"I hereby verify that I have read this report and I find it sufficient in terms of quality and scope to be awarded with the Bachelor's Degree in Mechanical Engineering (Thermal-Fluids)."

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Date : 12 December 2005

UTILIZATION OF EMPTY FRUIT BUNCHES AS A COMBUSTION FUEL TO GENERATE STEAM

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This thesis report submitted to Faculty of Mechanical Engineering in partial fulfillment of the requirements for the award of Bachelor's Degree of Mechanical Engineering (Thermal-Fluids)

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November 2005

"I hereby to declare that the work is my own except for summaries and quotations which have been duly acknowledged"

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ACKNOWLEDGEMENT

I would like to express my gratitude and appreciation to my supervisor, Mr. Safarudin Gazali Herawan for his valuable suggestion and advice throughout the project. He also help in obtaining the reference and read through the manuscript of this report.

Thanks should also be forwarded to Golden Hope Plantations Berhad especially to the manager Cheok Sing Chia , assistant manager Mr. Bakhtiar Effendy Kamaludin, and also Mr.Tan of Tan Engineering Works for giving their helping hands in the construction of the project.

I would like to take this opportunity to thank my family and classmate, who have been by my side throughout this time for their friendship, support and loyalty.

ABSTRACT

In today's high energy demand world, power generation makes important role day by days. There are many different kind of power generation system available for instance biomass, solar, nuclear, wind and conventional energy. Anyway nature energy will dry up sooner or later. Estimated that by year 2020, a total of 1.8 million ton of solid wastes by- products and 2.5 million m^3 of wastewater are generated.

As the largest palm oil export country, Malaysia has the advantages of using palm waste as an alternative energy. In the palm industry, as much as 70% of the fresh fruit brunches (FFBs) are turned into wastes in the form of empty fruit bunches (EFBs). Thus, palm oil factories have the potential of generating large amounts of electricity using their own residues. Extra power can be exported to the national grids.

The objective of this thesis is done focused on the utilization of empty fruit brunches as a combustion fuel to generate steam as an alternative way to consume power for industrial use. It will be focus on the developing the usage in waste from palm oil mill that is empty fruit brunches. At the end of the thesis, an actual design of biomass combustion chamber that results a schematic diagram for the empty fruit bunches needed to generate a value of steam is produced.

ABSTRAK

Pada dunia masa kini yang dipenuhi permintaan tinggi dengan bekalan tenaga, penjanaan kuasa menjadi semakin penting dari masa ke semasa. Terdapat pelbagai jenis sistem penjanaan kuasa contohnya tenaga biojisim, tenaga suria, tenaga nuclear, tenaga angin dan penjanaan kuasa tradisional. Akan tetapi tenaga semulajadi ini akan luput pada suatu hari.nanti

Sebagai negara pengeksportan kelapa sawit yang terbesar, Malaysia mempunyai kelebihan untuk mengguna pakai sisa buangan industri kelapa sawit sebagai sumber tenaga alternatif. Dalam industri kelapa sawit, sebanyak 70% tandan kelapa sawit segar bertukar menjadi bahan buangan dalam bentuk tandan kosong kering. Oleh itu, kilang pemprosesan kelapa sawit mempunyai potensi untuk menjana kuasa elektrik dengan menggunakan sisa buangannya.

Objektif tesis ini memberi focus kepada penggunaan tandan kelapa sawit kosong sebagai bahan pembakaran untuk menghasilkan wap sebagai satu sumber kuasa alternatif dalam perindustrian. Tesis ini akan focus pada pembangunan dalam penggunaan sisa buangan kepala sawit dari kilang pemprosesan iaitu tandan kelapa sawit kosong. Semasa berakhirnya tesis ini, suatu rekabentuk untuk pembakaran biojisim yang menghasilkan sebuah jadual mencatatkan jisim tandan kelapa sawit kosong yang diperlukan untuk menjana nilai stim yang diperlukan.

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LIST OF SYMBOLS

Symbols	Definition
P	Pressure
P_{atm}	Pressure Atmosphere
T	Temperature
T_{atm}	Temperature Atmosphere
T_1, T_{inlet}	Inlet Temperature
T_2, T_{outlet}	Outlet Temperature
A	Area
D	Diameter
V	Velocity

Greek	Definition
ρ	Density
$\dot{m}$	Mass Flow Rate
γ	Ratio of Specific Heat

CHAPTER 1

INTRODUCTION

1.1 Overview

World petroleum supply crisis which knock over the world in the year 1973-1974, makes various countries cope to exploit available natural resources as a source of energy alternative. Industrial waste has become a major concern in dealing with ecosystem or in the other word, controlling pollution nowadays. It is important to produce cleaner production and sustainable development. Reuse of resources are important because :

- It transforms the useless component of waste into usable substance.
- It slows down the depletion of primary resources in industrial production.

The concept of marketing biomass energy has a huge potential in Malaysia considering that the country has an abundant supply of agricultural wastes that can be used to generate energy. In palm oil industry, a large fraction of the fiber and much of the shell are used as fuel to generate process steam and electricity in the palm processing mill itself. However, much is wasted by dumped in areas adjacent to the mill, or utilized as manure in the palm oil plantation [3]. As of present, resources recycling and recovery are mostly concerned by industry. The use of crude palm oil

industry waste and the result of generating steam for power energy are discussed in this paper.

Palm fruits yield edible oil. Palm oil export is an important part of tropical agriculture business in Malaysia and Indonesia. Palm fruit residues from palm oil extraction process are a valuable boiler fuel. It is estimated that a total of 42 million tones of Fresh Fruit Bunches (FFB) were produced in Malaysia by end of last decade.[4]. The steam from the boiler is used for generating electric power for the plant, or as process heat for the oil refining processes.

Refer to all the statement above, we can believe designing a combustion chamber with empty fruit brunches is an effective yet commercialize way to reduce pollution and also fully utilize the large amount of waste in palm oil industry

1.2 Problem Statement

For all this time, biomass waste replacement for energy generation had been strongly promoted as it would help to improve the productive value of the finite energy resources. Biomass energy has great potential for large power demands since wind and solar energy are only suitable for small to medium power demand.

The first factor to identify is to decide kind of biomass waste to use for the combustion chamber. There are many kind of biomass can be found as Malaysia has produce a large field of crops and wastes of it, but of all the waste, solid waste of the palm oil mill is the most.

After identifying palm oil waste is the material to use, we have to decide which part of the waste have to be use such as specification of each equipment is also important.

The problem of current system is the usage traditional fuel material such as petroleum. The purpose of this study is to replace the current material with renewable energy due to the boom of the energy collapsing crisis. The result carried out is to utilize empty fruit brunches of palm oil as a combustion fuel to generate steam for energy generating. As a result, a design of a biomass combustion chamber through the implementation of biomass solid waste is proposed.

1.3 Objective

The main objective of this study is:

- To design a working model of biomass combustion chamber which use biomass waste from palm oil that is Empty Fruit Brunches(EFB)
- To obtain experiment data for steam temperature and pressure that will be produce by using a value of fuel mass with the combustion chamber.
- To produce a diagram of fuel mass versus steam generated according to the result taken.

1.4 Project Scope

The scope of this work generally involved the following:

- Literature review specifically on biomass usage as fuel material in this country.
- Material quantity analysis
- Burning process description and technology of steam generation
- Fuel Preparation and Equipment Sizing
- Determination of the temperature changes in biomass solid waste in process.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of Boiler

Broadly speaking a boiler is a device used for generating steam for power generation, process use and heating or hot water for heating purposes. A boiler is also a closed pressure vessel for generating steam under pressure. It includes all the mounting fitted to such vessels which remains wholly or partly under pressure when steam is shut-off.

In general steam boiler are of two types, base on the physical arrangement of the working fluid, hot gases from the combustion and the water for the production of steam. There are water tube boiler and fire tube boiler.

2.2 Type of Boilers

Boilers can be classified in many ways and some of the ways are as follows :-

2.2.1 By Uses

Utility Boiler

To produce steam for electric power generation . Large capacity , high steam parameters , high boiler efficiency , completely water – cooled furnace with burners when pressure is greater than or equal to 14mpa usually with reheater.

Industrial boiler

To produce steam for heating and process, etc. Smaller capacity , lower steam parameters, furnace with burners, stokers or fluidized beds, no reheater.

Marine Boiler

As a source of motive power for ships. Compact general shape , lighter boiler weight , mostly fuel –oil fired , no reheater.

2.2.2 By Steam – Water Circulation

a) Natural – circulation Boiler

The circulation of the working fluid in the evaporating tubes is produced by the difference in density between the steam – water mixture in the risers and water in the down comers. With one or two drums , can only operate at sub critical pressure.

b) Forced Multiple Circulation Boiler

The circulation of the working fluid in the evaporating tube is produced forcedly by means of a circulating pump included in the circulating circuit .

With single drum or separators, can only operate at sub critical pressure.

c) Once –Through Boiler

No drum , the working fluid forcedly passes through the evaporating tubes only under the action of the feed-water pump , can operate at sub critical and supercritical pressure.

d) Combined – Circulation Boiler

There are a circulating pump ,a back – pressure valve , and a mixer in the circuit. At starting the back –pressure valve is opened and the boiler operates as a forced multiple- circulation boiler , on attaining the specified load , the circulating pump is switched off, the back-pressure valve is closed automatically, and the boiler operate at sub critical and supercritical pressure.

2.2.3 By Pressure

a) Low-and middle pressure boiler (< 10 Mpa)

Used as industrial boiler, natural circulation , some with boiler bank , furnace with burners or with stockers, no reheater.

b) High Pressure Boiler (10 – 14 Mpa)

Used as utility boilers for large capacity once through or combined circulation, with reheater, the prevention of pseudo-film boiling and high temperature corrosion should be considered.

2.2.4 By Fuel or Heat Sources

a) Solid Fuel or Heat Sources

Cost is mainly used : The component of fuel and the characteristic of ash are important influential factors for boiler design.

b) Fuel Oil Fired Boiler

With higher flue gas velocity and smaller furnace volume.

c) Gas Fired Boiler

Natural gas or blast –furnace gas are mainly used with higher flue gas velocity and smaller furnace volume.

d) Waste Heat boiler

Utilizing waste heat from industrial processes the heating sources.

2.2.5 By Firing Method

a) Boiler with stokers

Mainly used as utility boilers.

b) Boiler with Burners

Mainly used as utility boilers or large capacity industrial boilers.

c) Boiler with Cyclone Furnace

Applicable to coal having low slag viscosity and low iron content ;fuel is fired in a water –cooled cylinder , and the flame is whirled by either tangential coast dust-air jets from burners or tangential high speed jets of secondary air (80-120m/s); as is removed from the furnace in liquid form.

d) Boiler With Fludized Bed

Solid – fuel particles (1-6mm) are place onto a grate and blown from burners with an air flow at such a speed that the particles are lifter above the grate and are burned in suspending state ; used as industrial boilers for burning low-grade solid fuels.

2.2.6 By Method Of Removing Slag In Furnace

a) Boiler With Dry Ash Furnace

Applicable to coals with high-ash fusion temperature; the ash removed from the hopper bottom of the furnace is solid and dry.

b) Doffer With Slag Tap Furnace

Liquid form aisg flows to the wet bottom of the furnace (a pool of liquid slag) and tapped into a slug tank containing water.

2.2.7 By Boiler layout Form

Tower shape and inverted u-shape.