Experimental and Simulation Study of Different WAG Injection Scenarios in Tight Oil Reservoirs

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Abstract

The Water-Alternating-Gas (WAG) process has been originally proposed to increase the extent of the oil reservoir contacted by the displacing fluids. Practically, the WAG flooding combines the advantages of both gas and water flooding and results in better microscopic displacement and macroscopic sweep efficiencies.

In this work, the performance of both continuous gas injection (CGI) and WAG injection processes in a tight carbonate oil reservoir was investigated at selected operational conditions. This performance evaluation has been conducted by comparing oil recoveries from secondary WAG injection with those from CGI. The core flooding experiments were carried out using nitrogen and CO_2 in different slug size of WAG injection as well as CGI scheme. In addition, CO_2 injection tests were performed in miscible CGI, miscible WAG, and hybrid WAG schemes.

According to the results of this study, nitrogen WAG flood observed to have higher performance rather than nitrogen CGI. Furthermore, among different nitrogen WAG slug sizes, it was found that 0.15 PV was the optimum slug size, which led to highest recovery factor. The results also revealed that the secondary oil recovery factor of miscible CO_2 WAG injection is higher than that of miscible CO_2 CGI. In comparison with CO_2 CGI and CO_2 WAG, CO_2 hybrid WAG injection scheme (i.e., a continuous CO_2 slug of 0.4-0.5 PV followed by 1:1 WAG injection) was able to recover more oil.

To verify the experimental results obtained in this study, a compositional simulation model was established using different modules (Winprop, Builder, GEM) of CMG software, ver. 2011. The simulation model was tuned to match with the experimental results and then was up-scaled to evaluate the performance of aforementioned injection scenarios in a typical reservoir case.