Ladle Furnace Preheating And Charge Heating With Graphite Heating Rods

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Abstract

Present work is done in the framework of the SisAl Pilot EU project, which aims at optimising the silicon production in Europe by recycling materials and using a carbon-emission friendly technology. The silicon production experiments are conducted on laboratory and pilot scales in different types of furnaces, including ladle furnaces used as chemical reactors for molten slag-metal mixtures. Besides experimental work, the process optimisation also relies on the numerical modelling.

In this work COMSOL Multiphysics® is used for the numerical testing of new thermal and electrical designs of a ladle furnace by simulating its preheating and charge heating in it with three graphite heating rods powered by a three-phase alternating current transformer. The one-heating-rod design was also tested. The following COMSOL® modules are employed: Heat Transfer in Solids and Fluids with phase change and convectively enhanced conductivity while fluid flow is not directly simulated, Surface-to-Surface Radiation, and Electric Currents to simulate the Joule effect in electrically conducting materials. A bidirectional coupling of all the modules is present due to multiple interdependencies via material properties.

The model predicts that available electrical equipment is sufficient for preheating the empty ladle furnace up to 1600°C in less than 4 hours. Thanks to the model, the geometry of the heating rod was optimised to keep its temperature below 2500°C. It is found, however, that a modification of the electrical equipment would be needed to be able to heat the furnace charge with the heating rods submerged into it. The presented modelling approach for testing new furnace designs can be applied to other similar thermoelectrical problems.

Keywords: Ladle furnace preheating, Charge heating, Graphite heating rods

Figures used in the abstract

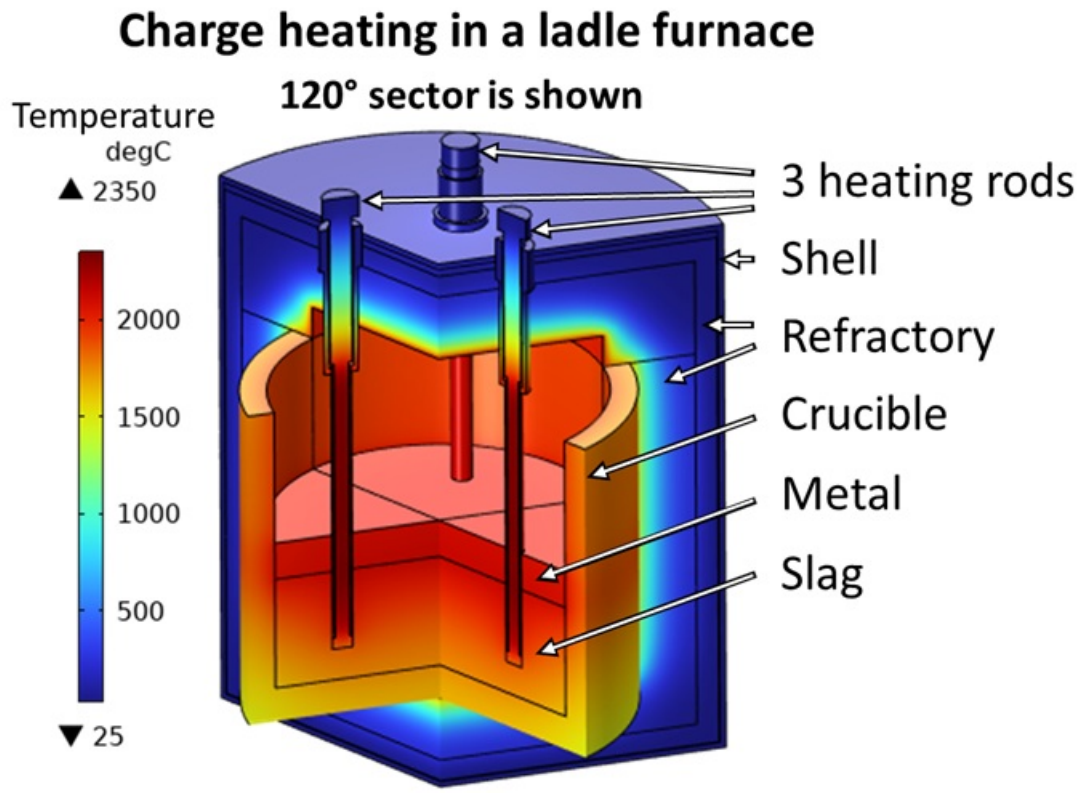

Figure 1 : Charge heating in a ladle furnace