Alcohol-Water Interactions on Montmorillonite Surfaces. I. Ethanol*

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Abstract: Infrared spectroscopic, X-ray diffraction and gravimetric techniques were used so study the vapor phase adsorption of ethanol on homoionic Cu-, Al-, Ca,, Na-, and NH_4-montmorillonite films. Equilibration of these films with ethanol vapor at a relative pressure of unity reduced the water content to less than 0.7% (300 ° C). As dehydration proceeded, the infrared absorption bands of the residual water were observed. Apparent differences between different cation saturations are reconciled by a consideration of the different types of ion-dipole interactions involved. Adsorption isotherms and X-ray diffraction results substantiated the interpretations of the infrared data. Prolonged evacuation did not remove all of the adsorbed ethanol as shown by spectroscopic and gravimetric techniques. Cu-, Al- and Ca-montmorillonite retained 4.5, 7.9, and 4.5 molecules per ion, respectively, while Na- and NH_4-clays retained less than one molecule per cation. Ethanol loss occurred rapidly at 40% relative humidity except in the Cu-system where 70 hr were required for complete replacement. These differences indicate that the adsorption and retention of alcohol by montmorillonite is affected by the saturating cation and that alcohol and water compete for the same adsorption sites. Ion-dipole type interactions should thus be considered in adsorption mechanisms of alcohol on montmorillonite.

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