Computer Modeling of Coupled Electromagnetic, Temperature, Magnetohydrodynamic and Stress Fields in the Induction Heating and Melting Devices

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ABSTRACT

Computer modeling is necessary part of design new induction heating and melting devices [1]. One of the complicated technologies when it is necessary to simulate coupled electromagnetic, temperature, magnetohydrodynamic and stress fields is heating and melting of titanium alloys in the alternating electromagnetic field.

Thermal processing of titanium alloys in the inductor has some features that it is necessary to take into account on the designing of the advanced technology and equipment. Low thermal conductivity and high temperature losses at the surface result in maximum temperature inside of the billet that could under appropriate conditions exceed melting point. In this way it is possible to obtain liquid phase of titanium alloy inside of the billet and protect it from the contact with surrounding atmosphere. To get this it is necessary to choose the right regime of processing, frequency of current, power and thermal conditions. At the same time precise heating with very strong execution of the temperature profile during the heating time are essential for thermal processing of titanium alloys in this technology [2].

Mathematical model comprising computation of electromagnetic, temperature, MHD fields after getting melt zone and dynamic of its growth was developed. The calculation of the melting process has been carried out by the method "enthalpy-porosity" with application of models of turbulent currents k-ω SST in a non-static setting. Electromagnetic forces and heat sources have been defined by solving a harmonic task by the method of finite elements on a vector magnetic potential in the system "inductor – load" for each iteration of the hydrodynamic task. Experiments confirmed need in simulation of MHD fields to receive good coincidence. Using of the developed models for simulation of electromagnetic processing billets make it easy to develop and implement optimal heat processing systems for the crucibleless induction melting of titanium alloys.

The calculations on the basis of the model and the analysis of physical processes with non-crucible melting of titanium alloy BT6 have also been carried out.

REFERENCES

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