

## CO<sub>2</sub>/CH<sub>4</sub> Exchange Studies on Shales to Assess the Potential for CO<sub>2</sub> Storage and Enhanced Shale Gas Recovery

**Authors :** Mateusz Kudasik, Katarzyna Koziel

**Abstract :** The work included detailed studies of CO<sub>2</sub>/CH<sub>4</sub> exchange on a shale core from the Lewino-1G2 well (Poland) from a depth of 3408 m. The sample permeability coefficients were determined under conditions of confining pressure from 5 MPa to 35 MPa. These studies showed that at a confining pressure of 35 MPa - corresponding to a depth of about 1000 m, the shale core was impermeable in the direction perpendicular to the bedding, and in the direction parallel to the bedding, the sample had very low permeability ( $k_{\infty}=0.001$  mD). The sorption tests performed showed low sorption capacities, which amounted to a maximum of 1.28 cm<sup>3</sup>/g in relation to CO<sub>2</sub> and 0.87 cm<sup>3</sup>/g to CH<sub>4</sub> at a pressure of 1.4 MPa. The most important study used to assess the possibilities of CO<sub>2</sub> storage and gas recovery from shale rocks were the CO<sub>2</sub>/CH<sub>4</sub> exchange experiments, which were carried out under confining pressure conditions of 5 MPa and 30 MPa. These experiments were carried out on a unique apparatus, which makes it possible to apply a confining pressure corresponding to in situ conditions. The obtained results made it possible to carry out a comprehensive balance of gas exchange during the injection of CO<sub>2</sub> into the shale sample, with simultaneous recovery of CH<sub>4</sub>. Based on the conducted sorption and gas exchange studies on the core sample under confining pressure conditions, it was found that in situ conditions, at the depths of shale gas occurrence in Poland of 3000-4000 m, where the confining pressure can be about 100 MPa: (i) poorly developed pore structure, (ii) very low permeability, and (iii) low sorption properties, make shale rocks poorly predisposed to the application of CO<sub>2</sub> storage technology with simultaneous recovery of CH<sub>4</sub>. Without the stimulation of CO<sub>2</sub>/CH<sub>4</sub> exchange rates through fracturing processes, the effectiveness of CO<sub>2</sub>-ESGR technology on shale rock is very low. The research presented in this work is extremely important from the point of view of precise assessment of the potential of CO<sub>2</sub>-ESGR technology.

**Keywords :** shale gas, shale rocks, CO<sub>2</sub>/CH<sub>4</sub> exchange, permeability, sorption, CO<sub>2</sub>, CH<sub>4</sub>

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