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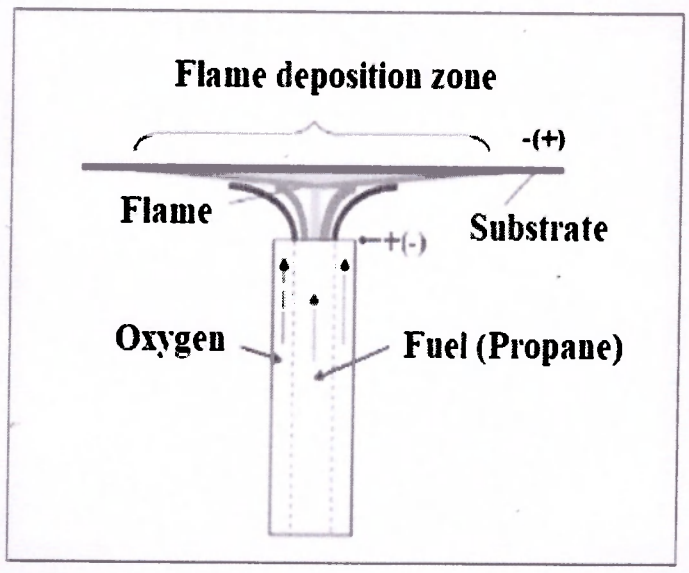

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«COMBUSTION AND PLASMOCHEMISTRY»

November 20-22, 2019
ALMATY, KAZAKHSTAN

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CARBON ELECTRODE FOR DESALINATION PURPOSE IN CAPACITIVE DEIONIZATION

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Introduction

The availability of clean water has become one of the most fundamental needs nowadays. One out of seven people worldwide still has no access to drinking water. Salty water contributes to the deterioration of world's heritage (buildings, monuments, routes) and has a big impact on the crops and human's health.

Capacitive deionisation (CDI) is a modern and efficient technology to purify water solutions of small concentration and, what is more, it is fully reversible. Such performance is possible thanks to the formation of an electrical double-layer (EDL) which enables to store charged ions in the pores of polarized electrodes. Hence, the most promising materials for electrodes are those with highly-developed specific surface area, large number of pores, good electrical conductivity and moderate cost. Due to these properties, nanoporous carbons received world's attention.

The objective of this work is to test various electrode materials and experimental parameters, in order to determine the most optimal conditions for desalination and to describe the behavior of ions while electrosorbing in porous electrodes.

Materials and Methods

Electrodes in form of squares (6 cm x 6 cm) were prepared from three carbon materials: Kuraray YP 50 F; Kuraray YP 80 F; Norit DLC Super 30. For the materials the content of activated carbon and binder were 95% and 5%, respectively. 60wt % dispersion of PTFE in H_2O (SIGMA ALDRICH) was selected as binder due to its lower reduction of pore volume than other commonly used binders. Carbon powder and binder were blended and after rolled with a calendaring machine. After achieving satisfactory size, thickness (500 μm) and texture, the material was dried under vacuum at 110°C for 3 hours, then cooled down and weighted.

Results and Discussion

All electrochemical experiments were carried out using a multi-channel potentiostat/galvanostat VMP3 from Biologic using Chronoamperometry Cyclic voltammetry Electrochemical impedance spectroscopy and Galvanostatic cycling with potential limitation methods.

As support for the CDI measurements, the electrochemical properties of the materials were determined in Swagelok® cell, using the highest NaCl concentration applied for CDI, which is 100 $mmol \cdot L^{-1}$ NaCl. From the obtained voltammograms, it was observed that all materials exhibit nearly rectangular shape of CVs. The highest capacitive current is observed for DLC Super 30 and the lowest for YP80F. There is not a direct correlation between this current and the textural

parameters, e.g., specific surface area of the materials. This is due to the fact that the trapping of ions is also strongly influenced by the relative relationship between size of pores and ions.
For the purpose of CDI analysis, usually adsorption peaks are taken into account. Salt adsorption measurements are obtained in solutions of 5, 10, 50 and 100 mmol L^{-1}. Applied voltage reached 1.2 V and flow rate of solution of 5 mL min^{-1}.

In each conducted experiment the curve displays the same shape, typical for CDI. The concentration rapidly decreases and after reaching minimum progressively increases heading for the initial value. The general performance of tested materials is comparable in concentrations below 10 mmol L^{-1} but it differs more at higher concentrations of solution.
In order to have a wider view on the adsorption/desorption CDI process, the entire cycle is presented in Figure 1 for YP80F.

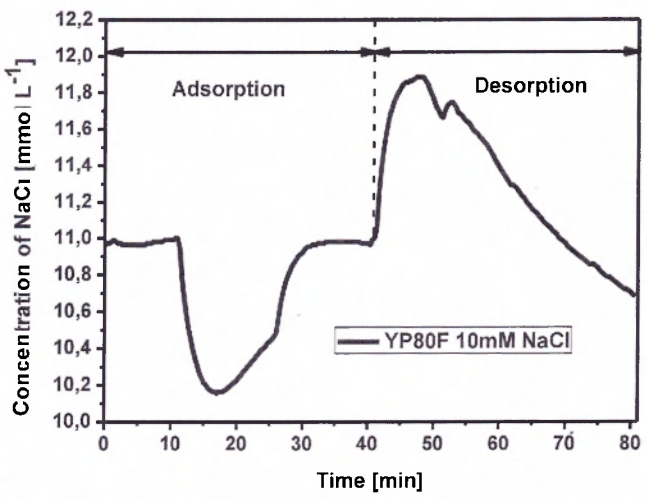

Figure 1. Outlet concentration vs. time for a complete CDI adsorption/desorption cycle with Kuraray YP 80F material electrodes, polarization voltage 1.2 V, flow rate 5 ml/min, concentration 10 mmol·L^{-1}

Conclusions

CDI is a quick and efficient technology for the desalination of water with low content of salt (up to 100 mmol · L^{-1}). The application of chronoamperometry allows for reversibility and cyclability of CDI process within the same cell assembling. The highest amount of adsorbed salt is observed in case of microporous electrodes. However some amount of mesopores is also necessary. The highest salt removal efficiency is obtained for the lowest salt concentrations.

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