Hydrolysis of Dextrin in a Reversed Micelle: Dependence of Some Behaviors of the Micelle on the Medium

An effective rate enhancement of the hydrolysis of dextrin in water solubilized in an organic solvent with dodecylbenzenesulfonic acid (DBSH) has been found.[1,2] For the case of normal micelle systems, it has been found that the solubilizing behavior of the micelle is influenced by its hydrophile–lipophile balance (HLB) and there is an optimum HLB for oil solubilized.[3,4] Therefore, for reversed micelle systems, the solubilizing behavior of the micelle was thought to be influenced by the hydrophobicity of the medium. In the present work, the dependence of some behaviors of DBSH-reversed micelle on the hydrophobicity of the medium was investigated.

EXPERIMENTAL

Purification of the materials used,[1] determinations of critical micelle concentration (CMC)[5] maximum amount of solubilized water,[5] and hydrolysis rate of dextrin[1] were carried out according to the methods previously reported.

RESULTS AND DISCUSSION

The maximum amounts of water solubilized with DBSH in *n*-hexane, cyclohexane, carbon tetrachloride, benzene, toluene, and *o*-xylene were examined. Figure 1 shows plots of the maximum amount of solubilized water against dielectric constant of the organic solvents present as the bulk phase at concentrations of DBSH of 0.20 and 0.30 mol L^{-1}. It is found that, at the lower range of dielectric constant, the maximum amount of solubilized water increases with an increasing dielectric constant. This amount shows a maximum value at a certain dielectric constant, which may indicate that there is an optimum hydrophobicity for solubilizing of water in this system. Since more water solubilized directly means more amount of substrate solubilized into the micelle, benzene is the preferable solvent for the catalytic hydrolysis.

Hydrolyses of dextrin in water solubilized with DBSH in cyclohexane, carbon tetrachloride, benzene, toluene, and *o*-xylene were investigated. Figure 2 shows plots of the hydrolysis rate against dielectric constant of the organic solvents at concentrations of DBSH of 0.20 and 0.30

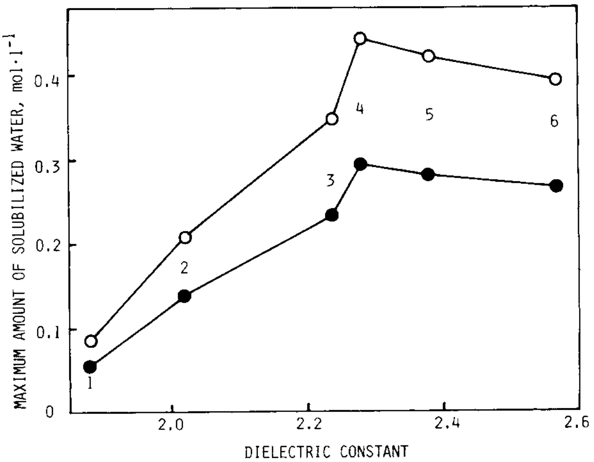

Fig. 1. Plots of maximum amount of water solubilized with DBSH in *n*-hexane (1), cyclohexane (2), carbon tetrachloride (3), benzene (4), toluene (5), and *o*-xylene (6) against dielectric constant of the organic solvents, at room temperature. [DBSH] (mol L^{-1}): (○) 0.30; (●) .20.

Journal of Applied Polymer Science, Vol. 29, 4399–4401 (1984)
CCC 0021-8995/84/5124471-03$04.00

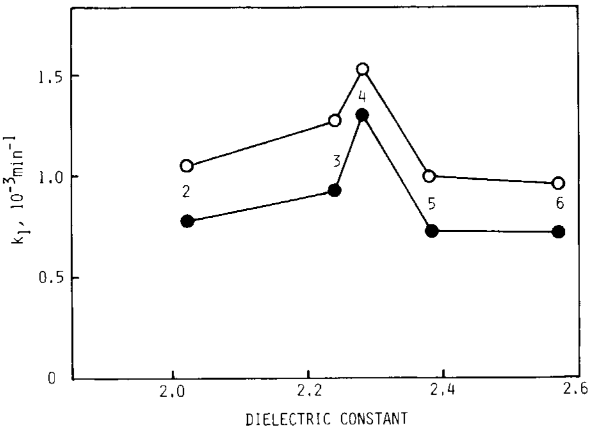

Fig. 2. Plots of pseudo-first-order rate constant k_1 of dextrin hydrolysis in water solubilized with DBSH in cyclohexane (2), carbon tetrachloride (3), benzene (4), toluene (5), and *o*-xylene (6) against dielectric constant of the organic solvents, at 60°C. Solubilized water (mol L^{-1}): (○) 0.99; (●) 0.67. [Dextrin]: 2.46×10^{-3} mol L^{-1}; [DBSH] (mol L^{-1}): (○) 0.30; (●) .20.

mol L^{-1}. It is found that, although the hydrolysis rate does not vary with dielectric constant in the range examined, it clearly shows a maximum value for benzene. This confirms the preference for benzene as the solvent for the hydrolysis of dextrin in the present system.

CMCs of DBSH reversed micelle in cyclohexane, carbon tetrachloride, benzene, toluene, and *o*-xylene were measured according to the method of methachromasis of methylene blue.[5] Figure 3 shows the relationship between the CMC and dielectric constant of the organic solvents, at an amount of solubilized water of 0.67 and 0.99 mol L^{-1}. It is found that, although all CMC values, excepting that in carbon tetrachloride, are similar, CMC in benzene shows the lowest value, indicating that the micelle formed in benzene is the most stable among those in the organic solvents examined. Some other differing behaviors of the micelle formed in carbon tetrachloride compared to other organic solvents were also found. For example, in the flocculation of DBSH in the measurement of the maximum amount of solubilized water, the flocculent precipitates in carbon tetrachloride looked very sticky whereas those in other organic solvents did not so. These differences might reflect the difference in binding manner of water into the micelle.

From these results, it was concluded that there was an optimum hydrophobicity of organic solvent as bulk phase in the present reversed micelle system for binding and hydrolizing of dextrin, and that benzene was the preferable organic solvent examined in the present work.

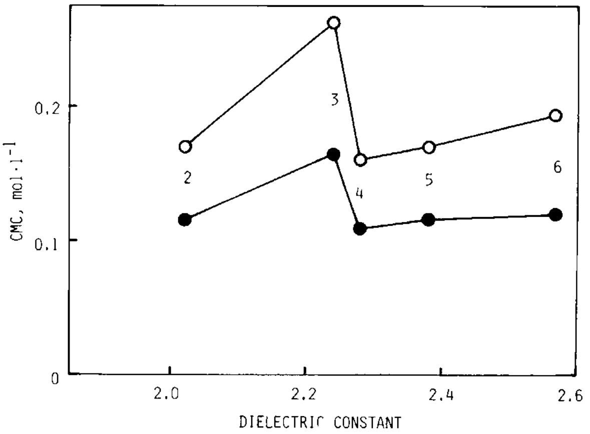

Fig. 3. Plots of critical micelle concentration (CMC) of DBSH in cyclohexane (2), carbon tetrachloride (3), benzene (4), toluene (5), and *o*-xylene (6) against dielectric constant of the organic solvents, at room temperature. Solubilized water (mol L^{-1}): (○) 0.99; (●) 0.67.

References

1. K. Arai and Y. Ogiwara, *Bull. Chem. Soc. Jpn.*, **55**, 838 (1982).
2. K. Arai and Y. Ogiwara, *J. Appl. Polym. Sci.*, **28**, 3309 (1983).
3. W. C. Griffin, *J. Soc. Cosmetic Chem.*, **1**, 311 (1949).
4. J. T. Davies, *2nd Int. Congr. Surface Activity,* **1**, 426 (1957).
5. K. Arai and Y. Ogiwara, *Bull. Chem. Soc. Jpn.*, **51**, 182 (1978).

KENICHIRO ARAI
YOSHITAKA OGIWARA

Faculty of Engineering
Gunma University
Kiryu, Gunma 376, Japan

Received March 27, 1984
Accepted June 1, 1984