

Thermodynamic Assessment of the Chemical Durability of Refractory Lining in Anode Baking Furnaces

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Abstract

The aluminosilicate refractory lining in anode baking furnaces undergoes thermal cycling and are exposed to harsh chemical environments. Consequently, the thermal stability and chemical durability of the refractory material is important for the lifetime of the lining. Here, we present a thermodynamic assessment of the stability of the aluminosilicate materials resembling the chemical environment of the anode baking furnace. Volatile species (NaF, NaAlF₄, SiO, CO, etc.) from anodes were identified based on typical chemical composition of green anodes. The most likely chemical reactions of the volatile species and the oxide components in the lining are evaluated. The variation in the volatility of substances due to the thermal cycling and reducing conditions during anode baking was examined in particular. Changes in the mineralogical composition in the lining were predicted based on the thermodynamic calculations and these are summarized in form of isothermal predominance phase diagrams. Formation of sodium aluminosilicate phases and volatile SiF₄ are proposed to be the main consequence of the chemical degradation of the lining due to traces of the cryolite in the green anodes.

Keywords: Anode baking furnace; refractory lining; degradation.