

## ANALYSIS OF THE LINEAR MATHEMATICAL MODEL FOR PREDICTING THE YIELDS OF COKING PRODUCTS

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Mathematical models for predicting coking product yields are necessary for making a material balance of the coking process when designing new plants, as well as for analysing the operation of existing plants. Such models are usually obtained by mathematical processing of experimental data. The main disadvantage of such models is that each of them is adequate only under the conditions of the experiment, in which it was obtained, and an attempts to extrapolate it generally lead to significant errors, i.e., a loss of adequacy.

The linear mathematical model for predicting coking product yields on a dry charge basis (%) by V.I. Sukhorukov and Yu.V. Stepanov consists of the following equations:

$$G_c = 100 - 0,857 \cdot V_{bl}^d \quad (1); \quad G_{c.o.g} = 0,559 \cdot V_{bl}^d - 0,166 \cdot S_{bl}^d \quad (2);$$

$$G_{res} = 0,135 \cdot V_{bl}^d - 0,04 \cdot S_{bl}^d \quad (3); \quad G_{b,h} = 0,0443 \cdot V_{bl}^d - 0,0132 \cdot S_{bl}^d \quad (4);$$

$$G_{NH_3} = 0,0125 \cdot V_{bl}^d - 0,0037 \cdot S_{bl}^d \quad (5); \quad G_{H_2S} = 0,255 \cdot S_{bl}^d \quad (6);$$

$$G_{p.w} = 0,106 \cdot V_{bl}^d - 0,0315 \cdot S_{bl}^d \quad (7).$$

In formulas 1–7, only two indicators,  $V_{bl}^d$  and  $S_{bl}^d$ , are used. These are determined during the technical analysis of coking coal in all plant laboratories, which makes them convenient for performing predictive calculations.

Formula 1, which is used to calculate coke yield, is linear with respect to single parameter  $V_{bl}^d$ . The coefficient value of 0,857 at  $V_{bl}^d$  in equation 1 indicates that 85,7 % of the vapor-gas coking products enter the gas collector from the coking chambers, while 14,3 % – participate in solid-phase polycondensation reactions, forming the so-called coke “annealing layer”. Formula 6, used to calculate the hydrogen sulfide yield, represents a direct proportionality with respect to  $S_{bl}^d$ .

Formulas 2–5 and 7, which are used to calculate the yields of coke oven gas, resin, benzene hydrocarbons, ammonia, and pyrogenetic water, are linear but depend on two parameters  $V_{bl}^d$  and  $S_{bl}^d$ . The coefficients at  $V_{bl}^d$  in all these formulas are positive, and the ratio between their numerical values reflects the distribution of vapor-gas coking products entering the gas collector among coke oven gas, resin, benzene hydrocarbons, ammonia and pyrogenetic water: 55,9 : 13,5 : 4,43 : 1,25 : 10,6. The coefficients at  $S_{bl}^d$  in these equations are all small in absolute value and negative, i.e., they perform a corrective function. Since the model is linear, the rates of change in the yields of coking products with respect to the parameters  $V_{bl}^d$  and  $S_{bl}^d$  remain constant within the ranges of variation of these parameters for coals of different origins.

For practical evaluation of the mathematical model, material balance calculations of the coking process were performed using a specially developed computer program. The linear model exhibits a balance discrepancy of only 0,01 % at high  $V_{bl}^d$  values (30–40 %), and in the range of  $V_{bl}^d$  from 12,5 % to 30 % the material balance closes completely. This indicates the high reliability of the linear model and its applicability to virtually any Donbas coking coal.

Thus within a very broad range of  $V_{bl}^d$  values (12,5–40 %) the linear mathematical model constructed on theoretical concepts of the coking process in modern industrial coke ovens can be recommended for predicting the yields of coking products. This model provides an almost zero discrepancy in the material balance.