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Efficient Probabilistic Estimation of Well Injectivity for CO_2 Storage

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Geological heterogeneity impacts the design and implementation of large-scale, underground injection of CO_2. For many saline water-bearing formations in the U.S., limited data are available in terms of the values and 3D spatial variability of porosity and absolute and relative permeability. Placement of multiple wells into a formation with uncertain properties poses risk in terms of inadequate CO_2 flow rates to accommodate captured power plant emissions. We propose a methodology for the generation of probability density functions (pdfs) of well injectivity (i.e., flow rate of CO_2 into a well, normalized by the pressure difference between the well and the storage formation). These pdfs give an indication of the range of well injectivity for a formation, which can be used in determining the number of wells needed for a storage project. The methodology uses averaging and upscaling of geostatistically-obtained porosity and permeability fields in an analytical equation of well injectivity. Since the data fields are probabilistic, the well injectivity output is a pdf. We compare this pdf with similar well injectivity output from the numerical simulator TOUGH2. The Mount Simon Sandstone of the Illinois Basin is used as a test case. This efficient well injectivity methodology is being applied to multiple formations throughout the U.S. via incorporation into the National Water, Energy, and Carbon Sequestration simulation model (WECSsim), which is a system dynamics tool that evaluates opportunities for CO_2 sequestration, extracted water use (e.g., power plant cooling), and the associated economic and water demand-related impacts of fossil fuel-based electricity generation. The authors wish to thank the National Energy Technology Laboratory for helping support this ongoing work.

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