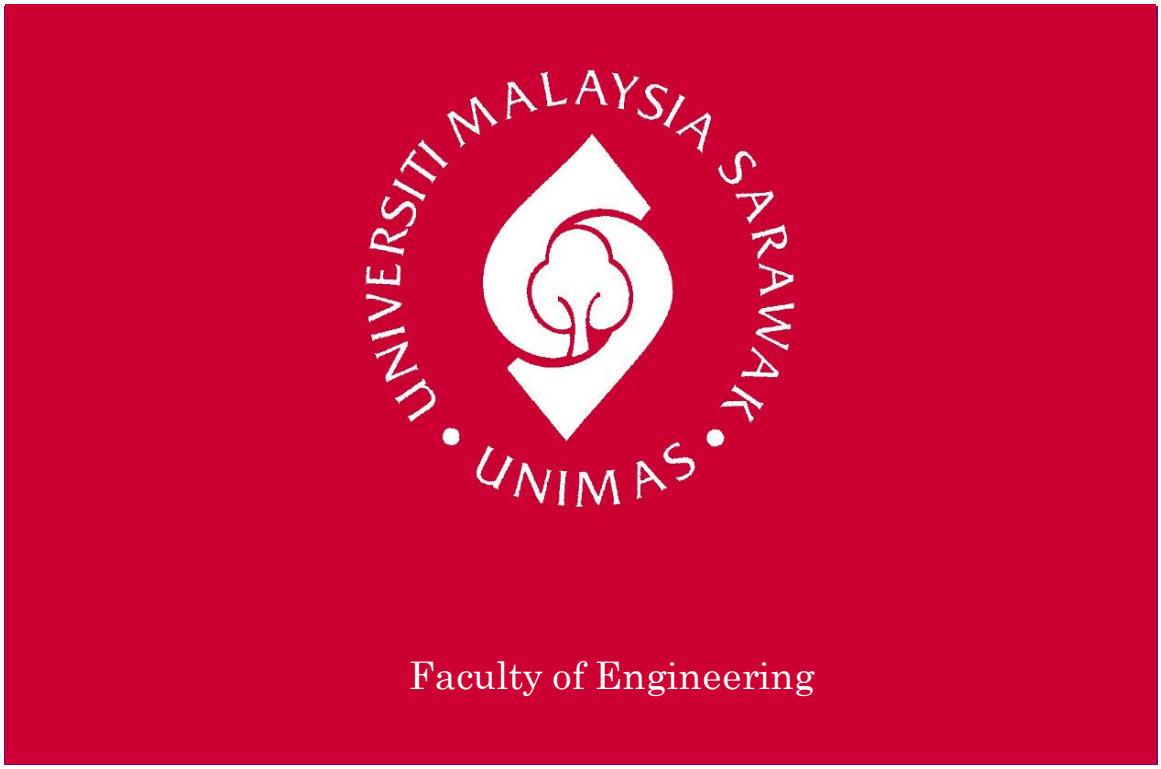

OPTIMISATION STUDY ON THE IMPROVEMENT OF CRUDE PALM OIL (CPO) PRODUCTION PROCESS FROM PALM OIL MILL

DAYANG SITI HERDAWATI BINTI ABANG HARDIN

Bachelor of Engineering with Honours
(Chemical Engineering)
2016/2017

UNIVERSITI MALAYSIA SARAWAK

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This declaration is made on the 26 day of May 2017.

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This research report which entitled **"Optimisation Study on The Improvement of Crude Palm Oil (CPO) Production Process from Palm Oil Mill"** was prepared by Dayang Siti Herdawati binti Abang Hardin (41009), as a partial KNC 4322 Final Year Project course fulfilment for the Bachelor of Engineering with Honours (Chemical Engineering) is hereby read and approved by:

_____

Dr Shanti Faridah Salleh
(Final Year Project Supervisor)

26 May 2017
Date

OPTIMISATION STUDY ON THE IMPROVEMENT OF CRUDE PALM OIL (CPO) PRODUCTION FROM PALM OIL MILL

DAYANG SITI HERDAWATI BINTI ABANG HARDIN (41009)

A dissertation submitted in partial fulfillment

of the requirement for the degree of

Bachelor of Engineering with Honours

(Chemical Engineering and Energy Sustainability)

Faculty of Engineering

Universiti Malaysia Sarawak

2017

Dedicated to my beloved parents and sister, who have always loved me unconditionally and for their support and encouragement

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ABSTRACT

Sterilisation is the first process in every palm oil mill. The process is significant in determining the quality of palm oil produces in terms of Free Fatty Acid (FFA) and the value of Oil Extraction Rate (OER) for every palm oil mill. Thus, the study is aimed do some improvement towards the crude palm oil (CPO) production process in palm oil mill industry. The objectives that related to the aim are to determine the parameters affecting the Free Fatty Acid (FFA) contains in palm oil, to identify the oil losses at different of CPO production process and to develop the programming of material balance on the process in palm oil mill using Microsoft Excel. The experiment is conducted using Hydrothermal Pre-treatment Reactor Model BP460 by SOLTEQ. A several of parameters is tested during the experiment such as temperature, heating time and pressure applied to the process in a reactor. The acceptable value of FFA (<5%) was achieved at temperature 120°C, heating time for 80 minutes with 1.8 bar applied pressure. Material balance was performed by programming using Microsoft Excel and there were three station identified which causes the major oil losses during the CPO production which were sterilization station, threshing station and sludge separator station. The new material balance was proposed and by changing the water-oil ratio at the clarification process by 35% the final oil generated was increased by 30% from 9769.18 kg/hr to 14047.2 kg/hr.

Keyword: Palm Oil Mill, Steriliser, FFA, Material Balance, Oil Losses

ABSTRAK

Pensterilan adalah proses pertama dalam setiap kilang minyak sawit. Proses ini adalah penting dalam menentukan kualiti kelapa sawit menghasilkan dari segi Asid lemak bebas (FFA) dan nilai Kadar Perahan Minyak (OER) bagi tiap-tiap kilang minyak sawit. Oleh itu, kajian ini bertujuan melakukan penambahbaikan terhadap proses pengeluaran minyak sawit mentah (CPO) dalam industri kilang minyak sawit. Objektif yang berkaitan dengan matlamat adalah untuk menentukan parameter yang mempengaruhi Asid Lemak Percuma (FFA) mengandungi minyak sawit, untuk mengenal pasti kerugian minyak pada berbeza daripada proses pengeluaran CPO dan membangunkan pengaturcaraan keseimbangan bahan pada proses di kilang minyak sawit dengan menggunakan "Microsoft Excel". Eksperimen ini dijalankan menggunakan "Hydrothermal Pre-treatment Reactor Model" BP460 oleh SOLTEQ. Beberapa parameter diuji semasa eksperimen seperti suhu, masa pemanasan dan tekanan digunakan untuk proses dalam reaktor. Nilai yang boleh diterima FFA (<5%) telah dicapai pada suhu 120 °C, masa pemanasan selama 80 minit dengan menggunakan 1.8 bar tekanan. Imbangan bahan telah dilakukan oleh pengaturcaraan menggunakan Microsoft Excel dan terdapat tiga stesen dikenal pasti yang menyebabkan kerugian minyak utama semasa pengeluaran "CPO" iaitu stesen pensterilan, stesen pengirikan dan stesen pemisah enapcemar. Imbangan bahan baru telah dicadangkan dan dengan menukar nisbah air-minyak pada proses penjelasan sebanyak 35% minyak akhir dijana telah dinaikkan sebanyak 30% daripada 9769.18 kg/jam untuk 14.047,2 kg/jam.

Kata Kunci: Kilang Kelapa Sawit, Pensteril, FFA, Imbangan Bahan, Kerugian Minyak

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ABBREVIATIONS

CPO	Crude Palm Oil
EFB	Empty Fruit Bunch
FFA	Free Fatty Acid
FFB	Fresh Fruit Bunch
IRRI	International Rice Research Institute
MPIC	Ministry of Plantation Industries and Commodities
MPOA	Malaysian Palm Oil Association
MPOB	Malaysian Palm Oil Board
MPOC	Malaysian Palm Oil Council
OER	Oil Extraction Rate
POI	Palm Oil Investigations

NOMENCLATURE

°C	Degree celcius
g	Gram
Ha	Hectare
kg/h	Kilo gram per hour
mm	Millimetre
MT	Metric tonne
psig	Pounds per square inch gauge
rpm	Revolutions per minute
w.b.	Weight basis

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Malaysia has been introduced to the ornamental plant name Oil palm (Elaeis guineensis) in 1870 by the British. The oil palm tree originated from West Africa in a belt from Angola to Senegal. The first commercial planting of palm oil tree took place in Tennamaran Estate in Selangor in 1917 (MPOC, 2012). According to MPOB (2011), about 1.5 million hectares of land were planted with a palm tree in 1985 and this number has increased by about 74% (4.3 hectares) in 2007. This what makes palm tree becomes the valuable crop in Malaysia. Despite threats of the Emergency during the 1960s, the oil palm expansion in Malaysia was rapid as its economic potential was recognised by the Malaysian Government as a complementary crop to rubber in the poverty eradication programme (Sime Darby, 2012).

Malaysia and Indonesia are sharing the title the most Asian country contributing to the increases in the production of palm oil (Teoh, 2002). As for 2012, about 4.49 million hectares of land in Malaysia is cultivated with palm oil tree which largely based on the estate management system and smallholder scheme where it producing 17.73 million tonnes of palm oil and 2.13 tonnes of palm kernel oil (MPOC, 2012). As reported by Teoh (2000) in his report entitled "Land Use & the Oil Palm Industry in Malaysia", Malaysia is the world's largest producer and exporter of palm oil. In 1999, Malaysia produced about 10.55 million tonnes of palm oil and this equivalent to 54% of world production. It is expected that the average annual production of palm oil in Malaysia will keep increasing and will reach 15.4 million tonnes in the period 2016-2020. According to the MPOC (2012), Malaysia is one the largest producers

and exporters of palm oil in the world, accounting for 11% of the world's oils & fats production and 27% of the export trade of oils & fats.

On each palm oil tree produces bunches weighing 10 kilogrammes or more and containing more than a thousand individual fruits similar in size to a small plum (POI, 2016). Each fruit is almost spherical or elongated in shape. Generally, the fruitlet is dark purple, almost black and the colour turns to orange-red when ripe as shown in Figure 1.1. Oil palm fruit is considered unique since two types of oil can be produced from the fruit. Palm oil is obtained from the fleshy mesocarp to produce crude palm oil (CPO) and palm kernel oil (PKO) from the seed. Crude palm oil which is orange-red in colour is refined, bleached and deodorised to produce the universally known bright golden oil (Soyatech, 2015). The colour comes from the antioxidant beta-carotene. Crude palm oil (CPO) is one of the raw material in making margarine, shortening, soap (MPOC, 2012). As for palm kernel oil (PKO), the oil comes from the seed contains more saturated fats than palm oil and is very commonly used in commercial cooking since the higher saturated fat content allows for greater stability at higher temperatures and better shelf life (Roussell, 2016).

Figure 1.1: Fresh fruit bunch (MPOB, 2016)

There are several main processes involves in producing the main products in palm oil mill industry which are the crude palm oil (CPO). The process includes loading, sterilisation, threshing, pressing, kernel recovery and clarification as shown in Figure 1.2. The process is start with the FFB are weighed at the weighbridge station. Then it will go to the loading and ramp station or known as the bunch reception area to unloading the FFB. Bunch reception is a place and intermediate storage to locate the fresh fruit bunch (FFB). The FFB then dumped into the hopper and transferred to the fruit cage which will be moved into the steriliser. The sterilisation process is the pre-treatment of the fresh fruit bunch (FFB) where the steriliser is functioned as pressure cooker at high-pressure steam.

Heat supply by the steam will destroy the oil splitting enzymes and stops the hydrolysis and autoxidation of fresh fruit bunch (FFB). At the same time, steam weakens the fruit stem to makes it easy in the removal of fruit from bunches in the rotating threshing drum (Poku, 2002). After threshing, the loose fruits is conveyed to the digester and oil is pressed out during the pressing process at screw press area. Digester is functioned to mashes up the fruitlets into mesocarp. The extracted oil after the pressing process ends up in the clarifier and to separate the pure oil and sludge.

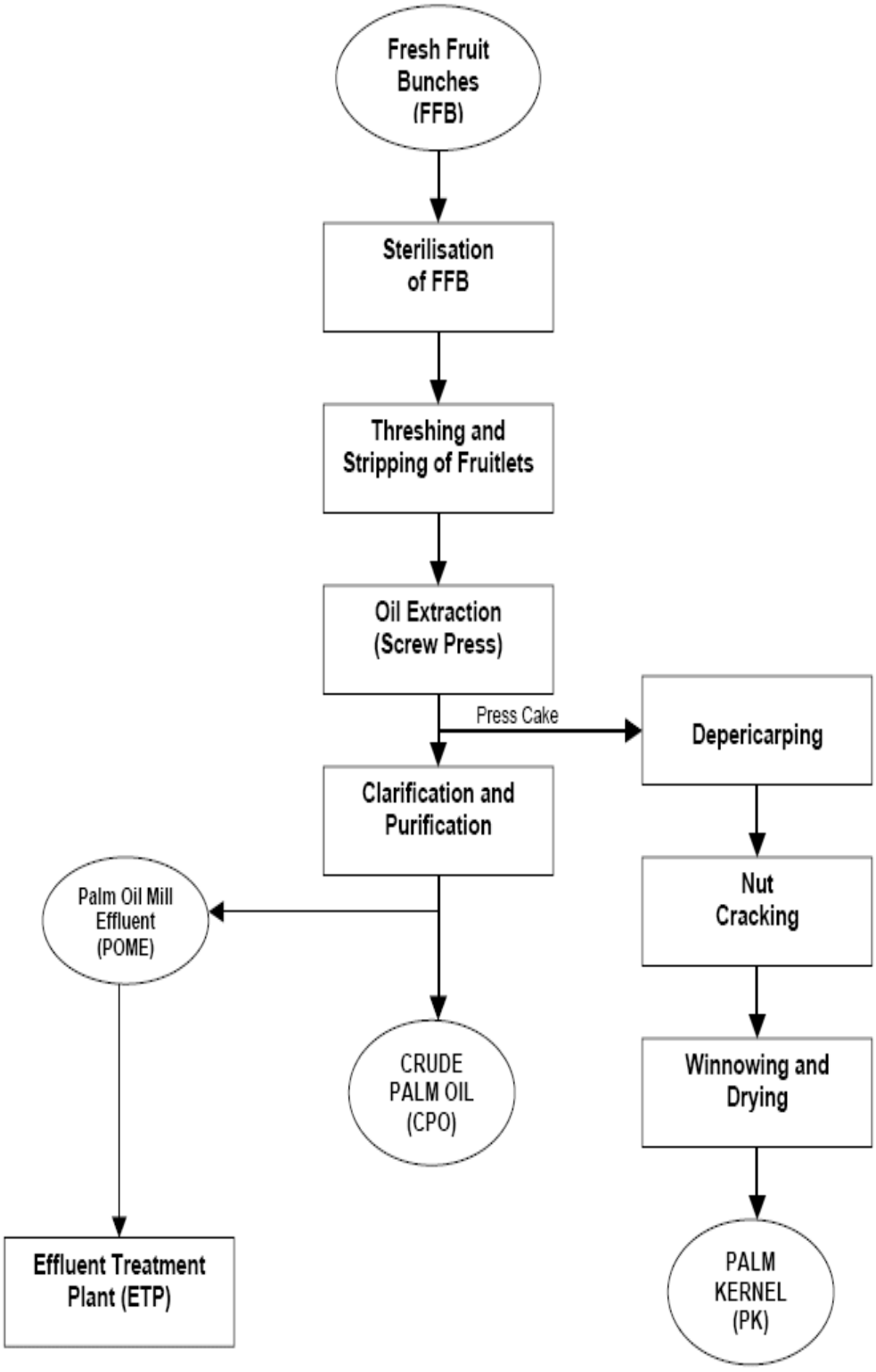

Figure 1.2: Palm Oil Mill Flow Process (Henan Doing Mechanical Equipment Co.,Ltd, 2016)

1.2 Problem Statement

An increasing of global demand for edible oils and animal protein in the last decade result in growing areas of oil crops cultivation especially on the palm oil plantation (Teoh, 2002). As at June 2015, The Star Online reported that The Ministry of Plantation Industries and Commodities (MPIC) expects improvement of the national average oil extraction rate (OER) at palm oil mills from 20% currently to 25% by 2020. This has become a challenge for each of the palm oil mill where the measurement have been implemented to strengthen the enforcement ensuring the quality and ripe FFB delivered to palm oil mills. The growth in OER and FFB can lead to higher national oil yield. Based on the statistics from the Malaysian Palm Oil Board (2016), the current oil extraction rate up until the December 2016 in every state in Malaysia is in a range of 20%-21%. According to Adzmi et al. (2012), the analysis towards the extraction efficiency is not calculated from the overall balance of oil entering the mill and oil produced, but through the estimation of oil losses in different stages involve in the palm oil production process. Until now there are only few comprehensive study or research related to oil losses in palm oil mill.

Pre-treatment of FFB during sterilisation process is the important process of determining the oil extraction rate in every palm oil mills. Sterilisation process helps in the separation of the fruit from bunches that will be further detached in a rotary drum called thresher. Apart of that, sterilisation helps in inactivation of lipolytic enzymes that responsible in rising of free fatty acid (FFA) in crude palm oil where the limit of FFA must be below 5%. The high content of free fatty acid (FFA) in crude palm oil is the most problems for the palm oil mill. Every operating condition must be operating correctly to prevent the oil losses, rising of free fatty acid (FFA) and proper oil extraction can be produced. Thus, the study on the performances of steriliser required to identify the optimised parameters affecting the current problems.

1.3 Research Gap

The experimental study on the sterilisation process effect towards the quality of palm oil in terms of FFA is conducting by using Hydrothermal Pre-Treatment Reactor. The consideration parameters for the study is the combination of pressure, temperature and time.

The oil losses throughout the CPO production process is performed by manipulating the water-oil ratio in the process via the setup of mass balance programming.

1.4 Aim of Study

This study is aimed to do some improvement towards the crude palm oil (CPO) production process in palm oil mill industry.

1.5 Scope of Study

The study's scope is focusing on the sterilisation process effect on quality of the Crude Palm Oil (CPO) produced in terms of Free Fatty Acid (FFA) and determination of oil losses towards the CPO production process.

1.6 Objectives of Study

The objectives of this study to achieve the aim are stated as follows:

i. To determine the parameters affecting the Free Fatty Acid (FFA) contains in palm oil from sterilisation process.
ii. To identify the oil losses at different of CPO production process.
iii. To develop the programming of material balance on the process in palm oil mill using Microsoft Excel.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discussed on the literature review related to the current studies. Here, the information on the overview of steriliser used in the palm oil mill, general introduction of free fatty acid (FFA) as well as the certain parameter considered during the pre-treatment process of fresh fruit bunch (FFB) is explained. Besides, the information regarding the flow process in producing the palm oil is also discussed in order to develop the material balance in palm oil mill.

2.2 Palm Oil Industry in Malaysia

Palm Oil industry have become the vital industry in Malaysia where it becomes the highest contributors to Malaysian's economic industry and absolutely a good things for our country. Other than that, this industry provides job opportunities to more than half a million people and livelihood for a million people. According to the Abdul Rani et al (2015), Malaysian has increased the production of crude palm oil (CPO) for about 1 million tons results in 7 million tons of crude palm oil (CPO) is produced up until May 2014. The growth of Malaysian palm oil industry is expected to increase endlessly since Malaysia aimed to produce 26-35 tons of crude palm oil (CPO) hectare from the 20.2 tons of crude palm oil (CPO) per hectare. Figure 2.1 shows the areas of palm oil mature tree plantation in hectares based on several countries. From the figure, it clearly shows Malaysia is leading the other countries with the amount for about 3.4 million areas of palm oil plantation for a mature plant.