Mathematical Modelling of Aluminium Electrolysis Cells

Company
Alcan

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Team common language
French

Abstract

This project will involve the simulation of a (thermoelectric) aluminium electrolysis cell with a phase transition. More precisely, one must carry out a static simulation of the heat balance of an electrolysis cell and compute the solidification front of the electrolyte. The company has provided three figures: a diagram of the industrial process, another diagram detailing some aspects of the first one (lower part of the anode, electrolyte, liquid aluminium, carbon material), and a third figure that includes a side view. The electrolyte is a fluorinated salt whose phase transition occurs at around 950^oC. Thus a solid crust is formed on the external wall of the cell. The properties of this crust are quite different from those of the liquid electrolyte.

The method currently used is a fixed mesh finite element method (ANSYS), with the change in properties being used for computing the phase transition. Since the location of the solidification front is not known a priori, this method entails the meshing of the entire zone where the solidification front can be located, and it does not enable one to choose a convection coefficient between phases.

The goal of the project is to identify the most promising approaches for determining the position of the solidification front, and to reach the best trade-off between the sensitivity of the results and the computation cost. In the first part of the project, we shall study the properties of elements in a finite element method (element shape, degree). In the second part, we shall study alternative methods. An essential criterion for evaluating such methods is the ease with which they can be implemented in commercial codes available at Alcan (such as ANSYS, Fluent and CFX).