International Petroleum Technology Conference 2025

IPTC-24675-Abstract

Leveraging Thermal Simulation Coupled With 3D Geomechanics for CO2 Storage Capacity Study of a Sarawak Field in Malaysia

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Objective/Scope

Understanding and accounting for temperature changes is critical in providing a robust estimate of CO2 storage capacity that factors integrity constraints. Hence, an efficient and robust thermal simulation using Intersect coupled with Visage's 3D geomechanics modelling is the foundation for delivering the key objectives of carbon dioxide (CO2) storage studies.

Methods/Procedures/Process

This paper outlines the importance of CO2 storage capacity study using thermal simulation coupled with geomechanics for a field in Sarawak, Malaysia. Maintaining reservoir and wells integrity is a key challenge for CCS to help prevent CO2 leakage. Geomechanics allows us to understand integrity challenges at rock level and derive from it operating limits, but it is important to include temperature as part of the analysis. Temperature changes are significant enough to affect fluid and rock properties, altering fracture pressure and seal strength. During CO2 sequestration in geological reservoirs, there could be a notable change in temperature of injected CO2 starting from wellhead all the way to the final storage location within the reservoir. Some of the reasons for change in temperature of injected CO2 are a) temperature difference between reservoir and injected CO2; b) geothermal effects as CO2 travels in the wellbore from wellhead to bottom of wellbore; c) Joule-Thompson effect when injected CO2 expands as it enters the reservoir; d) geothermal effects as CO2 migrates through the reservoir to its final storage location. To account for those effects, thermal modelling has been utilized to estimate storage capacity and CO2 plume migration in the reservoir.

Results/Observations/Process

Thermal modelling results show significant cooling near wellbore and all the way up to caprock vertically above injection point. A temperature change of up to ~100 °F observed near wellbore and a temperature change of up to ~80 °F has been observed at the caprock. The temperature remains similar as moving away from the injector. But the temperature changes are observed near caprock directly above injection point. This has a significant impact on the storage capacity due to the reduction in caprock injection pressure limit. Storage capacity from the thermal model is lower by as much as 5% compared to storage capacity from the isothermal model.

Novel/Additive Information

By integrating INTERSECT's thermal simulation and Visage's 3D geomechanics modeling in a coupled framework along with the power of High-Performance Compute (HPC) in Delfi, this study precisely assesses the impact of temperature changes on CO2 storage capacity in the Sarawak reservoir, which is beyond the capabilities of conventional isothermal dynamic modeling.