ENERGY EFFICIENCY IMPROVEMENT AND RENEWABLE ENERGY IMPLEMENTATION FOR COPRA OIL EXTRACTION PROCESS

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ABSTRACT

The global demand for coconut oil has become more as the shortage of raw material and war happening across the world. Each country needs to find or ensure they have adequate supply of food for the internal usage. The current copra oil extraction method is similar to other seeds available which is using the expeller press method. The process has been in the market for very long and has been used by most of the copra producers. To ensure the market player has a more competitive processing plant in terms of energy efficiency and less impact to the environment, this research help to fill the major gap which helps to reduce the impact. To do benchmarking and to obtain live data, the suitable key energy consumption indicator is identified based on the performance of the current operational system and all necessary improvement is added as needed to increase the production rate while reducing the energy consumption of the overall plant. All data and information is collected based on actual operation of a plant. The plants performance has been monitored and a lot of improvement needed to be done on many part of the operational features. The main feature which we have studied and implemented is the additional plant which is called the "Solvent Extraction Plant". The adding of this feature will actually increase the overall capacity of the plant by nearly **40%** while maintaining or reducing the overall energy consumption of the plant by **5%-8%**. Other than the above improvement, Renewable energy is also implemented on the plant. 2 type of RE is implemented which is the Solar power system which will substitute or reduce the usage of the Grid supply by **5%** with the available space. The capacity of the solar system can be optimized by increasing the space or changing the solar panel spec to a higher efficiency panels. As for the Biomass Boiler which is introduced to the plant, the main function to reduce the dependency on the bunker oil and to reduce carbon footprint. The biomass boiler is considered good for this plant as they have abundance of coconut shell which is underutilized at this moment. Thus we have the opportunity of fine tuning the copra extraction plant energy efficiency while increasing the overall capacity, our main aim is to improve and extend the same solution or technology to other Copra extraction plants in Malaysia. Even if a lot of players are aware of the technology but they have not implemented on the solution because of lack of experience and working models.

ABSTRAK

Peningkatan permintaan minyak kelapa pada peringkat global telah bertambah kerana kekurangan bahan mentah serta peperangan yang berlaku diserata dunia. Setiap negara perlu memastikan supaya bekalan makanan dalam negara cukup untuk keperluan domestic. Teknik proses minyak kelapa yang terdapat di pasaran merupakan sama seperti proses yang digunakan oleh bahan mentah lain iaitu menggunakan teknik " screw press". Teknik ini sudah ada dalam pasaran agak lama dan digunakan oleh kebanyakan pengeluar minyak kelapa. Untuk memastikan pengeluar minyak kelapa mempunyai proses yang lebih baik dari segi kecekapan tenaga dan kurangkan impak pada alam sekitar, kertas kajian ini bertujuan untuk menangani serta mengurangkan impak tersebut. Untuk mendapatkan data serta informasi yang tepat mengenai pemprosesan kelapa, sebuah kilang yang beroperasi dijadikan sebagai model bagi kertas kerja ini. Segala data diambil berdasarkan operasi yang berlaku.Segala data yang diambil bertujuan untuk meningkatkan prestasi pemprosesan serta meningkatkan kecekapan pengurusan tenaga pada keseluruhan kilang. Ciri penting yang dikaji dan dilaksanakan adalah penambahan proses yang dinama "Solvent Extraction Process". Penambahan proses ini boleh menambahkan kapasiti keseluruhan kilang sebanyak 40% dengan mengekalkan atau meugurangkan penggunaan tenaga sebanyak 5% - 8%. Selain penambahan ini, tenaga yang boleh diperbaharui telah diperkenalkan pada proses ini. 2 jenis tenaga diperkenalkan iaitu tenaga solar dan tenaga biomass. Tenaga Solar yang diperkenalkan boleh mengurangkan pengunaan tenaga dari grid sebanyak 5% dengan kawasan yang boleh digunakan pada kilang. Penggunaan ini boleh ditingkatkan dengan menambahkan kawasan penggunaan dan juga menggunakan panel solar yang mempunyai kecekapan yang lebih tinggi berbanding dengan panel yang dicadangkan. Untuk tenaga biomass pula, fungsi utam adalah untuk mengurangkan penggunaan minyak bunker dan gas asli sebagai bahan mentah untuk pembakaran. Penggunaan tempurung kelapa adalah medium utama yang disyorkan kerana boleh didapati dengan wenangnya di lading kelapa sawit. Tujuan utama kajian ini dilakukan kerana banyak pengeluar kelapa yang mengetahui mengenai proses-proses ini, tetapi tidak banyak kajian atau pengalaman dalam mengimplemantasikan proses tersebut dalam kilang sebenar.

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LIST OF ABBREVIATION

PV	-	Photovoltaic
PSH	-	Peak Sun Hour
POE	-	Polyolefin Elastomer
P	-	Positive
N	-	Negative
LCC	-	Life Cycle Cost
LCOE	-	The Levelized Cost of Electricity
GHG	-	Green House Gas
SEDA	-	Sustainable Energy Development Authority
UNDP	-	United Nation Development Program
SDG	-	Sustainable Development Goal
RE	-	Renewable Energy
NPV	-	Net Present Value
DTP	-	Dynamic Investment Payback Period
PHE	-	Plate Heat Exchanger
PKC	-	Palm Kernel Cake
PK	-	Palm Kernel
OC	-	Oil Content

LIST OF SYMBOLS

ɳ	-	PV Module Efficiency
G	-	The intensity of solar power at a point of observation
L	-	PV Module Length
W	-	PV Module Width
H	-	PV Module Height
ɳ	-	PV Module Efficiency
G	-	The intensity of solar power at a point of observation
L	-	PV Module Length

CHAPTER 1

INTRODUCTION

1.1 Research Background

Coconut oil is an edible oil that has been consumed in tropical countries for thousands of years. As it has a long shelf life and a melting point of 76 °F, it is used in baking industries. A negative campaign against saturated fats in general, and the tropical oils in particular, led to most food manufacturers abandoning coconut oil in recent years in favour of hydrogenated polyunsaturated oils, particularly soy, which contain Tran's fatty acids. Studies done on populations consuming diets high in coconut oil show no adverse effects on the health of the population. The coconut oil market size was valued at $3,440.00 million in 2020 and estimated to reach $7,390.20 million by 2030.

The extraction of oil from copra is one of the oldest seed crushing operations. Most of the existing copra extraction plant is either using the old method of extraction with high consumption with low extraction rate. Proposed 'Pre press Solvent Extraction Method' is a process introduced to combine the existing expeller press and solvent extraction to get a much better yield by increasing the yield and reducing the overall consumption of the energy.

Global energy demands have increased exponentially due to the growing population and rapid urbanization. Global energy consumption rebounded with a 5% growth in 2021, after a 4.5% decline in 2020, in a context of global pandemic.

Additional integration of solar power supply, introduction of biomass plant using coconut shell and Integrating the numerous heat exchanger will tremendously increase the overall performance of the plant.

The above not only provides additional revenue for the plant but the integrated system with RE provides environmentally friendly solution.

Figures show the copra meal market growth by region globally copra meal market growth by region globally.

Figure 1.1: Market Growth, by Region Global

1.2 Problem Statement

Even though copra oil extraction in general has been in the market for very long and the current process is being widely used in the industry, there are a lot of problem or unresolved matter which still can be addressed further to increase the efficiency of the plant in terms of energy consumption. There are few major problem which will be highlighted to improve the efficiency rate of the plant.

The most important problem is the extraction rate compared to the overall yield and energy consumption. Based on the current process which is the expeller press

extraction, the yield or the oil that is recovered is low but the overall consumption of the energy is high. This make the overall efficiency in terms of energy low.

Next, at this current rate, the overall plant is using energy source from non-renewable energy source only. The current power demand is taken solely from the grid supply provided to the factory. As for the steam demand, the bunker oil boiler is used fully to cater for the entire plant facilities. No improvement or connection is done to the vast available RE energy around the plant.

From the above, several of the main challenges faced to achieve better energy efficiency for the extraction of copra, solution to these challenges would be explored in depth through this research study.

1.3 Research Objectives

The primary objective of this research is to improve the energy efficiency of the plant and to implement renewable energy for the copra oil extraction process as below:

a) To evaluate and assess the existing extraction process capability by integrating another extraction method to increase the performance.
b) To evaluate and assess the current energy demand in terms of power and steam by introducing new RE energy. The new source of RE is including Solar and Biomass in replacing the existing energy from grid supply and Bunker oil Boiler.

1.4 Research Scope

The research scope includes:

a) Performing a through literature review on various technologies and solution related to the copra extraction methods in Malaysia, to determine the challenges that prevent the development of a viable or better extraction system in this country.

b) Gathering data on the copra extraction, power demand, steam demand, overall system integration, utilities of the plant from online databases, literatures or technology suppliers as case studies to validate he effectiveness of the proposed improvement.

c) Identifying, analysing and comparing the technical, commercial (e.g. pay back period) and environmental aspect of the extraction plant with the existing operating system and the new proposed improved system for a given study period.

1.5 Significance of Research

Our research for the current proposed copra plant is based on UNDP's sustainable development goal (SDG) 7 – affordable and clean energy and 12 – responsible consumption and production.

SDG 7 focus on RE which all participating countries are to actively invest in solar, thermal and wind energy to improve energy productivity and ensure its accessibility to all. As for SDG 12 – all participating countries are to actively ensure good use of resources, improving energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and ensuring a better quality of life for all.

Hence, in accordance with the above, this research study is performing techno-economic and environmental analysis the feasibility of the new improvement measures based on many criteria.

The techno-economic study using all combined efficiency improvement will be a benchmark or reference to all plant operators to implement the new modification. Finally this research shall act as a mechanism towards the optimal planning and establishment of the new improved system for copra extraction system in Malaysia and also globally.

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