PREPARATION AND CHARACTERIZATION OF ACTIVATED CARBON PREPARED FROM OIL PALM SHELL BY PHYSICAL AND THERMAL ACTIVATION PROCESS

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PREPARATION AND CHARACTERIZATION OF ACTIVATED CARBON PREPARED FROM OIL PALM SHELL BY PHYSICAL AND THERMAL ACTIVATION PROCESS

Submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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DECLARATION

I hereby, declared this report entitled “Preparation and Characterization of Activated Carbon Prepared from Oil Palm Shell By Physical And Thermal Activation Process” is the result of my own research except as cited in references.

Signature : .....

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Date : 15 September 2021

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

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ABSTRAK

Satu dekad yang lalu, bahan pencemar air menjadi perhatian besar kerana terdapat banyak kesan terhadap kesihatan manusia yang boleh menyumbang kepada sebarang masalah kesihatan. Akibatnya, bahan cemar dapat diatur dengan adanya karbon aktif. Dalam cecair dan gas, karbon aktif membolehkan racun, racun serangga, bau busuk, rasa, logam berat dan unsur-unsur yang tidak diingini terperangkap. Di samping itu, beberapa eksperimen telah dilakukan pada kulit kelapa sawit dalam berbagai aplikasi karbon aktif untuk mengawal pelepasan. Untuk mencapai penyerapan pelepasan udara dan air tertinggi, masa pemprosesan yang lebih pendek, biaya rendah dan pelbagai aplikasi yang dapat digunakan, kaedah pengeluaran karbon aktif digunakan melalui proses kimia, termal atau fizikal tetapi pada suhu yang dapat diterima oleh yang dihasilkan bahan kimia. Fokus penyelidikan ini adalah untuk mengkaji karbon aktif dengan pengaktifan terma dan fizikal melalui penggunaan tempurung kelapa sawit untuk menghasilkan karbon aktif penyerapan tinggi yang disediakan oleh kawasan permukaan spesifik yang lebih tinggi dan untuk mencirikan pencirian kulit inti kelapa sawit. Penyelidikan sebelumnya, karbon aktif berdasarkan kayu biasa dihasilkan dari jenis kayu dan habuk papan terpilih. Beberapa masalah yang dihadapi oleh proses penguraian kayu yang berlaku kerana pemanasan dalam proses penyulingan . Dengan menggunakan tempurung kelapa sawit sebagai bahan mentah baru untuk menghasilkan karbon aktif yang lebih berkesan, kelemahan bahan kayu dapat diperkuat dan mempunyai sifat yang lebih baik daripada diaktifkan secara komersial. Walaupun begitu, oleh kerana banyak penyelidik menumpukan perhatian pada pengaktifan kimia, sehingga kini terdapat kajian yang terhad mengenai kaedah pengaktifan termal dengan menggunakan tempurung kelapa sawit. Permukaan morfologi dan pengaruh pH karbon aktif telah ditetapkan sebagai parameter untuk pengumpulan dan analisis karbon aktif. Permukaan morfologi sebelum dan selepas proses pengaktifan, struktur dan kesan pelebaran liang disebabkan suhu dijangka wujud .karbon aktif pada suhu 600 ℃ dipilih sebagai sample yang terbaik dengan hasil darjah bakar yang tinggi iaitu 74.71 wt%, liang pori lebih luas seperti yang ditunjukkan oleh struktur mikrograh dan penyaringan air yang terbaik pada pH 7. Oleh itu, berbanding dengan bahan bukan organik lain, karbon aktif dari tempurung kelapa sawit dapat menjadi pasaran global yang baik untuk kecekapan penggunaan air dan bahan berpotensi tinggi.

ABSTRACT

Since decade ago, water pollutants became a big concern as there are many impacts on human health that may contribute to any health issue. Activated carbon can be used to regulate water contaminants. In both liquid and gas, activated carbon allows poison, insecticides, bad odor, taste, heavy metal, and undesirable elements to be trapped. In addition, several experiments have been carried out on oil palm shells in various applications of activated carbon to control emissions. In order to achieve the highest absorption of air and water emissions, shorter processing time, low cost and a wide variety of usable applications, the method of activated carbon production is used through chemical, thermal or physical processes but at an acceptable temperature to the produced chemical. The focus of this research is to study activated carbon prepared using oil palm shells by thermal and physical activation through the use of to generate high absorption activated carbon provided by a higher specific surface area and to characterize the oil palm shell derived activated carbon. In previous researches, activated carbon were prepared using common wood. Some problems faced by the wood decomposition process that occurs due to warming in the dry distillation process. By using the oil palm shell as the new raw material to generate more effective activated carbon, the weakness face by wood material can be strengthened and has better properties than commercially available activated carbon. Nevertheless, as many researchers concentrating on chemical activation, there has been limited research to date on the method of thermal activation by using oil palm shell. The surface morphology and effect of activated carbon pH has been set as a parameter for the collection and analysis of activated carbon. The surface morphology before and after the activation process of carbon structure and the pore widening impact due to the temperature expected to be present. Activated carbon prepared of 600 ℃ of activation process was selected as the best sample sample as it is yield high burn-off degree of 74.71 wt%, wider pore as shown by micrograph structure and performed the best water filtration of pH 7. Thus, compared to other inorganic materials, activated carbon from oil palm shell could be the favourable global market for its water application efficiency and low potential cost material.

DEDICATION

Only

my beloved father, Yusof bin Abd Kadir

my appreciated mother, Siti Noraizah binti Mohd Sharif

my adored sister and brother, Nur Afiqah and Muhammad Wafiq

for giving me moral support, money, cooperation, encouragement and also understandings

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LIST OF ABBREVIATIONS

AC	-	Activated Carbon
FTIR	-	Fourier Transform Infrared Spectroscopy (FTIR)
FESEM	-	Field Emission Scanning Electron Microscopy
PAC	-	Powdered Activated Carbon
GAC	-	Granular Activated Carbon
EAC	-	Extruder Activated Carbon
FELDA	-	Federal Land Development Authority
FELCRA	-	Federal Land Cosolidation and Rehabilitation Authority
RISDA	-	Industry smallholders Development Authority
ASAP	-	Accelerated Surface Area and Porosimetry

LIST OF SYMBOLS

%	-	Percent
wt. %	-	Weight percent
mm	-	Millimetre
°C	-	Degree Celsius

CHAPTER 1
INTRODUCTION

The background of study, problem statement, goals, research scope and significance of this research are mentioned in this chapter.

1.1Background of Study

The oil palm tree or the other name (*Elaeis guineensis*) is a native African tropical palm plant. The cultivation of oil palm trees has grown in less than 100 years from being a latively small-scale crop in Africa to one of the most lucrative agricultural commodities in the world. In Malaysia's climate, oil palm trees will grow well (Awalludin et al., 2015). Malaysia is one of the countries that is effectively harnessing the oil palm industry's beneficiaries and is responsible for the global uprising of this industry through contributing significantly and continuous commitment. As one of the world's most successful palm oil producers, Malaysia has kept the tittle for decades (Sayer et al., 2012).

Using agricultural waste as a supply for activated carbon synthesis might lower production costs. Agricultural waste has a high carbon proportion. Agricultural waste, as a renewable resource is also suitable in large quantities. The use of simple methods for the processing of activated carbon would also substantially reduce the cost of production. An easy, low-cost system for producing carbon from agricultural waste would greatly improve living standards in rural and remote areas (Aravind & Amalanathan, 2020). Moreover, many raw material from waste agricultural such as corn straw, wheat straw, rice straw, sawdust, corncob, bagasse, cotton stalk, coconut husk, rice husk, tobacco stem, nut shells, soybean oil cake and oil palm fiber have been prepared from farming for a large variety of activated carbon (Adegoke & Bello, 2015).

An attractive technique for extracting toxins from water is activated carbon adsorption. Research is being conducted worldwide for the production of low-cost activated carbon (Adegoke & Bello, 2015). Other than that, water treatment is a method of reducing to appropriate levels the number of pollutants present in water that are not harmful to living organisms and their environment. Water treatment utilities use traditionally to reduce the number of pollutants present in water that is safe for potable use and disposal to the environment (Rahman et al., 2019). The activated carbon method is commonly used and is well known to be effective in the treatment of water and waste water (Thamilselvi & Radha, 2017).

The objective of this current work is to prepare and characterize activated carbon that derived from oil palm shell using physical activation and thermal activation method followed by temperature as parameter. This is due to the lack of previous studies that using thermal activation process and the parameter of pH effect that shows the efficiency activated carbon to apply in water treatment. Using selected methods such as Fourier Transform Infrared spectroscopy (FTIR), the activated carbon produced will be further examined and Scanning Electron Microscopy (SEM), a well define activated carbon structure can be evaluated due to the preparation the activated carbon.

1.2 Problem Statement

The world production of activated carbon demand is estimated at 375,000 tons in 1990, except for Eastern Europe and China (Mozammel et. al, 2002). Order activated reached up to 200,000 tons per year in the United States in activated carbon 2002, and demand is increasing. The growth of the market for these materials to a various application is estimated at 4.6% per year (Mozammel et. al, 2002).

The activated carbon produced from waste material such as rubber, wood, sawdust and coconut oil. Activated carbon mainly used as adsorbents to remove organic compound and

contaminants from the flow of liquid and gas. Common wood based activated carbon is produced from selected types of wood and sawdust. However, there are materials such as woods have listed some of the problems faced by wood decomposition process that occurs due to warming in the dry distillation process. The weakness that faced on wood material can be improved by using the oil palm shell as the new raw material to produce more efficient activated carbon and has better properties than commercial activated.

The series of pre-treatment washing procedures should be carry out in the physical and thermal activation phase. Scanning Electron Microscope used to the characterization of surface morphology. The study concentrated on the growth of pore size and their activated carbon behavior.

The most common type of water filter, particularly for household use, is activated carbon based on charcoal, which is significantly determined by factors such as molecular weight, pH, particle size, surface area, and flow rate. Sand filtration and ceramic filtration are also types of filtrations. The purpose of this research is to determine the potential of oil palm shells to replace the current filter absorbent as a cost-effective activated carbon. The figure 1.1 shows the summarize of problem statement and research gap.

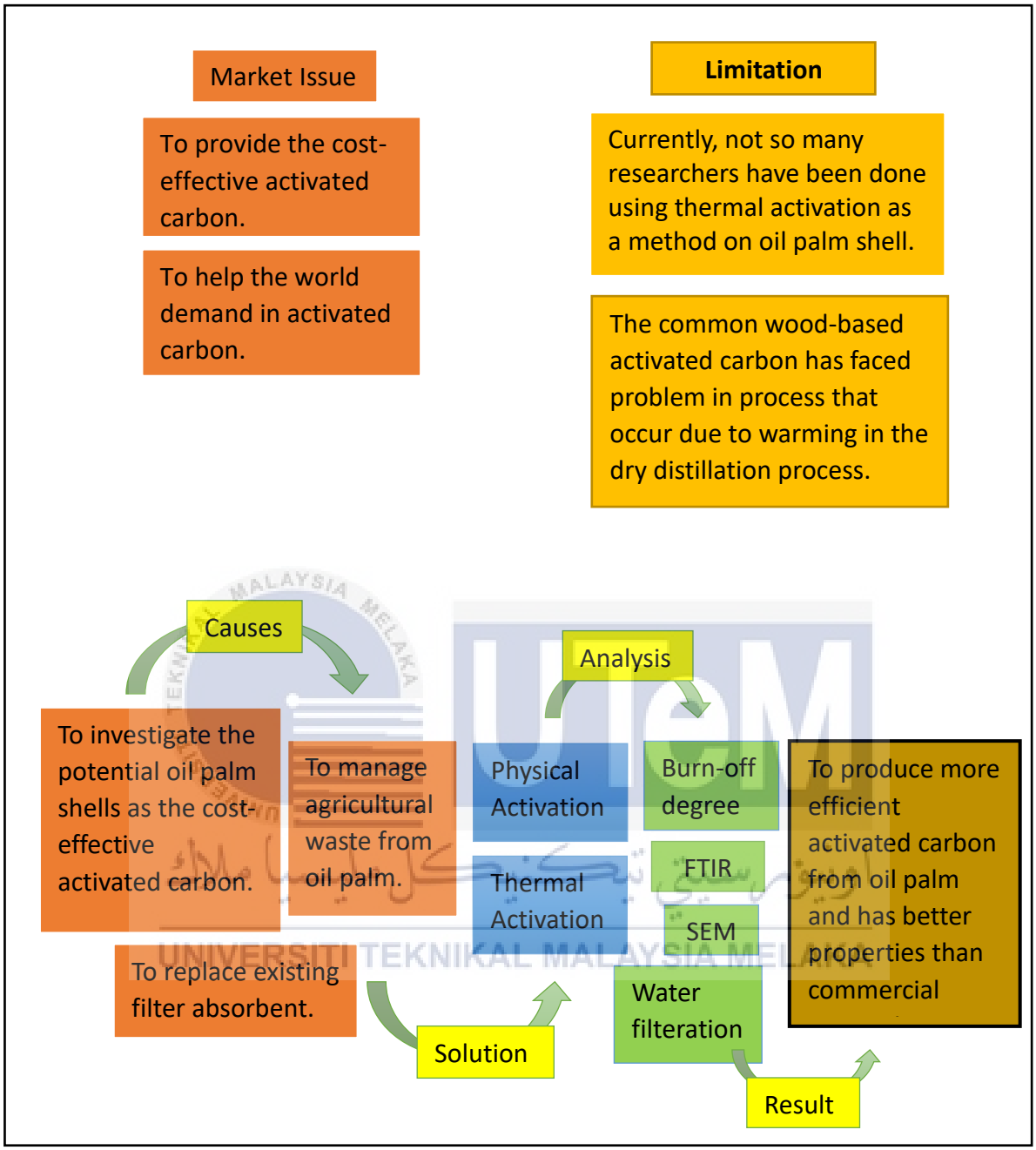

Figure 1.1: The summarize of problem statement and research gap

1.3 Objective

The objective are as follows:

1. To produce activated carbons by physical and thermal activation process by utilizing oil palm shell.

2. To characterize the surface morphology of the oil palm shell based activated carbon.

3. To evaluate of activated carbon for water filtration application by water filtration analysis.

1.4 Research Scopes

The research concentrates on the preparation and characterization activated carbon based on oil palm shell via physical activation and thermal activation method. In order to achieve the purpose of the study, the experiments are carried out in different conditions based upon various scopes in order to produce productive activated carbon in order to provide cost-effective active carbon.

In this research, the first objective is to produce activated carbons by physical activation and thermal activation process by utilizing oil palm shell. The method used in this study was to activate the oil palm shell, resulting in activated carbon. The parameter that will be vary in these two methods are the temperature reading and the preparation of the activated carbon. Physical activation boiled the oil palm shell in 150℃ distilled water. The thermal activation burns the oil palm shell at 400 ℃,600 ℃ and 900 ℃. However, the time is fixed for the thermal activation.

This tools used to characterize the pores growth, the structure and the efficiency of water filtration were used to achieve objective numbers two and three. The Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM) were two machines for this research. The FTIR analysis is used to assess the elemental raw oil palm shell and

the whole sample of activated carbon, and the SEM is used to describe the morphology of the surface and the growth of the pore scale. Furthermore, the burn-off degree and will be use in this study. Figure 1.2 shows the relation objective and scope.

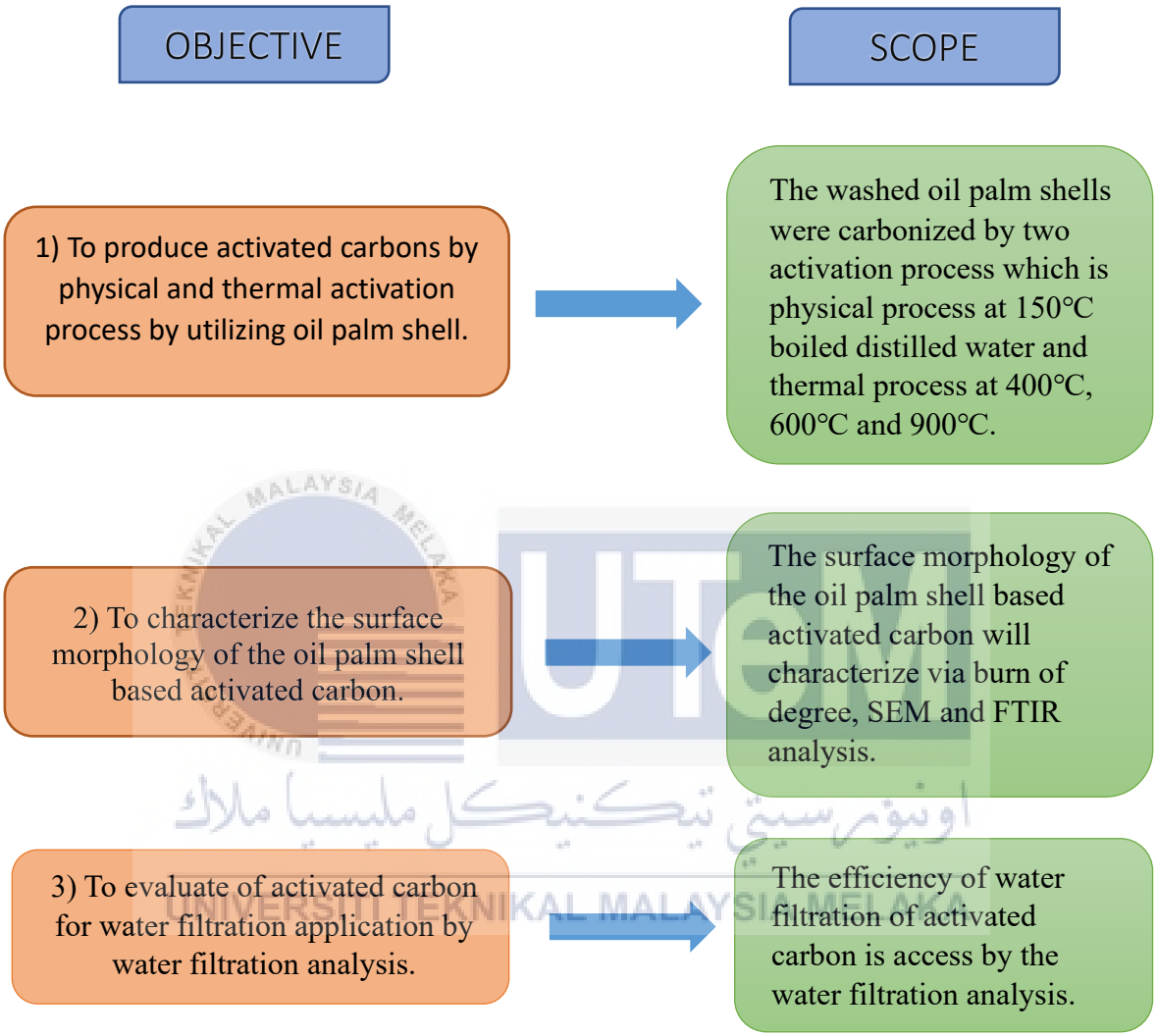

Figure 1.2: The relation objective and scope.

1.5 Significant of The Study

The research of preparation and characterization of activated carbon by physical activation and thermal activation process is done to provide the cost-effective activated carbon and to overcome the waste of agricultural. Beside that also to help the world demand in commercial activated carbon. The oil palm shell provides another alternative raw material for activated carbon. It also helps save the problems of the ecosystem caused by agricultural waste since the oil palm shell is a waste of agriculture, it can be served as a sustainable source for activated carbon. The study also avoids the chemical usage or chemical method would be hazardous in order to obtain excellent activated carbon that can be used in many applications for example at industry of filters such as in air conditioning air purifier and water filter..