OU researchers developing shale gas reservoir simulator

January 5 2011

University of Oklahoma researchers are developing a new simulator for shale gas reservoirs that will provide oil and gas companies with an essential tool for managing production and choosing drilling locations to lower costs and increase production.

OU professors Richard Sigal, Faruk Civan and Deepak Devegowda, Mewbourne College of Earth and Energy, are the first to systematically tackle this challenge. The project is supported with $1,053,778 from the Research for Partnership to Secure Energy for America plus an additional $250,000 in matching funds from a consortium of six oil and gas producing companies.

Natural gas has a smaller greenhouse gas effect and is less polluting than other fossil fuels, plus gas produced from shale gas reservoirs can have a positive impact on the U.S. economy by replacing coal used for electrical generation, natural gas imports and oil imports in some applications.

"Simulators for conventional reservoirs are not suited for shale gas reservoirs," says Sigal. "An example of this is the deposition of frac water used to force the gas from the reservoir. In a shale gas reservoir, massive hydraulic fracturing opens up the reservoir so the gas can flow. This involves pumping a large amount of water into the reservoir. In conventional reservoirs all this water is produced back, but in shale gas reservoirs only a small percentage of the water is produced."

According to Sigal, "Current commercial simulators do not successfully predict the amount of water produced. Researchers need to model the deposition of this water to better understand the reservoir and address concerns the effects this water can have on shallow aquifers. One goal of the simulator project is to determine and provide the capacity to model frac water deposition."

"Predicting long-term gas production with history matching requires more accurate physics and geology," states Sigal. "Using a new $2 million microscope at OU to see the detailed porosity of the rocks, Professor Carl H. Sondergeld and his collaborators have found two kinds of pore space in the rocks. Besides the inorganic pore space where we expect to find gas, they discovered pores the size of nanometers in the organic portion of the rock. This discovery needs to be incorporated into the simulator design."

OU researchers recognize the physics of fluid flow and storage are very different in the inorganic and the organic portions of shale gas reservoirs. And, these reservoirs contain both natural and induced fracture systems each with different properties. OU researchers will develop a quad porosity model to take into account these differences.

There are three basic issues with the physics of these natural non-porous systems. First, the standard equations used to describe gas transport are incorrect in the small pores in the organic material where a significant portion of the hydrocarbon gas is stored. Researchers studying artificial nanomaterials have developed new gas transport equations that need to be adapted to the complicated pore spaces that describe shale gas reservoirs.

Secondly, in standard simulators, an assumption known as instantaneous capillary equilibrium provides the relationship between the gas and water pressure. Equilibrium cannot be maintained because of differences in the transport rates for water and gas in shale gas reservoirs, so the standard equations must be modified. Finally, the very large capillary forces caused by the very small pore size require a different treatment of relative permeability, which controls the relative transport of the water and gas.

"This is a three-year project to develop the new simulator starting with the fundamentals," Sigal remarks. "We have already developed a 1-D model. The next step will be to build a simple 3-D testbed system. At first, we will test this model against models run on commercial simulators."

"Next, we will build modules that incorporate the individual modifications needed for conventional simulators to correctly model shale gas reservoirs," Sigal comments. "These modules will be available for adoption by industry for use in existing company or commercial simulators. Finally, we will use the modified simulators to history match production from existing reservoirs. Our commercial sponsors will provide data for this."

Provided by University of Oklahoma