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ENRICHMENT OF NONIONIC SURFACTANTS WITH FLUOROCARBON POLYMER MEMBRANE

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Nonionic surfactants were enriched by the permeation through a fluorocarbon polymer membrane under a pressure gradient when the concentration of the surfactants were low. The enrichment factor increased with a decrease in the operating pressure and an increase in the lipophilicity of the surfactant.

Hydrophobic membranes have characteristic permeation properties under a pressure difference such as the selective permeation of metal ions,[1] pertraction of heavy metal ions with chelating agents,[2] and the enrichment of hydrophobic organic solutes.[3] Further, we have tried the enrichment of the common nonionic surfactants with a fluorocarbon polymer membrane because the separation of nonionic surfactants is a practical problem and the membrane process is promising for the purpose. It is well known that the surfactants are rejected by the reverse osmosis membrane[4] but we found that the hydrophobic membrane enriched the surfactants in a low concentration. The preliminary study of the enrichment of the nonionic surfactants will be reported in this paper.

The hydrophobic membrane used in this study was a fluorocarbon polymer membrane prepared by coating Teflon FEP-120 dispersion on a fluorocarbon polymer membrane filter, whose coating density was 0.5 to 0.7 mg cm^{-2}, and then melting as reported previously.[1] The nonionic surfactants used in this study were polyethylene sorbitan esters, Tween 20, 40, 60, 80, and 85 (Kanto Chemical Co., Inc.) and polyethylene glycol mono-p-nonylphenyl ethers, NPs whose ethylene oxide units (n) were 5, 10, 15, and 20 (Tokyo Kasei Kogyo Co., Ltd.). The solute concentrations of the permeated solution and the feed solution were determined by TOC and UV measurements. The permeation data were described with the enrichment factor, which is (concentration of permeated solution)/(concentration of feed solutition).

The pressure dependence of the NP(n=20) permeability was examined and it was observed that the surfactant was enriched by the membrane under a pressure difference. The solute diffused to some extent without the pressure difference and the enrichment factor decreased with an increase in the operating pressure as the case of benzene.[3] Figure 1 shows the concentration dependences of the enrichment factor and the solute flux in the case of NP(n=20) and NP(n=5). The surfactant concentration influenced its permeation properties and the enrichment factor decreased with an increase in the concentration. When using dense membrane, the

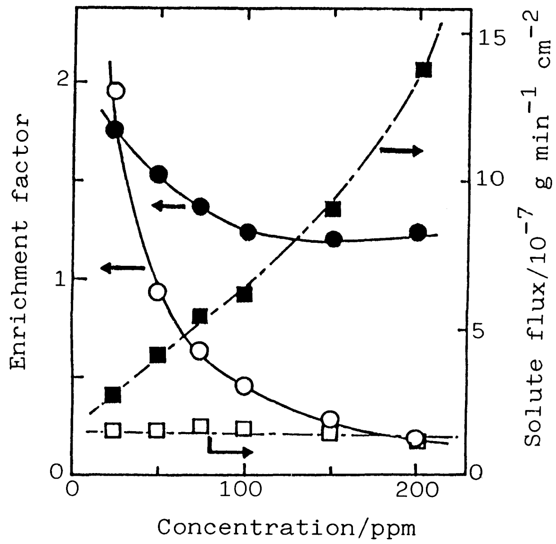

Fig. 1. Effect of concentration on permeation properties.
●, ■ : NP(n=20). o, □ : NP(n=5)
Operating pressure : 10 kg cm^{-2}.

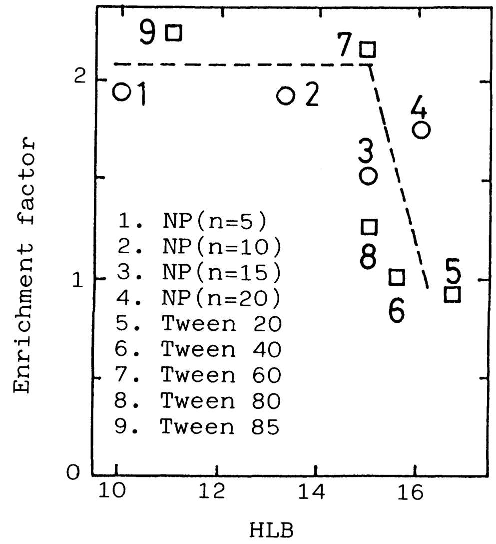

Fig. 2. Relationship between enrichment factor and HLB.[5)]
Feed concentration : 25 ppm.
Operating pressure : 10 kg cm^{-2}.

factor of each NP became rather low in a high concentration. The permeation properties of NP changed much with the number of ethylene oxide units, which brings about the hydrophilicity of NP. The solute flux was also shown in Fig. 1 and the solute flux of NP(n=20) increased with an increase in its concentration, while that of NP(n=5) was constant. The surfactant in the bulk permeated well through the membrane in the case of NP(n=20). But in the case of NP(n=5), only the surfactant adsorbed on the interface of the membrane moved with the volume flow under the pressure difference and the micelle in the bulk did not permeate through it because the coupling between volume flux and the solute flux was little for the lipophilicity of the surfactant.

The hydophilicity lipophilicity balance (HLB) of the surfactant also influenced its permeation properties in a low concentration as shown in Fig. 2. The enrichment factor was about 2 in the case of the lipophilic surfactants with HLB of below 14, whereas it was about 1 in the case of the hydrophilic ones with HLB of over 16. The factor of each surfactant became low in a high concentration and the dependence on the concentration was greater in the case of Tween than in that of NP.

The process with this hydrophobic membrane must be useful for the treatment of the waste water containing nonionic surfactants.

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