CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

From the study of the recirculation flow rate and applied pressure effects on permeate flux, at low biomass concentrations, the permeate flux increased with recirculation flow rate (from 0.4 to 0.6 m^3/hr) and with applied pressure (from 0.0^+ to 0.8^+ kg_f/cm^2). At high biomass concentrations (more than 45 g/l) the permeate flux increased with recirculation flow rate but remained relatively constant with pressure.

From the fact that membrane fouling occured rapidly when the applied pressure was more than 0.0^+ kg_f/cm^2 and high cell lysis and high formation of foam occured after operating at 0.5 and 0.6 m^3/hr recirculation flow rates. The suitable applied pressure and recirculation flow rate for application in the cell recycle system was 0.0^+ kg_f/cm^2 and 0.4 m^3/hr respectively.

The solvent productivity can be increased considerably by cell recycling. With this system, the productivity was more than 10 times higher than that of the batch process and more than 2 times higher than the continuous process. From the experiment, the maximal solvent productivity was achieved from the cell recycling with feeding glucose concentration at 42.4 g/l and a dilution rate of 0.55 hr^{-1}. The maximal solvent productivity was 6.06 $gl^{-1}hr^{-1}$ with butanol productivity 3.47 $gl^{-1}hr^{-1}$. The total solvent concentration was 11.03 g/l which was the combination of 6.3 g/l of butanol, 4.4 g/l of acetone and 0.3 g/l of ethanol. The maximal glucose consumption was 19.30 $gl^{-1}hr^{-1}$ with 0.31 production yield. At present, many researchers have used polymeric membranes which could not be steam

sterilized, thus it is difficult and time consuming to sterilize these cell recycle systems. But in the study, the cell recycle system was operated by mineral (ceramic) microfilter tubes which could be sterilized by steam, therefore the system applied in this study is more practical and more credible in scaling-up for industrial applications.

The solvent productivity obtained from this study was also higher than that obtained from other recycle processes published by many researchers. The higher productivity might come from the operation with very high cell concentration at the optimum parameters.

Based on this experiment, further improvements are neccessary. From the fact that this total cell recycle system can not be operate for long periods, due to lack of equipment for cell bleeding. So, the cell concentration increases highly until the equipment is inoperable. This problem can be solved by assembling a turbidostatically controller to control cell concentration in the system. Using such a controller, fermentation can be regulated at steady state condition with optimal cell concentration. So higher productivity for long periods ought to be expected from this improved system.

Another suggestion is that to measure cell concentration by measuring cell dry weight is not quite correct for this high cell concentration experiment. Because the cell concentration measured by cell dry weight not only contains active cells but also contains non-active cells, dead cells and some complex components from cell lysis. This can be corrected by using the method of counting active cells using a microscrope or by ATP analysis instead.

However, from the point of view that the method applied in this study yielded higher productivity and was simple to operate, it was possible to apply this system for improved productivity in acetone-butanol fermentation and other fermentation processes.