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Supercritical Adsorption of CO2 and CH4 on Shales and Surrogate Porous Media

Tuesday, 31 May 2022 11:30 (15 minutes)

Low natural gas recovery factors from shale reservoirs have stimulated interest in Enhanced Shale Gas Recovery (ESGR) using CO_2 injection. This process seeks to exploit the preferential adsorption of CO_2 in shale' s nanometric pores, so as to enhance desorption of CH_4 and to promote geological sequestration of CO_2. To facilitate the design of this process, an integrated experimental and modelling workflow was developed and deployed on shale samples from the Longmaxi (China), Marcellus (USA) and Bowland (UK) formations to achieve the following: (i) high-resolution textural characterisation, (ii) supercritical adsorption measurements with CO_2 and CH_4, and (iii) their description by a novel mathematical model that predicts adsorption in chemically and morphologically heterogeneous materials. The results show that CO_2 adsorbs more than CH_4 at all pressures (2–3 times) and that both adsorption capacities and textural properties are strongly influenced by the shale mineralogy. The model developed in this work is based on the lattice Density Functional Theory and describes adsorption systems featuring both slit and cylindrical pores and accounts for the presence of energetically distinct organic- and clay-rich pore surfaces. The workflow was calibrated on three model adsorbents (micro/mesoporous carbon [1] and source clays [2]) that have been used in this study as surrogates for the organic- and clay-rich fractions of shale, respectively. As such, the model is used in a predictive fashion to describe supercritical adsorption, only requiring knowledge of the shale's composition. The adsorption data have been used as input to an equilibrium-based ESGR proxy reservoir model, which uses the concept of Pressure Swing Adsorption, and was deployed to demonstrate that a cyclic CO_2 injection operation, including three stages (Injection/Soak/Production), may be required to achieve sufficient recovery and secure CO_2 storage [3]. The results indicate that competitive adsorption and partial pressure both influence enhanced recovery and reveal a trade-off between CH_4 production and CO_2 sequestration. The practical workflow presented in this work can be used to quantify accurately the Gas-in-Place and CO_2 storage potential of shale reservoirs at subsurface conditions and design an optimal CO_2-ESGR process.

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References

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Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

In person

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