Combining Poromechanics with Molecular and Reservoir Simulations to Model Coal Bed Methane Production

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ABSTRACT:

Coal bed reservoirs naturally contain methane. During the methane recovery process, the reservoir permeability evolves as a consequence of coal shrinkage that is induced by methane adsorption. In this work, we propose a multiscale approach that combines poromechanics with molecular and reservoir simulations in order to model such variations of permeability of the bed.

The coal bed reservoir is modeled as a two-scale porous medium made of cleats and micropores. We assume that cleats govern the transport properties of the reservoir and that adsorption occurs by filling of the micropores of the coal matrix. The poromechanical behavior of the coal matrix is modeled with constitutive equations that are valid for a microporous medium.

At the scale of the microporous coal matrix, molecular simulations of adsorption of methane in coal are performed. In those simulations, the molecular model for coal is kept flexible. The adsorption isotherms are simulated for various pressures of the fluid and strains of the solid. The coupling between adsorption and volumetric strain is quantified and compared to experimental data.

The results of the molecular simulations are used as inputs in reservoir simulations of a coal bed reservoir. Those reservoir simulations enable to estimate how the rate of production and the permeability of the bed evolve during production of the methane.

REFERENCE:

[1] L. Brochard, M. Vandamme, R.J.-M. Pellenq. Poromechanics of microporous media, accepted, J. Mech. Phys. Solids