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COMPARATIVE MODELING OF THE CONTROL SYSTEM

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Abstract
The purpose of the modeling was to compare the operation of the control system with a classic PI controller with a system using a neural network setting of the PI controller.

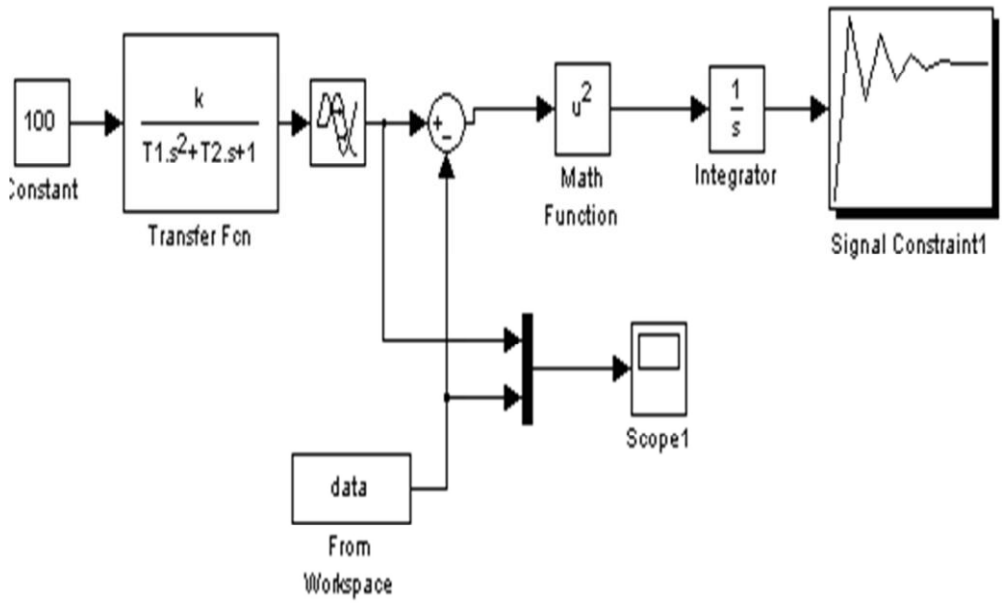
Keywords: boiler unit, mathematical model, identification, modeling, controller, regulation.

Introduction

The primary task for carrying out the modeling was to identify the mathematical model of the boiler unit. Due to the continuity of production, identification using a test signal is impossible, since it can disrupt the current process mode. Taking this fact into account, the identification was carried out using statistical data on the operation of the boiler unit SPC-1 of JSC OEMK. To obtain a mathematical model, the least squares method was used, for the implementation of which the following Matlab system blocks were used:

1) Control action const=100%;
2) Structural model of the control object, in the form of two aperiodic links of the 1st order;
3) Delay links;
4) Mathematical functions of squaring and integrator;
5) Data block, containing statistical values with a real boiler unit.

As a result, the following structural identification diagram was obtained, shown in Fig. 1.



Rice. 1. Structural diagram of boiler zone model identification

As a result of the identification, a model was obtained, which consists of two aperiodic links of the first order and a lag link, shown in the figure

$$W(s) = \frac{20,72}{1636s+1} \cdot \frac{1}{69,4s+1} \cdot e^{-63,8s}.$$

In the process of identification, the following graphs were obtained (Fig. 2), which allow us to consider the quality of identification satisfactory and sufficient. It is quite difficult to identify a more accurate model on a non-linear, dynamic, subject to the constant action of various perturbations. At the same time, the purpose of identification is to obtain a model to check the performance and effect of the neural network tuner implementation, due to which the quality of identification for this task can be considered sufficient for modeling.

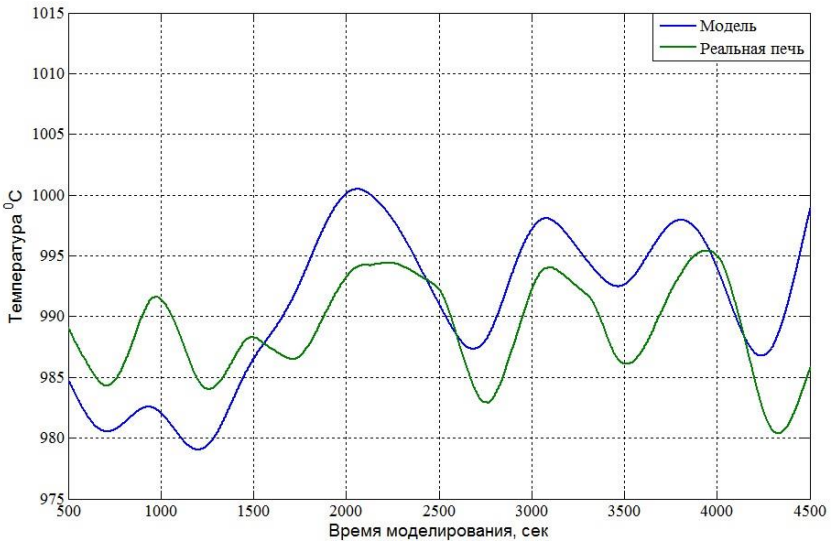


Fig.2. Transient graphs based on measured and model values

The experiment was carried out on a model of the SPC-1 boiler unit with the following features and limitations:

1) The transient process in the furnace was considered to be completed when the temperature was within 5% of the setpoint difference for 300 s without the presence of self-oscillations;

2) at the end of the transient process, the temperature setpoint was changed;

3) For the initial state of the furnace, acceptable parameters of the PI-regulator were experimentally selected: Kp = 0.4, Ti = 4000. These coefficients ensure a satisfactory quality of control for an empty furnace;

4) After two tests of the 5050C – 5500C – 6300C – 5050C setpoint schedule on a partially loaded furnace, the parameters of the control object model were changed in the form of a 5% decrease in the gain K and a 50% increase in the T time constant, which simulates the full loading of the furnace with steel billets and a change in the weight of the metal charge. After changing the parameters, the setpoint schedule was reworked out.

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5) After working out the setpoint graph twice with the changed parameters, the model returned to its original state and the setpoint schedule was re-tested.

When choosing the setpoint schedule, the possibility of conducting a full-scale experiment on a laboratory bench for practical testing of the system was taken into account in the future. The laboratory bench is a muffle furnace of electric heating with a maximum heating temperature of 700 °C. Due to the fact that real heat treatment modes require higher temperatures (above 700 0C), the temperature setpoints were reduced by 15% in this study. For example, the setpoint graph 600 0C –650 0C –745 °C was chosen , corresponding to the annealing of chromium steels (20X13, 30X13, etc.) [40]. After a 15% reduction, we obtain the following setpoint graph for modeling 505 $^{0C–550\ 0C–630}$ °C.

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