Development of Non-Linear Equations for Predicting Electrical Conductivity in Silicates

Authors

P.Q. dos Anjos, Federal Institute of Espírito Santo, Vitória, ES, Brazil
patrick.dosanjos@outlook.com

L.A. Quaresma, Federal Institute of Espírito Santo, Vitória, ES, Brazil

M.L.P. Machado, Federal Institute of Espírito Santo, Vitória, ES, Brazil

Electrical conductivity is extremely important for the production of steel by electric arc furnaces as it interferes with productivity. Data were analyzed through a database for the non-linear modeling of electrical conductivity as a function of chemical composition and temperature with statistical evaluations of sensitivity analysis, mean, and standard deviation of the error between the predictions and the database.

Electric arc furnace (EAF) slag is composed of a SiO_2-CaO-MgO-Al_2O_3-FeO[1,2] system with a temperature of up to 1,756 K.[3] The electrical conductivity of the slag in the EAF is important in the industrial process and directly affects the quality of the final product and energy consumption.[4]

Slag foaming consists of introducing gas bubbles into molten metal and slag by bubble injection or chemical reaction. The slag foam protects the refractory, increasing the working time of the lining composed of refractories. The foam prevents oxidation of the molten material and allows control of its chemical composition, aiding refining and homogenization, also acting as a thermal insulator between the molten material and its surroundings, thus reducing the energy required to maintain the operating temperature.[2]

To form and maintain the CO gas bubbles responsible for slag foaming, formed through the $2Fe + O_2 \Rightarrow 2FeO$ in steel and $C + FeO \Rightarrow CO + Fe$ in slag reactions (Fig. 1), optimized slag chemistry is required. The slag, also composed of solid phases, mainly formed by MgO and CaO, must have a viscosity in a narrow range that generally occurs when there is the formation of the MgO·FeO phase through the saturation of MgO.[5]

The electrical conductivity of slag can generally be determined by electronic conduction and ionic conduction[7] correlating the structure of the slag composed by the NBO/T parameter. In CaO-SiO_2-B_2O_3 slags, charge transport occurs through Ca^{2+} ions because Si^{4+} and B^{3+} ions

Figure 1

The action of Fe, O_2 and C in the formation of CO bubbles.[6]