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LTAB FURNACE AUTOMATIC CONTROL SYTEM MODEL CREATION

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It's a very important problem nowadays to save the state fuel and energy resources, including the coal resources. To solve this problem is possible as by means of involving into industries the new energy sources as by means of developing new methods of the fuel resources exploitation, which allow to use their heat potential completely. The technology of the coal burning in the law temperature air-fluidized bed (LTAB) combined both these approaches.

To achieve the required characteristics of the solid fuel burning processes it's necessary to provide the high control quality. For this purpose the structural scheme of the LTAB furnace operation control was developed and grounded.

When we create the burning process math model we assume the following: we neglect the diffusion substance transfer, when the heat conductivity is so high, that the temperatures in all reactor interior points are possible to consider equal [1]. So, the mass-and-heat transfer equation of the given model may have the following view:

$$\rho\frac{d\xi}{dt}+m\frac{d\xi}{dx}-\rho f(T_ш)(\xi_m-\xi)=0;$$

$$\rho\frac{dT_ш}{dt}+\frac{\lambda 1}{l}m(T_ш-T_0)-\frac{h}{l}f(T_ш)(\xi_m-\frac{1}{l}\int_0^1\xi dx)=0; \qquad (1)$$

$$(\lambda 1=\frac{\gamma lS}{m_0V}+1,\;\; T_0=\frac{\gamma lS}{mC_nV\lambda}T_{н.с.}+\frac{1}{\lambda 1}T_n),$$

It's possible to pass on from the mathematical formulation of the processes, running in the LTAB furnaces, to the dynamic performance of the furnace. The system external disturbance response rate may be valued according to the following equation of the bed heat balance:

$$C_n\rho FH_ш(dT_ш/dt)=j_mQ_н{}^PF(1-q_{х.н}-q_{ф.н})-C_гV_n\rho_гF(T_ш-T_{д.п.})-$$
$$-h_{н.в.}S_{п.н.}(T_ш-T_{т.н.})-(Q_{ф.ш.}+Q_{з.о.}), \qquad (2)$$

According to the equation (2), there are two typical time constant of the LTAB furnace reaction for stepped disturbance of the input parameters:

$$t_1=\frac{C_ï\,fÏFT_ø}{C_ã fÏV_í F(T_ø-Ò_{ä.ï.})+h_{í.â.}S_{ï.í.}(T_ø-Ò_{ò.í})+Q_{ô.ø}+Q_{ç.î}}, \qquad (3)$$

$$t_1=\frac{j_iQ_i^ð F(1-q_{õ.í.}-q_{ô.í})}{Ñ_ã fÏV_í F(T_ø-Ò_{ä.ï.})+h_{í.â.}S_{ï.í.}(T_ø-Ò_{ò.í})+Q_{ô.ø}+Q_{ç.î}}, \qquad (4)$$

The first component (*t1*) is the typical time of the LTAB cooling with the immediate burning break, the second component (*t2*) is the time of fuel burning-up in the steady-state burning conditions.

Thus, taking into account equations (3) and (4), the automatic control system of the LTAB furnace operation is possible to be created with necessary dynamic characteristics. From the of LTAB furnace dynamic model creation point of view we are interested in the parameter *t2*, as we create our model for the steady-state conditions of the furnace operation. As the LTAB furnace has the different reaction constants and the transmission coefficients for main parameters changes, so for the furnace dynamic model creation it's necessary to determine two transmission functions – for the solid fuel channel and for the blower air channel.

The transmission function for the solid fuel channel has the following view [3]:

$$W_{Ø.Â}(ð) = \frac{\hat{E}_{Ø.Â.}}{ð(\grave{O}_{Â}p+1)}, \tag{5}$$

It's known from the results of experimental data [2], that the average regulation depth of the LTAB temperature by the given parameter is 6%, so the transfer function of the LTAB furnace with the solid fuel expenditure has the following view :

$$W_{Ø.Â}(ð) = \frac{63{,}6}{ð(1200p+1)} \tag{6}$$

In the same way we determine the transfer function with the blower air speed:

$$W_{Ø.V}(ð) = \frac{\hat{E}_{Ø.V.}}{ð(\grave{O}_{V}p+1)} = \frac{23}{p(300p+1)}, \tag{7}$$

So on the base of determined dynamic characteristics of the controlled object (LTAB furnace), it's possible to develop the functional scheme of the furnace operation control system.

This system will consist of the three main components – the controlled project (LTAB furnace), the control device (digital regulator) and the perturbation actions. We'll be also able to divide it into the two control loops of the LTAB furnace operation (LTAB temperature regulation) – the control loop with the solid fuel expenditure and the control loop with the blower air speed.

There is also one subordinate control loop in every main control loop. In the control loop with the solid fuel expenditure there is the loop of the batcher shaft rotation velocity control and in the control loop with the blower air speed there is the loop of the blower fan pressure regulation (practically the blower air speed).

So on the base of math model of the solid fuel burning processes we can achieve the functional scheme of the LTAB furnace operation control system, which satisfy the necessary requirements and can provide the necessary control quality.

References

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