Extraction of Formation Water from CO₂ Storage (IEA/CON/11/189)

Ground Water Protection Council Annual Forum
Carbon Capture & Storage & Water
September 26, 2011

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• A collaborative research programme founded in 1991.
• Aim: *Provide members with definitive information on the role that technology can play in reducing greenhouse gas emissions.*

• Producing information that is:
  • Objective, trustworthy, and independent.
  • Policy-relevant but NOT policy-prescriptive.
  • Reviewed by external expert reviewers.
  • Subject to review for policy implications by members.

• IEA GHG is an IEA Implementing Agreement in which the Participants contribute to a common fund to finance the activities. Funding approx 2.5 million $/year.
Presentation Outline

• Background
• Project Goals
• Scope of Work
• Modeling and Simulation
• Extracted Water Management
• Surface Dissolution
• Case Studies
• Economics and Recommendations
• Expected Results
Background

• Monitoring and managing the formation pressure within a CO₂ storage formation is critical to the success of a carbon storage project.
• Extraction of formation water for CO₂ plume and pressure plume management may provide the following benefits:
  – Reduction of overall scope and costs of monitoring, verification, and accounting (MVA) activities.
  – Reduction of storage reservoir pressure.
  – Increase in overall CO₂ storage volume.
  – Generation of supplemental water to surface and subsurface supplies, providing immediate and tangible benefits to local and regional stakeholders.
Water and Carbon Storage

- **Storage targets:**
  - Oil/gas reservoirs
  - Coal seams
  - Saline formations

- Each target represents a unique storage environment.
Project Goals/Objectives

- Assess global potential for extraction as part of deep saline formation (DSF) storage projects and evaluate the potential for water management and reuse.
Scope of Work

Task 1. Literature Review

Task 2. Expand the EERC’s Average Global Database (AGD)

Task 3. Brine Extraction/Pressure Relief Modeling

Task 4. Options for Extracted Water Management

Task 5. Feasibility of Surface Dissolution of CO₂ and Reinjection

Task 6. Identify Regulatory Constraints (site-specific)

Task 7. Case Study Analysis

Task 8. Report Writing and Lessons Learned
Modeling and Simulation

- Establish “base case” CO₂ injection scenarios
- Implement various water extraction scenarios to evaluate potential impact on storage and water extraction volumes
Modeling Approach

1) Incorporate existing well logs

2) Incorporate structure maps

3) Grid data

4) Object model target formation

5) Property model target formation
Simulation

5-year Injection Period

25-year Postinjection Period
Options for Extracted Water Management

• Water quality potential for extracted water:
  – Total dissolved solids (TDS) range = low to very high.
• Water quality needed for beneficial use:
  – Most uses require lower TDS than expected.
• Water treatment processes:
  – Desalination methods will be used to match extracted water quality to water quality needs.
Extracted Water Treatment Technologies

• Managing salinity
  – Reverse osmosis
  – Forward osmosis
  – Membrane filtration
    ➢ Micro-, ultra-, and nanofiltration
  – Electrodialysis, electrodialysis reversal
  – Thermal treatment
    ➢ Crystallizer, mechanical vapor compression/recompression, multieffect distillation, industrial evaporation, solar evaporation, freeze–thaw evaporation
  – Ion exchange and other deionization (e.g., Higgins loop)
Extracted Water Treatment Technologies

• Managing organic contaminants
  – Biological treatment
  – Oxidation
  – Sorption and air sparging
  – Constructed wetlands
## Summary for Surface Dissolution

<table>
<thead>
<tr>
<th>Storage Target Formation Water</th>
<th>TDS</th>
<th>pH</th>
<th>Minimum CO\textsubscript{2} Dissolved</th>
<th>Reservoir Conditions</th>
<th>Maximum CO\textsubscript{2} Dissolved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg/L</td>
<td></td>
<td>P=50 bar; T=170 C</td>
<td>(kg CO\textsubscript{2}/ton of water)</td>
<td>(kg CO\textsubscript{2}/ton of water)</td>
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<tr>
<td>Low TDS</td>
<td>329</td>
<td>7.6</td>
<td>18</td>
<td>72</td>
<td>290</td>
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<tr>
<td>Fort Nelson</td>
<td>35,000</td>
<td>7.2</td>
<td>10.9</td>
<td>52</td>
<td>203.6</td>
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<tr>
<td>Gorgon</td>
<td>37,000</td>
<td>9.7</td>
<td>14.5</td>
<td>75</td>
<td>210.8</td>
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<tr>
<td>Nugget Formation of the Green River Basin</td>
<td>43,000</td>
<td>7.2</td>
<td>11.1</td>
<td>55</td>
<td>188.4</td>
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<tr>
<td>High TDS</td>
<td>270,000</td>
<td>7.2</td>
<td>3</td>
<td>15</td>
<td>48</td>
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</tbody>
</table>
Case Study Sites
Economics and Recommendations

Use case study analysis to assess the potential of the following:

1) Water extraction
2) Water management and reuse
3) Local water use practices
4) Site-specific variables
5) Site-specific regulatory issues
Expected Results

- Realistic expectations for rates and volumes of water extracted from commercial-scale CO$_2$ storage projects
- Potential methods and applications for beneficial use of extracted water
- Cost estimations for implementation of an extracted water plan
- Regulatory assessment and potential obstacles
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