UNIVERSITI TEKNOLOGI MARA

CATALYTIC CO-PYROLYSIS OF PALM KERNEL SHELL AND POLYPROPYLENE USING METAL INCORPORATED MESOPOROUS ZEOLITE FOR HIGH-QUALITY BIO-OIL

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ABSTRACT

The increasing global fuel consumption and growing environmental concerns are the impetuses to explore alternative energy that is clean and renewable for fuel production. Converting biomass and plastic waste into high-value fuel and chemicals via catalytic co-pyrolysis and co-pyrolysis technique may provide a sustainable remediation to this problem. The highest bio-oil yield of 67.65 wt.% was obtained at 600 °C and PKS:PP ratio of 25:75. Positive synergistic effect on the production of hydrocarbons and esters, as well as the inhibition of acids and ketones were prominent at 500 °C and PKS:PP ratio of 75:25. The plausible reaction mechanism for formation of major products was proposed. Co-pyrolysis of PKS and PP has generated bio-oil with a larger hydrogen and carbon content and lower oxygen composition compared to PKS bio-oil. Additionally, the resultant bio-oil has a slightly higher calorific value (47.74 MJ/kg) than of the calorific value of commercial diesel fuels (46 MJ/kg), thus, offering an alternative for fuel applications. The effects of metal dosage (5, 10, 15, and 20%), reaction temperature (400, 500, 600, and 700 °C), catalyst-to-feedstock ratio (1:10, 1:8, 1:6, 1:4, and 1:2), and biomass-to-plastic ratio (100:0, 25:75, 50:50, 75:25, and 0:100) on product yields and chemical compositions were examined in the catalytic co-pyrolysis section. The optimum catalyst-to-feedstock ratios for catalytic co-pyrolysis of PKS and PP over Zn-FAU-EAFS and Ga-FAU-EAFS were chosen at 1:10 and 1:4 was chosen, respectively. In comparison to individual pyrolysis of PKS (14.05 MJ/kg), the higher heating values of catalytic co-pyrolysis oils over both catalysts were obtained between 44.20 and 44.83 MJ/kg, thus offering an alternative for fuel applications.

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CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter presented the renewable energy demand, pyrolysis of biomass, co-pyrolysis of biomass and plastics with and without mesoporous zeolite. A detailed problem statement together with the objectives of the study comprised of co-pyrolysis and catalytic co-pyrolysis were presented. In addition, the scope and limitations of this study are also presented in this section.

1.1 Renewable energy demand

An enormous quantity of greenhouse gases (GHGs) is produced each year because of economic expansion and the increasing consumption of fossil fuels be more inclined to be living in polluted locations with water that is contaminated. Furthermore, kids and pregnant women are more vulnerable to pollution-related health concerns (Office of Disease Prevention and Health Promotion 2023). The above factors heightened the immediacy of identifying environmentally friendly and sustainable resources for the energy production and fuels (Vuppaladadiyam et al. 2022).

Biomass can be considered as an appropriate source of renewable energy due to its resilience, availability, and low levels of emissions (Derman et al. 2018; An et al. 2020). Biomass is the fourth largest renewable resource after coal, oil, and natural gas, and it plays a significant part in the overall energy system. Due to its wide distribution in nature and carbon neutrality, biomass is regarded to be a viable alternative energy source to mitigate the problem of CO_2 emission (Zhong et al. 2022). It is anticipated that by the year 2050, biomass provides about 14% of the world's primary energy needs and this value is expected to rise by 50% (Ansari, Kamal, et al. 2021). According to the International Energy Agency (IEA) 2021 (International Energy Agency 2022), a growth in renewable capacity of over 8% is anticipated in 2022, breaking above the 300 GW barrier for the first time. According to the (International Renewable Energy Agency 2021), Malaysia renewable energy generation capacity amounted to 28, 918