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Analysis and evaluation of the efficiency of fuzzy controllers in the control systems of foundry resistance furnaces

Abstract

Foundry resistance furnaces are heating devices characterized by relatively high values - among all parameters such as delay times and time constants. Such furnaces, as automated control objects, require the design of specific controllers. The paper presents an analysis of delayed object control theory, with the use of classic PID regulators and fuzzy controllers. The methodology of designing control circuits in feedback systems includes the following topics: identification of the control object, structure of the controller and selection of optimal values of its parameters. For example, in the MATLAB/Simulink environment of the selected real resistance furnace, different versions of the fuzzy controller were elaborated, the parameters of which were determined with the use of genetic algorithms and simple search. In the dissertation, quality indicators were defined, which were used to compare the efficiency of classical PID regulator optimized by an automatic procedure in Simulink and various versions of the fuzzy controller. Simulations of the operation of the control system for a specially selected set temperature curve were carried out both without the presence of interfering signals as well as considering the sinusoidal and rectangular disturbances with the assumed amplitudes and frequencies. Based on the gathered results of the computation of qualitative indicators during computer simulations of the operation of the control system with different versions of fuzzy controllers, it has been shown that it is possible to design a fuzzy controller with a predetermined structure and appropriately designated parameters allowing to obtain much better control effects in comparison to the classical optimized PID controller. Among the developed version of the fuzzy controller, the one that works very well in the simulated control system of the casting resistance furnace was selected, both without interference and in the presence of interfering signals with assumed parameters. In the summary, it was also concluded that the elaborated methodology for the design of a simplified fuzzy controller structure could be used in control systems of other foundry furnaces for which the temperature dependence in the furnace chamber is known in the function of power supply of the furnaces.