

Adsorption of 2,4-D and atrazine onto Kaolinite: Effects of pH and background electrolytes

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The fate and transport of pesticides in soils can be greatly influenced by adsorption onto clay minerals such as kaolinite. The purpose of this study is to identify possible mechanisms of pesticides (2,4-D and atrazine) adsorption onto kaolinites by investigating the effect of electrolytes, pH, and organic carbon content. The adsorption coefficient (K_d) of 2,4-D and atrazine on two kinds of kaolinite (named as Japanese kaolinite (JK) from the Clay Science Society Japan, and US kaolinite (USK) from Clay Minerals Society USA) was measured through batch experiment in water, in the presence of divalent (CaCl_2) or another monovalent (KCl) electrolytes (0.005M CaCl_2 and 0.01M KCl for 2,4-D and 0.005M CaCl_2 for atrazine). The experiments were conducted under a solid to liquid ratio of 1:20, and at equilibrium pH range 2 - 6. The initial concentrations in the batch adsorption experiments were 5, 10, and 20 mg/L for 2,4-D and 2, 5, and 10 mg/L for atrazine.

Adsorption of 2,4-D was higher at lower background electrolyte concentrations but atrazine adsorption was higher in the presence of high CaCl_2 concentration. The effect of equilibrium pH of pesticide adsorption was more obvious in atrazine than in 2,4-D; atrazine adsorption increased significantly with decrease in equilibrium pH (pH 2.4- 5.7). Almost no adsorption was observed at natural pH for both 2,4-D and atrazine. Adsorption of 2,4-D and atrazine on JK were higher than that on USK, likely due to higher specific surface area. The adsorption of 2,4-D could be controlled by electrostatic and ligand exchange; the ion exchange reaction could retain anionic 2,4-D with electrostatic force at low electrolyte concentrations, and the ligand exchange reaction, which replaces a surface hydroxyl of kaolinite with a carboxyl group of 2,4-D and forms a strong coordination bond, could occur at both in lower and higher electrolyte concentrations. On the other hand, the adsorption of atrazine may be dominated by the hydrophobic interaction between an electrically neutral atrazine and charge-neutralized surface on kaolinite, rather than the electrostatic force between a cationic atrazine and negatively charged surface of kaolinite.

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