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DETERMINATION OF REQUIRED MEASUREMENT ACCURACY OF PARAMETERS OF TECHNOLOGICAL PROCESS ON VOLNOGORSK MINING AND SMELTING COMPLEX

On basis of dispersion technical parameter definition in dressing technology with the help of dispersion specter exchange of initial mineral flow, the demands for accuracy of measure devise of these parameters are shown.

As is known, the measurement of parameters of quality of currents of concentration processes is made with certain inaccuracy. The less is inaccuracy (the bigger is accuracy), the more expensive is measuring process. The testing of great number of parameters for controlling of their values is made in processing line of concentration. Some parameters are rather sensitive to changes of technological regulations or concentration signs and the others are not sensitive. Obviously, depending on sensibility of the process different accuracy of measurement must be applied.

Commonly, the highly sensitive processes have wider allowable limits of change comparing with the low-sensitive. For the low-sensitive processes small deviations are significant and therefore the accuracy of measurement of their parameters must be high.

The parameters themselves can be measured more or less accurately depending on the value of mineral product and the purpose of information about it.

So for the management of process when only direction of change is important it is possible to carry out measurement with poor accuracy. It is more accurate for calculation with consumers of concentrates. Thus, the intermediate products can be measured more roughly and the concentrate more accurately.

Let's introduce the concept of sensibility and inaccuracy of technological process.

If, as a result of measurement of technological index, the deviation of index of quality by the value ΔX_{II} occurred with the initial value of the index of quality X_{II} , the value

$$\delta = \frac{\Delta \tilde{O}_I}{\tilde{O}_I}$$

will determine the accuracy of process

Tests and control

$$\tau = \frac{1}{|\delta|} = \frac{X}{\Delta X}.$$

If as a result of measurement of technological index the inaccuracy σ_{II} is allowed, with the initial value of the index of quality X_{II} , the value

$$\delta = \frac{\sigma_{II}}{X_{II}}.$$

will determine the accuracy of process

$$\tau = \frac{1}{|\delta|} = \frac{X_{II}}{\sigma_{II}}.$$

Thereby, the accuracy of measurement σ_{II} of the value must be higher than the accuracy of technological process σ_{II} , i.e.

$$\sigma_{II} < \sigma_{II}.$$

Herewith, the value of X_{II} with inaccuracy σ_{II} must match the value of technological process X_{II} :

$$X_{II} \approx X_{II}.$$

The inequality can be of the small or considerable difference.

Performance of technological process must be used for objective choice of the rate of inequality. Let's use the sensibility index here. The change of qualitative parameters at changing of operating parameters or parameters of concentration signs determines the sensibility. For this purpose we researched the change of quality of intermediate products to the change of the said parameters. The research was performed numerically using the determined model of technological process. The scheme of concentration of alluvial deposits of Volnogorsk Mining and Smelting Complex was taken as technological process. The research results made up the table where mathematical model was verified for adequacy and the assessments of derivatives were obtained for all the points of technology and for the change of content of valuable minerals: zircon, ilmenite, granatite, disthene, rutile. The table is of considerable size so we deem unnecessary to put it in this article, so let's pitch upon some generalizing parameters of it.

Since at operation of technology all parameters of modes and concentration signs act simultaneously, we chose the highest derivatives in terms of the absolute value among research results. Expectedly, no higher values of derivatives were observed, since it would lead to instable conditions of technology. We can assume that the limits of change of derivatives:

$$-2,0 \leq \frac{d\beta}{dx_i} \leq 2,0.$$

At an average the derivatives are of approximate value $\frac{d\beta}{dx_i} = 0,5$.

The higher is the value of derivative, the bigger is the change of quality at small changes of modes and the more inaccurate can be the measuring assessment of this quality. And vice versa: the less is the change of quality at small changes of modes, the more accurate must be the measuring assessment of this quality.

To select the required measurement accuracy the binding to some stable parameters of technological process must be provided. It can be the average value of the mode, median etc. The research of technological process using the Monte Carlo method showed that distribution of quality parameters of industrial products at all points of the system is even, so we use its average value – \bar{X}_{II} . Then the expression binding the inaccuracies of technology and measurement can be represented as follows:

$$\frac{X_{II}}{\sigma_{II}} - \frac{X_{II}}{\sigma_{II}} = \frac{\kappa}{f^1},$$

where κ – coefficient matching the dimensionalities.

We can represent $X_{II} = X_{II} + \sigma_{II}$. Then:

$$\frac{X_{II} + \sigma_{II}}{\sigma_{II}} - \frac{X_{II}}{\sigma_{II}} = \frac{\kappa}{f^1},$$

or

$$X_{II} \left(\frac{1}{\sigma_{II}} - \frac{1}{\sigma_{II}} \right) = \frac{\kappa}{f^1} - 1.$$

As a result we have

$$\sigma_{II} = \frac{\sigma_{II}}{1 + \frac{\sigma_{II}}{X_{II}} \left(\frac{\kappa}{f^1} - 1 \right)}.$$

So, when the ratio of the average quadratic deviation to the average value of technological process is quite small, the inaccuracy of measurement can be equal to inaccuracy of technological process, i.e. the change of parameters of concentrates can be produced with the inaccuracy, that is in the technological process. The change of values at the beginning of technology must be produced with the accuracy of bigger

the maximal divergence of not more than 5%. On this ground the decision on adequacy of the method of calculation of output parameters of concentration – output and content of valuable mineral was taken.

Using such modeling the derivatives for quality parameters of intermediate products and concentrates were obtained:

$$\frac{\partial \beta_i}{\partial \alpha_j} \approx \frac{\beta_{i \max} - \beta_{i \min}}{\alpha_{j \max} - \alpha_{j \min}} = f^1.$$

In that way, all variables for determination of required inaccuracy of measurement of intermediate products and concentrates are obtained.

Using this method for technology of concentration of disthene that is produced on Volnogorsk Mining and Smelting Complex (concentration scheme on Figure 1 and 2) the dispersions along the processing line are obtained (table 1), where Di – number of point of processing line is specified and the lower columns specify the values of dispersions at corresponding points.

As follows from the table 1 the dispersions of quality parameters along the processing line decrease and the bigger is the number of devices, the more considerable is this decrease. Beginning from the 17th point, the required accuracy of control of technological parameters increase appreciably and must have the order 10⁻⁴-10⁻⁵ %. It is problematically to reach such accuracy at single measurement, therefore the measurement volume V must be increased which, as is known [4], depends on the ratio of the accuracy of measuring device C to the required accuracy ε that is numerically represented as ratio of average quadratic deviations:

$$V = \left(\frac{3C}{\varepsilon} \right)^3 d^3.$$

Table 1

The value dispersion of technological results into scheme disthene dressing product

Dispersion							
D1	D2	D3	D4	D5	D6	D7	D8
0,92	0	0,934	3,237*10-5	0,46	1,181	0,703	0,081
D9	D10	D11	D12	D13	D14	D15	D16
0,087	0,252	0,232	0,017	0,058	0,014	2,544*10-3	7,965*10-4
D17	D18	D19	D20	D21	D22	D23	D24
1,721*10-7	0	3,619*10-3	0	3,076*10-4	0	7,116*10-5	0
D25	D26	D27	D28	D29	D30	D31	D32
1,402*10-5	2,584*10-6	2,145*10-7	2,512*10-6	1,39*10-9	1,908*10-9	5,528*10-12	3,384*10-12

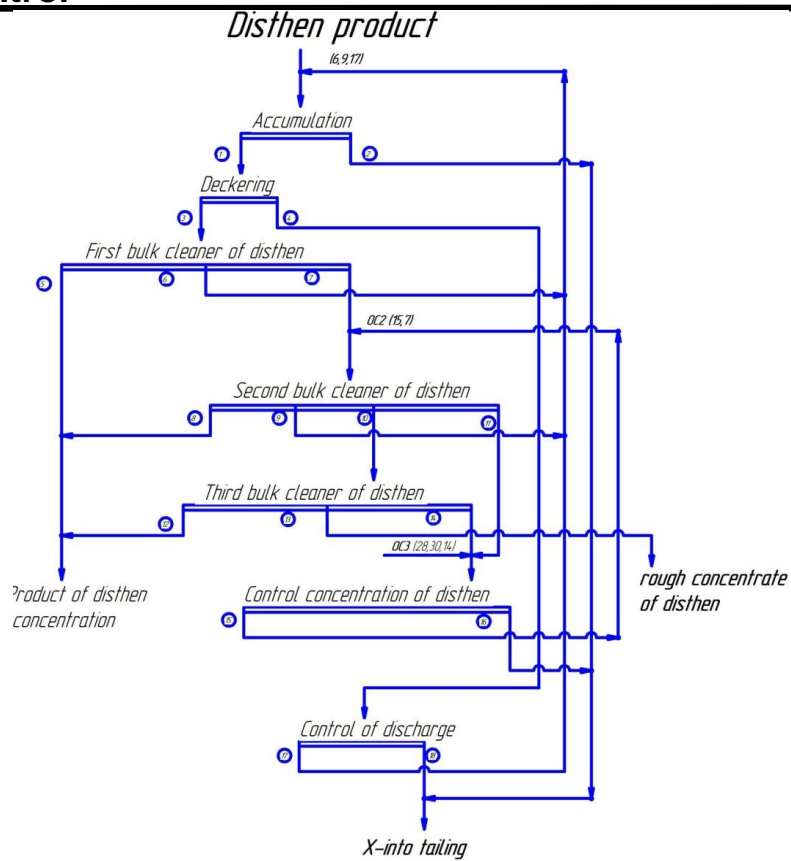


Fig. 1. Scheme of dressing disthen chapter 1

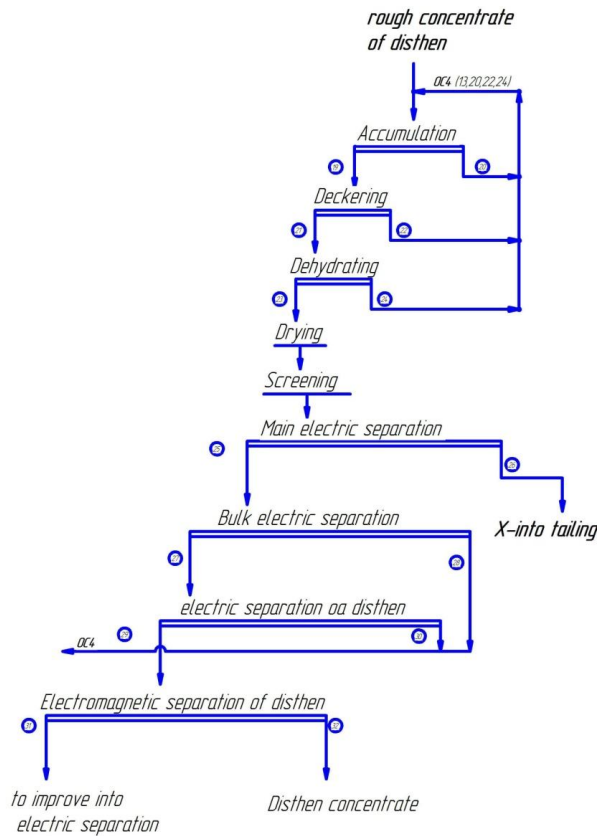


Fig. 2. Scheme of dressing disthen chapter 2

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