Numerical Simulation Of Non-aqueous Phase Liquids Imbibition In Unconsolidated Porous Media

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Abstract

A three-dimensional multiphase laboratory experiment was simulated with a view to evaluating the subsurface distribution of non-aqueous phase liquids (NAPL). The experiment was set-up to reconstruct the migration of hydrocarbon-leaks, occurring in the earth´s surface, predominantly driven by capillarity. Likely real-life occurrences and typical subsurface sources may include but not limited to, buried pipelines and underground storage tanks, from where leakages discharge. The study is, not only, targeted at understanding hydrocarbon capillary imbibition but intended to guide a sustainable approach towards limiting the spread of contaminants and remediating contaminated subsurface system. Managing hydrocarbon subsurface contamination, would require solving problems associated with NAPL fate, flowrate, and extent of contaminants spread. The experimental outcome, validated by numerical results, provided the requisite model for resolving the above problems. A major consideration, with respect to decontamination of hydrocarbon leaks, is that the amount of oil released is always smaller than its catchment area, in terms of spreading and contamination. Richard's equation is applied in COMSOL Multiphysics® using equation-based interface to validate different laboratory experiments in order to model NAPL (e.g. hydrocarbons like diesel and crude oil) subsurface imbibition in porous media. It validated our empirical estimates suggesting that the porous media was not 100% saturated with fluids but are substantially occupied by air or gas. Our numerical model contribute solution for tracking the rate and extent of spread, of diffusing fluids in subsurface formation. The experimental study and numerical model can help in the future to simulate real scale models in environmental related studies.