Development of Intelligent Bioreactor Systems

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Recent development of intelligent bioreactor systems has resulted in significant evolution in terms of tools, objectives, and concepts. Stimulated by rapid progress in the field of artificial intelligence (AI) backed up with powerful personal computers, AI-based computer control of bioreactors is making marked progress. The present paper describes the state of the art for the development of intelligent control systems for bioreactors. Attention is focused on the application of fuzzy expert systems, neurocontrol, and neuro-fuzzy control. It is recognized that the development of on-line intelligent sensors is critical to promote further development of intelligent bioreactor systems.

1.   Introduction

The ability to control fermentation processes to their optimal states accurately and automatically is of considerable interest in bioindustries since it can enable reduction of production costs and increase of yield while at the same time maintaining the quality of metabolic products.

It should be noted, however, that the control system design of bioreactors is not straightforward due to (1) significant model uncertainty, (2) time-varying and nonlinear nature, (3) lack of reliable on-line sensors, and (4) slow response.

It is important to note that the microorganisms themselves have complex regulatory mechanisms within the cells and that the external control system can only manipulate the extracellular environment which may indirectly affect the intracellular metabolic reactions.

Many control strategies have been proposed so far and applied in practice to overcome the above problems, and many others are being developed.[1,2] Most of them, however,