Preparation of high performance micro- and mesoporous carbon-based sorbents from rice husk and walnut shell

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Activated carbon (AC) is a porous substance that is obtained from various carbonaceous materials of organic origin: charcoal, coal coke, rice husk, walnut shell and other materials. AC has a huge number of pores and is characterized by a large surface area per unit mass, as a result of which it has a high adsorption capacity. Carbon adsorbents are widely used in various purification processes from harmful impurities and the recovery of valuable substances from liquid and gaseous media. The need for cheap sorbents that meet the production requirements (good sorption capacity, adjustable pore size and structure, etc.) leads to the development of new methods for obtaining sorbents. Activated carbon based on vegetable raw materials is a cheap and easily accessible sorbent, characterized by high porosity, strength and the possibility of repeated use by adsorption and electochemical desorption.

Rice husk (RH) and walnut shell (WS) were selected as widely spread agriculture waste as solid carbon sources to prepare micro- and mesoporous carbon-based sorbents. In order to transform rice husk and walnut shell into a high surface area and high active nano-sized porous sorbent, we performed chemical activation with potassium hydroxide. Influence of activation temperature, amount of activating agent and pre-grinding of raw vegetable waste on the porosity and formation of new crystallized phase in resulting carbons have been investigated. The yield of AC by using RH as starting material was ~ 10% by weight. The weight loss is attributed to the removal of silica and other impurities in the RH, as well as the removal of disordered carbon. The yield of AC by using WS as starting material was ~ 21% by weight. Activated carbons were applied for a novel metal separation from leached solutions of low concentrations; the kinetics of adsorption was investigated. For our better understanding of the sorption process, adsorption/desorption was studied under controlled polarization conditions. Electrochemical characterization of resulting carbons was performed by cyclic voltammetry, galvanostatic charge-discharging, and electrochemical impedance spectroscopy. The specific capacitance values were up to 223 F/g for a scan rate of 10 mV/s in 6 mol/l potassium hydroxide electrolyte, which is higher than most of commercially available activated carbons tested under similar conditions.