The problem of stabilizing the productivity of the technological equipment of the production line

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Annotation. The problem of designing a system for optimal operational control of random deviations in the productivity of technological equipment is considered. The synthesized control ensures the synchronization of the productivity of the technological equipment of the production line and asymptotic stability of the given planned state of the flow parameters of the production line for the steady and transient mode of operation.

Keywords: production line, production control system, PDE-model, flow production.

The parameters state of the production line will be described by the equations system [1]

$$\frac{\partial[\chi]_0(t,S)}{\partial t}+\frac{\partial[\chi]_1(t,S)}{\partial S}=\Upsilon_0(t,S), \qquad (1)$$

$$\frac{\partial[\chi]_1(t,S)}{\partial t}+\frac{\partial[\chi]_2(t,S)}{\partial S}=f(t,S)[\chi]_0(t,S)+\Upsilon_1(t,S), \qquad n=1,2.3...., \qquad (2)$$

where $[\chi]_0(t,S)$ and $[\chi]_1(t,S)$ are the values of the inter-operational backlogs and the processing tempo of the details at a time t для for a technological position in a technological route with a coordinate S; $f(t,S)$ is the production function of the technological process [2].

The system of the two-moment balance equation for the model stabilization of the productivity deviations of the technological equipment can be represented in the form [3]:

$$\frac{\partial[y]_0}{\partial t}+\frac{\partial[y]_1}{\partial S}=q_{01}u_1, \qquad (3)$$

$$\frac{\partial[y]_1}{\partial t}+\frac{\partial[y]_1}{\partial S}B+[y]_1\frac{\partial B}{\partial S}=q_{11}u_1, \qquad (4)$$

$$q_{01}=const_1, \qquad q_{11}=const_2, \qquad u_1(t,0)=0,\ \ B=\left.\frac{[\chi]_{1\psi}}{[\chi]_0}\right|_0, \qquad (5)$$

where $[y]_0$, $[y]_1$ are unknown random small perturbations of the production line flow parameters $[\chi]_0,[\chi]_1$ relative to the unperturbed state $[\chi]_0^*$, $[\chi]_1^*$:

$$[y]_0=[\chi]_0-[\chi]_0^*, \qquad [y]_1=[\chi]_1-[\chi]_1^*. \qquad (6)$$

The quality Criteria of the transient process let's choose from the condition, that determines the minimum cost of the technological resources that require the solution of the specified problem [4]

$$I=\int_{t_0}^{\infty}\frac{1}{S_d}\int_0^{S_d}\left(\alpha u_1^2\right)dSdt, \qquad (7)$$

where the parameter α is the scale factor; S_d is the technological position of the last technological operation in the technological route. The Lyapunov function $V^0([y]_0,[y]_1)$ will be sought in the form of a quadratic form with time-constant coefficients c_0, c_1:

$$V^0([y]_0,[y]_1)=\frac{1}{S_d}\int_0^{S_d}\left(c_0[y]_0^2+c_1[y]_1^2\right)dS=c_0\{y_0\}_0^2+c_1\{y_1\}_0^2,\ \ \frac{\partial V^0}{\partial t}=0. \qquad (8)$$

$$[y]_k = \{y_k\}_0 + \sum_{j=1}^{\infty} \{y_k\}_j \sin[k_j S] + \sum_{j=1}^{\infty} [y_k]_j \cos[k_j S], \qquad k_j = \frac{2\pi j}{S_d},$$

$$[u]_n = \{u_n\}_0 + \sum_{j=1}^{\infty} \{u_n\}_j \cdot \sin[k_j S] + \sum_{j=1}^{\infty} [u_n]_j \cdot \cos[k_j S].$$

The solution of the system of equations (3) - (5) taking into account expressions (7), (8) makes it possible to determine the optimal control of the productivity of technological equipment u_1

$$\{u_1\}_0 = -\frac{2}{q_{11}} \left.\frac{\partial B}{\partial S}\right|_0 \{y_1\}_0 ,.$$

which, along with the requirements for the asymptotic stability of a given planned unperturbed state, ensures the best quality of the transient process.

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