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Correlation between gas permeability and pore structure of coal matrix

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The sequestration of CO_2 in unminable coal seams represents a promising option for CO_2 geologic storage, because the injected CO_2 may enhance coalbed methane recovery (CO_2-ECBM), which could partly offset the costs of the storage process. The CO_2-ECBM technology is based on the relative affinity of CO_2 and CH4 to coals under given pressure and temperature conditions. The excess sorption capacity of coals for CO_2 is generally higher than the sorption capacity for methane. The coal seams are characterized by a dual porosity structure including cleat and matrix pores. The cleats in the coal seams are considered as highways for gas and water flow, while the matrix is the storage location of gas by adsorption. The slow transport process of gas in coal matrix may constrain the efficiency of the displacement of CH4 by CO_2 due to the compacted pore structure of the coal matrix. Therefore, a detailed understanding of the correlation between permeability of gas and pore structure in coal matrix is crucial for the CO_2-ECBM processes.
Yangquan coals originating from the Qingshui basin, which contains gas-rich coals in China, were selected for the tests in this study. Yangquan coals are classified as anthracite. In order to avoid the influence of coal cleats on fluid flow, small coal plugs ($\sim$6 mm in diameter, $\sim$13 mm in length) were selected and fixed in the sample compartment by special glue. A test system for simultaneously measuring adsorption-porosity-permeability on the coal matrix blocks in its free state is constructed. The permeability of gas and porosity in coal plugs to He under different gas pressure and temperature conditions were simultaneously investigated. The permeability and excess sorption capacity of the coal plugs to He, N2, CH4 and CO_2 were compared at a constant gas pressure and temperature.
It is expected that gas break through a cleat-plug is much faster than that through a coal matrix-plug. Different sample plugs with the different pore structure results in different breakthrough behavior. The breakthrough curves of coal plugs with respect to He were found to vary with pore gas pressure (0.5-0.8MPa) and temperature (30-60 oC). It was influenced by the retention of moisture and air. The corresponding excess sorption capacity of the coal matrix-plug decreases in the order of CO_2>CH4>N2>He. The connectivity of the pores is an important factor to be considered.