The National IOR Centre of Norway

Improve IOR models in IORSim

Preliminary Project Report, 1.4.7

Project manager: J. Nossen (IFE), A. Hiorth (UiS)

Postdoc: Felix Feldmann

Other key personnel: Jan Sagen, Børre Antonsen, Jan Ludvig Vinningland

Project duration: 15.01.2021-15.01.2023

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1.4.7 - IFE (UiS, NORCE, IFE):
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Executive summary

IORSim is developed as a plug-in tool for commercial reservoir simulators that allows the implementation of complex reactive transport simulations at field scale. While an industry-standard flow simulator is used to solve the transport equation, IORSim calculates and visualizes chemical reactions. Besides the already implemented geochemical, sodium silicate, and tracer IORSim modules, the software design supports an uncomplicated and user-friendly implementation of new chemical module segments.

The sequential solving of fluid flow (host simulator) and geochemical reactions (IORSim) has several advantages. After reading and detecting the flow pattern from the host simulator, IORSim aligns the grid cells along flow lines to divide the reactive species transport calculations into a sequence of local problems. The localized and sequential reactive transport calculations ensure numerical stability and convergence. Compared to the traditional Newton Raphson method, the numerical structure of IORSim is significantly faster. Moreover, integrating IORSim inside industry-standard reservoir flow simulators supports a user-friendly visualization of geochemical reactions inside existing reservoir models. Besides the default fully implicit numerical scheme, IORSim supports explicit and adaptive numerical schemes.

Results

During the development of IORSim as an UiS, NORCE, and IFE joint venture, the numerical scheme and geochemical models have been tested on idealized 3D cases. This post-doc project focuses on implementing complex field data simulation to advertise the capabilities of IORSim to the research community and industrial partners. After successfully improving the host simulator/IORSim coupling, the project currently focuses on implementing Snorre sodium silicate field pilot simulations. Furthermore, the numerical schemes of IORSim are validated against analytical solutions and reference software programs. The submission of the paper 'IORSim - A numerical tool for complex reactive transport simulations' is targeted for January 2022 and will provide the first IORSim reference in a peer-review journal.

Following milestones have been achieved during the ongoing project.

1. Processing and handling of complex/irregular grid structures in IORSim.
2. Substantial modifications of the IORSim GUI to improve the communication between IORSim and Eclipse.
3. Reading and processing of injection/production history in IORSim.
4. Implementation of a restart function to decrease computation times.
5. Realization of a Snorre sodium silicate simulation in collaboration with Equinor.
6. Bug detection and bug fixing.
7. 'IORSim - A numerical tool for complex reactive transport simulations' (to be submitted, January 2022).

As both protect a strongly related, project 1.4.7 – "Improve IOR models in IORSim" contributed to the final project report of 1.4.1, "IORSim – IOR chemistry simulator coupled to commercial reservoir simulator".

Future work/plans

The first peer-review IORSim article, 'IORSim - A numerical tool for complex reactive transport simulations', explains the mathematical and numerical formulation of IORSim. Furthermore, the Snorre sodium silicate field pilot test was selected to demonstrate the capabilities of the developed geochemical solver. After receiving the latest Snorre field data, the project will finalize the first IORSim field simulation study in close cooperation with the Snorre license partner.

After completing the numerical work on the Snorre field, a geochemical (low-salinity) field study is planned.