Distributed closed-loop control formation for technological line of iron ore raw materials beneficiation

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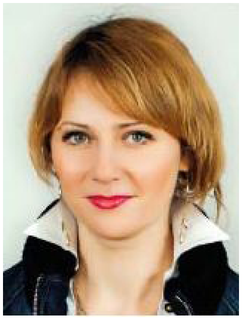

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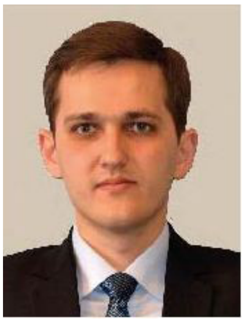

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Abstract
A method of distributed closed-loop control formation for the ore beneficiation technological processes within the ore-dressing factory technological line is proposed.

Key words: AUTOMATIZATION, DISTRIBUTED CONTROL, ORE BENEFICIATION

Currently, a significant number of works are devoted to the problems of technological processes control of iron ore raw materials beneficiation as a complex objects with a large number of controlled parameters and disturbances [1-5]. It should be noted that their significant spatial extent also affects the complexity of these objects control formation through the formation of the optimal separation characteristics of technological units.

It should be also noted that the technological processes control formation of iron ore raw materials beneficiation is complicated by a significant range of changes in the characteristics of its mineralogical and technological varieties [6-11]. Different approaches to the formation of beneficiation process control of ore, which are represented by a several mineralogical and technological varieties, are proposed in [3-7].

The most perspective approach for the problem solving of concentrating technological lines control is the representation of processing of mineralogical and technological varieties of iron ore raw materials as a system with a concentrated inputs: consumption of ore and water in the technological units, and the output distributed in time and space, which is the function of the mineral content distribution by the ore material size classes. This approach will allow describing the concentrated control actions, which are formed by grinding, classification and separation technological units. Moreover, the continuous character of iron ore raw materials variations in the factory process streams will be considered. In accordance with the control theory of systems with the distributed parameters [1], the beneficiation technological line can be represented as a linear stationary system, as well as the characteristics of iron ore raw materials in the process of multi-stage processing as space-time variables distributed on the interval x∈ [0, L]. For a given zero initial conditions, after submitting of variable $Q_i(t)$ (the consumption of ore and water in technological units) to the input of this system - we will get the system output in the form of distributed variable of *βi(x, t)* - the iron content in ore material size classes.

The ratio between the output and input variables are described by convolution

$$\beta_i(x,t) = G_i(x,t) * Q_i(t) \tag{1}$$

where $G_i(x,t)$ – is the distributed system impulse function. As a result of transition process in the control system, with a single step function $Q_i(t)$ on the input, at the system output we will obtain the distributed transition function of $\beta_i^{(H)}(x,t)$. The ratios between the individual input variables $\{Q_i(t)\}_{i=\overline{1,n}}$ and the corresponding distributed output variables $\{\beta_i(x,t)\}_{i=\overline{1,n}}$ we will get analogously. Then, according to the method described in [1], the distributed output variable, which characterizes the content of iron in the process streams, is defined by the expression

$$\beta(x,t) = \sum_{i=1}^{n} \beta_i(x,t) = \sum_{i=1}^{n} G_i(x,t) * Q_i(t) \tag{2}$$

Since the ore stream characteristic measurements are carried out close enough to the concentrating technological units, which are the points of control actions application, so in these points we will get the partially distributed outputs $\beta_i(x_i,t)$, which are located on respective surfaces of the distributed output variables $\beta_i(x,t)$. In these points the partial distributed impulse response functions are defined $G_i(x_i,t)$. Thus, using the (1) we will obtain

$$\beta_i(x,t) = G_i(x,t) * Q_i(t) \tag{3}$$

Applying the results of the study [1] using a zero-order extrapolator {Hi}i we will get an expression describing a discrete control system for ore beneficiation technological line

$$\beta_i(x,(k+\Delta)T) = GH_i(x,(k+\Delta)T) * Q_i(kT) \tag{4}$$

where $GH_i(x,(k+\Delta)T)$ – is the distributed impulse response function of the system consisting of the continuous part and zero-order extrapolator H_i. The total distributed discrete output variable characterizing the iron content in ore particle size classes, can be written as

$$\beta(x,k) = \sum_{i=1}^{n} GH_i(x,k) * Q_i(k) \tag{5}$$

Let's consider the structure of a distributed control for iron ore processing technological line, formed in accordance with the recommendations in [1]. This system consists from the following components. A generalized control object – ore-processing technological line, including zero-order extrapolator, on the input of which the vector of concentrated control actions of $Q(k)$ is supplied, characterizing the ore and water flow in the technological concentrating aggregates and disturbing influences $Z(x,t)$, as well as the output signal is distributed output value of $\beta(x,t)$. The control system (Ore-processing control system), on the input of which the reference signal of $\beta^*(x,\infty)$ is supplied, in general consists from the model of reduced spatial components (RHLDS) $\{\beta R_i(x,k)\}_{i,k}$ and blocks of spatial (SS1, SS2) and temporal (TS) control synthesis of iron ore raw material beneficiation technological line [1]. The discretization of control object output signal of (Δ) provides the corresponding element.

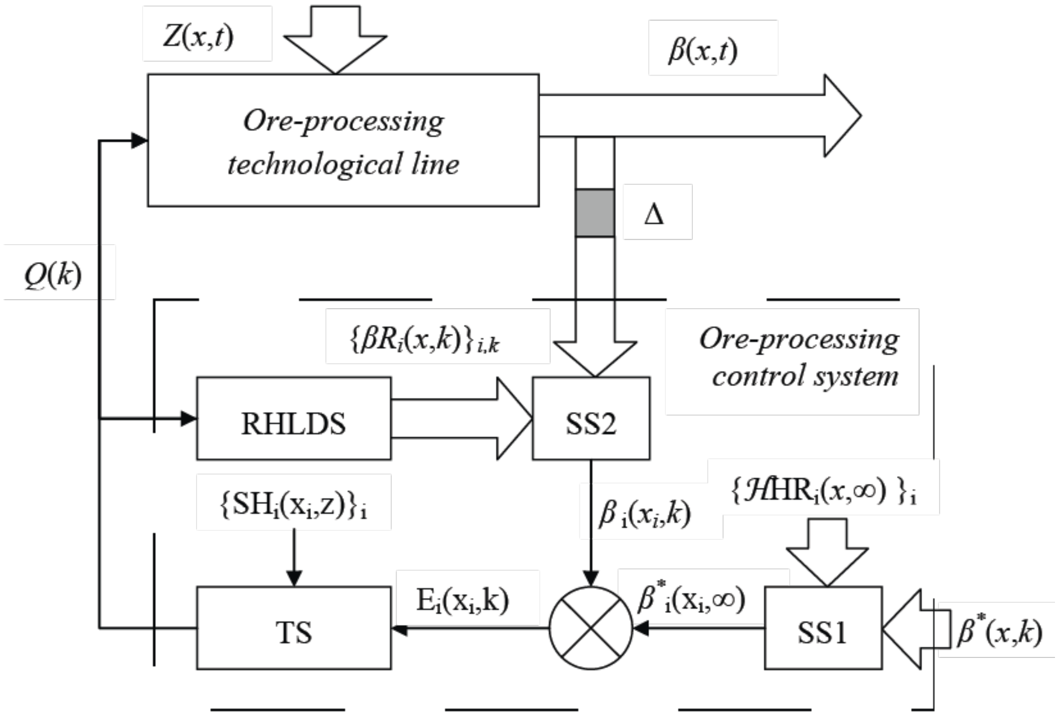

Figure 1. The process control system of iron ore raw materials beneficiation with distributed parameters

Time control block TS (Fig. 1) includes regulators, designed for focused single-channel control systems by local aggregates of iron ore processing technological line, the formation method of which is described in [1-3,12].

During the simulation the HLDS block and the internal model block, in accordance with the recommendations in [1], was accepted as identical. The spatial synthesis is carried out in accordance with a change in the reference signal $\beta^*(x,k)$ under the influence of the disturbing variable Z(x,t).

During modeling (Fig. 2 and 3) the setpoint change of iron content in the size classes of the feedstock $\beta^*(x,k)$ was carried out, and after reaching a steady state of the output variable of $\beta(x,t)$ the change of the disturbance of Z (x,t) at step $k = 50$, which characterizes the change in the ratio of mineralogical and technological varieties in the processed ore was carried out.

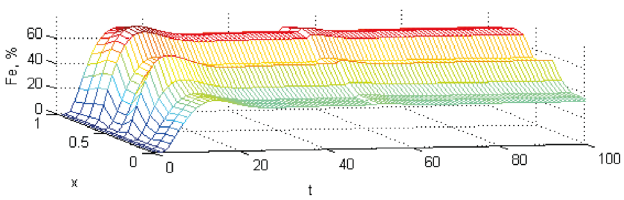

Figure 2. Distributed characteristics of the iron content in the ore

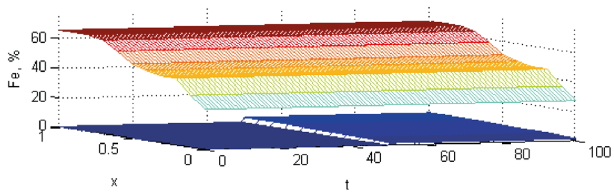

Figure 3. The distributed setting signal and the disturbing effects

Thus, when solving the problem of control formation for concentrating production technological lines, it is advisable to carry out the presentation of mineral processing of iron ore raw materials mineralogical and technological varieties as a system with concentrated inputs and outputs distributed in time and space.

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The gas bubble size parameters monitoring and control method

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Abstract
A method for the effective control of the pulp gas phase composition in the flotation process using dynamic effects of high energy ultrasound and nature experiments on laboratory installation using high-speed video recording with data feedback via function programmed in Matlab for gas bubble size parameters monitoring and control are described.

Key words: ULTRASOUND, PULP, CONTROL, CONTROL FEEDBACK, FLOTATION, GAS BUBBLES