Abstract

A pyrometallurgical process was developed for the recycling of Ni bearing dusts and laterite ore fines by direct reduction smelting in DC (direct current) arc furnace. In the course of the performed industrial trials, besides the Ni-recovery in the liquid bath, slag composition was deliberately adjusted in order to produce a series of metallurgical slags with different chemical and mineralogical composition. The aim of this study was to investigate their suitability as clinker substitute in cement manufacturing. Examined parameters were slag FeOx content, basicity and applied cooling media (air, water cooling). A series of composite Portland and slag cements were manufactured in laboratory scale incorporating 20% and 40% of each slag, respectively; the rest being clinker of OPC (ordinary Portland cement) and 5% gypsum. The extended mineralogical analysis and microstructural properties of the produced slags were examined and correlated with the properties of the produced cements. The physical and mechanical characteristics of all examined cement products were found to meet the requirements of the regulation set for cements. The present research revealed that the most critical parameter in the compressive strength development of the slag cements is the mineralogical composition of the slag. Even in cases where rapid cooling to obtain glassy matrix is not feasible, adjustment of slag analysis to obtain mineralogical phases similar to those met in clinker of OPC, even at higher FeO contents (up to ~21wt.%), can result in production of slag with considerable latent hydraulic properties. These results indicate that there is potentially space for adjustments in conventional EAF (electric arc furnace) steel slags composition to allow for their wider use in cement manufacturing with significant environmental and economic benefits resulting from the reduction of energy requirements, CO₂ emissions and natural raw materials consumption.