Modeling CO2 hydrate formation during aquifer storage and during storage in CH4 hydrate with associated CH4 production

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Abstract (300 word limit)

Storing CO2 in aquifers is already a practice offshore Norway and a very promising concept for reducing emissions of CO2 to the atmosphere. Possible future storage reservoir may contain thermodynamic regions of temperature and pressure that facilitate formation of CO2 hydrate locally. This might be a positive effect since it might reduce vertical migration but the question is whether it also has negative impact on horizontal spreading of CO2 in the reservoir. Another option for underground storage of CO2 is to inject it into CH4 hydrate deposits. CH4 hydrate filled sediments are located worldwide in huge amounts. These hydrates are crystalline structures in which CH4 is entrapped into cavities formed by hydrogen bonded water molecules. CO2 also makes a hydrate with water and the same macroscopic structure as CH4 but with increased thermodynamic stability as compared to CH4 hydrate. Injection of CO2 into CH4 hydrate filled sediments will therefor lead to a conversion from the initial CH4 hydrate over to CO2 dominated hydrate with simultaneous release of CH4 gas from the *in situ* CH4 hydrate. In order to model the two types of systems in realistic reservoir flow situations there is a need for a simulator that can handle non-equilibrium thermodynamics and competing phase transitions which involves hydrate formation and dissociations. RetrasoCodeBright (RCB) is the only reservoir simulator for hydrate which handles that so far. The basic feature of the simulator is discussed and relevant examples are presented. In particular we find that a reservoir with hydrate formation zones will narrow the CO2 flux both verticsall and horizontally and as such have both positive and negative effects on CO2 storage.

Recent Publications

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2. Qorbani, K., Kvamme, B.,, Modelling of CH4 production through CO2 injection into gas hydrate reservoirs – non–equilibrium approach. 2017, Energies, 2017, in press
3. Qorbani, K., Kvamme, B., Non-equilibrium simulation of CH4 production through the depressurization method from gas hydrate reservoirs, Journal of Natural Gas Science & Engineering. 35, part b, 2016, pp 1544-1554
4. Kvamme, B., Thermodynamic limitations of the CO2/N2 mixture injected into CH4 hydrate in the Ignik Sikumi field trial, 2016, J. Chem. Eng. Data, 2016, 61 (3), pp 1280–1295
5. Qorbani, K., Kvamme, B., Olsen, R., Sensitivity analysis of CO2 injection within saline aquifers for storage purposes in the form of hydrate using a reactive transport simulator, J. Chem. Eng. Data, 2016, 61 (12), pp 4148–4156
6. Kvamme, B., Iden, E., Tveit, J., Veland, V., Zarifi, M., Qorbani, K., Effect of H2S content on thermodynamic stability of hydrate formed from CO2/N2 mixtures, J. Chem. Eng. Data, 2017, 62. 1645-1658

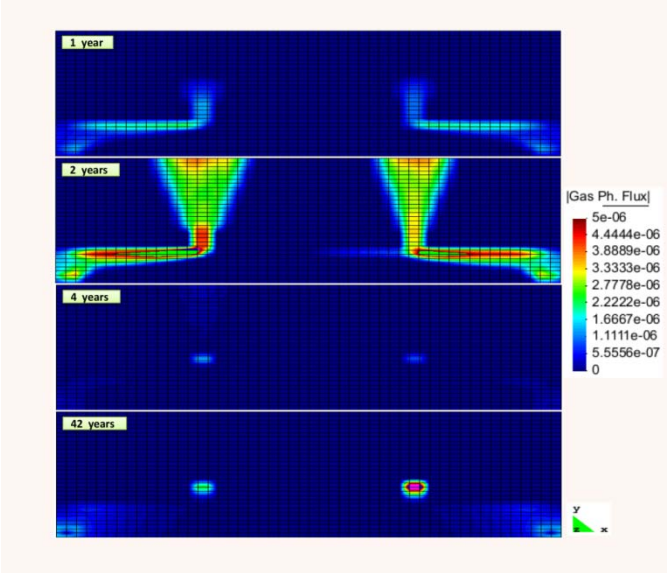


Fig.1. Simulation of CO2 injection in a system with two small fractures and hydrate forming conditions above the fractures. After one year (top) flow through fractures is slow. After two years hydrate is growing but still not blocking (next) while after 4 years CO2 flux is reduced to a low value (3rd) and after 42 years (bottom) the system is very stational with very low CO2 flux.. Without hydrate formation situation is similar to fig2 also after 42 years.



Biography

Bjørn Kvamme obtained his M.Sc. in Chemical Engineering (1981) and Ph.D. in Chemical Engineering (1984) from the Norwegian University of Technology and Natural Sciences. After a short period with SINTEF and two years at Bergen University College he was appointed to full Professor in 1987 and started education of M.Sc. and PhD in Process Technology in Telemark. He entered a position as Professor in Gas Processing at Department of Physics, University of Bergen, March 2000. He is the author/coauthor of 461 publications during latest 25 years, of which 153 are in good international scientific journals. Number of citations per September 1, 2017 is 2394. In addition numerous international presentations. His main research effort is in in thermodynamics, statistical thermodynamics, Quantum mechanics and molecular simulations. Molecular integral equation theories based on atomistic interactions for predictions of structure and thermodynamic properties. Non-equilibrium thermodynamics. Hydrates stability and kinetics. Polar solutions and electrolyte solutions. Kinetics of phase transitions. Emulsion fundamentals.

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