CHAPTER V
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

Semi-batch operator under inert atmosphere performed thermal and catalytic degradation of 1.00-1.40 mm of waste tire and aged rubber compound at 500°C with heating rate of 10°C. The obtained product from thermal and catalytic pyrolysis represented in dark-brown color, and the pyrolysis solid residues were in the similar dimensions and shape for all samples. The gaseous product mainly consisted of methane, ethane, C_4-, C_5- hydrocarbons and other hydrocarbons such as ethylene, propane, propylene, C_6- to C_8- hydrocarbons.

Non-catalytic pyrolysis was performed on aged rubber compounds for investigating the effect of aging on product distribution. The gas yields from pyrolysis of these compounds decreased with aging time up to 3 weeks and then markedly increased due to the residual curatives. On the other hand, the liquid yields slightly increased after the gas rapidly decreased. At longer aging time, the valuable gasoline fraction was presented. Besides, the aging time had no significant effect on the solid yield. At various aging time, no significant difference in lighter hydrocarbons were observed but heavy ones were affected, and liquid oil was also produced in narrow carbon number distribution.

Superacid catalyst, ZrO_2/SO_4^{2-}, were used for catalytic degradation to study the influence of catalyst acidity on product distribution. ZrO_2/SO_4^{2-} was prepared by incipient wetness impregnation. Amount of sulfate was varied up to 8%. XRD, TGA, and BET were performed to characterize the catalysts. The results showed the amount of sulfate did not have impact on the structure of ZrO_2 which were monoclinic phase, and the surface area decreased with the increase of impregnated sulfate. Moreover, ZrO_2/SO_4^{2-} lost some component linearly with sulfate on concentration at about 550°C.

Catalyst to tire ratio at 0.50 was selected for studying the effect of loaded sulfate. The results showed that the influence of the presence of catalysts was to increase the gas yield with a consequent reduction of the yield of liquid and solid residue as compared to thermal cracking of waste tire. Catalytic cracking passed through carbenium ion mechanisms, but free radical belongs to thermal cracking. The volume of liquid yield increased while gas and solid residue yield decreased after loaded sulfate or acid strength was markedly increased. When the percentage sulfate increased from 0 to 8%, fuel oil, gas oil, and gasoline were not continuously increased but the first two fractions dominated with the maximum at 6% while gasoline presented at 8% sulfate. Thus the catalysts helped to improve the quality of oil.

Furthermore, the influence of catalyst to tire ratio on the product yield and distributions was also examined with fixing the total weight of sample at 1.00 gram. ZrO_2/SO_4^{2-} at 4% SO_4^{2-} was inspected at catalyst to tire ratio of 0.00, 0.11, 0.25, 0.50, and 1.00. The optimum ratio was discovered to be 0.25 due to cracking reaction occurred in the appropriate acid strength. It did not only give the narrow carbon number distribution and high mass percentage, but also produced high amount of gas oil fraction. No remarkable differences in both aging time and the presence of catalyst were found in carbon content.

5.2 Recommendations

For the future work, the reaction should be further investigated in other factors such as temperature, heating rate, flow rate of carrier gas, residence time, and non-contact mode for observation of the production distribution. Moreover, ZrO_2 should be synthesized for high surface area and compared with commercial ZrO_2. Besides, the economics of research should be studied for comparison between the traditional process, non-catalytic usage, and recently developed process, catalyst usage, in order to determine which one is more satisfied for financial aspect.