Fish dryer with heat condensor refrigerator using solar energy

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Abstract. The fish dryer used is an innovation that utilizes the exhaust heat of the Refrigerator condensor using solar energy. The fish cooling system has an evaporator component with very low pressure and temperature so that it can absorb heat or cool the fish, while the refrigerator condensor functions to dissipate heat. The potential for condensor exhaust heat reaches a very good temperature as a source of heat energy for fish drying for fishermen. The test method is carried out on the dryer using the exhaust heat of a solar-powered refrigerator condensor as a heater in the fish drying rack space. The material in the form of dried fish is split beforehand so that the fish meat can easily release water content and dry quickly. This research was conducted by measuring the exhaust heat temperature of the Refrigerator condensor pipe which is placed in the fish drying rack space and decreasing the mass and water content of the fish. The results of this study produce a new method of utilizing the Refrigerator condensor exhaust heat that has not yet been available. The facts in the field show that the refrigerator condenser exhaust heat is very potential and effective to be used to dry fish. Drying takes place under controlled temperature, the exhaust heat from the condenser can reach 65.3 °C and dry fish reaches a moisture content of 10.50%.

1. Introduction

Energy is the ability to do work or power that can be used to carry out various activity processes including mechanical energy, heat, and others. Therefore, almost all disputes in this world originate from the struggle for energy sources. There are several natural energy as alternative energy which is clean, non-polluting, safe and has unlimited supply, known as renewable energy [1,2]. New and renewable energy sources in the future will increasingly have a very important role in meeting energy needs. This is because the use of fossil fuels for conventional power plants in the long term will deplete the sources of oil, gas and coal whose reserves are getting depleted over time [3]. In Indonesia, which is located in the tropics, actually has a significant advantage, namely receiving continuous sunlight throughout the year.

Unfortunately, this energy seems to be left wasted for natural purposes only [4]. In addition, solar energy can be utilized with the help of other equipment, namely by changing solar radiation to other forms. There are two kinds of ways to convert solar radiation into other energy, namely through solar cells and collectors [5,6]. There is no doubt that solar energy is one of the energy sources that are environmentally friendly and very promising in the future, because no pollution is generated during the energy conversion process, and also the energy source is widely available in nature [7]. Therefore, the application of solar energy technology to exploit the potential of solar energy available in these locations is the right solution [7]. Solar cells (Photovoltaic cells) will be more in demand because they
can be used for various relevant purposes and in various places such as offices, factories, housing, and others. So this is deemed necessary to be studied further, in order to obtain a technical comprehensive study [8,9]. In this research, solar panels with 370 WP capacity are used on fishing boats

2. Methodology
The method used in this research is to carry out several stages, including: (a). Determination of the solar panels used, so that in their use there is no damage to the solar panels themselves; (b). Determination of the components of the regulator that will be used, so that in its application there is no misuse that results in unfavorable or damaging solar panels and electrical equipment that is installed later [11]; (c). From the point of view of component use, it is also considered from an economic point of view and conditions in the market, so that the search for components is not difficult; (d). In terms of aesthetics, the design of the tool can be made in such a way that it is neat, attractive and safe in use; (f).

Select components that pass the qualifications and match the system and inverter requirements. Based on the research implementation stages that have been achieved from the research method used is to optimize solar electrical energy in the power generation system. Solar cells will convert energy from the sun into electrical energy which can be stored in the accumulator via a charger controller that regulates the voltage and current that enters the accumulator (battery) [12,13]. Load is an electronic device that requires an alternating current (AC) power supply, so an inverter is needed to convert the direct current (DC) from the accumulator to alternating current (AC), as shown in Figure 1 as follows.

**Figure 1. Schematic Measurement of Charging Voltage and Current from Solar Panels to Battery**

Solar cell charge controller is an electronic device that is used to regulate the direct current added to the battery [3]. Solar cell Charger controller on solar cells is controlling the overload and overvoltage of the solar panels reduces the battery. The power control solar cell uses Pulse Width Modulation technology to regulate the battery charging function and discharge current from the battery to the load [14, 15]. Some of the functions of charge-controlled solar cells are battery monitoring, regulating the current released / taken from the battery so that the battery is not overloaded, adjusting the current for charging to the battery, overcharging, overvaulting [16, 17]. To
make a charge controller it is necessary to consider the characteristics of the solar cell and accumulator.

Based on the implementation stage of the solar cell power generation system, energy converted from the sun into electrical energy can be stored in the Accumulator via a charger controller which regulates the voltage and current entering the accumulator. Loads are electronic devices that require alternating current (AC) power supplies, so an inverter is needed to convert the direct current (DC) voltage from the accumulator to AC voltage. The solar cell charge controller is an electronic device that is used to regulate the direct current added to the battery [18,19, 20]. The charge controller solar cell is also overcharging (overcharging because the battery is full) and excess voltage from the solar panel, which will reduce the battery, applying pulse width modulation technology to regulate the battery charging function and release current from the battery to the load.

Some of the functions of the solar cell charge controller are (1). Battery monitoring, (2) Adjusting the current drawn from the battery so as not to "full discharge" overloading, (3). Adjust the current for charging to the battery so as not to overcharging or overvoltage. To make a charge controller, it is necessary to pay attention to the characteristics of the solar cell and accumulator. The test installation in Figure 2 is a fish drying device on a fishing boat with the specifications of the equipment used, namely the Solar Module 370 Wp, 40 Volt charging voltage, 110 Ampere Accumulator and Refrigerator condenser with 70 Watt power, 50 Hz frequency. The research data is shown in table 3. Solar panels are very effective when there is direct contact with sunlight so that they absorb or capture most of the energy of solar rays [21]. The solar panels are positioned properly so that they are well exposed to the sun rays so that the maximum solar energy can be captured. Sun exposure can vary depending on the season and the position of the sun on earth, solar panels must be installed in such a way that they can face the maximum position of the sun each season [22].

3. Result and Discussion

The results of the study provide the expected data for a fish dryer with a capacity of 25 kg / batch by reaching the expected drying temperature. The maximum temperature of 65°C began to occur after 4 hours and within 6 hours of drying the fish. which is very suitable for the desired quality of dried fish or other food as in table 1 as follows

| No | Research Result                  | Unit      |
|----|----------------------------------|-----------|
| 1  | Fish Drying Time                 | 6 hour    |
| 2  | Maximum drying temperature       | 65°C      |
| 3  | Capacity                         | 25 kg     |
| 5  | Color                            | Bright    |
| 6  | Shape                            | Intact Or Good |
| 7  | Taste                            | Tasteful  |

Based on Figure 2 below, the solar panels made are used as follows: the sun is shining, the radiation produced from the sun's light is then captured by the photovoltaic solar panels. This solar panel is a technique, a combination of several solar cells that are very small and thin in series, parallel or mixed (series and parallel), so that it becomes a solar panel that is large enough and can produce large currents and voltages as well. The working principle of the solar panel is that if sunlight hits the solar panel, the electrons in the solar cell will move from N to P, so that the output terminal of the solar panel will produce electrical energy. The amount of electrical energy produced by solar panels varies depending on the number of solar cells combined in the solar panel. The output of this solar panel is direct current (DC) electricity, the output voltage depends on the number of solar cells installed in the solar panel and the amount of sunlight shining on the solar panel [9].
The results of the research obtained regarding the electrical voltage generated by solar panels and the drying temperature of the fish that utilize the Refrigerator condenser exhaust driven by solar energy are shown in Table 2 as follows:

**Table 2. Data on Fish Drying Research Results**

| Time (hour) | Solar Panel Output Voltage (Volt) | Environmental Temperature (˚C) | Fish Drying Refrigerator Condenser Temperature (˚C) |
|-------------|----------------------------------|--------------------------------|-----------------------------------------------|
| 08.00       | 38.4                             | 35˚C                           | 34˚C                                           |
| 09.00       | 39.6                             | 36˚C                           | 35˚C                                           |
| 10.00       | 39.7                             | 37˚C                           | 42˚C                                           |
| 11.00       | 39.9                             | 38˚C                           | 50˚C                                           |
| 12.00       | 39.9                             | 39˚C                           | 60˚C                                           |
| 13.00       | 39.9                             | 38˚C                           | 65˚C                                           |
| 14.00       | 39.8                             | 37˚C                           | 63˚C                                           |
| 15.00       | 39.7                             | 36˚C                           | 62˚C                                           |
| 16.00       | 39.6                             | 34˚C                           | 56˚C                                           |
| 17.00       | 39.5                             | 32˚C                           | 55˚C                                           |

Based on Table 2, the results of fish drying research clearly show that the chilled fish can reach the temperature increase as expected so that the fish caught by fishermen remain fresh after being caught and stored in the drying room. The fish dryer on the fishing boat is connected to a solar power generator on the ship that uses a Poly-crystalline type panel, the average voltage generated is 39.9 Volt DC, with a power of 370 Wp. In the current and voltage distribution of the solar cell source by charging the battery is very stable because it is regulated by the solar charger controller [8]. Voltage and current will start to increase in the morning at 07.00WITA, then will reach the maximum level in the afternoon at 08.00-17.00 Eastern Indonesian Time, and begin to fall in the afternoon [9].

Cooling is a technology for preserving fish by reducing or decreasing the temperature so that biochemical reactions and microbial growth in fish meat can be slow to increase the shelf life of fish and other products. Longer storage must be done by lowering the temperature lower to inhibit changes in the structure of the product because it can cause bacteria and microbes to become inactive. Care should be taken for fresh fish handling before cooling and freezing. Chilling and freezing is the process of taking heat from food products so that the product temperature and frozen product temperature are reduced to freezing temperatures to increase the shelf life of the food product being processed [10].

A decrease in temperature below the minimum temperature is intended to decrease microbial growth or can extend the time it takes for microbes to reproduce. Chilling reduces the rate of enzymatic reactions or microbial changes and slows down the respiration of fresh food. Factors controlling the shelf life or life of fresh food products during refrigeration are the type of food product, the degree of microbial breakdown and enzyme inactivation during processing, controlling the level of...
hygiene during processing and packaging, the nature and type of packaging materials, temperature and distribution storage. With the rapid development of technology and the increasing heat flux, there is a demand for the right solution. A suitable heat transfer device from the heat source as an evaporator to the heat sink removes heat over a relatively long period of time through the evaporation of latent heat from the working fluid [10,11]. The development of heat pipe technology has been widely felt, one of which is used as a cooling system for electronic components as heat dissipation which produces a greater heat flux due to increased performance and smaller dimensions. The heat pipe has three parts, namely the evaporator, the adiabatic part and the condenser as heat dissipation.

The output from this solar panel can be used directly to loads that require a DC voltage source with a small current consumption. So that the electrical energy produced can also be used in conditions such as at night (conditions when the solar panel is not exposed to sunlight), the output of this solar panel must be connected to a storage medium, in this case the battery. But this is not directly connected from the solar panel to the battery, but must be connected to the regulator circuit, where in the circuit there is a series of automatic battery chargers (Automatic charger).

The function of this regulator is to regulate the output from the solar panel and regulate the current entering the battery automatically. In addition, the regulator functions to connect and disconnect the current from the solar panel to the battery automatically and also functions to cut off the flow of current from the load battery in the event of a short circuit or excessive load. The type of regulator designed here is a modified type or a combination of series and parallel. Solar panels can actually be used directly without being given a regulator or battery circuit, but this is not done because it can burden the performance of the panel (due to excessive loads) so that there will be no fatal damage to the solar panel.

In addition, this regulator also functions to protect against overloading of solar panels so that the solar panels do not break quickly [12,13]. The battery-load connection is directly parallel to the load. If the battery is fully charged. To protect the battery due to excessive load (over load) or short circuit on the load, before connecting the battery directly must pass through the protection circuit. Where the function is quite clear, namely to protect or protect the battery due to an overload or a short circuit in the load. This research found the effect of the angle of incidence of the sun on the output of solar cells. The difference in the results of the Open Circuit Voltage (VOC) is obtained because the solar module is always positioned perpendicular to the sun so that the results obtained will be greater than the solar module with a smaller angle.

Furthermore, to determine the ratio of short circuit current to time can be seen in Figure 5 which explains that the current generated by the solar module which forms a greater angle than the current generated by the solar module in a perpendicular (horizontal) position has static properties, this occurs because the irradiation captured by the solar module is at a larger angle so that the current captured at the position forms a larger angle because the greater the irradiation value, the greater the irradiation value. From the measurement data taken, the average measurement value of short circuit current in the solar module is at an angle and the average short circuit current is obtained when the solar module is in a horizontal position.

4. Conclusion
The results showed that the solar energy converted in solar panels with a capacity of 370 WP is very good as a supplier of electrical energy to a fish dryer with a capacity of 25 kg / batch by reaching the expected drying temperature. The maximum temperature of 65 °C began to occur after 4 hours and within 6 hours of drying the fish. which is very suitable for the desired quality of dried fish or other food.

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