CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The catalytic dehydration of bioethanol to aromatic-rich hydrocarbons was investigated in the systems of two consecutive catalytic beds separately controlled at two different temperatures. The effect of different catalysis system and different type of aromatic production catalysts were studied in this work. In addition, the economic pre-feasibility study of the best case was also evaluated. In catalyst testing, the gallium oxide supported on the HZSM-5 catalyst was found to be the best catalyst among those used in the single-bed catalytic system for bioethanol conversion to aromatic-rich hydrocarbons. Moreover, both oil yield and aromatic content from bioethanol can be enhanced by using the hybrid catalyst, which is the combination of ZnO-Al_2O_3 with HZSM-5. Furthermore, the dual-bed catalytic system can also improve the efficiency of both oil and aromatic production from bioethanol. The two consecutive bed-case of $MgHPO_4$-added alumina and gallium oxide supported HZSM-5 catalyst was the best dual-bed system for aromatic production derived from bioethanol because the highest aromatic yield was obtained.

For the economic pre-feasibility evaluation, the plant capacity of 172.2 ton per day ethanol was determined. The total capital cost was 2,272.2 millions Baht , and the total annual operating cost was 1459.1 millions Baht per year. The annual revenue from the product selling (natural gas and naphtha range hydrocarbons) was 728.4 millions Baht per year. Since the revenue was lower than the operating cost, the net annual profit cannot be achievable. It can be suggested that the bioethanol-based aromatic-rich hydrocarbon production plant was not economically feasible. Apart from the economic evaluation, the sensitivity analysis was also studied. The results revealed that the price of ethanol had to reduce to around 0.7 Baht /liter so that the 15 % of IRR was obtained. At the same target of IRR, the product prices had to increase at least 165 % of the current prices.

5.2 Recommendations

According to the results, the system of two consecutive bed-case of $MgHPO_4/Al_2O_3$ and Ga_2O_3/HZSM-5 gave the highest yield of aromatic hydrocarbons. However, the obtained aromatic yield can still be enhanced. Therefore, in order to enhance the aromatic yield derived from bioethanol, the catalyst at Bed #1 shell be operated at a higher temperature to promote the ethanol conversion toward ethylene. Also, the catalyst at Bed #2 may be changed to other catalysts. Additionally, the operating condition at catalytic Bed #2 shell be varied to find the optimum condition for aromatic formation.