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Impact of Calcium Aluminosilicate Glasses and Mixed Alkali Effect on Pozzolanicity of blended cements

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A common and effective approach to reduce CO₂ emission associated with cement production is to substitute the Portland cement clinkers by Supplementary Cementitious Materials (SCMs) in as high a fraction as possible. Waste glasses represent potential candidates as SCMs for reducing CO₂ emissions. However, the availability of commercial waste glasses (cullet) has become rather limited due to the fast development of glass technologies in terms of recycling and reusing cullet. To solve this problem, we synthesize calcium aluminosilicate glasses from waste materials. We investigate the hydraulic reactivity of these glasses with various amounts of additional alkali oxides. The purpose of adding alkali oxides to the glasses is to lower the melting temperature and thus lower the energy consumption for producing the new potential SCMs. We study the glass structure and thermal stability of these glasses, and characterize the physical performances of blended cements containing the most reactive glasses. We also determine the dominating factors that contribute to the reactivity of these glasses.

The investigated glasses are representative to the slag domain within the CaO-Al₂O₃-SiO₂ ternary phase diagram, modified either with Na₂O, K₂O or a mix of these alkali oxides in order to explore the effect of the mixed alkali effect on the hydraulic reaction of the glasses. We show the relation between the thermodynamic properties measured by DSC and dynamic properties by viscometry. We perform a kinetics study of the dissolution of the mixed alkali glass series. Physical performances of resulting blended cements will be an indicator for the potential application of the glasses resulted from alkali oxides modified artificial slags as new SCMs in low energy cement.