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ULPA PARTICLE SEPARATION MODEL IN A SPIRAL CLASSIFIER

Purpose. Development of a model that describes the relationship of parameters characterizing the operating mode of the spiral classifier with the particle size distribution of the ore product in the classifier discharge to increase the efficiency and accuracy of controlling the process of enrichment of iron ore raw materials.

Methodology. Theoretical studies were based on classical models of separation of the classified material and justification of the parameter, characterizing the granulometric composition of the classified material in the classifier discharge, which can be calculated in the framework of the general theoretical model with subsequent control calculations. Methods of analysis, synthesis, systematisation and generalisation, and mathematical model method were used.

Findings. Dependencies are obtained that make it possible to calculate the parameter characterizing the particle size distribution of the product in the spiral classifier discharge by the observed parameters of the enrichment process of the classified product.

Originality. For the first time, a model for the separation of classified material in spiral classifiers is substantiated and the influence of the temperature of the separation medium on the classification process is shown.

Practical value. The results can be used to automatically stabilize the particle size distribution of the product in the discharge of the spiral classifier.

Keywords: *spiral classifier, drain comb, indicative diameter, separation*

Introduction. For many years, spiral classifiers have been the main aggregate that ensures the separation of ore material in the first stage of iron ore processing at ore-dressing plants. Their main function is the separation of particles in ore sands by size. A large class of particles (sand) is sent for re-grinding, a small class – in the discharge of the classifier. Mechanical constructions, in particular, spiral ones, classifiers have been worked out, and the theoretical foundations for classifying materials in them (separation in a vertical stream or in a horizontal liquid stream) are described [1, 2]. Nevertheless, there are no somewhat acceptable theoretical models linking the parameters characterizing the classification process with the particle size distribution of the material in the classifier discharge. The complexity of creating such models lies in the fact that, by transporting sand, the strokes of the screw of the spiral classifier create, firstly, large-scale turbulence in the pulp, i.e., both ascending and descending flows in the pulp, and, secondly, move water from drain threshold in the direction of unloading sand, i.e. in the horizontal direction there are flows both in the direction of discharge and from it. In this regard, the processes occurring in the spiral classifier do not fall under any classical model of separation of the classified material. The absence of such models does not allow us to control the separation process in a spiral classifier with any predictable accuracy, or to respond to controlled disturbances of the grinding process of the first enrichment stage in a timely manner.

Literature review. Currently, the drain density of the spiral classifier is its main characteristic that determines the separation mode [3, 4]. Traditionally, density is controlled by sampling followed by weighing. In sections equipped with an automatic process control system, the classifier drain density is calculated on the basis of the balance of material flows or is controlled by density meters [4] in real time. Currently, granulometers [5], which allow automatic control of the particle size distribution of the pulp stream of technological processes of grinding and classification, are becoming more widespread. There is positive experience in using these devices in industry to stabilize the separation characteristics of a spiral classifier [6].

Work is underway to identify the weighted average size of the sands of the spiral classifier using a magnetoelectric system [7].

At the same time, as shown by studies of the dynamic characteristics of the enrichment process [8], the enrichment section is a very inertial object. Reducing the time of the transition process in such objects is achieved through the disturbance control. The implementation of a disturbance control to stabilize the particle size distribution of the spiral classifier drain requires a model linking the main parameters of the separation process in the spiral classifier with parameters of the particle size distribution process of the drain.

The problem of creating models for complex technical systems is not new. This problem is considered, for example, in [9, 10], but it is not possible to directly use the research results presented in them to solve the problem posed [11]. Alternatively, the control of complex technical systems can be carried out on the basis of using various states of the system (operating modes of objects) from the database [12], however, with a large number of states. But this way does not provide correct

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identification of the current state. In [13], the model of a complex technical system is presented as a set of relatively simple models, with cross and non-linear relationships. But for the case of a spiral classifier, there are only a number of empirical formulas that do not reflect the principles of separation of the enriched material in this classifier.

Unsolved aspects of the problem. Summarizing of foregoing general problem, one can conclude that there are currently no models describing the relationship of mode parameters of the spiral classifier with the granulometric composition of the ore product in the plum. The solution of this problem is an integral part of the general problem of controlling the iron ores enrichment process to obtain minimum specific costs for obtaining a concentration of the given quality.

Purpose. In this article, the goal is to develop a model of the separation process in the spiral classifier in the way to link the parameter of granulometric composition of the spiral classifier drain with the main parameters of the separation process in it. Such a model is necessary to increase the dynamic accuracy of stabilization of the particle size distribution of the spiral classifier discharge under the influence of controlled disturbances on the classification process due to the formation of control actions that compensate for the influence of technological disturbances on the particle size distribution of the discharge.

Methods. The solution of the problem of constructing a model of the separation characteristic of the spiral classifier involves the following sequence of the research. At the first stage of the research, it is necessary to determine which of the two classical models of separation of classified material should be used to solve the problem. At the second stage of the research, a parameter is selected that, on the one hand, characterizes the granulometric composition of the classified material in the discharge of the classifier, and, on the other hand, can be calculated within the framework of the general theoretical model justified at the first stage of the research. The development of a separation model of a spiral classifier ends with a numerical assessment of the influence of the separation process parameters in the spiral classifier on the parameter of the particle size distribution of the classified material in the classifier drain. The assessment will be carried out on the example of the 2KSN 30 × 125 spiral classifier [14] and the data from the automatic process control system of the section of the first enrichment stage where a classifier of the indicated type is installed.

Results. Regardless of the location of the discharge points of the pulp and the water supply to the spiral classifier, spirals carry out the surge of water towards the place of discharge of sand. The volume of water moved by the spirals in the direction of unloading the sands significantly exceeds the total volume of water and pulp entering the classifier. This makes it possible to present the movement of water toward the discharge of the classifier in the form of a simplified model shown in Figure, *a*). The main objective of this model is to determine the main direction of water flow into discharge place and, accordingly, the basic mechanism of particle separation in a horizontal or vertical flow.

The balance difference between two counter-currents is determined by the volume of pulp $Q_{\text{V\_cl}}$ entering the discharge of the classifier and is represented by streamlines in Figure, *a* and calculated by the formula (Gorelov, Yu. V., Gorelova, L. S., Gorelova, D. Yu.)

$$Q_{\text{V\_cl}} = k_{\text{h\_d}} \cdot \sqrt{2 \cdot g} \cdot B_d \cdot H_d^{3/2},$$

where B_d is the width of the discharge stream (the width of the trough of the classifier for the discharge); H_d is the pressure over the crest of the drain; $k_{\text{h\_d}}$ is a hydraulic discharge coefficient.

Then we have

$$H_d = \sqrt[3]{\frac{Q_{\text{V\_d}}^2}{2 \cdot g \cdot k_{\text{h\_d}}^2 \cdot B_d^2}}.$$

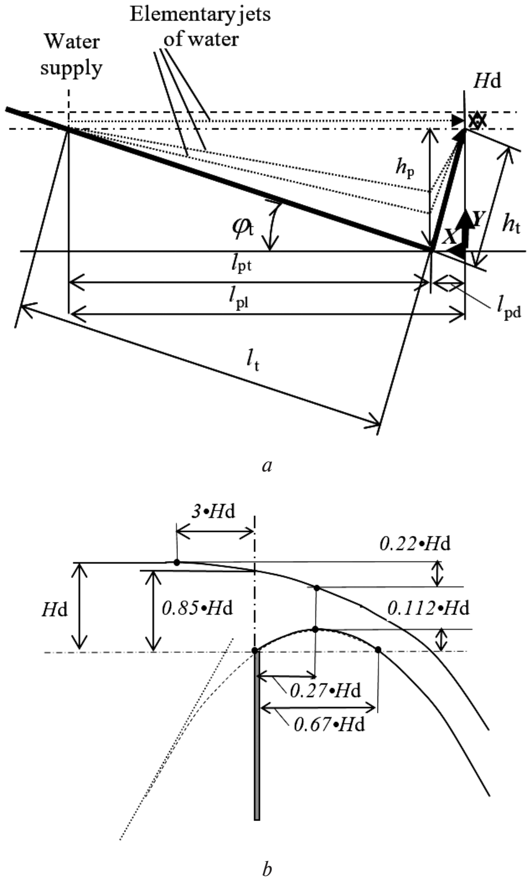

Fig. Structure of the water flow of the discharge of the classifier:

a – the structure of the water flow in the trough of the classifier; b – the structure of the water flow in the discharge place of the classifier

Consider an elementary stream of water with a "thickness (height)" tending to zero.

If the elementary stream is located at the level of discharge or higher, then its length l_{es} is equal to the length of the trough at the level of discharge of pulp l_{pl}

$$l_{es} = l_{pl}.$$

In turn, the length of the trough in terms of the level of pulp discharge can be related to the values depicted in Figure, *a*) as follows

$$l_{pl} = l_{pt} + l_{pd},$$

where l_{pl} is the length of the pulp mirror from the drain to the bottom of the classifier trough; l_{pt} is the length of the pulp mirror from the bottom of the trough of the classifier to the cross section of its maximum depth; l_{pd} is the length of the pulp mirror from discharge to the section of its maximum depth.

Let the ordinate of the elementary stream in the cross section $x = l_{pd}$ be equal to y_{es}.

Then the length of the elementary stream l_{es}, can be estimated as

$$l_{es} = \sqrt{l_{pt}^2 + \left(h_p - y_{es}\right)^2} + \sqrt{l_{pd}^2 + \left(h_p - y_{es}\right)^2}, \qquad (1)$$

where h_p is the maximum pulp depth in the classifier trough.

We accept the hypothesis that for elementary streams of the flow the statement is true that

$$l_{es} \cdot v_{es} = \text{const}, \qquad (2)$$

where v_{es} is the velocity of the elementary stream.

Water flow $Q_{\text{pt\_d}}$ through the section $x = l_{pd}$ can be calculated as

$$Q_{\text{pt\_d}} = B_d \cdot v_{esb} \cdot H_d + \int\limits_{y=0}^{h_{\text{ïê}}} B_d \cdot v_{es}\left(y\right) \cdot dy, \tag{3}$$

where v_{esb} is the velocity of the basic elementary stream, i. e. stream with $y \geq h_{pt}$; B_d is the classifier trough width; H_d is the height of the pulp level above the level of discharge of the classifier.

Based on (2) for the velocity of an arbitrary elementary stream, we can write

$$l_{es} \cdot v_{es} = l_{pt} \cdot v_{esb}, \tag{4}$$

whence, after substituting (1) in (4), we have

$$v_{es}\left(y\right) = \frac{v_{esb} \cdot l_{pl}}{\sqrt{l_{pt}^2 + \left(h_p - y\right)^2} + \sqrt{l_{pd}^2 + \left(h_p - y\right)^2}}. \tag{5}$$

After substituting (5) in (3) we have

$$Q_{\text{pt\_d}} = B_d \cdot v_{esb} \cdot \left(H_d + l_{pl} \cdot \int_{Q_{\text{pt\_d}}}\right);$$

$$\int_{Q_{\text{pt\_d}}} = \int\limits_{y=0}^{h_{\text{ïê}}} \left(\sqrt{l_{pt}^2 + \left(h_p - y\right)^2} + \sqrt{l_{pd}^2 + \left(h_p - y\right)^2}\right)^{-1} \cdot dy.$$

Then the rate of movement of the pulp in the upper layer is equal to

$$v_{esb} = \frac{Q_{\text{pt\_d}}}{B_d \cdot \left(H_d + l_{pl} \cdot \int_{Q_{\text{pt\_d}}}\right)}.$$

The consumption $Q_{\text{pt\_H}}$ of horizontal flow discharge of the classifier will be equal to

$$Q_{\text{pt\_H}} = v_{esb} \cdot B_d \cdot H_d = \frac{1}{1 + \frac{l_{pl} \cdot \int_{Q_{\text{pt\_d}}}}{H_d}} \cdot Q_{\text{pt\_d}}.$$

Accordingly, the flow of pulp through the drain from the trough $Q_{\text{pt\_t}}$ will be equal to

$$Q_{\text{pt\_t}} = Q_{\text{pt\_d}} - Q_{\text{pt\_H}}.$$

The calculation of the proportion of the horizontal flow consumption in the total flow consumption of the drain carried out for the operating modes of the 2KCH 30 × 125 classifier showed that the ratio $Q_{\text{pt\_H}}/Q_{\text{pt\_d}}$ lies in the range of 0.01–0.025. This leads to the conclusion: the main flow of water into the drain comes from the inner layers of the classifier trough. Therefore, the basic mechanism for separating particles of different sizes in a spiral classifier is separation in an upward flow.

Consider the structure of the stream directly in the discharge area. Figure, *b*) shows the structure of such a stream for discharge with a thin wall (from the book by I. I. Agroskin, G. T. Dmitriev, F. I. Pikalov). This type of discharge is closest to the type of discharge for the spiral classifier, and, if necessary, the drain spiral classifier can be easily modified to fully match the drain with a thin wall.

The lower streamline can be approximated by a parabola with a vertex at point $\{x_v = 0.27 \cdot H_d; y_v = 0.112 \cdot H_d\}$. The equation of such a parabola passing through point $\{x_{bd} = 0; y_{bd} = 0\}$ corresponding to the upper face of the drain will be sought in the form

$$y = a + b \cdot (x - c)^2. \tag{6}$$

The coefficients of such a parabola are

$$\begin{cases} a = y_v = 0.112 \cdot H_d \\ c = x_v = 0.27 \cdot H_d \\ b = y_{bd} - y_b \Big/ \left(x_{bd} - x_b\right)^2 = -1.536 \Big/ H_d \end{cases}.$$

Then equation (6) takes the form

$$y = (0.112 - 0.536 \cdot (x/H_d - 0.27)^2) \cdot H_d.$$

The derivative that determines the direction of the velocity vector is

$$\frac{\partial y}{\partial x} = -3.072 \cdot \left(x/H_d - 0.27\right).$$

From here you can determine the direction of the velocity vector at point $\{x_{\text{bd}} = 0; y_{bd} = 0\}$. This is the angle of its inclination to the horizontal: φ_{bd}

$$\varphi_{bd} = \text{arctg}\, 0.82944 = 39°20'.$$

Then the vertical $v_{\text{bd\_v}}$ and horizontal $v_{\text{bd\_g}}$ components of the velocity at point $\{x_{bd} = 0; y_{bd} = 0\}$ are related by

$$v_{\text{bd\_v}} = v_{\text{bd\_g}} \cdot \text{tg}\, \varphi_{bd}. \tag{7}$$

Since the vertical speed changes under the influence of gravity from $v_{\text{bd\_v}}$ at point $\{x_{bd}; y_{bd}\}$ to zero at point $\{x_b; y_b\}$, then, given the fact that the rise height above the level of the drain edge at point $\{x_b; y_b\}$ is $0.668 \cdot H_d$ (Figure, *b*)) it is fair to write

$$v_{\text{bd\_v}} = 0.473 \cdot \sqrt{g \cdot H_d}. \tag{8}$$

Thus, the vertical component of the fluid velocity at the point of contact of the stream of the discharge edge is uniquely determined by the discharge pressure.

The horizontal component of the drain rate can be determined from (7) after substitution of (8) into it and solution regarding $v_{\text{bd\_g}}$ $v_{\text{bd\_g}}$

$$v_{\text{bd\_g}} = 0.57 \cdot \sqrt{g \cdot H_d}.$$

As an indirect assessment of the fractional composition of the classifier drain, it is proposed to take the diameter of a solid particle located on the edge of the drain edge, in which the vertical component of the flow velocity is balanced by the fall speed of the constrained particle in a polydisperse medium (pulp) v_{con}. As v_{con} in our case, $v_{\text{bd\_v}}$ calculated according to (8) is assumed.

The relationship between the equilibrium velocity of the hindered falling of particles in the pulp and the speed of the free fall of particles in a liquid v_{fr} is described by the Godain formula

$$v_{con} = v_{fr} \cdot \left(1 - \sqrt[3]{\gamma_p^2}\right) \cdot \left(1 - \gamma_p\right) \cdot \left(1 - 2.5 \cdot \gamma_p\right),$$

where γ_p is solid pulp volume

$$\gamma_p = (\rho_d - \rho_w)/\rho_s - \rho_w,$$

where ρ_s is the density of the solid in the sink; ρ_w is the density of water; ρ_d is the drain density.

Then

$$v_{fr} = v_{con} \Big/ \left(\left(1 - \sqrt[3]{\gamma_p^2}\right) \cdot \left(1 - \gamma_p\right) \cdot \left(1 - 2.5 \cdot \gamma_p\right)\right). \tag{9}$$

The free fall of a particle with a diameter d_{prt} in a liquid is obtained from the equilibrium condition

$$\frac{\pi \cdot d_{prt}^3}{6} \cdot \left(\rho_s - \rho_w\right) \cdot g = C_D \cdot \frac{\pi \cdot d_{prt}^2}{4} \cdot \frac{v_{fr}^2}{2} \cdot \rho_w,$$

where C_D is the frontal resistance coefficient.

From which we have

$$d_{prt} = 0.75 \cdot C_D \cdot \left(v_{fr}^2 / g\right) \cdot \left(\rho_w / \left(\rho_s - \rho_w\right)\right). \tag{10}$$

It should be noted that the flow in the drain is partly turbulent in nature and the particle in the drain has a swirl movement, along with the translational vertical and horizontal movement. The consequence of this is the uniform flow of water around the particle and the possibility of applying the Stokes formula to calculate the drag coefficient

$$C_D = 24/\mathrm{Re}. \tag{11}$$

Reynolds number is calculated as

$$\mathrm{Re} = \rho_w \cdot d_{prt} \cdot v_{fr}/\mu_w, \tag{12}$$

where μ_w is the coefficient of dynamic viscosity of water, which depends on the temperature of the water. This dependence can be described by the Poiseuille formula.

Equating $v_{\mathrm{bd\_b}}$ to v_{con} and solving (9–12) relatively to d_{prt}, we obtain an indicative value of the particle diameter $d_{\mathrm{ind\_d}}$ for assessing the fractional composition of the solid in the discharge of the classifier

$$d_{\mathrm{ind\_d}} = \frac{k_{\mathrm{d\_d}} \cdot Q_{\mathrm{V\_cl}}^{\frac{1}{6}}}{\left((\rho_s - \rho_w)\cdot A_\gamma \cdot B_\gamma \cdot C_\gamma\right)^{\frac{1}{2}}},$$

where $k_{\mathrm{d\_d}}$ is the drain design coefficient

$$k_{\mathrm{d\_d}} = \frac{2.7541}{\left(g^2 \cdot k_{\mathrm{h\_d}} \cdot B_d\right)^{\frac{1}{6}}} \approx \frac{1.287}{\left(k_{\mathrm{h\_d}} \cdot B_d\right)^{\frac{1}{6}}};$$

A_γ, B_γ, C_γ are coefficients of the Godain formula

$$A_\gamma = \left(1 - \left(\frac{\rho_d - \rho_w}{\rho_s - \rho_w}\right)^{\frac{2}{3}}\right);$$

$$B_\gamma = \left(1 - \frac{\rho_d - \rho_w}{\rho_s - \rho_w}\right);$$

$$C_\gamma = \left(1 - 2.5 \cdot \frac{\rho_d - \rho_w}{\rho_s - \rho_w}\right).$$

Several modifications of formula (13) are possible depending on the variables taken as the basic ones. So, for example, if instead of the volumetric flow consumption of the pulp through the drain, we take the solid mass consumption through the drain Q_{mP}, then (13) will be written in the form

$$d_{\mathrm{ind\_d}} = \frac{k_{\mathrm{d\_d}} \cdot \mu_w^{\frac{1}{2}} \cdot \left(Q_{mP} \cdot \frac{1 - \rho_w/\rho_s}{\rho_d - \rho_w}\right)^{\frac{1}{6}}}{\left((\rho_s - \rho_w)\cdot A_\gamma \cdot B_\gamma \cdot C_\gamma\right)^{\frac{1}{2}}}. \tag{14}$$

Note that in the steady state, the solid mass consumption in the drain of the classifier is equal to the consumption of the ore mass entering the first stage of enrichment.

As you can see, the dependence of the indicative diameter, and, hence, the particle size distribution of the classifier drain, on the density of the drain is not unique. Therefore, an analysis of the sensitivity of the indicative particle diameter in the discharge of the classifier to the parameters from the right side of formula (14) was conducted.

The density regimes of the classifier discharge were calculated for the density of ore $\rho_s = 3400$ kg/m^3 and the density of water $\rho_w = 1000$ kg/m^3. The water temperature in the discharge of the classifier was taken equal to $t_w^0 = 20\,^\circ\mathrm{C}$.

The dynamic viscosity of water μ_w is calculated by the approximating dependence (Poiseuille formula) as a function of water temperature.

Table 1 shows the initial data of the modes for calculating the indicative diameter of the particle size distribution in the discharge of the classifier and its sensitivity to parameter variations from the right-hand side of (14).

The results of calculating the absolute values of sensitivity (derivatives) for the studied density modes are given in Table 2

The influence of disturbances can be estimated by comparing them with the maximum values of the relative changes in the density parameters of the classifier drain and the indicative particle diameters in the classifier drain for the enrichment regimes presented in Table 1. They amounted to 12.68 and 26.09 %, respectively. This indicates that these parameters should be directly or indirectly taken into account for setting up and managing the enrichment regimes of the first stage. At the same time, the indicative particle diameter in the classifier discharge should be taken as the main tuning criterion, since it more fully characterizes the separation mode of the spiral classifier.

It should be noted that the density of the drain of the classifier should be adjusted depending both on the density of the rock entering the enrichment, and on the temperature of the water in the trough to stabilize the particle size distribution of the drain.

Conclusions.

1. Separation of particles in a spiral classifier is carried out in an upward flow of water.

2. To assess the separation characteristics of the spiral classifier, it is advisable to take an indicative particle diameter that corresponds to the diameter of the particles on the classifier drain ridge, in which the impact of the vertical component of

Table 1

Parameters of the enrichment regimes of the first stage

Line number (mode)	ρ_d classifier discharge density (estimated) kg/m^3	ρ_d classifier discharge density (modified) kg/m^3	Q_{mP} solid mass consumption (ore) through the drain. kg/s	$d_{\mathrm{ind\_d}}$ m
9	1548	1639	64.101	0.001034
363	1364	1518	48.146	0.000782
555	1562	1652	64.568	0.001058
584	1406	1445	46.998	0.000815
628	1375	1399	45.6	0.000784
899	1476	1464	58.931	0.000907
931	1483	1532	59.186	0.000929

Table 2

The sensitivity of the indicative diameter to a change in the parameters of the enrichment regime of the first stage

mode number	$d_{\mathrm{ind\_d}}$ 10^{-3} m	$\frac{\partial d_{\mathrm{ind\_d}}}{\partial \mu_w}$ m/(Pa · s)	$\frac{\partial d_{\mathrm{ind\_d}}}{\partial t_w^0}$ m/grade. °C	$\frac{\partial d_{\mathrm{ind\_d}}}{\partial Q_{mP}}$ m/(kg/s)	$\frac{\partial d_{\mathrm{ind\_d}}}{\partial \rho_s}$ m/(kg/m^3)	$\frac{\partial d_{\mathrm{ind\_d}}}{\partial \rho_d}$ m/(kg/m^3)
9	1.034	0.5139	$-0.012478 \cdot 10^{-3}$	$0.002686 \cdot 10^{-3}$	$-0.6296 \cdot 10^{-6}$	$0.0015932 \cdot 10^{-3}$
363	0.782	0.3892	$-0.009449 \cdot 10^{-3}$	$0.002708 \cdot 10^{-3}$	$-0.3189 \cdot 10^{-6}$	$0.0007749 \cdot 10^{-3}$
555	1.058	0.5260	$-0.012771 \cdot 10^{-3}$	$0.002729 \cdot 10^{-3}$	$-0.6670 \cdot 10^{-6}$	$0.00168654 \cdot 10^{-3}$
584	0.815	0.4051	$-0.009835 \cdot 10^{-3}$	$0.002887 \cdot 10^{-3}$	$-0.36168 \cdot 10^{-6}$	$0.00089937 \cdot 10^{-3}$
628	0.784	0.390	$-0.009468 \cdot 10^{-3}$	$0.002865 \cdot 10^{-3}$	$-0.32672 \cdot 10^{-6}$	$0.00079984 \cdot 10^{-3}$
899	0,907	0.45757	$-0.0111096 \cdot 10^{-3}$	$0.00260127 \cdot 10^{-3}$	$-0.47453 \cdot 10^{-6}$	$0.001199099 \cdot 10^{-3}$
931	0.929	0.46213	$-0.0112203 \cdot 10^{-3}$	$0.00261588 \cdot 10^{-3}$	$-0.48676 \cdot 10^{-6}$	$0.001230794 \cdot 10^{-3}$

the upward velocity component on the particle is balanced by the particle's gravity.

3. A significant effect of the density of the classifier rock and a noticeable effect of the temperature of the water in the trough of the spiral classifier on its separation characteristics at a constant discharge density have been established. To stabilize the particle size distribution, the classifier discharge density should be adjusted depending both on the density of the rock supplied for enrichment and on the temperature of the water in the classifier trough.

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Модель розділення частинок у спіральному класифікаторі

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Мета. Розробка моделі, що описує взаємозв'язок параметрів, які характеризують режим роботи спірального класифікатора, з гранулометричним складом рудного продукту у зливі класифікатора для підвищення оперативності й точності керування процесом збагачення залізорудної сировини.

Методика. Теоретичні дослідження базувалися на класичних моделях поділу матеріалу, що класифікується, та обґрунтування параметра, що характеризує гранулометричний склад цього матеріалу у зливі класифікатора, який може бути розрахований у рамках загальної теоретичної моделі з наступними контрольними розрахунками. Застосовані методи аналізу, синтезу, систематизації та узагальнення, математичного моделювання.

Результати. Отримані залежності, що дозволяють розрахувати параметр, який характеризує гранулометричний склад продукту у зливі спірального класифікатора за параметрами, що спостерігаються у процесі збагачення продукту, який класифікується.

Наукова новизна. Уперше обґрунтована модель поділу матеріалу, що класифікується у спіральних класифікаторах, і показано вплив температури середовища поділу на процес класифікації.

Практична значимість. Отримані результати можуть бути використані для автоматичної стабілізації гранулометричного складу продукту у зливі спірального класифікатора.

Ключові слова: *спіральний класифікатор, гребінь зливу, індикативний діаметр, сепарація*

Модель разделения частиц в спиральном классификаторе

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Цель. Разработка модели, описывающей взаимосвязь параметров, характеризующих режим работы спирального классификатора, с гранулометрическим составом рудного продукта в сливе классификатора для повышения оперативности и точности управления процессом обогащения железорудного сырья.

Методика. Теоретические исследования базировались на классических моделях разделения классифицируемого материала и обоснования параметра, характеризующего гранулометрический состав классифицируемого материала в сливе классификатора, который может быть рассчитан в рамках общей теоретической модели с последующими контрольными расчетами. Применены методы анализа, синтеза, систематизации и обобщения, математического моделирования.

Результаты. Получены зависимости, позволяющие рассчитать параметр, характеризующий гранулометрический состав продукта в сливе спирального классификатора по наблюдаемым параметрам процесса обогащения классифицируемого продукта.

Научная новизна. Впервые обоснована модель разделения классифицируемого материала в спиральных классификаторах и показано влияние температуры среды разделения на процесс классификации.

Практическая значимость. Полученные результаты могут быть использованы для автоматической стабилизации гранулометрического состава продукта в сливе спирального классификатора.

Ключевые слова: *спиральный классификатор, гребень слива, индикативный диаметр, сепарация*

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