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Improving oil recovery and CO₂ storage in a mature oil field using CO₂ EOR approach

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Statement of the Problem: This research presents a numerical study of CO₂ enhanced oil recovery (EOR) and storage in partially depleted reservoirs. A field-scale compositional reservoir flow model was developed for assessing the performance history of a CO₂ flood and optimizing oil production and CO₂ storage in the Farnsworth Field Unit (FWU), Ochiltree County, Texas.

Theoretical Orientation: A geocellular model was constructed from geophysical and geological data acquired at the site. The model aided in characterization of heterogeneities in the Pennsylvanian-aged Morrow sandstone reservoir. Seismic attributes illuminated previously unknown faults and structural elements within the field. A laboratory fluid analysis was tuned to an equation of state and subsequently used to predict the thermodynamic minimum miscible pressure (MMP). Datasets including net-to-gross ratio, volume of shale, permeability and burial history were used to model initial fault transmissibility based on the Sperivick model. An improved history match of primary and secondary recovery was performed to set the basis for a CO₂ flood study. The performance of the current CO₂ miscible flood patterns were subsequently calibrated to historical production and injection data. Several prediction models were constructed to study the effect of recycling, addition of wells and/or new patterns, water alternating gas (WAG) cycles and optimum amount of CO₂ purchase on incremental oil production and CO₂ storage in the FWU.

Conclusion and Significance: The history matching study successfully validated the presence of the previously-undetected faults within FWU that were seen in the seismic survey. The analysis of the various prediction scenarios showed that recycling a high percentage of produced gas, addition of new wells and a gradual reduction in CO₂ purchase after several years of operation would be the best approach to ensure a high percentage of recoverable incremental oil and sequestration of anthropogenic CO₂ within the Morrow reservoir. This study serves as a benchmark for potential CO₂ EOR projects in the Anadarko basin and/or geologically similar basins throughout the world.

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