Assessing Coke Readiness: A Response

E. I. Toryanik
Ural Coal-Chemistry Institute, ul. Vesnina 7, Kharkiv, 61023 Ukraine
e-mail: toryanik36@maik.ru

DOI: 10.3103/S1068364X16050069

In an issue of this journal devoted to the anniversary of OAO EVRAZ NTMK, Berkutov and his colleagues wrote a critique [1] of our previous article on determining the electrical resistivity of coke powder [2].

Since the critique was controversial in nature and claimed that we were incompetent, a response seems necessary.

Our article was devoted to improvements in determining the resistivity of coke powder. It was not intended as an analysis of existing methods of assessing coke readiness and the complex phenomena that accompany the final stage of coking, contrary to the claims in [1].

By coke readiness, we meant the set of physico-chemical characteristics that ensure its required performance. Therefore, in assessing the readiness of coke, attention must be paid, on the one hand, to the parameters of coke production that shape these properties and, on the other, to customer requirements.

This was a novel approach to coke readiness, and merits further discussion. In this perspective, the measure of readiness must take account of all the properties specified by the customer. By the same token, it must assess a parameter ensuring the whole spectrum of customer requirements, and not a single isolated property.

The coke temperature prior to discharge from the coking chamber is a parameter that correlates with its readiness in terms of the formation of a product with specified properties. Note here that the final temperature and coking rate determine the readiness of the coke (in terms of particle size, strength, etc.), for fixed clinkering properties, degree of crushing, packing density, moisture content, and other properties of the coal batch. In other words, all of these properties of the coal also affect the readiness of the coke.

Our critics suppose that these factors have no influence on coke readiness.

At the same time, it is well known that, in order to obtain the maximum possible yield of coke of the required quality, each batch requires particular coking conditions, depending on its preparation and properties. Thus, batch with impaired clinkering properties, like batch with elevated density and moisture content, must be coked at elevated rates and final temperatures in order to obtain the required coke readiness.

In fact, many characteristics determine the readiness of coke, since many properties determine its value to the customer. Of course, the selection of a particular method of determining coke readiness depends on the characteristics of the production process and the skill of the operating staff.

Therefore, the information in the specialist literature on new and existing methods of monitoring production processes and the final product is of great importance for the development of coke chemistry.

Our critics correctly state that “the yield of volatiles, which is the traditional characteristic of coke used to assess its readiness, is no longer applicable for current coke ovens.”

This is obvious in that coking in modern coke ovens ends at temperatures above 1050 ± 50°C, whereas the residual yield of volatiles from the coke is determined at 900°C in accordance with State Standard GOST 6382–2000. Therefore, with variation in the coke temperature from 950 to 1250°C and in the coking period by 4–6 h, the yield of volatiles from coke varies from 0.9 to 1.1%.

Obviously, this problem may be eliminated by determining the yield of volatiles on heating coke to 1150°C, which requires the use of a special furnace.

Therefore, it was decided to use the method of determining the yield of volatiles from anthracite outlined in State Standard GOST 7303–77, with modification and modernization of a vertical tube furnace capable of heating the sample to 1150°C.

The yield of volatiles may be determined here in terms of either volume or mass. The main benefit of this method is clear determination of the yield of volatiles as a function of the coke temperature.

At OAO EVRAZ NTMK, the readiness of coke is assessed in terms of the difference in the yield of volatiles from coke breeze and from coke. On this topic, our critics make contrasting statements.

---

1 This article discusses a commentary by N. A. Berkutov, D. A. Koshkarov, and Yu. V. Stepanov, which was published in this journal in 2015 [1].
1. “Measuring the yield of volatiles from coke in modern-day coke ovens (whether in mass or volume terms) is not a useful means of assessing the coke readiness.”

2. “At the same time, data on the yield of volatiles for coke breeze \( V_{cb}^{\text{daf}} \) and coke \( V_{co}^{\text{daf}} \) show that, as the coke readiness \( V_{co}^{\text{daf}} \) declines, \( V_{cb}^{\text{daf}} \) steadily rises.” (In support of this statement, they cite [3].) “Thus, the difference \( \Delta V = V_{cb}^{\text{daf}} - V_{co}^{\text{daf}} \) may be used to assess the readiness of coke samples.”

Such contrary assertions abound in [1]. For example, they state, “Since January 2001, the central laboratory of coke production at OAO EVRAZ NTMK has assessed the readiness of wet-quenched coke from the yield of volatiles measured for coke breeze and also on the basis of visual assessment of coke readiness by shift supervisors. The determination of coke resistivity was discontinued.”

Regarding visual assessment of coke readiness, we should note that it depends on the skills of the shift supervisors and other shop and laboratory specialists, who somehow manage, in the presence of hoods above the quenching cars, not only to visually assess the coke readiness but also to ensure “complete agreement” with assessments based on the yield of volatiles.

In fact, visual assessment of the coke cake from the coking chamber is very important, since it permits judgments regarding the level of charge in the furnace chamber, the vertical and horizontal shrinkage of the coke, the distance of the coke cake from the chamber walls, the presence of a temperature seam, the uniformity of the heating over the height, length, and width of the cake, and the quantity of dust emissions.

However, such assessments cannot be made in the presence of the dust-trapping hoods and must be based not on subjective expert judgment but, for example, on the temperature readings of a pyrometer.

Such temperature monitoring has been introduced in the coke shop at ChAO Makeevkoks. A door-removing machine with no dust-trapping hood is employed. A digital pyrometer determines the temperature at nine points of the coke cake during its discharge from the coking chamber.

These readings are compared with the results of improved determination of the electrical resistivity of coke powder at the given temperature. That not only permits the identification of a relation between these data but also the assessment of the values that ensure the required properties of the coke and the maximum coke yield and quality.

The monitoring of coke readiness may then be based on the deviation of the electrical resistivity from the value corresponding to optimal quality of the coke and customer satisfaction.

Our critics assert that coke readiness means “that all the properties of coke prior to its discharge are uniform over the length, height, and especially the width of the coke cake, thanks to selection of the appropriate coking temperature and time.” This notion is problematic, since such nonuniformity cannot be attained in bed coking.

As is well known, significant difference in molecular structure, chemical composition, and strength of the coke (and also in other properties that characterize the coke readiness for some customers but not for others) is noted over the length of a coke piece taken from a specific point over the chamber width in bed coking.

Therefore, the concept of coke readiness is not without scientific basis. Rather, it is assessed by a broad range of methods, and careful discussion is required in order to correctly evaluate the effectiveness of a particular method.

However, this discussion should be conducted in the appropriate venue, as was done previously in this journal for discussions regarding the furnace-chamber width and the size requirements on blast-furnace coke, for example. A general issue on the anniversary of a particular industrial enterprise is not the appropriate venue.

Our critics’ most absurd conclusion was as follows: “Despite the large team of authors, the literature on methods of assessing coke readiness was not satisfactorily reviewed. Including articles on coke resistivity, they made no more than 12 citations. By contrast, 76 works were cited, for example, in” [4].

We could not have referred to the review [4] in our article, since it was published two months later. Our critics evidently mixed up their citations.

For our part, we considered sources relating to methods of determining the resistivity of coke powder, rather than the resistivity of solid carbon materials in general.

We drew on existing methods with a view to simplifying and accelerating the determination of the resistivity, on the basis of up-to-date equipment for the preparation and pressing of coal powder and instruments for monitoring and regulating the electric current.

Given the difficulty of certifying a new method for inclusion in a GOST standard, we presented an outline of the method, in the hope that specialists would offer informed and constructive comments for use in its further development.

We might make the following comments regarding the assessment of coke readiness on the basis of the yield of volatiles of coke breeze.

(1) As our critics acknowledge, the yield of volatiles “is the traditional characteristic of coke used to assess its readiness.”

(2) The output of coke breeze is usually about 4–6% of the output of coke, while the >25 mm fraction of blast furnace coke will be rejected if it contains more than 3% of the <25 mm class.