CHAPTER V

CONCLUSIONS

Yeast has long been known as high nutritional value containing, together with an abundance of brewery waste yeast produced annually, the possibility in using for enhancing H_2 production is studied. The two sets of batch experimental set-up were carried out in CSTR operating at 30°C, by means of brewery waste yeast adding and non-waste yeast adding using glucose as substrate. Factorial design experiments with a central composite design (CCD) and response surface methodology (RSM) were used for finding optimal point of glucose, brewery waste yeast and microbial sludge concentration that yielded the maximum hydrogen production rate. For explanation process reaction and design, the Monod kinetic coefficient rate of k and Ks were determined using the integrated Monod equation weighted least-square model. The modified Gompertz equation could be used to best fit the accumulative hydrogen production with correlation (R^2) greater than 0.98. It was shown that at 7.0 g/l glucose, 11 g/l brewery waste yeast and 12 g/l of microbial sludge was obtained as the optimum point. The result of batch culture with the BWY addition clearly shows that the H_2 production obtained both yield and rate were 1.42 mol/mol glucose and 3.90 ml H_2/gVSS.h higher than that with the absent of BWY, along with acetate presented as the major metabolites. Confirmation by the shifted value of k (maximum specific substrate utilization rate) from 0.52 to 1.84 d^{-1}. The H_2 production was further improved in the continuous CSTR operated at low HRTs. For continuous hydrogen production, the experiment was conducted in the reactor operated at pH 5.0 under mesophilic temperature, with varying HRTs. It was found that CSTR seed with

thermal-treatment digested sludge (boiled at about 80°C, 30 min) was developed on glucose with brewery waste yeast fed to the reactor at 4-24 h HRT. At 4h HRT test run, the resulting COD: N: P: Fe = 100: 2.0: 0.5: 0.02 and no methane was found during 40 days of operation. The overall yield of H_2 production was obtained as the highest value when compared to the other HRT. Particularly in terms of H_2 yield was obtained as the peak value of 2.87 mol/mol glucose utilized, corresponding to 71.8% of the theoretical yield, and also has the advantage regarding reduce reactor size which meaning saving on capital cost and preventing methanogenic restored. The shortened HRT was also found as the key role on microbial selection. A transition in the community structure as HRT was decreased to 4 h in CSTR showed a dominant species with high similarity to *C. pasteurianum* and uncultured bacterium clone HPR 146 that are the organisms responsible for H_2 fermentation in the shortest HRT, CSTR operated at 4 h HRT. Moreover, the H_2 content is quiet stable, which accounts for 40 to 60% in the biogas during 40 days of operation, suggests stable population structure of H_2 producers in the reactor.

The continuous-flow stirred tank (CSTR) system that has been widely used in H_2 production study, is always referred to as unstable reactor when conducted at higher dilution rate (short HRTs) because of the wash-out of cell. To solve this problem, the reactor configuration was designed to develop approach enabling a better biomass retention time, analogous to A.S process. As a result, the cell wash out effect was not occurred from the reactor operated at low HRTs. The stable and higher yield of H_2 production could be achieved at 4h HRT when compared to the other reactor configurations, although H_2 production rate obtained seems to be lower. This is due to the limited glucose concentration used as a substrate in this study. Thus further study in increasing influent substrate is recommended. Therefore the reactor configuration

and operation strategies applied in this work are suggested for a better and higher yield of H_2 fermentation.

According to the results obtained also emphasize the beneficial properties of brewery waste yeast for improving H_2 production, which is not only stimulated the hydrogen producing bacteria, but also simultaneous enhancing the rate of H_2 production. In addition, the speed of fluid flow at shortened HRT may be suitable and favorable to the hydrogen producers and enabling to inhibit the methanogenic activity. Withstanding this, the results from this experimental work support the hypothesis. Therefore brewery waste yeast could be used as a function of both nutrient supplement and trace elements for the H_2 process optimization and cost effectiveness.