ENHANCING OPERATION AND DESIGN OF ALTERNATE CURRENT-POWERED INDUSTRIAL FURNACES: INSIGHTS FROM MATHEMATICAL MODELING AND SIMULATION

ALFREDO BERMÚDEZ, DOLORES GÓMEZ, AND DAVID GONZÁLEZ

Abstract. Electric furnaces play a key role in many industrial applications, providing precise control of heat generation and distribution. Research and development efforts in the field of industrial furnaces rely heavily on mathematical models and numerical simulations. These tools enable researchers to test hypotheses, explore new technologies and develop innovative solutions in a cost-effective and controlled manner. This presentation will examine a particular type of furnace and show how mathematical models and numerical simulations are used to improve its operation and efficiency. The furnace is a vacuum furnace used for the purification of silicon. A conductive molten mixture contained in a crucible is heated by a resistor connected to three-phase alternating current. This induces eddy currents that create an electromagnetic force within the melt. Stirring and heating cause impurities to evaporate and condense on a chamber wall. The whole problem is a multiphysics problem involving different mathematical models: electromagnetic, thermal, hydrodynamic, gas kinetic and thermodynamic. In this talk the main features of the different models are introduced. As the geometry of the furnace requires a 3D solution, a methodology combining distributed and lumped models is also presented to simulate the current distribution in the furnace and, in particular, to calculate the current to be supplied to obtain a desired power [**?**].

Keywords: Metallurgical furnaces, indirect resistance heating, numerical simulation, eddy current models

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References

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Universidade de Santiago de Compostela and CITMAga
Email address: alfredo.bermudez@usc.es

Universidade de Santiago de Compostela and CITMAga
Email address: mdolores.gomez@usc.es

Universidade de Santiago de Compostela and CITMAga
Email address: david.gonzalez.penas@rai.usc.es