CO2STORE: Case Studies

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CLIMIT Webinar: HPC-G, 22/09/2023
Contents

➢ Case 1: CO2 Storage in Aquifer

➢ Case 2: CO2 Storage in Aquifer with Thermal Effects

➢ Case 3: CO2 Storage in Aquifer with Salt Precipitation
Case 1: CO2STORE in Aquifer

https://github.com/OPM/opm-tests/blob/master/co2store/CO2STORE_GASWAT.DATA
Case 1: Comparison Summary

Injector BHP

CO2 Dissolved in Water

Field Gas In Place (Gas Phase)
Case 1: Comparison Performance

- Default solver and tuning parameters for both simulators, serial run
- OPM-Flow master-branch 21/09/2023 (target release 2023.10)
- Intel Core i7-8850H, 6(12) @2.60GHz, RAM 128GB
Case 2: CO2STORE + THERMAL in Aquifer

After 3 year of injection
Case 2: Comparison Field Summary

CO2 Dissolved in Water

CO2 Mobile as Gas Phase

CO2 Trapped as Gas Phase
Case 2: Comparison Performance

- Default solver and tuning parameters for both simulators, serial run
- OPM-Flow master-branch 21/09/2023 (target release 2023.10)
- Intel Core i7-8850H, 6(12) @2.60GHz, RAM 128GB
Case 3: CO2STORE + THERMAL + PRECSALT

Salt precipitation and dissolution assuming instantaneous equilibrium:

\[
\frac{\partial}{\partial t} \left[ \varphi b_w s_w c_w^{salt} + m_\varphi \varphi_0 s_s \rho^{salt} \right] + \nabla \cdot \left( c_w^{salt} b_w v_w \right) + c_w^{salt} q_w = 0
\]

- \( \rho^{salt} \): Density of solid salt [kg/m\(^3\)]
- \( s_s \): (Volume) saturation of precipitated salt, assumed to be immobile
- \( c_w^{salt} \): Salt concentration in water [kg/Sm\(^3\)]

- Change in porosity: \( \varphi = (1 - s_s) m_\varphi \varphi_0 \), with \( m_\varphi (p) \)
- Change in permeability: \( k = k_0 (\varphi / \varphi_0)^\lambda \) (or any user-defined input table)

Extension of primary variable switching logic

- Salt precipitation and dissolution:
  - If \( c_w^{salt} \) exceeds solubility limit, \( s_s \) becomes primary variable
  - If \( s_s \leq 0 \), then \( c_w^{salt} \) becomes the primary variable

Case 3: Brine-CO2 System

- Black-oil formulation internally, but
  - PVT and solubility computed dynamically as function of temperature, pressure, composition and salinity.
  - Molar fractions of components are computed and output
- This setup for CSS is straightforward for the user
- CO2STORE can be combined with THERMAL and PRECSALT

CO2STORE: CO2-Brine properties

<table>
<thead>
<tr>
<th>Density</th>
<th>Brine</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>Brine</td>
<td>Water</td>
</tr>
<tr>
<td>Duan, Z., &amp; Sun, R. (2003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enthalpy</td>
<td>Brine</td>
<td>Water</td>
</tr>
<tr>
<td>Dissolved CO2</td>
<td>Duan, Z., &amp; Sun, R. (2003)</td>
<td></td>
</tr>
</tbody>
</table>


Case 3: Benchmark

Tough2

Opm-Flow

CO2

* Sarah Gasda, Nematollah Zamani and David Landa Marban. ”Management of salt precipitation for large-scale CO2 storage projects.” InterPore2023
Thank you!

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