PhD Defense

Time: Monday, December 4, 2017 at 12:30 pm
Place: Room 3546D Engineering Building

“Mechanochemical Synthesis of Sustainable Hydraulic Cements”

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ABSTRACT

A mechanochemical approach was developed for synthesis of sustainable hydraulic cements based on the alkali aluminosilicate chemistry. This approach is energy-efficient with distinctly low carbon footprint; it also enables large-volume use of abundant wastes and carbon dioxide as raw materials. A theoretical framework was developed to explain the production process and the hydraulic mechanism of the alkali aluminosilicate cement.

Refinement of the raw materials formulations and the processing conditions led to production of cements that meet or surpass standard requirements. The performance, cost, energy content and carbon footprint of the mechanochemically processed hydraulic cement were generally better than those of conventional Portland cement. The approach developed for production of alkali aluminosilicate cements is particularly effective in achieving significantly reduced carbon footprints by reducing the energy use in production of cement, avoiding chemical release of carbon dioxide, and making value-added use of CO₂ as a raw material. The scalability of the production process of the alkali aluminosilicate hydraulic cements was verified through integrated theoretical and pilot-scale experimental investigations.

A methodical approach to concrete mix design with the alkali aluminosilicate cements was implemented, and was accompanied with experimental investigations of concrete materials of different mix designs prepared with either the alkali aluminosilicate cement or Portland cement. The trends in the effects of the concrete mix design parameters on its properties indicated that the popular mix design procedures developed for Portland cement are generally compatible with the alkali aluminosilicate cement, which produces concrete materials of improved mechanical, physical and durability characteristics.