Optimizing laterite soil bed filters via predictive modelling and simulations

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Abstract

The presence of arsenic in drinking water can have significant effects leading to cancer, including skin, lung and bladder carcinoma, on both chronic and acute exposure.The increased use of pesticide and fertilizer to meet agricultural needs (especially in places like Pakistan, India, Nepal and Bangladesh) has led to the release of arsenic from rocks contaminating groundwater. The quality of our drinking water and its treatment depends critically on filtration solutions. Recent studies have reported the success of laterite soil bed filter to filter arsenic. Depending on the operating conditions and the material properties, a comprehensive understanding of the dependence of filter life is investigated in a virtual environment using 3D predictive modeling and simulation framework. We employ the mathematical model from R.Mondal et. al (2019), and extend the flow model to a coupled Navier–Stokes-Brinkman system of equations. The flow model is coupled to the convective, diffusive, advective transport equation for the arsenic. The adsorption is incorporated as a functional change of porosity/permeability over time, which is essential towards predicting the efficiency and lifetime of the filter. We use different CAD filter designs for domestic use to predict the lifetime of these filters under real operating conditions in a virtual environment.