CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

This chapter will be focused on conclusions of all experimental details on microfiltration of yeast suspension, in which the effects of applied pressure, feed flow velocity and feed concentration were studied. Effect of sound intensity and frequency in case of microfiltration coupling with ultrasonic irradiation were investigated. The effects of ultrasonic irradiation on the membrane and the yeast will also be explained. In section 6.2, problems occurred during the experiments and the recommendations will be described.

6.1 Conclusions

1. Ultrasonic cleaning introduced to the microfiltration of yeast suspension gives rise to the increase in permeate flux in the ratio of 1.5 to 3.0 compared to filtration without ultrasound at the same conditions.

2. Increase in feed concentration results in the stronger compaction of cake layer, thereby the decrease in permeate flux is observed. However, ultrasonic effects to the increase in permeate flux is not lessened though high feed concentration is introduced.

3. The increase of permeate flux under an ultrasonic irradiation is more pronounced at the lower feed flow velocity.

4. The limitation of cake removal by ultrasound is observed. Increase in sound intensity above the value of 2.68 W/cm^2 hardly affects the permeate flux due to the incomplete collapse of the transient cavitations.

5. Increase in the sound frequency in the range between 19.8 to 30.0 kHz hardly affects on the permeate flux.

6. After being sonicated for a long period of time, the destruction of membrane surface, the more open pores and the less of membrane resistance, R_m, are found.

7. At the highest acoustic power of 40 W applied by the made transducers under the controlled temperature of 30 °C, there is no change to the morphology, particle size distribution and cultivation capability of the sonicated yeast cells observed.

8. From the experiments, the maximum steady-state permeate flux (= 0.00202 cm^3/cm^2.s) is observed when ultrasound was continually (25 W and 23.8 kHz) applied to the microfiltration under the applied pressure of 11.27 kPa, the feed flow velocity of 0.02 m/s and the feed concentration of 0.005 g/cm^3.

9. The comparison between the operating costs of microfiltration with and without ultrasound, based on the low filtration rate, expressed that ultrasonic system can save the operating costs per unit volume of permeate.

6.2 Problems and recommendations

1. The rotating tubular module should be studied to save the number of transducers used and prevent the destruction of membrane structure caused by the direct irradiation for a long time.

2. The flow meter should be installed into the system for the more convenience.

3. The experiment of which the feed is introduced from the outside surface of the membrane should be performed in order that the reduction of the membrane thickness will become unnecessary to lessen the sound absorption.

4. The problems observed from the made transducer are as follows,

   4.1 The resonance frequency and irradiated power of each transducer are inconsistent. In the experiments, the fixed position and input power of the transducer were performed to solve these problems. More studies about the characteristics of transducer should be employed.

   4.2 Heat generated during the long operating caused the epoxy glue lost its adhesive property, the operating, therefore, had to be stopped. New installation method should be used to lengthen the operating time. Longer high strength bolt which clamps between the front portion of the transducer can be used together with the glue in order to strengthen the adhesion.