Comparison of potential removal mechanisms of phosphorus in soil adsorption systems using analytical and numerical modeling techniques

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Abstract. Phosphorus is a common nutrient found in the effluent of Onsite Wastewater Systems (OWS) and can have serious impacts on surface water quality if transported from soil adsorption systems to groundwater and eventually to surface water. Primary removal mechanisms for phosphorus in soil include sorption and precipitation, but it is unclear to what degree these processes work together and the rate at which they occur. In an attempt to better understand the processes, phosphorus breakthrough data for one dimensional columns applied with septic tank effluent were used to fit conceptual models including: (1) sorption following a linear isotherm model, (2) sorption following a surface complexation model, (3) equilibrium precipitation of phosphorus minerals, (4) rate-limited precipitation, and (5) first-order decay. Both the linear and surface complexation sorption models can be used to obtain acceptable fits to the data, but the surface complexation model is sensitive to pH, leading to potentially unrealistic increases in removal. It is clear that equilibrium precipitation is not a removal mechanism while rate-limited precipitation could potentially be used to model P removal. Modeling removal simply as first-order decay also yields a poor fit to the data. Further work will involve the development of models that will evaluate the effects of modeling multiple simultaneous processes and simultaneous but depth-specific processes to describe phosphorus removal.

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