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A micro-scale study of CO2 mobility control characteristics of a green foam in porous media

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Geological carbon dioxide (CO2) sequestration is considered as a technology for reducing the atmospheric content of CO2 [1, 2]. CO2 has been widely injected into saline aquifers or oil reservoirs for sequestration in recent decades [3]. This process involves displacing resident fluids from porous media, which is unstable due to the unfavorable mobility ratio between the resident and injected fluids. Although some fluids with chemical agents are used to inhibit gas channeling, these methods tend to cause pollution and damage to environment and formation.

In this work, we propose an environmentally friendly aqueous foam to control the CO2 mobility and enlarge its sweeping efficiency. To get insight into the CO2 mobility control behavior of the aqueous foam, we conducted a series of analysis including the stabilization and rheological properties of the CO2 foam with cellulose nanofibrils (CNFs) and camellia oleifera saponin (COS). Pore-scale dynamics of CO2 foam in a 2D visual micromodel obtained from a real core via micro-CT images were analyzed. The stabilization and rheology experiments allowed us to explore the special properties of foam as a CO2 carrier in porous media, while the microfluidic experiment was used to evaluate the dynamics of generation and rupture of foam bubbles with enhancers. The microscopic visual experiments make it possible to analyze the flow behaviors and sweep efficiency increase of foams in porous media simulating aquifers and oil reservoirs.

Results demonstrate that the higher viscoelasticity and stability cause large numbers of small bubbles to group together, providing greater flow resistance to control the mobility of CO2. CNF/COS foam carries CO2 deeper into porous media and increase CO2 saturation in aquifers and oil reservoirs, while also showing a higher oil resistance stability compared to bare surfactant foam. Abundant hydrogen bonds between CNFs and COS molecules support the formation of tight bubble film which can stably encapsulate CO2 and inhibit its diffusion. The interlacement and entanglement of CNFs endows liquid phase with high viscosity, which restrains liquid drainage and improves the interfacial viscoelasticity of the bubble film.

Participation

In-Person

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