Electrodialysis of Salt Solutions: Effect of Salt on the Electrical Resistance of ED Membranes

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Introduction

For the electrodialysis (ED) process design it is important to know the performance of the ion-exchange membranes as a function of process conditions and kind of ions to be separated. The effect of concentration polarization and limiting current densities has been thoroughly investigated [1, 2]. However, also the change of the electrical resistance of ion exchange membranes as a function of the kind of ion to be separated, the pH value on both sides of the membrane as well as the ionic concentration and the presence of non-ionic species may significantly influence the performance of the ED process [3].

Experimental

ED (200 cm², 14 cell pairs) operated at constant stack voltage, varying temperatures, different salts (NH_4ac, $(NH_4)_2SO_4$, Kac, Na_2SO_4) to get potential differencees, current efficiences, pH changes, etc. as a function of operating conditions.

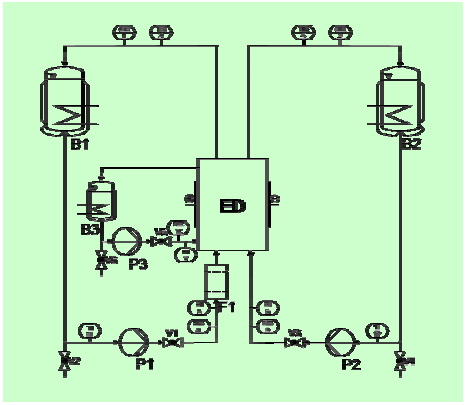

Fig. 1: Flow sheet of lab-scale ED unit.

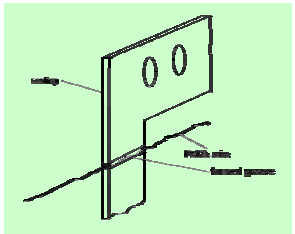

Fig. 2: Spacer with electrode for potential difference measurement.

Table 1: Membrane properties of membranes investigated.

membrane type: (Manufacturer: Tokuyama Soda)	CMX	AMX
electrical resistance [Ωcm²]	2,5-3,5	2,5-3,5
transport number [-]	>0,98	>0,98
burst pressure [kg/cm²]	5,0-6,0	4,5-5,5
water content [g H_2O/g membrane]	0,25-0,30	0,25-0,30
ion exchange capacity [meq/g membrane]	1,5-1,8	1,4-1,7
thickness [mm]	0,17-0,19	0,16-0,18

Results

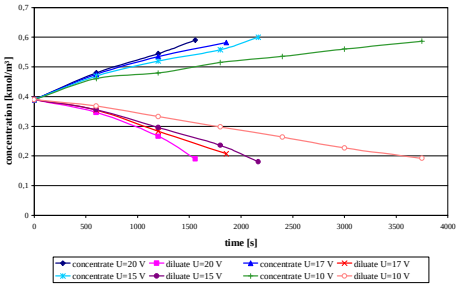

Fig. 3: Concentration as f(t), ammonium acetate, 3,5 w%, 2x 8 l.

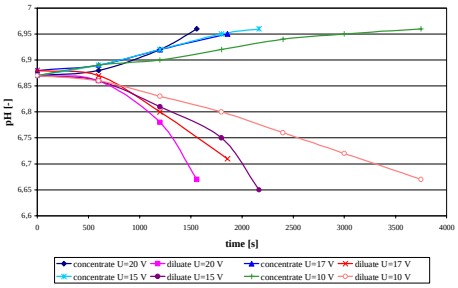

Fig. 4: Corresponding pH-changes (see fig.3).

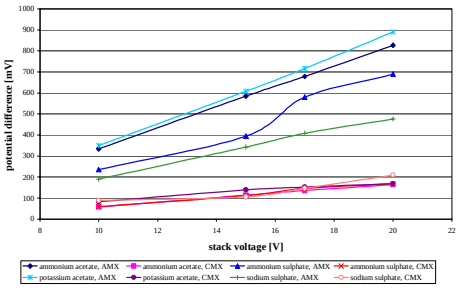

Fig. 5: Potential difference as function of stack voltage for different salts (NH_4ac, $(NH_4)_2SO_4$, Kac, Na_2SO_4).

Conclusions & Outlook

The performance of ED is strongly dependent on the operating conditions. As was shown, the anion exchange membrane used in this study contributed significantly more to the overall electrical resistance.

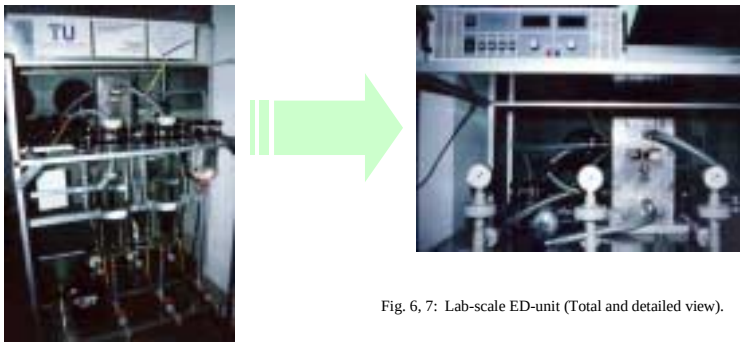

Fig. 6, 7: Lab-scale ED-unit (Total and detailed view).

Literature

[1] Tanaka, Y.: J. Membr. Sci., 57, 1991, 217-235.
[2] Tanaka, Y.; Iwahashi, M.; Kogure, M.: J. Membr. Sci., 92, 1994, 217-228.
[3] Wen, T.; Solt, G.S.; Gao, D.W.: J. Membr. Sci., 114, 1996, 255-262.

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