A calorimetric study of hydration of magnesia-ferriferous slag mechanically activated in air and in CO_2 atmosphere

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The research object in this study has been granulated magnesia-ferriferous Cu–Ni slag from "Pechenganickel" smelter plant (Murmansk Region, Russia). The slag mainly consists of magnesia-ferriferous glass (95–98 wt.%) with minor amount of the crystalline phases of olivine (2–5 wt.%) and ore minerals (1–3 wt.%). The reactivity of the slag as cementitious material is relatively low. However in building materials it can be used as a component of blended cement, lime-activated cement and alkali-activated cement in combination with Portland cement, lime or alkali agent, respectively.

In the present study, the hydration behaviour of the magnesia-ferriferous slag without additional reagents has been studied by isothermal calorimetry. To enhance the reactivity, mechanical activation of the slag has been carried out in a planetary mill AGO-2 in air and in CO_2 atmosphere for 10 min at a centrifugal factor of 40 g. Earlier studies showed that the reactivity of the slag milled in CO_2 was higher than that of the slag milled in air [1,2]. The increase of the reactivity was due to carbonization of the slag as a result of the MA-induced chemisorption of carbon dioxide molecules in the form of carbonate ions by the slag particles.

The slag hydration heat evolution rate and total hydration heat emission have been measured with an TAM III isothermal calorimeter at 25ºC within two months. The mechanically activated slag to water ratio has been 0.24. The results have shown that MA in CO_2 in comparison to MA in air substantially enhances the hydration of the slag. The induction period of heat evolution for the slag mechanically activated in air and in CO_2 is about 25 d and 6 d, respectively. The total hydration heat emission for the both milled slag samples is about 2 times larger than that for supersulfated cement [3] and is comparable with that for Portland cement [4].

The results of calorimetric experiments have been compared with X-ray diffraction, FT-IR spectroscopy measurements and compressive strength of the slag samples. Hydration scheme of the mechanically activated slag has been suggested.

The calorimetric experiments have been performed at the Centre for Thermogravimetric and Calorimetric Research of the Research Park of St. Petersburg State University.

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