Influence of a configuration of current leads on uniformity of a temperature field in the resistance furnace with carbon-carbon composite heaters

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Abstract **Thermal processes in the high-temperature vacuum resistance furnace with carbon-carbon composite heaters taking into account influence of current leads are investigated by method of mathematical modeling. The configuration of current leads providing uniformity of a temperature field in the heated product is offered.**

Keywords **Resistance furnace, carbon-carbon composite heaters, current leads, temperature field, mathematical modeling, electrothermal task, construction.**

I. INTRODUCTION

High-temperature vacuum resistance furnaces of resistance are used for carrying out processes of heat treatment, agglomeration, refinement, the soldering, etc. in the nonoxidizing environment at a temperature up to 3000°C.

In high-temperature vacuum furnaces often use heating elements from carbon-carbon composite. Such heater is manufactured of a composite plate by making of the cuts giving to the heater the form of a zigzag tape. Copper current leads are joined to the heater. As the working temperature of the heater considerably surpasses temperature of melting of copper, current leads carry out the water-cooled. Because of a difference of temperatures of the heater and a current lead essential losses of heat through current lead (especially considering the big area of section of a current lead) take place, and it results in unevenness of a temperature field in the heater, and, therefore, and in the heated product.

The problem of finding of such configuration of current leads at which unevenness of a temperature field will be the smallest is actual.

II. MATHEMATICAL MODELING OF ELECTROTHERMAL PROCESSES IN THE VACUUM HIGH-TEMPERATURE FURNACE TAKING INTO ACCOUNT CURRENT LEAD'S INFLUENCE

Calculation of a temperature field in the resistance furnace represents an electrothermal task in which distribution of density of current and the allocated Joule heat in the heater pays off and the heat exchange problem with internal sources of warmth is solved.

Modeling was carried out by FEM-method with use of a software package of ANSYS. Various options of a configuration of current leads were analysed: current leads of round section of various diameter, rectangular current leads and current leads with an intermediate copper plate in a place of joining of a current lead with the heater.

Results of modeling showed that the increase in diameter of a round current lead doesn't lead to essential reduction of unevenness of a temperature field in the heated product, and reduction of diameter conducts to an inadmissible overheat of a current lead, despite water cooling. The worst uniformity of a temperature field turns out when using rectangular current leads.

The most uniform temperature field in the heated product is reached when using current leads with an intermediate copper plate not less than 3 mm thick in a place of joining of a current lead with the heater (Fig. 1). Shortcomings of such constructive decision are the raised copper consumption (for 15% and more), need of providing a dense fit of a plate to the heater, the deformation of a plate at high temperatures leading to reduction of service life.

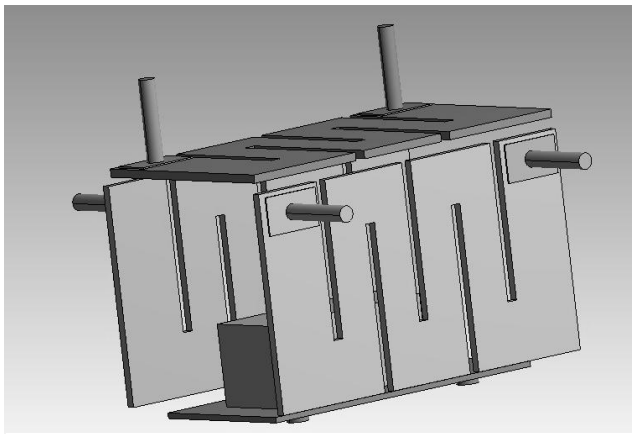

Fig. 1. Heaters and current leads with intermediate copper plate

III. CONCLUSION

The best uniformity of a temperature field in resistance furnaces with carbon-carbon composite heaters is reached when using current leads with an intermediate copper plate. Such configuration of a current leads can be recommended for application, despite the raised consumption of copper and some technological difficulties.

IV. REFERENCES

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