



## Gas and water sorption on coal for CBM and CO<sub>2</sub>-ECBM

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To predict a CBM production profile either during primary or secondary production, aspects like coal permeability and porosity, density, ash and moisture content, initial gas-in-place (GIP) (from canister desorption tests), gas sorption capacity from laboratory isotherms (to obtain gas saturations and desorption pressure), gas diffusivities, coal volumetrics (thickness and areal extent) or thermodynamic properties (e.g. viscosity, equation of state) of the fluids involved need to be understood as a minimum requirement. When dealing with CO<sub>2</sub>-ECBM selective adsorption, counter diffusion in the coal matrix, or coal shrinkage and swelling (from CH<sub>4</sub> desorption and CO<sub>2</sub> adsorption, respectively) need to be investigated in addition to the parameters above.

During CO<sub>2</sub>-ECBM processes, the areal distribution of the CO<sub>2</sub> injected is accomplished by flow through the cleat network. When CO<sub>2</sub> is entering the coal matrix by a combined sorption/diffusion process it will adsorb to the coal inner surface and at the same time replace part of the CH<sub>4</sub>. This replacement occurs either by a reduction in the CH<sub>4</sub> partial pressure or by a higher selective sorption of CO<sub>2</sub> over CH<sub>4</sub>. Because of a concentration gradient between CH<sub>4</sub> in the matrix compared to the cleat system, CH<sub>4</sub> diffuses from the coal matrix into the cleat system where, by pressure drawdown towards a production well, it can be produced.

In this context this review summarizes gas (CO<sub>2</sub>, CH<sub>4</sub>) and water sorption on coal and specifically addresses the following topics:

- The most common experimental setups for determining gas and water sorption on coal (or other microporous materials), its differences and experimental uncertainties. Further the modeling of sorption isotherms and the problems of calculating absolute from excess sorption is addressed.
- CO<sub>2</sub> and CH<sub>4</sub> sorption on natural coals and its dependence on coal specific parameters like coal rank, maceral composition or ash content.
- Water sorption on coal, its dependence on coal properties like rank and coal chemistry and gas sorption in the presence of water.
- Findings related to sorption kinetic data obtained from the pressure decline versus time plots of individual sorption steps. The different model assumptions are introduced, sorption rates are compared for different moisture contents, coal rank and differences between CO<sub>2</sub> and CH<sub>4</sub> sorption rates are defined.