Chapter VI

CONCLUSION AND PERSPECTIVE

6.1 CONCLUSION

6.1.1 Determination and simulation of oxygen distribution inside biofilm

The distribution of oxygen in a biofilm is very important in oxidation processes such as simultaneous carbon oxidization and nitrification using a fluidized bed biofilm reactor. In this study, attention was paid to biofilm thickness and biofilm density which significantly affect the oxygen distribution in biofilms. Using an oxygen microelectrode that we fabricated, the oxygen distribution in biofilms of different thicknesses was measured, and subsequently oxygen penetration depth and ratio were determined. As a result, oxygen penetration ratio decreased gradually with increasing biofilm thickness. Moreover, the kinetic parameters of a Monod-type reaction and the effective diffusion coefficient were computed based on the oxygen distribution in the biofilms. Using the obtained biofilm dry density, kinetic parameters and effective diffusion coefficient, the oxygen distribution in biofilms was successfully fitted to the results of a microelectrode analysis. The oxygen distribution was simulated by the finite difference method using the kinetic parameters and effective diffusion coefficient. Therefore, oxygen penetration ratio can be predicted at various biofilm thicknesses and oxygen concentrations in a bulk solution.

6.1.2 Simultaneous nitrification and denitrification in single reactor

Nitrogen and carbon components in domestic modified wastewater were completely removed by simultaneous nitrification and denitrification using a membrane-aerated biofilm reactor (MABR) where biofilm was fixed on a hollow fiber membrane. To measure the spatial distribution of pH, ammonium and nitrate ions and to observe microbes inside the biofilm formed on the membrane, microelectrodes and a fluorescent in situ hybridization (FISH) method were applied. Due to plug flow in vertical direction (from the bottom to the top of the reactor), ammonium nitrogen was gradually removed, and negligible nitrate nitrogen was detected throughout the reactor. The FISH revealed that ammonia-oxidizing bacteria were mainly distributed inside the biofilm and other bacteria which included denitrifying bacteria were mainly distributed outside the biofilm and over the suspended sludge. In order to characterize bacterial activity in the vertical direction, the nitrification

rates at lower, central and upper points were calculated using microelectrode data. The nitrification rate at the lower point was 7 and 125 times higher than those at central and upper points, respectively. These results show that the removal of carbon and nitrogen compounds was accomplished efficiently by using various kinds of bacteria distributed vertically and horizontally in a single reactor.

6.2 PERSPECTIVE

The combined information from various approaches will contribute to the further clarification of the mechanism underlying treatment activities and highlight unfavorable fluctuations. Furthermore, the information will be used to construct a novel and reliable mathematical model for the biofilm reaction based on the microscale activities and spatial organization of biofilm communities that have previously been regarded as a black-box.