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Design and Initial Results of EOR and Flow Assurance Laboratory Fluid Testing for K2 Field Development in the Deepwater Gulf of Mexico

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Abstract

K2 is a large Gulf of Mexico offshore oil field located in Green Canyon Blocks 518 and 562 approximately 175 miles south of New Orleans, Louisiana (Figure 1). It is one of the first deepwater subsalt Miocene fields to begin production from reservoir depths below 25,000 feet SSTVD. Since first production in May 2005, the field reached a peak production rate of 40,000 bopd before following a continuous decline rate. Well performance analysis and reservoir simulation history match results indicate the main producing M14 and M20 sands lack any substantial natural drive recovery mechanisms. The potentially huge oil resource, that could go unrecovered, justified efforts to evaluate the feasibility of various injection processes to maximize ultimate oil recovery. Initial screening resulted in seawater and nitrogen injection as the most technically and economically viable oil recovery methods. The process selection stage is in progress to evaluate these two recovery methods. K2 field delineation and reservoir studies are in progress and much additional work (including geomodeling and reservoir simulation using fluid and core experimental studies) will be performed prior to selection of a suitable recovery process to proceed to the project definition stage.

The purpose of this paper is to document the design and initial results of EOR and flow assurance fluid studies to be used in evaluation of the feasibility of nitrogen gas injection for recovery of substantial incremental oil over pressure depletion. Conventional EOR laboratory studies were complicated by the need for flow assurance considerations due to the deepwater offshore environment and high asphaltenes content of the main producing horizon EOR target M14 oil zone. Also, it became important for laboratory testing to thoroughly evaluate the EOR process mechanisms and provide rigorous data for reliable reservoir modeling and simulation. Unlike onshore EOR projects, implementation of an EOR project in K2 would have to be done without the benefits of a pilot flood to fully test the EOR process and provide design data for the fieldscale project. This is due to the prohibitive cost and time for the facilities, equipment, and wells needed to conduct a producing nitrogen injection pilot test in the deepwater offshore environment and subsalt reservoir depths below 25,000 feet.

Results of the initial laboratory work revealed new and different ideas to suggest novel directions in how fluid studies and flow assurances issues should be addressed in evaluating an EOR process for deepwater offshore application. We conclude from the findings thus far: (a) surface separator fluid samples can be successfully recombined to obtain representative reservoir fluids for PVT, EOR, and flow assurance work, (b) asphaltene stability tests resulted in a substantial increase in the AOP with increase in the solution GOR and a greater effect for hydrocarbon vs nitrogen gas, and (c) improved procedures for experimental slim tube tests can provide more representative determinations of miscibility pressures. A comprehensive strategy and program for fluid sampling and laboratory fluids testing has been prepared and is being implemented. Basic fluid properties and PVT data have been measured. Initial results of miscibility, PVT, and flow assurance lab tests with nitrogen and reservoir oil mixtures are presented. The lessons learned from the initial lab work provided new insights and ideas for planning fluid sampling and lab testing programs for operators to evaluate other reservoirs for gas injection EOR processes in deepwater offshore environments.