ABSTRACT

This doctoral dissertation focuses on the possibilities of using bioadsorbents in the processes of carbon dioxide capture and reduction, as an element supporting the circular economy. The research was divided into two main parts: research on the process of producing bioadsorbents from biowaste and analysis of their physicochemical properties and research on sorption/desorption on bioadsorbents and assessment of the possibilities of their use in the VPSA adsorption installation.

The first part of the work included research on the physicochemical properties of selected bio-waste, obtaining biochars from them and analysis of their physicochemical properties. The next stage was the transformation of biochars into bioadsorbents by chemical activation using potassium hydroxide and testing their physicochemical properties, which allowed for the assessment of the potential of these materials for CO_2 capture. Biowaste such as coffee and tea grounds, potato peelings, walnut shells and husks were used to synthesize bioadsorbents. Advanced analytical techniques were used to analyze the physicochemical properties of biowaste, biochars and bioadsorbents, such as elemental analysis of carbon, nitrogen and hydrogen content, thermogravimetric analysis, scanning analysis, specific surface area studies, X-ray and spectroscopic analysis. The results of these studies allowed for a detailed determination of the structure, composition and surface properties of materials at each stage of processing biowaste into bio-adsorbents.

The second part of the work included studies on CO_2 sorption and desorption on the obtained modified bioadsorbents in order to assess their potential for use in the VPSA adsorption installation. Equilibrium sorption studies consisted in assessing the ability of the selected bioadsorbent, characterized by the best physicochemical properties and the highest efficiency initially determined in comparative tests, to adsorb CO_2 under various pressure and temperature conditions. The determined CO_2, N_2, O_2, H_2O sorption isotherms allowed to determine its maximum sorption capacity and ability to work in conditions similar to industrial ones. The influence of CO_2 partial pressure (CO_2 content in exhaust gases) and temperature on the sorption capacity of bioadsorbents in relation to CO_2 was determined. Thermogravimetric methods using a TGA/SDTA 851^e thermogravimeter and a TGA-Vacuum system simulating the VPSA process were used to determine the sorption capacity of bioadsorbents in relation to CO_2, their stability, regenerability and cyclic operation. In order to assess the durability

and stability of bioadsorbents, tests were carried out in a cyclic sorption/desorption process in the VPSA system in order to check the suitability of bioadsorbents in VPSA adsorption installations for CO_2 removal from exhaust gases.