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Mathematical model for calculating enrichment efficiency

Mathematical models for the enrichment efficiency indicators calculating are well known. These models are based on probability theory and mathematical statistics methods [1]. The basis of such modeling is random values functions determination defining the raw materials parameters as well as the separation characteristics used for the equipment classification. For raw material of heterogeneous carbonate deposits such models were not created.

The identification of regularity of stochastic bounds of limestone mass fraction in the mineral with the particles size mentioned in research paper [2], allows us to apply a new method in order to create a new model which takes into account the results of granulometric (raw materials separation into size classes) and chemical (limestone percentage determination in each size class) compositions of raw material. The use of regression analysis for raw material experimental data processing, provided as discrete parameter values, allows us to obtain regression equations defining the stochastic bounds between the quality of the oversized product of the classification device (screener) and the size of d particles separation.

The process of the raw material enrichment with classification devices usage must be accompanied by the oversized product quality improvement and the target component (limestone) content decrease in the undersized product. Moreover, the weight indicators are important for the effectiveness evaluating. These components show us the enrichment efficiency parameters E

$$E = \frac{\varepsilon_1 - \gamma_1}{1 - \alpha}, \tag{1}$$

in this formula ε_1 – limestone extraction into the oversized product; γ_1 – oversized product output; α – limestone content in the source material.

The parameters of formula (1) are measured in unit fractions.

The value of the oversize product (concentrate) output is obtained from formula

$$\varepsilon_1 = \frac{\gamma_1 \beta_1}{\alpha}, \tag{2}$$

in this formula β_1 – the content of limestone in the oversized product (concentrate).

An important parameter of material device effectiveness classification is an indicator of classification process effectiveness. Using screener as a classification device a material screening effectiveness is to be considered E_{screen}

$$E_{\text{screen}} = \frac{m_2}{m_{2d}}, \tag{3}$$

in this formula m_2 – undersized product mass; m_{2d} – the mass of lower size class particles in the initial product;

E depends on the separation size d of the raw material by the screener. The higher the level of d separation the more material will be in the undersized product which leads to the E value change because different size classes have different limestone concentration [2]. The E dependence (d) can be obtained by means of regression equations using which connect material mass $m_{2d}(d)$ and limestone mass $m_{u2d}(d)$ with d parameter value in the lower size classes of the raw material. In relative units such dependences have the following form $m_{2d}/m(d)$ and $m_{u2d}/m(d)$, in these formulas m – the mass of source material. Such regression equations obtaining is possible by experimental raw material data analyzing represented in [2]. The function *pwzfit* of MathCAD system allowed us to obtain the following regression dependencies.

$$m_{2d}/m = 22.2d^{0.347}, \quad (4)$$

$$m_{u2d}/m = 7.88d^{0.449}. \quad (5)$$

The calculated values of the correlation ratios r for the nonlinear models are the following: - for the curve (4) – r = 0.989; - for the curve (5) – r = 0.992.

Figure 1 illustrates the obtained dependencies in the following graphic:

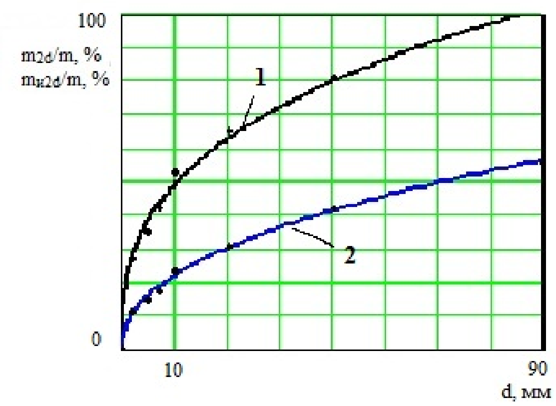

Figure 1. The dependences $m_{2d}/m(d)$ – curve 1 and $m_{u2d}/m(d)$ – curve 2.

Such high levels of correlation ratios allow us to consider the dependences (4) and (5) as functional links between parameters and to use them to calculate enrichment efficiency indicators. Such significant r values allow us to suppose the existence of strong links between the parameters due to the geological conditions of minerals formation and to confirm the acceptability of power functions in regression dependences.

References

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2. A.S. Dreshpak. Limestone Enrichment Initial Parameters from Heterogeneous Carbonate Deposits. Minerals Processing. Vol. № 64 (105). 2016. Page. 59-68.