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SIMULATION AND COMPUTER CONTROL OF MOBILE SOURCE OF ACTION

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1. Urgency of the theme and problem statement. Now electron-beam installations use for zonal clearing of metals, melt of ingots in crystallizers, heat treatment, welding by an electron beam; electron-beam installations use also for thermal trials, for evaporation of films in a vacuum. The quality of final output is formed by fidelity, with which the given temperature field of plant is maintained during a manufacturing process.

The theoretical problem statements of mobile control for distributed parameter systems was given in works of A.G.Butkovskiy and L.M.Pustylnikov [1]. Before an engineering solution of control systems of electronic and laser beams realised with the help of analog devices. These devices were cumbersome enough, and technique of their usage was complicated [3]. The mobile control of electronic and laser beams was imperfect for following reasons. The law of movement of a beams was imaged by the electronic oscillograph, which one has restricted possibilities. The alteration of mobile source speed on one of trajectory section result to an alteration of speed on remaining sections. The possibilities of devices using for control of a temperature field by a feedback principle were limited. Now control engineering is carried out facilities of programming on computer base, and the realization of control systems is made by facilities of digital engineering. This approach allows to engineer and to design composite systems by the way of programs and programmatic complexes. The finalized version of a system can be realised in an autonomous microprocessor control unit. The purpose of the given paper is the working out of principles of constructing and creation of software permitting: 1) to model plant and process of its treating; 2) to count programmatic controls of a mobile source of heat; 3) to control of a mobile source of heat in real installation both in a manual control mode, and by a principle of a feedback.

2. Principal scheme of a control system. In a Fig. 1 the principal scheme of a control system of a mobile power source of heat is showed. The example of ingots melt in a flat crystallizer with the help of an electron beam is reviewed.

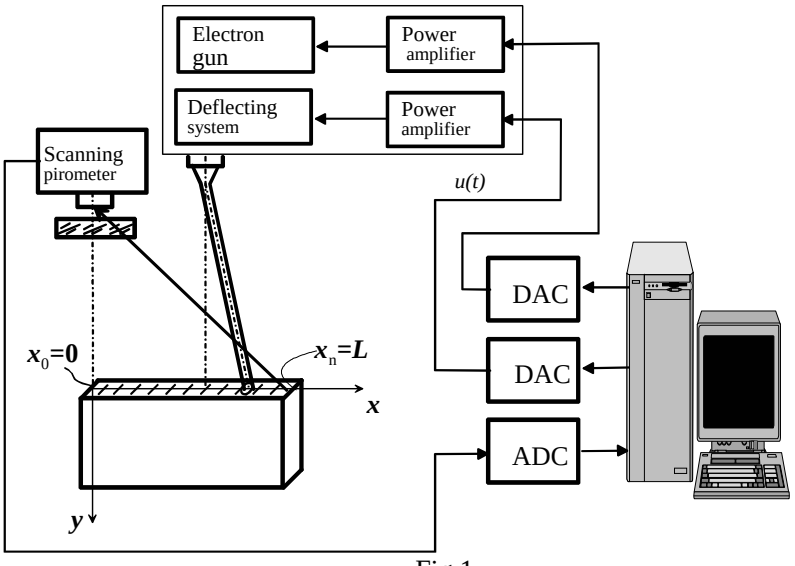

Fig.1

The control system forms signals, which one are proportional to power of an electron beam *p (t)* and law of movement of a heat source *u (t)*. The problem of control is to create and to maintain given distribution of temperature on a surface of plant during a manufacturing process. During a manufacturing process the centre of a heat source moves on a linear pathway from its beginning, dot

$x_0 = 0$, up to the end, up to a dot $x_0 = L$, and back. Such move is called cyclical or multicyclical [2]. The source of heat power can be alteration much more slowly passage time of a source centre of a cut [0, L]. The creation of sections with different given temperatures is reached with the help of programmatic sectionally continuous control of movement speed of a source of heat and by variation of a source intensity.

It was determined the structure of the computer control system. The control system should consist of two function blocks: the block of simulation and control block. The following program modules go into structure of the simulation block: 1) program module for simulation of process of propagation of heat in control plant; 2) program module for account of control of a mobile source of heat ; 3) screen user interface for on-line operation with the programs of the simulation block. The control block contains: 1) program module for forming of control signals for the DAC, proportional power and position of a source centre; 2) program module of correction of power and movement speed of a heat source on each trajectory section. The correction of power and movement speed of a source of heat is made in accordance to signals that take of from a scanning pyrometer.

3. Description of the simulation methods. Mobile control for one-, two- and three-dimensional spatial object model is considered. Control by movement and power of the mobile heating source is applied. The mobile source control program is calculated to provide the object steady state close agreement with preset state in prescribed area. The mobile source control calculation method called "a method of a substitution" is offered to solve this problem [2]. The idea of the method is that the mobile concentrated heat source exposure is substituted by distributed heat exposure to find preset temperature field. Then the law of mobile source motion and the power of the mobile source are calculated. It is implementation problem. In common case solution of this problem is reduced to a solution of Fredholm I of a kind integral equation with limitations on a required solution. The methods of a solution of such equations do not exist. So the approximated solution methods of a implementation problem are examined.

4. Description of the control system software. The control system software for concrete plants with mobile heat source control was developed in programming environment MATLAB and described in the article. The developed software complex allows calculating the demanded law of movement of a mobile source due to change of the law of exposure capacity and speed of movement on separate sites of a one-dimensional trajectory. These changes can be carried out as in a manual mode by the person-operator, and automatically.

The control system software consists of two functional units: the modeling unit and control unit. The modeling unit contains program modules: 1) modeling of heat distribution process in object; 2) calculation of law of control by a mobile source; 3) the user screen interface for interactive work with programs of the modeling unit. The control unit contains program modules: 1) DAC control signal conditioning in accordance with exposure capacity and position of the mobile source center relative to object; 2) exposure capacities and mobile source speed corrections (manual or automatic) on scanning pyrometer signals at each site of a trajectory; 3) the user screen interface of the for interactive work with a software.

5. The basic results and scientific novelty. The structure and the basic scheme of a computer control system by a mobile energy source in electron beam plants are offered. The system allows calculating laws of program control by mobile heating source movement and exposure capacity for various types of objects. Work principles of computer control system units and modules are considered. The variant of computer control system with mobile source movement along one-dimensional trajectory is developed and described. The offered control system is applicable at zone clearing of metals, melt of ingots in flat crystallizers, for thermal tests in electron beam plants. It is necessary to note, that in each concrete case detailed research of a temperature field identification is necessary for authentic data reception.

Literature

1. A.G. Butkovskiy, L.M. Pustylnikov. Theory of mobile control by distributed parameter systems. Moscow: Nauka, 1980, 384 p.
2. V.A. Kubyshkin, V.I. Finyagina. Mobile Control in Distributed Parameter Systems. Moscow: SINTEG, 2005, 240 p.