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CO2-enhanced shale gas recovery –Monotonic and cyclic injection

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The process of CO2 enhanced shale gas recovery CO2-ESGR seeks to recover the maximum amount of shale gas while simultaneously injecting and trapping CO2 to reduce greenhouse gases. CO2-ESGR has been studied in the laboratory and tested in small field prototypes, however, its commercial feasibility remains questionable. Therefore, more fundamental and experimental research need to be conducted (Nuttal et al., 2005; Schepers et al., 2009).

CO2 enhanced shale gas recovery relies on the preferential adsorption of CO2 and uses pressure gradient to displace and produce methane gas (Hughes et al., 2012; Klewiah et al., 2020). CO2 has a higher adsorption affinity compared to methane gas in shale reservoirs (Weniger et al., 2010; Shi et al., 2019). Competitive gas adsorption depends on the gas type, pressure, temperature, water content, mineralogy, organic content and maturity (Liu et al., 2019). Multiple studies have investigated the competitive adsorption of single-or-mixed gases under static conditions (Heller and Zoback, 2014; Zhou et al., 2018; Sun et al., 2020); however, adsorption-desorption under cyclic conditions remains unexplored.

We explore the interaction between CO2 and CH4 with dominant shale components (clay and organic matter) and natural shale specimens under reservoir pressure and temperature conditions (P=10MPa and T=40C). Experiments are designed to identify the interplay between governing parameters for different boundary conditions. The pressure vessel includes separate gas injection systems; an in-line binary gas analyzer measures the produced gas composition. In this presentation, we compare the methane recovery factor for two different injection protocols: (1) continuous flow injection and (2) pressure cycles. Experimental results show a significant increase in methane recovery efficiency driven by CO2 injection, particularly during pressure cycles.

A parallel numerical model takes into consideration gas advection, adsorption/desorption, diffusion and mixing. This numerical analogue allows to comprehend the interaction between ongoing processes, to develop injection/production protocols that optimize methane production and CO2 storage, and to upscale results to the field.

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