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ANALYSIS OF THE POTENTIAL FOR UTILIZING PALM WASTE AS A BOILER MATERIAL IN STEAM POWER PLANT PT. SYAUKATH SEJAHTERA

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Abstract – Utilization of palm oil solid waste as boiler fuel is an option in the effort to manage waste in palm oil mills. This utilization is to realize the need for electrical energy for the process of generating electric power by generators. PT. Syaukath Sejahtera is a company engaged in the argo-industrial processing of palm oil into CPO (Crude Palm Oil), has its own power plant system with a total installed electric power capacity of 1000 kW. This research aims to study the potential utilization of palm oil solid waste as boiler fuel at PT. Syaukath Prosperous. After conducting a study by observing field data analysis, it is known that the potential amount of fuel (shells and fibers) is 9450 kg/hour and the calculation of the need for boiler fuel is known to be 5149.34 kg/hour. The optimum mixture of waste palm shells and fibers for boilers in PT. Syaukath Sejahtera with a fuel mixture of 25% shells and 75% fiber, namely: Shells 1287.33 kg/hour and fibers 3862 kg/hour with a total steam produced of 20000 kg/hour. The total output of electrical energy from the steam turbine is 706.99 kW, while the electrical energy requirement is 651.14 kW. It can be concluded that the demand for electrical energy in the palm oil processing process at PT. Syaukath Sejahtera has been fulfilled.

Keywords: Boiler, Shell, Energy, Waste, Fiber.

I. INTRODUCTION

Oil palm is one of the plantations that is quite popular among the people, because it promises quite large profits and the costs required for gardening are quite cheap and uncomplicated. Almost two parts of Indonesia have oil palm plantations, because it can grow well in the highlands and lowlands and is one of the producers of vegetable oil [1]. Based on the palm oil commodity statistics book published by the Directorate General of Plantations, in 2021 the area of oil palm plantations will reach 15 million hectares with a production of 49.7 million tonnes of CPO [2]. This shows that oil palm plantations in Indonesia have a high impact on the waste generated, especially solid and liquid waste from palm oil.

PT. Syaukath Sejahtera is one of the factories on the Indonesian island of Sumatra. This palm oil mill is located in Keude Lapang Village, Gandapura District, Bireuen District, Aceh Province. This palm oil mill was established in 2010, and started commissioning in January 2012. Processing at the palm oil mill currently has a processing capacity of 45 tonnes/hour.

In fulfilling the electrical energy the palm oil mill must be able to provide several important things for the electricity energy needs. In this case the availability of fuel is the most important thing for the realization of the need for electrical energy for the process of generating electricity [3]. However, palm oil processing factories will at some point experience problems related to fuel shortages and their careers. Of course this is a very serious problem, because without fuel the factory cannot produce steam, and without steam the processing cannot be carried out.

Energy Conversion Process

Stages to obtain electrical energy starting from a fuel source into electrical energy. The shells and fibers are put into the combustion chamber to be used as fuel to heat the steam boiler to produce high pressure steam. The steam boiler used in the waste burning process is a special type that uses a grate system. Different from other fuels which do not use a grate system. When using shells and fibers, 25% shells and 75% fibers are used, this is due to the boiler specifications. If it is not used properly it will damage the grate.

After burning the shells and shells, the air will heat up to produce steam. High pressure steam from the boiler (20 kg/cm2 280˚C) flows through a nozzle which simultaneously reduces the steam pressure until it becomes pressurized (19 kg/cm2 260˚C) regulated with an efficiency of 85%. The shaft by the reduction gear is installed between the turbine and generator so that speed synchronization is obtained between the turbine and generator. Because the generator rotates, it will create an electric magnetic field so that it will generate electric power.

The residue from burning the shells and fibers is called ash (dust) and is discarded. The dust from burning shells and fibers still contains a lot of calories, which is currently being researched to be used as fertilizer, where the ash from burning shells and fibers contains nutrients P = 1.74 – 2.61%, K = 16.6 – 24.9 %, and Ca = 7.1% [4].

Palm Oil Mill Electricity

The use of high electrical energy consumption automatically affects operational costs to be higher. If operational costs for fulfilling electricity are not offset by increased production and factory capacity, then this will result in large losses, therefore efforts need to be made to identify the causes of the high use of electrical energy in PKS. The impact of electricity consumption values that are above the standard can indicate a waste of energy or the use of large loads, but it is also necessary to review the existing loads first, apart from that, high electricity consumption can cause high operational costs if a large contribution of electrical energy comes from the generator. Ideally, palm oil mills are able to independently meet energy needs. Palm fiber and shell waste is used as boiler fuel as a steam generator which is used to drive turbines for electric power plants as well as a source of steam for boiling and processing processes [5].

The energy sources installed in the palm oil mill with a capacity of 45 tons/hour are two 400 kW generator units, one 200 kW generator and one 100 kW steam turbine generator which can operate alternately or together. Generators with a capacity of 200 kW are operated to supply domestic needs and lighting when the factory is not active and the turbines cannot work. Generators with a capacity of 2 × 400 kW are operated for ignition and the factory's first process until the factory produces for ignition and the factory's first process until the factory produces Shells and Fibers for Boiler fuel and the Boiler is able to produce steam with the expected capacity to drive a steam turbine to produce electrical energy continuously.

The turbine can operate normally if the steam pressure is in the range of 18 – 20 bar. If the boiler working pressure shows a decreasing trend of up to 15 bar then the turbine cannot be loaded for the factory process and a trip will occur so that to ensure the process does not stop suddenly, the engine room operator immediately activates the 400 kW generator to synchronize with the turbine.

II. METHODOLOGY

Research data obtained from the results of observation reports, such as the calorific value of fuel, fuel flow rate, engine specifications and specifications of the turbine-generator generator under study. Research data collection was carried out at the palm oil mill PT. Syaukath Sejahtera, who was in Keude Lapang Village, Gandapura District, Bireun Regency, Aceh Province on July 27-29 2022. This method was used after obtaining the data needed to conduct an analysis on the potential utilization of boiler fuel at steam power plant PT. Syaukath Prosperous.

Table I
Steam Turbine-Generator Specification at PT Syaukath Sejahtera

Model	RB4M
Serial No.	1149567
Output	1000 kW
Turbine speed	5294 rpm
Output Shaft Speed	1500 rpm
Steam Press	20 barG
Steam Temp	215°C
Exhaust Press	3.5 barG
Weight	6350 kg
Date	06-2020

Table II
Boiler Specifications PT. Syaukath Sejahtera

Capasity	20 tons/hour
Steam Temp	280°C
Steam Press	20 kg/cm^3
Feed Water Temp	90°C
Steam Boiler Efficiency	85%
Fuel Usage	75% fibers 25% shells

The procedure is carried out as shown in Figure 1.

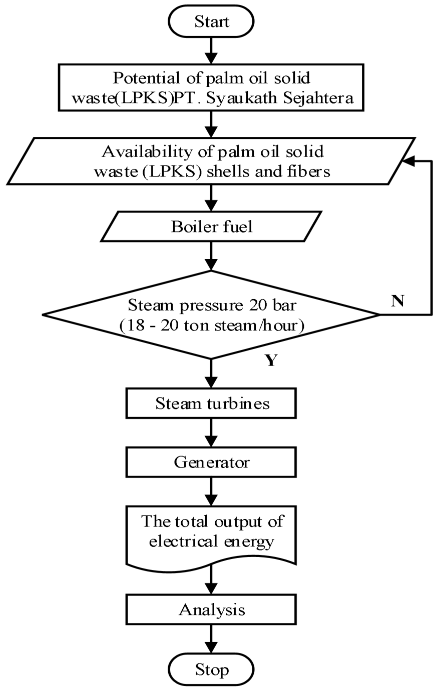

Fig. 1 Research Flowchart

III. RESULTS AND DISCUSSION

A. Analysis of the Use of Palm Oil Waste as Boiler Fuel

PT. Syaukath Sejahtera has a factory processing capacity of 45 tons of FFB/hour. The fuel produced from palm oil solid waste is in the form of shells, fibers, and tankos (empty fruit bunches). However, only shells and fibers are used as boiler fuel.

To find out the potential amount of palm oil solid waste to become boiler fuel at the PLTU at PT. Syaukath Sejahtera will describe the calculation as follows:

1. Calculation of Shell Fuel Availability

Production = Manufacturing Capacity×Shell Rendering
= 45,000 kg FFB/hour × 8%
= 3,600 kg/hour

2. Calculation of Fiber Fuel Availability

Production = Manufacturing Capacity×Fiber Rendering
= 45,000 kg FFB/hour × 13%
= 5,850 kg/hour

Then the total availability of shell and fiber fuel is:
= 9,450 kg/hour

Table III
Total Production Potential of Shells and Fibers

Palm Oil Mill Capacity (kg FFB/hour)	LPKS	Presentation of TBS on Fuel (%)	Amount of Fuel (kg/hour)
45000	Shells	8	3600
	Fibers	13	5850
		Total	9450

Table IV
Boiler Fuel Requirements

No	Name	Value
1.	Boiler Steam Capacity	20,000 kg/jam
2.	Boiler Technical Efficiency	85 %
3.	Boiler Working Hours	13 jam
4.	Shell Calorific Value	4300 Kkal/kg
5.	Calorific Value of Fiber	2350 Kkal/kg
6.	Fuel Calorific Value	6650 Kkal/kg
7.	Shell Fuel Requirements	1287,33 kg/jam
8.	Fiber Fuel Requirements	3862 kg/jam
9.	Total Fuel Requirements	5149,33 kg/jam

From the discussion above, it can be concluded that the amount of shell and fiber production is sufficient to meet the needs of boiler fuel. Where the fuel produced by palm oil solid waste is 9450 kg/hour, while the boiler fuel requirement is 5149.34 kg/hour, then the excess (residual) boiler fuel is 4300.66 kg/hour. This is also proven by the observations made that to meet boiler fuel, shells and fibers are sent directly to the combustion chamber in the boiler (boiler) after they are produced from the FFB processing process, so there are no restrictions on fuel use just by maintaining the steam rate in the boiler, amounting to 18-20 kg/cm2 [6].

B. The Total Output of Electrical Energy Generated from Turbines for Electrical Energy Needs

From observing the measuring instruments installed on the main panel in the engine room station, data on the measured electric current, measured electric voltage and measured cos φ were obtained. From the data that has been obtained, calculations can be carried out to obtain the amount of measured electrical power (kW) at each processing station in a three-phase electrical system using the formula [7] [8] [9] [10].

$$P = \sqrt{3} \times V \times I \times \cos\varphi \quad (1)$$

Where :
P = Electrical power (kW)
V = Voltage (Volts)
I = Current (Amperes)
Cos φ = Power factor

The calculation of the measured power on the main electrical panel can be seen in Table 5.

Table V
Measured Electrical Power in the Electrical Panel

Activity	Electric current Measured (A)	Measured Electrical Voltage (V)	Cos φ	Measured Rated Electrical Power (kW)
Fruit Reception & Boiling	162	380	0.8	83.72
Threshing	88	380	0.8	45.47
Compression	240	380	0.8	124.03
Oil Refining	238	380	0.8	122.86
Seed Processing	230	380	0.8	118.86
Energy Supply	200	380	0.8	103.36
Water Supply	102	380	0.8	52.71
Amount	1620			651.14
Fruit Reception & Boiling	162	380	0.8	83.72

A series of research results based on a logical sequence/arrangement to form an explanation. The contents show facts/data and do not discuss the results. Can use tables and figures but not describe repeatedly the same data in pictures, tables and text. To further clarify the description, you can use subtitles.

Discussion is a basic explanation, relationships and generalizations shown by the results. The description answers the research question. If there are doubtful results then present them objectively.

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IV. CONCLUSION

The results of the calculations and data analysis carried out in this research can be concluded as follows:

Palm oil mill PT. Syaukath Sejahtera utilizes LPKS in the form of fiber dregs (Fiber) and shells (Shell) as fuel in the boiler station to produce steam to generate electrical power to drive factory machines in the palm oil processing process. Meanwhile, the potential amount of fuel produced from LPKS with a factory capacity of 45 tons of FFB/hour is 9450 kg/hour, and the boiler fuel requirement used is 5149.34 kg/hour, then the excess shell and fiber fuel is 4300 kg/hour . The optimal mixture of palm shell and fiber waste for boilers at PT. Syaukath Sejahtera with a fuel mixture of 25% shell and 75% fiber, namely: 1287.33 kg/hour shell and 3862 kg/hour fiber with total steam produced of 20,000 kg/hour. The total electrical energy output from the steam turbine is 706.99 kW, while the electrical energy requirement is 651.14 kW, so it can be concluded that the electrical energy requirement in the palm oil processing process at PT. Syaukath Sejahtera has been fulfilled.

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