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COMPUTER SYSTEM FOR AUTOMATIC CONTROL OF ARC SURFACING PROCESSES USING ELECTRODE WIRES

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A computer system for automatic control of processes of arc surfacing by electrode wires was developed. The use of a computer system in the appropriate surfacing equipment enables the operator to perform selection of arc surfacing method (under flux, with open arc or in shielding gases); selection of the type of electrode material, its grade and dimensions; to set, automatically maintain, control and record the set parameters of surfacing modes of a part, providing the necessary operational properties and geometric dimensions of deposited layers. With the accumulation of relevant databases on surfacing of parts of different purpose, dimensions and configuration, the use of the developed computer control system will significantly improve the efficiency of arc surfacing processes. 9 Ref., 4 Figures.

Keywords: *arc surfacing, automation of surfacing processes, surfacing technology, computer systems for surfacing control, surfacing power consumption*

The state-of-the-art of automation of surfacing processes assumes the creation of appropriate computer systems for presetting and control of the process parameters in a real time, analysis, processing and, if necessary, automatic correction of values of these parameters taking into account their influence on penetration depth, volume of base metal (VBM) in the deposited metal, as well as formation of deposited layers, their dimensions and quality.

The creation of effective means for automation of surfacing processes due to the development of methods for control and monitoring of the penetration of base metal and formation of deposited layers will allow significant improving the welded joint quality, operational properties of deposited metal and efficiency of surfacing works, as well as reducing the power intensity of surfacing processes.

For arc surfacing these systems, depending on the design, degree of wear and operational requirements for the deposited parts should provide:

- selection of arc surfacing method (under flux, with open arc or in shielding gases);
- selection of type of electrode material (solid or flux-cored wire, cold rolled or flux-cored strip), its grade and dimensions (diameter, cross-section);
- setting and automatic maintenance of the preset electrical and mechanical (surfacing speed, electrode wire stickout) parameters of surfacing modes, providing the necessary geometric dimensions of deposited layers;
- marking of random or deliberate deviations from the set surfacing modes;
- accumulation of relevant databases, recording and subsequent use of optimal modes for surfacing of specific parts.

The existing experience [1–3] shows that state-of-the-art of a computer technology can successfully solve these problems.

The main volume of information, used to evaluate different components of technological process of arc surfacing, is obtained as a result of analysis of signals of current I_s and voltage U_a. Other process parameters are as a rule less important.

To obtain the necessary information directly from the object under control (deposited part), visualization, registration of output data and processing of this information, different information and measuring systems (IMS) [4–9] are used.

Using the computer information and measuring system (CIMS) [3], developed at the E.O. Paton Electric Welding Institute, the authors of the article carried out systematic investigations of influence of electrical parameters of different methods of arc surfacing by flux-cored wire on stability of the process, penetration of base metal and formation of deposited layers [2]. CIMS provides control and registration of the following parameters of surfacing process:

- input of tasks for arc voltage U_{ap} and arc current I_{ap};
- actual values of arc voltage $U_a(t)$;
- actual values of arc current $I_a(t)$;
- mean values of arc voltage $\bar{U}_a$ and arc current $\bar{I}_a$ for the time of surfacing;

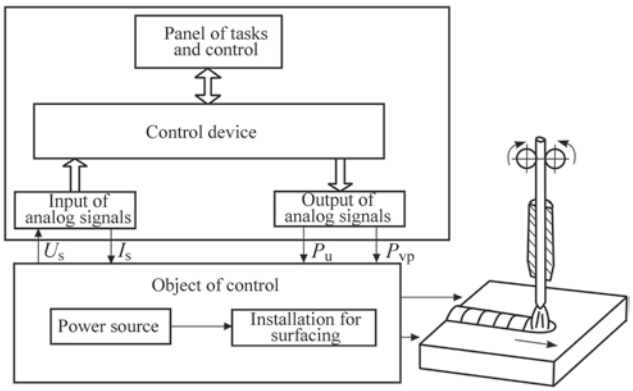

Figure 1. Block diagram of computer system for automatic control of arc surfacing (U_s, I_s — the values of actual voltage and current of surfacing; P_u, P_{vp} — the position of regulator of output voltage of current source and regulator of wire feed speed on the control panel)

- indication of working area of approximating functions (in the parameters of $\bar{U}_a$ and $\bar{I}_a$) which provide the accuracy of approximation by voltage ±1 V and current ±10 A.

As a result of investigations, a database on different methods and technologies of arc surfacing by flux-cored wires and their influence on penetration depth and VBM in the deposited metal as well as on sizes of the deposited beads was accumulated. On the basis of CIMS and accumulated database, a computer system for automatic control of arc surfacing technologies was developed.

A block diagram of the proposed computer control system is shown in Figure 1.

As is seen from the diagram, the task and control panel allows entering and controlling the modes data of the selected arc surfacing method for a particular part in the process of surfacing. These data are then automatically transferred to the control device of surfacing installation. From the control device, the analog signal is supplied directly to the surfacing installation and the power source. After switching on the process of surfacing of a particular part, the computer system installs a set mode by current and voltage for it. In the process of surfacing from the object under the control (surfacing installation and power source) a signal about actual values of surfacing current and voltage is supplied to the control device. In case of deviation of these values from the preset ones, the system performs their corresponding correction.

Depending on the specified task, the system enables the operator to solve different tasks when presetting the modes of automatic arc surfacing of a particular part. Thus, for example, if the operator enters the data on the method of arc surfacing, selected diameter of the electrode wire and surfacing modes into the computer system, then he receives data from the system about the possible dimensions of bead being

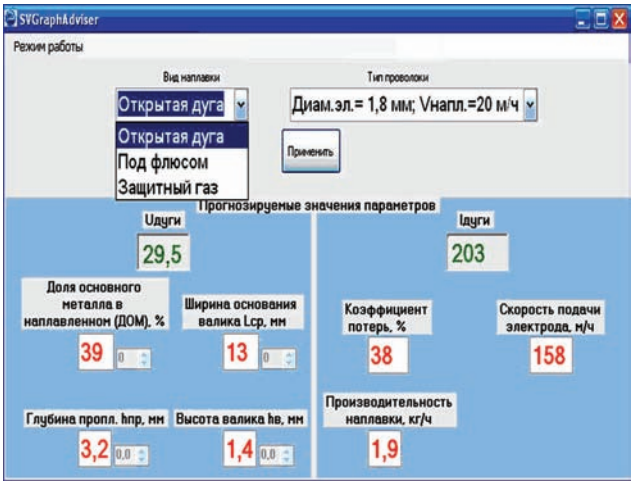

Figure 2. View of computer screen in selecting the surfacing method

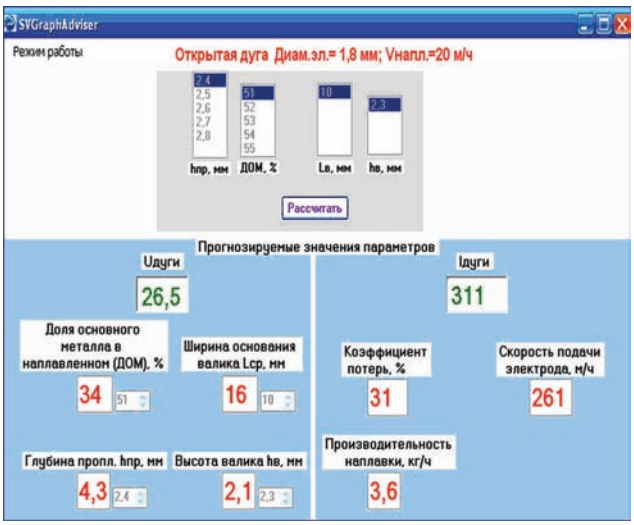

Figure 3. View of computer screen in selecting the electrode wire diameter

Figure 4. View of computer screen with preset modes of open arc surfacing by flux-cored wire of 1.8 mm diameter and predicted characteristics of surfacing process and geometric dimensions of deposited beads

deposited (width, height, penetration depth), VBM in deposited metal, surfacing efficiency, loss factor (Figures 2–4).

Or, on the contrary, if the operator enters the geometric characteristics of bead and VBM to the system, preset according to requirements of the drawing of a part to be deposited, then he receives data about electrical parameters of surfacing mode from the system, which will ensure the obtaining of such characteristics.

In the computer system, the order of priorities for setting parameters of melting bead was introduced. In particular, in the first case such parameters as «Type of surfacing» and «Diameter of flux-cored wire» (see Figures 2, 3) were taken as priority. Then, the surfacing modes are selected (see Figure 4). The list of values of selected parameters is limited within the range of «Admissibility of surfacing modes» from 0.85 to 1.0, which were selected from the results of experimental investigations and entered into the database. In the case of production needs, the «Admissibility of surfacing modes» can be extended to a minimum value of 0.25, but at the same time the deposited beads with a good formation should not be expected.

After calculation, the system provides predicted characteristics of surfacing process (loss factor and surfacing efficiency) and geometric dimensions of beads being deposited.

It should be noted that experience in developing a computer system for control of arc surfacing processes showed that when creating such systems, it is necessary to take into account the electrical characteristics of a specific surfacing installation and power source. The complex of these characteristics should include characteristics of welding source, electrical characteristics of connecting cables and electrical parameters of connections in the installation itself, including the resistance of contact of workpiece with the installation.

Conclusions

A computer system for automatic control of electrode wires arc surfacing processes was developed and tested in the laboratory conditions. Using a computer system in the appropriate surfacing equipment enables the surfacing operator to select the method of arc surfacing (under flux, with open arc or in shielding gases); to select the type of electrode material, its grade and dimensions; to preset, automatically maintain, control and record the set parameters of modes for surfacing of a particular part, providing the necessary geometric dimensions of deposited layers.

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