal whose properties are at the boundary of adjacent ranks may be finally identified by different methods.

In State Standard GOST 25543–88, the methods selected for coking coal are based on the petrographic characteristics, the yield of volatiles, the plastometric characteristics, and the clinkering properties (Roga method).

For example, ranks TS and T are distinguished in terms of the Roga index. Ranks KO and KSN are distinguished on the basis of *y*. Ranks KSN and KS are best distinguished on the basis of the petrographic characteristics. Thus, all of the test methods included in the standard are very important. Particular methods are better suited to particular cases.

Without going into the details of the discussion on ranking that has been conducted in this journal, we may note that *y* is the last characteristic considering in rank assignment according to State Standard GOST 25543–88. Of course, the 1-mm deviation permitted in the standard leaves scope for rank manipulation, as noted in [1–4]. The method and apparatus used for plastometric analysis are of critical importance here.

Most analytical apparatus currently employed in Russia was developed by OAO VUKhIN, as already noted [5, 7]. The main factors responsible for the discrepancy in the results obtained for tests of the same coal at different laboratories include the following [5, 7].

(1) Manufacture of plastometric equipment that does not conform to the drawings developed by OAO VUKhIN.

(2) Manual or inadequate temperature regulation.

(3) The use of materials in the plastometric equipment that do not agree with the corresponding drawings.

(4) Difference in granulometric composition of the coal samples at different laboratories, on account of the use of different grinding equipment and methods and consequent difference in packing density of the sample.

(5) Different thickness of the plastometric needle's tip in different laboratories. As a rule, depending on the measurement frequency, the tip will be considerably less than the permitted value of 1.5 ± 0.1 mm, as a result of cleaning. That will affect the measurement results.

(6) Brick of different materials that has been operating for different periods and, perhaps, differences in the wear and configuration of the brick or operation with broken brick.

(7) Difference in the time for which the equipment has been operating.

Of course, to use any single method will not be effective. Therefore, we employ several characteristics. It would be possible to add *Vt* to State Standard GOST 25543–88, as proposed in [3, 4]. Note, however, that petrography does not determine the initial oxidation of the coal, whereas plastometry does. Therefore, it is expedient to add inspection of the coke bead to State Standard GOST 25543–88. At present, this standard is being revised, and such a modification should certainly be considered.

We believe that OAO VUKhIN should organize and conduct trainings for plastometric specialists, not only for laboratories at coke plants and metallurgical enterprises but also for those at enrichment facilities and mines and other institutions where plastometric indices are used for rank assignment. Those laboratories are prone to fundamental errors in the analysis of coal samples. For example, grinding the samples for technical analysis prevents the use of *y* in the ranking of coking coal.

CONCLUSIONS

(1) State Standard GOST 25543–88 should be revised so as to add new items to the list of characteristics employed in rank assignment: in particular, the description of the coke bead after plastometry and the vitrinite reflectance.

(2) To determine the rank assignment of coals, all the relevant test methods must be employed. One is not sufficient.

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