Reducing CO2 Bypassing and Optimizing CO2 Flood Design in Heterogenous Formation

Marylena Garcia, Erwinsyah Putra, Dewi T. Hidayati, David S. Schechter

Abstract

This research utilized a modeling approach to reduce oil bypassed in CO2 flood pattern. A fully compositional simulation model with detailed geological characterization was developed to optimize the flood pattern. The simulation model is a quarter of an inverted nine-spot and covers 20 acres area. The Peng-Robinson equation of state (EOS) was used to describe the phase behavior during CO2 flooding. Simulation layers represent actual flow units and resemble large variation of reservoir properties. A-27 year production and injection history was matched to validate the model. Then, several sensitivities run including CO2 injection rate, slug size, WAG ratio, pattern reconfiguration and conformance control were conducted to improve CO2 sweep efficiency and increase oil recovery.

We found that the optimum CO2 injection rate is approximately 300 rb (762 MSCF/D). The optimum water-alternating-gas (WAG) ratio is 1:1. This ratio allows an incremental oil recovery up to 18% with an ultimate CO2 slug of 100% hydrocarbon pore volume (HCPV). If a polymer is placed in high permeability streak during the course of 1:1 WAG ratio, an additional recovery could increase up to 34%. The simulation results also reveal that a pattern reconfiguration change from inverted nine spot to staggered line drive could significantly increase oil recovery.

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