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Effect of coal properties on CO_2 sorption capacity under supercritical conditions

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Storage of CO2 in deep, unmineable coal seams is being considered as an option for reducing greenhouse gas emissions in Australia. To assist in identifying suitable coals for sequestration, relationships between coal properties and CO2 sorption capacity have been investigated for 24 coals covering a wide range of rank, maceral composition and sources. A range of coal properties was measured including: CO2 sorption capacity, mercury porosity, helium density and chemical and petrographic composition.

Carbon dioxide adsorption isotherms were measured on dry coal at 55 ˚C and at pressures up 15 MPa using a gravimetric apparatus. In this system, the density of the gas in the sample cell void space is measured directly by the use of a reference cell maintained at the same conditions, thus avoiding the need for equations of state to calculate the mass of free gas. Isotherms were fitted to a modified Dubinin-Radushkevich (DR) model using gas density rather than pressure to enable the model to be applied to supercritical conditions. The form of the modified DR equation is:

$$W_{ads} = W_0 \left(1 - \rho_g/\rho_a\right) e^{-[D \ln(\rho_a/\rho_g)]^2} + k\rho_g$$

where Wads is the excess sorption, W0 is the maximum sorption capacity, ?g is the density of the gas, ?ads is the density of the adsorbed phase and k is a term related to Henry's Law to account for gas absorbed by the coal. This model provided very good fits to the experimental data; in most cases the difference between the predicted and measured value was less than 1 % over the entire pressure range.

Sorption capacities of the coals investigated were found to vary by over a factor of two, but in general there was little correlation between the sorption capacity and other properties. Australian Permian and US and Polish Carboniferous coals were not distinguishable by their sorption capacity. CO2 capacity did not appear to be strongly related to rank, although there was a weak correlation in which increasing C and H corresponded to decreasing sorption capacity. Two of the coals showed significantly higher sorption capacity than any of the other samples examined. In both of these cases, the coals had been naturally weathered and exhibited high porosity relative to the other samples. The implications of these findings on estimating the feasibility of coal sequestration will be discussed.