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Publication date:
2020

Document Version
Peer reviewed version

[Link back to DTU Orbit](#)

Citation (APA):

Pandey, J. S., Almenningen, S., von Solms, N., & Erslund, G. (2020). *Visualization of Gas Hydrate Dissociation Using Micromodel under Permafrost conditions*. Abstract from 10th International Conference on Gas Hydrates (ICGH10), Singapore, Singapore.

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Visualization of Gas Hydrate Dissociation Using Micromodel under Permafrost conditions

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Abstract

Understanding of Gas Hydrate dissociation and stability in permafrost sediments are essential for modelling these systems both with respect to global warming and in schemes of CH₄ recovery and/or CO₂ storage. It is known that CH₄ hydrate is thermodynamically less stable than CO₂ hydrate due to the lower activation energy of the decomposition. However, recent studies show that the presence of ice with hydrate in permafrost sediments have a different impact on the dissociation rate of CH₄ and CO₂ hydrate due to different self-preservation mechanism.

In this work, pore-scale visualization of CH₄ hydrate, CO₂ hydrate dissociation in sedimentary rock in permafrost temperature is carried out using the micromodel and image analysis. The primary purpose of the research work is to evaluate CH₄ and CO₂ hydrate dissociation kinetics containing different ice quantity at moderate pressure and temperature below the ice melting point and further compare the self-preservation characteristics. Pore level visualization is carried out in transparent, etched, micromodel of sedimentary pores of a 2D thin section of the actual sandstone rock. We have studied the effect of ice content, pressure, and temperature change on the dissociation rate below the ice melting point.

Micromodel experiments show that the presence of Ice develops different dissociation rates for CH₄ and CO₂. Effect of ice content on methane hydrate dissociation rate is stronger in comparison to CO₂ hydrate. We experimentally evaluate the effect of initial hydrate saturation on CH₄ and CO₂ hydrate dissociation using high-pressure micromodel, and we report the variation in the dissociation pattern as the function of pressure and temperature change.

Keywords: Micromodel, Methane Hydrate, CO₂ hydrate, Self Preservation, Hydrate dissociation