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Automatic Water Temperature Control System In Hydroponic Plants With Peltier Tec1 12706 And Temperature Sensors DS18B20

Tholib Hariono[1*], Ayu Mahdalena[2], Hilyah Ashoumi
[1,2]Informatics Study Program, KH. A. Wahab Hasbullah University
[*]E-mail:hariono@unwaha.ac.id

ABSTRACT
Hydroponic planting techniques are generally carried out by flowing nutritious water into pipes that have been given holes for plants. Overheated water temperatures in hydroponic plants will cause plants to wither and grow not maximally. So it is necessary that the temperature of the water that is too hot can be reduced to a good extent for plants. This research aims to create a water-control system in hydroponic plants to use peltier Tec1 12706 to lower water and DS18B20 sensors ro measure water temperature. So that plant growth is maintened well. From the test results, it is known that the temperature of solar hot water from 38.10˚C drops to 30.31˚C with every 10 minutes of recording data and within a period of approximately 4 hours the water temperature can drop to 7.79˚C. although it has not reached the normal temperature of hydroponic water, which is 28˚, Peltier is stable in decreasing water temperature without any fluctuations in temperature. So this peltier is very effective in reducing water temperature.

Keywords: *Tec1 12706, Sensors, Peltier, Temperature, DS18B20*

INTRODUCTION

Agriculture is one of the important sectors that has a role as the main source of supporting food availability for the people of Indonesia. Along with the development of Indonesia's growing population and the narrowing of agricultural land, it has the potential to cause a decline in agricultural production and scarcity of food sources in the future. The hydroponic system can be a solution for the development of both fruit and vegetable crops with various advantages over conventional farming systems.

Hydroponic farming techniques are generally carried out without using soil media but with water, namely by flowing nutritious water into pipes that have been given holes for plants. In order for plants to grow well, they are usually placed in a place that gets sunlight. Because it uses water media so that the water temperature also needs to be considered. It can be seen that the temperature in Indonesia in the summer is quite hot. And will affect hydroponic plants. Therefore, in a hydroponic planting system, the temperature factor in plants is one of the success factors in implementing a hydroponic farming pattern. Water temperatures that are too high in hydroponic plants will cause the plants to wither and the body not optimal.

In hydroponic farming, it is possible to check and regulate temperature control if done manually, but it will take a long time and be less efficient. To make it easier to manage hydroponic water, a system was created which can regulate and maintain water temperature with the Arduino microcontroller system, tec1 12706 and the ds18b20 temperature sensor.

Based on the literature and journals that have been reviewed, the authors are interested in making an automatic water temperature control system for hydroponic plants with Peltier tec1 12706 and a DS18B20 temperature sensor. This water temperature control system if it has been built will be applied to mustard plants.

LITERATURE REVIEW

- **Hydroponic Farming Patterns by Regulating Water Temperature**

Planting with hydroponic techniques is a pattern of farming using media other than soil or using water media in which it has been mixed with the nutrients needed for plant growth. In a hydroponic planting system, the temperature factor in plants is one of the success factors in implementing a hydroponic farming pattern. Water temperatures that are too high in hydroponic plants will cause the plants to wither and the body not optimal. So we need a way so that the temperature of the water that is too hot can be reduced to a good level for the plants used to be in the appropriate temperature range. In all hydroponic water systems the ideal water temperature ranges from 18˚C -26˚C. The water temperature can also be regulated by the water temperature controller.

- **Arduino Microcontroller**

Microcontroller is a functional computer system on a chip. It contains a processor core, memory (a small amount of RAM, program memory, or lack of), and input output equipment. Arduino is a microcontroller board based on Atmega328. Arduino has 14 input/output pins of which 6 can be used as PWM outputs, 6 Analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP head, and a reset button, Arduino is able to support a microcontroller, can be connected to a computer using a cable. USB.

Arduino has its own advantages over other microcontroller boards, apart from being open source, Arduino also has its own programming language in the form of C language. Besides that, the Arduino board itself has a loader in the form of usb, making it easier for us to program the microcontroller in Arduino. The open source nature of Arduino also provides many advantages for us in using this board later, because the open source nature of the components we use does not only depend on one brand, but allows us to use all the components on the market.

Arduino programming language is a C language that has been simplified with its programming language making it easier for us to learn and explore microcontrollers. Below is a sample image of the Arduino microcontroller (Lutfiana , 2015).

Figure 1. Arduino Microcontroller

- **DS18B20 Suhu Temperature Sensor**

A temperature sensor is a component that can convert heat into electrical quantities so that it can detect symptoms of temperature changes in certain objects. The temperature sensor measures the amount of hot/cold energy produced by an object so that it allows us to know or detect symptoms of these temperature changes in the form of analog or digital outputs (Waqfin et al., 2021).

The DS18B20 temperature sensor with waterproof capability is suitable for measuring temperature in difficult or wet places. Since the sensor data output is digital data, there is no need to worry about data degradation when using it for long distances. The DS18B20 provides 9 bit to 12 bit configurable data (Habibullah, 2020).

For temperature readings, the sensor uses a 1 wire communication protocol. DS18B20 has 3 pins consisting of 3 pins consisting of +5v, ground and data input / output. Following are the features of the DS18B20 (Akbar B, 2017) :

- Calibrated directly in degrees Celsius
- Guaranteed accuracy from -10^0C to + 85^0 C
- Range of values from -55 C to 125 C

- Operating voltage from 3.0V to 5.5V
- Request time less than 750ms.

Below is an example of a DS18B20 temperature sensor:

Figure 2. DS18B20 . Temperature

- **Peltier TEC1-12706**

Thermo Electric Cooler (TEC) / Peltier is an electronic component that uses the pelter effect to create heat flux at the junction between two different types of materials. Although its name is "cooler" according to its main application, TEC can also be used as a heater by reversing the placement of these electronic components. Thus TEC can be used as a temperature control device (can be a cooler or vice versa heater). (Hariono & Fajriyah, 2020)

This research model uses the TEC1-12706 series which is very commonly used as a cooling component for mini refrigerators and CPU cooling systems. Peltier type TEC1-12706 has sufficient. Capability to be used as a cooler for canned drinks in cars, CPU coolers and cabinets with temperature and humidity controls (Szodrai, 2020).

The working principle of TEC is that when two conductors are connected by electrical contact, the electrons are more bonded. When two conductors with different fermi states are combined, electrons will flow from the conductor with the higher to the lower level until the change in electrostatic potential brings the two fermi states to the same value (Singgih et al, 2018).

Below is a sample image of the Peltier TEC1 12706:

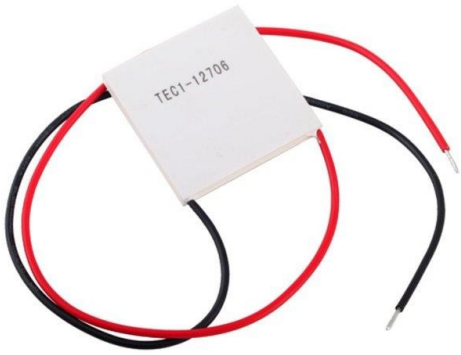

Figure 3. Peltier TEC1 12706

Figure 4. Cooler Kit

- **Power Supply**

The power supply is an electronic device that is used as a power source so that other devices can work. The power supply has a circuit that converts AC electric current to DC. DC Power Supply or Power Supply is also often known by the name "Adapter". The power supply 11 has 4 main parts in order to produce a stable DC current. The four sections include:

- Transformer
  The transformer is the main component in making a power supply circuit that functions to change the electrical voltage, namely increasing and decreasing the voltage. Based on the output voltage is divided into 2, namely: Step Up Transformer and Step Down Transformer. In the manufacture of the power supply, the transformer used is a step down transformer which functions to reduce the 220 VAC voltage to a smaller voltage (5V, 9V, 12V) or as needed.
- Rectifier
  The role of the rectifier in the power supply circuit is to convert AC voltage into DC voltage. Rectifiers usually consist of diodes. In the rectifier circuit there are 2 types, namely "Half Wave Rectifier" which consists of 1 diode component and "Full Wave Rectifier" which consists of 2 or 4 diode components.
- Filters (Filters)
  The filter is a part consisting of a capacitor which functions to equalize the DC current signal coming from the rectifier. As a result of installing a capacitor as a filter, the DC voltage will be smoother and cleaner, so that the wave that comes out is an output wave VD
- Regulator that functions as a voltage stabilizer.
  Voltage regulator is a part that consists of a Zener diode, transistor, IC or a combination of these three components. This component functions as a stabilizer and DC voltage regulator originating from the filter circuit, so that it is not affected by the load voltage. There are several IC series, namely the 78XX series components as a positive fixed voltage regulator and the 79XX series which is a negative fixed voltage regulator.(Muhammad Naufal Nazif, 2018: pp. 10-15)

Below is an example of a power supply image:

Figure 5. Power Supply

METHOD

This research method will explain the approach, scope or object and explain the tool design system and how it works as the system that will be used in this study. In this research method begins with data collection methods in the form of block diagram design, Peltier flow chart design and temperature sensor. The next stage is the analysis of system requirements involving components such as Peltier TEC1 12706, DS18B20 and Arduino microcontrollers. After the design process, it will be continued on the process of integration and system implementation. The last stage is the system testing process.

- **System Analysis and Design**

The step of solving the research problem begins with designing a block diagram circuit system with the main control being the Arduino microcontroller which will later be used to control and stabilize the water temperature. Then the next step is to design a temperature sensor and Peltier flowchart system which will later serve to display the results of the temperature sensor readings and the work of the Peltier.

- **Block Diagram Design**

Block diagram is a diagram of a system, where the function of the block diagram is to design the relationship between the design blocks of the water temperature control system. The following is an image of a system block diagram for the design of a water temperature controller which is shown in Figure 6.

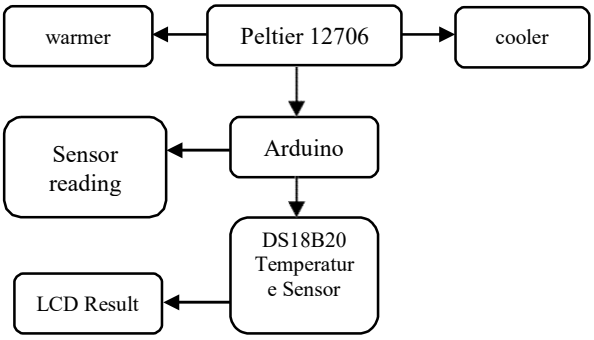

Figure 6. Block Diagram

Based on the block diagram above. The water temperature controller uses the DS18B20 sensor which is the first step in detecting the temperature of the water. Is the water hot or too cold. If the water is hot then the cooling part of the Peltier will turn on or if the water is too cold the warmer Peltier will try to normalize or control the temperature according to the water temperature needed for hydroponic plants.

- **Flowchart Design**

The design of the flow chart aims to make the working logic of the Peltier and temperature sensors on the Arduino microcontroller system so that they can work according to the initial planned concept. In the logic concept in this flowchart the microcontroller will receive data and then will read the temperature sensor which will then be displayed on the LCD to display the results of the temperature sensor readings.

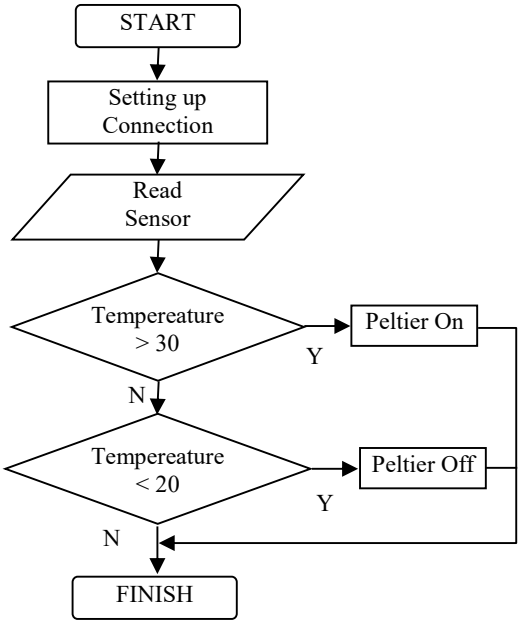

Figure 7. Flowchart Design

From the flow chart above. It can be concluded that if the water temperature is above 30˚C then the peltier will turn on and if the water temperature is below 30˚C then the peltier will die.

RESULT AND DISCUSSION

The following is the result of data and analysis from the temperature sensor using 1 condition, namely the temperature of the solar hot water. In this discussion, to check the peltier is on for hot water temperature, it takes a temperature > 30 then the peltier will turn on and will turn off if the temperature is < 30. The results of this test show the length of the water temperature being tested to the normal water temperature of hydroponic plants and the accuracy of the Peltier in working. In this test using a cold side Peltier, which serves to reduce the temperature of the hot water. For this reason, below will show the effectiveness in reducing water temperature.

- **Peltier Test And Water Temperature Sensor**

  This test was conducted to determine the effectiveness of Peltier in lowering the water temperature. This test uses 35 liters of water with a normal temperature limit of 20 to 28 degrees Celsius. The test was carried out during the day.

Table 1. Peltier Test Results in Cooling Water

NO	MIN/TIME	WATER TEMPERATURE	PELTIER
1	00 Minutes	38,10 C	ON
2	10 minutes	34.94 C	ON
3	20 minutes	34.25 C	ON
4	30 minutes	33.81 C	ON
5	40 Minutes	33.38 C	ON
6	50 Minutes	33.06 C	ON
7	60 Minutes	32.75 C	ON
8	70 Minutes	32.50 C	ON
9	80 Minutes	32.25 C	ON
10	90 Minutes	32.00 C	ON
11	100 Minutes	31.75 C	ON
12	110 Minutes	31.62 C	ON
13	120 Minutes	31.37 C	ON
14	130 Minutes	31.25 C	ON
15	140 Minutes	31.06 C	ON
16	150 Minutes	30.94 C	ON
17	160 Minutes	30.82 C	ON
18	170 Minutes	30.69 C	ON
19	180 Minutes	30.62 C	ON
20	190 Minutes	30,50 C	ON
21	200 Minutes	30.37 C	ON
22	210 Minutes	30.37 C	ON
23	220 Minutes	30.37 C	ON
24	230 Minutes	30.31 C	ON
25	240 minutes	30.31 C	ON
26	250 Minutes	30.31 C	ON
27	260 Minutes	30.31 C	ON

The picture above is the result of testing the temperature of solar hot water with a Peltier and water temperature sensor. The results that appear with the first water temperature are 38.10 C with a total water of approximately 35 liters. From the table, it can be seen that in the 10th minute the temperature was 34.94 C, meaning that the temperature had decreased by 3.16 C in the first 10 minutes of testing. It is possible that the initial temperature dropped drastically because the peltier immediately adjusted the temperature and immediately lowered the temperature. Then the 20th minute the temperature was at 34.25 C which means the temperature dropped only 0.69 C, the performance of the peltier began to decline but the decrease in the peltier temperature was successful. In the 60-100 minutes the temperature drops steadily in the range of 0.25 C and in the 110-170 minutes the Peltier is also stable in lowering the temperature in the range of 0.13 C. but at 200-220 minutes the peltier began to slowly lower the temperature and there was still no change in temperature for up to 30 minutes. Likewise, at 230-260 minutes the peltier did not have a temperature change of 30.31 C and remained the same for up to 40 minutes. Even though it still can't reach 28 C as the normal temperature for hydroponic water, Peltier is quite capable of lowering the water temperature and takes about 4 hours to lower the temperature from 38.10 C to 30.31˚C. Peltier is also better able to lower the water temperature faster and is very helpful in reducing the effectiveness of the water temperature.

- **Graph of Hot Water Temperature to Normal Hydroponic Water Temperature**

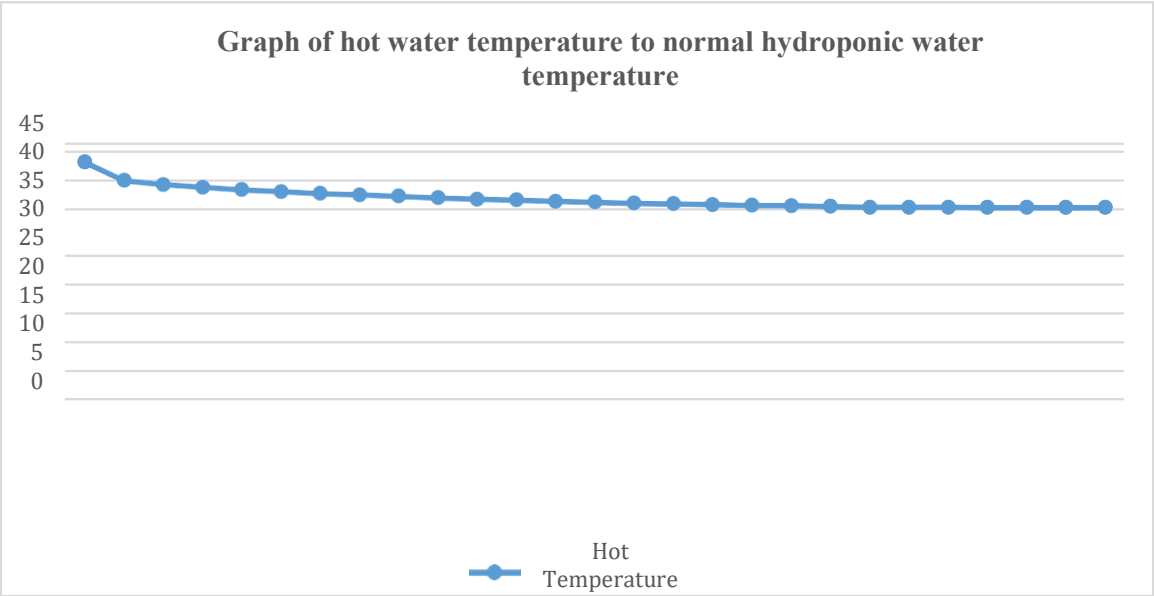

Figure 8. Graph of hot water temperature to normal

From graph 1 the results of the graph above in the test time of approximately 4 hours each for the water temperature to the normal temperature of hydroponic water. As a result, the temperature of the hot water decreased to a normal temperature of up to 7.79˚C within 4 hours. In the minutes there was a slight delay in the decline due to the declining peltier performance because the temperature had already entered 30˚C, this possibility was the cause of the decreased peltier performance. Even so, Peltier is stable and effective in lowering the water temperature.

CONCLUSION

From the results of the discussion and research above, it can be concluded that:

- A hydroponic water temperature control system has been successfully created that can regulate the water temperature in mustard plants. To make it easier for us in terms of controlling the water temperature in the development of hydroponic plants.
- Testing the Peltier tec1 12706 system to get the extent of the Peltier work and measuring the speed of cold and hot water temperatures to the normal temperature of hydroponic water.
- Testing the ds18b20 temperature sensor system to see the temperature of the water temperature.
- Peltier is still not able to work according to plan but still able to reduce water temperature effectively
- The test is carried out within 4 hours and every 10 minutes is recorded to produce temperature change data.

- The data in table 1 gives the results that the hot water temperature of 38.10˚C to a temperature of 30.31˚C fell within 4 hours and the temperature dropped by 7.79˚C.
- The final result of water temperature testing is that Peltier is capable and effective in reducing water temperature.

From the conclusions above, it can be concluded that the current water temperature controller sensor can be a way to help hydroponic plant cultivators so that plants can be maintained properly, assisted by this water temperature controller.

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