Effect of Prolonged Aging on the Transformation of Short-Range Ordered Aluminum Precipitation Products Formed in the Presence of Organic and Inorganic Ligands

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Abstract: More than 40 samples of Al precipitation products formed in the presence of organic (aspartic, oxalic, citric, tartaric, malic, salicylic, and tannic acid, and acetylacetone) and inorganic (chloride, sulfate and phosphate) ligands, which were short-range-ordered materials after 2 – 5 months of aging, were analyzed by X-ray diffraction (XRD), infrared spectroscopy (IR), and transmission electron microscopic (TEM) examination after prolonged periods of aging in the mother liquids (from 7 – 15 years). Noncrystalline materials were found after 7 – 10 years of aging in samples formed in the presence of citrate, tartrate, and tannate at pH $\leqslant$ 8.0 and at ligand/Al molar ratios (R) ranging from 0.05 – 0.1; they were found as well in the presence of phosphate and malate at ligand/Al molar ratios from 0.1 – 0.5. Poorly crystalline Al-oxyhydroxides (pseudoboehmite) without $Al(OH)_3$ polymorphs were found in solutions with a wide range of pH (from 6.0 – 11.0) in the presence of tartrate, citrate, tannate, malate, salicylate, sulfate, and phosphate after 7 – 15 years. The crystallinity of these samples was indeed very poor. On the contrary, gibbsite formation was observed in samples formed at pH 7.0 or 8.0 in the presence of oxalate (R = 0.1 or 1.0), aspartate (R = 0.1 and 0.5), malate (R = 0.03 or 0.17), salicylate (R = 0.05), and in samples containing very high concentrations of chloride (R = 700 or 1000). Finally, the formation of gibbsite was promoted in the presence of montmorillonite, but some samples at pH $\leqslant$ 6.0 in the presence of citrate (R = 0.1), tartrate (R = 0.1), or tannate (R = 0.02 or 0.1) showed after 6 years of aging interstratification of OH-Al species in the interlayers of the clay mineral and complete lack of $Al(OH)_3$ polymorphs.

Key Words: Aging • Gibbsite • Montmorillonite • Noncrystalline Al products • Pseudoboehmite

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