



Smart Isotope Tracking Strategies: Cost-Effective And Real-Time Dynamic Monitoring Of CO₂ Enhanced Oil Recovery In Oil Reservoirs

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Summary

Article text should be Arial 11pt, left and right justified. 2 pages including at least one graphic is suggested. Please use the headings that are appropriate for your work, deleting the ones that are not.

Theory / Method / Workflow

This study aimed to enhance the efficiency of Enhanced Oil Recovery (EOR) in an onshore carbonate field in Abu Dhabi, utilizing a Water Alternating with Gas (WAG) injection strategy. To achieve this, we utilized cost-effective CO₂ and H₂O composition and isotope data to accurately measure sweep efficiency and monitor breakthrough in producer wells. This approach allowed us to optimize both the injection and production processes. Our findings were validated through compositional analysis, downhole pressure gauges, and real-time inline CO₂ content measurement using a Multiphase flowmeter

Oil, gas, and water naturally contain carbon, oxygen, and hydrogen isotopes that can serve as tracers to detect annulus leakage, gas storage leakages, and monitor exploration and field development projects. The unique isotope signatures of CO₂ and H₂O were utilized in conjunction with downhole pressure gauge and multiphase flowmeter data to monitor sweep efficiency and breakthrough. This approach enabled the optimization of injection and production operations. The CO₂ used in WAG injection is sourced from a steel mill, having a distinct isotope signature compared to the reservoir oil-related CO₂. Periodically, CO₂ and water are injected into the reservoir through specific injectors distributed across the field. To establish a baseline for assessing sweep efficiency and breakthrough, initial measurements of oil-related CO₂, H₂O, carbon, and oxygen isotope values were taken. At each injection cycle, the compositions and isotope values of the injected H₂O and CO₂ are measured. Similarly, the same components in the oil and water production wells are periodically measured to assess breakthrough levels. By comparing these measurements, it is possible to accurately monitor and optimize the injection and production processes.

Results, Observations, Conclusions

By analyzing CO₂ and H₂O compositions, as well as the carbon and oxygen isotopes in injector and producer wells, we have determined that the injected CO₂ and H₂O reaches certain areas of the field more rapidly than others. This observation suggests that reservoir quality varies across the field, with higher permeability between injector and producer wells experiencing quicker breakthrough. Compositional and isotopic measurements of carbon and oxygen offer earlier



detection of changes in the producer wells compared to estimated breakthrough times from downhole gauges and compositional data.

Novel/Additive Information

This study presents an innovative methodology that employs cost-effective analysis of CO₂, H₂O, carbon, and oxygen isotope compositions to evaluate sweep efficiency and predict breakthrough in an EOR project. It is recommended to implement this technique from the beginning to establish a compositional and isotopic baseline. This baseline will facilitate accurate monitoring of changes during injection, especially when the CO₂ content variations in the reservoir and injected water composition are similar to those of the formation water. Consequently, this allows for more precise determination of the effects on production wells.

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