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Microscale study on green remediation of non-aqueous phase liquid contamination in heterogeneous groundwater systems

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The presence of non-aqueous phase liquids (NAPLs) like crude oil in groundwater systems is a major environmental concern. Conventional remediation methods often fail to remove NAPLs from low-permeable regions due to subsurface heterogeneity. Surfactants, like Tween80, are commonly used to enhance remediation; however, concerns about their toxicity and resulting secondary contamination remain. This study explored the use of a green bio-derived solvent and several other oil displacing agents for NAPL remediation. Two structurally different heterogeneous micromodels were designed and fabricated to mimic the longitudinal section of the heterogeneous regions of natural aquifers. The results indicated that the heterogeneity of porous media could significantly influence the displacement process and final results. Generally, the injection fluid preferred to flow through the high permeable area with larger pore size and lower flow resistance, resulting less residual oil compared to the low permeable area under various experimental conditions, with an average difference in residual oil saturation of 56.76%. Besides, the bio-solvent could effectively mobilize and remove NAPL residuals from low permeable zones, improving the efficiency of remediation by 30-45%, compared with other agents. Our findings suggest that the bio-solvent is a promising, environmentally-friendly alternative chemical agent for in situ NAPL remediation, offering improved efficiency and reduced secondary pollution.

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References

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Primary author: Prof. WANG, Xiaopu (China University of Petroleum (East China))

Co-authors: Mr ZHAO, Hailong (China University of Petroleum (East China)); Ms LI, Yan (Nanjing Institute of Environmental Sciences, Ministry of Ecology and Environment); Dr LONG, Tao (Nanjing Institute of Environmental Sciences, Ministry of Ecology and Environment); Prof. LI, Hangyu (China University of Petroleum (East China))

Presenter: Prof. WANG, Xiaopu (China University of Petroleum (East China))

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