Partially Coupled Geomechanics and Reservoir Simulation in Tight Carbonate Reservoirs

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ABSTRACT

Understanding the reservoir deformation as a result of depletion is crucial in making reservoir development plans. The process includes a geomechanical investigation on the compaction behavior of the rock using volumetric deformation of the reservoir. This paper presents a comparison of primary reservoir production with and without rock compaction. The purpose is to study the effect of compaction on reservoir properties, reservoir depletion, and ultimately well spacing.

The model is built for a tight carbonate reservoir with low porosity and permeability that was hydraulically fractured. A section of 1mile x 1mile was modeled using available well logs and was history matched with producing wells. The model is then simulated using reservoir simulators without considering rock deformation. On the other hand, a model was run taking into account rock compaction as a result of reservoir depletion. Porosity reduction is calculated at 6 month intervals using finite element volumetric strain calculation based on a poroelastic model. Permeability changes can then be calculated and fed into the reservoir simulator at every stage. The depletion data was in turn looped back to the geomechanic model to simulate the reservoir deformation for the next time steps.

The advantage of using a coupled model is to calculate changes of stress using a stress-strain solution. This approach provides more realistic information about deformation and reservoir property changes than a pressure dependent permeability table, which does not take into account stress changes. A 6 month time step was chosen to reduce the run time, yet maintain a pseudo coupled and iterative model.

By comparing the two models, the partially coupled model results in a lower five year recovery than the reservoir model without compaction. As a result, an alternative well spacing can be recommended to ensure effective drainage and higher ultimate recovery. The comparison highlights untapped zones that are otherwise assumed to be drained.