Effect of Cooling Using Added Peltier Ice Pack on Cool Box

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Abstract: - Technology is currently developing rapidly, one of which is the cool box. Cool boxes are used by humans to store food so that it lasts a long time. The cool box used so far uses peltier so it is safe for food. However, the peltier used only reaches a temperature of 19,5 ^{0}C. Therefore, so that the resulting temperature is maximized, it is necessary to add additional ingredients such as ice packs. Ice packs can lower the temperature of the cool box room. Ice packs are a very good material because they are easy to get and can be used repeatedly and ice packs are more durable than ice cubes. This study aims to determine the effect of cooling using peltier added ice packs to the cool box when it is turned on and off. In this study using the direct test method. The results of the research that has been done show that the cool box that only uses peltier when turned on reaches a temperature of 18,1 ^{0}C and the temperature of the tool is turned off 30,7 ^{0}C, while the cool box that uses peltier and ice packs when the tool is turned on reaches a temperature of -7,2 ^{0}C after the temperature of the tool is turned off until it reaches -5,4 ^{0}C, then the cool box that uses peltier and ice packs that contain frozen food reaches a temperature of -6.7 ^{0}C when the tool is turned on and then turns it off reaches a temperature of -3,5 ^{0}C. So the cool box that is added to the ice pack affects the cooling of food storage and can be used repeatedly.

Keywords: cooler box, peltier, ice pack, temperature

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1 Introduction

The growth of a country is getting busier with daily activities and activities. In addition, it is hoped that for daily needs such as food raw materials, vegetables, meat and fish it is expected to be practical in obtaining them. Instant food products are widely available in the market and are sold freely so that in choosing these food products, product quality and taste really need to be considered and maintained. At present human needs are increasingly facilitated by the existence of supporting equipment, especially for everyday life, one of which is a cooling machine. This cooling machine, more and more used in accordance with technological advances and standard of living. The general use of this refrigeration machine is to store food and beverage ingredients so that they are kept fresh. Apart from that, slaughterhouses, exports of marine materials (fish, shrimp etc.) using a cooling machine with a large enough size. Even in the food industry, transport vehicles (trucks, boxcars) are equipped with refrigeration.[1]. Cooling machines for air conditioning needs are currently developing rapidly followed by more attractive designs as needed. In the wider community, refrigeration machines such as (cold storage), freezers and refrigerators are used to maintain and maintain the condition of a product in good condition as it was in its original state. As is the case with food and fruit sellers in shops and in traditional markets or in modern markets, the use of refrigeration machines is intended to make the decomposition process of food and fruit products last longer. Thus, losses can be avoided on the part of the seller[2]. Cooler box is one of the tools used by humans at this time. This is marked by causing many changes in all business fields that use cooler boxes. Of course, this has had a huge impact on humans who are starting to compete fiercely to achieve maximum or best results[3]. Therefore, street vendors prefer cooler boxes without freon compared to those with freon. The temperature inside the cooler box is maintained stable by adding ice packs. A cold cooler box with the addition of ice packs can last a long time. Therefore an idea emerged to modify a cooler box that can cool food ingredients by utilizing a

thermoelectric cooler[4]. The cooling system that can be used on styrofoam is the TEC (Thermo-Electric Cooler) cooling system or commonly called peltier. This cooling system can be used to store various types of food and drinks[5]. The peltier used in the cooler box to cool the maximum box room temperature that can be achieved by peltier is at 19.5 ^{0}C[6]. Therefore ice packs are one of the solutions to help peltier reach the desired temperature for storing food, because ice packs are reusable which is a potential cold medium to be developed for commodity transportation packaging. In utilizing ice packs as a cooling medium, it is necessary to have packaging so that the cold temperature produced by the ice pack does not escape easily. Styrofoam boxes were chosen as packaging to keep the cold because styrofoam boxes are packaging that does not conduct heat, is easy to obtain, lightweight, can be used repeatedly and can be carried anywhere[7]. As is known, high temperatures in food received during storage reduce quality. Pre-cooling is intended to slow respiration, reduce sensitivity to microbial attack, reduce the amount of water lost through transpiration and facilitate transfer into the cold storage room when this system is used[8].
This study aims to find out how the effect of cooling using Peltier added ice packs when the tool is turned on and off.

2 Problem Formulation

2.1 Cooling Machine

Refrigeration machine (refrigerator) is a tool used to transfer heat from indoors to outdoors to make the temperature of the object/room lower than the temperature of the environment so as to produce a cold temperature/temperature. According to the concept of conservation of energy, heat cannot be destroyed but can be transferred[9].

2.2 Cool Boxes

Cool box is a room or warehouse that is specifically designed to use certain temperature conditions and is used to store various kinds of products, especially perishable products with the aim of maintaining freshness[2].

2.3 Ice Packs

An ice pack or gel pack is a portable plastic bag filled with water, or a gel or liquid refrigerant. For use the contents are frozen in the freezer. Both ice and other non-toxic coolants (mostly water) can absorb large amounts of heat before the temperature rises above 0 ^{0}C, due to the high latent heat of water. Ice packs are usually used to keep food cold in portable coolers[10].

Figure 1. Ice pack

2.4 Thermoelectric (TEC)

Thermoelectric technology is a technology that works by directly converting thermal energy into electricity (thermoelectric generator), or vice versa, from electricity to produce cold (thermoelectric cooler). To generate electricity, the thermoelectric material is simply placed in such a way that connects the hot and cold sources. From the circuit a certain amount of electricity will be generated according to the type of material used[11]. This refrigeration system works by converting electrical energy to produce cold and heat in one part of the thermoelectric module[12]. The thermoelectric element can be increased by carrying out heat transfer by forced convection at the hot terminal so that the resulting temperature at the cold terminal increases to a maximum[13]. The working principle of a thermoelectric cooler is based on the peltier effect, when a DC current is applied to a thermoelectric element consisting of several pairs of p-type semiconductor cells which have a lower energy level and n-type which has a higher energy level[14].

2.4.1 The Type of Thermoelectric Used

The applied thermoelectric (TEC) results in a greater heat load that can be absorbed so that the temperature in the room becomes lower[15]. or the peltier element used in this study is TEC which is widely sold in the market, namely thermoelectric/peltier single stage with type 12706. TEC1-12706 thermoelectric cooling uses the peltier effect to create heat flow between the junctions of two different types of materials[16]. *Thermoelectric* this with good performance can produce temperatures below zero degrees Celsius on the cold side. For data and specifications can be seen in Figure 2.

Hot Side Temperature (^{0}C)	25^{0}C	50(^{0}C)
Qmax (Watts)	50	57
Delta Tmax (^{0}C)	66	75
Imax (Amps)	6,4	6,4
Vmax (Volst)	14,4	16,4
Module Resistance (omns)	1,98	2,30

Figure 2. Peltier element specifications/thermoelectric coolers (TEC)

Source:[12].

2.4.2 Peltier Placement Position On the Cool Box

The peltier position on the wall produces a very low temperature compared to the peltier position above or the peltier position below, this is due to easier air circulation than the peltier position above or the peltier position below. So the peltier position on the wall is the best[17].

2.5 Thermocouple

A thermocouple is a temperature sensor that converts temperature differences into changes in voltage, this is due to the difference in the density of each metal which depends on the density of the metal. If two metals are put together at both ends and then heated, the electrons that have a high density will move towards the metal that has a lower density. Thus there is a voltage difference between the two ends of the thermocouple[18].

2.6 Power Supplies

Power Supply or in Indonesian it is called power supply is an electrical device that can provide electrical energy for other electrical or electronic devices[19]. As a power source from the cooler box, a power supply is used which has a voltage output of 12-15 VDC and a max output current of 15 Amperes according to the specifications of 2 thermoelectrics connected in series[1].

3 METHOD

The research method used in this work was to experiment use peltier and ice packs. The steps to be taken are as follows:

3.1 Empirical Studies

At this stage, a study was carried out on Phase Change Material (PCM) made from ice packs that can be influenced for experiments. At this stage identify the experimental configuration for Phase Change Material (PCM) and the components needed.

3.2 Design

At this stage, the cooler box design matches the PCM experiment to be carried out. The PCM that will be tested is PCM made from ice packs. Conditions for the cooler box used:

Material :styrofoam
Dimensions
Long : 54 cm
Deep leghth : 47 cm
Wide : 39,5 cm
Tall : 30 cm
Thickness : 3,5cm
Deep high : 27 cm
Inner width : 32,5 cm

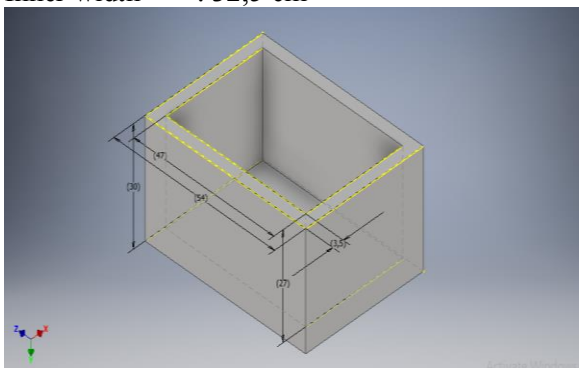

Figure 3. Styrofoam box

3.3 Place and Time of Execution

This cooler box study was conducted for approximately one week starting, May 2023, from 14.00 noon until finished, at the Laboratory of the Faculty of Mechanical Engineering, University of Muhammadiyah Pontianak which is located at University of Muhammadiyah Pontianak Jalan Jendral Ahmad Yani No.111, Pontianak, West Kalimantan.

3.4 Experimental Procedures

In this experimental procedure, a 54 cm type Styrofoam cooler box was designed to be used for the cooler box frame for dimensions 54 cm long, deep leght 47 cm, 39,5 cm wide, 30 cm high, deep high 27 cm, and 3,5 cm thick Styrofoam and 30 cm deep high, 32,5 cm deep wide. Power supply with a voltage capacity of: ac input 110 – 220, DC output 12 voltage 20 amperes, transmits power to the peltier and to rotate the fan, With the peltier type TEC 12706 and the external fan is 18 amperes and the internal fan is 0, 09 amperes with Styrofoam type 54 cm which has 10 pieces of ice packs as a cooling medium.

3.4.1 Cooler Box Design Steps

1. Install the peltier on the wall of the cooling box as seen in figure 4 because the peltier will produce a very low temperature compared to the top or bottom.
2. The position of the ice pack must surround the cooler box room so that the cooling can reach the entire space in the cooler box as in Figure 5.
3. The thermocouple is placed on the side of the cooler box to see the distribution that occurs in the cooler box.

Figure 4. Side view of the cooler box

Figure 5. Top view of the cooler box

3.4.2 Data Collection Steps

1. Prepare ice packs that have been frozen in the refrigerator (for data collection on the use of peltiers with ice packs and the use of peltiers with ice packs and cooler boxes containing frozen food) then put them in the cooler box.
2. turn on the peltier used
3. Turn on the thermocouple then insert the cable connected to the thermocouple into the cooler box.
4. Turn on the peltier for 1 hour and after 1 hour turn the peltier back on.
5. Every 10 minutes data is taken via a thermocouple when the device is turned on and off.

4 Discussion

The results of previous studies using a peltier cool box can cool the temperature inside the box. There is a difference between the cool box with load and without load.The use of peltier has not yet reached minus degrees, so it can only be used to cool drinks.

4.1. Research Time

This cooler box study was conducted for 2 hours at 14.00 pm to finish. By observing several temperatures, such as the room temperature of a cooler box with a thermocouple.

4.2. Cool Box Test Results

4.2.1 Test Results Using Peltier

The results of cooler testing in maintaining temperature are displayed in graphical form for ease of reading and analysis. Sequentially, data from cooler box research using peltier can be seen from the graph below.

Tabel 1. Data collection using a peltier

Test results using peltier non ice packs		
TIME	TURN ON	TURN OFF
0	34	18,1
10	19,7	28,4
20	19,5	28,8
30	19,2	29,4
40	18,8	29,9
50	18,5	30,1
60	18,1	30,7

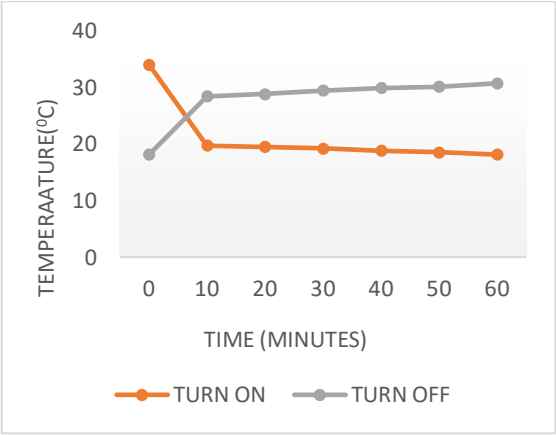

Figure 6. Graph temperature vs times peltier in cooler box

From the graph above it can be seen that all test points show a trend of increasing and decreasing temperature in the room when it is turned on and off relatively the same as the cooling time.
Testing in this box without using ice packs and without containing frozen food starts from minute 0 with the initial temperature of the room reaching 34 ^{0}C testing for 60 minutes when it is turned on and 60 minutes when it is turned off. This graph shows the results that when the tool is turned on from the 0 minute to the 10 minute there is a drastic decrease in temperature in the cooller box room starting to be seen from the initial temperature of 34 ^{0}C to 19,7 ^{0}C and the results from the 10 minute to the minute 60 the room temperature of the cooler box began to decrease slowly from 19,7 ^{0}C to 18,1 ^{0}C.
Whereas when the device is turned off from minute 0 to minute 10 there is a drastic increase in temperature in the cooller box room from the initial temperature of 18,1 ^{0}C to 28,4 ^{0}C and from the 10 minute to the 60 minute there is an increase in room temperature in the cooler box slowly from 28,4 ^{0}C to 30,7 ^{0}C.
This happens because the temperature inside the cooler box only comes from the peltier used and there is no help from other materials. Even in the cooler box there is no load in it. This happens because the temperature inside the cooler box only comes from the peltier used and there is no help from other materials. Even in the cooler box there is no load in it. This happens because the temperature inside the cooler box only comes from the peltier used and there is no help from other materials. Even in the cooller box there is no load in it.

4.2.2 Test Results Using Peltier With Ice Packs

The results of cooler testing in maintaining temperature are displayed in graphical form for ease of reading and analysis. Sequentially, data from cooler box research using peltier and ice packs can be seen from the graph below.

Tabel 2. Data collection using a peltier with an ice pack

Test results using peltier with ice packs		
TIME	TURN ON	TURN OFF
0	34	-7,2
10	-5,5	-6,9
20	-5,7	-6,4
30	-6,1	-6,1
40	-6,5	-5,9
50	-6,8	-5,7
60	-7,2	-5,4

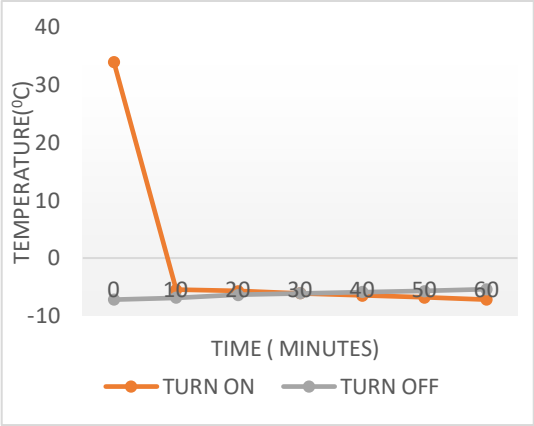

Figure 7. Graph of temperature vs times with ice packs in cooler boxes.

In this graph it can be seen that the test points show the trend of decreasing and increasing temperature of the tool that uses the peltier and the tool is turned off, the temperature in the cooler box that uses the peltier with ice packs when the tool is turned on from the starting point of the 0 minute 34 ^{0}C until the 10 minute decreased rapidly -5,7 ^{0}C and the 10 to 60 minute decreased slowly from -5.7 ^{0}C to -7,2 ^{0}C.
Meanwhile, cooller boxes that use peltier with ice packs when they are turned off experience an increase in temperature in the room from the 0 minute to the 60 minute, the room temperature increases slowly with the starting point of -7,2 ^{0}C to -5,4 ^{0}C for 60 minutes. minutes when the device is turned off.

4.2.3 Test Results Using Peltier With Ice Packs Containing Frozen Food

The results of cooler testing in maintaining temperature are displayed in graphical form for ease of reading and analysis. Sequentially, data from cooler box research using peltier with ice packs containing frozen food can be seen from the graph below.

Tabel 3. Data collection using a peltier with an ice pack containing frozen food

Test results using peltier with ice packs containing frozen food		
TIME	TURN ON	TURN OFF
0	34	-6,7
10	-4,4	-5,3
20	-4,9	-4,8
30	-5,2	-4,6
40	-5,8	-4,2
50	-6,2	-3,8
60	-6,7	-3,5

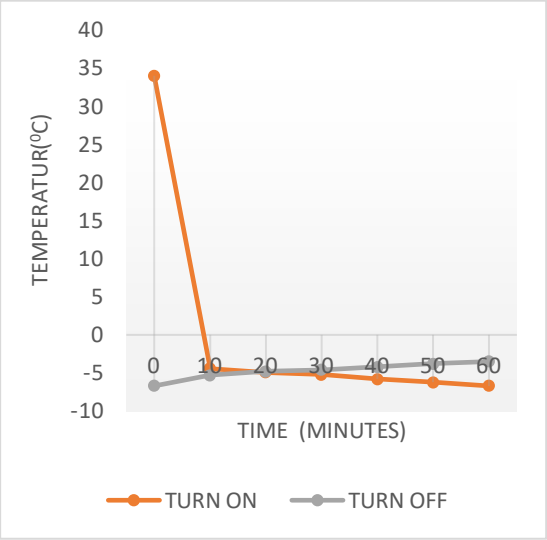

Figure 8. Graph of temperature vs times with ice packs containing frozen food in cooler boxes.

In this graph it can be seen that the point of decrease and increase in the temperature of the cooller box when the appliance is turned on the turned off uses peltier with ice packs containing frozen food.
As seen in the graph above, when the tool is turned on, there is a decrease in the cooller box room temperature from the starting point in the 0 minute, the room temperature in the cooller box is 34 ^{0}C and in the 10 minute, there is a decrease in room temperature which very swift -4,4 ^{0}C, in the 10 to 60 minute there was a slow decrease in the temperature of the cooler box room from -4,4 ^{0}C to -6,7 ^{0}C.
While using peltier with ice packs containing frozen food when the tool is turned off there is an increase in the tenperature of the cooler box room fro the 0 minute with an intial temperature of -6,7 ^{0}C and in the 10 minute there is a gradual increase to -5,3 ^{0}C, after a while the cooler box room temperature experiences temperature increase continuously until from the 10 minute to the 60 minute the temperature increase -5,3 ^{0}C to -3,5 ^{0}C.
The results above show that the cooler box containing frozen food will experience a temperature increase because the room temperature is absorbed by eating frozen food inside the cooller box. This is pletres because the temperature that reashes the cooller comes from peltier with ice packs, after being loaded the temperature inside the cooller box decreases because the load absorbs the cold that isin the cooller box.

5 Conclusion

Based on the results of the research that has been done, several conclusions can be drawn in this study as follows:

1. The use of a cool box that uses a peltier is good for storing food but the peltier has not yet reached a cold temperature for storing food, therefore the addition of ice packs affects the temperature drop in the cool box that uses a peltier.
2. From the results of research that has been carried out for 2 hours, including 1 hour when the tool is turned on 1 hour when the tool is turned off, it can be seen that the cool box which only uses peltier when the tool is turned on reaches a temperature of 18,1 ^{0}C while when it is turned off it reaches a temperature of 30,7 ^{0}C, the cool box that uses peltier and ice packs when the device is turned on reaches a temperature of -7,2 ^{0}C while when it is turned off the temperature reaches -5,4 ^{0}C, and the cool box that uses peltier and ice pack containing frozen food when it is turned on reaches - 6,7 ^{0}Cwhile when it is turned off the temperature reaches -3,5 ^{0}C.
3. In previous research they only used a peltier as a cooling tool and only applied it to drinks, while the current research was carried out to cool drinks and also food such as frozen food.
4. The advantage of this research is that the ice pack used can be used repeatedly and is safe for food and drinks and the cooler box can be taken anywhere.

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