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ESTIMATION OF THERMAL PARAMETERS DESCRIBING SURFACING BY WELDING PROCESS

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ABSTRACT

In the paper the inverse analysis of thermal resistance of the air gap between the padded material and the welding bench is presented. The mentioned air gap appears due to the thermal stresses, which are the consequence of the non uniform temperature field in the surfacing plate. Due to the thermal resistance of the gap, the heat flux transferred from the welding pool is decreased. The structure of the final surface strongly depends on the heat flux, so the knowledge of the thermal resistance of the gap is essential. This quantity can not be measured directly. The best way of evaluating the resistance seems to be employing the inverse procedure utilizing measurements of surface temperature during the process. In the paper, such procedure is proposed.

Surfacing is the process of renovation of worn machine parts. The surface of the part, which is damaged due to operation, is covered by a layer of new material. The material is provided to the surface in molten form. During surfacing, the base material is partially melted, so the added layer (deposit) is mixed with the base one. The participation of the base material in the deposit can be up to 60%, but high values of this participation are not desired.

The are a number of surfacing techniques: gas surfacing, arc surfacing, submerged arc surfacing, electroslag surfacing, GTA (gas tungsten arc), TIG (tungsten inert gas), GMA (gas metal arc), SSA (self shielded arc), PTA (plasma transferred arc), laser surfacing and the others. In the paper, the GMA technology is considered. In GMA method, the deposit is delivered to the base material in the inert gas shield. The melting of the wire is accomplished by the electric arc acting between two electrodes. One of them is the base material while the wire constitutes the second one. The wire is provided by the feeding system through the inert gas nozzle. The gas is used to separate melted material from the external environment. The surfacing head moves over the base material in several passes. This movement can be performed manually, semi automatic or in full automatic way. The technological process which inspired the investigation presented in the paper was fully automatic. In the process flat metal sheets were surfaced. The time of one sheet surfacing is about several hours. One way of decreasing this technological time is increasing the surfacing head velocity. It can be easily done, but the net power of arc should be also enlarged. If the net power of the arc is too high, the problems with rejecting the heat from the base material appear. The base material is located on the welding bench, which construction allows heat rejecting from the surfacing sheet. Namely, the welding bench is the upper closure of an water container filled with slowly flowing water, which carries away heat from the sheet. Cooling works perfectly, if the contact between the sheet and the welding bench is ideal. Unfortunately, the increment of the arc net power enlarges the thermal stresses in the surfacing sheet. Due to that, air gap between the base metal sheet and the welding bench appears. The thermal resistance of the air gap is the reason of the base metal sheet temperature increment. The temperature can exceed the melting temperature of the base sheet not only on its upper surface (what is required in the surfacing process) but also in its deeper layers, what can cause burned-through holes in the sheet. This makes the whole sheet useless and is a reason of meaningful financial losses. There are two ways of overcoming this problem. One of them is reconstruction of the welding bench in the way to reduce the thermal resistance of the air gap. In such case, the knowledge about the thermal resistance of the gap is essential. Second one is providing the process of surfacing with the controlled head velocity which does not cause the creation of the air gap. This means limitations of head speed. This maximum velocity is difficult to predict and is rather a stochastic quantity. It can be reduced on line when the thermal resistance of the appearing gap starts growing. Thus the knowledge of the thermal resistance value in this case is also essential. In both presented cases, the thermal resistance of the gap should be known. This value can not be achieved by the direct measurements. There is one quantity which can be easily measured: the surface temperature. Thus the procedure which allows to evaluate the air gap resistance basing on the surface temperature measurements seems to be of great practical importance. Such a formulation of the problem places the procedure in the field of inverse problem techniques. In the full paper, the formulation of the inverse problem is presented. The exemplary inverse procedure utilizing sensitivity coefficients [1,3] is provided. In the inverse problems, the solution of direct problem is an essential part of procedure. The direct problem was solved with the utilization of the commercial package Fluent. The procedure [2], assumptions and experimental verification (infra red mapping) are shown in the full paper. In the figures 1 and 2 the exemplary distributions of temperature and sensitivity coefficients in the electric arch surroundings are shown. Additionally, figure 3 shows, how the number of the measurements influences the accuracy of inverse procedure.

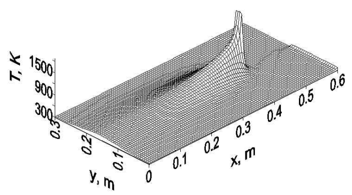

Figure 1. Exemplary distribution of temperature.

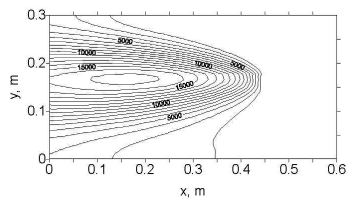

Figure 2. Exemplary distribution of sensitivity coefficients.

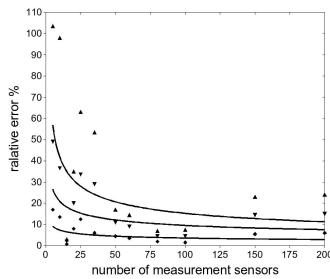

Figure 3. Accuracy of inverse procedure

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