DEVELOPMENT OF THE ALGORITHM FOR CHEMICAL TECHNOLOGY CONTROL IN INTERFERENCE CONDITIONS

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The technological processes of most difficult chemical technologies, in particular technologies of the soda ash production on an ammoniac method (SAP), behave to a class of technologies in which the processes of processing of raw materials, while in continuous contact with devices of various technological purposes, change own chemical compositions. This processing is arrived at as a result of reactions of chemical transformations, interfacial mass-transfer, mixing and division, heating and cooling and is characterized as continuous, nonlinear multidimensional technology with extreme non-stationary descriptions that are the article of consideration of theory of adaptation optimization [1-4]. There is of interest development of algorithm of adaptive control such technology in the conditions of obstacles.

For control non-stationary technologies it is expedient to apply the adaptive model of technology that modeling its dynamic properties (AMTMDP). Thus on the inputs of technology of control (TC) and AMTMDP are given n-dimensional control actions of $x_1(t)$, $x_2(t)$, … , $x_n(t)$. TC converts these influences in the initial signal of *y(t)*, which is given also on the inputs AMTMDP, and this model will realize the optimal adaptive algorithm of identification [1-4]:

$$k_i(t) = k_i(o) + \frac{1}{T}\int_o^t \frac{y(t) - \sum_{i=1}^{n} k_i(t)x_i(t)}{\sum_{i=1}^{n} x_i^2(t)} x_i(t)dt, \tag{1}$$

where $k_i(o)$ – initial value of coefficients $i=\overline{1,n}$ models that calculate the value of coefficients $k_i(t)$ and are serving as initial information for the calculation of control actions.

The identification algorithm (1) most simply can be realized by means of modern multichannel, high-performance, fast-acting, hi-rel and multifunction Micro Controller Unit (MCU) with the special programs (SP). The MCU real-time SP runs standard functions of summing, dividing, integrating, multiplying, subtracting, squaring, and differentiating, as well as calculating the value of the signal of incongruity $\varepsilon(t)$ between required (set) output TC $y^*(t)$ and its actual output $y(t)$, to wit, $\varepsilon(t) = y^*(t) - y(t)$.

The value of the inconsistency signal is used to determine the MCU for SP of intermediate signal values, in particular: $\frac{y^*(t) - y(t)}{\sum_{i=1}^{n} k_i^2(t)} k_i(t)$. These signals are needed to calculate the MCU for SP of corrected values of control actions:

$$x_i(t) = x_i(o) + \frac{1}{T}\int_0^t \frac{y^*(t) - y(t)}{\sum_{i=1}^{n} k_i^2(t)} k_i(t)dt, \tag{2}$$

where $x_i(o)$ corresponds to the initial values of control actions.

The control algorithm (2) is an adaptive gradient and optimally by speed algorithm that minimizes inconsistency between the required (given) output value *y*(t)* and its actual value *y(t)* non-stationary multidimensional TC.

Indeed, if as an optimization criterion a quadratic functional is chosen for inconsistency between the required (given) output value *y*(t)* and its actual value *y(t)*, then the gradient algorithm for minimizing this functionality has the form

$$\bar{x}_i(t) = \gamma[y*(t) - \sum_{i=1}^{n} k_i(t)x_i(t)]k_i(t), \quad (3)$$

where $\gamma > 0$ - some parameter. Consider the value:

$$\varphi(t) = \sum_{i=1}^{n}[\bar{x}_i(t) - \bar{x}_i*(t)]^2, \quad (4)$$

which represents the sum of the squares of deviations controlling $\bar{x}_i(t)$ from their optimal impacts $\bar{x}_i^*(t)$.

Using the algorithm (3) leads to the fact that the value $\varphi(t)$ (4) turns into a form:

$$\varphi(t) = 2\sum_{i=1}^{n}[x_i(t) - x_i*(t)][\bar{x}_i(t) - \bar{x}_i*(t)]. \quad (5)$$

Substituting in (5) the value $\bar{x}_i(t)$ from (3) and taking into account that the required (given) $y*(t)$ associated with the required value of the vectors control actions $x_i*(t)$, by ratio: $y*(t) = \sum_{i=1}^{n} k_i(t) \cdot x_i^*(t)$, get:

$$\begin{aligned}\varphi(t) &= -2\gamma\sum_{i=1}^{n}[x_i(t) - x_i*(t)]k_i(t) - 2\gamma\sum_{i=1}^{n}[x_i(t) - x_i*(t)]\bar{x}_i^*(t) \geq \\ &- 2\gamma\sum_{i=1}^{n}[x_i(t) - x_i*(t)]^2\sum_{i=1}^{n}k_i^2(t) - 2\gamma\sum_{i=1}^{n}[x_i(t) - x_i*(t)]\bar{x}_i^*(t)\end{aligned}. \quad (6)$$

From (6) we can see that the rate of error reduction $(x_i(t) - x_i^*(t))$ depends on the values of the parameters of the technology $k_i(t)$.

Choice $\gamma = 1 / \left(\sum_{i=1}^{n} k_i^2(t) \right)$ results to significantly less dependence or (in the case of, for example, stabilization when $x_i^*(t) = 0$) independence of the rate of change $\varphi(t)$ from $\sum_{i=1}^{n} k_i^2(t)$. If the speed of change of control actions is necessary $\bar{x}_i(t)$ insignificant, then such a choice of parameter γ obeys an exponential law of change $\varphi(t) \geq \varphi_0 \cdot e^{-2}$, де $\varphi_0 = \sum_{i=1}^{n} [x_i(0) - x_i*(0)]^2$ – the initial inconsistency, hence, and the maximum speed of the algorithm under the monotonic nature of the transient response.

As a result of the consider, an noise-imune algorithm of adaptive control for the technological processes of complex chemical technologies, in particular for SAP technology, was developed. The use of an adaptive model and an noise-imune adaptive control algorithm will allow high-precision and high-speed control of non-stationary control technologies in interference conditions.

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