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Transport of bacteria and colloids in intermittent sand filters

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Intermittent sand filters used for water treatment can achieve high disinfection performance if properly designed and operated. In order to predict pathogen removal in sand filters and natural porous media, the effects of cyclic infiltration and draining events (transient unsaturated flow) on microorganism fate were investigated. We visualized bacterial transport in unsaturated porous media at the pore scale using micromodels. Column experiments provided quantitative measurements of the phenomena observed at the pore scale. *Escherichia coli* and a conservative tracer (NaI) were applied once in a pulse to a 1.5 m sand column. Outflow concentrations during subsequent tracer-free pulses were monitored for 4 days. We observed earlier breakthrough of bacteria compared to the dissolved tracer, as predicted from pore scale studies. Transport of bacteria and tracer was influenced by the temporal variations in pore water velocity and moisture content. Advancement of the wetting front remobilized bacteria either attached to the air-water interface (AWI) or entrapped in stagnant pore water between gas bubbles leading to successive concentration peaks of bacteria and tracer in the effluent. Overall microbial retention rate was high, due to reversible bacteria entrapment in stagnant regions and sorption onto the AWI and essentially irreversible attachment onto solid-water interface. Bacterial detachment from the AWI was only observed during complete gas bubble dissolution or if bubble interface stress occurred during the dissolution process.