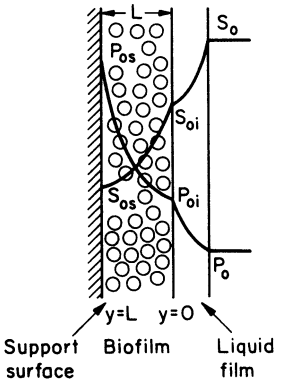

Figure 9.11 Schematic representation of a biofilm.

improvement in reaction stoichiometry (e.g., high yield) may overcome the reduction in reaction rate, and it may be more beneficial to operate the system under diffusion limitations. Usually, the most sparingly soluble nutrient, such as dissolved oxygen, is the rate-limiting nutrient within the biofilm. A typical variation of dissolved oxygen concentration within the biofilm is depicted in Fig. 9.12.

9.4.4. Diffusional Limitations in Immobilized Cell Systems

Immobilization of cells may cause extra diffusional limitations as compared to suspension cultures. The presence and significance of diffusional limitations depend on the relative rates of bioconversion and diffusion, which can be described by the Damköhler number (Da) (see eq. 3.52 also).

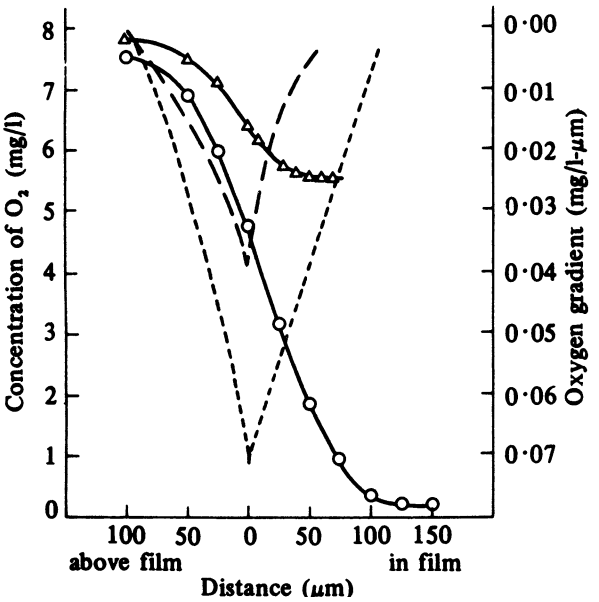

Figure 9.12. Dissolved-oxygen profiles and oxygen gradients in a microbial slime bathed in flowing medium: -Δ-Δ- oxygen profile for 20 ppm nutrient broth, 27.5°C; – –oxygen gradient for this profile; -O-O- oxygen profile for 500 ppm nutrient broth, 26°C; --- oxygen gradient for this profile. (With permission, from H. R. Bungay and others, *Biotechnol. Bioeng. II*:765, 1969, John Wiley & Sons, Inc., New York.)