Reservoir Modeling for CO2 EOR in Mississippian Carbonate Reservoir at Wellington Field in South-Central Kansas

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ABSTRACT

Since early 1930s over 2.4 trillion cubic feet (TCF) of gas and more than 290 million barrels of oil (MMBO) have been produced in south-central Kansas from Mississippian carbonate reservoirs. Many Mississippian reservoirs are currently undergoing final stages of secondary recovery and are suitable for enhanced oil recovery (EOR) with CO2 with estimated recoverable potential of 250-350 million barrels of oil. Wellington field in South-Central Kansas has produced 20 MMBO since 1937 and is ready for a tertiary oil recovery phase with CO2. A Department of Energy sponsored pilot-scale CO2 EOR project is led by Kansas Geological Survey, Energy Research Section team and its industry partner and operator of the field, Berexco LLC. Approximately 23,000 metric tons of CO2 will be injected in the upper part of the Mississippian reservoir to verify CO2 EOR viability in carbonate reservoirs and evaluate a potential of transitioning to geologic CO2 storage through EOR.

Baseline geologic characterization, geologic model development, studies of oil composition and properties, miscibility pressure estimations, geochemical characterization, reservoir modelling were performed. However, field deployment was delayed due to problems with CO2 supply until early 2015. In March of 2015 the injection well (class II) KGS 2-32 was drilled, cored, and logged through an entire anticipated injection interval. Whole core samples were obtained and tested for porosity and permeability, relative permeability, and capillary pressure. The Drill Stem Test (DST) was also conducted to estimate injection interval permeability and pore-pressure. After the injection well KGS 2-32 was acidized, Step Rate (SRT) and Interference (IT) tests were conducted and analysed for permeability, well pattern communication, and fracture closing pressure.

These additional characterization efforts and previous studies of the oil composition and properties, miscibility pressure estimations, and comprehensive 3D geological model for the entire Wellington field led to updates and enhancements in the strategy for the CO2 flood and the economic forecast for CO2 EOR performance. The geological model estimates that the Wellington Field still holds at least 5 million barrels of oil that could be potentially recovered. The reservoir simulation of the CO2 miscible flood projects that additional 10-15% of primary and secondary oil production could be recovered, which amounts to nearly 8,500 bbls of additional oil production for the given part of the oilfield. It is also forecasted that nearly 73% of all injected CO2 will be permanently stored during this EOR operation by the means of structural, residual, solubility, and mineral trapping.

Total of 1,101 truckloads, 19,803 metric tons, average of 120 tonnes per day were delivered over the course of injection that lasted from January 9 to June 21, 2016. Current incremental average oil production rate is 30 bbls/day and a total of incremental more than 7,00 bbls of oil were produced as a result of CO2 injection.