OBTAINING A LIGNITE-BASED BIOCHAR DISPLAYING ADSORPTION PROPERTIES

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INTRODUCTION

Power generation in Poland relies to a great extent on hard and brown coals as fuels. As a result, the power generation sector has become a major source of atmospheric emissions. Extensive efforts are made, therefore, to reduce the amounts of atmospheric emissions, particularly of carbon dioxide. The problem of too high emission levels can be resolved by gas trapping strategies utilising adsorption processes.

This study summarises the research efforts undertaken to obtain an inexpensive and effective absorbent of CO2. The precursor used in the process was lignite activated by physical methods. The conventional process of obtaining active carbons involves two steps: carbonisation and activation. Carbonisation prompts the formation of original porous structure which is further developed in the course of the activation process. In consideration of the fact that lignite features a large proportion of micropores, the carbonisation stage in our case was omitted and the activation using CO2 was performed directly, to avoid further loss of the precursor.

Testing was done on a brown coal (lignite) sample whose parameters are summarised in Table 1. The elemental analysis was carried out in an accredited laboratory of the Department of Solid Fuels Quality Assessment in the Central Mining Institute in Katowice, in accordance with the procedure set forth in relevant standards (Table 1).

Table 1. Parameters obtained from the element analysis

Coal sample	C^{daf} [%]	H^{daf} [%]	V^{daf} [%]	A^{a} [%]	W^{a} [%]
Turów (T)	70,2	6,00	54,06	12,3	8,3

EXPERIMENTS

A lignite sample with the grain size 0.5-1.5 mm was subjected to physical activation in a laboratory reactor, designed and engineered at the Department of Fuels and Energy AGH-UST. Schematic diagram of the reactor is shown in Fig 1. The activation procedure was carried at 850 °C for 15 minutes, with the use of CO_2. The lignite sample was placed in a steel basket, which was then lowered downward through a cylindrical pipe in the central position inside a xyloid furnace. The activating gas was admitted at the bottom of the furnace. The activation process being over, the sample was pushed upwards to the cooling zone where its temperature was reduced while it still remained in the atmosphere of activating gas which isolated the sample from air, thus preventing self-heating.

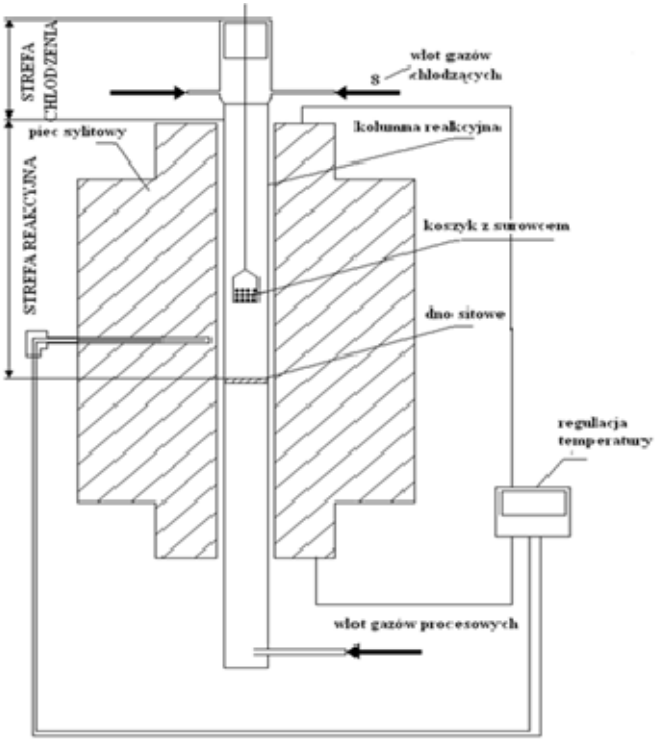

Fig 1. Schematic diagram of the reactor

RESULTS AND DISCUSSION

Experiments demonstrated a density increase following the activation process (table 2).

Table 2. Measurements of real density of the investigated lignite sample

Time [min]	0	15
Density [g/cm^3]	1,45	2,13

For thus obtained carbon material the Dubinin and Radushkiewicz (DR) adsorption isotherm equation was derived alongside the formal description of experimental sorption data. Results are summarised in table 3.

Table 3. Calculated parameters of the DR equation

Average pore width	Micropore volume	Micropore surface area
1,226 nm	0,148 cm^3/g	395 m^2/g

CONCLUSION

Application of a relatively simple method yields an absorbent with a microporous structure (the pore diameter <5 nm according to IUPAC classification) well-developed specific pore surface. Little effort was needed to obtain a valuable biochar product which can be well utilised in adsorption of carbon dioxide.