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Insights into pore-scale hydrate morphologies during formation and dissociation in microfluidic for CH4 hydrate exploitation

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Natural gas (main methane CH4) hydrates are such a prospective energy resource that feeds the global energy demand. Depressurization has been proved the most economical method for CH4 hydrate exploitation. However, micro characteristics of hydrate distribution and fluid migration in porous media are still lacking for efficient CH4 hydrate exploitation. In this work, morphologies of CH4 hydrate formation in synthesis and dissociation in exploitation were investigated in microfluidic chip resembling sandstone. During hydrate synthesis, morphological results showed CH4 hydrate nucleated at gas-water interfaces, and hydrate nucleation is much more apparent at dynamic fluid flow. The hydrate nuclei then grew towards gas phase, changing from coarse patterns to smooth ones by consuming CH4 gas. During hydrate exploitation, gas bubbles emerged in hydrate phase after dissociation pressures reduced to or below CH4 hydrate equilibrium pressure. Hydrate reformation was observed during depressurization because of localized pressure variation as a result of fluid migration. Pressure differences between inlet and outlet existed and after its disappearance, scattered gas bubbles merged into gas flow, depending on constant-rate of depressurization and mass transfer barriers in different pores. Higher initial water saturation triggered more coarse hydrates during formation, which turned into crystal patterns acting as barriers for mass transfer. Pore surface wettability and pore size exerted a significant effect on fluid appearance and distribution during hydrate dissociation. These micromorphology findings are beneficial to understand the mechanisms of hydrate transitions in confined porous media and thus provide insights for efficient CH4 hydrate exploitation through controlled depressurization.

Participation

In-Person

References

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