Development of 12 Volt Voltage Heating Element Model using Solar Energy

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Abstract: Currently, solar energy conversion is widely used to generate heat and generate electricity. This paper describes a heating element using solar energy as a low-voltage heating element model, focused on how to plan and manufacture a low-voltage heating element using solar energy. The research method used is the research and development method or Research & Development (R&D). The products resulting from this research and development are. development of a low-voltage heating element model using solar energy. The results of the analysis show that the research was conducted to test the heating element directly measuring the resistance according to the length of the material. Measurements were made on the nickeline heating element material, making the heating element model two samples, namely model one and model two. The heating element can be interpreted as the desired amount of resistance equal to the planned amount of electrical power. The wider the nickeline material, the greater the resistance, and the greater the electrical power, the smaller the resistance, the smaller the power generated. The battery voltage using solar cells reaches the maximum voltage peak during the day, the use of heating elements is adjusted at these times. The test is determined by calculation only because the voltage and resistance are known. The amount of current is inversely proportional to the resistance, so it can be measured as resistance, if the resistance is large, the current is small and the resistance is small and the current is large.

1 INTRODUCTION

The development of technology is currently very rapid from all fields, including heating element devices of various models such as electric stoves, hair dryers, incubators, space heaters and others. This paper describes the process until the results of research on the design and manufacture of heating elements with a voltage of 12 volts using solar energy. Heating elements on the market are mostly high-voltage at least 110 volts, it is rare to find a voltage of 12 volts using solar energy so that this is the basis of this research, namely the absence of a heating element using a 12 volt battery charged with solar energy using energy-efficient solar cells. and environmentally friendly. Based on this description, answering the existing problems focused on how to plan and make a 12 volt heating element using solar energy. Judging from these problems, this paper aims to develop a 12 volt low-voltage heating element that is energy efficient and environmentally friendly. So far, consumers only get a 12-volt heating element, which must be converted from alternating current (AC) electricity to direct current (DC) using an inverter. Some supporting research, among others, research on photovoltaic solar water heating systems (Fanney and Dougherty, 1997) states that using photovoltaic cells to produce electrical energy is connected in several heating elements. The microprocessor controller continuously selects the appropriate heating element so that the resistive load causes the photovoltaic array to operate at or near maximum power. Photovoltaic solar thermal systems eliminate the components most commonly associated with solar thermal heating systems. Although currently more expensive than solar thermal heating systems, the continued decline in photovoltaic cell prices is likely to put these

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systems in competition with solar thermal hot water systems in the next decade. and further describes the system, discusses the advantages and disadvantages relative to solar hot water heating systems, reviews the various control strategies that have been considered, and presents experimental results for two full-scale prototype systems. A review of water heating systems for solar energy applications (Jamar, 2016) where solar energy is one of the widely used renewable energies that can be utilized either by obtaining energy directly from the sun or indirectly. On the other hand, solar heating system is one of the applications of solar energy that has attracted the attention of many researchers in this field. The solar collector, storage tank and heat transfer fluid are the three core components in solar heating and its applications.

This paper discusses the latest developments and advances in heating elements using a voltage of 12 volts sourced from batteries using solar energy with solar cells as conductors. The heating element consists of a heating element plate wrapped with fire-retardant lime material with resistance according to design. The heating element plate is connected by positive and negative wires.

Ohm's law states that current flows through a wire at a constant temperature, proportional to the voltage across its two ends. By inserting one form of Ohm's law (Kavasoglu, 2011). The amount of heat generated by the current flowing through the heat resistance can also be used to calculate the resistance of a circuit, which will be explained further.

This paper is expected to solve the problem of making 12 volt heating elements using solar energy from solar cells, using renewable energy, saving energy and not damaging the environment. The world's energy demand is growing rapidly due to population explosion and technological advances. Therefore, it is important to plan and manufacture a product that uses reliable, cost-effective and enduring renewable energy sources for future energy demands. It has become a tool for developing the economic status of developing countries and for sustaining the lives of many underprivileged people.

2 HEAT SOURCE PLATE

The plate can be a heating element in which heat is generated by passing an electric current through it. If we assume there is a steady state; that the material is homogeneous. A journal describes the effect of strain paths under heat transfer work (Davenport, 2000). Material models are often needed to facilitate the development of new products. This is especially true for hot rolled products, especially shaped parts. Most material models assume that the behavior of a material can be explained by reference to equivalent plastic strain rate, temperature, and strain. The use of the last variable implies that the "strain path" does not significantly affect the behavior of the material. The review discusses previous investigations of the effect of strain paths, mainly carried out under cold working conditions.

The plate heat exchanger which has high efficiency and small size is one of the most widely used heat exchangers. Improvement of heat transfer plate heat exchanger can be done by using nanoparticles including working fluid. An experimental study was carried out using infrared thermovision to monitor the temperature distribution over the plate-finned surface in a plate-finned tube heat exchanger. The temperature differentiation function was derived to determine the local convective heat transfer coefficient in the tested fins, using the local element centered conduction equations including convective effects at the boundary with experimental data.

It is disclosed that infrared thermography is capable of rapidly detecting the location and extent of transitions and separation regions of the boundary layer over the entire surface of the tested model. By comparing the test results on the in-line and staggered regulatory areas, it is easier to understand or interpret the detailed dynamic phenomena of the flow present in the heat exchanger (Davenport, 2000).

2.1 Power and Energy

Power is the amount of work done per unit of time. Power is equal to the amount of energy consumed per unit time. Power is a scale quantity, the integral of power over time defines the work done. As a basic physics concept, power requires a change in matter and a specific time when the change occurs. While energy is a concept that can be transferred as a potential to cause change or can be interpreted as a work that can be done by certain forces such as gravity, electromagnetic and others.

Electrical energy has become a very important part of human life. Various equipment that we use requires electrical energy, and to be able to use electrical energy, we have to pay to the electricity service provider. The available power is limited, and overuse will stop the power supply. Cost savings that must be paid can also be done by reducing the amount of electricity consumption.

2.2 Solar Energy

The territory of the State of Indonesia is a country that is geographically traversed by the equator so that it has great potential in terms of utilizing solar energy. This is because the amount of solar radiation is influenced by the latitude, atmospheric conditions, and the position of the sun with respect to the equator. According to NASA's Power Data Access Viewer in 2019, Indonesia had a relatively high average radiation level of 4.8 kWh/m2/day. This is a big advantage for Indonesia in terms of utilizing solar energy into electrical energy through photovoltaic. The use of solar energy is very important in reducing greenhouse gas emissions. Although there have been some advances in single solar power systems, the efficiency and cost of these systems are not very attractive. Utilization of solar energy, namely using solar heat to replace heating elements to heat water, air and space.

Global energy demand is currently growing beyond the limits of installed generating capacity. To efficiently meet future energy demands, energy security and reliability must be improved and alternative energy sources must be aggressively investigated. Effective energy solutions must be able to overcome long-term problems by utilizing alternative and renewable energy sources. Of the many renewable energy sources available, solar energy is definitely a promising option because it is widely available.

Solar energy, especially as it reaches a level that is more competitive with other energy sources in terms of cost, can serve to sustain the lives of millions of people. Furthermore, solar energy devices can benefit the environment and economies of developing countries. The need for utilization of alternative energy sources, evaluates the global scenario of installed generation systems, reviews the technology underlying various solar powered devices, and discusses some of the applications and challenges in this area. In addition, this paper discusses the deployment, maintenance, and operating costs, as well as the economic policies that drive the installation of solar energy systems (Devabhaktuni, 2012).

3 RESEARCH METHOD

Action research simultaneously helps in solving practical problems and expands scientific knowledge, as well as increasing the competence of each actor, is carried out collaboratively in direct situations using data feedback in a cyclical process that aims to increase understanding of a particular situation, especially applies to understanding the process of change in the system and carried out within a mutually acceptable frame of reference (Hult, 1980).

The research method used is the research and development method or Research & Development (R&D). The research and development method is a method used to produce a product and test the effectiveness of the product in accordance with the development objectives. The products resulting from this research and development are. development of a 12 volt heating element model using solar energy. The methods used include experimental methods and action research methods. The experimental method is a systematic and planned experiment of the truth to prove the truth of a theory. The action research method is the design approach stage, the tool-making approach stage and the tool-testing stage.

Through the product evaluation and test process, it is hoped that input can be obtained about the advantages and disadvantages of the product using the developed design model (Zhao, 2020). The testing stage is measuring and analyzing, the stages and processes of tool design and tool testing systems which include measuring resistance (Ω-ohms), temperature (°C -degrees Celsius), and current (A - amperes) with voltage (V - volts).) . Measuring instruments, which are used in the test to analyze changes, use 1 multimeter which functions to measure resistance, voltage and current, 1 automotive gauge to measure temperature. The material used is 0.01mm thick Nickel (heating element), 2.5 mm diameter cable. Observational data in the form of measurement of resistance measurements, in ohms, voltage in voltage and temperature in degrees Celsius. The results of this study are the amount of power from the calculation results. The research steps are presented in Figure 1 the following flow chart:

4 RESEARCH RESULTS

The research is carried out in stages starting from planning to product making and sampling or testing. Test material 1 consists of a heating element wire with a flat size of 0.1 mm, a width of 10 mm and a length of 100 mm. For the length of the test material the length is varied to get the resistance varies as well. The results of this study presented data on resistance (Ω-ohm), temperature (°C - degrees Celsius), and current (A - amperes) with voltage (V - volts) from the test results. Each - each is presented as follows:

material 1. nickeline heating element wire, 0.1 mm thick, 10 mm wide, 300 mm long. Material 2 nickelin with a thickness of 0.4 mm, a width of 10 mm and a length of 1000 mm. In this study, sample tests were carried out, namely: the elongated model (HE1) and the woven model (HE2).

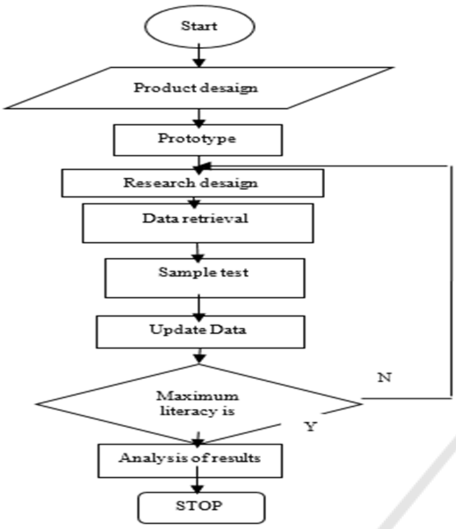

Figure 1: Research flow chart.

In this study, a heating element test was conducted to measure resistance directly according to the length of the material. The heating element model 1 (HE1) and the heating element model 2 (HE2) on the heating element where the desired resistance is in accordance with the planned electrical power. We conducted a test with a target power of 50 watts, 100 watts, 200 watts, 300 watts and 500 watts, the wider the heating element, the greater the electrical power generated. This can be proven by some of the tests we carried out which can be seen as follows:

The voltage is set at 12 volts (V) DC, 0.1 mm thick nickeline, 100 mm wide and 600 mm long, producing a voltage of 0.8 Ohm so the power generated is 180 watts. Then we tested again the nickeline material, 0.1mm thick, 200mm long, 100mm wide, the results of the 0.3 Ohm voltage measurement resulted in 480 watts of power. In the third test also at the same voltage, 0.1 mm wide and 200 mm long measuring resistance 0.7 Ohm produces 206 watts of power, and so on, the length is varied with the same thickness and width. The wider the nickeline material, the greater the resistance and the greater the electrical power.

Electric current (amperes) is the rate at which electric charge flows through a point in a circuit. In this test, the calculation is determined only, because the voltage and resistance are known. Unless the voltage is increased by 24 volts, 36 volts and so on. The results of the calculation are as follows: it is known that the amount of current is inversely proportional to the resistance, then it can be obtained for a resistance of 0.8 Ohms to produce a current of 15 amperes, if the resistance is 0.7, the current is 17 amperes and a resistance of 0.3 produces a current of 40 amperes and so on.

The HE1 model and the HE2 model can be stated to have an effect on the amount of electric power caused by the increase in the length of the nickeline heating element. While the current source of solar energy is used in the test as additional energy does not decrease when the sun shines. Solar cell testing is carried out starting at 08 - 16.00 by measuring the voltage that goes into the battery. From the measurement results, it was found that the highest voltage at 9.04 hours reached a voltage of 14.47 volts until 13.00 hours after that hour until 16.00 the voltage became 13.39 volts. Next, the heating element product was tested on refractory limestone, measuring the starting point at a temperature of 32 F/5 minutes then 180 F and so on until the peak point reached 220 F. The initial battery voltage was 14.47 volts and then decreased to a voltage of 10.99 so that the temperature also continued to decrease. When it reaches the battery voltage of 10.0 volts then the battery does not distribute heat anymore. Figure 2 is the connection between the heating element (HE1) of the battery and the solar cell, while Figure 3 of the heating element (HE1) radiates heat.

Figure 2: HE1 relationship, battery and solar cell.

Figure 3: HE1 Radiant Heat.

5 HEATING ELEMENT TEST

The test data obtained from the measurement and testing results are presented in the following graph:

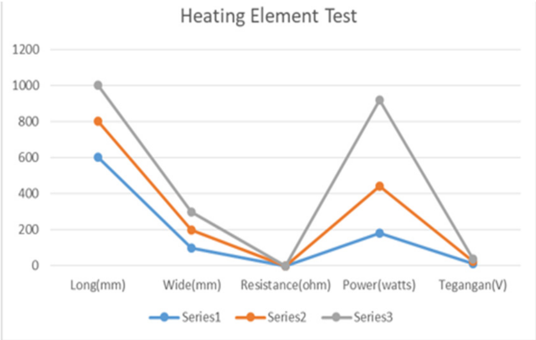

Figure 4: Test results of heating elements.

Figure 4 shows that electrical resistance has an effect on the amount of power according to the test power. The electrical resistance of 0.8 produces 180 watts of power, the resistance of 0.7 produces 260 watts of power, and the 0.3 resistance produces 480 watts of power. So the smaller the electrical resistance, the greater the electrical power generated. The following is a comparison of electricity and electric current presented in figure 5

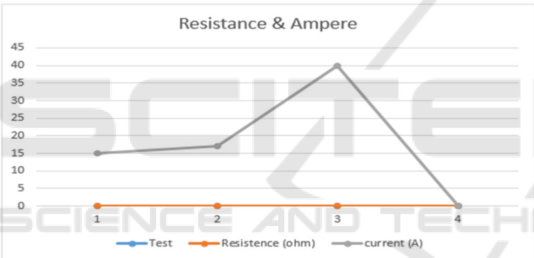

Figure 5: Test results of resistance and ampere.

Figure 5 shows that the comparison between electrical resistance and electric current in the heating element material, where the smaller the electrical resistance, the greater the electric current obtained. The electrical resistance of 0.8 ohms is obtained by an electric current of 15 amperes, an electrical resistance of 0.7 produces an electric current of 17 amperes and 0.3ohm produces an electric current of 40 amperes. So when it is concluded that the size of the electrical resistance is very influential on the size of the electric power and electric current.

6 DISCUSSION

Based on the results of the research written in this paper to answer the problems described above, namely how the relationship between voltage (volts), current (amperes) and electric power (watts). We have often heard of this division, and how is it related. The test results show that the nature of the heating element where the greater the electric power (wattage) affects the size of the voltage (volts) and electric current (amperes) flowing, and the relationship is as follows: The greater the voltage (volts), the greater the power (watts) and the greater the current (amperes), the greater the power (watts).

As the theory of George Simon Ohm found the relationship between current, voltage, and resistance in an electric circuit. He discovered, by experiment, that pressure is equal to the product of current and resistance; This relationship is known as Ohm's law (Wells, 1987). This law is the practical basis on which most electrical calculations are determined. Formulas can be expressed in various forms and by their use.

So in an electrical circuit, a larger voltage (volts) will flow an amount of current (amperes) through a smaller conductor (resistance) than is required to force the same amount of current (amperages) through a larger conductor (resistance). A smaller conductor will allow less current (amperes) to pass than a larger conductor if the same electrical pressure (volts) is applied to each conductor for the same period. Smaller conductors can only be considered to offergreater resistance(ohms) than larger conductors. Thus, we can define resistance as "a property of a body that resists or limits the flow of electricity through it." Resistance is measured in ohms — a term similar to friction in a hose or pipe.

In many low power applications, solar cells are used as an environmentally friendly power source. To provide electricity also without solar radiation, we invented a device that combines solar cells and rechargeable batteries in one unit. The main component is the p h o t o a c t i v e layer in the charge storage layer. As such, this new device represents an empty battery, which charges itself on lighting (Hidayat, 2015). Charge and discharge characteristics are presented with special consideration of variations in light intensity and ion concentration in the electrolyte. The relatively high reverse reaction at the electrodes is still taking place. A 1 hour charge under 1000 W/m2 illumination of the first sample yields 1.8 C/cm 2.

Batteries that use solar cells or solar panels. In addition, this tool is a real action in fighting global warming or what is commonly called global warming. Thus, one way that can overcome or minimize the impact of global warming is the use of solar energy which can be used as an alternative source of electricity. The solar energy can be used to recharge the battery, so it is hoped that this tool with solar cells can reduce gas emissions that can cause global warming (Hidayat, 2015). The battery is needed as a support force or as an energy supply in the use of electronic devices. In certain circumstances, charging the battery from the power grid is a difficult task, so that a battery charger is needed without the need for an electricity network, therefore solar or solar power is used for that reason. The main components of this tool are solar cells (as input by converting solar energy into electrical energy), battery charger circuit (as controller), LED indicator (as battery charging indicator), and battery (12 volt voltage). This tool works when there is a supply of energy from sunlight which is converted into electrical energy through solar cells.

The results of testing the maximum battery voltage of 14.47 volts are at 9:00 to 13:00 and will remain stable when not in use. The heat of the heating element rises to its maximum peak at a temperature of 220 C in 16 minutes when it is connected to the battery, and when it is used continuously for 1-2 hours, the battery voltage drops to 11 volts and the voltage is below 10 volts the heat emitted HE1 cannot be used.

7 CONCLUSIONS

From the exposure of the research results and discussion, it can be concluded as follows:

1. The form of the heating element design model is divided into two, namely heating element 1 (HE1) straight model with an element length of 300 mm and a woven heating element model 2 (HE2) with an element length of 1000 mm. While the average element thickness is 0.1 mm and a width of 100 mm.
2. The wider the nickeline material, the greater the resistance and the greater the electrical power. It is proved by a resistance of 0.8 Ohm that produces a current of 15 amperes, if the resistance is 0.7, the current is 17 amperes and a resistance of 0.3 produces a current of 40 amperes and so on. 180 watts of power, 205 and 480 watts of power, proportional to the current.
3. The smaller the resistance, the greater the power generated and the battery voltage using solar cells reaches its maximum voltage peak at 09.00 - 13.00, the use of heating elements is adjusted at that time. This means that the input voltage is equal to the output voltage, in this case the amount of power of the heating element is small from the input voltage through the solar cell.

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