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Electromembrane Processes in Environment Protection

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Abstract

The separation membrane techniques in which an external electric field is applied as a driving force (such as electrodialysis, electro-electrodialysis, and membrane electrolysis) are shortly described and their application in environment protection is presented. Attention was focused on recovery of valuable chemicals from effluents and waste gases. Examples of new production methods that eliminate environment polluting intermediate or by-products are presented. The possibility of the use of bipolar membrane is emphasized. The application of ion-exchange membranes in "green" power sources is also discussed.

Keywords: ion-exchange membranes, bipolar membranes, electrodialysis, electro-electrodialysis, membrane electrolysis, treatment of waste gases, water

Introduction

Membrane processes that use ion-exchange membranes and electric potential difference as the driving force for ionic species are called electromembrane processes. The following electromembrane processes can be distinguished:

- electrodialysis
- electro-electrodialysis
- membrane electrolysis.

In other techniques where ion-exchange membranes are used (such as diffusion or Donnan dialysis) the driving force is not external electric potential difference but a concentration difference.

Electromembrane processes are based on the selectivity of ion-exchange membranes. These membranes contain electrically charged groups fixed to the polymer matrix and allow permeation of ions of opposite sign through the membrane under the influence of an electric field. There are cation- and anion-exchange membranes depending on the sign of the permeating ions. Progress in electromembrane processes was closely connected with developing modern ion-exchange membranes in the early 1950s. The membranes fulfilled more and more the basic requirements important in electromembrane processes: today they are highly permselective, physically strong and have low electrical resistance [1, 2].

Electromembrane processes have found numerous practical applications and many of these are directly related to environment protection. The following area of application can be listed as the most important in that field:

- removal of harmful chemicals from effluents or waste gases,
- recovery and reuse of valuable compounds from wastes;
- closing the loops in technology;
- developing new production methods, that require lower energy consumption. Lower energy consumption causes a reduction in environmental pollution by min es, power stations etc.

In the forthcoming parts of this article electromembrane techniques will be characterized and examples of application will be presented.

Electrodialysis and Electro-Electrodialysis

Electrodialysis (ED) is usually defined as an electrochemical separation process in which electrically charged membranes and an electrical potential difference are used to separate ionic species from an aqueous solution and other uncharged components [2, 3, 4, 5, 6]. Electrodialysis as a method combining electrolysis and dialysis was proposed for the first time in 1890 by Maigrot and Sabates [7]. In the late 1930s Meyer and Strauss introduced a multicompartment ED apparatus consisting of two electrodes and a stack of ion-exchange membranes between them [1].