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LIST OF ABBREVIATIONS/ SYMBOLS

AC	-	Activated carbon
ANOVA	-	Analysis of variance
BB	-	Box Behnken design
CB	-	Carbon block
CCD	-	Central composite design
CRS	-	Critical rotation speed
DOE	-	Design of experiment
EPA	-	Environmental protection agency
FESEM	-	Field emission scanning electron microscope
GAC	-	Granular activated carbon
HEBM	-	High energy ball milling
MnT	-	Million tonnes
PAC	-	Powder activated carbon
RSM	-	Response surface methodology
SAJ	-	Syarikat Air Johor
SEM	-	Scanning electron microscope
UV	-	Ultra violet
W_p	-	Mass pass a sieve
W_t	-	Total mass

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CHAPTER 1

INTRODUCTION

1.1 Overview

Filtration and purification of drinking water and waste water treatment are among of processes that use charcoal powder in transforming water from dirty to clean condition. One of the factors that contributes to water quality is filtration method. Good quality of filtration method may produce high quality of water. Ceramic filtration, reverse osmosis filtration, UV radiation system, magnetic system and energetic water treatment are among of the popular purification method. Even, charcoal is one of the sources that can be used to remove impurities from water. They are quite excellent in removing organic and carbon based materials from water. According to Environmental Protection Agency (EPA) National Drinking Water Standard, activated charcoal is the best elements shall be used to remove contaminants from water. They noted that charcoal is used in certain metallurgical processes and as a filter to remove organic compounds such as chlorine, gasoline, pesticides, and other toxic chemicals from water and air.

Usually the activated charcoal is packaged in filter cartridges and inserted into the purification device. Then, water needs to pass through the cartridge, contacting the activated charcoal on its way to the faucet. The cartridges need to be

replaced when activated charcoal filters eventually become fouled with contaminants and lose their ability to absorb pollutants.

The amount and size of activated carbon charcoal in a filter are among important characteristics that affects the rate of pollutant removal. By using a correct size of activated carbon charcoal powder, the best quality water shall be produced.

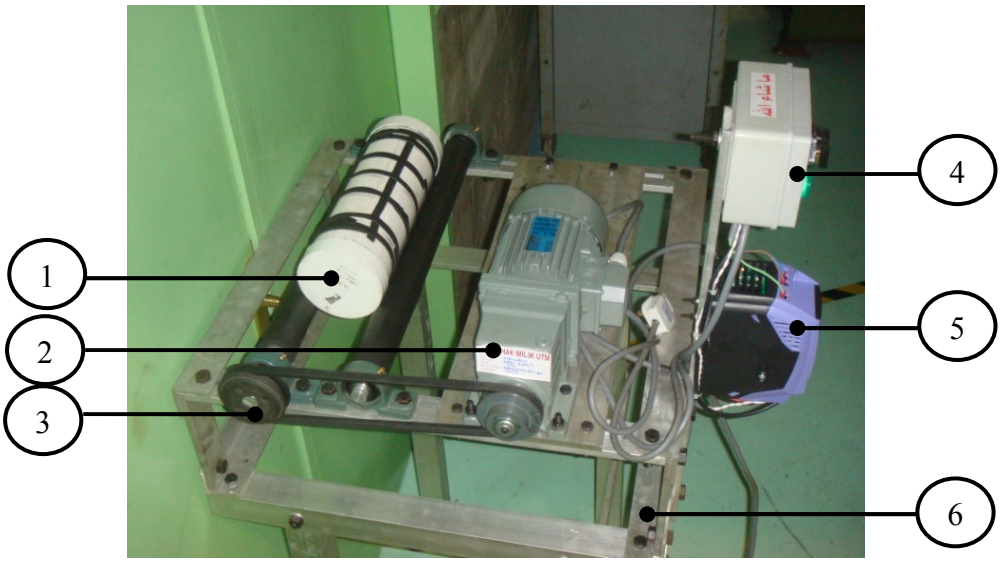
1.2 Background of Project

A ball mill process is used to transform a charcoal into powder shape. Ball mill is an efficient tool for grinding many materials into fine size. By considering all significant parameters on this machine, maximum output of charcoal powder with permitted range size shall be achieved.

In systems optimization, the goal is to optimize the operation or arrangement of existing processes without replacing older, less efficient equipment or incorporating new equipment (Metzger *et al*. 2009). This project is continuity from previous work of UTM's student. In previous work, that student had designed and fabricated a ball mill machine. Solid angle bar aluminium were used as main frame of this machine. Each frame was tighten using bolt and nut. Meanwhile, analysis of variance (ANOVA) was used to identify significant parameters that affect output. In completing the analysis, wood charcoal was used as a charcoal material to be ground. This material was chosen because it is easy to obtain compared to other type of charcoals.

This machine was equipped with castors that were attached at the bottom of the structure frame for ease transferring purposes. Basic dimension of machine is

1200mm X 600mm X 600mm with total weight is about 40 kg. Plastic jar was used as a container to fill with a charcoal material. This jar was placed on two sticky rollers horizontally. The jar was rotated by rollers that had been connected to electrical motor. The rollers are connected to electrical motor through V-shape belt type. Inverter was used to regulate the rotational speeds of jar as per required. Sticky carpet ensures the jar rotate simultaneously with speed of the roller. Besides charcoal, jar also is filled with steel ball. This steel ball acts as a crusher to the charcoal. Jar rotation forces charcoal and steel ball rotate simultaneously at a certain speed. This rotation causes them to collide and rub each other, then produce powder size of charcoal. Steel balls inside the container crush the charcoal to small size. Figure 1.1 shows main parts of ball mill machine.



(1): Jar
(2): Electrical motor
(3): Belt and pinion system
(4): Speed controller panel
(5): Inverter
(6): Aluminium frame

Figure 1.1: Main parts of the developed ball mill machine

1.3 Project Statement

Feasible range size of palm oil charcoal powder provides an effective function for filtration of drinking water and wastewater treatment. Initial study found that the developed ball milling capable of grinding charcoal into powder. However, no study was done on the feasible processing parameters to produce charcoal powder at various sizes. In addition to that, the earlier study was merely tested on the wood charcoal only. Very limited reports are available on palm oil charcoal study but even that they are not discussing on the producing method.

1.4 Research Question

a. What are the significant parameters that affect amount of charcoal powder?

b. What are the feasible ball mill parameters to obtain maximum output with micron range size of charcoal powder?

1.5 Objectives of project

i. To determine significant processing ball milling parameters for crushing palm oil mill charcoal
ii. To evaluate the feasible range of crushing processing parameters for palm oil shell into active carbon powder

1.6 Scopes of project

In producing maximum output of active carbon powder from palm oil shell charcoal, the study was focused on the following scopes:

1. Parameters under study were:
    a. Relative speeds between electrical motor and jar
    b. Ball size and number of balls
    c. Processing time

2. The study was conducted using the existing prototype ball mill machine developed in FKM, UTM.

3. The weight of palm oil charcoal used in the experiments was fixed in all conditions.

4. One of the experimental design approaches was employed for planning the experimental trials and analysing the experimental result.

OPTIMIZING CRUSHING PROCESSING PARAMETERS OF OIL PALM SHELL CHARCOAL

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Mechanical)

Faculty of Mechanical Engineering

MAY 2010

To my beloved mum & dad, wife

ACKNOWLEDGEMENT

In the name of Allah, the most Gracious and most Compassionate

First of all, thanks to Allah S.W.T for the blessing and opportunity for me to accomplish this thesis. I would like to thank and express my sincere appreciation to my supervisor, Assoc. Prof Dr Izman Sudin for guidance and advices in every way I need to go through this study.

Besides, I would also thank to technicians in Geotechnical Lab, Faculty of Civil Engineering and technicians in Material Lab, Faculty of Mechanical Engineering for providing measurement equipments and assisting me in laboratory tasks.

An honourable mention goes to all my colleagues who have provided assistance at various occasions. Their views and tips are useful indeed. Without helps of them, I would face many difficulties while doing this project.

Finally, my further gratitude goes to my family. Thank you for your love, support, and patience. I am truly blessed to have you as my family. Also to all people that directly or indirectly in helping me to completed my thesis.

ABSTRACT

Ball mill is a machine that used to produce powder size of materials from ceramics, glass and coal. This project is optimizing ball mill processing parameters in order to obtain a maximum output with permitted range size of powder. Activated carbon palm oil charcoal is selected as a material to be ground. Powdered activated carbon (PAC) of palm oil has a multipurpose usage such as filter for drinking water and absorption agent in wastewater treatment. In this project, granular activated carbon form of palm oil with a uniform size distribution was used in the experiment. Meanwhile, each experiment also used a constant amount of material, namely 100gram per experiment. Four independent variables were investigated, namely processing time, size of grinding media, grinding media quantity and rotation speed of jar. Sieve shaker was used to separate between coarse and fine particles size of material. Field Emission Scanning Electron Microscope (FESEM) was used to confirm size of powder that had produced. The amount of PAC produced was the main focus and act as a response value. Full factorial experimental designs with two levels of variables were used. Response surface methodology (RSM) was used to find the set of operating conditions for this process variables that result in the producing the maximum output. Result showed that all chosen independent variables were significant and contributes for obtaining maximum output.

ABSTRAK

Mesin kisar bebola digunakan untuk menghasilkan bahan bersaiz serbuk daripada seramik, kaca dan arang. Projek ini adalah mengoptimumkan parameter-parameter pemprosesan mesin kisar bebola bagi mendapatkan hasil keluaran yang maksimum dengan saiz serbuk yang dibenarkan. Arang teraktif karbon dari tempurung kelapa sawit digunakan sebagai bahan kisaran bagi projek ini. Serbuk arang teraktif karbon (PAC) daripada kelapa sawit mempunyai pelbagai kegunaan seperti sebagai penapis bagi air minuman dan juga agen penyerapan untuk rawatan loji kumbahan. Dalam projek ini, arang kelapa sawit teraktif karbon dalam bentuk granular yang seragam telah digunakan dalam setiap eksperimen yang dijalankan. Sementara itu, jumlah berat bahan kisaran untuk setiap eksperimen ditetapkan sama iaitu 100 gram. Terdapat 4 pembolehubah bebas yang dikaji iaitu masa pemprosesan, saiz media pengisaran, kuantiti media pengisaran dan kelajuan putaran bekas kisaran. Alat ayakan digunakan untuk mengasingkan hasil kisaran bagi setiap eksperimen di antara butiran kasar dan halus. *Field Emission Scanning Electron Microscope* (FESEM) pula digunakan untuk memastikan saiz hasil proses ayakan adalah tepat., Jumlah berat serbuk terhasil (PAC) adalah fokus utama dan dijadikan sebagai respon. Dengan menggunakan 2 tahap bagi setiap pembolehubah, kaedah faktorial digunakan bagi menentukan pembolehubah yang signifikant. Kaedah tindak balas permukaan (RSM) digunakan bagi menentukan keadaan pembolehubah bebas yang optimum untuk mendapatkan keputusan terbaik. Keputusan menunjukan semua pembolehubah bebas yang dipilih adalah signifikant dan memberi sumbangan dalam proses untuk mendapatkan jumlah serbuk yang paling maksimum.