Enhanced Poromechanics for the Modeling of Adsorption-Induced Swelling in Microporous Materials: Simple and Double Porosity Modeling

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The purpose of our work is to achieve a better understanding of the coupling between adsorption and swelling in microporous materials. This is typically of utmost importance in the enhancement of non-conventional reservoirs or in the valorization of CO2 geological storage. We consider here the case of fully saturated porous solids with pores down to the nanometer size (≤ 2nm). Hardened cement paste, tight rocks, activated carbon or coal are among those materials. Theoretically, most continuum approaches to swelling upon adsorption of gas rely on a coupling between the adsorption isotherms and the mechanical deformation. A new poromechanical framework [1] has been recently proposed to express the swelling increment as a function of the increment of bulk pressure with constant porosity. This framework has been extended recently to take into account the porosity evolution upon swelling [2] for simple porosity media. This paper aims at presenting an extended poromechanical framework where the porosity is variable upon swelling. The framework is derived for both simple or double porosity media. A new incremental nonlinear scheme is proposed where the poromechanical properties are updated at each incremental pressure step, depending on the porosity changes. Interactions between swelling and the adsorption isotherms are examined and a correction to the classical Gibbs formalism is proposed. Predicted swellings are compared with results from the literature and with our own experimental database.

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References

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