

II. 特別講演抄錄

Current Status of the Research in Fed Batch Culture as an Aspect of General Optimization Problems in Fermentation

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The general efforts of applied research and development can be divided into product development, process development, process design, process equipment design, and operation. The fed batch culture as one effort of the process development in fermentation industry has been practiced since the early times of human history. One particular industrial application with long history is in the cultivation of the baker's yeast where the glucose effect at relatively high glucose concentration is the general rule.

The first use of the terminology "fed batch culture" came into existence in 1973 when Yoshida and Yamane applied the fed batch culture technique to hydrocarbon fermentation with colloidal feed. The current application of the fed batch technique can be categorized into two areas, i. e. the biomass cultivation and the production of the secondary metabolite or the intermediary products. The theoretical developments based on the Pontryagin maximum principle have carried out quite extensively and the theoretical results from these studies have been practiced on hardware in either feed forward mode or feed back mode.

However the problems of correct mathematical modeling and instrumentation for specific systems still remain to be refined. One particular feature of recent development is the use of the mini or

micro-computers in the optimal control of the fed batch culture. The use of micro-computers in the control of fermentation plant has become feasible thanks to the substantial miniaturization of the electronic computer itself and the yearly reduction in the computer price.

The complex nature of the fermentation system renders one to get help from the electronic computer and one such application occurred in the indirect monitoring of the biomass concentration through the component balancing. This kind of indirect monitoring of the process variables difficult to measure was coupled to the optimal control scheme and the overall results were successfully practiced on-line via the electronic computer. In addition to the feed rate variable used in addition to the feed rate variable used in the fed batch culture other process variables such as pH and temperature have also been employed as control variables and the application of the optimal control theory gave results of practical interest. Industrial applications include the activated sludge process of waste treatment, the production of the flavoring components such as MSG and the antibiotics such as the penicillin, and the production of the industrial enzymes.

The results from this particular fed batch technique together with those from the other optimization efforts in such areas as the general system dynamics, the steady state multistage operation, and the genetic manipulation of the microbes may continue to make a major contribution to the improvement of the product yield and the productivity in the coming future.