

Assessment of the Thermodynamic Stability of Thermal Insulating Materials in Aluminium Electrolysis Cells

Raymond Luneng¹, Tor Grande² and Arne Petter Ratvik³

1. PhD-candidate

2. Professor

Department of Materials Science and Engineering, Norwegian University of Science and Engineering (NTNU), Trondheim, Norway.

3. Senior Research Scientist, SINTEF Materials and Chemistry, Trondheim, Norway.

Corresponding author: raymond.luneng@ntnu.no

Abstract

The cathode bottom lining in aluminium electrolysis cells serves as a thermal insulating barrier and is important for the overall thermal and dimensional stability of the cell. The thermal insulation layer is protected against chemical degradation by a refractory layer, but due to recent technological developments and new cell designs, the stability of insulating materials is expected to become an important matter of concern in the years to come. The thermodynamic stability of thermal insulating materials in chemical environment corresponding to the one below the carbon cathode has been assessed. Thermodynamic evaluation was used to predict possible chemical reactions caused by sodium vapour, which possibly can penetrate through the refractory barrier and react with the insulation material. The most likely chemical reactions with the insulation materials were identified by minimization of Gibbs energy of the system. Changes in the mineralogical composition of the insulation materials were predicted based on the thermodynamic calculations. The structural integrity of the thermal insulation materials is discussed in relation to the mineralogical changes predicted based on the thermodynamic assessment.

Keywords: Thermal insulating materials; aluminium electrolysis cell; thermodynamic stability; degradation.