

# The Fresh Fruit Bunch Boiling Process at the Sterlizer Station in Palm Oil Processing at PT. Sumber Bumi Sawit Jadi Jaya

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## ABSTRACT

This study aims to analyze the Fresh Fruit Bunch Boiling Process at the Sterlizer Station in Palm Oil Processing at PT. Sumber Bumi Sawit Jadi Jaya. In writing this report, data collection is very important. The data collection methods used by the author are as follows: Documents or References Data collection through written and electronic documents from PT. Sumber Bumi Sawit Jadi Jaya. Field Observation. The method is carried out by direct observation in the company environment. Literature Review. In addition to field observations, data is also taken from several literatures related to this report. The location of the field work practice was held at PT Sumber Bumi Sawit Jadi Jaya which is located on Jalan Besar Mandoge-Kisaran. And the field work practice lasted for 1 month. Starting from September 1st – October 1st, 2023. The conclusions obtained from the results of the practical work are as follows: PT. Sumber Bumi Sawit Jadi Jaya is a factory that processes fresh oil palm fruit bunches into CPO and palm kernel. The processing capacity at PT. Sumber Bumi Sawit Jadi Jaya is 30 Tons of FFB / Hour The organizational structure at PT. Sumber Bumi Sawit Jadi Jaya is a functional organizational structure. The results of processing the percentage of cardiovascular load obtained that all boiler workers needed repairs, and the workload category of the four workers was influenced by age factors.

**Keywords:** Process, Boiling, Sterlizer Station, Palm Oil



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## INTRODUCTION

The first stage of FFB processing is the boiling or sterilization process carried out in a pressure vessel (*sterilizer*) using saturated steam. The use of saturated steam allows the hydrolysis/evaporation process of the water in the fruit to occur (Dharmawan et al., 2020). If dry steam is used, it can cause the skin of the fruit to burn, inhibiting the evaporation of water in the fruit flesh and can also complicate the pressing process (Pinem, 2024). Therefore, controlling the quality of the steam used as a source of boiling heat is very important to obtain perfect boiling results (Nainggolan et al., 2020).

### General purpose

The general objectives of this internship are as follows:

1. So that students can recognize the problems faced by a company, industry or workshops and with analytical skills students can gain work experience, especially related to problem-solving procedures.

2. Sharpen reasonable, logical, rational thinking patterns as well as be skilled and flexible in understanding and dealing with problems in the workplace.
3. Motivate students to participate in development issues, such as design, implementation, manufacturing, use, processing and supervision activities related to construction, production, power generation and company management related to industrial machinery in general.
4. Providing students with the opportunity to learn more specifically about industrial or company problems related to operations and mechanical engineering, so that they can be used as a choice for choosing a final assignment study title.

### Special purpose

The purpose of analyzing the steam requirements for this sterilizer in a palm oil factory is to calculate how much steam is needed in the sterilizer unit or boiling kettle (Vieira & al., 2020).

### Benefits of Internship

The benefits of field practice are reviewed from several perspectives, namely:

For the benefit of students

1. By participating in field work practice (PKL), students are expected to improve their hard skills and soft skills.
2. Can get an overview of the world of work which will be useful for students when they have completed their education so they can adapt to the world of work.
3. Can apply the knowledge and skills that have been acquired while increasing insight and experience.
4. Improve discipline and responsibility at work.

For College

1. Increase cooperation between educational institutions and companies and industry.
2. The Faculty of Engineering, UHKBPNP, especially the Mechanical Engineering Study Program, can improve the quality of its graduates by combining knowledge on campus with the industrial world.
3. The Faculty of Engineering, UHKBPNP, especially the Mechanical Engineering Study Program, is well-known in the industrial world.
4. Can find out the existence of the company from the perspective of students who are doing field work practice (PKL) at the company.

For the benefit of the company

1. The company participates in making national education a success
2. By implementing field work practice (PKL), it is hoped that the company will be able to improve partnership relations with the campus.
3. Able to see the potential abilities of students participating in field work practice (PKL), so that it will be easier to plan improvements in the field of human resources (HR).

### Palm Oil Processing Process

The palm oil processing process aims to extract *crude palm oil (CPO)* and *palm kernel oil (PKO)* from the oil palm fruit. Generally, this process involves the following steps: Freshly harvested Fresh Fruit Bunches (FFB) are transported to the palm oil processing plant. The FFB quality is then assessed to ensure ripeness and free from contamination. The FFB are then weighed to record the total weight used to calculate production yield (Astari et al., 2025).

The purpose of sterilization is to stop the activity of the lipase enzyme, which can cause oil damage, and to facilitate the release of the fruit from the bunch. The process involves placing the fresh fruit bunches (FFB) in a sterilizer (a large autoclave) and subjecting them to high-pressure steam (2-3 bar) for 60-90 minutes. Sterilization also kills microorganisms that can degrade the oil's quality. The process involves feeding sterilized oil palm bunches into a thresher to remove the fruit. The separated fruit goes to the next step, while the empty bunches (janjangan) are used as organic fertilizer or boiler fuel.

Pressing aims to extract crude palm oil (CPO) from the flesh of the palm fruit. The process involves grinding the fruit into a pulp and then pressing it using a screw press. The resulting mixture is oil, water, and fiber (mesocarp) (Pasaribu & Vanclay, 2021).

The purpose of crude oil refining is to separate crude oil from impurities, water, and remaining fibers. There are processes that are passed through, namely: Decantation, the mixture is passed through a sand trap and vibrating screen to filter out large fibers. Then Clarification, the mixture is heated in a clarification tank to separate the oil from water and impurities by gravity. Then centrifuge, which uses a centrifuge to separate the crude oil more perfectly (Wahab & Dollah, 2023).

The process involved is nut cracking, where the palm kernel is separated from the shell using a nutcracker. Then, the kernel is purified, where the separated kernel is dried to reduce the water content before being exported or further processed into palm kernel oil (PKO) (Awere, Bonoli, et al., 2023).

There are two types of waste: liquid waste and solid waste. Liquid waste is palm oil mill effluent (POME) treated in anaerobic or aerobic ponds to reduce environmental impact. Solid waste, such as fiber and shells, is used as boiler fuel, while empty fruit bunches are used as organic fertilizer or mulch.

### Loading ramp station

The loading ramp serves as a temporary storage area for fresh fruit bunches (FFB) before processing. The *Loading Ramp Station* is the initial section of the palm oil processing plant, receiving, weighing, and transporting fresh fruit bunches (FFB) to the sterilization stage. This station is a crucial element in ensuring the processed palm oil is in optimal condition, resulting in optimal quality oil (Pangestu Utomo et al., 2024).

The tools at the *loading ramp station* are Ramp Platform (Plate Loading Ramp), Tipping Ramp (Automatic Spiller), Weighbridge, Fruit Conveyor, Ramp Door, Grizzly Bar or Dirt Filter, Forklift or Wheel Loader, Manual or Mechanical Separator.

### Slope

The function of the loading ramp is to receive fresh fruit bunches (FFB) from the estate, and outside, where fruit grading is carried out. The purpose of fruit grading is to determine the quality of the fresh fruit bunches received from suppliers and must comply with the standards set by the Company (Putra et al., 2024). The quality of these fresh fruit bunches greatly determines the products to be produced, namely CPO Yield and Kernel. For this reason, good cooperation is required between the fruit grading officer and the loading ramp operator in arranging the loading of fruit into the lorry (Wardhani & Rahadian, 2021). What is important to note is that the fruit (FFB) that first enters the loading ramp must be the first to be loaded into the lorry for processing. Remember FIFO (*First In First Out*).

### Fruit Truck

A lorry is a container for sorted fresh fruit bunches (FFB) that will be boiled. A fruit lorry is a transport tool used in palm oil processing factories to move fresh fruit bunches (FFB) from one station to another, especially from the receiving station (*loading station*). *ramp*) to the sterilization station or vice versa. This lorry is part of the factory's internal transportation system, working in conjunction with rails or specific tracks to ensure the efficient movement of palm fruit. The fruit lorry's function is to move palm fruit from the loading ramp to the sterilizer. After the sterilization process, the lorry also transports the processed bunches to the threshing station. (Hayawin et al., 2023).

### Rail track

*Rail track* is a rail-shaped path used as a track to move transportation equipment such as fruit lorries in palm oil mills. *Rail track* is a major component in the factory's internal transportation system, especially for transporting Fresh Fruit Bunches (FFB) from one station to another (Elias et al., 2021). The function of *the rail track* is the path that the fruit lorry will pass through. What needs to be noted here is that this path must be clean from oil, fallen fruit (FFB) and soil, because this is to prevent the fruit lorry from coming off the rail or being heavy when pulled with a capstan (Julio et al., 2021).

### Transfer carriage

A *transfer carriage* is a means of transportation used in palm oil processing plants to move fruit trucks or sterilizer trucks from one rail track to another. The transfer carriage's function is to move the fruit trucks to the rail track. The transfer carriage is designed to carry two fruit trucks (Sari et al., 2021).

### Boiling station (sterilizer)

A *sterilizer* is a device for boiling fresh fruit bunches (FFB) until ripe using steam from a Back Pressure Vessel (BPV) for further processing. The ripeness or rawness of the fruit boils is crucial for the processes of the other three stations (e.g., press station, kernel station, etc.). The main function of this station is to boil fresh fruit bunches using hot steam to prepare the fruit for further processing, such as threshing and oil extraction. This boiling is carried out in a device called a sterilizer (Ayub et al., 2021).

### Thresher station

The Thresher Station is a crucial part of the palm oil processing process at the mill. Its function is to separate the loose fruits from the empty bunches after sterilization (Dashti et al., 2022). This process ensures that only the fruits are processed further for oil extraction, while the empty bunches can be used as a by-product. This station separates the loose fruit from the bunches after boiling.

### Digester

The digester is one of the main tools in a palm oil processing plant that functions to crush and pulverize the flesh of the oil palm fruit (mesocarp) after sterilization. This process aims to prepare the fruit before extracting the oil at the pressing station. The digester plays an important role in breaking down the cell structure of the fruit flesh so that crude palm oil (CPO) can be extracted optimally (Kurniawati et al., 2022). Functions to peel, stir the loose fruit so that the flesh (*pericarp*) is separated from the nut with the help of a knife (Long & Short Arm) and sufficient heat (90 - 95 °C), to prepare the feed to the pressing process (Ngan et al., 2022).

### Press

The *press* (pressor) in a palm oil processing plant has the primary function of extracting oil from previously processed oil palm fruit flesh. Generally, the press machine is used after the sterilization and threshing processes to separate the crude oil from the denser pulp (mesocarp) (Mohammad et al., 2021). The press machine functions to produce crude palm oil (CPO) for further processing or direct storage. Functions to press (press) the loose palm fruit that has become a *cake* after the crushing process in the digester to ensure the oil liquid contained in the loose palm fruit. can be separated from the fiber (Apriyanto et al., 2021).

### Oil refining station (clarification)

The Oil Refining (Clarification) Station in a palm oil mill is a crucial stage in the process of producing high-quality Crude Palm Oil (CPO). At this station, the oil obtained from the pressing of Fresh Fruit Bunches (FFB) is separated from impurities such as water, fiber particles, and other materials that can reduce the oil's quality (Zakaria et al., 2023).

Crude oil (pressed product) from the press station is sent to the clarification station for further processing. To obtain CPO products that meet the expected standards, proper operation at the clarification station is required, including:

### Kernel

In the pressing process at the press station, what is produced is *crude. oil* and press cake consisting of *Fiber* and *Nut*. *Fiber* must be separated from *Nut* to prepare for the cracking process in the ripple mill to obtain high cracking efficiency (minimum 95%) with low broken kernels and this separation activity is carried out at the kernel station (Jun, 2021).

A *boiler* is a device designed to produce pressurized steam for external use. A *boiler* is a vital component of a palm oil processing plant, providing steam for various important processes, particularly sterilization and heating. The steam produced by the boiler is the result of heating water in the combustion chamber, which is then circulated through pipes to produce high-temperature, high-pressure steam, which is then used to generate electricity and for other process purposes. **The boiler** serves as an energy source for various production processes, including providing steam for sterilization, heating, and engine operation.

A steam turbine is a device that generates electrical energy driven by pressurized steam produced by a saturated steam boiler with a temperature of approximately 260 degrees Celsius and a working pressure ranging from 17 to 20 kg/cm<sup>2</sup>. A steam turbine is a device used to convert the heat energy contained in water

vapor into mechanical energy that can be used to drive electric generators or other industrial machines. Steam turbines are widely used in palm oil mills, power plants, and various other industrial applications, especially in steam power generation systems (Ifa et al., 2022).

### Diesel generator (diesel engine)

A diesel engine is a combustion engine that uses diesel fuel (solar), where combustion in the *cylinder combustion chamber* occurs by spraying diesel fuel into the combustion chamber at high pressure. A Diesel Genset (Generator Set Diesel) is a device used to generate electricity using a diesel engine as a driver. Diesel gensets function as a backup source of electrical energy or the main source of electrical energy in locations that do not have an electricity supply from the PLN network or in areas that require a stable and continuous electricity supply (Yashni et al., 2021).

*Water Treatment Station* is a water treatment station from water sources (rivers / reservoirs) to produce good quality water according to factory raw water standards, including neutral pH and clean and suitable for use as material or raw material for process activities and domestic needs (Apriani et al., 2020). Internal Boiler Water Treatment is also a process used to treat water used in boiler systems in palm oil processing plants (or other industries) to meet the quality required to maintain the efficiency, safety, and longevity of the boiler equipment itself. The boiler system in a palm oil mill functions to produce hot steam used in various processes, such as sterilization of fresh fruit bunches (FFB) and other processing. However, the water used in the boiler needs to be processed first to prevent damage to the boiler system and ensure optimal performance.

### Storage tank

*Storage Tank* is a storage tank used in palm oil processing plants to store crude palm oil (CPO) and other by-products, such as oil-containing water or liquid waste. Storage tanks have a very important role in maintaining a stable supply of raw materials and final products in the factory, as well as enabling further processing or shipping of products in large quantities. *Storage tanks* function to temporarily store CPO production results before being sold. *Storage tanks are cylindrical tanks made of MS Plate material with a steam coil* installed at the bottom that functions to stabilize the temperature of CPO storage in *the storage tank* (Lin et al., 2021).

## METHOD OF COLLECTING DATA

In writing this report, data collection is crucial. The data collection methods used by the author are as follows (de Vos et al., 2023):

1. Documents or References Data retrieval through written or electronic documents from PT. SUMBER BUMI SAWIT JADI JAYA.
2. Field Observation. A method carried out by direct observation in the company environment.
3. Literature review. Apart from field observations, data was also taken from several literatures related to this report.

The internship will be held at PT SUMBER BUMI SAWIT JADI JAYA, located on Jalan Besar Mandoge-Kisaran (Jagaba et al., 2023). The internship will last for one month, from September 1 to October 1, 2023.

## RESULTS AND DISCUSSION

### Understanding Sterilizers

*Sterilizer* is a pressurized steam vessel, the function of which is to boil Fresh Fruit Bunches (FFB) using the heating medium used is wet steam originating from the exhaust of a steam turbine with a pressure of  $\pm 3 \text{ kg/cm}^2$  and a temperature of  $132.88^\circ\text{C}$ . If the temperature used is above  $132.88^\circ\text{C}$  during boiling, it will cause the fruit to become charred or burnt so that the quality of CPO oil is damaged and if using a temperature below  $132.88^\circ\text{C}$  during boiling, it will cause the enzymes in the fruit not to die and still contain a lot of water content.

The first stage of fresh fruit bunch (FFB) processing is boiling or sterilization, which is carried out in a pressurized vessel (*sterilizer*) using saturated steam. The use of saturated steam allows for hydrolysis/evaporation of the water in the fruit. Using dry steam can cause the fruit skin to burn, inhibiting evaporation of the water in the fruit flesh and complicating the pressing process. Therefore, Controlling the quality of the steam used as a source of boiling heat is very important in order to obtain perfect boiling results.



**Figure 1. Sterilizer**

### **Sterilizer Function**

Essentially, successful boiling will facilitate subsequent processes, including the threshing, press, digester, and other stations. The sterilizer's function is to sterilize the fresh fruit bunches (FFB) before they are processed into oil. The purpose of the FFB sterilization process includes:

#### **Stopping Enzyme Activity**

Harvested fruit contains lipase and oxidase enzymes that continue to function within the fruit before the enzymes are stopped. Lipase enzymes act as catalysts in the formation of free fatty acids (FFA), while oxidase enzymes play a role in the formation of peroxides, which then convert to aldehyde groups and cations. These compounds, when oxidized, form free fatty acids. Therefore, the free fatty acids found in palm oil are the result of the action of lipase and oxidase enzymes. Enzyme activity increases when the fresh fruit bunches (FFB) are bruised (wounded). Enzymes are generally inactive when heated. up to a temperature of  $>50$  C. Then boiling at a temperature of  $>120$  C simultaneously stops enzyme activity (Ng et al., 2022).

#### **Releasing the Fruit from the Sign a**

Palm oil and palm kernel are found in the fruit, so to facilitate the oil extraction process, the fruit needs to be separated from the bunch. The release of the fruit from the bunch is due to pectin hydrolysis that occurs at the base of the fruit (Kwong, 2021). So, this pectin hydrolysis occurs naturally in the field, causing the fruit to fall off. Pectin hydrolysis can also occur in a boiling kettle, with the reaction accelerated by heating. The heat and steam in the kettle will penetrate the fruit due to pressure. Pectin hydrolysis in the stalk does not completely release the fruit, therefore the fruit threshing process is necessary in a tressing machine.

#### **Lowering Water Content**

The fruit sterilization process can reduce the water content of the fruit and kernel, namely by evaporation from the inside during boiling and before being put into tressing. The interaction of reduced water content and heat in the fruit will cause the palm oil from between the cells to unite and have a low viscosity, making it easy to remove during the pressing process (oil extraction).

#### **Softening Palm Fruit**

The pericarp (fruit skin) that undergoes heat and pressure treatment exhibits properties where the fibers are easily separated from each other. This facilitates the digester and depericarper/polishing process. Due to

the heat and pressure, the water contained in the kernel evaporates through the kernel, facilitating the kernel cracking process (in the Rippel Mill) (Waudby & Zein, 2021).

### Removing fiber and seeds

Incomplete boiling of the fruit can make it difficult to separate the fibers from the seeds in the polishing drum, making it more difficult to break the seeds in the nutcracker. Adequate steam penetration will facilitate the separation of the pericarp fibers and seeds, which is accelerated by the hydrolysis process (Awere, Obeng, et al., 2023).

### Helps the process of releasing the core from the shell

Perfect boiling will reduce the moisture content of the beans by up to 15%. A drop in moisture content of up to 15% will cause the kernel to shrink while the shell remains intact, resulting in the kernel being detached from the shell. This will aid the fermentation process in the Nut Silo, allowing the beans to break down properly. Similarly, separating the kernel and shell in a dry or wet separation process can result in a kernel containing impurities. Smaller (Harimisa et al., 2021).

### S sterilizer equipment

The sterilizer is equipped with several pieces of equipment, each of which has a different function, to obtain good boiling results and provide a sense of safety when the operator boils the fruit.

Sterilizer equipment includes:

#### *Inlet Valve*

The inlet valve's function is to introduce steam from the BPV into the boiling water during the boiling process. Sterilizers No. 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 have 10 inlet valves, all of which are operated automatically. The automatic valves are operated using air from a compressor (a pneumatic system).



Figure 2. inlet valve

#### *Exhaust valve*

The exhaust valve's function is to release steam from the sterilizer at specific points during the fruit boiling process. The exhaust valve is also driven by air power from the compressor. The exhaust valve is responsible for removing waste steam or exhaust gas from the engine's cylinder chamber after the process is complete, whether in diesel engines or steam engines used in palm oil mills (V. W. G. Tan et al., 2023). This valve ensures that exhaust gas exits smoothly and does not impede the operation of the piston or system.



Figure 3. *Exhaust valve*

#### *Condensate valve*

A *condensate valve* is a valve that functions to remove condensate (water resulting from steam condensation) from piping systems, equipment, or machines that use hot steam, such as *boilers*, *heat exchangers*, and steam pipes in palm oil mills (Khurshid et al., 2022). The function of the condensate valve is to remove *condensate water* and release air from the sterilizer during the boiling process. The valve is operated automatically.



Figure 4. *Condensate valve*

#### *Safety Valve*

A *safety valve* is a safety valve that automatically releases excess pressure from a system, such as a *boiler*, steam pipe, pressure tank, or other pressurized equipment, to prevent explosions or damage due to pressure exceeding safe limits (Fikri et al., 2022). The function of *the safety valve* is to automatically release excess steam pressure inside the sterilizer if the pressure inside the sterilizer exceeds *the safety valve*'s *setting pressure*.



Figure 5. *Safety Valve*

### Steam Sprayer

A *steam sprayer* (more commonly called a steam sprayer or steam nozzle) is a device used to spray steam onto specific areas or equipment during the palm oil production process. This device assists in heating, cleaning, or softening materials using the high pressure and temperature of the steam. The *steam sprayer* is located inside the sterilizer and its function is to distribute *steam* throughout the sterilizer to achieve optimal boiling results (James et al., 2023).

### Safety Bleed Valve

A *Safety Bleed Valve* is a safety valve that functions to release (discharge) residual pressure or gas/air trapped in the system after the process is complete or when the equipment is turned off. Its purpose is to ensure that no residual pressure could be dangerous during maintenance or system opening. Each sterilizer is equipped with two *safety bleed valves* near the door, which function to release residual steam inside the sterilizer after the boiling process is complete (Mubarak et al., 2023).

#### 1. Indicator lights and siren

Indicator lights and sirens are visual and audio devices used to signal or warn about the operating conditions of equipment or systems in a factory, particularly for monitoring machine safety and operation. Sterilizer indicator lights serve to alert operators during the fruit boiling process. Each sterilizer is equipped with three indicator lights with different colors.

- a. The yellow light means the sterilizer is ready to operate (*standby*)
- b. The red light means the fruit boiling process in the sterilizer is running.
- c. A green light means the fruit boiling process in the sterilizer is complete.

The siren on the sterilizer has the same function as the indicator light, only the siren will sound when the fruit boiling process is complete (the fruit is ripe), along with the green indicator light turning on.



Figure 6. Indicator Lights and Siren

### Steam Formation Process

Steam boilers convert liquid to gas/steam using the heat generated from fuel combustion. During the heating process, the pressure and temperature of the water change, thus changing its phase. At a critical pressure of 3200 psi (22.1 MPa), the latent heat normally required to convert water to steam is no longer needed. Under these conditions, the evaporation process does not produce steam bubbles, allowing the phase change from water to steam to occur more smoothly. Based on this phenomenon, a boiler technology known as a critical boiler was developed, a type of boiler that operates by circulating a mixture of water and steam through boiler pipes at a critical pressure of 22.1 MPa (221 bar) (Hutabarat, 2019).

The rate of heat transfer per unit area, known as *heat flux*, is shown on the Y-axis of the graph, while the X-axis shows the temperature difference between the metal surface and the surrounding water. The following explains each point on the graph.

1. In the section from point A to B, heat transfer occurs through convection, which causes cooling of the metal surface and inhibits the boiling process. Just after point B, boiling begins, where the water temperature quickly adjusts to the temperature of the metal, approaching the saturation point. Steam bubbles begin to appear on the metal surface but quickly collapse due to contact with cold water. This condition is called *subcooled boiling*, which is characterized by points B and S. Although the heat transfer rate is quite high, the amount of steam formed is still limited.

- From point S to point C, the water reaches saturation temperature more evenly, so that the vapor bubbles no longer collapse, but continue to grow and increase in number. This region is called *the nucleate boiling region*, which is characterized by a high heat transfer rate and a small temperature difference between the metal surface and the water saturation point (Sodri & Septiana, 2022).
- Approaching point C, the evaporation surface area increases, and vapor formation occurs rapidly. This results in the formation of a thin vapor layer that prevents direct contact between the water and the metal. As a result, heat transfer decreases. This phenomenon is known as *the critical heat flux* (CHF).
- Moving on to points D through E, unstable film boiling occurs, where the metal surface temperature no longer increases, but the heat transfer efficiency per unit area decreases drastically. Thereafter, from points E through D' to F, the vapor layer formed on the metal surface acts as a very effective thermal insulator, further inhibiting energy transfer (Loo et al., 2021).

### Types of S sterilizer

There are two types of sterilizers commonly used, namely vertical and horizontal sterilizers.

#### Vertical sterilizer

The vertical sterilizer is cylindrical and can hold 2-6 tons of fresh fruit bunches (FFB). Fruit is loaded through the top door and discharged through the lower front outlet. The sterilizer is lined with a perforated plate that slopes downward toward the door, making it easier to remove the contents (Y. Y. Tan et al., 2021).

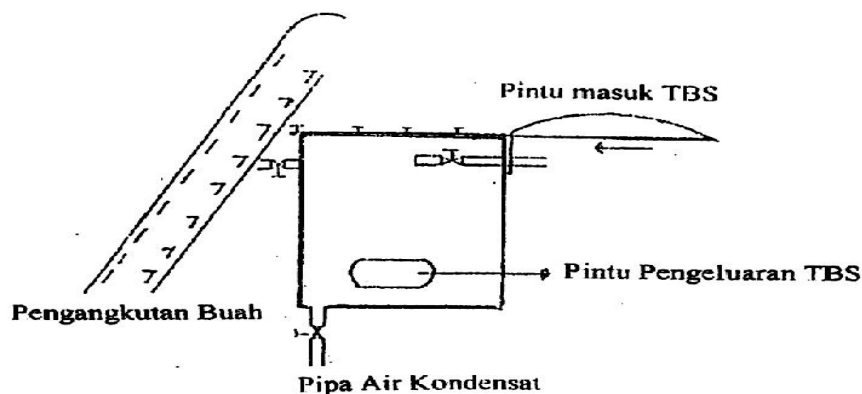


Figure 7. Vertical Sterilizer

The upright type has the following weaknesses:

- boil is very small, because the large tool requires a large space. quite high. The average boiling capacity is 5 tons of fresh fruit bunches.
- Vessels containing fruit filled using bunch elevators experience a high level of injury during the transportation process, as one of the causes of the increase in free fatty acids tall.
- The operating technique is more difficult and requires more effort. Lots especially when closing and opening, and removing the fruit from within which is done manually.

#### Horizontal Sterilizer

Horizontal sterilizers, on the other hand, are cylindrical, mounted horizontally, supported by their length. Horizontal sterilizers come in single-door and double-door versions. These sterilizers are loaded with fruit bunches, which are loaded into lorries. These lorries come in capacities of 1.5, 2.5, and 7 tons of fresh fruit bunches (FFB). Horizontal sterilizers can accommodate 7–10 lorries for a single boiling process, with a capacity of 2.5 tons of FFB per lorry (Zulqarnain et al., 2021).

#### Boiling System

The quality of the fruit received from the estate does not always have good fruit quality, sometimes the fruit received is sand fruit, unripe fruit and even rotten fruit. Thus, we need a boiling system that suits the condition of the fruit received in order to get good boiling results (Toumbourou & Dressler, 2021). The Sterilizer Operator must always check the condition/quality of the fruit so that the operator can determine the right boiling system.

The boiling system is divided into three (3) boiling systems for 90 minutes, namely: *A single-peak sterilizer* uses a single-stage boiling process. Steam enters at a predetermined rate, reaching constant pressure, and then drops, releasing the steam from the boiling chamber.

### **Double Peak Sterilizer**

*A double peak sterilizer* is a sterilizer with a two-stage boiling system, steam input and condensate (water vapor) discharge stage, which can be described as follows (Harianja et al., 2024).

### **Boiling Time**

Boiling requires steam to penetrate to the deepest part of the bunch. At 100 °C, steam penetration takes 25–30 minutes for bunches weighing 3–6 kg to reach 100 °C, and 50 minutes for bunches weighing 17 kg. The relationship between boiling time and oil extraction efficiency is as follows:

1. The longer the fruit is boiled, the higher the number of flattened fruit, or the lower the percentage of unflattened bunches (Joseph et al., 2017).
2. The longer the fruit is boiled, the more the seeds will cook, resulting in seeds that are easier to break and have a softer texture.
3. The longer the fruit is boiled, the higher the oil loss in the condensate water.
4. The longer the fruit is boiled, the higher the oil content in the empty bunches, namely the absorption of oil by the empty bunches due to the presence of empty cavities.
5. The longer the fruit is boiled, the more the quality of the palm oil will decrease.

### **Boiler Water Treatment Process**

The water that will be used in the steam boiler must undergo a complex water purification process so that the steam produced is as expected. So, the first step is to flow the water source from the river by pumping it into a cone tube (*Water Clarifier*) then into a *water basin* which aims to settle the water from impurities, then it is continued to *water treatment* which aims to inject alum chemicals into the water and then pumped to *the sand filter* for filtering from impurities as well because *the sand filter* is a filter material consisting of silica sand and gravel (MCCARTHY & ZEN, 2009). The water that comes from *the sand filter* is water that has been cleaned from impurities and is pumped into a clean water tower with a volume of approximately 40 m<sup>3</sup>. Then the clean water is pumped again to the *Demint Plant station*. After being in the demint plant, the water is processed again in the Cation which aims to separate the water hardness (Tarigan & Purwanggono, 2022). Then it is continued to Anion which aims to separate silica from the water and then it is continued again to *the Feed Water Tank* (Boiler Feed Water Tank) which has a minimum capacity of 120 m<sup>3</sup> then to *the Deaerator*, in the boiler feed water tank that the water has become hot or is the initial stage of heating the water before going to the steam boiler where the temperature is around 80 °C then pumped to a *vacuum* which is a tool that functions to reduce oxygen to a minimum from the water so that there are no air bubbles in the steam boiler (Berenschot et al., 2022). Then the water from the vacuum before being pumped into the steam boiler is first given a mixture of chemicals called BWT (*Boiler Water Treatment*) which aims to avoid corrosion in the boiler pipes. The water is then pumped into a steam boiler through pipes, which are typically *tube-type boilers* (Mahidin et al., 2020).

## **CONCLUSION**

The conclusions obtained from the results of the practical work are as follows:

1. PT. SUMBER BUMI SAWIT JADI JAYA Me is a factory that processes fresh oil palm fruit bunches into CPO and palm kernel.
2. The processing capacity at PT. SUMBER BUMI SAWIT JADI JAYA is 30 tons of fresh fruit bunches (FFB) per hour.
3. The organizational structure at PT. SUMBER BUMI SAWIT JADI JAYA is a functional organizational structure.

- The results of processing the percentage of *cardiovascular load* showed that all *boiler workers* needed repairs, and the workload category of the four workers was influenced by age factors.

### Suggestion

The suggestions that the authors convey to the industry are as follows:

- In order to maintain and increase consumer trust, it is hoped that PT continue to maintain the quality standards that have been set by SUMBER BUMI SAWIT JADI JAYA.
- It is hoped that in the long term, PT. SUMBER BUMI SAWIT JADI JAYA will not only produce semi-finished oil but also can produce finished oil.

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