UNIVERSITI TEKNOLOGI MARA

Cawangan Terengganu
Kampus Bukit Besi

TITLE:
THE THERMAL STABILITY OF THE POTASSIUM METAL CATALYST SUPPORTED BY ACTIVATED CARBON

NAME:

NOR AIN NATASYA BINTI AZIZ

MATRIX NUMBER:

2020830138

SEMESTER: 5

SUPERVISOR:
TS NORKAMRUZITA BINTI SAADON

SCHOOL OF CHEMICAL ENGINEERING
COLLEGE OF ENGINEERING

FEBRUARY 2023

ABSTRACT

A material is thermally stable if a substance doesn't break down when heated up. The thermal stability of a substance can be determined using a thermogravimetric analyser (TGA). Catalyst is a substance that initiates and increases a chemical reaction without changing the reaction itself. Due to high temperature, there is a limit to how many times the catalyst can be used before it become worn out or turn to ashes. This study focuses on determining the effects of temperature on the mass loss of carbonized oil palm kernel shell (OPKS) and the mass loss of potassium metal catalyst in ratio potassium to activated carbon of 1:1, 1:3 and 1:4. There are three steps involved in this study. The OPKS needs to undergo the preparation of the raw materials where the OPKS needs to be cleaned after being collected from the palm oil industry. Then, the OPKS will be put into the furnace for physical activation and turned into activated carbon. Lastly, the process was continued with the wet impregnation step for catalyst preparation and calcination process. The thermal stability test was run at temperature of 25°C - 1000°C from the TGA showed that 1:3 is the best ratio of K/AC catalyst with good thermal stability and lowest mass loss. Thus, the result concludes that the best catalyst can be used when dealing with fatty acid methyl ester transesterification.

TABLE OF CONTENTS

CHAPTER ONE
BACKGROUND

1.1 Introduction

Palm oil is a significant substance that is utilised in several everyday items all over the world. Once established, the oil palm is highly productive, effectively absorbing large amounts of carbon, and protects the land. Oil extraction facilities become self-sufficient in energy and generate excess electricity when they employ wastes as fuel (Mutsaers, 2019). Additionally, according to a study by Sadhukhan (2018), the production of biofuel and bioenergy from palm-oil waste along with fine and platform chemicals, polymers, and ingredients for food and pharmaceuticals could replace the demand for fossil fuels. One of the biggest producers and exporters of palm oil is Malaysia. With the oil palm sector in progress, a lot of biomass waste is being produced by palm oil mills. This results in the waste materials from the plantations, such as the oil-palm trunks (OPTs), oil-palm fronds (OPFs), empty fruit bunches (EFBs), palm kernel shells (PKSs), and palm-oil mill effluent (POME), causing significant environmental problems (Loh, 2017). The use of waste from the palm oil industry has been found to yield highly valuable activated carbon (AC), which serves as the catalyst support to produce biodiesel. Researchers have extensively researched activated carbon made from waste palm oil, particularly the palm kernel shell (PKS), which has a high caloric value, low sulphur content, low ash content, no species variation, improved shelf life, and great year-round availability (Abdullah et al., 2020). According to Astuti and Mufrodi (2020), in addition to having numerous natural elements, the cost of the catalyst made from these materials is also reasonably low when compared to other catalysts, making the manufacturing of biodiesel more environmentally friendly and sustainable.

1.2 Literature Review

1.2.1 Oil palm kernel shell (OPKS) as activated carbon

The shell fractions left over after the nut has been taken out and crushed in the palm oil mill are known as oil palm kernel shells (OPKS). As a fibrous material, kernel shells could be delivered in bulk from the production line to the customer. Activated carbon is a suitable catalyst support for the impregnation of base catalysts because it has a higher microporous surface and larger active sites than the other adsorbents. From the study by Kosheleva (2018), the interparticle surface area and porosity of activated carbon are both highly developed. The OPKS undergo two steps of carbonization. First, volatile compounds are removed by carbonization at low temperatures (700–800 K) without oxygen, and second, the OPKS are activated at higher temperatures (1100–1300 K) to enhance their porosity and surface area. There are two methods for carrying out the activation process. The first one is the chemical activation that use chemical agents such as KOH, H_3PO_4 or $ZnCl_2$ and the second method is physical activation that use steam, water vapor or CO_2. According to Fadhil (2018), as activated carbon contains a higher micro-porous surface and large active sites, it suits for the impregnation process as catalyst support. Utilizing industrial wastes for the synthesis of activated carbon lowers the cost of the catalyst support, which in turn lowers the cost of producing biodiesel. In this study, the physical activation was carried on where the OPKS were heated in the furnace for 4 hours at 800°C.

1.2.2 Potassium hydroxide (KOH) catalyst

From the study by Fadhil (2018), waste cooking oil (WCO) and waste fish oil (WFO) were transesterified with methanol using potassium hydroxide (KOH), a solid base catalyst supported by activated carbon. To create a KOH/AC solid base catalyst, activated carbon was made from palm kernel shells and mixed with KOH in the wet impregnation process. To speed up the transesterification reaction, various catalysts, including potassium carbonate, ferrous sulphate, potassium hydroxide, calcium oxide, and potassium fluoride, were conveniently dispensed on the support surface. By study from Wang (2017), the surface area and pore volume of the meal biochar (MB) were increased by activating it with potassium hydroxide (KOH). This may be due to the hydroxyl ion from the KOH catalysed the breaking of ether bonds in the MB, releasing the liquid's soluble phenolics. In this study, potassium hydroxide (KOH) was used as an activating agent to make activated carbon from the palm kernel shell.

1.2.3 Thermogravimetric analysis (TGA)

TGA is a possible screening method for observing the transesterification of OPKS