Contribution ID: **415** Type: **Oral Presentation**

Pore-scale investigation into the effects of fluid perturbation during hydrate formation

Thursday, 16 May 2024 14:20 (15 minutes)

In order to increase the gas production efficiency during methane hydrate exploitation, the research focus should be on the methane hydrate formation and decomposition mechanism nowadays. As methane hydrate reformation and the hydrate heterogeneity in the pore of sediments show great influence on gas production during hydrate decomposition, new insights need to be supplemented to reveal the mechanism of hydrate phase transition. In this work, a new microfluidic chip "simple straight pipe chip"was designed based on the microfluidic device. By comparing with the former chip "cylindrical structure chip", a series of experiments was conducted to investigate the morphology of hydrate phase transition. The "water perturbation under gas-filled situation"method and the "gas perturbation under water-filled situation"method were applied for hydrate formation. The results connect different methane hydrate growth patterns to different occurrence patterns in hydrate-bearing sediments. In the gas-filled situation, with the water migration rate rising, the hydrate stable state varies from grain-coating hydrate to load-bearing hydrate. In the water-filled situation, with the gas migration rate rising, the hydrate stable state becomes narrower. These results also gave explanations for hydrate reformation and heterogeneity in hydrate-bearing sediments. The depressurization in gas production will create water and gas flow to varying degrees, which will lead to hydrate reformation and the heterogeneity situation. Finally, these findings also provided valuable information and data for gas production and further research into gas hydrate.

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Session Classification: MS11

Track Classification: (MS11) Microfluidics and nanofluidics in porous systems