Practical implications. Further development and manufacturing application of the research results will provide a significant reduction in the cost price of iron ore products by increasing the efficiency of drilling and blasting operations in the open pit.

Keywords: ore, explosive destruction, open pit, acoustic waves, blasting, borehole charges

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ДОСЛІДЖЕННЯ СЕГРЕГАЦІЇ ДЛЯ РОЗРОБКИ ТЕХНОГЕННИХ ПОКЛАДІВ З МЕТОЮ ВДОСКОНАЛЕННЯ ЯКОСТІ ПРОДУКЦІЇ

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USING OF SEGREGATION FOR DEVELOPMENT OF TECHNOGENIC DEPOSITS WITH THE PURPOSE OF UPGRADING OF PRODUCTS

Виявлено теоретичне підґрунтя ефекту сегрегації при складуванні відходів збагачення з урахуванням високоякісного опису різних фракцій, проведені розрахунки щодо визначення основних параметрів технологічного процесу складування та подальшої розробки техногенного родовища з урахуванням рекомендацій щодо застосування результатів у гірничодобувній промисловості.

Приведены теоретические основы сегрегации при складировании отходов обогащения с учетом качественного описания различных фракций, составлены расчеты по определению основных параметров технологического процесса складирования и последующей разработки техногенного месторождения, учитывая рекомендации по применение результатов в горнодобывающей промышленности.

The inalienable feature of technological processes of booty and enriching of minerals is formation of wastes and passing products considerable part of which presents raw material for different industries of national economy.

A modern raw material, power and ecological situation requires more complex going near the use of natural resources, further improvement of development and processing of raw material processes. So, for example, it is very important to know conformities to law of segregation processes at determination of flowsheets of the repeated affecting dumps and storages of useful minerals, at the decision of tasks on engaging in exploitation of technogenic deposits with the certain areas of concentration of useful component, at prognostication of the state of bulk and loose objects [1]. It largely restrains temper absence of possibility of consideration of role of making dividing processes taking into account their probabilistic nature, and it does not allow

to synthesize, for example, processes of ore preparing of mineral raw material before his enriching with segregation processes.

The purpose of work is determination of parameters of flowsheet of warehousing of wastes of enriching of mining factories №1, 2 and 3 of Dokuchaevsk Flux and Dolomite Joint Stock Company in Donetsk region, taking into account the subsequent working off them as technogenic deposits on the basis of the set conformities to law of processes of segregation of mountain mass.

In times of work JSC «DFDK» was accumulated more than 100 million cub.m. wastes of enriching of limestones and dolomites which by virtue of small grain-size distribution in 0 – 15mm long time were not claimed as by commodity products [2]. In the last, time from the increase of demand on an attle, necessary at development of iron-ore deposits (mainly mining enterprises of the Krivoy Rog Basin), particular interest is presented by faction 0 – 5mm, which along with other positive descriptions possesses cementation properties. The organizations are ready to use for construction-works (mainly for the production of concrete) faction 5 – 15mm, at minimum maintenance of other factions.

With the purpose of processing of wastes of enriching the technological line of successive screening of rock mass is created for the receipt of two types of commodity products is a macadam of faction 0 – 5mm for the book-mark of mine-out space and macadam for the construction-works of faction 5 – 15mm.

A serious problem is a presence in faction 5 – 15mm of more shallow factions. Principal reasons of decline of quality of sieving are: at first is the additional growing of product shallow at hittings of pieces of breed on pouring devices, on a conveyer ribbon, at motion on the sloping surface of slope of dump, and secondly, from the brightly expressed effect of sticking of shallow moist particles on-the-spot more larger with subsequent cementation connections. The table of contents of non-standard factions can arrive at to 22 -27% from the general volume of product (Fig. 1.).

In this case the use of segregation of mountain mass, both on the sloping surface of tier of dump and at forming of cone of storage allows to dissociate «commodity» faction from «non-standard» faction.

Segregation process, as the physical phenomenon is a division of friable material on a largeness as a result of certain mechanical influence, for example - at pouring out of him on a sloping surface [3].

In theoretical physics dividing processes are described kinetic equalization (1) of diffusive type (by equalization of Einstein – Fokkera – Planka – Kolmogorov).

$$\frac{\partial W}{\partial t} = \left[-\sum_{i-1}^{N} \frac{\partial}{\partial x_i} D_i^1(x_1,...,x_N) + \sum_{i-1}^{N}\sum_{j-1}^{N} \frac{\partial^2}{\partial x_i \partial x_j} D_{ij}^2(x_1,...,x_N) \right] W,$$
(1)

where W(v, t) is a function of closeness of probability, describing probability that a particle has speed in an interval (v, v + dv), if in the moment of time 0 it had initial velocity of v0; D1 is a vector of tearing down, and D2 is a vector of diffusion, thus diffusion is caused the action of forces of stochastic nature.

Fig. 1. General view of display of segregation on-the-spot of dump.

In most cases the decision of differential equalization abuts against numeral methods, and presentation of results is difficult for perception. Brings difficulties over of mathematical description of process of segregation to introduction to analytical dependences of auxiliary coefficients which hamper engineerings calculations and does not allow to attain adequate description of motion of mountain mass in the real terms of mountain works [4].

In this plan most, perspective is the use of mathematical model of process of segregation of the theoretical mechanics built on the basis of fundamental laws realized with the use of modern software products.

By virtue of certain symmetry of the decided task tangential and normal making speeds of particle (piece of breed) are determined correlation:

$$v_x = v_{xo} + dt \cdot fx / m \qquad v_z = v_z + dt \cdot fz / m$$
$$x = x_0 + dt \cdot v_x \qquad z = z + dt \cdot v_z \tag{2}$$

Forces of co-operation between I – ouch and j – ouch have a particle accordingly the following kind:

$$f_x = f_{xi} + dt \cdot x_i \cdot r_{эi} - G_j \cdot G_i \cdot (v_{Xi} - v_{Xj}) + \sigma$$
$$f_z = f_{zi} + dt \cdot z_i \cdot r_{i1} - G_j \cdot G_i \cdot (v_{zi} - v_{zj}) + \sigma \tag{3}$$

where: Gi, Gj are parameters, characterizing a friction between I - by a й piece and j is a m; (it is an additional element taking into account influence of environment (for example, friction at air).

The developed program allows to set not only necessary grain-size distribution and unloading descriptions but also to change, in the known limits, character of co-operation as between the elements of the system (by the pieces of breed) so character of scope terms - planes of co-operation. The generation of random numbers and statistical treatment was carried out by the program Matlab.

From an analysis got by a calculation by results and results of experiments on enrichment factory №1 JSC of «DFDK» (fig.2.) evidently, that for every horizontal section layer of embankment grain-size distribution is redistributed properly - dependence of maintenance of large faction in relation to the axis of cone has a polynomial kind (4), that confirms the statistician of distributing of particles on a middle radius.
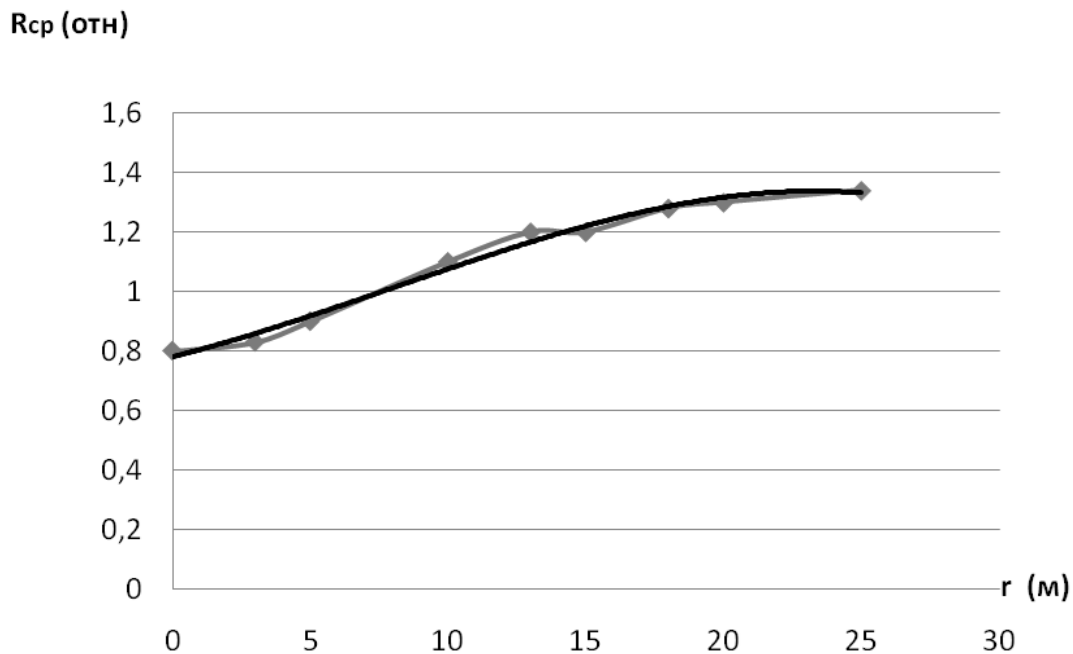

Fig. 2. Character of distributing of size of middle piece of breed in relation to the axis of cone (on horizon of foundation of embankment).

$$R_{cp} = Ar^3 - Br^2 + Cr + d \qquad (4)$$

where coefficients A, B and C proportional r = (R0 × H) / (Rwed × h) and rate fixing coefficient taking into account grain-size distribution, connectedness of elements between itself, d – a permanent size is proper stakes of the least faction.

Dependence (fig.3.) set as a result of design between the middle size of piece of breed for the selected horizontal layer from position of this layer in relation to foundation and height of cone (muck pile) allows to forecast quality of segregation effect on a sloping surface for an initial product. The aftertreatment of calculation and ex-

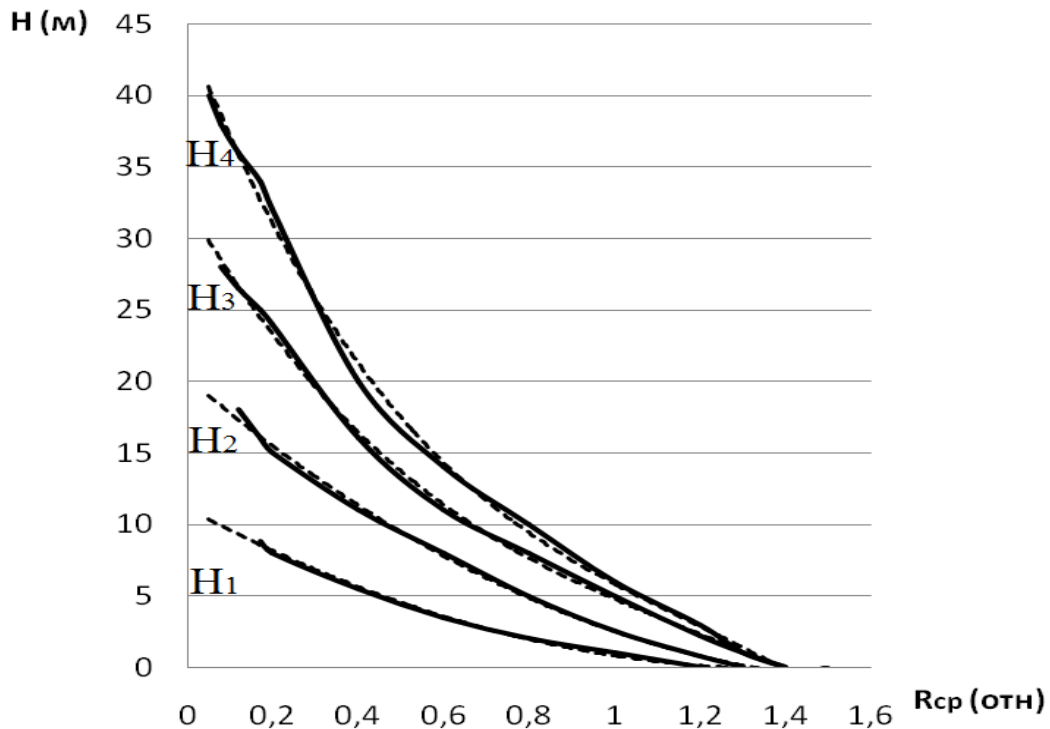perimental results confirms adequacy of the got mathematical model, that is convincingly rotined on a fig. 3.

Fig. 3. Dependence of segregation effect on the height of unloading on the sloping surface of faction of 0-5мм (20%) and macadam of faction 5-15 мм (80%) for Rcp=0,85мм. A continuous line is experimental information of N1 – N4; the dotted line is calculation information on a model [5].

For fracture storage conditions of 5-15 mm fraction from 20% is the maintenance of the fraction 0-5mm, the height of the optimum cone height of at least 30m can be considered, which ensures both normal quality of the rubble and optimal parameters of the coal seam for shipment of the products of the ECG-5A excavator. In the case of pouring out raw materials with high humidity, the height of the pouring must be increased. This will make it possible to improve the cleaning of large pieces from the adherence of dust particles due to an increase in shaking time when particles move on a slope.

As far as shipping of faction 5 – 15мм it is necessary periodically to besiege the «cap» of cone containing more than 73% faction 0 – 5мм with shipping for the production of book-mark works.
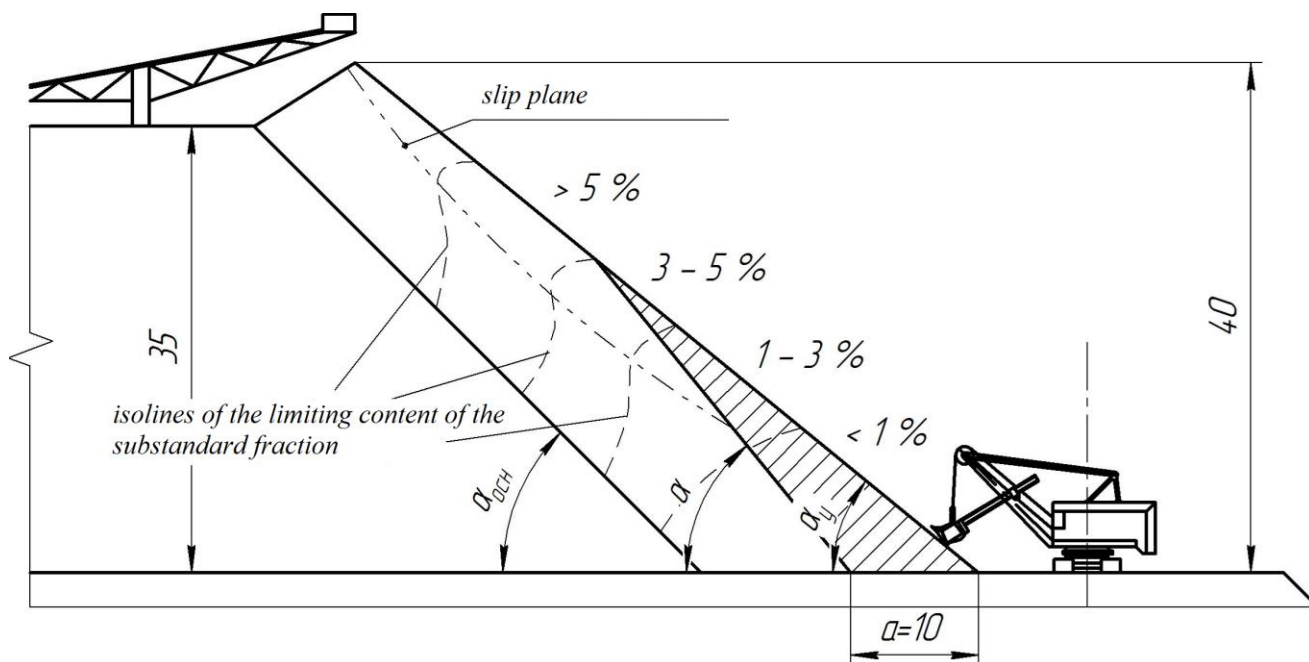
Fig. 4. Chart of working off the area of standard faction from the surface of slope of cone of dump.

Thus, it should be noted that offered approach by us near the decision of task of segregation of mountain mass allows to forecast quality of segregation effect on a sloping surface not dependency upon faction of breed, angle of slope and height of cone of embankment. Adequacy of mathematical model is experimentally well-proven, to the process examined in-process.

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ABSTRACT

Purpose. The use of the process of segregation of rock mass on the inclined surface of the tier of the dump during the formation of the storage cone to develop technology for separating the "commodity" fraction from the "non-standard" fraction.

The methodology of the investigations consists in the use of segregation processes, which are described by the kinetic equation of the diffusion type (Einstein-Fokker-Planck-Kolmogorov), for the separation of friable material into faction as a result of a certain mechanical action.

Findings. The approach we proposed to solve the problem of segregation of rock mass allows us to predict the quality of the segregation effect on an inclined surface that does not depend on the rock fraction, the slope angle and the cone height. The sufficiency of the mathematical model is experimentally well tested for the process.

The originality. Dependence of segregation effect on the height of unloading on the sloping surface set as a result of design between the middle size of piece of breed for the selected horizontal layer from position of this layer in relation to foundation and height of cone (muck pile) allows to forecast quality of segregation effect on a sloping surface for an initial product.

Practical implications. For fracture storage conditions of 5-15 mm fraction from 20% is the maintenance of the fraction 0-5mm, the height of the optimum cone height of at least 30m can be considered, which ensures both normal quality of the rubble and optimal parameters of the coal seam for shipment of the products of the ECG-5A excavator. In the case of pouring out raw materials with high humidity, the height of the pouring must be increased. This will make it possible to improve the cleaning of large pieces from the adherence of dust particles due to an increase in shaking time when particles move on a slope.

As far as shipping of faction 5 – 15мм it is necessary periodically to besiege the «cap» of cone containing more than 73% faction 0 – 5мм with shipping for the production of book-mark works.

Keywords: segregation, technogenic deposits, mining industry, faction, excavator