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Application of Carbons Produced from Rice Husk in the Process of Capacitive Deionization

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Abstract

Nanoporous carbon materials are well recognized as the main components of electrodes in capacitive deionization. Herein, the activated carbons were produced based on rice husk which is an abundant waste material in southern regions of Kazakhstan. The resulting carbons were characterized electrochemically by comparing their performance with well-known brands of commercial porous carbons (i.e. Norit DLC Super 30, Kuraray YP 50F). The features of carbon/carbon electrochemical cells were analyzed using the means of galvanostatic cycling with potential limitation and cyclic voltammetry. Whilst the surface morphology and elemental composition of carbons were observed using scanning electron microscopy combined with energy dispersive X-ray spectroscopy. Using the method of low-temperature nitrogen adsorption it has been established that the specific surface of home-made carbon produced based on rice husk is equal to 2290 m^2g^{-1}. The salt adsorption analysis has been performed using different concentrations of inlet solutions of sodium chloride. Our study has shown that the manufacturing and application of activated carbons based on rice husk can be highly efficient because the resulting electrode materials exhibit a high electrosorption capacity of 20.02 mg g^{-1}, which exceeds similar values obtained in the case of application of commercial porous carbons.

1. Introduction

Capacitive deionization (CDI) is a modern method of water desalination which has been recognized to have high economic feasibility [1]. Structurally it includes a pumping system of an aqueous solution through an electrochemical cell consisting of two porous electrodes having a highly developed surface, between which a certain potential difference is set [1–3]. When an electric current is applied to the electrodes, a potential difference arises, and an electric double layer (EDL) is formed on the surface of the polarized electrodes. The formation of an electric double layer is accompanied, respectively, by the adsorption of anions on the positive electrode and cations on the negative electrode. This charging-discharging process of the electric double layer is similar to that for supercapacitors [4]. Under the influence of an electric field, anions are adsorbed on the positive electrode, and cations on the negative electrode, and thus the electric double-layer is charged. As a result, deionization (desalination) of the aqueous solution takes place. After the electrodes are saturated with adsorbed ions, a significantly smaller water flow is supplied to the electrochemical cell and at the same time the voltage in the external circuit is turned off or a polarity reversal is organized. This leads to the desorption of ions from the electrodes and their concentration in the second stream [5–6].

In [7–8], carbon electrodes were synthesized using the PVA binder through a cross-linking method. It was shown that the application of carbon electrodes having hydrophilic properties allowing

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