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Thermal - Catalytic Cracking of Real MSW into Bio Crude Oil

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Abstract—The thermal decomposition method has been able to convert of real Municipal Solid Waste (MSW) into bio-crude oil (BCO) which is mainly contained hydrocarbon fuel such as light oil (gasoline) and heavy oil (diesel). By this method, sustainable MSW management and energy problem can be considered. Hence, this research was conducted the pyrolysis experimental to BCO production from the real MSW under thermal and catalytic pyrolysis at 400 oC and 60 minutes for time reaction. To increase the BCO yield in this study, the natural activated zeolite as a catalyst was employed. BCO was analyzed by Gas chromatography–mass spectrometry (GC-MS) which it can be used to identify carbon number range by percentage of peak areas. It was found that the catalytic pyrolysis has performances better than the thermal pyrolysis. Both of thermal and catalytic pyrolysis were the produce of BCO around 15.2 wt% and 21.4 wt% respectively with the main organic components are gasoline and diesel. Furthermore, paraffin and olefin fraction are major species in the gasoline and diesel. It can be concluded that the content of MSW and their processes has an impact on the fuel produced. In the thermal cracking produce BCO with higher content in the gasoline range. More plastic in MSW is also produce more gasoline while more biomass produces more in diesel range.

Keywords: Pyrolysis; Bio Crude Oil (BCO); Municipal Solid Waste (MSW), Thermal cracking; Catalytic cracking

1. Introduction

Cities around the world are producing more and more municipal solid waste (MSW) due to economic growth, increasing human populations, the rise of consumerist lifestyles and continued urbanization. Many developing countries, including Indonesia, manage MSW through an open dumping system in which the MSW is disposed of in a way that leaves it exposed to the elements [1], posing health and environmental risks. Piles of trash in open landfills provide a habitat for bacteria and insects as well as pollution surrounding air, land and water [2]. The costs of transportation, maintenance and labor for improved MSW management are very high and population growth has reduced the availability of landfill space in cities. However, as a material MSW stores energy in the form of chemical bonds between molecules of carbon, hydrogen and oxygen [3]. When these chemical bonds are destroyed, the organic material reacts and converts into gas, liquids or solids that are commonly called bio-fuel [4]. The calorific value that can be generated from most MSW is around 20.57/kg [5]. Thus, MSW is a raw material with considerable potential to be converted into bio-energy. Several methods for bio-energy production from MSW have been proposed, one of which is the pyrolysis method.

The pyrolysis method is a thermal degradation in which MSW is converted into solids, liquids and gasses at an elevated temperature without the presence of oxygen [6]. Usually, the temperature ranges from 400-600^{o}C**.** This process is intended to break down long hydrocarbon chains into short-chain hydrocarbons. MSW appears eligible as a raw material for bio crude oil (BCO) production through pyrolysis [7-10]. However, the pyrolysis process has low efficiency regarding the endothermic reaction at high temperatures. Fortunately, the addition of a catalyst in the process can overcome these problems, as the presence of the