CHAPTER 5 CONCLUSION AND RECOMENDATION

5.1 Conclusions

The purpose of this project is to study the effect of H_2SO_4, HCl, NaOH and KOH pretreatment on the sugars production. The operating parameters namely concentration, temperature and reaction time were investigated to study their effects on sugar products.

Since there are several parameters to study then the Design of Experiment (DoE) was applied for determining the number of experiment. Fractional Factorial Design (FFD) was firstly applied to identify the significant factor for sugar production especially xylose and glucose together with inhibitor products such as furfural, HMF and acetic acid and soluble lignin by using ANOVA analysis. After that, the 3 – dimensional diagram was employed to determine the suitable conditions that lead the products to be the highest yield. Finally, the enzymatic hydrolysis was applied to indicate the appropriate condition that could produce the highest concentration of glucose product.

In the acid pretreatment, xylose sugar is the major product of this chemical type with a small amount of glucose and soluble lignin product. For the H_2SO_4 pretreatment, reaction time was the only parameter that significantly affected the xylose production and this parameter should be sustained as shorter time as possible in the highest concentration of xylose was 20.51 g/l at reaction of 60 min. Moreover, to maintain all of parameters at high condition, the inhibitor products would be easily produced under this condition. According to the same type of chemical, the major product from HCl pretreatment was xylose sugar; however, all of parameters significantly affected this product; moreover, these factors should all be sustained at a low level of operation. From the RSM result, 3% HCl at 105 °C for 30 min was the suitable condition that gave the highest concentration yield of xylose as 31.39 g/l.

For alkaline pretreatment, the soluble lignin is the major product for this chemical type. From the ANOVA result of NaOH pretreatment, the concentration was the only parameter that significantly affected the decomposition of lignin and this parameter should be maintains at a high concentration; moreover, the highest concentration of lignin was 62.50 g/l as the NaOH concentration of 3% w/v. Similar to NaOH pretreatment, KOH concentration was the only parameter that significantly affected the lignin removal and the highest concentration of product was 70.0 g/l at 5% w/v KOH. The effect of the alkaline pretreatment was not measurable for the formation of inhibitor products which cause the problem for enzymatic hydrolysis and formation process.

The cellulases enzymatic hydrolysis was applied to determine the effective of each chemical pretreatment. The highest yield of glucose sugar was derived from 5% NaOH at 130 °C for 90 min as the concentration of 19.31 g/l or 99.07% recovery. However, about 5 g/l was the concentrated concentration of glucose that produced from H_2SO_4 pretreatment. Therefore, the highest yield of glucose concentration from cellulases hydrolysis should obtain from the pretreatment that can remove the most of lignin from

bagasse, and the alkaline solution is considered as the most effective chemical that used for lignin removal. In conclusion, xylose is a product obtained from acid hydrolysis, while the alkaline solution can effectively remove lignin from the lignocelluloses material. However, glucose is produced from enzymatic hydrolysis and this product has directly effects on the effectiveness of pretreatment. The result revealed that lignin is the barrier composition for enzyme hydrolysis, so the effective chemical pretreatment to remove this fraction is very important. Therefore, the effective alkaline pretreatment under suitable condition is the preliminary step that leads to achieve high production of glucose.

5.2 Recommendations

5.2.1 The particle size of bagasse and the ratio of liquid to solid are the important parameters that affect the pretreatment result, and then these parameters should be considered for the future studies.

5.2.2 The accuracy of Response Surface Methodology (RSM) result depends on the degree of polynomial equation. This project is designed for screening the parameters (independent variable) that significantly affect the dependent variable. Moreover, the equation used in this study is linear, for this reason, the accuracy of the RSM result of this project can still be enhanced. Executing the optimization step by full factorial design or center composition design (CCD) will improve the accuracy of the result of 3-dimesional RSM.

5.2.3 The concerning of the best pretreatment condition for xylose and glucose production not only depends on the concentration of the sugars in filtrate but also the % recovery of product should be considered. The % recover value represents the bagasse compositions in the product phase. For the calculation, the level of % recovery depends on the volume of the filtrated liquid and concentration (g/l) then the % recovery that calculated from the concentrated product (lower volume of filtrate) will be lower than the value from dilute product (higher volume of filtrate). For this reason, the % product recovery should be regarded when the suitable conditions of the pretreatment method are discussed.