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Exercise on Ultrafiltration - 2001

1. Introduction

Ultrafiltration is one of membrane filtration processes used by the industry as separation and concentrating method for macromolecules. In this method of separation, membrane - a semi-permeable barrier is used to control relative rate of passage of various species (solvent and solute (s)) through itself. Materials smaller than the pore size rating of the membrane passes through and thus can be clarified and separated from higher molecular weight contaminants. Or, materials larger than the pore size rating are retained by the filter and can be concentrated or separated from the low molecular weight contaminants.

The performance of an ultrafiltration membrane is defined in terms of two factors: flux and retention. Flux is the volumetric (mass or molar) flow rate of liquid passing through the membrane per unit area of membrane per unit time. Retention is the fraction of solute in the feed retained by the membrane. There are several phenomena that affect the performance of the membrane during an ultrafiltration process: like concentration polarization, pore plugging and adsorption of solute. The effect of these phenomena depends on the operating conditions: transmembrane pressure, cross flow velocity, concentration, etc.

In this exercise, the effect of these operating parameters will be studied from literature and tested experimentally. Since the dairy industry is one of the application area for ultrafiltration, skimmed milk is chosen as working solution (feed).

2. Description of the tasks

The protein in the skimmed milk can be concentrated using ultrafiltration process. The behavior of the proteins toward the membrane can be sought from literatures. Generally, the flux and retention are known to depend on the transmembrane pressure, cross flow velocity and the feed concentration, and others – like pH, temperature, etc. In order to study this dependence, the students are expected to execute the following tasks depending on the exercise no. they are assigned to do.

- I. Determine the fluxes for four transmembrane pressures and three cross flow velocities (the feed concentration will be assigned by the supervisor).

- II. Determine the retention of the membrane at different operating conditions.
- III. Discuss the dependence of flux and retention on operating parameters.
- IV. Suggest the model and compare with your result.
- V. Calculate the uncertainty of the results.

<u>Exercise 1.</u>	I-II
<u>Exercise 2.</u>	I-III
<u>Exercise 3.</u>	I-V

3. References

1. Marcel Mulder, Basic Principles of Membrane Technology, 2nd ed., Kluwer Academic Publishers, The Netherlands, 1996
2. Winston Ho, W. S., Sirkar, Kamallesh K., Membrane Handbook, pp. 391-429, Van Nostrand Reinhold, New York, 1992.
3. Fouling and cleaning in pressure driven membrane processes, International Dairy Federation.