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Title(English)	Study on Joule-heating flow in a cubic cavity
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Thesis outline

Title “Study on Joule-heating flow in a cubic cavity”

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This thesis presents a study on Joule-heating flow in a cubic cavity using ultrasonic velocity profiling. The main objective of the study are to investigate Joule-heating flow characteristics and effect of boundary conditions on the flow behavior. The numerical investigation using GSMAC-FEM is also performed to predict Joule-heating flow.

Chapter 1, “**Introduction**”, this chapter presents the background of research about the vitrification technology of High Level Radioactive Wastes (HLLWs) using Glass melter. In Japan, Liquid-Fed Ceramic glass melter (LFCM) has been developed which applied a constant AC voltage between the main electrodes in order to generate the volumetric heating of the molten glass. Understanding the flow behavior in glass melter is important. GSMAC-FEM (Generalized Simplified Marker and Cell- Finite Element Method) is applied to predict the flow behavior and temperature distribution by solving coupled analysis models of three fields: flow field, thermal field and electromagnetic field. However, GSMAC-FEM is confirmed before applying for the molten glass.

Chapter 2, “Experimental Investigation of Joule-heating flow in a Cubic Cavity using Glycerol-water solution”. This chapter presents the characteristics observation of Joule-heating flow occurs in the cubic cavity (0.1m×0.1m×0.1m) using glycerol-water solution as working fluid. The flow behavior is very unstable flow. Thus, Ultrasonic Velocity Profiler (UVP) method is expected to observe the Joule-heating flow characteristics. The most advantages of this method are non-intrusive, applicable in opaque fluids and high temperature fluid such as molten glass. Study on the effect temperature-dependent of sound speed on the accuracy measurement have to be examined. The temperature effect on ultrasound beam is negligible. As a results, the characteristic of flow is observed as homogeneous turbulence flow.

Chapter 3, “**Numerical Simulation of Joule-heating Flow for Glycerol-water solution**”. This chapter presents the simulation analysis of Joule-heating flow by computational codes. GSMAC-FEM can reproduce the chaotic flow. The frequency spectrum is also observed as homogeneous turbulence flow. Moreover, a comparison of history of temperature shows a good agreement between GSMAC calculation and experiment data. The applicability of numerical analysis for Joule-heating flow is confirmed.

Chapter 4, “Boundary Condition Effect on the Joule-heating Flow Behavior”. In glass melter, there are many parameters which affect the chaotic flow such as top cooling temperature, cooling condition of electrode plates due to high temperature. The effect of cooling condition of electrode plates on the side wall and cold cap located on the top surface is investigated experimentally and numerically using glycerol-water solution. As a result, when cooling electrode the flow behavior in glass melter is unstable on the upper part. The cold cap boundary condition effect is also investigated. with a main vortex which has a diameter of about 90mm for both 50% cooling and 75% cooling.

Chapter 5, “**Numerical Investigation of Molten Glass in a Cubic Cavity**”. This chapter present the numerical analysis for molten glass. In these calculation, the shape of a glass melter is simplified as a cubic cavity which has dimension of (0.7m×0.7m×0.7m). A chaotic flow behavior of molten glass is observed by numerical calculation. The averaged force profile such as buoyancy force, diffusion force, convection force and Lorentz force are calculated. Therefore, the effect of magnetic field on the molten glass flow behavior must be considered.

Chapter 6, “**Conclusions**” Insights the chapter 2 to chapter 5 are summarized in this chapter.