Parametric Study on the Production of Dried Long Fiber in Palm Oil Mill

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Declaration

I hereby declare that this thesis entitled “Parametric Study on The Production of Dried Long Fiber in Palm Oil Mill” is result of my own research as part of my requirement to graduate with honors degree in Mechanical Engineering.

I also declare that this works has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signature:

_____

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Date: ……

Acknowledgement

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List of abbreviation

GGS	Global Green Synergy
DLF	Dried Long Fiber
EFB	Empty Fruit Bunch
FFB	Fresh Fruit Bunch
CPO	Crude Palm Oil
SERC	Science and Engineering Research Centre
SEM	Scanning Electron Microscope
CPKO	Crude Palm Kernel Oil
POME	Palm Oil Mill Effluent
OPS	Oil Palm Shell
OPF	Oil Palm Fiber
NaOH	Sodium Hydroxide

Abstrak

Kajian kes ini telah dijalankan di Kilang Minyak Sawit Kamunting Sdn. Bhd, Taiping bertujuan meningkatkan pengeluaran serat minyak kepala sawit. Ini boleh dicapai dengan meningkatkan kelajuan dram dengan suhu yang sesuai sebagai input untuk mesin. Drum pengering adalah salah satu bahagian mesin serat minyak kelapa sawit yang berfungsi sebagai penapisan dan pengeringan serat kelapa sawit yang dicincang. Pada akhir, drum pengering hanya terdapat serat minyak sawit yang panjang dengan gumpalan yang banyak kemudian dipindahkan ke mesin pembungksan yang sedia di ikat. Skop kajian ini adalah untuk menyiasat kelajuan dan input suhu yang dengan menggunakan kajian parametrik. Kelajuan dan suhu bermain peranan penting untuk memastikan pengeluaran dan kualiti serat minyak sawit adalah mengikut spesifikasi syarikat. Ia menunjukkan bahawa masa yang diambil untuk pengeluaran pada kelajuan tertentu akan sekata pada satu keadaan dan input suhu yang lebih tinggi akan mengurangkan kandungan lembapan. Di samping itu, eksperimen keatas sifat mekanikal serat minyak sawit juga dijalankan dengan dan tanpa rawatan alkali. Ujian single fiber telah dilakukan untuk melihat kesan ke atas rawatan dengan tiga NaOH yang berbeza konsentrasi. Eksperimen menunjukkan bahawa serat kelapa sawit dengan rawatan menunjukkan sifat-sifat mekanikal yang lebih baik daripada yang tidak dirawat. Pemerhatian mikrostruktur dilakukan juga menggunakan SEM untuk melihat kesan fizikal oleh rawatan untuk menyokong kesan ujian tegangan.

Abstract

This case study was carried out at Kilang Minyak Sawit Kamunting Sdn. Bhd, Taiping aiming in increasing the production of dried palm oil fiber. This could be achive by improving the speed of the drum and suitable temperature as an input for the machine. Dryer drum is one part of dried long fiber machine that function as sieving and drying the shredded palm oil fiber. At the end of the dryer drum there were only long fiber palm oil in abundance then being transferred to packing machine to be pack. The scope of the study is to investigate the suitable speed and temperature input by using parametric study on it. Speed and temperature are playing the important rule to make sure the production and quality of the palm oil fiber is follow the company requirement. It shows that the time taken of the production is constant certain speed and the higher temperature input will decrease the moisture content. In addition, experimental on palm oil fiber mechanical properties also being carried out with and without alkaline treatment. Single Fiber Tensile testing was done to see the effect on treatment with three different concentration NaOH. The experiment indicates that the palm oil fiber with treatment shows better mechanical properties than the untreated. Microstructural observation also was done using SEM to see the physical effect by the treatment to support the effect of the tensile testing.

CHAPTER 1

INTRODUCTION

1.1 Project Background

In general, a palm oil mill produces two kinds of product, which is primary products; crude palm oil and kernels and secondary product; biomass. The primary product are Crude Palm Oil and Palm Kernel that are obtained from Fresh Fruit Bunches(FFB). The secondary product is Dried Long Fiber from Empty Fruit Bunch(EFB). The overview process of is shown in Figure 1.1[1].

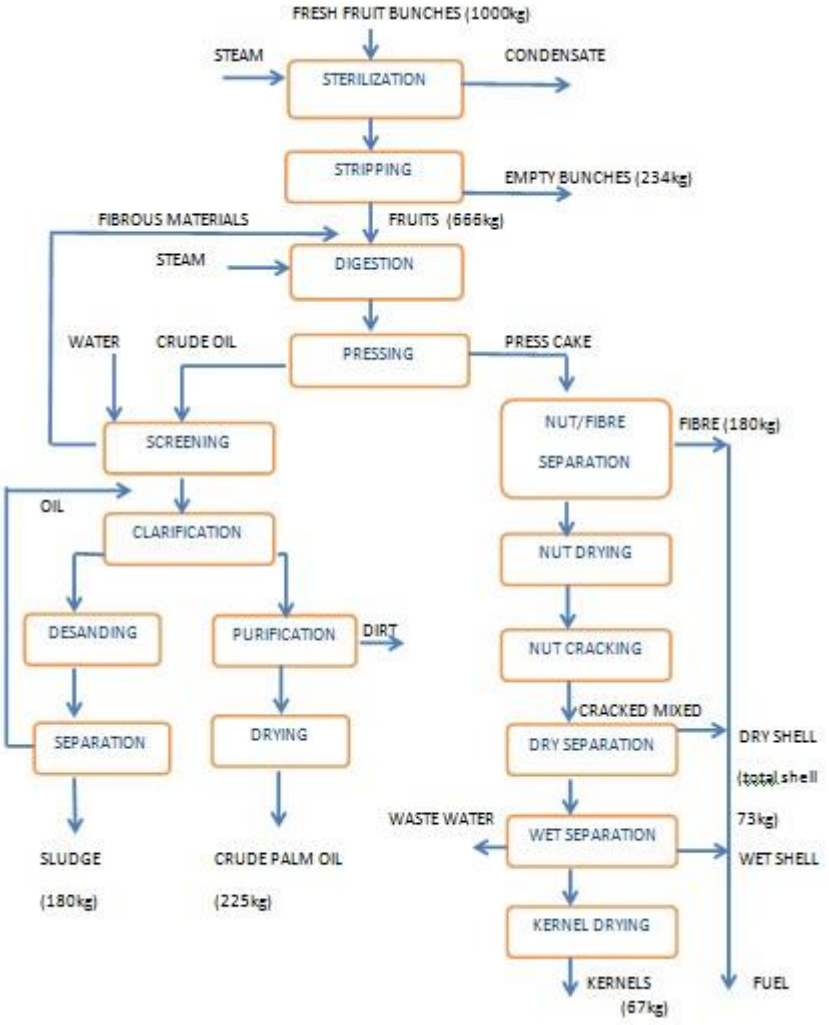

Figure 1.1 flowchart of the palm oil mill

The process is started with the fruit receiving of fresh fruit bunch (FFB) which is collected from the orchard. Then, the FFB are airtight sterilized in sterilization with injection of direct steam inside of it. Sterilizing is a process where the fruit bunches are cooked under steam pressure. During the process, the fruit will become soft and the enzymes that produce free fatty acid are deactivate. This process will also make the fruit will be easily separate from the bunch which is will be separate on the next stage of the palm oil extraction process, called threshing or stripping. There are 2 kinds of product will produce from threshing process which are stripped fruit and empty bunch. The palm fruit are conveyed to the digestion process with injection of steam to keep it on high temperature. The process will undergo to the press machine to become crude oil and press cake[2]. Palm oil mill process of mashing and pressing using screw press nut and fiber separator (figure 1.2) will separate the pulp and nut and crush the palm pulp. The crude oil and press cake which will get kernel will undergo some more stage until it produces final product which are crude palm oil (CPO) and palm kernel.

Figure 1.2 Screw Press Machine

By referring to the previous station, after the threshing process the empty fruit bunch (EFB) will undergo second press to remove excess of moisture inside the EFB. The pressed EFB are conveyed to the long fiber plant. In long fiber plant stage, the EFB will go to the EFB separating to fiberize the bulky EFB to produce long strand fibers. The fiber is going through the rotary dryer drum to reduce the moisture content down to 15% or less, with help of the hot air fan in addition of steam to increase the heat inside the dryer drum. The impurity and sieving short fiber will go down along the rotary dryer drum and it became waste. Next, the long strand fiber is fed into baling machine. The bailing machine will press the fiber and packed in bales like in Figure 1.2.

Dried Long Fiber (DLF) has its own specification that been set as requirement so it can be sell and export to other country. By referring Global Green Synergy Sdn. Bhd. website, this are the specification that indicate the quality of DLF; moisture: 12% - 15%, Oil content: < 1%, Fiber Length: 5 - 15cm, Impurities: <5%, Weight: ±250kg/bale. Palm Dried Long Fiber is useful and strong; it can be managed into various dimensions and grades to suit applications in [3]:

- Mattress and cushion production
- Erosion control, landscaping and horticulture
- Molded wares and composite material production
- Medium density fiberboard manufacturing
- Paper and pulp production
- Acoustics control

- Compost and fertilizer

Figure 1.3 Dried Long Fiber packaging

As we can see the dried long fiber itself has potential to be commercialized. Dried long fiber is still new to be used as one of natural fiber than the other such as kenaf, wood, coconut and sheep wool. It is one of the alternative materials that can be used and have potential due to its own advantages. The current study was a parametric study on the process of producing long fiber of reasonable strength for load testing application.

1.2 Problem Statement

The case study was carried out at Kilang Minyak Sawit Kamunting Sdn. Bhd. Taiping on Dried Long Fiber station. Based on 11 weeks' internship on this station, the main problem that effect the output production of dried long fiber is the throughput is too low of the dry long fiber machine. Based on case study, it causes the feeding input of conveyor (Figure 1.4) and the speed of the hammer mill (Figure 1.5). Another factor that effect the output is the moisture of the long fiber is too high. This may cause from the steam supply from the boiler. In addition, the dried long fiber of

different moisture content may affect their strength. This assumption needs to be investigated and verified. Hence, observation on the existing operation of the machine at the field and getting some data for the basis of the study is necessary.

Figure 1.4 Feeding conveyor to hammer mill

Figure 1.5 Hammer Mill to shred EFB

1.3 Objectives

Due to the above problem statement, the main objective in this research is to increase the throughput and lower moisture of the dry long fiber machine. This can be accomplished through the following objectives.

1. To determine the suitable speed of dryer drum of the long fiber machine to increase the throughput of production of dried long fiber.
2. To determine the steam temperature supply of heat exchanger to decrease the moisture of output dried long fiber.
3. To determine the mechanical properties of treated and untreated palm oil fiber.

1.4 Scope of Work

The field work is carried out at Kilang Minyak Sawit Kamunting Sdn.Bhd, Taiping. The area of focus is on dried long fiber machine under the Dried Long Fiber Station in Palm Oil Mill. The scope of the case study is on determine the optimum speed of rotary dryer drum and the steam temperature supply of heat exchanger. The observation and data collection is done in the field whereas mechanical testing is performed at USM. Experimental and microscopic observation were compared and recorded.

1.5 Thesis Outline

Essentially there are five chapter in this thesis contain of introduction, literature review, research methodology, results and discussion, and conclusion and future works.

Each chapter plays rule to archive the readers have a better understanding on research were carried out.

In the introduction, general palm oil mill process, problem statement of the project, objectives and scope works were covered. It's also explain generally about Dried Long Fiber in GGS company that was produced in the palm oil mill being used in the experiment. The literature review briefly explains thoroughly the condition of Malaysia as one of the biggest palm oil plantation and the biomass that produce by it. In addition, the various type of waste that usually found in palm oil mill was been explain and going through some other research that been doing experiment on natural fiber.

The experimental were carried out on Dried Long Fiber Machine in Kamunting Palm Oil Mill, Kamunting, Perak were explained in Chapter 3 and also it related processes. Besides that, mechanical testing that was done at Science and Engineering Research Centre (SERC) and treatment that being used in palm oil was also explain too. Observation on fiber surface also been done using SEM.

Results and discussion section shows all the recorded result and data that been gained from the palm oil mill and in SERC. Result from the Scanning electron microscope (SEM) also being compared to see the difference in physical properties of it. Experimental were being done in palm oil was compared with theoretical production that should be get from it. All the data were analyzed and discussed thoroughly. The data that being extract can be concluded on last chapter to see the achievement on the objectives of the thesis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Malaysian is the second largest country worldwide that produce palm oil by 20,000.00 MT in 2016 by referring to United States Department of Agriculture. Palm oil is one of the seventeen major oils and fats in the world market. It is considered one of most popular and consumable in vegetables oil around the world. With 4.49 million hectares of Malaysia land being used for palm oil plantation, it produced 17.73 million tons of palm oil and 2.13 tons of palm kernel oil. Malaysia was considered as one of the leading country in accounts for 39% of world palm oil production and 44% of world exports. In fulfilling the global need in oil and fats, Malaysia plays the major role to make sure it sustainable across the world.

Malaysian government is fully passionate and committed in expanding the palm oil industry and encourage palm oil production. With ideal climatic condition, advance milling and refining technologies and facilities, research and development, and competent skills helps the success of Malaysian palm oil industry. Practically all palm oil generates their own power and heat through the co-generation system. The total oil planted area in Malaysia is increased gradually each year from 2014 to 2016. The area expansion happen is because of in Sabah and Sarawak with combined growth than in Peninsular Malaysia. Sabah remain the biggest contribution in Malaysia palm oil plantation. The table 2.1 shows the palm oil planted areas in each state in Malaysia for 2014 until 2016 in hectares and percentage contribution of it.

Table 2.1 Oil Palm Planted Area 2014-2016 (Hectares)[4]–[6]

State	2014		2015		2016	
	Total	%	Total	%	Total	%
Johor	733,467	13.6	739,583	13.1	745,630	13
Kedah	86,182	1.6	87,244	1.5	87,786	1.5
Kelantan	144,762	2.7	151,973	2.7	155,458	2.7
Melaka	52,849	1.0	54,603	1.0	56,149	1
N.Sembilan	169,368	3.1	177,741	3.1	178,958	3.1
Pahang	719,613	13.3	725,239	12.9	732,052	12.8
Perak	389,164	7.2	398,314	7.1	397,908	6.9
Perlis	295	0.0	294	0.0	652	0
P.Pinang	14,204	0.3	14,447	0.3	14,135	0.2
Selangor	138,482	2.6	137,336	2.4	138,831	2.4
Terengganu	168,948	3.1	172,587	3.1	171,943	3
Peninsular Malaysia	**2,617,334**	**48.5**	**2,659,361**	**47.1**	**2,679,502**	**46.7**
Sabah	1,511,510	28.0	1,544,223	27.4	1,551,714	27
Sarawak	1,263,391	23.5	1,439,359	25.5	1,506,769	26.3
Sabah & Sarawak	**2,774,901**	**51.5**	**2,983,582**	**52.9**	**3,058,483**	**53.3**
Malaysia	**5,392,235**	**100.0**	**5,642,943**	**100**	**5,737,985**	**100**

The production of palm oil is increased each year from 2012 until 2015 by 5% as shown in figure 2.1. It shows that the increment is caused by expansion of area plantation by 2% and rise in the average fresh bunches yield per hectare by 3.8% due to efficient management and agricultural inputs. However, in 2016 the production is

decreased by 10% due to climate effect after El Nino cut yield in the first half, according to Plantation Industries and Commodities Minister Mah Siew Keong.

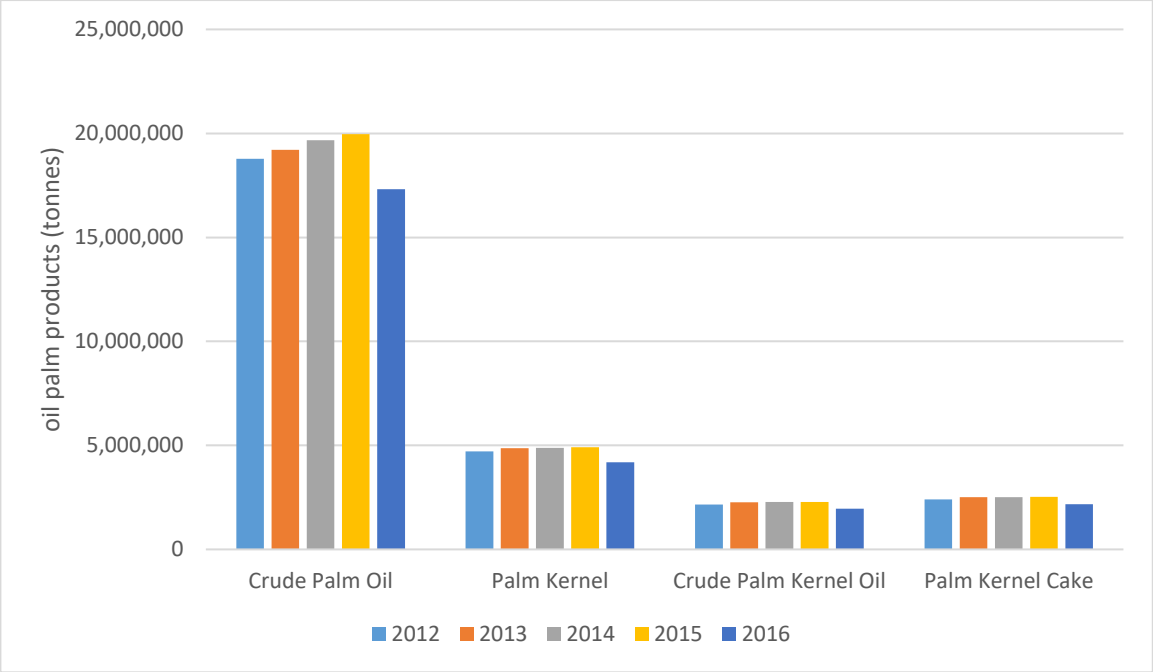

Figure 2.1 Palm Oil Production from 2012 to 2016 [4]–[7]

The highly demand of palm oil production in worldwide and rapid expansion palm oil cultivation has shown intention about the sustainable and environmental impact in palm oil plantation. It effects the ecosystem of animals and deforestation. Wastes from palm oil industry is also major concerns and the way managing waste is a challenge for palm oil mill to deal with it. Nowadays, there are lot of ways to manage of waste disposal/management techniques that prevent any harm to environment and health.

2.2 Type of waste in palm oil

Palm oil mill generates a various kind of waste. Every palm oil industry has this challenging task to dispose and manage their waste. As these wastes are organic in origin, they are rich in plants nutrients, Air pollution, climate change, liquid wastes as Crude Oil (CPO), Crude Palm Kernel Oil (CPKO), Palm Oil Mill Effluent (POME) and Solid Waste, Empty Fruit Bunches (EFB), Oil Palm Shells (OPS), Oil Palm Fiber (OPF) [8].

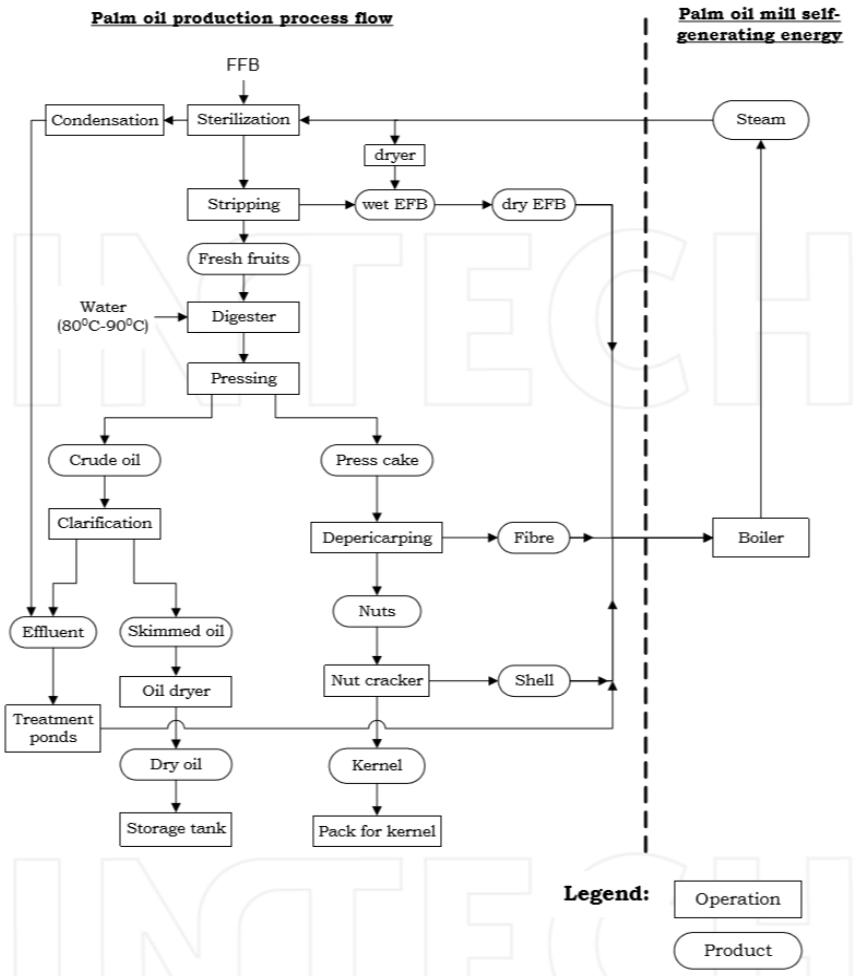

Figure 2.2 Palm oil Process flow[12]

2.2.1 Oil Palm Shells(OPS) and Oil Palm Fiber (OPF)

Oil palm shells and oil palm fiber were origin from the fruit of the palm oil. This is the waste that produce after depericarpring to separate the nut from the fiber and nut cracker process to separate the nut to gain the kernel.

Currently palm oil mill was using these wastes as by product for their boiler as fuel to produce its own steam. The pressure vessel used for cooking FFB with steam is known as sterilizer and the process as sterilization [9]. The steam also being used as to drying the wet EFB in Long Fiber Station.

Figure 2.3 oil palm shells and oil palm fibers

2.2.2 Empty Fruit Bunches (EFB)

Stripping process will remove the fruit from the bunches; called empty fruit bunches (EFB). Raw EFB has moisture content in 60% water and oil inside of it [10]. The raw EFB need to go through bunch press machine to extract the content to 50%.

Bunch press type that being used in some company is screw type press. Content inside of EFB need to be clarification because of it has water and oil.

Current practice that being done in palm oil were through mulching process as an organic fertilizer for the palm oil plant. However, due to the increased cost of labor and transports and its utilization as mulch is becoming more expensive [11]. In addition, it also increases the breeding of pest and exposed to open air and natural decomposition which produce methane. Other alternative method that being practice was by burning it into ashes and use as fertilizer. But its drawback some effect to the environment which is air pollution and has been enact in law led to banned to be practice it anymore[12]. Latest method that being used was by turn it into by product as dried long palm fiber by shredded the EFB.

Figure 2.4 Abundance of EFB and mulching process in palm oil plantation

2.2.3 Palm Oil Mill Effluent (POME)

POME is water discharge from various process such as sterilization, crude oil clarification, digester and bunch press process. It is the largest Palm Oil industry by-product, a colloidal suspension containing 95-96% water, 0.6-0.7% of oil and grease

and 4-5% of total solids[8]. Anaerobic pond (figure 2.5) emits a huge amount of the strong greenhouse gas such as methane gas.

Traditionally, POME was being disposed after treatment into the river, streams or surrounding land [13]. This are effected the living organism in water and caused pollutant that cannot be used as domestic use for human[14] and there were some evidence that shows that some villagers complained that oil and dirt pollution from the mill that effect the water source in that region[15]. Nowadays, advance technology being used to treat POME more efficiently to make sure a better environment. These include biogas[16], anaerobic digestion [17], aerobic digestion[18]. These technologies being used in palm oil mill to reduce pollution and challenges that need to be control as required by Department of Environment (DOE).

Figure 2.5 Effluent treatment will go through certain stage before discharge to river.