Summary of doctoral dissertation.

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„Laboratory analysis of exchange sorption in coal under confining pressure conditions with reference to the description of the processes of underground C02 storage with simultaneous capture of CH4"

This work has chosen to use the experimental method to investigate one of the very important aspects related to the concept of CO_2 location in coal seams. All the coal seams that could potentially be used for Enhanced Coal Bed Methane recovery (ECBM) are at considerable depths. This means that the geological layers above the seam exert a load on the coal seam. The main aim of the research was to investigate the effect of confining pressure on the course of sorption processes, including exchange sorption.

The research method is unique. Instead of a single sample of coal, a sample in the form of a cylinder with a length of about 15 cm was used. During the tests, the sample was loaded with confining pressure in the range of up to 30 MPa. This corresponds to a seam depth of approximately 1,100 meters. The long sample enabled the process to be analysed in both time and space. Once the sorption equilibrium with methane had been reached, carbon dioxide was applied to one side of the sample, while the other side examined the components of the gas flowing out of the sample. Accurate measurement of the experiment enabled for precise balancing of the gas at the inlet and outlet of the sample. This enabled accurate temporal and spatial analyses of the processes occurring in the coal bed during exchange sorption.

The most important conclusions resulting from the conducted research, based on which the correctness of the thesis of the work can be assessed, are as follows:

- The sorption capacity of studied coals in relation to CH_4 was reduced, and the maximum decrease was 1.2% of the sorption capacity per 1 MPa increase in confining pressure.
- The increase in the confining pressure from 1.5 MPa to 30 MPa significantly, even by an order of magnitude, extended the kinetics of the CO_2/CH_4 exchange sorption processes.
- The sweep efficiency values obtained were about 90% for all samples tested at different confining pressures, and a slight decrease in sweep efficiency was observed as the confining pressure increased.

In summary, based on comprehensive laboratory and experimental studies, supported by theoretical considerations, the thesis set out in the dissertation was confirmed: "The confining

pressure has a significant influence on the CO_2/CH_4 exchange sorption processes in coal in the aspect of the sorption sweep efficiency and the kinetics of the process". The extensive series of studies carried out made it possible to confirm the influence of confining pressure on the sorption processes taking place in the coal material.

However, it should be clearly noted that the effect of confining pressure is particularly strong on the kinetics of the exchange sorption process. Such a strong effect of the confining pressure on the kinetics of the processes is due to the strong decrease in coal permeability and diffusivity that occurs with the value of the confining pressure. The decrease in sorption capacity with increasing confining pressure is also unambiguous but is not critical in terms of the utilitarianism of the concept of geological storage of CO_2 with CH_4 recovery.

The decrease in sorption capacity with increasing confining pressure was evident. However, it should be noted that sorption capacities in the range of confining pressure up to 30 MPa (corresponding to a coal seam depth of about 1000 m) do not decrease to the extent that coal seams cannot be considered as a potential CO_2 storage site. The sweep efficiency parameter decreases, depending on the coal, from about one to several percentage points when the sample is loaded with 30 MPa of confining pressure. This also confirms that the considerable depth of the seam does not prevent the use of underground CO_2 storage with CH_4 recovery. The greatest difficulties associated with increasing the confining pressure relate to process kinetics. It takes about 10 times longer to reach sorption equilibrium, or a similar level of exchange sorption, for coal loaded at 30 MPa of confining pressure compared to the same process for minimum loading (1.5 MPa). As a result, the practical application of geological CO_2 storage with CH_4 recovery in deep coal seams requires prior stimulation of the seam to increase coal permeability.