Cross-flow ultrafiltration of model bovine serum albumin solutions on a laboratory scale

Introduction

The presented studies have been undertaken in order to investigate possibilities of applying ultrafiltration for treatment of salted water produced in fish processing industry. The results could be a basis for elaboration of a treatment technology enabling recycling of both regenerated salted water and proteins, thus decreasing water use and wastewater discharge by closure of water loops [Afonso, Borquez, 2002; Kuca, Szaniawska, 2009a,b]. Development of membrane processes for waste brine purification requires studies on model solutions of individual proteins including analysis of the membrane selectivity and performance.

The model proteins were selected taking into account molecular weight range of fish proteins and their solubility in water and solutions of low and high ionic strength. One of the basic groups of proteins found in fish, in respect of their behavior in solvents, are proteins soluble in water and dilute, neutral salt solutions. These include albumins representing approximately 30% of the total protein content in fish meat. Due to the unavailability of fish albumin the most commonly applied bovine serum albumin was used.

In the first step of the present research the assessment of operating parameters influence on permeability in ultrafiltration processes of aqueous bovine serum albumin (BSA) solutions using laboratory-scale membrane installation working in pseudo-cross-flow regime was performed.

Experimental

The measurements were carried out in the laboratory-scale installation working in a tangential flow mode. In the research flat ceramic Al₂O₃/ZrO₂ membranes were used. Investigated membranes are thoroughly characterized in Tab. 1.

Results and discussion

Membrane permeability for water

Membrane permeability for pure water was determined in order to determine the membrane resistance \( R_M \) for different TMP values. The membrane resistance was calculated according the equation:

\[
R_M = \frac{TMP}{J_W} \text{ [MPa·s·m}^{-2}] \tag{1}
\]

where:

\( J_W \) - water permeate flux through clean membrane [m³/m²s]
\( R_M \) - membrane resistance [MPa·s/m]

Using the values of permeate fluxes \( J_M \), and water fluxes of clean membranes \( J_W \), presented in Tab. 3, fouling resistances, \( R_F \), were calculated according to the equation:

\[
R_F = \frac{TMP}{J_W} - R_M \tag{2}
\]

where:

\( J_P \) - average permeate flux in the process of UF of BSA taken from 3 measurements every 5 minutes [m³/m²s]
\( R_F \) - fouling resistance [MPa·s/m]

To shortly analyse the fouling phenomenon in investigated ceramic membrane systems.

The results of membrane permeability for water are presented in Fig. 1 and the calculated values of \( R_M \) and \( R_F \), are listed in Tab. 3.

Ultrafiltration of BSA model solutions using laboratory scale system

Transport properties of flat ceramic membranes working in pseudo-cross-flow regime in relation to the model BSA solutions for different NaCl concentrations are presented in Tab. 3.
There was observed (Fig. 2) decline in permeate flux with increasing NaCl concentration and decreasing pH during UF tests of BSA solutions.

Analysis of fouling resistance $R_F$ and flux decline $J_{FD}$ shows that in case of investigated process $R_F >> R_M$, thus $J_{FD} \to 1$ and noticeable decrease in permeate flux $J_v$ is observed.

**Conclusion**

In order to perform preliminary tests with proteins solutions laboratory scale measurements were planned because of the lower volume of the feed solutions (lower cost of preparation of protein solutions).

The study on permeability of ceramic membranes with 150 kD cut-off showed that in a short time after the start of measurement, the significant permeate flux decline was observed, the greater the higher the TMP and sodium chloride concentration, and the greater the lower the pH. Therefore, further studies on the selectivity and permeability of investigated ceramic membranes in ultrafiltration process with BSA solutions are planned using pilot scale membrane installation.

**LITERATURE**


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