Effect of Kaolinite and Sulfate on the Formation of Hydroxy-Aluminum Compounds

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Abstract: OH-Al solutions were prepared by adding appropriate amounts of NaOH to $AlCl_3$ to obtain OH/Al mole ratios of 2.0, 2.5, 2.7, 3.0, and 3.3 in the final suspension. Solid Na_2SO_4 and Georgia kaolinite (KGa-2) were added individually and jointly to the OH-Al solutions. All samples were aged for 30, 70, and 180 d. X-ray diffraction, infrared spectroscopy, scanning electron microscopy, and energy dispersive X-ray spectrometry were used to characterize precipitates. Bayerite, gibbsite, and nordstrandite crystallized at mole ratios of 3.0 and 3.3, with bayerite being the most abundant. A morphology of clusters of triangular pyramids is described for bayerite. Despite the aging duration, only noncrystalline Al compounds were obtained in mole ratios of 2.0, 2.5, or 2.7. The addition of sulfate to OH-Al solutions in mole ratios of 2.0 and 2.5 produced crystalline basic aluminum sulfates of variable morphology, but with similar chemical compositions. These phases lost crystallinity with aging. The product from a 2.7 OH-Al solution was X-ray amorphous hydroxysulfate. In contrast, products obtained at mole ratios of 3.0 and 3.3 contained no sulfate ion, which restricted the formation of gibbsite, bayerite, and nordstrandite. The addition of kaolinite to the solutions in OH/Al mole ratios of 3.0 and 3.3 favored the formation of nordstrandite. The simultaneous addition of sulfate and kaolinite to the OH-Al solutions in mole ratios of 2.0 and 2.5 produced prevalent sulfate over kaolinite, whereas the opposite occurred at mole ratios 3.0 and 3.3.

Key Words: Bayerite • CMS Clay KGa-2 • Gibbsite • Hydroxysulfate • Noncrystalline Compounds • Nordstrandite

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