

The Effects of Cleat Orientation and Confining Pressure on Cleat Porosity, Permeability and Relative Permeability in Coal

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Abstract

Many previously reported measurements of gas-water relative permeability in coal have been performed with fluid flow perpendicular to the bedding planes. The cleat structure of coal suggests that permeability in coal should be anisotropic and dependent on net confining pressure. Nothing has been previously reported concerning the anisotropy of gas-water relative permeability in coal or its dependence on confining pressure. Laboratory measurements of cleat porosity, permeability and gas-water relative permeability as a function of cleat orientation and confining pressure on Fruitland formation coal collected from the La Plata mine in the San Juan basin of New Mexico have been performed with the following results.

There is no effect of cleat orientation on gas-water relative permeability in well-cleated La Plata coal cores. Relative permeability measurements on well-cleated coal samples can be performed using vertical cores (fluid flow perpendicular to the bedding planes).

As expected, permeability is largest parallel to the bedding planes in the face cleat direction. At 1,000 psig confining pressure, permeability parallel to the bedding planes in the face cleat direction is 0.6-1.7 md and in the butt cleat direction, 0.3-1.0 md. These compare with 0.007 md measured perpendicular to the bedding planes. The permeability measurements parallel to the bedding planes are comparable to those observed in coal seams and used in simulation studies. In general, laboratory permeability measurements made perpendicular to the bedding planes in coal are much lower than the values used in simulation studies.

Confining pressure (i.e., stress) has an effect on cleat porosity, permeability and relative permeability. Increasing confining pressure from 450 psig to 1,000 psig with an injection pressure of 370 psig and a 70 psig pressure drop lowers the permeability by a factor of approximately 5 in all cleat orientations. The cleat porosity is lowered by approximately a factor of 1.7. Increasing confining pressure increases the ratio of the gas relative permeability to the water relative permeability.