Hydrophobicity of Siloxane Surfaces in Smectites as Revealed by Aromatic Hydrocarbon Adsorption from Water

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Abstract: The nature of the siloxane surface in smectites was investigated by measuring the adsorption of aromatic hydrocarbons from water by organo-clays. The organo-clays were prepared by replacing the hydrophilic, inorganic exchange cations of a series of smectites with the small, hydrophobic organic cation, trimethylphenylammonium (TMPA). Smectites with a range in charge densities were used that resulted in different TMPA contents in the organo-clays. Adsorption isotherms of benzene, alkylbenzenes, and naphthalene from water by the TMPA-smectites indicated that sorption was inversely related to TMPA content. The Langmuir form of the isotherms suggests that the aromatic compounds adsorb to the clay surface. Possible adsorptive sites in TMPA-smectites are limited to the TMPA cations and the siloxane oxygen surfaces. Because sorption increased as layer charge and TMPA content decreased, the organic compounds must adsorb to the siloxane surfaces.

Calculations based on an adsorbed compound monolayer, which was estimated by fitting adsorption data to the Langmuir equation, and the N_2 specific surface area of each TMPA-clay, indicate that the surface area occupied by each adsorbed molecule increases as the planar area of the molecule increases. This strongly indicates that the planar surfaces of the compounds adsorb directly to the clay surface. Apparently, the TMPA cations function to keep the smectite interlayers open. Interactions between the phenyl groups of TMPA cations on opposing interlayer clay surfaces may act to increase the size of the adsorptive regions. These results show that the siloxane surfaces of smectites can effectively adsorb aromatic hydrocarbons from water if the hydrophilic, inorganic exchange cations are replaced with small, hydrophobic organic cations. The strong adsorption of hydrophobic organic molecules from water demonstrates the hydrophobicity of the siloxane surfaces in smectites.

Key Words: Adsorption isotherm • Alkylbenzene • Benzene • Langmuir equation • Naphthalene • Organo-clay • Surface area

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