

ORGANIC LIGANDS IMPROVE THE REACTIVITY OF ALUMINOSILICATE PRECURSORS AND ACCELERATE AAM HARDENING

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Sufficient rate and extent of dissolution of aluminosilicate precursors are crucial when preparing alkaline activated materials (AAMs). Traditional approach to improve the reactivity is to use concentrated alkaline solutions, typically a mixture of sodium hydroxide and sodium silicate solutions. However, their use is not preferred as alkaline solutions cause most of the environmental impact of AAMs; they are user non-friendly due to the high alkalinity; they are the most expensive component of the mix; and cause efflorescence and instability of the binder. It is possible to use small amounts of additives to improve the solubility of the solid precursors without the need for high concentrated aggressive alkaline media.

This work explores the effect of various conjugate bases of organic acids (called as 'organic ligands' here) on the extent of dissolution of multi-oxide silicate materials and on the fresh and hardened properties of the prepared AAM binders. The results show that extent of dissolution is increased by formation of various Al-, Mg-, Ca-, and Fe-complexes. The ligands accelerate the reaction kinetics, increase the flowability of the paste, and improve the 1-day strength of typical Na₂CO₃-activated BFS from 4 MPa (without ligand) to 16 MPa (0.1 wt.% ligand dosage).

The results obtained are discussed in a more general sense regarding aqueous speciation chemistry. Organic ligands improve the dissolution rate by forming aqueous complexes with the dissolved ions which will create a driving force for the dissolution reaction, but also affects the availability of aqueous ions in the pore solution. Different organic acids have different pK_a's depending on the functional groups of the acid which consequently affects their ability to form complexes at alkaline conditions. The aqueous speciation of ions and complex formation reactions are thermodynamically modelled with PHREEQC software and compared with experimental results.