Primary aluminium production – applications

Characterization of the Electrolyte in Primary Aluminium Production

For several years, SINTEF has worked with characterization of cryolite-based melts. Based on a large number of experimental data as well as theoretical considerations, mathematical expressions have been derived for the computation of liquidus temperature, alumina solubillity, electrical and thermal conductivities, and density. For some melt compositions, activity data have also been made available.

Industrial Basis

Today, primary aluminium is produced exclusively by the Hall-Heroult process. The process involves electrochemical reduction of alumina dissolved in a cryolite-based electrolyte at about 960 ^{o}C. The efficiency of the process depends largely on the properties of the electrolyte. Furthermore, mathematical modelling is becoming increasingly important in cell control and process optimization, as well as in the design and planning of new cells and alternative processes. In this context, it is of crucial importance to have precise physical and chemical data for the relevant range of electrolyte compositions in order to avoid misinterpretations and conseptual misunderstanding. It is also beneficial to have the data in the form of analytical expressions, rather than tables.

Experimental and Theoretical Basis

There exist several theories concerning the properties of molten salts. However, the theories often lack quantitative accuracy, since the electrolyte used in the Hall-Heroult process is a ternary salt mixture that undergoes the formation of complexes. The equations describing the physical properties are therefore mainly based on experimental work, comprising literature data as well as our own measurements. Our laboratories are equipped with different kind of high-temperature equipment, e.g., a special apparatus for thermal analysis. Much of this work is done in close collaboration with personnel from NTNU.

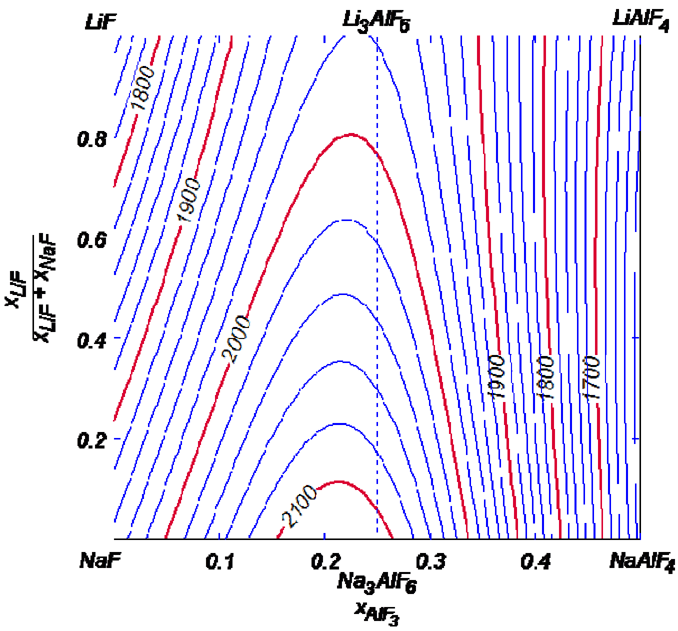

Figure 1. Iso-density lines [kgm^{-3}] in the system NaF-LiF-AlF_3 at 1000 ^{o}C.

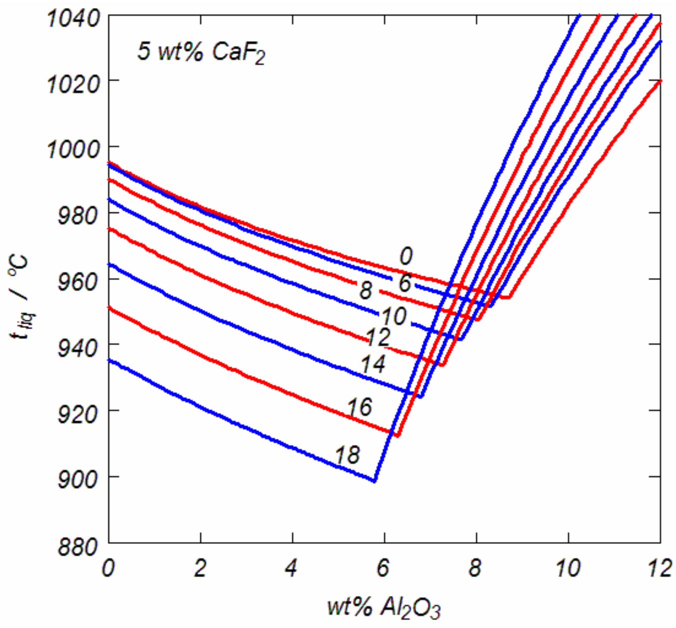

Figure 2. Quasi-binary phase diagrams in the system Na_3AlF_6-AlF_3-Al_2O_3-CaF_2. The numbers in the figure give the concentration of AlF_3 [wt%].

Some References

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