포스터 발표 P-38

MEUF에 적용되는 양쪽성/생분해성 나노고분자입자의 제조와 평가

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Preparation and evaluation of amphiphilic biodegradation nanoparticles applied to micellar-enhanced ultrafiltration

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1. Introduction

Micellar-enhanced ultrafiltration (MEUF) has been shown to be a promising method for the removal of toxic heavy metal ions and organic compounds from industrial effluents because of the synergetic effect of two techniques such as reverse osmosis and ultrafiltration which showed the high selectivity and flux, respectively [1]. The advantage of this method are the low-energy requirements involved in the ultrafiltration processes and its high removal efficiency owing to the effective trapping of solutes by the micelles. The amphiphilic nanoparticles (ANPs) composed of hydrophobic methoxy poly(ethylene glycol) (MPEG) and hydrophilic polycaprolactone (PCL) could be self-assembled to form micelles in a selective solvent [2]. The ANPs are available for the MEUF system due to low critical micelle concentration (CMC) and high stability under trans-membrane pressure, in the results of reducing the secondary contamination caused by collapse of micelle. The purposes of this work are to prepare and evaluate the ANPs for the removal of organic pollutants and metal ions from aqueous phase in the MEUF. The

removal efficiency was evaluated as the functions of transmembrane pressure and concentrations of the ANPs.

2. Theory

Fig. 1 is a schematic diagram illustrating MEUF using a surfactant. In the MEUF process, a surfactant is added to the aqueous stream containing the organic solute. The surfactant concentration in the combined stream is considerably greater than the CMC, so that the surfactant consists mainly of micelles in equilibrium with a small concentration of monomeric surfactant [3]. The solute largely solubilizes in the micelles, with only a small fraction of the solute remaining insolubilized at equilibrium. When this solution is forced through an ultrafiltration membrane having pore diameters smaller than the micelle diameters, the micelles are rejected by the membrane [4]. If micelle rejection were 100 %, the permeate would be very pure, containing the surfactant at a concentration near or below the CMC and the organic solute at a concentration equals to or less than that of the insolubilized molecules.

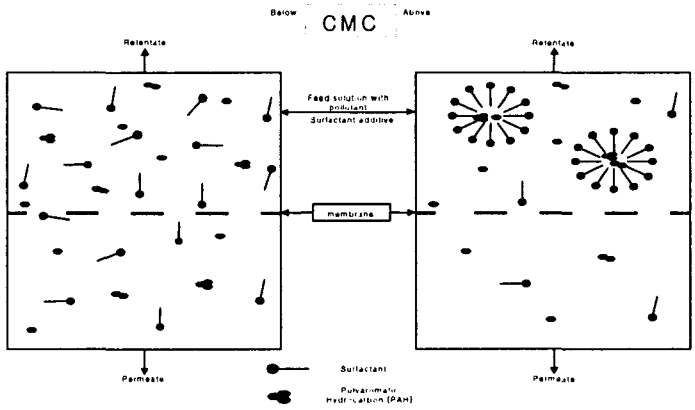

Fig. 1. Schematic diagram of MEUF

3. Experimental

MPEG/PCL amphiphilic block copolymers (MEP) were synthesized by a ring opening polymerization of ε-caprolactone in the presence of MPEG homopolymer in the absence of a catalyst [5]. A dead-end stirred cell

filtration system was used to characterize the filtration performance with ANPs. Experiments were carried out to study the effects of applied pressure, ANPs concentration and toxic organic solutes and metal compounds concentration on the permeate flow rate and rejection. The rejection (R) is defined as follows:

$$R = 1 - \frac{C_{per}}{C_{feed}}$$

where C_{feed} and C_{per} are the concentration of solute in feed and permeate solutions, respectively. The flow rate was measured and recorded as a function of time. Runs were taken at variously applied pressures at a fixed feed solution concentration to observe their influence on flow rate and rejection.

4. Results and discussion

Fig. 2 shows the molecular structure of MPEG/PCL block copolymer and molecular scheme of forming the micelle.

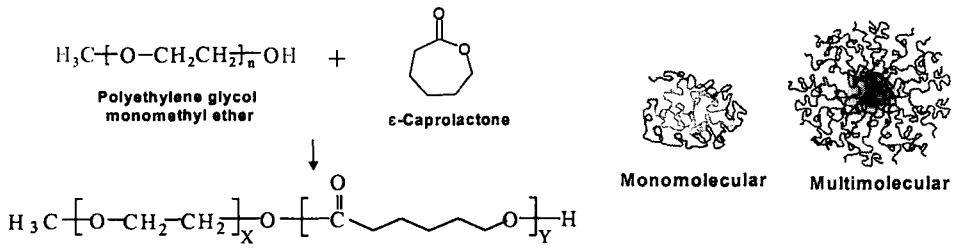

Fig. 2. Molecular structure of MPEG/PCL block copolymer

In the analysis of GPC and ^{1}H-NMR, the molecular weight of the copolymer using could be controlled by adjusting the length of MPEG. The sizes of the nanospheres followed narrow distributions and the zeta potential of MPEG/PCL was -35 mV (see Fig. 3).

Results for rejection rate and flow rate revealed that ultrafiltration using MPEG/PCL particles is very effective at low concentration of nanoparticles to remove the toxic organic solutes and metal ions. In addition, the nanoparticles had no detrimental effect on the secondary contamination due to the

biodegradation of particles.

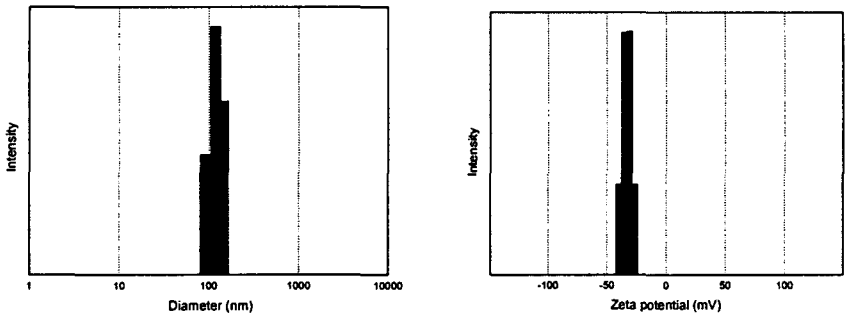

Fig. 3. (a) Size distribution of MPEG/PCL and (b) zeta potential profile of MPEG/PCL

5. References

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