Reservoir Modeling to Characterize Dual Porosity, Tengiz Field, Republic of Kazakhstan

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Tengiz Field is the world's deepest developed supergiant oil field, with an oil column height of nearly 1600 meters. The reservoir consists of Devonian and Carboniferous platform/slope carbonates, divided into three stratigraphically-defined producing units. Production of more than 500,000 BOPD is mainly from the upper unit. A significant portion of this production is controlled by natural fractures. A new reservoir model has been constructed to support a future growth project, including miscible gas injection, and to provide input to reservoir management strategies, development planning, and oil-in-place estimation.

Our new model represents a significant change from previous Tengiz reservoir models in that a conventional dual porosity flow simulation (fracture and matrix) is being applied. This change to dual porosity, which is necessary to effectively characterize the fracture-matrix flow in the depositional slope, requires a significant modification of the overall reservoir modeling workflow. Initially matrix porosity and permeability are distributed into the fine-scale model and because fracture properties are only available at a much larger scale, fracture density, fracture porosity and fracture permeability are populated into the model after upscaling.

Fracture porosity is high in the depositional slope area (as high as 0.5%) due to the cavernous character of portions of the fracture system. This fracture porosity represents a significant volume, and has a large impact on reserves. Fracture permeability is also a critical factor, and has a large affect on flow behavior and the recovery associated with the potential miscible gas injection project. Although fractures are important at Tengiz, their intersection by well bores is relatively rare, due mainly to under-sampling of sub-vertical fractures by vertical wells and to a limited number of wells in the slope area. Because of this under-sampling, and general ambiguity in image-log data, there is a large uncertainty associated with fracture properties at Tengiz. To address this uncertainty, a significant effort has gone into collecting production logging and pressure transient test data in the slope area. In addition, we attempted to reconcile fracture properties derived from image log analysis with fracture properties from well tests and other logs.

This presentation summarizes the fracture characterization and modeling workflow to incorporate dual porosity into the Tengiz reservoir model.