Influence of Inorganic and Organic Ligands on the Formation of Aluminum Hydroxides and Oxyhydroxides

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Abstract: Hydroxide and oxyhydroxide products of aluminum were formed at room temperature at an initial Al concentration of 2×10^{-3} M, pH 8.2, and at varying concentrations of organic and inorganic ligands commonly found in nature. The effectiveness of the ligands in promoting the formation of noncrystalline products over crystalline $Al(OH)_3$ polymorphs was found to be in the following order: phthalate $\cong$ succinate < glutamate < aspartate < oxalate < silicate $\cong$ fluoride < phosphate < salicylate $\cong$ malate < tannate < citrate < tartrate. The lowest ligand/Al molar ratio at which the production oral hydroxides or oxyhydroxides was inhibited ranged from 0.02 to 15. Above critical ligand/Al ratios, crystalline products were inhibited and ligands coprecipitated with noncrystalline products which remained unchanged for at least 5 months. Polydentate and large ligands generally were more inhibitive than those with fewer functional groups or of smaller size.

The perturbing ligands promoted and stabilized the formation of pseudoboehmite over crystalline $Al(OH)_3$ polymorphs in the following sequence: chloride < sulfate < phthalate $\cong$ succinate < glutamate < silicate < aspartate < phosphate < salicylate $\cong$ malate < tannate < citrate < tartrate. The optimal range of the ligand/Al molar ratios for the formation of pseudoboehmite varied, for example, from $0.005 - 0.015$ for tartrate to $600 - 1000$ for chloride. Pseudoboehmite was not formed in the presence of fluoride.

Key Words: Aluminum hydroxide • Boehmite • Ligand • Precipitation • Pseudoboehmite • X-ray powder diffraction