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Influence of Granulation Media on the Reactivity of Electric Arc Furnace Slag as Supplementary Cementitious Materials

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The transition to hydrogen-based reduction processes will alter slag compositions and volumes in ore-based steelmaking, with potential consequences for the established industrial symbiosis between steel and cement sectors. Presently, ground granulated blast furnace slag is widely utilized as a supplementary cementitious material (SCM), replacing clinker and thereby lowering the carbon intensity of cement production. As blast furnaces (BFs) are expected to be locally replaced, alternative SCM sources from future ore-based steelmaking must be assessed. One such future route is the melting of hydrogen direct reduced iron in electric arc furnaces (EAFs), which generates slags that could be valorized as SCMs provided they are vitrified during granulation. Since granulation technologies involve different cooling rates and associated costs, the influence of granulation media on slag vitrification and reactivity is of particular interest. In this study, synthetic EAF and BF slags were granulated at laboratory scale using both water jets and air blasting. Continuous cooling transformation experiments using hot-stage confocal laser scanning microscopy showed that, relative to EAF slag, BF slag underwent greater supercooling prior to crystallization and exhibited lower growth rate. This was confirmed by the granulation experiments, where air granulation drastically reduced the amorphous fraction of EAF slag, while BF slag achieved nearly full vitrification with both media. The inherent reactivity, assessed by R3 isothermal calorimetry, reflected this difference: EAF slag reactivity was strongly dependent on granulation medium, whereas BF slag reactivity was less affected. Energy dispersive X-ray spectroscopy indicated similar glass compositions within the respective slag types, suggesting that the observed reactivity differences are linked primarily to vitrification and thermal history rather than chemistry. These findings underline the critical role of granulation media in pursuing EAF slag valorization as SCMs.

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