Preparation and characterization of carbon dioxide adsorbents

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SUMMARY

Climatic changes observed during recent two hundred years are linked with the anthropogenic extensive emission of carbon dioxide into the atmosphere and are caused mainly by burning fossil fuels. European Union has been taking actions in order to counteract against this phenomena. Renewable sources of energy and carbon dioxide storage that requires its separation from other gases are promoted. New absorbents that are highly efficient and have good adsorbing qualities are searched and the basic element seem to be obtaining the highest adsorption capacity keeping high selectivity and low energy consumption in the process. Efficient and selective sorbents of CO_2 play also a very important part in many branches of chemical industry.

This dissertation concludes research on carbon dioxide adsorption on adsorbents of two types, that is: activated carbons and zeolites.

Part containing literature review covers the issue of increased emission of carbon dioxide caused by human activity and the ways to limit it. It also contains description of the structure and the properties of adsorbents used in the dissertation together with the literature review on carbon dioxide adsorption on their surface.

The experimental part is composed of two basic chapters. The first presents the way of increasing sorption abilities in commercial carbon materials, through removal of mineral matter as a result of acid treatments. This chapter also contains detailed characteristic of modified activated carbons taking into account examination of the composition of inorganic impurities, effects connected with its removal, effects of activated carbon surface oxidation together with the influence of mentioned factors on the adsorption abilities of used materials.

The second chapter of the part two in the dissertation deals with commercial zeolite 13X modification by ion exchange and optimization of its synthesis procedure. It contains the description of modification of EDS technique using internal standard as an effective tool which enabled determination of the degree of zeolite ion exchange. After modification this technique exhibit numerous advantages when compared to widely used ICP method.

Detailed analysis of porous structure of activated carbons and zeolites showed that sorption abilities toward carbon dioxide primarily depends on submicropores volume of these materials.

Optimization of zeolite 13X synthesis procedure led to obtaining materials with improved carbon dioxide adsorption capacity at about 8% and 6% respectively at 0°C and 25°C in comparison to zeolite obtained on a commercial scale.

An essential part of the dissertation were CO_2 selectivity measurement which was determined via competitive coadsorption of gas mixture consisted of 15% vol. of CO_2 and 85% vol. of N_2 on both types of absorbents. The selectivity obtained in this manner reflects true performance of the sorbent in real conditions. However it is difficult to measure and due to this reason the majority of the papers gives apparent selectivity i.e. comparison of uptakes of pure gases.

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