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THE SYSTEM OF AUTOMATIC CONTROL FOR AGGLOMERATION PROCESS ON BASE OF FUZZY LOGIC

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There is the principle of development of two circuit's model for the automatic control by process of agglomeration sinter mix. This model is based on fuzzy regulators and provides stabilization of gas-dynamic properties at the layer of mixture. There is shown that the proposed system allows reduces the time of control in system and improve the accuracy of maintaining process parameters at a given level in the article.

Key words: agglomeration, control system, charge, gas-dynamic properties, fuzzy regulator, mathematical model

A considerable place in the technological scheme of sintering production are occupied by processes which are related to sintering of the charge layer inflamed under a hearth. The maximal performance of sintering machines and quality of agglomerate is arrived at in that case, when sintering of all layer of sintered charge is covered at the end of working (active) length of sintering machine [1]. So, the primary purpose of automatic control of sintering is a concordance of rate of movement for pallets of sintering machine with the rate of sintering for charge.

It is known [1-3], that the process of agglomeration is characterized by speed of charge sintering on a sintering machine, which is related with the technological parameters by correlation:

$$\frac{v_{si}}{v_{p.a.m.}} = \frac{h_{ch}}{L},$$

where v_{si} is speed of charge sintering, m/s; $v_{p.a.m}$ is a rate of movement of pallets for sintering machine, m/s; h_{ch} it is a height of layer of charge on sintering ribbon, m; L is length of sintering machine.

Thust speed of sintering v_{si} determines the rate of movement of pallets for sintering machine $v_{p.a.m}$ at the height of layer of charge h_{ch} and length of sintering machine L. Then, at the change of speed for sintering, with the purpose of maintenance of permanent place for completion of sintering, it is necessary to influence or on the rate of movement for pallets of sintering machine, or on the height of layer, or on that and other.

The analysis of many systems of automatic control (SAC) by process sintering charge at sintering machines showed that they did not provide high quality of agglomerate and maximal performance of machines. It is related to that a technological process is characterized by large time of a transport delay (15-20 min) and presence of casual indignations, and adjusting is conducted, mostly after parameters which characterize only the completeness of sintering [2,3].

With the purpose of providing of the high-quality adjusting of process of sintering for sintering mixture it is necessary to develop such system of automation, which would use information about motion of process of sintering on the early stages and formed effective stimulus.

For the decision of the assigned task the method of automatic control of sintering process is offered, according to which the rate of movement for pallets of sintering machine is regulated after speed of sintering for middle layer of charge, and height of loading of charge on sintering ribbon - on gas-dynamic properties of charge layer in the initial period of sintering.

The difference of temperatures for gases of combustion t_g a parameter which characterizes speed of sintering of middle layer of charge is used in a that vacuum-chamber, above which at the optimal flowing of process drying of the last layer of charge, and surfaces of sintering charge t_{ch} must be closed after a hearth in a place, where a temperature at optimal lead of process of sintering equals a temperature t_g.

A parameter which characterizes gas-dynamic properties of layer of charge is product of shrinkage of charge under a hearth on the rate of movement for pallets of sintering machine.

The mathematical model of two contours of the system for automatic control of agglomeration on the base of fuzzy logic is realized on computer by means of package of modeling of «*Simulink*» for interactive application «*Matlab*» and consists of object of management and unclear PID-regulators, which provide stabilizing of gas-dynamic properties of charge layer on the size of product of his shrinkage under a hearth on speed of sintering ribbon, and speeds ruff sintering of middle layer of charge after the difference of temperatures for gases of combustion and surface of sintering charge after a hearth ($t_g - t_{ch}$).

Unclear PID-regulators are realized on the base of unclear checker (Fuzzy Logic Controller) on three admissions of which signals are given, that proportional to the unconcordance of current and set value of the managed size (p), integral of unconcordance of current and set value of the managed size (i) and differential of unconcordance of current and set value of the managed size (d). On the output of unclear checker a management (u) signal was formed.

At created unclear logical checker the method of construction for data areas was used based on the analysis of characteristics of the closed systems of stabilizing of product of shrinkage of charge layer under a hearth on speed of sintering ribbon and differences of temperatures for gases of combustion and surface of sintering charge after a hearth.

Fuzzy Logic Controller includes three basic blocks - block of fuzzyfication, block of forming forlogical decision (inference) and block of defuzzyfication.

Turn-downs of entrance and initial variables after tuning of regulator of Fuzzy Logic Controller with of Ruleviewer_1 in the contour of adjusting for product of shrinkage of charge layer under a hearth on speed of sintering ribbon evened: $p \in [-0.005; 0.005]$, $i \in [-0.25; 0.25]$, $d \in [-1; 1]$, $u \in [0; 0.1]$ and after tuning of regulator of Fuzzy Logic Controller with of Ruleviewer_2 in the contour of adjusting of difference of temperatures ($t_g - t_{ch}$), accordingly: $p \in [-9; 9]$, $i \in [-43.7; 0]$, $d \in [-300; 300]$,

$u \in [-0.4; 0]$.

Modeling of work for two contours of the system of automatic control for sintering of sintering mixture with synthesized fuzzy-regulator it is conducted at step entrance signals which modeled the changes of shrinkage for sintering charge from 0.064 a to 0.056 m and rate of climb of sintering for middle layer from a 0.0284 a to 0.0251 m/min.

Coming from the got transients, in the system of automatic control of product for shrinkage of charge layer on speed sintering ribbon time of modeling of adjusting does not exceed 8.5 s, and a dynamic error folds a 0.0002 m/min.

In the system of automatic control of difference of temperatures for gases of combustion and surface of sintering charge after a hearth ($t_g - t_{ch}$) time of modeling for adjusting does not exceed 12 s, and a dynamic error folds 0.4 °C.

Conclusions. The comparative analysis of work of two contours for the system of automatic control of agglomeration showed on the base of analog and modeled unclear PID-regulators, that SAC with unclear PID-regulators provides the considerable upgrading of adjusting. So in the contour of adjusting of product for shrinkage of charge under a hearth on speed of sintering ribbon with an unclear regulator adjusting time grows short in two times, and a dynamic error less, than in the contour of management with an analog PID-regulator in five times. And in the contour of ma-nagement of sintering of middle layer of charge speed after the difference of tem-peratures ($t_g - t_{ch}$) adjusting time and dynamic error in the system with an unclear regulator in two times less, than in the contour of management with an analog PID-regulator. Except for that, control system with unclear regulators has considerably higher firmness at the change of dynamic properties for adjusting object.

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