Advances in Water Resources

Volume 68, June 2014, Pages 62–73

Mathematical modeling of colloid and virus cotransport in porous media: Application to experimental data

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http://dx.doi.org/10.1016/j.advwatres.2014.03.001

Highlights

- A 3-D model for virus–colloid cotransport was developed.
- An efficient numerical solution to the new cotransport model was provided.
- Experimental data of bacteriophage-clay cotransport were fitted.

Abstract

A conceptual mathematical model was developed to describe the simultaneous transport (cotransport) of viruses and colloids in three-dimensional, water saturated, homogeneous porous media with uniform flow. The model accounts for the migration of individual virus and colloid particles as well as viruses attached onto colloids. Viruses can be suspended in the aqueous phase, attached onto suspended colloids and the solid matrix, and attached onto colloids previously attached on the solid matrix. Colloids can be suspended in the aqueous phase or attached on the solid matrix. Viruses in all four phases (suspended in the aqueous phase, attached onto suspended colloid particles, attached on the solid matrix, and attached onto colloids previously attached on the solid matrix) may undergo inactivation with different inactivation coefficients. The governing coupled partial differential equations were solved numerically using finite difference methods, which were implemented explicitly or implicitly so that both stability and speed factors were satisfied. Furthermore, the experimental data collected by Syngouna and Chrysikopoulos [1] were satisfactorily fitted by the newly developed cotransport model.