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Enhancing Bioremediation: Insights from a Numerical Modeling Approach

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Bio-remediation of soil contaminated by petroleum hydrocarbon is a highly complex process, requiring coupled interactions and synergistic effects between physical, chemical and biological phenomena. Monitoring and improving the bio-remediation of such system remains a formidable challenge. Our approach involves the development of a comprehensive mathematical and numerical model that couples two-phase flow, bio-reactive transport, and the dynamic of bacterial populations, with the aim of investigating the mechanisms governing pollutant and nutrient transport, bacterial activities and bio-degradation within porous media. Important processes including the effect of biofilm growth on the permeability of the porous media and the interaction between the biofilm matrix and the fluid system, are taken into account. Numerical simulations were carried out to evaluate the effect of biomass accumulation and nutrients availability on the bio-degradation rate, providing new insights into optimizing in-situ bio-remediation processes for effective cleanup. Additionally, key issues such as controlling contaminant mobility and estimating efficiency criteria will be addressed as well.