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Experimental study on supercritical CO_2 adsorption on coals from Upper Silesian coal Basin

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Although coal seams, besides saline aquifers and depleted oil and gas reservoirs, have the lowest capacity for deposition of carbon dioxide yet this relatively new technology is considered advantageous from an economical standpoint, especially in the case of location of a repository in the vicinity of a power plant producing carbon dioxide. Another appreciable positive aspect is injection of carbon dioxide into unmineable methane-bearing seams, which simultaneously increases production of coal methane as a valuable energetic resource.
Suitability of coal seams as carbon dioxide repositories is given by exceptional properties of coal, which during the coalification process retained in its interior spatial arrangement a substantial part of the porous structure of the original plant material with predominance of cavities of an effective size < 2nm. The major mechanism of the storage is represented by sorption processes taking place in the coal porous system. The effectivity of the sorption process depends on properties of the coal matter, seam environment, and carbon dioxide under the conditions corresponding to the situation in situ. Among the basic parameters for selection of a suitable repository based on simulation of the deposition process there is determination of its sorption capacity. The capacity can be determined in a laboratory by measuring the amount of carbon dioxide captured in a coal sample at a pressure and temperature corresponding to supercritical conditions in situ using high pressure sorption techniques. Similarly, the amount of methane bound in coal is based on high pressure measurement of it sorbed amount
The present study has been aimed at investigation of the effect of the coal properties on the carbon dioxide and methane sorption capacities. High pressure sorption experiments with carbon dioxide and methane were carried out at the temperature 45 oC and the pressure up to 15 MPa with three samples of methane-bearing, medium rank coals in a moisture equilibrated state using a manometric method. The samples were taken from selected positions of drill cores from exploration boreholes in the Bohemian part of the Upper Silesian Basin, and were characterized by a narrow range of the degree of coalification and extremely different petrographic composition. A positive correlation has been found between the equilibrium moisture in the coal samples and the total abundance of oxygen functional groups determined by FTIR. The experimental isotherm data were fitted partly by the modified Langmuir sorption isotherm, partly by the modified Dubinin-Radushkevich sorption isotherm. The calculated values of sorption capacities were compared. After recalculation to the mineral-matter free basis, a positive trend has been observed in the studied samples in the dependence of the sorption capacity on the micropore volume, as well as a positive trend in the dependence on percentage of vitrinite and collotelinite, which forms a major part of vitrinite. On the contrary, a negative trend has been found in the dependence on inertinite percentage.