Gas Transport and Sorption Processes in Coals and Shales: New Insights and Concepts from Laboratory Experiments

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Physical sorption is the key process in coalbed methane (CBM) and gas shale systems. Sorptive storage capacity, the principal thermodynamic parameter, is commonly expressed in terms of excess sorption isotherms and depends on pressure, moisture content, temperature, and type and maturity of the organic matter. It can be readily assessed by laboratory experiments at pressures and temperatures relevant for CBM and shale gas systems.

For both, exploration and production purposes the kinetics of sorption and desorption and the interrelation of sorption and transport processes are of crucial importance.

In coals, the cleat systems act as transport avenues while the microporous, polymer inter-cleat matrix system represents a source or a sink, depending on partial pressure (chemical potential). Rate and efficiency of mass transfer between the cleat and matrix system, and the transport and sorption rates within the coal matrix are therefore of prime interest for quantitative descriptions and modelling.

In carbonaceous shales, the connectivity of the pore and fracture systems determines the accessibility of the dispersed organic matter and its participation in gas transport. Capillary processes and two-phase (water/gas) transport appear to be relevant both in gas shale and CBM systems. Combined fluid flow and sorption experiments on cylindrical plugs under controlled temperature, pressure and stress conditions are being conducted in our laboratory to study the interaction of gas sorption and transport processes in coals and carbonaceous shales with a largely undisturbed fabric. The tests are performed with methane, CO_2, and non-sorbing inert gases (He, Ar). By systematic variation of the initial and boundary conditions, individual processes such as compressible Darcy flow, diffusion, capillary breakthrough, sorption and desorption kinetics can be distinguished and described by numerical models. Selected examples for both, CBM and shale gas systems will be presented to illustrate this approach.