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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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References

Heller, R., & Zoback, M. (2014). Adsorption of methane and carbon dioxide on gas shale and pure mineral samples. *Journal of unconventional oil and gas resources*, 8, 14-24. Hughes, T. J., Honari, A., Graham, B. F., Chauhan, A. S., Johns, M. L., & May, E. F. (2012). CO₂ sequestration for enhanced gas recovery: New measurements of supercritical CO₂-CH₄ dispersion in porous media and a review of recent research. *International Journal of Greenhouse Gas Control*, 9, 457-468. Klewiah, I., Berawala, D. S., Walker, H. C. A., Andersen, P. Ø., & Nadeau, P. H. (2020). Review of experimental sorption studies of CO₂ and CH₄ in shales. *Journal of Natural Gas Science and Engineering*, 73, 103045. Liu, J., Xie, L., Elsworth, D., & Gan, Q. (2019). CO₂/CH₄ competitive adsorption in shale: implications for enhancement in gas production and reduction in carbon emissions. *Environmental science & technology*, 53(15), 9328-9336. Nuttal, B. C., Eble, C., Bustin, R. M., & Drahovzal, J. A. (2005). Analysis of Devonian black shales in Kentucky for potential carbon dioxide sequestration and enhanced natural gas production. In *Greenhouse Gas Control Technologies 7* (pp. 2225-2228). Elsevier Science Schepers, K. C., Nuttall, B. C., Oudinot, A. Y., & Gonzalez, R. J. (2009, November). Reservoir modeling and simulation of the Devonian gas shale of eastern Kentucky for enhanced gas recovery and CO₂ storage. In *SPE International Conference on CO₂ Capture, Storage, and Utilization*. OnePetro. Shi, J., Gong, L., Sun, S., Huang, Z., Ding, B., & Yao, J. (2019). Competitive adsorption phenomenon in shale gas displacement processes. *RSC advances*, 9(44), 25326-25335. Sun, Y., Li, S., Sun, R., Liu, X., Pu, H., & Zhao, J. (2020). Study of CO₂ enhancing shale gas recovery based on competitive adsorption theory. *ACS omega*, 5(36), 23429-23436. Weniger, P., Kalkreuth, W., Busch, A., & Krooss, B. M. (2010). High-pressure methane and carbon dioxide sorption on coal and shale samples from the Paraná Basin, Brazil. *International Journal of Coal Geology*, 84(3-4), 190-205. Zhou, S., Xue, H., Ning, Y., Guo, W., & Zhang, Q. (2018). Experimental study of supercritical methane adsorption in Longmaxi shale: Insights into the density of adsorbed methane. *Fuel*, 211, 140-148.

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