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Assessing pH Impact on Miscible Phase Displacement and Mixing within Porous Structures

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pH-induced reactive transport among miscible phases in porous environments is pivotal in carbon capture and storage (CCS) applications, especially in the carbon sequestration process, where the mixing process among the miscible phases affects the pH transport. However, separating the mixing from the pH migration is challenging due to the pore-scale heterogeneities and limited understanding of the role of pH in the mixing and displacement processes within porous media.. In this study, we use two sets of basic water solution to displace weak acidic water glycerol mixed solution, one set with certain concentration of pH-sensitive fluorescent dye Pyranine as the pH indicator in both phases to examine the influence of pH on miscible phase flow and displacement in porous media, the other set with fluorescent dye Rhodamine 6G as the mixing process indicator, explicitly visualizing how heterogeneity affect the mixing and displacement patterns and comparing this theoretical pH pattern obtained from the mixing process with the actual visualized pH migration pattern. The research employs confocal microscopy to visualize these processes, revealing diverse patterns across different heterogeneity porous media types, and mainly illustrates the significant role of pH in shaping fluid dynamics and reactive transport by leading to enhanced fluid migration and mixing. An initial outcome has showed that the migration of pH follows a different mechanism from the mixing process. Thus, it offers new insights for modeling such complex systems in natural and industrial settings, which may be practical for field-scale applications by outlining the details of pore-scale transport and reaction

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Primary author: GAN, Tongzhou

Co-authors: ABEZGAUZ, Ludmila; EDERY, yaniv (Technion)

Presenter: GAN, Tongzhou

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