(1) Si "primary" veut dire Principalement, i.e. la méthode la plus utilisée ...
=> Metallic aluminium is [primarily/mainly] produced by the transformation of aluminium oxide ...

Abstract

Metallic aluminium plays a key role in our modern economy. Primary metallic aluminium is produced by the transformation of aluminium oxide with the Hall-Héroult industrial process. This process, which requires enormous energy quantities, consists in performing the electrolysis of an aluminium oxide solute in large pots and with hundreds of thousands of amperes of electrical current. (1)

The topic of this thesis is the study of some selected aspects of the modelisation of the electrolysis process from the point of view of numerical simulation. This thesis is split in two parts.

The first part is focused on the numerical modelisation of the alumina powder dissolution and transport in the electrolytic bath as a function the bath temperature. We provide a mathematical model for the transport and dissolution of the alumina powder, followed by its time and space discretisation by means of a finite element method. Eventually, we study the behavior of this numerical model in the case of an industrial electrolysis pot.

The second part devoted to the development of a numerical scheme for the approximation of the fluid flows in an electrolysis pot. The scheme on a Fourier basis decomposition of the unknowns. The amplitude of each Fourier componant satisfy a partial differential equation which is explicitely derived. The solution of this equation is approximated by means of a finite element method. Eventually, the approximate fluid flow obtained with this novel method is compared with the solution provided by the reference model in an industrial electrolysis pot.

Keywords Numerical simulations, Finite element methods, Partial differential equations, Advection-diffusion equation, Electrolysis, Alumina, Dissolution, Temperature.