Integration of reservoir simulation, history matching, and 4D seismic for CO_2-EOR and storage at Cranfield, Mississippi, USA

GCCC Publication Series #2016-01

M. Alfi
S.A. Hosseini

Keywords: seismic 4d, CO2-EOR, fluid flow model

Cited as:
Alfi, Masoud, and Seyyed A. Hosseini, 2016, Integration of reservoir simulation, history matching, and 4D seismic for CO_2-EOR and storage at Cranfield, Mississippi, USA, GCCC Publication Series #2016-01, originally published in *Fuel*, 175, 116-128.

Abstract

In this paper, we compare 4D seismic interpretations of CO_2 plume evolution with fluid-flow numerical simulation results for Cranfield, Mississippi. Historic pressure trends, oil and gas production rates, and current CO_2-EOR production data from the field were history matched, and a tuned model was used for predictive simulations.

For CO_2-EOR operations, numerical simulation results of the CO_2 plume distribution and CO_2 first arrival (breakthrough) times in production wells were compared to the available field data. Three interpretations of 4D seismic data show discrepancies on the edges of the seismic survey, and along the sealing fault, where numerical simulations show high CO_2 saturations. In areas between these two limits, the match between simulation and 4D seismic interpretation improves. In addition, for most of the production wells, comparison of the breakthrough time of CO_2 showed a reasonable match.

The tuned model was then used to predict reservoir response and storage capacity in different field development scenarios under CO_2 injection. We compared hypothetical scenarios where the operator transitions from CO_2-EOR to CO_2 injection without oil production (CO_2-EORT) when oil production is not economical anymore, to a scenario of continuing with CO_2-EOR. Our results show that CO_2-EOR can store more CO_2 and operations will last longer, whereas if switched to CO_2-EORT, the field must be abandoned earlier because of spillover of the CO_2 plume. However, the amount of CO_2 stored per year is larger for CO_2-EORT as compared to CO_2-EOR.