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DEVELOPMENT OF MATHEMATICAL MODEL AND ALGORITHM OF CALCULATION FOR HEATING THERMALLY MASSIVE BODIES IN FLAMING THERMAL FURNACES OF CHAMBER TYPE

(Report I)

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There are carried out analysis of mathematical optimization featured tasks for heating metal by heat treatment in the flaming furnaces of chamber type. It is set that for solution of stated type tasks is complicated by absence of simple model, define-like dependence of end measures for quality of heating on control responses in the system «warming gases – fettling – metal». The acceptance of row assumptions allows to use on modeling results only for the high-quality analysis of heat work for furnaces. It is necessary to choose the optimal model of heating for thermally massive bodies, allowing to determine both the form of control responses and moments of their switching.

Keywords: flaming thermal furnace of chamber type, heating of metal, mathematical model, analysis, algorithm of calculation

At the terms of continuous increase of market value of energy carriers and limitation of consumption of natural gas a task of economy of the mentioned gas in a metallurgical industry, where its main consumers flaming are served thermal furnaces of chamber type is actual.

Furnaces of the mentioned type got most distribution on account of universality in relation to execution of thermal treatment of different as a form and mass of ingots, however considerable part of constructions of such aggregates remains by physically and morally old-fashioned. In this connection by main direction of advance of them heat work it follows to consider the betterment of control by temperature fields in a working chamber and by motion of gases, which carry out heating of metal, and also optimization of them heat work.

At development of the rational temperature-time modes of heating of metal at thermal treatment widely apply them mathematical modeling.

For thermally thin bodies the mathematical models of heating, as a rule, develop on the basis of usual differential equations of heat-conductivity in a non-dimensional kind. At solution of such equations consider that change of thermo physical parameters of metal at times is unknown, i. e. their values accept permanent and in the process of modeling did not add to refining that reduced the value of the got results. The attempts of account of dependence of thermophysical parameters of metal from a temperature, and also non-stationary character of temperature of gases which heat a metal, resulted both to complication as model and solution of tasks heat-conductivity.

The analytical solution of nonlinear tasks of convective-radiant heat exchange at the non-stationary temperature of gases which heat a metal has significant com-

plexities. In this connection the row of approximate numeral and numeral-analytical methods is worked out. So, setting the function of distribution of temperature in direction of metal, equation in the partial derivatives there are resulted in the system of usual differential equations. However, having regard to nonlinear dependence of thermophysical parameters of metal on a temperature linear differential equations used for a modeling heating of metal only in the narrow ranges of temperature for the furnaces of continuous action. For flaming thermal furnaces of chamber type from to the variables at times a temperature condition differential equalizations are nonlinear and does not have an only solution.

For the tasks of optimization heating at time there are got the stepped temperature-time modes, i. e. relay laws of change of the thermal loading in complete accordance with Fel′dbaum theorem. At distribution of mathematical methods of optimization: to Pontryagin method and Bellman dynamic programming, - on the systems which describe with means of equations in the partial derivatives, there are got an analogical on a kind optimal solution.

At optimization of control by heating of metal quite often imputed restriction not only on quality of incineration of gaseous fuel but also on composition of gases which heat a metal, In addition there are imputed restriction on the maximal and minimum heat loading of furnace taking into account its productivity, as type of burners, their range of adjusting, and also output possibility of fume-collecting channel.

Known tasks of optimization of metal heating process at thermal treatment in flaming thermal furnaces of chamber type does not provide the real character of distribution of temperature in direction of ingots which process thermally, and also on a height and width of working chamber of furnace. Thus development of simple mathematical model of heating of ingots with adaptation directly at the process of control which provides the calculation of the optimal temperature-time modes, with the purpose of decline of cost of energy resources and increase of the productivity forf furnaces of chamber type it is necessary.