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Comparison of modeling approaches for assessing density-driven and gravitation-induced gas transport in porous media

Chiu-Shia Fen
Department of Environmental Engineering and Science, Feng Chia University, Taichung, Taiwan, ROC (csfen@fcu.edu.tw)

Volatile organic compounds (VOCs) are often found in contaminated soil zones and groundwater. Vaporization of VOCs residing in unsaturated zone with vapors migrating upward to ground surface and downward into groundwater is a significant driver of health risk. Besides, landfill gas, methane, emitting from subsurface recognizes as one of the main greenhouse gases contributing to enhance global warming. Molar weights of these hazardous vapors and gases are very different from those of soil gases, i.e. oxygen and nitrogen, as a result that mixtures of these vapors and gases can significantly migrate in unsaturated soils due to total density variation, in addition to external pressure variation (e.g., fluctuation of atmosphere), component concentration variation and gravitational effect. Modeling gas phase transport in subsurface conventionally uses the advective-dispersive (diffusive) transport equation with various forms of Fick's law of diffusion. The transport equation is usually coupled with the flow equation and further incorporated with an approximated function of total density in terms of total pressure and component concentrations for assessing density variation. Another approach is to add a slip term in the transport equation to account for density-driven transport. A third alternative is the dusty gas model, which includes a forced diffusion term in the constitutive equations of multicomponent gas diffusion to assess gravitation-induced diffusion. This study intends to delineate these different approaches on assessing density-driven and gravitation-induced gas transport in porous media. Predictions obtained with different approaches will be compared and assessed with experimental data sets reported from articles.