

Development of Membrane for Molecular Transport of Water and Its Rate Control

Yoshikiyo Moroi

Department of Chemistry, Graduate School of Sciences, Kyushu University

Evaporation rate measurement of water molecules across the air/solution interface covered by amphiphilic molecules is quite valuable for a basic study on molecular transport across an interface. This can be made by using the remodeled apparatus for a thermal gravitational analysis. The activation energy of water evaporation is quite useful to see the process through which evaporation takes place. This can be investigated by determining the temperature dependence of the evaporation rates. The amphiphiles examined were cationic, anionic, and nonionic ones to see if there exists any difference in effect on the rate among the kinds of soluble surfactants. The rate was also examined from the viewpoint of molecular surface area of the amphiphiles at the air/solution interface derived from the surface excess obtained by surface tension vs. concentration relationship. The effect of insoluble monolayer on the water evaporation was also examined using long chain n-alkanols.

The evaporation rate of water molecules across three kinds of interfaces (an air/water interface(1), an air/surfactant solution interface(2), and air/water interface covered by an insoluble monolayer(3)) was examined using the remodeled thermogravimetric balance. There was no difference in both the evaporation rate and the activation energy between the first and the second for three kinds of surfactant solutions not only below but also above the cmc. This means that the molecular surface area from the Gibbs surface excess has nothing to do with the evaporation rate. In the third case, the insoluble monolayer of n-alkanols decreased the evaporation rate and increased the activation energy, indicating a clear difference between an insoluble monolayer and a conventional adsorbed film of a soluble surfactant. The concentration profile of water molecule in an air/liquid interface region was drawn using the equations derived by solving the Fick's second law. The profile indicates that a definite layer just below the air/liquid interface of surfactant solution is made of water molecules only and that the layer width is a few times the root mean square displacement ($\sqrt{2Dt}$) of surfactant molecules. The width was found to be longer than a few nm, judging from several relaxation times of kinetics of amphiphile molecules in aqueous systems and from a maximum evaporation rate of just purified water.