

(Short Paper)

Organic fouling properties of anion-exchange membranes with various electro dialysis conditions

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Abstract

Organic fouling behavior of commercially available anion-exchange membranes (AEMs), AMX and ASM was examined by measuring the voltage drop between probe electrodes in an electro dialysis (ED) system consisting of AEM and NaCl solutions containing sodium dodecylbenzene-sulfonate (DBS) as an organic foulant. The slope of the time-voltage curves through AEMs increases with increasing DBS concentration. The slope of the two AEMs increases with increasing current density. ASM has a higher anti-organic fouling property than AMX at high DBS concentrations and/or high current densities because of its high water content.

Key Words : Anion-exchange membrane, Organic fouling, Electro dialysis, Current density

1. Introduction

Ion-exchange membranes have been applied to many industrial fields such as water treatment, food industry, medical supplies, acid recovery from pickling solution and wastewater treatment, *etc*¹⁾. To apply an ion-exchange membrane to various industrial fields, membrane fouling is one of the most significant considerations in the operation of an electro dialysis (ED) desalination process. Organic fouling of ion-exchange membranes occurs during ED processes using electrolyte solutions containing organic substances.

There have been many reports on anion-exchange membranes (AEMs) with anti-organic fouling properties. However, to the authors' knowledge, there has been no study to examine the relationship between these anti-fouling properties of AEMs with various ED conditions such as foulant concentration and current density.

The aim of this study is to investigate the relationship between the anti-fouling properties of AEMs and the ED conditions.

2. Experimental

Commercially available AEMs [Neosepta AMX, ASM: ASTOM Corp.] prepared from chloromethyl styrene and divinylbenzene were used as a sample membrane. AMX and ASM are the standard grade membrane and a specific grade membrane with high water content, respectively.

After soaking in 0.1 mol/dm³ NaCl aqueous solution for 1 h and washing with deionized water, a sample membrane was fixed between the two chambers of an ED cell

²⁾ equipped with a silver electrode and a silver chloride electrode. The anode chamber was filled with 0.1 dm³ of 0.1 mol/dm³ NaCl aqueous solution and the cathode chamber was filled with 0.1 dm³ of a mixed solution of 0.1 mol/dm³ NaCl and various concentrations (0, 100, 200, 300, 400, 500 ppm) of sodium dodecylbenzene-sulfonate (DBS) as an aromatic foulant. The solution in both chambers was stirred at a rotation speed of 1,000 rpm and ED was conducted at a current density of 2, 4, 6, 8, 10 mA/cm². The effective area of the cell is 4.0 cm². The voltage drop between the platinum wire electrodes fixed near the membrane surfaces was measured during the ED period.

3. Results and Discussion

Figs. 1 (a) and (b) show the voltage drop between the probe electrodes for AMX and ASM, respectively, as a function of measuring time at various DBS concentrations. The voltage drop will increase when organic fouling occurs during the ED time period. These figures show that the slope of the voltage-time curve of ASM is gentler than that of AMX. It indicates that ASM has better anti-fouling properties than AMX does. The water contents of AMX and ASM are 24% and 38%, respectively³⁾. This means that AMX has a denser membrane network structure than ASM. When DBS pass through the membrane matrix, the denser membrane network structure an AEM has, the more frequently DBS collide with the network. Hence, the adsorption of DBS on/in the membrane matrix will increase with decreasing membrane water content. These figures also show that the slope increases with increasing DBS concentration. This

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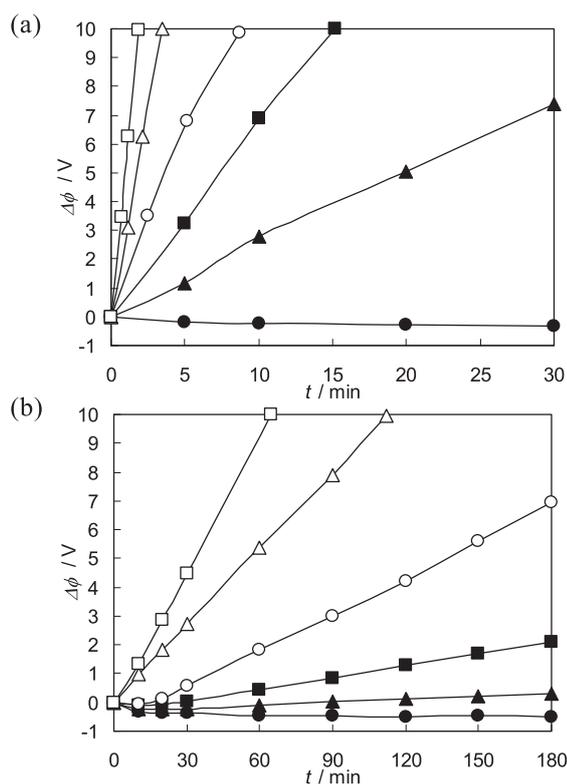


Fig. 1 Voltage drop between the probe electrodes, $\Delta\phi$, as a function of measuring time, t , in (a) AMX, (b) ASM. Constant current: 10 mA/cm². DBS concentration (ppm) : solid circles, 0; solid triangles, 100; solid squares, 200; open circles, 300; open triangles, 400; open squares, 500.

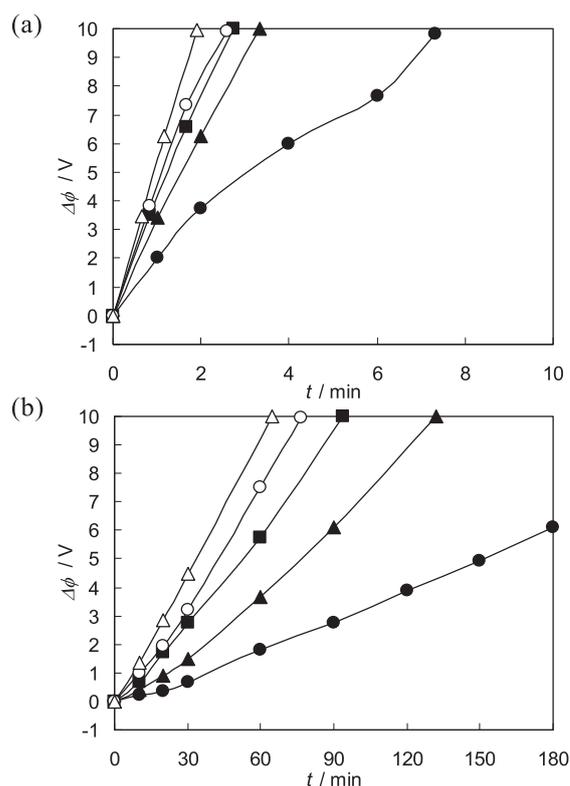


Fig. 2 Voltage drop between the probe electrodes, $\Delta\phi$, as a function of measuring time, t , in (a) AMX, (b) ASM. DBS concentration: 500 ppm. Constant current density (mA/cm²) : Solid circles, 2.0; solid triangles, 4.0; solid squares, 6.0; open circles, 8.0; open triangles, 10.

means that the amount of DBS adsorbed on the membrane surfaces will increase with increasing DBS concentration.

Figs. 2 (a) and (b) show the voltage drop between the probe electrodes for the AMX and ASM, respectively, as a function of measuring time at various current densities. These figures show that the voltage drop decreases with decreasing current density. This means that the amount of DBS adsorbed on the membrane surfaces will increase with increasing current density because the amount of transported DBS through the membrane increases with current density. Hence, for desalination of salt solutions containing high foulant concentrations, the lower current density an ED system has, the more stable the operation it performs. The slope of the voltage-time curves of ASM is also gentler than that of AMX at all current densities.

In conclusion, ASM has higher anti-fouling properties than AMX at high DBS concentrations and/or high current densities.

Acknowledgement

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