Multiphase flow and mass transport in porous media for remediation of polluted sites and oil recovery

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ABSTRACT

Our research activities focus in the study of multiphase flow in porous media, which occurs in many natural and artificial processes, such as subsurface flow and recovery of hydrocarbons, migration of organic pollutants in soil, aquifer remediation from organic contaminants, mineral scale formation in soil, geologic storage of CO_2, etc. Dynamic simulators are developed incorporating complex, but very important physics of multiphase flow processes, such as wetting and viscous phase flow phenomena in capillary elements, mass transfer and convection between different phases, biodegradation of toxic chemicals by bacteria, chemical reactions, etc. with the minimum number of adjustable parameters. From scientific point of view, these research efforts are directed towards (a) understanding the fundamental issues of the various flow processes taking place in porous media, (b) determination of the transport properties and (c) elucidation of the interactive effects of the pore structure, geometrical and physicochemical properties of particles and hydrodynamic conditions on the transient flow of particulate systems through porous media. From engineering point of view, the aim of this research is to provide a platform to investigate improvements and optimization of the existing technologies and suggestion of new, innovative, cost-effective and sustainable methodologies for applications such as contaminant transport in groundwater and soil remediation, enhanced oil recovery, scaling in porous materials and CO_2 sequestration.

Transport and interfacial phenomena, and physicochemical, chemical and biological processes are studied across scales, from the microscopic scale to the macroscopic scale, using a variety of theoretical (both numerical and analytical) techniques. Typically, simulation tools are developed starting from the fundamentals (flow, diffusion, particle dynamics, activity of micro-organisms) and building-up numerical schemes to the mesoscopic and macroscopic levels.