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A Parametric Analysis of Carbon Dioxide Sequestration Potential in Depleted Marcellus Shale Gas Reservoirs

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ABSTRACT

Most existing unconventional gas reservoir simulators often treat shale gas reservoirs as dual-porosity, single-permeability flow systems with no water saturation and with no permeability in the micropore (matrix) structure. The PSU-SHALECOMP, is a compositional dual-porosity, dual-permeability, multi-phase reservoir simulator, which also incorporates the effects of water presence in the micropore structure and those of matrix shrinkage and swelling. In PSU-SHALECOMP, shale gas reservoir is treated as a dual-porosity, dual-permeability system consisting of shale matrix and fracture network allowing realistic natural fracture spacing characteristics. In the simulator, computations on the partial adsorption capacity of gas components are based on the thermodynamic equilibrium between gas components in the free and adsorbed phases following the ideal adsorbed solution model using an analogy to vapor-liquid-equilibria calculations. Apart from the aforementioned capabilities of PSU-SHALECOMP, the concept of stimulated reservoir volume (SRV) approach is introduced to the numerical models. The SRV is approximated by modifying the values of fracture spacing, fracture permeability and fracture porosity where the hydraulic fractures exist. In the validation phase of the simulator, rock and fluid properties and reservoir conditions of Marcellus Shale gas reservoir were used with the implementation of a computationally inexpensive SRV model, which has the ability to generate similar behavior in terms of production performances to that of an equivalent discrete fracture network model. The results were also compared with a series of normalized field production data that is obtained from existing Marcellus Shale wells, and it is shown that the PSU-SHALECOMP simulator with the implementation of SRV model is capable of matching the historical data very efficiently and rapidly.