Thermal Analysis of Induction Furnace

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Abstract

Induction furnaces are employed for vacuum distillation process to recover heavy metals after electro-refining operation. Induction furnace of suitable heating rate and cooled by passive means are required to be developed for this purpose. It is planned to set up a mock up induction furnace which will simulate the conditions to be realized in actual vacuum distillation furnace for this purpose. The mock-up facility will be used to demonstrate melting of 10 kg of copper in a graphite crucible and heated by induction furnace in a vacuum environment. The coil configuration and electrical parameters of the furnace are to be finalized to attain a temperature of about 1500 degC in 2 hours for the charge. Figure1 shows the schematic layout of the mock-up facility used. The furnace liner enclosing the crucible, essentially coupled with the magnetic field generated by coil, gets heated up and indirectly heats the crucible by radiation heat transfer. The melting of copper takes place in crucible. The copper liner prevents the coupling of stainless steel vessel with magnetic flux lines. The carbon felt insulation is used to prevent the heat loss to the coil and other parts. The stainless steel vessel encloses all the above parts. Thermal analysis of the mockup facility is being carried out using COMSOL Multiphysics code to optimize the various electrical parameters. First the Induction Heating Interface under the Heat Transfer Module of COMSOL Multiphysics was modeled and validated with the experimental data reported in the literature. The validated model was then used for 2D-axisymmetric transient thermal analysis of the mock-up facility. The heat transfer and electromagnetic characteristics have been investigated. The temperature distribution is shown in figure 2. The effect of various operating parameters, geometrical factors and material parameters has also been carried out. This paper details the thermal and electromagnetic modeling of the induction furnace and discusses the results obtained.

Reference

1. V. Rudnev, D. Loveles, R. Cook, and M. Black, "Handbook of Induction Heating", New York, NY, 2003.

2.C. Chaboudez, S. Clain, J. Rappaz, J. Swierkosz, and R. Touzani, 1994. “Numerical modeling of induction heating for axi- symmetric geometries”, Mathematicl Models and Methods in Applied Sciences.

Figures used in the abstract

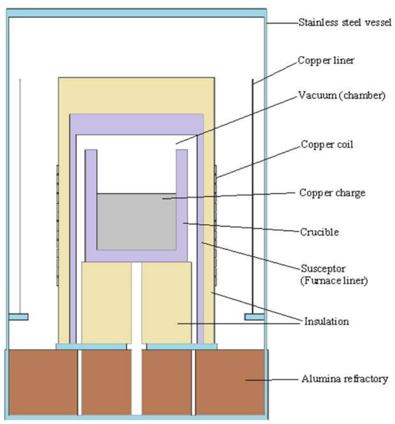

Figure 1: Fig.1: Schematic model of mock-up induction furnace

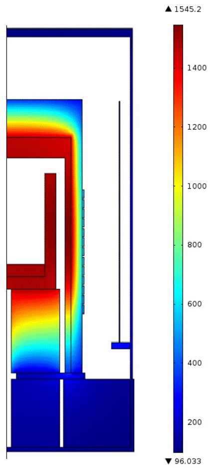

Figure 2: Fig.2: Temperature distribution in mock-up . Temperature distrbution (Temperature in degree celsius) in mock-up equipment after two hours