FULL PRACTICUM REPORT
RENEWABLE ENERGY
(19G04130501)

YULIANA MAHMUDDIN
G041201051

AGRICULTURAL ENGINEERING
DEPARTMENTT OF AGRICULTURAL TECHNOLOGY
FACULTY OF AGRICULTURE
HASANUDDIN UNIVERSITY
MAKASSAR
20 22

ATTESTATION PAGE

TITLE : COMPLETE REPORT OF RENEWABLE ENERGY
NAME : YULIANA MAHMUDDIN
NIM : G041201051
GROUP : IV (FOUR)

This Full Report Is Prepared As One Of The Requirements
To Pass the Renewable Energy Practicum Course
(19G04132501)

On
Agricultural Engineering Study Program
Department of Agricultural Technology
Faculty of Agriculture
Hasanuddin University
Makassar
2023

Agreement,

Assistant 1	Assistant 2
FEBRY SAUTAMA TINGARA	**MUH. SON OF ANSYARI NAIM**
NIM. G041181329	**NIM. G041191069**

Assistant Coordinator

FADILA
NIM. G041191022

Approved by

Course Coordinator

Dr. GEMALA HARDINASINTA, S.TP

FOREWORD

Alhamdulillah, that is the most beautiful word as a thanksgiving for the presence of Allah SWT who has bestowed His mercy, hint and guidance, so that the complete report of this Renewable Energy practicum can be completed. Do not forget also we always offer shalawat and greetings to our lord and role model Prophet Muhammad SAW. In this stage of preparing a complete report, it is inseparable from various obstacles that hinder the preparation. However, thanks to the help and motivation of various parties, all these obstacles and obstacles can be overcome.

This full report is prepared as a requirement to take the Renewable Energy laboratory exam. My best wishes go to my friends, Renewable Energy practicum assistants and others who have helped in completing this complete report that was not mentioned.

Hopefully this report can be useful for the author and readers in general. The author expects suggestions and criticisms from various parties that are constructive.

Makassar, 18 November 2022

Yuliana Mahmuddin

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BIOGAS PRODUCTION FROM VEGETABLE WASTE AND ANIMAL FECES

Yuliana Mahmuddin[1]), Febry Sautama Tingara[2)] and Muh. Putra Ansyari Naim[2)]

[1)] Renewable Energy Practicum Practice of Agricultural Engineering Study Program, Hasanuddin University

[2)] Renewable Energy Practicum Assistant for Agricultural Engineering Study Program, Hasanuddin University

ABSTRACT

Biogas has become an alternative energy in the form of gas by going through an anaerobic fermentation process by utilizing vegetable waste and animal waste. Vegetable waste and animal waste are very rich in methane content so it will be very helpful in accelerating the process of biogas formation. The purpose of this practicum was to determine the use of biogas from organic waste, such as vegetable waste and animal waste, as well as to understand how to make biogas from organic waste. The method of making biogas was to carry out anaerobic fermentation using a digester. The result obtained was that the fermentation process carried out does not produce gas. In addition, the results of the gas distribution test also did not provide a flame. The conclusion that could be drawn was that the failure of the biogas manufacturing process occurs because of oxygen that manages to enter the digester, thus affecting the gas manufacturing process.

Keywords: Anaerobic, Biogas, Waste

INTRODUCE

Background

Organic waste in the life of living things has become an inseparable thing. Household waste such as vegetables and fruits turns out to have many contents that can be used, especially in agriculture. Animal waste in a liquid state also contains methane which can be processed into a fertilizer. One of the processes of making gas that can be used as organic fertilizer in agriculture is biogas.

Biogas in agriculture can be interpreted as a gas manufacturing process that can be used as alternative energy in Indonesia. Biogas can be made by utilizing organic waste materials such as vegetable waste and animal waste by going through an anaerobic fermentation process. Vegetable waste and animal waste are very rich in methane content so it will be very helpful in accelerating the process of biogas formation.

The process of making biogas can be done using a digester. A digester is a device used to accommodate vegetable waste materials and animal waste waste, this tool has a closed working principle so that oxygen cannot enter the tool because in the process of making biogas an anaerobic process occurs. Anaerobic is the process of decomposing a complex organic compound in the absence of oxygen because the bacteria that work are anaerobic bacteria, where the bacteria can only move in the absence of oxygen. Making biogas also utilizes EM4 and mollase solutions, so that the biogas formation process can take place quickly with optimal

results. This EM4 solution can also help in fertilizing the soil and supplying nutrients needed by plants.

Based on this description, the practicum of Making Biogas from Vegetable Waste and Animal Manure needs to be carried out to know the process of making biogas using organic waste and to be able to understand the process of making biogas using a digester.

Purpose and Uses of Practicum

The purpose of the practicum on Making Biogas from Vegetable Waste and Animal Manure is to be able to understand how to make biogas using vegetable waste and animal waste through an anaerobic process.

The use of the practicum on Making Biogas from Vegetable Waste and Animal Manure is being able to understand the use of biogas as renewable energy, and compost in agriculture and can reduce organic waste.

LITERATURE REVIEW

Biogas

Biogas is a gas produced from the process of decomposing organic materials by microorganisms in an anaerobic state. The biogas produced can be used for cooking, lighting and motor fuel or generators. Biogas has several advantages compared to fossil fuels. Its environmentally friendly and renewable nature is an advantage of biogas compared to fossil fuels. Biogas is a fuel that can be made easily (Afrian et al., 2017).

Biogas is a flammable gas produced from the fermentation process of organic materials by anaerobic bacteria. The principle of making biogas is the decomposition of organic matter anaerobically (closed from free air) to produce gas, most of which can be methane gas (CH_4) and carbon dioxide (CO_2). The process of anaerobic decomposition is assisted by several microorganisms, especially methane-producing bacteria. A series of processes that occur in the formation of biogas include hydrolysis, acidogenesis, acetogenesis and methanogenesis. Understanding the stages of making biogas is very important to support the success of the biogas manufacturing process. Here are the stages of biogas formation that can be done in anaerobic digestion (Scarlat et al., 2018).

Hydrolysis

Theoretically, the first step in the process of biogas formation is hydrolysis. In this stage of hydrolysis, the complex of organic matter is decomposed into smaller units. During the process, polymers such as carbohydrates (complex compounds), lipids, nucleic acids and proteins are converted into glucose, pyrimidine and glycerol. Hydrolytic microorganisms secrete a hydrolytic enzyme, converting the polymer into a simple compound. The hydrolysis process requires an exo-enzyme mediation excreted by fermentative bacteria. Products that can be produced from the hydrolysis process can be further broken down by a microorganism involved and can also be used for their metabolic processes, in the process, of acid-decomposing bacteria that decompose glucose compounds.

Asidogenesis
During the process of acidogenesis, hydrolysis products are converted by acidogenic bacteria into methanogenic substrates. Simple sugars, amino acids and fatty acids degrade into acetate, carbon dioxide and hydrogen (70%) as well as into Volatile Fatty Acids (VFA) and alcohols (30%).

Acetogenesis
During the process of acetogenesis, products of acidogenesis that cannot be converted directly into methane by methanogenic bacteria will be converted into methanogen substrates. VFAs and alcohols are oxidized into methanogenic substrates such as acetate, hydrogen and carbon dioxide. Hydrogen products increase the partial pressure of hydrogen, it is considered a waste product of the process of acetogenesis and inhibits the metabolism of acetogenic bacteria. The next stage of methanogenesis, the process of hydrogen methanogenesis will be converted into methane.

Methanogenesis
The production of methane and carbon dioxide from intermediate products is carried out by methanogenic bacteria, 70% of the methane formed comes from acetate while the remaining 30% is produced from the conversion of hydrogen (H) and carbon dioxide (CO_2).

Organic Waste
The waste problem is still a problem that until now has not been solved. Current efforts have been made, such as providing temporary and final TPS (Landfills), as if only as an effort to move the accumulation of waste from one location to another. One of the efforts to solve the waste problem is to use it as biogas raw material. The waste used in the process of making biogas is leftover vegetables that are not cooked in the household. Biogas results from vegetable waste based on the results of laboratory analysis of vegetable waste found that vegetable waste contains 88.78% water content, 7.68 pH and 33.56 C/N ratio. In addition, of course, the leftover vegetables still contain substances such as protein, fiber, vitamins and minerals. Biogas energy is one of many kinds of renewable alternative energy sources. Biogas can be obtained from household wastewater, liquid manure from farms, organic waste and the food industry. In general, biogas consists of methane gas around 55%-80%. Methane gas produced from animal waste, contains energy of 4,800-6,700 Kcal/m3. Pure methane gas contains an energy of 8,900 Kcal/m3. The biogas production system has several advantages, namely reducing the greenhouse effect, and reducing odor pollution, as fertilizer and heat (Rhohman et al., 2021).

Effective Microorganism (EM4)
Effective Microorganism 4 (EM4) is a mixture of beneficial microorganisms. The number of fermented microorganisms in EM4 is very large, about 80 types. Such microorganisms are selected that can work effectively in fermenting organic matter. Of the many microorganisms, there are five main groups. The advantage of EM4 is that it is a material that can accelerate the process of forming organic fertilizer and improve its quality. In addition, EM4 can improve soil structure for the better and supply nutrients needed for the growth of treated plants (Meriatna et al., 2018).

Effective Microorganism 4 (EM4) is a type of fermented microorganism that is easily found on the market at an affordable price. One way to increase soil fertility

is to utilize fermented microorganisms that play a role in providing organic matter, fertilizing plant material and nourishing the soil. EM4 also contains large amounts of methane (CH_4) so that it can accelerate the fermentation process in the biogas process, where EM4 solutions are very easy to obtain (Astutik et al., 2020).

Anaerobic

Effective Microorganism 4 (EM4) is a type of fermented microorganism that is easily found on the market at an affordable price. One way to increase soil fertility is to utilize fermented microorganisms that play a role in providing organic matter, fertilizing plant material and nourishing the soil.

The anaerobic fermentation process by utilizing several microorganisms that can convert complex compounds from organic waste materials to simpler ones, namely methane and carbon dioxide, water and ammonia, where the main ingredients of the biogas formation process to be more perfect are the right methane and carbon dioxide (Arifan et al., 2021).

Digester

The process of making biogas requires a series of tools called digesters or biogas reactors. Digesters are usually tubular and are used as a place for anaerobic fermentation processes. The type of digester can be divided into 2 if seen from the way it is filled, namely batch feeding (one filling) and continuous feeding (continuous filling) (Pratiwi et al., 2019).

Batch Feeding (one fill)

Batch feeding is a type of digester where the raw materials are put into it until it is full, then waited until the fermentation process occurs and produces biogas. After no more biogas is produced or a little biogas is produced, all stuffing materials are removed from the digester and then replaced with new stuffing materials.

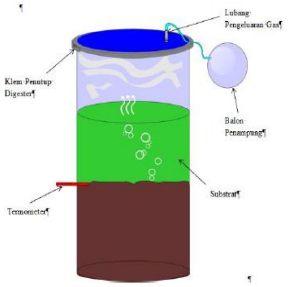

Figure 1. Batch Feeding-Type Digester.
(Source: Afrian et al., 2017).

Continuous Feeding

Continuous feeding is a type of digester whose replenishment of organic matter is carried out every day in a certain amount after biogas starts producing. At the initial filling, the digester is filled, then waited until the biogas is produced. After biogas is produced, the filling of organic matter can be done continuously every day with a certain amount. Continuous feeding digesters type has two types, namely floating dome type and fixed type.

A digester is one of the tools that can be used as a shelter for organic waste materials that will be used in the process of making biogas. The working principle of the digester is to work in a closed state so that oxygen cannot enter the tool because in the process of making biogas an anaerobic process occurs. One digester

that is often used is a batch digester which can be used to study the potential of substrates in biogas and the influence of variables on biogas products (Syaichurrozi, 2017).

Influencing Factors

High temperatures will generally provide good biogas production. However, the temperature should not exceed room temperature. These bacteria can only thrive when the surrounding temperature is at room temperature. The good temperature for the biogas formation process ranges from 20 °C-40 °C and the optimum temperature is between 28 °C-30 °C. Stuffing raw materials in the form of organic materials such as livestock manure, agricultural waste, kitchen waste and organic waste. The commonly used raw material is usually dairy cow dung. Stuffing raw materials must be avoided from inorganic materials such as sand, stone, plastic or broken glass because it can inhibit the fermentation process of organic materials. The filling material must contain at least 7%-9% dry matter. High biogas productivity does not determine that the production of biogas produced is also high and vice versa. This is due to the degradation of organic matter, the type of organic matter processed greatly affects the productivity of biogas, this occurs due to microorganisms that decompose organic matter during fermentation. Oxygen that enters the digester will also greatly affect the fermentation process. It could be that the fermentation process that is carried out fails or can be called only producing gas in small amounts or none at all which will certainly be very detrimental (Pratiwi et al., 2019).

PRACTICUM METHODOLOGY

Time and Place

Practicum for Making Biogas from Vegetable Waste and Animal Manure was held on Tuesday, September 6, 2022, at 14.50 WITA-finished, at the Laboratory of Agricultural Tools and Machinery, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

Tools

The tools used in the practicum for Making Biogas from Vegetable Waste and Animal Waste are buckets, 2-liter bottles, transparent hoses, balloons, valves or small taps, shooting glue, soldering and funnels.

Materials

The materials used in the practicum for Making Biogas from Vegetable Waste and Animal Manure are 175 grams of gamal leaves, 250 ml of cow dung, EM4, water and sugar solution.

Practicum Procedures

The practicum procedure for Making Biogas from Vegetable Waste and Animal Manure, namely:

1. Preparing tools and materials.
2. Chop gamal leaf waste until smooth.
3. Perforating the drink bottle using a solder the size of a hose.
4. Connecting the hose with a tap or valve.

5. Attach the hose to the hole of the bottle that has been made and glue it with shooting glue.
6. Mix and mix cow dung, gamal leaves, sugar solution and water in a bucket with a size of 2: 2.
7. Pour EM4 with water then mix with the previous ingredients.
8. Pour the mixed ingredients into a 2-liter bottle using a funnel.
9. Hit the balloon at the end of the bottle and close the valve or faucet tightly.
10. Silence and Observe on days 1, 5, 10 and 14 for 2 weeks.

RESULTS AND DISCUSSION

Figure 2. Biogas Fermentation Results Day 1.

Based on Figure 2, the results of biogas fermentation on the first day can be known, that the process of making biogas was carried out in an anaerobic way or without the presence of air carried out on a digester. The working principle of the digester was as a container of ingredients to be fermented by closing all gaps that allow air to enter. The fermentation process was carried out for 14 days, where the results of fermentation on the first day could be seen on the balloon which was one indicator of the presence of gas produced in the process of fermentation. The gas produced on the first day looked still very lacking and it could even be that gas had not yet formed. This happens because the process of making biogas was divided into 4 stages, namely hydrolysis, acidogenesis, acetogenesis and methanogenesis. The results of biogas fermentation on the first day were still undergoing a hydrolysis process so that the process that occurs was still in the water stage reacting with long-chain polymers to form short-chain polymers. This is in accordance with the statement of Scarlat et al. (2018), that theoretically, the first step in the biogas formation process is hydrolysis. In this stage of hydrolysis, the complex of organic matter is decomposed into smaller units. During the process, polymers such as carbohydrates, lipids, nucleic acids and proteins are converted into glucose and glycerol. Hydrolytic microorganisms secrete a hydrolytic enzyme, converting the polymer into a simple compound.

Figure 3. Biogas Fermentation Results Day 5.

Based on Figure 3, the results of biogas fermentation on the fifth day could be known, that gas formation had not been seen, which could be seen in balloons that had not been filled with gas. This happens because it could be that on the fifth day there was still an acidogenesis process, namely the oxidation process of hydrolyzed compounds into fatty acids. The ingredients used in making biogas are cow dung, gamal leaves, EM4 and molasses. All materials used in the biogas manufacturing process contain methane and glucose which could accelerate the fermentation process and produce maximum gas. This is in accordance with the statement of Rhohman et al. (2021), that biogas can be obtained from household wastewater, liquid manure from farms, organic waste and the food industry. In general, biogas consists of methane gas around 55%-80%. Methane gas produced from animal waste, contains an energy of 4,800-6,700 Kcal/m^3. Pure methane gas contains an energy of 8,900 Kcal/m3.

Figure 4. Biogas Fermentation Results Day 10.

Based on Figure 4, the results of the tenth day of biogas fermentation can be known, that the fermentation process carried out has not produced gas. This could happen because on the tenth day the process that occurs is acetogenesis, which is the process of converting fatty acids and ethanol or alcohol into acetate, carbon dioxide and hydrogen. The fermentation process carried out in biogas is anaerobic, where the anaerobic process is the right process because the activity of the microorganisms used can only be occurs in the absence of air in the digester so that the incoming air

can be one of the failure factors in making biogas. This is in accordance with the statement of Arifan et al. (2021), that the biogas formation process uses an anaerobic method, where the bacteria contained in a mixture of organic waste materials are anaerobic bacteria or bacteria that can freak activity in the absence of oxygen.

Figure 5. Biogas Fermentation Results Day 14.

Based on Figure 5, the results of the fourteenth day of biogas fermentation can be known, that the results of gas formation from the fermentation process have not been seen while the process that occurs on the day to Fourteen is methanogenesis which is the final process of making biogas which can be seen from testing the distribution of gas in the flame but the results obtained are not gives a flame. The failure of making biogas can be caused by several factors, namely the presence of oxygen entering the digester through a gap that allows oxygen to enter Such as fine leaks in balloons and fine leaks in bottles so that they can affect the activity of anaerobic microorganisms which results in the gas formation process does not occur. Room temperature also greatly affects the fermentation process, where the good temperature for the fermentation process is room temperature around 20 °C-40 °C. The presence of inorganic materials mixed into organic materials will also greatly affect the process of breaking long-chain polymers to form short-chain polymers. This was in accordance with the statement of Pratiwi et al. (2019), that oxygen entering the digester will also greatly affect the fermentation process. It could be that the fermentation process carried out can fail or can be called only producing gas in small amounts or none at all which of course will be very detrimental.

CONCLUSION

Based on the practicum of Making Biogas from Vegetable Waste and Animal Manure, it can be concluded that biogas is a gas formed from the decomposition of organic matter in an anaerobic state. The process of biogas formation is carried out by fermentation using a digester for 14 days in an anaerobic state. The result of making biogas that has been done is that it fails or does not produce gas. This

happens because the presence of oxygen that manages to enter the digester affects the process of making gas, where oxygen entering the digester will inhibit activity Anaerobic bacteria because anaerobic bacteria can only move in the absence of oxygen.

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ATTACHMENT

Attachment 1. Practicum Documentation for Making Biogas from Vegetable Waste and Animal Manure.

Figure 6. Documentation Putting Gamal Leaves in the Container.

SIMPLE BIOETHANOL PRODUCTION

Yuliana Mahmuddin[1)], Febry Sautama Tingara[2)] and Muh. Putra Ansyari Naim[2)]

[1)] Renewable Energy Practicum Practice of Agricultural Engineering Study Program, Hasanuddin University
[2)] Renewable Energy Practicum Assistant for Agricultural Engineering Study Program, Hasanuddin University

ABSTRACT

Alternative energy is made from biomass raw materials of starch and sugar that undergo a fermentation process by utilizing microorganisms called bioethanol. The use of bioethanol in agriculture, namely as fuel from agricultural tools and machinery with advantages as an environmentally friendly fuel. The purpose of the Simple Bioethanol Making practicum is to understand the process of making bioethanol and know the benefits of bioethanol in agriculture. The method used from the Simple Bioethanol Making practicum was by fermentation on cassava that had been mixed with yeast and NPK in a fermenter container then the fermentation results would be separated with a distillation. The results of the fermentation carried out failed. The conclusion that could be drawn was that the failure in making bioethanol occured due to mixing between tapai and fermipan yeast, and the period of fermentation process still needs to be extended and the presence of air that had managed to enter the fermenter container after fermentation and before distillation.

Keywords: Bioethanol, Energy, Fermentation

INTRODUCE

Study Background

Energy has become one of the very important factors in human life. The energy crisis in Indonesia has become a serious problem. Alternative energy is to provide solutions to energy problems. One alternative energy that is easy to make is bioethanol which is an environmentally friendly alternative energy compared to others.

Alternative energy is made from biomass raw materials of starch and sugar that undergo a fermentation process by utilizing microorganisms called bioethanol. Bioethanol is an alternative energy that is very easy to obtain because it is made from easily obtained materials such as the use of agricultural waste containing sugar, starch, cellulose and hemicellulose. Starch raw materials that are often used in making bioethanol are cassava, corn and sorghum while sugar raw materials are cane sugar, palm sap and coconut sap.

The process of making bioethanol has three stages, namely hydrolysis, fermentation, and distillation. The use of raw materials for sugar sources undergoes a short manufacturing process because sugar can be directly broken down into ethanol while starch biomass raw materials must go through the process of breaking down amylum molecules into simple components such as glucose and then processed into alcohol. The selection of the right ingredients in the manufacture of bioethanol is necessary. Making a good bioethanol is determined by a good manufacturing process and the right composition of ingredients.

The use of bioethanol in agriculture is as fuel for agricultural tools and machinery. The advantages of this fuel are environmentally friendly, can make the engine sound smoother, make combustion more complete and can extend engine life.

Based on this description, the Simple Bioethanol Making practicum needs to be done so that practitioners can know and understand the process of making bioethanol using cassava, yeast and NPK and understand the process of making bioethanol using fermenter containers and distillators.

Purpose and Uses of Practicum

The purpose of this Simple Bioethanol Making practicum is to understand how to make bioethanol and understand the process of bioethanol formation.

The use of the Simple Bioethanol Making practicum is so that practitioners can understand the use of bioethanol as alternative energy in agriculture and can reduce agricultural organic waste containing sugar and starch.

LITERATURE REVIEW

Bioethanol

Bioethanol is a biochemical liquid sourced from carbohydrates by fermenting glucose using the help of microorganisms followed by the distillation process. Carbohydrate-containing materials can be obtained from organic agricultural waste which contains sugar, starch, cellulose and hemicellulose. Agricultural waste and organic waste require handling and serious use so as not to harm the environment. Agricultural organic waste generally contains starch, cellulose, and hemicellulose which are quite high. The chemical content of agricultural waste can be used as raw material in the process of making bioethanol. The bioethanol production process of raw materials used must contain starch or carbohydrates, carried out through the process of converting carbohydrates into water-soluble sugars (glucose). Glucose can be prepared from starches, the manufacturing process can be distinguished based on the auxiliary substances used, such as acid hydrolysis and enzyme hydrolysis. Acid hydrolysis (e.g. with sulfuric acid) is less developable, so the process of making glucose from starches is used enzyme hydrolysis. The process of converting carbohydrates into sugar (glucose) is done by adding water and enzymes. The process of fermentation of sugar into ethanol is carried out by adding yeast (Luth et al., 2020).

One promising alternative energy is bioethanol. Bioethanol is a liquid resulting from the fermentation process of sugar from carbohydrate sources (starch) using the help of microorganisms. Raw materials that can be used in making ethanol are sugary sap (sucrose), sugarcane sap, coconut sap and palm sap. Starchy ingredients can be in the form of sago, cassava, sweet potatoes and canna. Examples of cellulose materials are wood, straw, dry leaves and banana stems. Bioethanol is ethanol whose main ingredient is from plants and generally uses a fermentation process. Ethanol (C_2H_5OH) is a clear colorless liquid, biodegradable, low toxicity and does not cause large air pollution when leaked. Burning ethanol produces carbon dioxide (CO_2) and water. Ethanol is a high-octane fuel and can replace lead as an octane rating enhancer in gasoline mixing ethanol with gasoline will oxygenate the fuel mixture so that it can burn more completely and reduce exhaust emissions such as carbon monoxide. One indicator of the success of making

bioethanol is the formation of alcohol (C_2H_5OH) which can be used as a fuel mixture (Rikana and Adam, 2017).

Cassava

Cassava is a tropical and subtropical perennial plant of the family Euphorbiaceae. The tubers are used as a staple food source because they contain high carbohydrates. Cassava is a potential food ingredient in the development of agribusiness and agro-industry, especially in Indonesia. Cassava can be processed or preserved into various kinds of products, both food and non-food. One of the most common and simple cassava processing is made into tapai. Processing cassava into tapai through the fermentation process can increase its nutritional value in it. In addition to increasing nutritional value, the texture of cassava tapai is also softer and easier to digest so that the absorption of nutrients can be maximized. Microorganisms found in yeast will convert starch into simple sugars, alcohols and organic acids. However, there are several obstacles in making cassava tapai, including inconsistent taste and texture. This is influenced by several factors such as storage conditions, type of yeast and fermentation time. The alcohol content resulting from fermentation is greatly influenced by the length of fermentation and the type of yeast used (Nurjannah and Nurhikmah, 2020).

Yeast

Tapai yeast is a dry starter culture made from a mixture of rice flour, spices and water or sugarcane juice. Yeast is an inoculum or starter for fermentation in the manufacture of certain products. This fermentation process will produce ethanol and CO2. The inoculum is the main source of active microorganisms in fermented dough and is responsible for the organoleptic quality of cassava tapai products. The microorganism that is usually used is saccharomyces cerevisiae which functions to convert carbohydrates (starch) into sugars and alcohol. The process also causes the texture of tapai to become soft and tender. Saccharomyces cerevisiae is a strong fermentative species but in the presence of oxygen, saccharomyces cerevisiae can also respirate, which oxidizes sugar to carbon dioxide and water (Dirayati et al., 2017).

Yeast is one of the important components in the fermentation process. Yeast is a microbe that can convert glucose into bioethanol. The amount of yeast needed to make bioethanol varies depending on the type of material used. The amount of yeast needed in fermenting sago starch, sago pith and sago fiber varies, as well as the ethanol content produced. Getting the perfect fermentation requires sufficient levels of yeast and fertilizer (Hastuti et al., 2017).

NPK

The growth of microorganisms is aided by the presence of NPK nutrients. Phosphorus is one of the important elements in the life of saccharomyces cerevisiae especially for the formation of alcohol from sugar. Application of NPK fertilizer as a source of nitrogen, phosphorus and potassium for saccharomyces cerevisiae to live, develop and carry out activities and increase the number of cells. Element N is useful for the formation of nucleic acids and amino acids. Element K is an enzyme cofactor and element P is useful for the synthesis of nucleic acids and other phosphorus-containing compounds. One of the nutrients needed by fermented microorganisms is phosphorus while in various trials of making bioethanol,

NPK-type fertilizer is the most widely used fertilizer in bioethanol harvesting (Swetachattra et al., 2019).

Bioethanol Process

According to Firdaus et al. (2019), the bioethanol manufacturing process consists of three stages, namely:

Hydrolysis

The process of hydrolysis is a chemical reaction between water and another substance that produces a new substance and also the decomposition of a solution using water. Starch hydrolysis can be used by chemical methods and enzymatic methods. Hydrolysis with acid aims to break the bonds of lignin, cellulose and hemicellulose so that cellulose and hemicellulose are easily redacted into glucose. Hydrolysis is the chemical process of converting starch into glucose. There are two stages of this stage, namely the liquidation of the liquidation process.

Fermentation

Fermentation is the process of converting glucose to bioethanol by mixing saccharomyces which will be stored in a room that is not exposed to direct sun for 10 days and 15 days at a temperature of 27 °C. The result of fermentation is liquid. The fermentation process is the process of producing energy in cells in a state without oxygen where sugars are broken down into bioethanol and carbon dioxide. The change that occurs during the fermentation process is that glucose becomes bioethanol by tapai yeast and baker's yeast cells.

Figure 7. Fermentation Process.
(Source: Firdaus et al., 2019).

Distillation

Distillation is the process of separating bioethanol from water. Bioethanol will evaporate in the steam tube in this tube the temperature of bioethanol vapor is lowered to below its boiling point, bioethanol will change again from the gas phase to the liquid phase, then the melted bioethanol is accommodated in the distilled tube. Distillation is a purification process carried out to extract bioethanol produced from fermentation. The rate of ethanol distillation itself is influenced by the alcohol content produced by the fermentation process. The higher the ethanol content produced, the faster the relative distillation rate. This is because the ethanol distillation process is carried out through an evaporation process where the boiling point of ethanol has been reached at a temperature of 78.32 °C. Ethanol distillation aims to separate ethanol from solutions that still contain a lot of water, with the distillation process, the ethanol produced can reach 96% levels.

Influencing Factors

The amount of yeast used in bioethanol fermentation affects the alcohol content produced. The higher the amount of yeast used, the higher the alcohol content produced. Excess yeast will inhibit alcohol production because glucose is more widely used for the growth of microorganism biomass. Another factor affecting the alcohol content of bioethanol is the length of fermentation. The fermentation time of bioethanol varies with the type of raw material used. In the fermentation process of bioethanol, fertilizer is added as an additional nutrient for the growth of fermented microorganisms. The amount of nutrients needed during the fermentation process varies depending on the type of bioethanol raw material used and the amount of yeast used. This is because the raw materials used already contain the nutrients needed for the growth of fermented microorganisms. One of the nutrients needed by fermented microorganisms is phosphorus while in various trials of making bioethanol, NPK-type fertilizer is the most widely used fertilizer (Hastuti et al., 2017).

PRACTICUM METHODOLOGY

Time and Place

The Practicum for Making Simple Bioethanol was held on Tuesday, September 20, 2022, at 14.50 WITA-finished, at the Laboratory of Agricultural Tools and Machinery, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

Tools

The tools used in the Simple Bioethanol Making practicum were fermenter containers, distillators, measuring cups, transparent hoses, clear plasters, scissors, scales, shooting glue and mobile phones.

Materials

The materials used in the Simple Bioethanol Making practicum were cassava 1 kg, yeast 80 grams, NPK 15 grams and cold water.

Procedures

The practicum procedure for Making Simple Bioethanol, namely:

1. Peeling and cleaning cassava.
2. Steaming cassava for 30 minutes.
3. Grind the cassava and weigh the cassava weighing 1 kg.
4. Put cassava in a fermenter container.
5. Weigh yeast weighing 80 grams and grind the yeast.
6. Put the yeast in the fermenter container.
7. Weigh the NPK weighing 15 grams and smooth the NPK.
8. Mixing NPK, cassava and yeast in a fermenter container.
9. Close the jar tightly (make sure that no air can enter the jar).
10. Store the mixture for 7-8 days (fermentation).
11. Separating the fermented liquid from the pulp.
12. Distilling fermented water to separate ethanol and water using a distillator.
    - Heating fermented water at 80 °C, the container in which to heat must be tightly closed.

- Cooling the steam coming out of the heating container to produce the ethanol vapor condensation process.
- Pour the ethanol produced into a measuring cup to find out the volume of ethanol produced.
- Conduct practicum documentation.

RESULTS AND DISCUSSION

Figure 8. Results of a series of distillator tools.

After fermenting for 8 days, distillation of fermented results in the form of bioethanol was carried out using a distillator. The working principle of distillation is that the fermentation results are heated and then distilled using the help of hoses and ice cubes as coolers from distillation. During the process of making bioethanol occurs several stages, i.e. hydrolysis, fermentation and distillation. This distillation process was the final process of making bioethanol by separating the fermentation results. This is to the statement of Firdaus et al. (2019), that distillation is the process of separating bioethanol from water. Bioethanol will evaporate in the steam tube in this tube the temperature of bioethanol vapor is lowered to below its boiling point, bioethanol will change again from the gas phase to the liquid phase, then the melted bioethanol is accommodated in the distilled tube.

Figure 9. The result of Bioethanol.

Based on Figure 9, it can be seen that the results of the fermentation distillation process that has been carried out have failed which was characterized by the non-flame when the experiment burns paper with a mixture of bioethanol results obtained. Failure to make bioethanol could occur because the fermentation period still needs to be extended. The process of opening the fermenter container after fermentation and before distillation was also a factor because air had successfully entered the fermenter container. The use of yeast in the bioethanol butane process that had been carried out was also a failure factor because there are two types of yeast used in the manufacturing process, namely tapai yeast and baker's yeast or fermipan, where the two yeasts could not be mixed in one treatment. Baker's yeast is not appropriate to use in the cassava fermentation process because baker's yeast

is only suitable for the fermentation of bread dough and cakes while the yeast suitable for cassava fermentation is tapai yeast. This is to the statement of Hastuti et al. (2017), that tapai yeast is a dry starter culture made from a mixture of rice flour, spices and sugarcane juice. Yeast is an inoculum for fermentation in the manufacture of certain products. The microorganism that is usually used is saccharomyces cerevisiae which functions to convert carbohydrates (starch) into sugars and alcohol.

CONCLUSION

Based on the Simple Bioethanol Making practicum that has been carried out, it can be concluded that bioethanol is ethanol whose main ingredient is from plants and generally uses a fermentation process with the help of microorganisms. The process of making bioethanol goes through three stages, namely hydrolysis, fermentation and distillation. The results of the fermentation carried out failed. This happens because the fermentation period still needs to be extended and there is a mixing between tapai yeast and fermipan yeast in making bioethanol, where fermipan yeast is not appropriate to be used in the cassava fermentation process and is only suitable for bread making. The process of opening the fermenter container after fermentation and before distillation is also a factor because air has successfully entered the fermenter container.

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ATTACHMENT

Attachment 2. Simple Bioethanol Making Practicum Documentation.

Figure 10. Documentation of Simple Bioethanol Making Practicum.

UTILIZATION OF SOLAR ENERGY FOR DRYING AGRICULTURAL PRODUCTS

Yuliana Mahmuddin[1]), Febry Sautama Tingara[2)] and Muh. Putra Ansyari Naim[2)]

[1)] Renewable Energy Practicum Practice of Agricultural Engineering Study Program, Hasanuddin University

[2)] Renewable Energy Practicum Assistant for Agricultural Engineering Study Program, Hasanuddin University

ABSTRACT

Rice as the largest agricultural product in Indonesia must now be maintained in quality. Maintaining the quality of rice after post-harvest can be done by drying so that the rice reaches the maximum moisture content for its shelf life. Solar energy drying is drying by utilizing direct sunlight. The purpose of practicum is to determine the process of mass change and measure the amount of sunlight intensity using a *lux* meter. The method used in practicum was drying rice with solar energy drying which utilizes white and black plastic as a medium that could help conduct heat where the results of mass reduction from both treatments would be compared. The results obtained after observation were that the mass of grain that decreases faster occurs in black plastic and the drying rate in both treatments occurs slowly and the percentage of grain moisture content with black plastic was greater than white plastic. The conclusion that could be drawn was that using black plastic in drying had a fast impact on the process of evaporation of moisture content because black plastic had an emissivity value of 1 while white plastic had an emissivity value of 0 so that the ability to absorb and emit heat on black sticks was greater than the white plastic.

Keywords: Mass, Rice, Temperature

INTRODUCTION

Background

Indonesia as an agricultural country has been known for a long time with a dominating agricultural coverage as a livelihood for the community and a support for Indonesia's economic development. Rice as the largest agricultural product in Indonesia must now be maintained in quality. Given that the staple food in Indonesia comes from rice. Maintaining the quality of rice after post-harvest can be done by drying so that the rice reaches the maximum moisture content for the future shelf life.

Rice drying can be done using solar energy drying. Drying by utilizing direct sunlight can be said to be drying solar energy. Drying is done to reduce the moisture content of rice. Food security after harvest has different levels. The resistance of rice after harvesting must be given drying treatment because in the shelf life rice must have a low moisture content to last a long time.

The safe moisture content for rice storage is 13%-14%. The principle of drying solar energy is the heat generated from a solar radiation so that the water content in rice will evaporate slowly due to the temperature difference between the environment and rice. Direct drying with sunlight has advantages for the

community because it does not cost much, but drying with sunlight takes a lot of time, the drying results are less than optimal, requires a large place, can be disturbed by animals and is very limited by the weather. Optimization of solar energy drying can be done using the help of media that can accelerate heat delivery, namely by using black objects as a base and cover or using materials that easily conduct heat.

Blackbody can be used as a medium to carry out more optimal drying. Black objects have a darker, opaque color of objects. A black body has an emissivity value of 1. Emissivity value is a value that indicates an object that has a greater ability to absorb and emit light, where the closer to 1, an object can absorb and emit light well. Blackbody radiation is when black objects absorb and hold light and then emit radiation around them so that temperature changes will be felt as a result of their radiation emission, because blackbody radiation can conduct good heat.

Based on the description above, it is necessary to do practicum on the Utilization of Solar Energy for Drying Agricultural Products in order to find out the process of drying solar energy which is carried out simply under direct sunlight using grain materials and can apply the process of drying solar energy in agriculture and in life.

Purpose and Uses of Practicum

The purpose of practicum on the Utilization of Solar Energy for Drying Agricultural Products is to know the process of changes in grain mass and temperature during the drying process and measure the amount of sunlight intensity using a *lux* meter and can find out the amount of decrease in moisture content in grain.

The use of practicum on the Utilization of Solar Energy for Drying Agricultural Products is being able to find out the drying process of food with solar energy which then the solar energy drying process of this food can be applied to agriculture, especially during post-harvest.

LITERATURE REVIEW

Drying

According to Tarigan (2020), stated that drying processes are one of the post-harvest processes for various agricultural products. Open drying directly in the sun is the simplest traditional drying method and is still widely practiced by farmers in Indonesia. Many obstacles are experienced with this method such as erratic weather, product contamination, hygienic problems and various things that ultimately affect the quality and quantity of agricultural products. On the other hand, the use of modern drying machines adds to production costs and is not affordable for farmers, in addition to the negative impacts that occur as a result of burning fossil energy sources in machines. Solar power is a clean energy source, its availability is abundant, especially in areas around the equator including Indonesia, and can be obtained freely, to anticipate unpredictable weather, system solar power dryers are smothered with heat obtained from biomass combustion. There are various types and types of solar dryers that are classified respectively according to the way of heating solar radiation, aids and types of products that are dried. Based on how the dried material gets heat from solar radiation, solar dryers are divided into 3, namely:

a. Direct-type dryer, direct solar radiation hits the material being dried.
b. Indirect type dryer, solar radiation is used to heat the air and then the hot air is passed on the dried material

c. Combined type dryer (hybrid dryer), solar radiation is used both directly on the material being dried and to heat the air to dry.

The drying process is one of the handling of foodstuffs to improve the quality and extend the shelf life of foodstuffs. Drying means reducing the amount of water or liquid from solid materials so that the remaining water or liquid in the solid material has a low and acceptable content. Drying is usually the final step in a series or operation and the product of the dryer is ready for final packaging. The drying process involves two transfer processes, namely the heat transfer process and the mass transfer process. The heat transfer process occurs from the drying air to the material to be dried while the mass transfer occurs in two stages. The first stage occurs in the water content contained in the material to the surface of the material (diffusion process), then the second stage occurs in the process of water absorption from the surface of the material to the air into steam so that there is a reduction in water content in food (Benefit et al., 2019).

Water Content

The presence of water in food is always associated with the quality of food and as a measure of the dry matter or solids part. Water in the material can be used as an index of stability during storage and a determinant of organoleptic quality, especially taste and tenderness. The water content in food greatly affects the quality and shelf life of these foods. Determination of the moisture content of a food is very important so that in the process of processing and distribution get proper handling because if there is improper handling in processing and determining the wrong water content, there will be damage to food that can be harmful to health. Law No. 18 of 2002 concerning Food, Food Safety is a condition and effort needed to prevent food from possible biological, chemical and other objects that can disturb, harm and endanger human health and do not conflict with religion, beliefs and culture of the community so that it is safe for consumption. Water content is the amount of water contained in an object such as soil, rocks, agricultural materials and so on. Water content is widely used in engineering and is expressed in ratios, from 0 (total dryness) to water saturation value where all pores are filled with water (Prasetyo et al., 2019).

The water content contained in materials, especially agricultural products, is divided into 2 parts, namely water contained in a free state (free water) and water contained in a bound state (bound water). Free water is the difference between the moisture content of a material at a certain temperature and humidity and the equilibrium moisture content at the same temperature and humidity. Free water is generally found on the surface of the material. Bound water is water contained by a material whose equilibrium vapor pressure is less than that of a pure liquid at the same temperature. Bound water exists in materials in a physically and chemically bound state. There are two ways to express the water content of foodstuffs, namely dry base water content is the ratio between the weight of water in the material and the dry matter. Wet base water content is a comparison between the weight of water in the material and the weight of wet material (Gultom et al., 2019).

Rice

Rice in Indonesia is still quite low where development is relatively slow. The low rate of rice production in Indonesia is sometimes caused by problems in developing rice product quality that is not optimal for environmental factors. High humidity

causes rice to rot easily, especially in tropical climates such as Indonesia. In the rainy season, the grain drying process does not run optimally, causing rice to rot and reducing the amount of quality rice. Drying of grain using conventional methods, carried out by direct heating in the sun in the open field can take three to eight days, depending largely on the intensity of sunlight. Based on the above phenomenon, it can be seen that drying is one of the important processes in post-harvest rice. Drying rice aims to remove water content, prevent fermentation and fungal growth and slow down chemical changes that can reduce rice quality. During the drying process there are two processes that work simultaneously, namely heat transfer from the heat source to the product, A good drying process can improve the quality of rice production and provide a safe storage period. Dry grain that has good quality generally has a water content of 18%-25% and to meet grain storage standards, the water content must be in the range of 14% while for grain that can be directly milled the water content must be in the range of 12%-13%, therefore to meet standards such as rice moisture content, farmers need to pay attention to the quality of grain through a a more optimal drying process (Irham, 2021).

Drying Rate

Each dried solid material has different drying characteristics. This characteristic can be represented by a drying rate curve. The curve can show the moisture content in the material, drying rate, and drying time so that it can determine the effectiveness of the process time to obtain the appropriate product. The drying process has several variables that can affect the quality of the product produced, for example, temperature and time. The higher the drying temperature, the faster the drying rate that occurs and can damage the product because the outer layer dries too quickly while the inside is still wet. Factors that influence the drying process include temperature, air humidity, initial moisture content of the material and final moisture content (Benefit et al., 2019).

Blackbody Radiation

A black body is defined as an object that absorbs all the radiation that comes at it. The ideal blackbody is modeled with a black cavity with a small hole. When the light beam enters the cavity through the hole, the light beam will be reflected many times on the cavity wall without having time to exit again through the hole. Light energy will be absorbed by the cavity wall every time reflection occurs. Blackbody radiation is electromagnetic radiation emitted by blackbodies. A black body can be an object that absorbs electromagnetic waves well and can also emit them well at the same time. An object if heated, then the object will emit electromagnetic wave radiation, when the object reaches a certain temperature, the object will appear to light up which means the radiation waves emitted by the black object are at the visible light frequency. Surface emissivity can be defined as an object's ability to radiate the energy it possesses. The currently known level of color emissivity is only for black and white colors with an emissivity coefficient of 1 for black and 0 for white (Sutarno et al., 2017).

PRACTICUM METHODOLOGY

Time and Place

Practicum on the Utilization of Solar Energy for Drying Agricultural Products was carried out on Saturday, 1 October2022 at 10.00 WITA until it was completed,

located at the Soil and Water Engineering Laboratory and the Courtyard of the Agricultural Technology Association, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

Tools

The tools used in the practicum on the Utilization of Solar Energy for Drying Agricultural Products are *lux* meters, black and white plastic 30x30 cm, scissors, rulers, digital scales, notebooks, pens and *mobile phone cameras.*

Materials

The material used in the practicum of Solar Energy Utilization for Drying Agricultural Products is grain.

Practicum Procedures

Solar Energy practicum procedures are as follows:

a. Using black plastic
1. Preparing tools and materials.
2. Cut black plastic with a size of 30x30 cm each.
3. Weigh a grain sample weighing 500gr for black plastic.
4. Drying grain samples that have weighed 500gr under the hot sun directly on a black plastic base.
5. Measure light intensity using a *lux* meter and weigh the weight of the grain sample every 15 minutes time interval.
6. Repeat the procedure 5 to 90 minutes.
7. Documentation of measurement results.

b. Using white plastic
1. Preparing tools and materials.
2. Cut white plastic with a size of 30x30 cm each.
3. Weigh a grain sample weighing 500gr for white plastic.
4. Drying grain samples that have weighed 500gr under the hot sun directly on a white plastic base.
5. Measure light intensity using a *lux* meter and weigh the weight of the grain sample every 15-minute time interval.
6. Repeat the procedure 5 to 90 minutes.
7. Documentation of measurement results.

Formula Used

$$m = \frac{A-B}{B} \times 100\%$$

Information:
m = dry base moisture content (%)
A = starting weight (g)
B = final weight (g)

RESULTS AND DISCUSSION

Table 1. Calculation Results of Grain Moisture Content in White Plastic.

Plastic Color	Observation Time	Grain Mass (g)	Solar Radiation (W/m^2)	Water Content (%)
White	0-15	500-233	231326	1,242
	15-30	223-219	223632	1,826
	30-45	219-218	214066	0,459
	45-60	218-217	204070	0,461
	60-75	217-216	193026	0,463
	75-90	216-215	170898	0.465

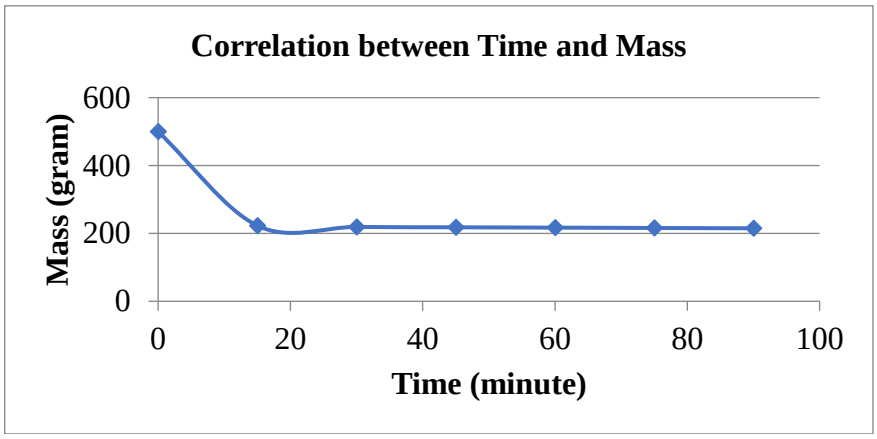

Figure 11. Graph of the Correlation between Time and Mass in White Plastic.

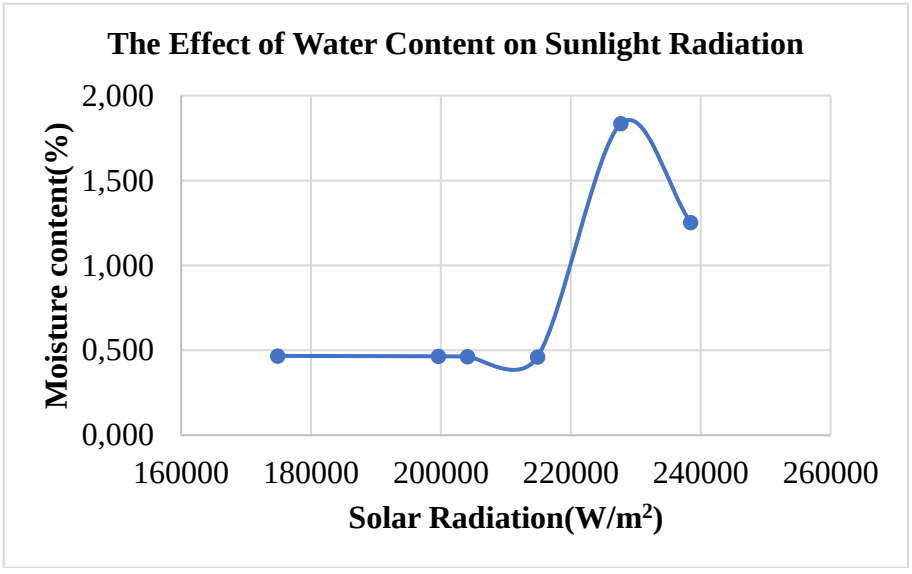

Figure 12. Graph of the Effect of Sunlight Radiation on Water Content in White Plastic.

Based on Figures 11 and 12, it can be seen that grain drying carried out in treatment using white plastic shows a decrease in mass at minutes 15 to 90, but grain mass at minutes 75-90 has decreased very slightly. This happens because of the water

content factor contained in the grain, where the water content in the grain in that minute is getting less and the intensity of sunlight is getting lower so that there can be evaporation of low water content and cause the grain mass in that minute to decrease very slightly. The grain mass is inversely proportional to time, where the longer the drying time, the grain mass will decrease. Based on the results of observations that have been carried out for 90 minutes, data were obtained from the dry base moisture content in grain samples using white plastic, that the dry base water content over time decreased. This happens because of the factor of the intensity of sunlight, where the more time increases, the intensity of sunlight that hits the grain decreases so that the water content that manages to evaporate is also less. The drying rate that occurs in grain using white plastic occurs very slowly. This happens because the intensity of light hitting the grain is lower, automatically the drying temperature will also be lower. The emissivity value of white sticks is 0 so that the ability of white plastic to absorb heat and emit radiation is very low so that it can affect the mass decrease in rice. This is in accordance with the statement of Benefit et al. (2019), the higher the drying temperature, the faster the drying rate that occurs and can damage the product because the outer layer dries too quickly while the inside is still wet. Factors that influence the drying process include temperature, air humidity, initial moisture content of the material and final moisture content.

Table 2. The Calculation of Grain Moisture Content in Black Plastic.

Plastic Color	Observation Time	Grain Mass (g)	Solar Radiation (W/m^2)	Water Content (%)
Black	0-15	500-222	238454	1,252
	15-30	222-218	227715	1,835
	30-45	218-217	214860	0,461
	45-60	217-216	204070	0,463
	60-75	216-215	199609	0,465
	75-90	215-214	174841	0,467

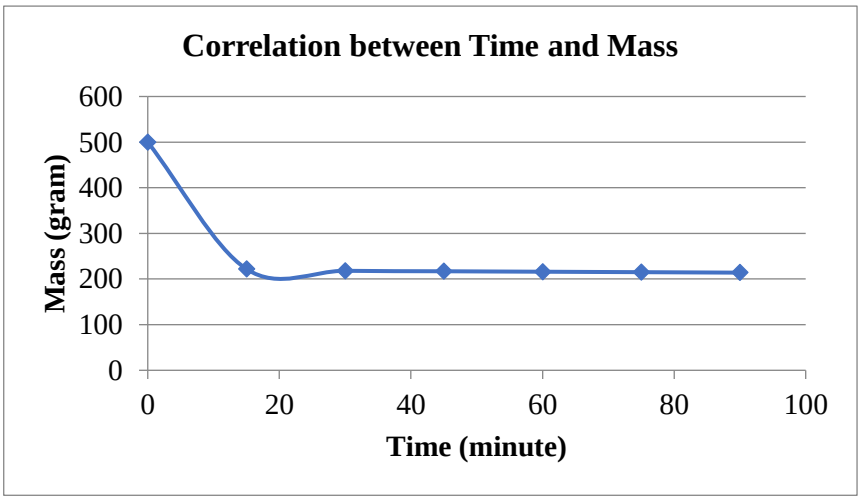

Figure 13. Graph of the Correlation between Time and Mass in Black Plastic.

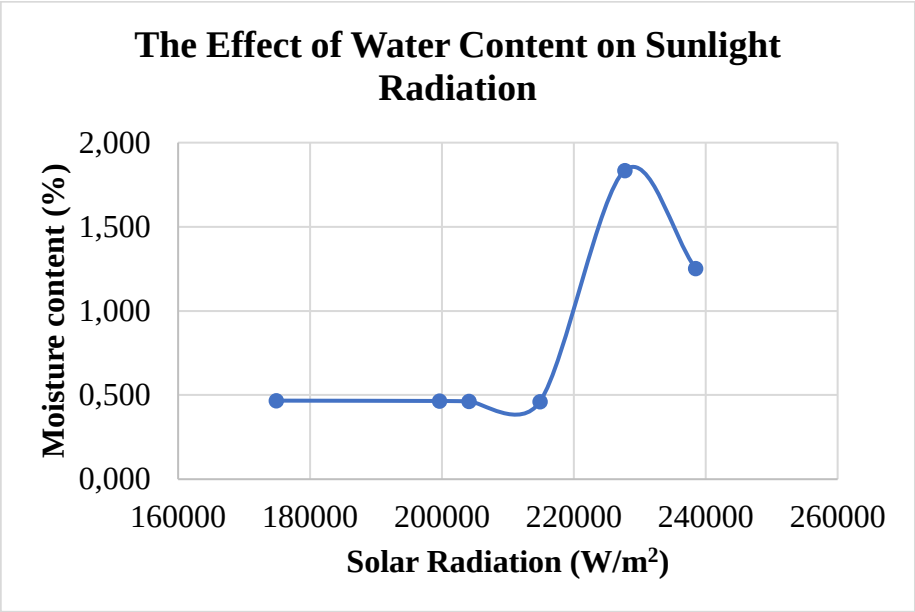

Figure 14. Graph of the Effect of Sunlight Radiation on Water Content in Black Plastic.

Based on Figures 13 and 14, it can be seen that grain drying carried out in treatment using black plastic shows a continuous decrease in mass. This happens because of the help of blackbody radiation. Black plastic used as a base undergoes radiation, where the emissivity value of black plastic is 1 so that the ability to absorb heat and emit radiation into its environment in the form of hot temperatures is greater than white plastic. The dry base water content obtained for 90 minutes has decreased very drastically. This happens because the intensity of light hitting the grain in minutes 15-30 has decreased very drastically so that the distribution of temperature at that minute has decreased which results in the process of evaporation of less water content. The drying rate that occurs in grain using black plastic occurs quite slowly. This happens because the light intensity factor that hits the grain gets lower over time so that the drying temperature is also lower, where the drying rate will be fast if the drying temperature gets higher over time. This is in accordance with the statement of Sutarno et al. (2017), that surface emissivity can be defined as the ability of objects to emit the energy they have. The currently known level of color emissivity is only for black and white colors with an emissivity coefficient of 1 for black and 0 for white.

CONCLUSION

Based on the practicum on the Utilization of Solar Energy for Drying Agricultural Products that has been carried out, it can be concluded that the fastest decrease in grain mass occurs in grain drying using black plastic and the percentage of dry base moisture content in drying grain with black plastic is greater than white plastic. This happens because black plastic has the ability to absorb and emit greater heat than white plastic. The drying rate in both treatments occurs slowly. This happens because the light intensity factor that hits the grain gets lower over time so that the drying temperature is also lower, where the drying rate will be fast if the drying temperature gets higher over time.

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ATTACHMENT

Attachment 3. Observation Table.

a. White Plastic

Table 3. Observation of Grain Drying on White Plastic .

Time (Minutes)	Weight (grams)
0	500
15	223
30	219
45	218
60	217
75	216
90	215

b. Plastic Color Black

Table 4. Observation of Grain Drying on Black Plastic .

Time (Minutes)	Weight (grams)
0	500
15	222
30	218
45	217
60	216
75	215
90	214

Attachment 4. Calculation of moisture content of grain dry base.

a. White Plastic

Known:
A = 500 g
B = 223 g
Asked:
m1 = ?
Settlement

$$m1 = \frac{500\text{-}223}{223} \text{ X } 100\%$$

$$= \frac{277}{223} \text{ X } 100\%$$

$$= 124.2\%$$

Known:
A = 223 g
B = 219 g
Asked:
m2 = ?
Settlement

$$m2 = \frac{223\text{-}219}{219} \text{ X } 100\%$$

$$= \frac{4}{223} \text{ X } 100\%$$
$$= 1.826\%$$

Known:
A = 219 g
B = 218 g
Asked:
m3 =?
Settlement

$$m3 = \frac{219\text{-}218}{218} \text{ X } 100\%$$
$$= \frac{1}{218} \text{ X } 100\%$$
$$= 0.459\%$$

Known:
A = 218 g
B = 217 g
Asked:
m4 =?
Settlement

$$m4 = \frac{218\text{-}217}{217} \text{ X } 100\%$$
$$= \frac{1}{217} \text{ X } 100\%$$
$$= 0.461\%$$

Known:
A = 217 g
B = 216 g
Asked:
m5 =?
Settlement

$$m5 = \frac{217\text{-}216}{216} \text{ X } 100\%$$
$$= \frac{1}{216} \text{ X } 100\%$$
$$= 0.463\%$$

Known:
A = 216 g
B = 215 g
Asked:
m6 =?

Settlement

$$m6 = \frac{216\text{-}215}{215} \text{ X } 100\%$$
$$= \frac{0}{215} \text{ X } 100\%$$

= 0.465%

b. Plastic Color Black

Known:
A = 500 g
B = 222 g
Asked:
m1 =?
Settlement

$$m1 = \frac{500\text{-}222}{222} \text{ X } 100\%$$

$$= \frac{278}{222} \text{ X } 100\%$$

= 12 5.2%

Known:
A = 222 g
B = 218 g
Asked:
m2 =?
Settlement

$$m2 = \frac{222\text{-}218}{218} \text{ X } 100\%$$

$$= \frac{4}{228} \text{ X } 100\%$$

= 1.835%

Known:
A = 218 g
B = 217 g
Asked:
m3 =?
Settlement

$$m3 = \frac{218\text{-}217}{217} \text{ X } 100\%$$

$$= \frac{1}{217} \text{ X } 100\%$$

= 0.461%

Known:
A = 217 g
B = 216 g
Asked:
m4 =?

Settlement

$$m4 = \frac{217\text{-}216}{216} \text{ X } 100\%$$

$$= \frac{1}{216} \text{ X } 100\%$$

= 0.463%

Known:
A = 216 g
B = 215 g
Asked:
m5 =?
Settlement

$$m5 = \frac{216\text{-}215}{215} \text{ X } 100\%$$

$$= \frac{1}{215} \text{ X } 100\%$$

$$= 0.465\%$$

Known:
A = 215 g
B = 214 g
Asked:
m6 =?
Settlement

$$m6 = \frac{215\text{-}214}{214} \text{ X } 100\%$$

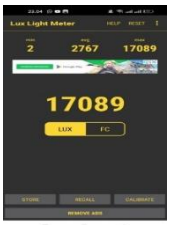
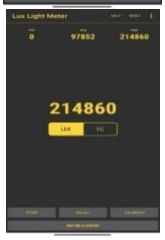
$$= \frac{1}{214} \text{ X } 100\%$$

$$= 0.467\%$$

Attachment 5. Lux Meter measurement.

Table 5. Measurement of light intensity.

Time (minutes)	Light Intensity (*lux*)	
	Black Plastic	**White Plastic**
0		
15		
30		

45		
60		
75		
90		

Attachment 6. Practicum Documentation on the Utilization of Solar Energy for Drying Agricultural Products.

Figure 15. Practicum Documentation on the Utilization of Solar Energy for Drying Agricultural Products.

BAYU POWER PLANT (PLTB)

Yuliana Mahmuddin[1]), Febry Sautama Tingara[2)] and Muh. Putra Ansyari Naim[2)]

[1)] Renewable Energy Practicum Practice of Agricultural Engineering Study Program, Hasanuddin University

[2)] Renewable Energy Practicum Assistant for Agricultural Engineering Study Program, Hasanuddin University

ABSTRACT

Electricity has become one of the sources of energy that cannot be separated from human life. The power plant is one of the uses of wind that can produce electricity. The purpose of practicum was to be able to understand the working principle of turbines that use wind energy as a source of electrical energy and can find out the amount of voltage produced by turbines in accordance with the available wind speed. The method used in practicum was to drive the turbine using wind power and then calculate the voltage generated from the rotation of the turbine based on distance and speed. The results obtained from practicum were the comparison between the speed and voltage produced which was directly proportional and the comparison between distance and voltage produced was inversely proportional. The conclusion that could be drawn was that the greater the wind speed given, the faster the turbine would rotate so that it produced a large voltage and the longer the distance in the distribution of wind, the wind speed that reached the propeller would decrease and the wind range given would spread before hitting the propeller.

Keywords: Wind, Electricity, Turbine

INTRODUCTION

Background

Energy is one of the basic needs of the Indonesian people. Electricity has become one of the sources of energy that cannot be separated from human life. Bayu power plant is one of the environmentally friendly power plants. The use of electrical energy in agricultural engineering greatly impacts the performance of agricultural equipment, such as the use of grain dryers and coffee grinders.

Wind power plants are one of the uses of wind that can produce electricity. The working principle of the Bayu Power Plant (PLTB) is to utilize wind as a source of drive from the propeller which then the rotary energy generated will drive the transmission system in the gearbox which will produce DC electrical energy and then channeled to the generator to be converted into AC electrical energy. Factors that can affect wind power are the volume of air, the speed of airflow and air masses. Wind power plants are one of the producers of electricity that is environmentally friendly and does not produce emissions so that the use of wind power plants in Indonesia is very necessary. PLTB can only be built in an area that has a lot of wind power sources and is free from hills that can block wind sources. The success of wind power plants is strongly influenced by wind power sources. The use of wind power plants has a great positive impact on the community, especially in agriculture which can be used in the distribution of electricity sources in agricultural tools and machinery.

Based on the description above, it is necessary to carry out a Bayu Power Plant practicum in order to find out the process of converting wind energy into electrical energy that can be used as a source of electrical energy for the community, especially in agriculture to minimize the use of costs.

Purpose and Uses of Practicum

The purpose of the wind power plant practicum is to be able to understand the working principle of turbines that use wind energy as a source of electrical energy and be able to find out the amount of voltage produced by the turbine according to the available wind speed.

The use of the Bayu Power Plant practicum is to be able to utilize wind energy as a source of electrical energy which later this electrical energy will be used as additional energy and to replace some of the use of electricity loads previously supplied from PLN.

LITERATURE REVIEW

Wind

According to Syamsuarnis and Candra (2020), stating that energy is important for people's lives. Various forms of energy are directly related to society such as heat energy for cooking and electrical energy for lighting and other electrical appliances. Electrical energy for modern society has become a primary need that cannot be separated from the daily life of the plant. Activities at home, office to transportation in fact require a lot of electricity supply, but the use of electrical energy for people who are less fortunate in terms of economy certainly cannot use it. The utilization of wind energy is actually not new to mankind. Since 2000 years ago, the technology of utilizing wind and water resources has been known to humans in the form of windmills. The design of this wind power plant is carried out through several steps, namely:

1. Design of technical equipment such as turbines, turbine controls, frames and installations.
2. Construction work on turbine support pylons.
3. Work on the flow connection network to residents' homes.

Figure 16. Bayu Power Plant.
(Source: Syamsuarnis and Candra, 2020).

Wind is a large-scale and large amount of gas flow caused by the rotation of the earth and also due to differences in air pressure around it. The wind moves from a place of high air pressure to a place of low air pressure. The air will expand when

heated, where the air that has expanded becomes lighter so that it rises. When this happens, the air pressure drops because the air decreases. The surrounding cold air rushed into the low-pressure place just now. The air shrank to become heavier and dropped to the ground. Winds of medium duration (about a minute) are called hard winds. Winds of long duration and have above-average strength are called hurricane winds. The wind flowing in the turbine will rotate the turbine and produce kinetic energy through a rotor consisting of two or more blades that are mechanically and directly connected directly to the electric generator and the location of the wind turbine is installed on one side to produce maximum rotation to produce power with the desired capacity. Vertical axis turbines are usually called rotor darriues after the name of the inventor. This turbine has been widely used because of its advantages in terms of a more specific structure. With the exception of the rotor, all other components have the same design and the difference is only in their placement (Maychel et al., 2019).

Bayu Power Plant (PLTB)

Electricity is an energy source that can transfer energy into another form of electronics. This electrical energy is needed by various levels of society. Technological developments cause an ease in the procurement of electrical energy with technological developments, so there are various ways to generate electrical energy. Electricity generation is a system that requires wind as a source to be converted into electrical energy. The simple concept of PLTB is wind as a source to rotate the mill connected to the generator where the generator has a copper winding so that GGL (Electromotive Force) occurs after the GGL produces electricity, the electricity is stored through the battery so that it can be used to load, for example lights or fans. Wind power is an unlimited natural source by utilizing wind power so we can produce environmentally friendly electricity. PLTB in general is a power generation system that can convert kinetic energy from wind into mechanical energy. In general, PLTB is divided into 4 parts, namely turbine rotor, *gearbox*, generator and loading. The working principle of PLTB is to convert kinetic energy from wind into mechanical energy from the rotation of propellers that can rotate the rotor. The rotation of the rotor is relatively slow, so PLTB generally uses *a gearbox* to accelerate the rotation rate of the rotor. After that the generator converts the rotation of the *gearbox* into electrical energy (Iqbal et al., 2018).

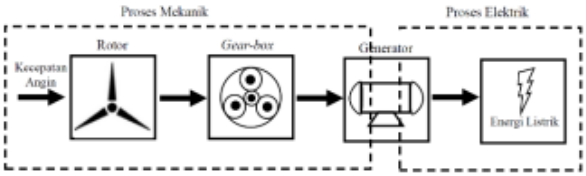


Figure 17. Working Principle of Bayu Power Plant.
(Source: Iqbal et al., 2018).

Wind Turbines

Wind turbines or also called windmills are tools used to capture wind energy in the form of translational motion to be converted into rotational motion and are a means of converting kinetic energy into mechanical energy. Generally, in the design of wind turbines, there are several parameters that must be taken into account, namely cut-in speed, rating speed and cut-off speed which is the speed at which the wind

turbine must stop operating to avoid damage due to the wind speed passing through the wind turbine exceeding the turbine endurance limit. The curvature and thickness of the rotor blades formed in such a way will cause turbulence in the propeller when the wind speed exceeds the specified speed limit. This turbulence will cause the transferred wind energy to be small when the wind speed is high. When the wind speed is low and medium, the propeller angle is adjusted to allow the wind turbine to work at its optimum condition while when the wind speed is high, the propeller angle will be increased so that aerodynamic power is reduced and keeps the rotation speed of the rotor within controllable limits (Prasetyo et al., 2018).

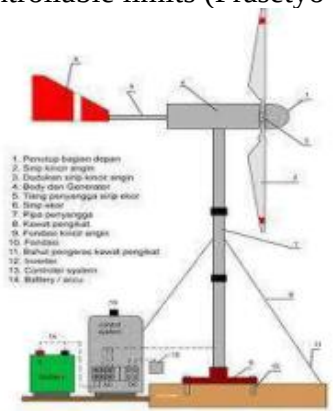


Figure 18. Wind Turbines.
(Source: Prasetyo et al., 2018).

Wind turbines are turbines that are driven by wind, through air moving over the surface of the earth. The basic principle of a windmill is to convert mechanical energy from rotation into electrical energy by electromagnetic induction. The greater the wind speed that hits the turbine, the greater the electrical energy produced. The availability of wind with a very adequate speed is the main factor in implementing windmill technology (Mirza et al., 2019).

Kinetic Energy

Windmill is an energy conversion machine that converts wind energy into useful power in the form of shaft rotation, wind that moves at a certain speed has energy in the form of kinetic energy. If the wind hits the blades on a windmill, then the rotor on the windmill will rotate and then be forwarded to the wind power plant performance system so that it can produce an energy from the resulting rotation. Some of the uses of windmills in general include water pumps for domestic use, irrigation, power generation, use in medium industries and so on (Mirza et al., 2019).

Generator

Generators are the main generation of electrical energy used today and are the largest conversion tool in the world. The principle of the voltage produced by the generator is alternating while the generator that produces voltage in the direction of the handover process in it is small so that it can be done. A generator is a machine that uses magnets to convert energy from mechanical energy into electrical energy. The principle of the generator can be said that voltage is induced on the conductor when the conductor moves in a magnetic field so that it intersects magnetic lines. A generator is a device that produces electrical energy from mechanical energy sources, using electromagnetic induction (Mirza et al., 2019).

PRACTICUM METHODOLOGY

Time and Place

The Bayu Power Plant Practicum washeld on Tuesday, October 4, 2022, at 14.50 WITA-finished, at the Soil and Water Engineering Laboratory, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

Tool

The tools used in the Bayu Power Plant practicum are turbines, fans, digital multimeters, notebooks, pens and mobile phone cameras.

Material

The material used in the wind power plant practicum is wind.

Practicum Procedure

The practicum procedures for the Bayu Power Plant are:

a. Wind Speed Testing
1. Setting up turbines and fans.
2. Put the turbine in front of the fan with a distance of 10 cm.
3. Turn on the fan at the lowest speed (speed 1).
4. Measure and record the results of the voltage generated using a digital multimeter.
5. Repeating procedures 3 and 4 at different fan speeds (speeds 2 and 3).
6. Document the practicum.

b. Distance Testing
1. Setting up turbines and fans.
2. Put the turbine in front of the fan with a distance of 20 cm.
3. Turn on the fan at the most moderate speed (speed 2).
4. Measure and record the results of the voltage generated using a digital multimeter.
5. Repeating procedures 3 and 4 at different distances (40 cm and 60 cm spacing).
6. Document the practicum.

RESULTS AND DISCUSSION

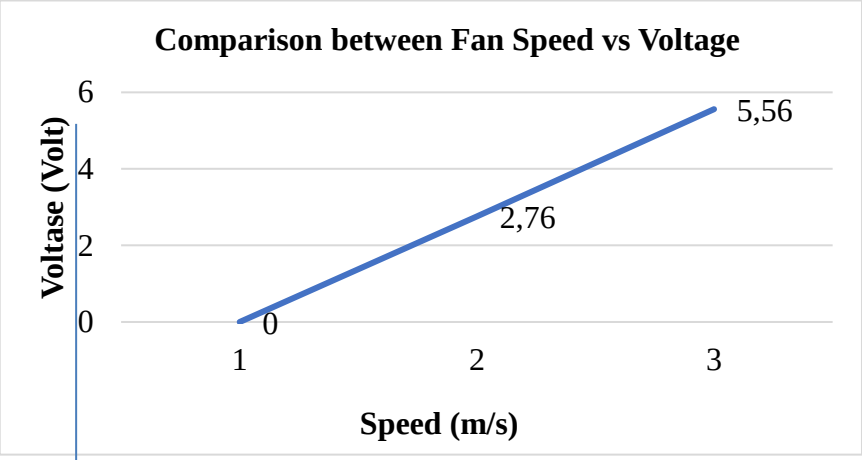


Figure 19. Comparison Graph between Fan Speed Variation Against Voltage.

Based on Figure 19 which shows a comparison graph between fan speed variations to voltage, it can be seen that the power source that can drive the turbine is wind. The wind will hit the turbine so that there will be a rotating movement in the turbine that generates kinetic energy. Kinetic energy will be converted into electrical energy through magnetic coils in the form of DC electric current which will be converted into AC electric current using a generator. Based on this, wind is one of the factors that greatly influence the production of electrical energy, where the greater the speed of the rotating turbine, the greater the energy produced. Based on the results of the distribution of fan speeds that vary with a distance of 10 cm on the turbine, it is found that the higher the speed of the wind buster, the greater the voltage obtained, but at speed 1 it does not produce voltage. This happens because the wind that hits the turbine is so low that the wind spread is not able to reach and drive the turbine. This is in accordance with the statement of Maychel et al. (2019), that the wind flowing on the turbine will rotate the turbine and produce kinetic energy through a rotor consisting of two or more blades that are mechanically and directly connected directly to the electric generator and the location of the wind turbine is installed on one side to produce maximum rotation to produce power with the desired capacity.

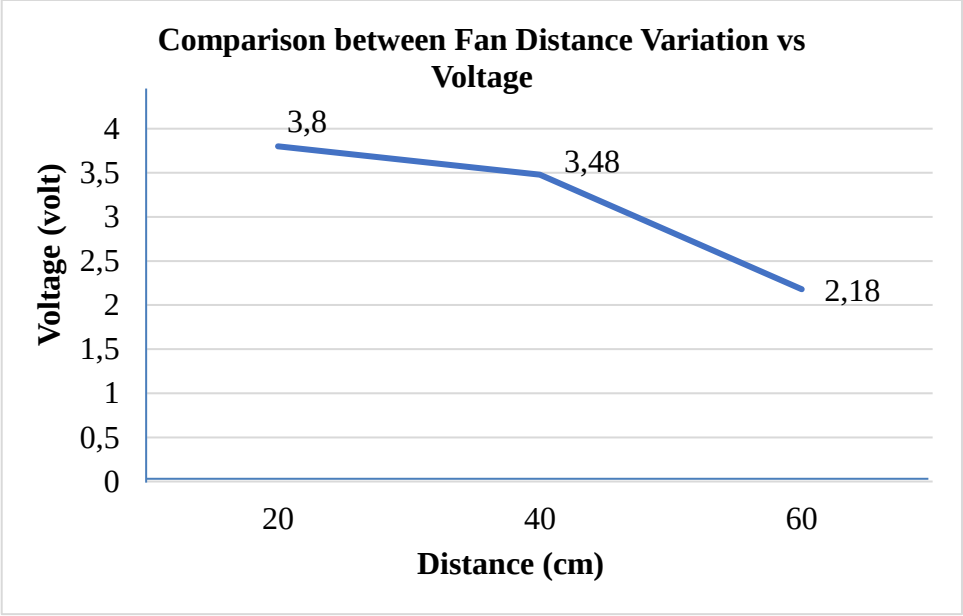


Figure 20. Comparison Graph between Fan Distance Variation Against Voltage.

Based on Figure 20 which shows a comparison graph between fan distance variation to voltage, it can be seen that the result obtained between the distribution of distance variation and voltage is inversely proportional, where the farther the distance given for wind distribution, the resulting tension decreases. This happens because the longer the distance in the wind distribution, the wind speed that reaches the propeller will decrease and the wind range given can spread before hitting the propeller. Wind power that drives propellers can also be influenced by the volume of air, airflow speed and air mass so that to produce large wind power it requires high wind speed, larger propeller size and air mass. This is in accordance with the statement of Mirza et al. (2019), that the basic principle of windmills is to convert mechanical energy from rotation into electrical energy by electromagnetic

induction. The greater the wind speed that hits the turbine, the greater the electrical energy produced.

CONCLUSION

Based on the Bayu Power Plant practicum that has been carried out, it can be concluded that the working principle of the turbine is that the wind will hit the turbine so that there will be a rotating movement in the turbine that generates kinetic energy. Kinetic energy will be converted into electrical energy through magnetic coils in the form of DC electric current which will be converted into AC electric current using a generator. The ratio between the speed and voltage produced is directly proportional because the greater the wind speed given, the turbine will rotate faster so that it produces a large voltage. The ratio between the distance and the voltage produced is inversely proportional because the longer the distance in the distribution of wind, the wind speed that reaches the propeller will decrease and the wind range given will spread before hitting the propeller.

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ATTACHMENT

Attachment. Table of Observations.

Table 6. Observations of wind speed testing.

Speed (m/s)	Voltage (volts)
Speed 1	0
Speed 2	2,76
Speed 3	5,56

Table 7. Observation results of distance testing.

Distance (cm)	Voltage (volts)
Distance 20	3,8
Distance 40	3,48
Distance 60	2,18

Attachment 8. Bayu Power Plant Practicum Documentation.

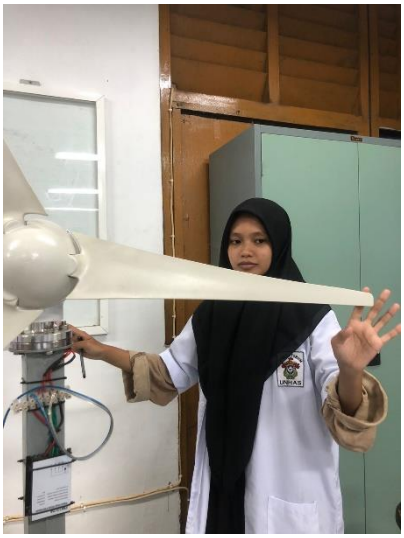

Figure 21. Documentation on Bayu Power Plant Practicum.

HYDROELECTRIC POWER PLANT (SIMPLE WATERWHEEL)

Yuliana Mahmuddin[1]), Febry Sautama Tingara[2)] and Muh. Putra Ansyari Naim[2)]

[1)] Renewable Energy Practicum Practice of Agricultural Engineering Study Program, Hasanuddin University

[2)] Renewable Energy Practicum Assistant for Agricultural Engineering Study Program, Hasanuddin University

ABSTRACT

Hydroelectric power plants are one of the producers of electricity that is environmentally friendly and does not produce emissions so that the use of hydroelectric power plants in Indonesia is very necessary. Wind Power Plant (PLTA) is one of the power plants by utilizing water. The purpose of practicum was to be able to understand the working principle of turbines that use wind energy as a source of electrical energy and could find out the amount of voltage produced by turbines in accordance with the available wind speed. The method used in practicum was to drive the turbine using hydropower and then calculated the voltage generated from the rotation of the turbine based on high, medium and low speeds. The results obtained from practicum were the ratio between speed and voltage produced, which was directly proportional. The conclusion that could be drawn was that the greater the speed of the water given, the faster the turbine wiould rotate so that it produced a large voltage.

Keywords: Water, Electricity, Turbine

INTRODUCTION

Background

Sources of electrical energy today have become a diminishing need along with the increase in human population. The development of power plants in recent years using renewable energy sources is very necessary. Generating electrical energy by utilizing renewable energy sources such as wind and water will greatly protect the environment and reduce the greenhouse effect.

Wind power plant (PLTA) is one of the power plants by utilizing water. The working principle of the Hydroelectric Power Plant (PLTA) is that the waterwheel or turbine will rotate because of the push from the water then the results of the rotation of the turbine will make the generator rotate, where the generator will convert motion energy into electrical energy. Factors that can affect the success of hydroelectric power plants, namely water speed, discharge and wind speed.

Hydroelectric power plants are one of the producers of electricity that is environmentally friendly and does not produce emissions so that the use of hydroelectric power plants in Indonesia is very necessary. Hydroelectric power plants can be built in an area that has a source of heavy water and not still water. The use of hydroelectric power plants in agriculture is very necessary as in the distribution of electricity sources in agricultural tools and machinery. Waterwheels can also be used to stabilize water pressure which will later be channeled to agricultural land.

Based on the description above, it is necessary to do a practicum for Power Generation Equipment (Simple Waterwheel) in order to find out the process of converting energy into electrical energy that can be used as a source of electrical energy in agriculture to minimize the use of costs.

Purpose and Uses of Practicum

The purpose of the practicum of Power Plant Equipment (Simple Waterwheel) is to be able to understand the working principle of turbines that use water energy as a source of electrical energy and can find out the amount of voltage produced by the turbine according to the speed of air.

The use of the practicum of Power Plant Equipment (Simple Waterwheel) is able to utilize water energy as a source of electrical energy which later this electrical energy will be used as additional energy and to replace some of the use of electrical loads.

LITERATURE REVIEW

Hydroelectric Power Plant (PLTA)

Electrical energy that is commonly used today is electrical energy produced by PT. PLN that uses non-renewable fuels or fossil fuels. Water is one source of energy that is easily obtained and relatively economical. The utilization of loose flow on irrigation lines that flow continuously (continuously) can be used as a turbine drive that can produce electrical energy. Electrical energy generated from the utilization of water flow is included in environmentally friendly energy or can be called a Hydroelectric Power Plant (PLTA). Hydropower is energy obtained from flowing water. In water, potential energy and kinetic energy are stored in running water (Anwar et al., 2017).

Hydropower is an example of an efficient type of renewable energy and a potential application for future power generation. Therefore, hydroelectric power plants do not produce air emissions but in most cases have adverse effects on water quality, wildlife habitat and prevent fish migration, but recently, new technologies such as gravity water vortex power systems can solve this problem. Hydropower is currently the safest, most efficient and reliable source of renewable energy. Hydroelectric Power Plant (PLTA) as a renewable energy source provides the community with benefits as a substitute for fossil fuels. Energy sources produced by water have great potential to be developed in Indonesia. In a country that has a large area of waters, it is very suitable in the application of electrical energy microhydro power plants. Based on the size of its capacity, hydropower is divided into several parts, including what we often find on a small scale is a microhydro power plant, which is with a power capacity of 0.5 KW – 100 KW and a picohydro power plant , which is < 500 W. The application of picohydro power plants is for low heads (Hakim et al., 2020).

According to Lukas et al. (2021), stated that the obstacles in the operation of hydropower plants that need to be considered in order to avoid failure, namely:

a. The maximum load caused by imperfect parts such as bearings or shafts that are not well positioned and less high water level in the tando pool so that the head is not enough to generate electrical energy.

b. The minimum load is caused by cavitation in the turbine and the water for the minimum requirements coming out of hydroelectric power plants is not enough.
c. Sediment, the height of a sediment in a reservoir can also affect the performance of the water turbine.

Working Principle of Hydroelectric Power Plant (PLTA)

Hydroelectric power plants (PLTA) work by converting potential energy (from dams or waterfalls) into mechanical energy (with the help of water turbines) and from mechanical energy into electrical energy (with the help of generators), but broadly, hydroelectric power plants are not only limited to water from a reservoir or waterfall, but also include power plants that use hydropower in other forms such as wave power. Hydropower generation is a form of changing power from hydropower with a certain height and discharge to electric power, using water turbines and the help of generators (Alamsyah et al., 2020).

The working system of hydropower plants is to convert the potential energy of water that has been accommodated in the reservoir into kinetic energy by flowing water through a rapid pipe (penstock) then the accelerated water will be used to rotate the turbine. The rotating turbine is connected with a shaft between the turbine and the generator so that the rotor on the generator will also rotate. The rotation of the rotor will result in a difference in the magnetic field which will produce electrical energy due to the intersection by the stator (Lukas et al., 2021).

The operation of hydroelectric power plants by utilizing water resources accommodated in reservoirs which are then channeled through rapid pipes so that the speed of water channeled through rapid pipes can rotate water turbines because the water turbine connected to the generator shaft causes the generator rotor to rotate so that between the rotor and stator there is a change in the magnetic field, from changes in the magnetic field, Electric Force Motion (GGL) occurs (Nelwan and Salman, 2019).

The flow of water at a speed of 220.5 m / s will rotate the screw turbine with a deep cross-sectional area with a size of 84 cm, a track length of 8.8 meters, a water discharge of 0.488 m3 / second and a cross-sectional area of the turbine Ø12.7 cm then the turbine will be connected to a dc generator using a V-belt to generate electricity, then the voltage generated by the generator will be controlled through a charger control, inverter to convert direct voltage into alternating voltage (DC to AC). The battery receives and stores the voltage generated by the tool to be released to the load with the power to be generated which is ±100 watts (Reza et al., 2021).

Influencing Factors

Water conditions that can be used as electricity-producing resources are water conditions that have a certain flow capacity and height from the installation. The greater the flow capacity and height of the installation, the greater the energy that can be used to produce electrical energy. The term capacity refers to the amount of water flow volume, unity of flow capacity time or commonly referred to as discharge, while the difference in the height of the flow area to the installation is known as the head. The speed of water can also affect the amount of electrical energy produced, where the faster the water hits the waterwheel, the greater the electrical energy produced (Anwar et al., 2017).

The decreasing performance of the Sengguruh hydropower plant also affects the total amount of sediment in the reservoir. The ratio between the amount of reservoir sediment and the average power produced is inversely proportional because if there is a lot of sediment, the power produced becomes small. If the sediment eats a little, the power produced will increase (Lukas et al., 2021).

Some factors that have an influence on the output power produced by picohydro are flow discharge where the greater the water discharge produced, the greater the mechanical energy produced to rotate the turbine, elevation (height difference) where the higher the inlet (inlet) the value of water discharge will be greater. Likewise, when the value of the exhaust channel (outlet) is getting bigger, the value of water discharge will also be greater and the type of turbine used (Hakim et al., 2020).

Water Turbine

A water turbine is a device for converting the potential energy of water into mechanical energy. This mechanical energy is then converted into electrical energy by the generator. Water turbines were developed in the 19th century and are used extensively for power generation. Based on the working principle of turbines in converting the potential energy of water into kinetic energy, water turbines are divided into two groups, namely impulse turbines and reaction turbines. The types of water turbines that are widely known and applied to microhydro power plants are crossflow turbines, kaplan turbines, propeller turbines, turgo turbines, francis turbines and pelton turbines. Screw turbine is a type of water turbine that has only been studied for a decade, adopted from the Archimedean Screw theory. The advantages of screw turbines include being able to operate at low heads (Reza et al., 2021).

The type of turbine used in this study is a vortex turbine. The working principle of this turbine is to convert hydropower into rotational force to drive the generator. Choosing the right turbine is very important because the overall efficiency of the system depends on this part. The turbine is transmitted by the generator so that the rotation generated by the turbine can rotate the generator. Generators convert mechanical energy into electricity, DC generators were used in this study. The generator works based on the principle of electromagnetic induction, which is by rotating a coil in a magnetic field so that GGL (Electromotive Force) induction arises (Hakim et al., 2020).

According to Lukas et al. (2021), states that a turbine is a device for converting mechanical energy of water into shaft rotation. The types of water turbines that are widely used, namely:

a. Pelton turbine, used for high waterfall height (head).
b. Francis turbines, used for various purposes due to the wide power range and with a medium head.
c. Kaplan turbine, used for low head. The rotor blades on the turbine have a movable construction and can change the direction of the runner angle manually or automatically. The runner on the Kaplan turbine is regulated by oil pressure through the controlling valve of the governor.

PRACTICUM METHODOLOGY

Time and Place

The Practicum for Power Plant Equipment (Simple Waterwheel) washeld on Tuesday, November 2, 2022, at 14.50 WITA-finished, at the Laboratory of Agricultural Tools and Machinery, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

Tools

A lat used in Hydropower Plant practicum is sticks, DC (Dirrect Current) dynamos, LEDs, single cables, spoons, bottle caps, boards, ties ropes, nails, digital multimeters and cameras.

Materials

Thethings used in the practicum of Power Plant Equipment (Simple Waterwheel) are water, matches and glue.

Practicum Procedures

Practicum procedures for Power Plant Equipment (Simple Waterwheel), namely:

c. Miniature Hydroelectric Power Plant (PLTA)
7. Preparing tools and materials.
8. Make a miniature pole by joining several sticks together using glue.
9. Make a miniature base by joining several sticks together using glue.
10. Unites the miniature base with the board.
11. Mounting the pole on a miniature base.
12. Install the support on the miniature pole, then tie it using a ties rope to make it stronger.
13. Install the DC dynamo on the top of the support, then tighten it using glue.
14. Connecting between a DC dynamo cable and a single cable by means of each end of the cable wound around each other.
15. Installing LEDs on the circuit by increasing the poles, the long legs are connected by a current wire (+) and the short leg is connected by a current wire (-).
16. Make a hole in the bottle cap using a nail that has been heated.
17. Cut the spoon according to the desired size.
18. Installing a spoon on the shaft or bottle cap using glue.
19. Mounting the propeller on the DC dynamo shaft.
20. Document the practicum.

d. Miniature Hydroelectric Power Plant (PLTA) Testing
7. Preparing miniature hydroelectric power plants.
8. Provide running water or water in a moving state.
9. Measure and record the voltage generated in miniature using a digital multimeter.
10. Repeating procedures 2 and 3 at different water speeds of 2 measurements.
11. Document the practicum.

RESULTS AND DISCUSSION

Figure 22. Miniature Hydroelectric Power Plant (PLTA).

Based on Figure 22 which shows a miniature hydroelectric power plant (PLTA) it can be known, that there are several components in a miniature hydropower plant consisting of a waterwheel, DC dynamo (Dirrect Current), single cable and LED. DC (Dirrect Current) dynamo has a very important role, where the dynamo will change the kinetic energy produced from the rotation of the waterwheel which makes the dynamo rotate into electrical energy. The minimum success indicator of setting up a Hydroelectric Power Plant (PLTA) is the presence of DC electric current that will be successfully channeled to the LED through a single cable that will make the lights turn on. The working principle of the DC (Dirrect Current) dynamo is the same as that of a generator. This is in accordance with the statement of Lukas et al. (2021), that the rotating turbine is connected to a shaft between the turbine and the generator so that the rotor on the generator will also rotate. The rotation of the rotor will result in a difference in the magnetic field that will produce electrical energy due to the intersection by the stator.

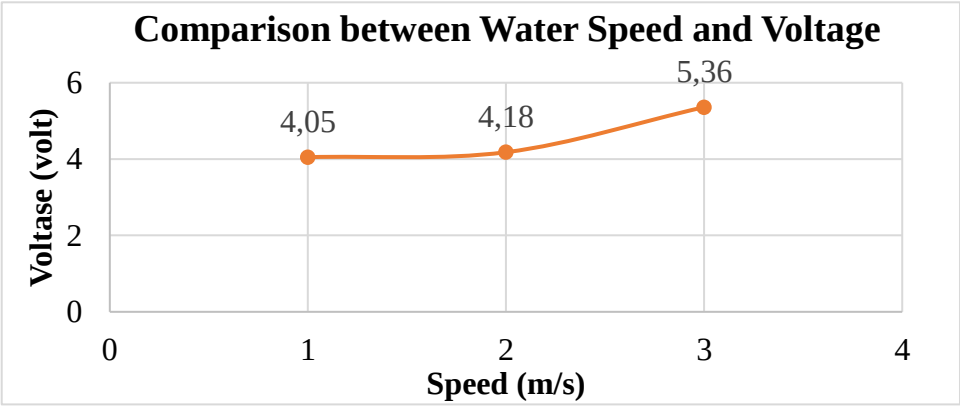

Figure 23. Graph of a Comparison of WaterwheelSpeed to Voltage.

Based on Figure 23 which shows a graph of comparison between water speed and voltage, it can be seen that the power source that drives a waterwheel or turbine is water. Water will hit the turbine so that there will be a rotating movement in the turbine that generates kinetic energy. Kinetic energy will be converted into electrical energy through a generator that moves due to the rotation of the waterwheel in the form of DC electric current. Based on this , water energy is one

of the factors that greatly influence the production of electrical energy, where the greater the speed of the rotating waterwheel, the greater the energy produced. Based on the results of the distribution of water speed which varies with speeds 1, 2 and 3 on the waterwheel, it is found that the higher the speed of water distribution, the greater the voltage obtained. Water discharge also affects the success of the waterwheel in producing electrical energy, where the greater the water discharge that hits the waterwheel, the greater the electrical energy produced. This is in accordance with the statement of Hakim et al. (2020), that several factors that have an influence on the output power produced by picohydro are flow discharge where the greater the water discharge produced, the greater the mechanical energy generated to rotate the turbine, elevation (height difference) where the higher the inlet) The value of water discharge will be even greater.

CONCLUSION

Based on the practicum of Power Generation Equipment (Simple Waterwheel) that has been carried out, it can be concluded that the working principle of the waterwheel is that water will hit the waterwheel so that there will be a circular movement that causes kinetic energy. Kinetic energy will be converted into electrical energy through a generator that moves due to the rotation of the waterwheel in the form of DC electric current. The ratio between the speed and voltage produced is directly proportional because the greater the speed of the water given, the faster the waterwheel will rotate so that it produces a large voltage.

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ATTACHMENT

Attachment 9. Table of Observation Results of Ferris Air.

Tabel 8. Results of speed testing observations.

Speed (m/s)	Voltage (volts)
Kspeed 1	4.05
Kspeed 2	4.18
Kspeed 3	5.36

Attachment 10. Voltage Measurement.

Table 9. Voltage measurement results.

Speed (m/s)	Voltage (volts)
Speed 1	
Speed 2	
Speed 3	

Attachment 11. Practicum documentation of power generation equipment (simple waterwheel).

Figure 24. Documentation makes miniature hydroelectric power plants.