
Vapor-Phase Sorption Kinetics for Methanol, Propan-2-OL, and 2-Methylpropan-2-OL on Al³⁺-, Cr³⁺-, and Fe³⁺-Exchanged Montmorillonite

C. Breen¹, A. T. Deane, J. J. Flynn and D. Reynolds

School of Chemical Sciences, National Institute for Higher Education Glasnevin, Dublin 9, Ireland
School of Mathematical Sciences, National Institute for Higher Education Glasnevin, Dublin 9, Ireland

¹ Current address: Chemistry Department, Sheffield City Polytechnic, Pond Street, Sheffield S1 1WB, United Kingdom.

Abstract: The rate of sorption of methanol (MeOH), propan-2-ol (i-PrOH), and 2-methyl-propan-2-ol (t-BuOH) onto a Wyoming montmorillonite saturated with Al³⁺-, Cr³⁺-, or Fe³⁺-cations has been studied by isothermal gravimetry in the temperature range 18° – 105° C using samples of differing weights and grain-size distributions. The rate of sorption for all the alcohols increased with decreasing sample and grain size, demonstrating that inter-, rather than intraparticle mass transfer was the rate-limiting process. Optimization of the sample parameters (2 mg sample of < 45-µm grain size, pretreated at 120° C yielded integral diffusion coefficients at 18° C of $1.1 \times 10^{-4} \text{ m}^2/\text{s}$ for t-BuOH for the Cr³⁺-form and $2.0 \times 10^{-14} \text{ m}^2/\text{s}$ for MeOH and i-PrOH for the Al³⁺-form. In general, the rate of alcohol sorption decreased as MeOH \geq i-PrOH > t-BuOH, but no temperature dependence of the sorption rate was observed. The alcohol sorption rate was dependent on the cation present, with Fe³⁺ < Cr³⁺ < Al³⁺.

Key Words: Adsorption • Alcohol • Diffusion • Grain size • Mass transfer • Montmorillonite

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