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The big fat LARS - a LArge Reservoir Simulator for hydrate formation and gas production

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Simulating natural scenarios on lab scale is a common technique to gain insight into geological processes with moderate effort and expenses. Due to the remote occurrence of gas hydrates, their behavior in sedimentary deposits is largely investigated on experimental set ups in the laboratory.
In the framework of the submarine gas hydrate research project (SUGAR) a large reservoir simulator (LARS) with an internal volume of 425 liter has been designed, built and tested. To our knowledge this is presently a word-wide unique set up. Because of its large volume it is suitable for pilot plant scale tests on hydrate behavior in sediments. That includes not only the option of systematic tests on gas hydrate formation in various sedimentary settings but also the possibility to mimic scenarios for the hydrate decomposition and subsequent natural gas extraction. Based on these experimental results various numerical simulations can be realized.
Here, we present the design and the experimental set up of LARS.
The prerequisites for the simulation of a natural gas hydrate reservoir are porous sediments, methane, water, low temperature and high pressure. The reservoir is supplied by methane-saturated and pre-cooled water. For its preparation an external gas-water mixing stage is available. The methane-loaded water is continuously flushed into LARS as finely dispersed fluid via bottom-and-top-located sparger. The LARS is equipped with a mantle cooling system and can be kept at a chosen set temperature. The temperature distribution is monitored at 14 reasonable locations throughout the reservoir by Pt100 sensors. Pressure needs are realized using syringe pump stands.
A tomographic system, consisting of a 375-electrode-configuration is attached to the mantle for the monitoring of hydrate distribution throughout the entire reservoir volume. Two sets of tubular polydimethylsiloxan-membranes are applied to determine gas-water ratio within the reservoir using the effect of permeability differences between gaseous and dissolved methane (Zimmer et al., 2011).
Gas hydrate is formed using a confined pressure of 12-15 MPa and a fluid pressure of 8-11 MPa with a set temperature of 275 K. The duration of the formation process depends on the required hydrate saturation and is usually in a range of several weeks.
The subsequent decomposition experiments aiming at testing innovative production scenarios such as the application of a borehole tool for thermal stimulation of hydrate via catalytic oxidation of methane within an autothermal catalytic reactor (Schicks et al. 2011). Furthermore, experiments on hydrate decomposition via pressure reduction are performed to mimic realistic scenarios such as found during the production test in Mallik (Yasuda and Dallimore, 2007). In the near future it is planned to scale up existing results on CH4-CO_2 exchange efficiency (e.g. Strauch and Schicks, 2012) by feeding CO_2 to the hydrate reservoir.
All experiments are due to the gain of high-resolution spatial and temporal data predestined as a base for numerical modeling.

References

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