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Comparison study of gas permeability of coal plug in self- and triaxial-confining flow cell

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CO2 storage in the unminable coal seams and simultaneously enhancing coalbed methane recovery (CO2-ECBM) is one of the options to reduce CO2 emission into atmosphere. The results of the CO2-ECBM pilot tests in several countries indicate that CO2-ECBM is feasible in technology. However, the efficiencies of CO2 trapping and CH4 recovery vary with coal seams. The coal seams are characterized by a dual porosity structure including cleat and matrix porosity. The slow transport process of CO2 and CH4 in the coal matrix constrains the efficiency of the displacement of CH4 by CO2 due to the compacted structure of the coal matrix and the mixed process of sorption and transport in the coal matrix. It is important to determine the permeability of the coal matrix. The pore structure of coal matrix may vary with the confining stress, which results in the change of permeability. However a change in pore structure of the coal matrix can also be introduced by the pressure of the injecting gas (gas pressure). Therefore it is necessary to study the permeability of the coal matrix under different confining stress and gas pressure conditions. The permeability of the coal matrix was determined in two types of experimental setup in this study. Self-confining flow cell was used to test for permeability of CH4 saturated coal blocks, in which the structure of coal block may nearly remain in its free state. Triaxial-confining flow cell was used to test for permeability of coal plug under higher confining stresses (10-40MPa). It was found that the permeability coefficients of the coal block in the self-confining flow cell decreased as the mean gas pressure increased. If the change on pore structure is negligible, the decrease in permeability is caused by the increase of the drag friction (between gas flow and pore wall) due to the increase of gas flow rate through the coal matrix. The permeability coefficients of the coal plug in the triaxial-confining flow cell decreased dramatically when the confining stress increased from 10 to 15 MPa, and decreased further with less extent when the confining stress further increased from 15 to 40 MPa. The increase in confining stress corresponds to the decrease in porosity of the coal matrix. As the confining stress increased the coal matrix became more and more compacted and hardly to be changed. It was interested to notice that for the coal plug with lower confining stress the permeability coefficient decreased with the increase of the mean gas pressure in the lower mean gas pressure region, increased in the higher mean gas pressure region, and kept constant in between. This change of the permeability coefficient is mainly due to the change of the mean gas pressure and the effective stress. A three-parameter analytical equation combining these two factors was proposed to model the observed permeability data under the confining stresses of 10 - 40 MPa. It was also encouraging that the prediction made by this model may be extended to the other conditions.