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SUBSYSTEM OF MAKING DECISION FOR АСУТП OF AGGLOMERATION

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There is offered the subsystem for backing of decision-making for ASUTP in the agglomeration. This subsystem ensures to carry out control of optimal damp of charge on the basis of the analytical search for the minimal value of batch of layer at the given technological parameters.

Keywords: agglomeration process, the subsystem for backing of decision-making, damp and batch layer of charge, mathematical model

Introduction. Quality of charge planning to sintering is determined by its properties, purchased on the stage of palletizing and at transporting on a sinter machine [1,2]. On the stage of palletizing and damping of charge closeness of particles are formed in granules, their structure, chemical, mineralogical and grain-size composition, and at transporting a charge is exposed to dynamic influence at falling from a palletizer in an intermediate bunker, to static pressure of charge, founding in a bunker, and segregation of granules on the height of layer its folding on pallets sintering machine.

It is known [1,2], that the defined value of damp corresponds every sintering charge, thus deviation of damp from an optimal value on 0.5 % is accompanied by worsening of quality of agglomerate and decline of the productivity of sintering machine on 6-8 %.

In spite of the fact that to the study of influence of charge damp on quality of its planning, and also motion and results of process of sintering is devoted many works, the single scientifically reasonable method of determination of optimal damp is not present. As a criterion of optimality use poured mass, gas-penetrability, productivity of sintering machine, quality of agglomerate and other. However by researches [1,2] it is proved that these parameters are unrepresentative facts, and the use of them as the managed sizes is limited by complication or impossibility of continuous control on an operating sintering machine.

In an initial period of sintering a charge, put on a sinter machine, is made more compact under the action of rarefaction, vibration and heat radiation forge. At drawing of hot air through the layer of charge there is displacement of granules in relation to large pores, evaporation of moisture from its overhead horizons, satiation of gas by water vapor and subsequent layer specific formation of zone of over-damping [2]. If a charge is totality badly lump an aggregate palletizing units, then additionally condensable water, accumulating in points their contiguity, promotes destruction and compression of granules, and also shrink of layer [1,2].

Problem formulation. In connection with that gas-dynamic properties of charge put on a sintering machine there is determined largely speed of sintering and quality of agglomerate and also a fact absents, characterizing quality of its planning to clot-

ting, researches in an initial period of sintering shrink of charge and degree of its influence on motion and results of agglomeration in the conditions of agglofactory of OAJ «Metallurgical combine «Zaporozhstal′» are executed.

Basic part of researches. The dispersive analysis of the got results showed that meaningful influence on the size of charge layer shrink Δh is rendered by the changes of her damp W and level H materials in an intermediate bunker, and also middle diameter of granules d [3]. Thus the investigated dependences have extreme character, and maximal speed of sintering and the best quality of agglomerate correspond minimum shrink of layer.

It is necessary on this basis that at sintering process control shrinkage of layer of charge in an initial period of sintering it is possible to use as a parameter, characterizing gas-dynamic properties of charge, put on a sintering machine. However complication of measuring of layer shrink under a forge, and also a transport lagging which is possessed by the dust of serve and piling of charge on a sintering machine is done practically by impossible development of the optimal system of automatic control without implementation of mathematical modeling of compression of friable materials on a sintering machine.

In connection with that the mechanism of charge shrink in an initial period of sintering has two the clearly expressed stages, related to the action of vacuum and vibration of sintering machine, and also presence of process of heat exchange, the modeling of process of compression was executed by installments [4].

It is known that basic influence on the process of compression of layer under the action of vacuum and vibration render geometrical factors: form, correlation of sizes for granules and co-operation at contacts. Therefore at a modeling used the formula of volume for ball $V_{ш} = \pi \cdot d^3 / 6$, dependence of shrink at the compression of granules from the change of porosity of layer:

$$\Delta h = h \frac{e_1 - e_2}{1 + e_1} \ ; \tag{1}$$

and also system of equations, describing the conditions of equilibrium of granule in a layer:

$$\sum F_k (x) = F \sin \alpha_1 + N \cos \alpha_1 - N_1 - F_2 \sin \alpha_1 - N_2 \cos \alpha_1 + N_3 = 0 \,, \tag{2}$$

$$\sum F_k (y) = N \sin \alpha_1 - F \cos \alpha_1 - P + F_1 - N_2 \sin \alpha_1 + F_2 \cos \alpha_1 + F_3 = 0 \ , \tag{3}$$

$$\sum m(c) = -F \frac{d}{2} + F_1 \frac{d}{2}(1 + \cos \alpha_1) + N_1 \frac{d}{2} \sin \alpha_1 + F_2 d - N_3 \frac{d}{2} \sin \alpha_1 + F_3 \frac{d}{2}(1 - \cos \alpha_1) = 0 \ , \tag{4}$$

where h is initial height of layer of charge; e_1 e_2 are accordingly initial and eventual coefficients of porosity; F, F_1, F_2, F_3 are forces frictions, operating on a granule in a layer, $F = f \cdot N$, $F_1 = f \cdot N_1$; $F_2 = f \cdot N_2$; $F_3 = f \cdot N_3$; N, N_1, N_2, N_3 are normal constituents of friction forces; f is a coefficient of internal friction of charge.

As a result of mathematical transformations of equations expression of dependence of layer shrink Δh_1 is got from the size of coefficient of internal friction f of charge under the action of vacuum and vibration

In connection with that the second constituent of shrink of charge layer Δh_2 in an initial period of sintering is determined by thermal processes, operating in a charge, the mechanism of which it is difficult to present an analytical way, for description shrink applied statistical methods.

$$\Delta h_2 = b_0 + \sum_{i=1}^{k} b_i x_i + \sum_{i>j}^{k} b_{ij} x_i x_j + \sum_{i=1}^{k} b_{ij} x_i^2 \ , \qquad (5)$$

where x_i is the normalized value of independent managing influences W, H, d; b_i are coefficients of equation of regressive.

For the estimation of coefficients of equation (5) it is used a central composition orthogonal plan and methods of its realization.

Then mathematical description of process of charge shrink in an initial period of sintering was presented as a sum of two constituents ($\Delta h_1 + \Delta h_2$) as [5]:

$$\Delta h = \Delta h_1 + \Delta h_2 = \left[1 - \frac{(1{,}367 - 0.005 f)\sin^2 \alpha_2}{\frac{1}{2} + \sqrt{\left(f^4 + f^2 + 1\right) / 2\left(f^2 + 1\right)}} \right] \cdot 100\% + 0{,}133(55 - t_{ш}) + 28{,}725W^2 -$$

$$- 471{,}09W + 0{,}689d^2 - 6{,}2d + 13{,}68H^2 - 36{,}416H + 1973{,}599.$$

$$-471{,}09W + 0{,}689d^2 - 6{,}2d + 13{,}68H^2 - 36{,}416H + 1973{,}599. \qquad (6)$$

For determination of coefficient of internal friction f of charge it is used equation, found an experimental way [6]:

$$f = \mathrm{tg}\left\{ 37{,}376 + 0{,}886\left[\mathrm{arctg}\left(0{,}62 - 0{,}085d\right) + 1{,}118W \right] \right\} \ . \qquad (7)$$

From the reduced dependences over evidently, that shrink of layer of sintering charge in an initial period of sintering is determined by both its temperature t_{cha} and by damp W and level of charge H in an intermediate bunker, and also by the middle diameter of granules d.

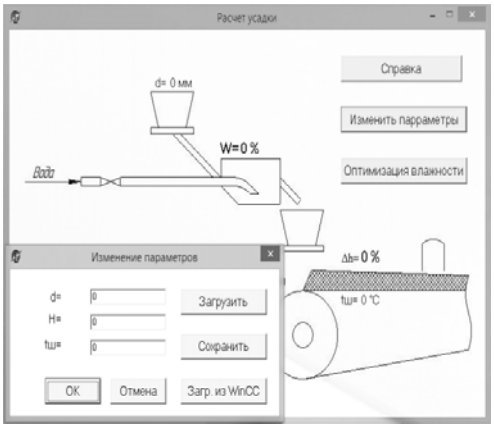
Comparison of dependences of shrink, expected on a formula (7), with its values, got an experimental way showed, the high enough coincidence of the forecast and experienced facts. Middle on the module error does not exceed 0.5 %. Verification of mathematical model with the use of Fisher criterion in the predictable relevant of variables H = 1.35 ± 0.85 m, W = 8.2 ± 0.5 %, d = 4.5 ± 2.0 mm was confirmed by its adequacy to the real process of charge shrink.

The got results of researches and mathematical modeling of charge shrink in an initial period of sintering allowed to work out the subsystem of making decision for Process Control System (ASUTP) of agglomeration. The mathematical model of shrink of sintering charge which the system of adjusting of optimal damp is realized on the base of this subsystem. In accordance with the algorithm of making decision, on the values of middle diameter of granules of charge and level of it's in an intermediate bunker with use a mathematical model it is carried out the search of value of damp of charge which minimum shrink is arrived. After it the found value of optimal damp is recommended as a task for the system of automatic control of process of damping of charge.

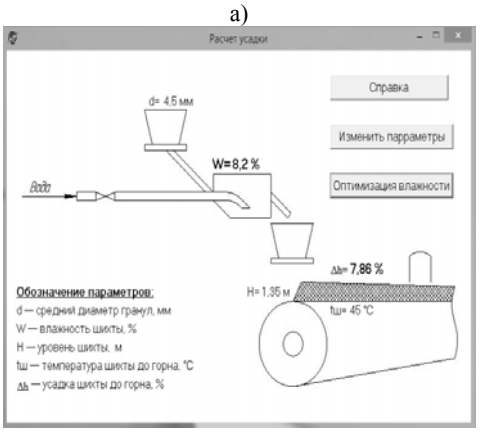
Subsystem of making decision software and graphic man-machine interface is realized by means of visual object-oriented programming of «Delphi 6» environment on language «Object Pascal». A subsystem is computer-integrated in ASUTP with use a code which from SCADA-system WinCC adds entrance values for the calculation of shrink to the file of «config.ini».

In the main window of subsystem of making decision (look fig) mimic over of area of preparation of charge to sintering and transporting of it's on a sintering machine is brought and also parameters which the operator of AWP and buttons of control.

At pushing button «Certificate» all objects hide, except for a technological line on which comments to every element of structure and return button in a main window appear.



а)



б)

Figure - Main windows for system of decision-making

The button «To change parameters» opens a corresponding window; a basic form is blocked here. On a new form (fig. a) the fields of input for variables and button «OK», «Abolition», «To load», «To save», «Load from WinCC» are accessible. With use the buttons «To save» and «To load» data of programs and result of calculations presented in the file of «config.ini», and loaded in the table of calculations for archiving. Button «Load from WinCC» passes the values of variables from corresponding SCADA. After pushing button «OK» facts are added to the program and hatch on a main screen. After pushing button «Optimization of damp» the program for the set values of level of charge in an intermediate bunker and middle diameter of granules determines, damp of charge at which minimum shrink is arrived at and destroys their values on a screen (fig.b). At the same time in the supervisor regime a

task in the system of automatic control of optimal damp of charge is corrected, what is provide maintenance of shrink at minimum level, the best gas-dynamic properties of charge, put on a sintering machine are created, and, consequently, and conditions of its sintering.

Conclusions. With the use of the worked out model of charge shrink the sub-system of making decision, allowing to carry out adjusting of optimal damp of charge on the basis of analytical search of minimum value of layer shrink at technological preset parameter, in an initial period of its sintering is realized.

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