Hydrolysis Kinetics of Organic Chemicals on Montmorillonite and Kaolinite Surfaces as Related to Moisture Content

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Abstract: The effect of the surface acidity of montmorillonite and kaolinite on the hydrolysis rate constants of different agricultural chemicals was studied at variable moisture contents. Ethyl acetate, cyclohexene oxide, isopropyl bromide, 1-(4-methoxyphenyl)-2,3-epoxypropane, and N-methyl p-tolyl carbamate were chosen as representatives of classes of chemicals that exhibit acid-catalyzed, base-catalyzed, and neutral hydrolysis. In addition to being commercially available in pure forms, these chemicals have well-characterized homogeneous kinetics. The presence of montmorillonite or kaolinite in water suspensions had a small effect on the hydrolysis rate constants (k_h), whereas, the addition of moisture to oven-dried clays up to the limits of sorbed water resulted in an increase in the rate of hydrolysis of the epoxide by a factor of 10.

The increase in the hydrolysis rate constant suggests that the surface pH of montmorillonite or kaolinite might be 1 – 2 pH units lower than the bulk pH. The k_h value for the carbamate on Na-montmorillonite surface (bulk pH = 8.5) is 6.4×10^{-8}/sec which is equivalent to the rate constant at pH values $\leqslant 7$. The hydrolysis rate constant of the epoxide was reduced by a factor of 4 when the moisture content exceeded the limit of sorbed water. The addition of humic acid to the clay minerals resulted in about a 40% reduction of the epoxide hydrolysis rate constant.

Key Words: Humic acid • Hydrolysis kinetics • Kaolinite • Montmorillonite • Surface acidity • Water

Clays and Clay Minerals; February 1984 v. 32; no. 1; p. 67-73; DOI: 10.1346/CCMN.1984.0320109

Clay Minerals Society (www.clays.org)