Modelling and Experiments for Stainless Steel Slag Valorisation

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Abstract

Zero-waste is an important concept in metallurgy, as it guarantees sustainability and competitiveness by avoiding to produce dangerous or invaluable side products. Slags from ferrous industry are important side products and find applications in road construction, concrete building etc. For stainless steel slags, control over mechanical properties and environmental compliancy is essential for some of the possible valorisations. A project between Ugine & ALZ Belgium and K. U. Leuven was set up to enhance properties and gain knowledge. Equilibrium calculations are an essential tool to link composition and conditions to microstructure.

Especially during primary smelting in the EAF, stainless steel slag is saturated in spinel. The solubility of spinel is of great importance for the leaching properties of the slag, as Cr is expected to be bound more stably in spinel and thus leach less easily from spinel, as compared to matrix phases such as C_2AS or C_3MS_2. A set of equilibrium experiments was performed to evaluate the quantitative accuracy of FACT database for stainless steel slags at the high temperature. The spinel, periclase and eskolaite liquidus was measured by supersaturated sampling, quenching and analysis in the system $CaO-MgO-SiO_2-Al_2O_3-CrO_x$ up to 1600°C and at various p_{O2}. Except for a minor but systematic deviation for the eskolaite (M_2O_3) liquidus, the match with the theory is excellent. Therefore the databases can be used for optimization of the high temperature process.

Furthermore, we used ChemApp to model the cooling sequence of various slags (EAF, AOD/VOD, desulphurisation) and found a good agreement when using Scheil-Gulliver assumptions. Hence, the investigation of the effect of additions to the slag was enabled. To prevent the dusting of slag by the presence of C_2S, two options were investigated. First, the current practice was examined, which consists of the addition of borates to suppress the destructive beta-to-gamma C_2S transformation. By calculations combined with controlled cooling experiments, the theoretical minimal amounts could be deduced. A second option, the addition of SiO_2 to reduce the basicity C/S, thus preventing any C_2S formation, was investigated by a process model. This enabled quick pilot testing by the industrial partner.