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Investigation of transport and deposition of micro-nano-bubbles in porous media using column test and microfluidics

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Micro-nano-bubbles (MNBs) enhanced oxidation presents a sustainable approach for contaminated groundwater remediation. Understanding MNBs transport and deposition in porous media is crucial for application and optimizing this technology. Firstly, the relationship between the number of MNBs and dissolved oxygen (DO) concentration was calibrated to provide a basis for the investigation of MNBs'migratory behaviors by employing DO concentration. Secondly, we developed a two-dimensional microfluidic model to simulate the pore structure of uniform-sized particles and directly observed the retention mechanisms of injected oxygen MNBs. The results indicated that MNBs retention predominantly occurs through surface deposition and hydrodynamic bridging, with no significant straining observed. Furthermore, we conducted one-dimensional column experiments using glass beads as porous media to examine the impact of porous media and groundwater chemical characteristics on MNB migration, deposition and re-mobilization. The findings revealed substantial MNB retention within the porous medium, with retention diminishing as the injection rate and glass bead size increased. Finally, the irregular quartz sand was employed in the column tests, which demonstrated a higher propensity for MNB capture comparing to uniformly-sized glass beads. Alterations in groundwater pH and salinity also influenced MNB migration by affecting the surface potential of both MNBs and the porous medium. In conclusion, this study provides a reference for further utilization of MNBs for remediation of contaminated groundwater.

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