

일반강연 2-4

A novel hydrogel-dispersed composite membrane of poly(N-isopropylacrylamide) in a gelatin matrix and its thermally actuated permeation of 4-acetamidophen

Suk-Won Chun and Jong-Duk Kim

Department of Chemical Engineering, Korea Advanced Institute of Science and Technology, 373-1, Kusong-dong, Yusong-gu, Taejeon, Korea

Introduction

The swelling behavior of hydrogels has been interested in many applications of drug carriers. These gels show reversible swelling changes in response to pH, electric current, and temperature. Among others, the temperature-responsive behavior of poly(N-isopropylacrylamide) (p(NIPAAm)) was studied, because a lower critical solution temperature(LCST) is in the vicinity of 32 °C, and remarkable temperature-response can be obtained.

We propose a novel composite membrane, which is appropriate for transporting drug ingredients above the transition temperature. Our object was to design a high permeation system above the shrinking temperature of p(NIPAAm). The membrane was composed of a matrix polymer and thermosensitive p(NIPAAm) hydrogel. The flux pattern of 4-acetamidophen through membrane in response of temperature was opposite to that of p(NIPAAm) membrane.

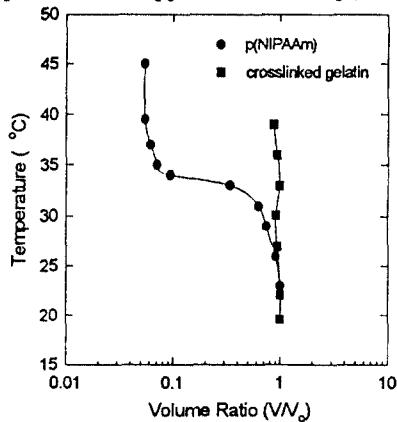


Figure 1. Swelling ratio of homo p(NIPAAm) and homo crosslinked gelatin as a function of temperature

Results

In Figure 1, the volume changes of pure p(NIPAAm) and crosslinked gelatin were shown. Gelatin is a water-soluble product decomposed from water-insoluble structural protein collagen, which undergoes a sol-gel transition. If gelatin is crosslinked by glutaraldehyde, it becomes insoluble in water but can still swell to in a certain degree. As shown in Figure 1, this crosslinked

gelatin did not have any thermosensitivity, and thus was selected as a matrix. The volume change of p(NIPAAm) was significant when temperature increased across 32 °C as reported.

Figure 2 shows the permeabilities of 4-acetamidophen through the pure p(NIPAAm) in response to temperature change between 25 °C and 40 °C. For pure p(NIPAAm) membrane kept initially at 25 °C, the permeation of 4-acetamidophen quickly dropped to lower level when the temperature increased to 40 °C. Such a rapid permeation drop can be explained by the formation of dense and rapid surface layer in deswelling rather than bulk deswelling change. For p(NIPAAm) hydrogel-dispersed membrane (Figure 3), however, the permeation rate of 4-acetamidophen at 40 °C was faster than at 25 °C. Such a permeation control may be responsible to the shrinking of p(NIPAAm) particles in complex membrane. In switching operation, the permeation change from 25 °C to 40 °C was relatively slow, while it was more fast in downward process (40 °C → 25 °C). In upward process, the dense skin of p(NIPAAm) particles in membrane retards the outflow of water and, thus, induces the slow increase of effective pore size, giving slow increase for the permeation. Therefore, it can be concluded that permeation change may become faster as the size of p(NIPAAm) is relatively small (CaCO_3 diameter order: μm).

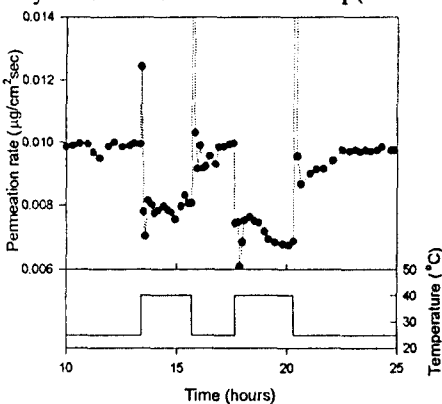


Figure 2. 4-acetamidophen permeation through the homo p(NIPAAm) membrane in response to step-wise temperature change between 25 °C and 40 °C

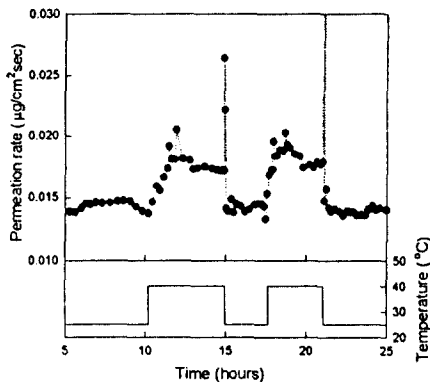


Figure 3. 4-acetamidophen permeation through the p(NIPAAm) hydrogel-dispersed composite membrane in response to step-wise temperature change between 25 °C and 40 °C (p(NIPAAm) contents : 16.5 wt%)

References

1. S. Gehrke and E.L. Cussler, *Chem. Eng. Sci.*, 44 (1989) 559-566
2. T.G. Park and A.S. Hoffman, *J. Appl. Polym. Sci.*, 46 (1992) 659-671
3. I.C. Kwon, Y.H. Bae, T. Okano, and S.W. Kim, *J. Controlled Release*, 17(1991) 149-156
4. H.G. Schilld, *Prog. Polym. Sci.*, 17 (1992) 163-249
5. Y.H. Bae, T. Okano and S.W. Kim, *J. Polym. Sci., Polym. Phys.*, 28, 923 (1990)
6. T. Tsuji, M. Konno and S. Sato, *J. Chem. Eng. Japan*, 23 (1990) 447-452
7. Y. Okahata, H. Noguchi and T. Scki, *Macromolecules*, 19 (1986) 493-494