Abstract

PhD thesis

Synthesis and characterization of sorbents used for reduction of anthropogenic CO_2 emissions

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Since The Industrial Revolution, people have begun to increase their influence on the surrounding environment. One of these negative aspects was anthropogenic carbon dioxide, which emission has been increasing every year, due to the increasing combustion of fossil fuels. Studies of air frapped in glacial ice allowed estimating the historical concentration of this gas. Therefore, it is known that during the period of about 800 thousand years and ending in the year 1800, CO_2 concentration in the air did not exceed over 290 ppm. This threshold was breached after 1800 when at first concentration started to increase slowly, but after the year 1960 began to increase even 1-2 ppm a year. Moreover, a simultaneous increase in average Earth surface temperature was observed. This led to the assumption that the emission of carbon dioxide with other greenhouse gases results in the warming of the planet.

It needs to be pointed out that there was a time on Earth, when CO_2 reached 5000 ppm in the atmosphere, but Sun activity was smaller than nowadays. Moreover, CO_2 threshold values for initiating a glaciation were estimated. If this threshold today was 500 ppm, the equivalent threshold 443 million years ago (Late Ordovician) would be 3000 ppm.

In order to prevent the negative effects of human activity, international cooperation began to reduce the emission of greenhouse gases, including anthropogenic carbon dioxide. Therefore, research and development of capturing and storing CO_2 is a high priority study. Thus, the following dissertation describes the preparation of solid sorbents — activated carbons.

During the preparation, the following procedures were performed — modification of commercial activated carbon and obtaining activated carbons from polymer (polifurfuryl alcohol) and biomass (beech wood). For this purpose chemical activation (KOH as activating agent) and physical activation (CO_2 as activating agent) were applied. Several analyses of obtained materials allowed determining the following properties — textural, structural, surface composition and CO_2 sorption capacity. Obtaining activated carbons with different properties, especially from beech wood, might be a reasonable idea for the national industry, due to the wide availability and affordable costs ofthis precursor. All the data presented in this dissertation allows concluding that beech wood might be successfully used for activated carbon production. Some selected materials, among others obtained in this study, revealed sufficient stability of CO_2 sorption capacity during 10 adsorption-desorption cycles.

An interesting addition to the presented results is the correlation between the height of (002) reflection determined with X-ray diffraction (XRD) and the value of specific surface area determined from the BET equation (volumetric measurement of nitrogen sorption at 77 K). Contrary to equations described in the literature, allowing for calculation of the specific surface area of activated carbon based on dimensions of graphite crystallites (absolute method), observed correlation is based on the height of (002) reflection and it requires a calibration curve for the specific batch of materials (relative method).

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