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Type: **Oral Presentation**

Investigating the Influence of Non-Linear Interfacial Partitioning on Aqueous Film Forming Foam (AFFF) Transport and Retention in the Unsaturated Zone

Friday, 4 June 2021 14:45 (15 minutes)

The widespread use of aqueous film forming foam (AFFF) in fire suppression over many decades has resulted in contamination of industrial and military sites with per- and polyfluoroalkyl substances (PFAS). Due to their long-term persistence, environmental toxicity and bioaccumulation, PFAS have become emerging contaminants of critical concern, subjected to rapidly evolving regulations.

Knowledge of PFAS sorption and accumulation at the air–water interfaces is critical to understanding the transport and retention of these substances in subsurface environments. Furthermore, PFAS interfacial accumulation is associated with changes in surface tension, which can alter water phase flow and retention in unsaturated soils. This presentation provides an overview of coupled experimental and modeling research designed to explore the influence of interfacial accumulation and soil sorption processes on transport of selected PFAS in soils.

A matrix of batch and column experiments was undertaken with selected PFAS compounds, both individually and in mixtures, to explore their potential for soil sorption and retention at air-water interfaces. Experimental results reveal that PFAS sorption is non-linear, conforming to a Freundlich isotherm and that accumulation at the air-water interface is well-described by a Langmuir-Szyszkowski expression. Significant reductions in air-water interfacial tension were observed for concentrated PFAS solutions and AFFF formulations. These experiments also demonstrate the competitive soil sorption and air-water adsorption behavior of the select PFAS when present as a multicomponent mixture.

A variable saturation flow and transport model, HYDRUS, was modified to incorporate experimentally derived competitive partitioning relations and used to explore the influence of interfacial adsorption processes on PFAS transport and fate. A modification was made to HYDRUS to introduce compositional dependence (i.e., PFAS concentration dependence) of interfacial tension into the water flow solver. The HYDRUS code was also modified to improve the solute mass balance conservation for nonlinear partitioning relationships.

The modified model was used to simulate the field-scale transport, and retention of AFFF in the vadose zone under various realistic spill scenarios. Simulations reveal the potential effects of surface tension reduction on aqueous phase redistribution and PFAS migration in the soil profile, as well as the significance of nonlinear adsorption processes. In addition, simulations suggest that use of linear partitioning relations to represent interface accumulation could lead to significant overestimation of predicted mass retention. These findings demonstrate the potential influence of PFAS on unsaturated water flow and solute transport in soils and presents a methodology to couple these processes in a predictive modeling tool.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

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Student Poster Award

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