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Achieving Net Zero Carbon Emissions Through CCUS in West Kuwait Fields

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Abstract

This paper evaluates Kuwait's strategic development of a large-scale Carbon Capture and Storage (CCS) project, focusing on the transition from initial site screening to the formulation of an optimum development plan inclusive of a Measurement, Monitoring, and Verification (MMV) strategy. The maturation of CCS projects involves a systematic approach that begins with identifying suitable geological formations and evaluating storage potential, injectivity, and leakage risks through static and dynamic modeling. The optimization of a safe CO_2 storage development plan is based on environmental, economic, and regulatory considerations, ensuring the commercial viability and long-term containment of injected CO_2. This paper explores the key considerations for simulating open aquifer systems compared to closed aquifer systems. It examines the unique challenges and dynamics involved in modelling open aquifers, highlighting differences in storage mechanisms, and plume migration. The insights gained from this comparison are crucial for optimizing CCS strategies in diverse geological settings.

The study highlights the geologic characterization of Kuwait Oil Company (KOC) CCS storage sites in West Kuwait, emphasizing its suitability for large-scale CO_2 storage. A thorough screening and detailed geologic modeling of potential storage formations and seals were conducted. The initial screening assessed reservoir properties, storage potential, and seal integrity of all reservoir seal pairs in the region. The Cretaceous Burgan formation within West Kuwait was identified as an ideal CO_2 storage candidate due to its substantial storage potential and excellent reservoir quality. The Ahmadi Shale serves as the ultimate seal for a CO_2 storage complex and minor intraformational seals within the Burgan and Wara formations provide additional redundant seals that minimizing the risk of vertical CO_2 plume migration.

Dynamic modeling of the Burgan formation was performed utilizing a compositional numerical simulator, evaluating various injection scenarios to optimize well placement and spacing to ensure safe long-term containment and sufficient injectivity with appropriate redundancy in the development. A four-well injection strategy was found optimal for injecting 3.22 million metric tons of CO_2 annually over a 25 year injection period, with the CO_2 plume migration stabilized within the complex after 200 years post-injection., Multiple sensitivity analyses were conducted to mitigate the risk and uncertainty and ensure robust decision-making for development.

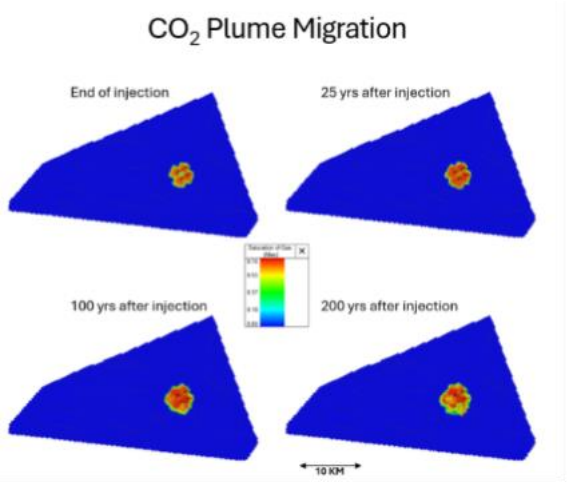

Figure 1 Maximum CO_2 saturation of all layers in the model to evaluate CO_2 plume migration in the Burgan Formation, West Kuwait from the injection of 3.22 million tons per annum of CO_2 for 25 years.

The study underscores the importance of residual trapping as the primary storage mechanism in open saline aquifer systems and highlights the need for extensive data collection to refine models to ensure accurate predictions.

Reaching global climate targets, as outlined in the Paris Agreement, will require large-scale CCS projects. This study contributes to the understanding of CO_2 storage dynamics and offers insights into injection optimization strategies for large-scale CO_2 sequestration projects in open saline aquifers that align with corporate, state, and global climate objectives.

References

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