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THE INTELLECTUAL SYSTEM OF AUTOMATIC CONTROL AT ENRICHMENT OF TECHNOGENIC WASTE IN THE FLUIDIZED LAYER

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Abstract: *In management of difficult technological processes the intellectual systems of automatic control are successfully applied. Among intellectual control systems the greatest distribution was gained by indistinct control systems. For design of the indistinct regulator the mathematical model of continuous and periodic processes of enrichment of technogenic waste of the mining and metallurgical plants (MMP) is constructed. Existence of indistinct sets the dispersion of the sizes of the separated particles, difference of a form of particles of real disperse materials from spherical, change of humidity of particles seasonally demand accounting of such factors as. Besides impact change of a consumption of gas, thickness and a poroznostipsevdoozhizhenny layer, diameter of particles, density, the device sizes, etc. exerts on their values.*

Keywords: *intellectual systems, automatic control, indistinct regulator, mathematical model, indistinct sets, enrichment, coefficient of a form of particles, indistinct control systems.*

Introduction

In recent years in management of difficult technological processes the intellectual systems of automatic control which allow to carry out adaptation, or control due to storing and the analysis of information on behavior of an object are successfully applied. Among intellectual control systems the greatest distribution was gained by indistinct control systems.

Usually, interaction of the indistinct regulator with object of management is presented in the form: "IF (an initial situation), THEN (response)" that corresponds to a form of human interaction. In the indistinct regulator, on the basis of base of "If-Then" rules, the logical decision in the form of an indistinct set in the form of the resulting function of accessory is formed. With use of indistinct management there is an opportunity to organize management in the form of dialogue with the operator as, rules of management register words in the form of expressions of "If-Then" [1,2].

For development of a method of calculation of installations of pneumoseparation of bulks in a fluidized layer and design of the indistinct regulator the mathematical model of continuous and periodic processes of enrichment of technogenic waste of the mining and metallurgical plants (MMP) is constructed.

The equation of material balance of enrichment looks as follows:

$$\frac{dm_1}{d\tau} = g_{10} - g_{11} - \Delta g_1, \qquad (1)$$

where, m_1 - the mass of material in a fluidized layer determined by the equation:

$$m_1 = m_0 * \alpha_1 \qquad (2)$$

Here: m_0 – the lump of a fluidized layer; the a_1-concentration of material in a fluidized layer; g_{10} and g_{11} – respectively arrival and a consumption of material to the device with a fluidized layer; Δg_1- the amount of material passing into a gas phase and defined as:

$$\Delta g_1 = k_1 * \alpha_1$$

(Here: k_1 – enrichment coefficient)

The hydrodynamic structure of streams in a psevdoozhzhizhenny layer can be referred to model of ideal hashing to which there corresponds identical concentration in all object a fluidized layer.

For finding of m_1 it is necessary to calculate the mass of a fluidized layer m_0:

$$m_0 = V_{пс} * \rho_{пс} \quad (3)$$

where V_{fl} - the volume of a fluidized layer, equal $V_{fl}=S_c*h_{fl}$; (S_c-cross section of a layer; h_{fl} - height of a fluidized layer), - density of a fluidized layer.

From here we find,

$$m_0 = S_c * h_{пс} * \rho_{пс} \quad (4)$$

The expense of the g_{10} component coming to the device is defined by the work by the general a material consumption in the device G_0 on its concentration a_{10}.

$$g_{10} = G_0 * a_{10} \quad (5)$$

The expense of the g_{11} component leaving the device is defined by the work of a consumption of the material G_1 on its concentration a_{11}.

$$g_{11} = G_1 * a_{11} \quad (6)$$

where G_0 - the general consumption of material in the device; G_1 expense of the coming-out material; Δg_1 - amount of the material passing into a gas phase:

$$\Delta g_1 = k_1 * a_1 \quad (7)$$

Here k_1 – enrichment coefficient.

Having substituted values of these parameters, we will receive the following differential equation

$$\frac{da_{i1}}{d\tau} = \frac{1}{S_c*h_{пс}*\rho_{пс}} (G_0 * a_{i0} - G_1 * a_{i1} - K * a_{i1}) \quad (8)$$

In the periodic mode of separation when G_0 =0, the equation (8) takes a form:

$$\frac{da_{i1}}{d\tau} = \frac{-k_1*a_{i1}}{S_c*h_{пс}*\rho_{пс}} \quad (9)$$

For creation of mathematical model of continuous process the dressed ore is accepted two-component. One fraction remains in a fluidized layer, and another has to pass into a gas phase. The material balance on a heavy component has an appearance:

$$G_0(1 - a_0) = G_1(1 - a_1) \quad (10)$$

where, G_0 – a consumption of two-component ore with concentration 10, the corresponding initial concentration of an easy component; G_1 - a consumption of the dressed ore from a fluidized layer with concentration of an easy component 11.

Solving this equation concerning G_1, we will receive:

$$G_1 = G_0 * \frac{1-a_{10}}{1-a_{11}} \quad (11)$$

Substituting values α_{10} and α_{11} in this equation it is possible to calculate G_1.

Substituting (2.11) in the equation (2.8), we will receive the differential equation

$$\frac{da_1}{d\tau} = \frac{1}{S_c*h_{пс}*\rho_{пс}}\left(G_0 * a_0 - G_0\left(\frac{1-a_0}{1-a_1}\right) a_1 - k_1 * a_1\right) \quad (12)$$

The coefficient of "k" depends on a consumption of gas, thickness and porosity of a fluidized layer, diameter of particles, density, the device sizes, etc.

k= f ($G_г$; $h_{пс}$; ε; $d_ч$; $\rho_ч$)

Determination of this coefficient for all cases is an independent task. Making experiments in the periodic mode, it is possible to define value of coefficient "k". For the case considered by us private decisions come to light. Laboratory installation is for this purpose developed and processing of experimental results is carried out.

We have conducted researches of pneumatic separation of the crushed particles.

If to present that each particle of the crushed material has the sphere form, with identical sizes, but with a different weight, then the task consists in allocation by means of an air stream of easy particles from mix.

Each particle is affected by forces of mass of a spherical particle, acting with top down:

$$F_1 = m_ч * g \quad (13)$$

where m_p – the mass of a particle, g – acceleration of gravity.

And the force created by an air stream and lifting a particle from below up:

$$F_2 = \lambda * s * \rho_в * \frac{w^2}{2} \quad (14)$$

where, λ – the coefficient reflecting existence of the turbulent or laminar mode w – the speed of an air stream, $\rho_в$ – density of air, s – the area of a spherical particle.

If forces operating on particles are equal each other, then particles are in balance:

$$m_ч g = \lambda * s * \rho_в * \frac{w^2}{2} \quad (15)$$

The mass of a particle of m_p can be determined by the following equation:

$$m_ч = \rho_ч * V_ч \quad (16)$$

where ρ_p - density of a particle, V_p – its volume.

The particle volume which as it was accepted earlier, has spherical shape:

$$V_0 = \frac{4}{3}\pi * r^3 = \frac{1}{6}\pi * d^3 \quad (17)$$

Having substituted value in the equation (2.16), after some transformations we will receive:

$$\rho_ч \frac{1}{6}\pi * d^3 * g = \lambda * \pi \frac{d^2}{4} * \rho_в * \frac{w^2}{2} \quad (18)$$

Solving this equation of rather equilibrium speed, w it is possible to receive the well-known equation [108,109]:

$$w = \sqrt{\frac{4}{3} * \frac{\rho_ч * d_ч * g}{\lambda * \rho_в}} \quad (19)$$

The maximum border of this speed shouldn't reach the speed removing particles with a heavy weight

$$w_л < w < w_т \quad (20)$$

Using Archimedes and Reynolds's criteria it is possible to determine the speed of ablation of particles

$$\omega_{вит} = \frac{Re_{вит} * \mu}{d * \rho} \quad (21)$$

This equation gives the chance to determine the speed and a consumption of gas for ensuring ablation of particles. Varying diameters of particles, it is possible to define a gas consumption for separation of particles with various density. It is possible to define a gas consumption in the conditions of pseudo-liquefaction or ablation for particles with various sizes by the equations given above and also for particles of various density. It is possible to investigate process of pneumoseparation of particles of various density for the purpose of delimitation of change of the sizes of particles.

However, there are such factors as, dispersion of the sizes of the separated particles, difference of a form of particles of real disperse materials from spherical, seasonally change of humidity of particles. Besides impact change of a consumption of gas, thickness and porosity of a fluidized layer, diameter of particles, density, the device sizes, etc. exerts on their values.

Existence of indistinct sets demand accounting of these factors when calculating a consumption of air in a fluidized layer. For example, it is recommended to carry out enrichment of bulk in the range of the crushed particles 0.030÷0.050мм and the extreme sizes of particles providing good separation (0.030÷0.033, 0.034÷0.038, 0.039÷0.044 and 0.045÷0.050 of mm) have been determined [3]. If the bunker in which particles with sizes from 0.030 to 0.033 mm are stored turns on, then the system of indistinct management in this range joins. With turning on of other bunker of storage of the particles separated on sets, the system of indistinct management in the range of the new extreme sizes joins.

Also, the form of particles taken in calculations spherical actually can have the petal form, oval and other forms. Such difference at mathematical modeling of technological processes is considered by means of geometrical coefficient of a form.

The coefficient of a form f is characterized by Fr particle surface area relation to a surface equal her F_S $f = Fr/F_S$ sphere (at V = Const). For determination of coefficient of a form f of the wrong asheric particle it is necessary to know the area of a surface of a particle of F_{ch} and volume of a particle of V. For determination of geometrical coefficient of a form the enlarged photo of particles of disperse material is used (fig. 1.).

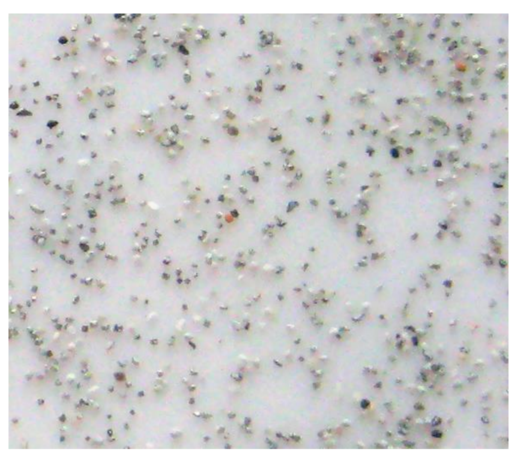

Fig. 1. ***Photo of particles of disperse material.***

Photos (several silhouettes) of particles form statistical selection. Data on geometrical coefficient of a form for each particle should be averaged statistically.

Conclusions.

Application of the theory of indistinct sets at design of regulators allows to increase their intelligence, functionality, having brought closer to intelligence of the person. If are available a set of adjustable sizes, then for each of them it is necessary to create separate control algorithms.

On modern control systems the indistinct regulator (IR) is practically implemented on the COMPUTER and works in the discrete mode. Therefore the system of automatic control with the indistinct regulator contains the device of interface to object of management–the analog-digital converter (ADC) and the digital-to-analog converter (DTAC). Now control of such separation of bulks is exercised the person - machine system. In this case the operator discretely enters information on humidity, the size of particles and geometrical coefficient of a form of particles and thus correction is brought in operation of the indistinct regulator.

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