Enhanced Gas Recovery and CO_2 Storage in Coal Bed Methane Reservoirs: Optimized Injected Gas Composition for Mature Basins of Various Coal Rank

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Nitrogen (N_2) and carbon dioxide (CO_2) injection has been a subject of enhanced coal bed methane (ECBM) and carbon capture and storage (CCS) research during the past decade. N_2 and CO_2 injection produce substantially different recovery processes. Coal has a higher affinity for CO_2 as compared to methane (CH_4), making it an ideal candidate for CCS and address environment issues related to green house gas emissions. However, preferential adsorption of CO_2, a larger molecule than CH_4, onto the coal surface results in a dramatic decrease in cleat permeability due to coal swelling. This ultimately induces a loss of injectivity creating a significant technical hurdle for CCS operations in coal. In contrast, N_2 increases cleat permeability because of its lower coal storage capacity relative to CH_4. As a result, injectivity increases during N_2-ECBM. Theoretically, the injection of a mixture of CO_2 and N_2 will result in ECBM and CCS without a loss of injectivity. This study presents an investigation of that concept.

Based on the lessons learned from several actual large-scale and small-scale field demonstrations to date, this paper will focus on the improvement of CO_2 sequestration and associated ECBM by optimization of gas composition and injection designs for different coal ranks. To characterize resources and identify key geological and reservoir parameters driving ECBM and sequestration processes in deep unminable coal seams, a Monte Carlo probabilistic approach was implemented for coal seams of different rank. To perform the study, a matrix of simulation scenarios consisting of multiple coal types (taken from mature coal basins such as San Juan, Warrior, Central Appalachian and Powder River), permeability values, pattern sizes and injected gas mixtures (from 100% CO_2 to 100% N_2,) was established. First results show that, for a specific coal rank, ECBM and CCS can drastically improve by increasing N_2 content in the injected gas stream.