ADSORPTION OF CO_2 ON ACTIVATED LIGNITE

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INTRODUCTION

Power generation in Poland relies mostly on coal, hence extensive research efforts are now being made to reduce CO2 emissions. One of the available solutions involves gas trapping by adsorption. This study summarises the research efforts to develop a cheap and effective adsorbent based on carbon dioxide-activated lignite. Testing was done on a lignite sample from one of the Polish collieries.

EXPERIMENTS

To evaluate the quality of thus obtained sorbent, adsorption tests were performed in the laboratory conditions, involving the measurement of CO2 adsorption isotherm at 273 K. Low- pressure sorption measurements were taken with an automatic apparatus Micrometrics ASAP 2010 (Accelerated Surface Area and Porosimetry System) using the volumetric method. Formal description of experimental data relied on the Dubinin and Radushkiewicz (DR) isotherm equation, which is applicable to analyses of microporous media adsorption. The pore width distribution was derived from the adsorption isotherm by the DTF and Monte Carlo method. Results are compiled in table 1 and 2.

RESULTS AND DISCUSSION

Table 1. Analysis of DR isotherm

	Correlation Coefficient	Average Pore width	Micropore volume	Micropore surface area
DR metod summary	0.9998	1.226nm	0,148 cm2/g	394 m/g

Table 2. Comparison of results obtained by the DTF and Monte Carlo method

	Pore volume	Surface area	Fitting error	Pore width
Monte-Carlo method summary	0.110 cm3/g	358m2/g	0.305 %	0.524 nm
DFT method summary	0.114 cm3/g	387m2/g	0.425 %	0.548 nm

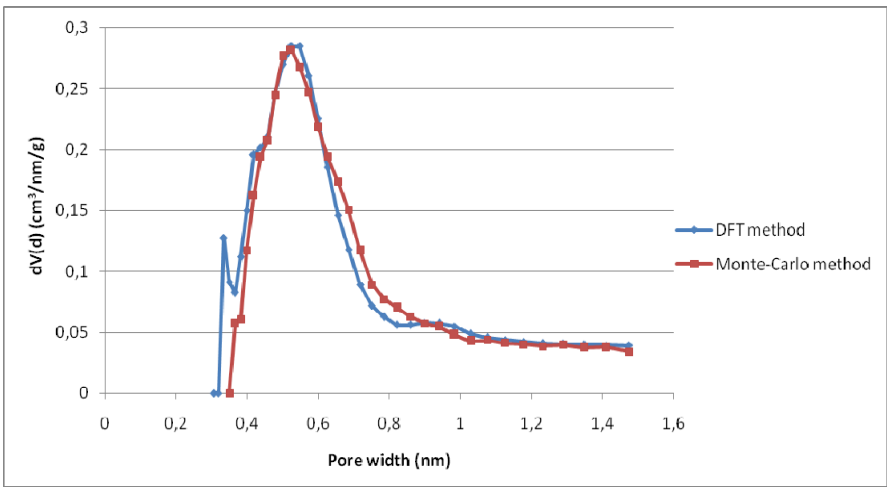

Fig 1. Pore width distribution obtained by DTF and Monte Carlo method

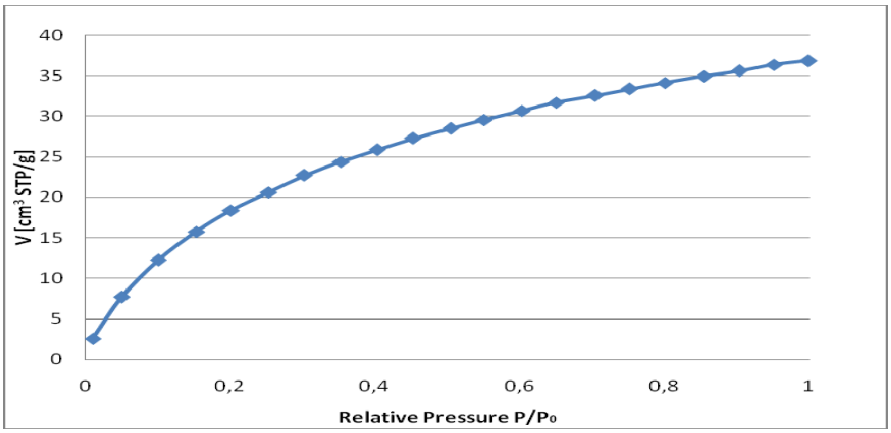

Fig 2. Isotherms of CO2 adsorption on activated lignite

It appears that thus obtained absorbent features a relatively high specific area. Good fit obtained for the DR isotherm (correlation coefficient 0.99) suggests that the absorbent structure is dominated by micropores, which is corroborated by results of DTF and Monte Carlo analysis showing that the predominant pore diameter slightly exceeds 0.5 nm (in the sub-micropore range). Comparison of results obtained by the two methods reveals the good agreement of the pore volume data and specific areas (table 2). Comparing the specific surface areas derived from the DR equation and computed by the DFT and Monte Carlo methods, it is reasonable to conclude that specific surface areas are associated mostly with the presence of micropores (<5 nm according to IUAPC classification) in the pore structure.

CONCLUSION

Results of CO2 adsorption in thus obtained carbon material are similar to those obtained in an analogous experiment performed on another lignite type (Baran et al., 2015, 2016). Experimental results clearly indicate that a simple process of physical activation of lignite will yield an absorbent with favourable structural parameters.