The Effect of Using Lauric Acid on Cooler Boxes and Peltier as a Media Cooler Box

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Abstract:-Ice pack consumption in the refrigeration industry is currently increasing. Ice packs are able to maintain temperature, but the use of ice packs is not able to maintain a stable temperature because the ice packs melt quickly, therefore the author is looking for other cooling alternatives that can maintain a stable temperature and have a relatively longer cooling time. The research carried out in this work was to carry out an experiment using a factorial design with the independent variable: lauric acid concentration with variations (100g, 150g, 200g, 250g) and (time 2 hours) with 2/3 replications. The dependent variable is the cooler box temperature. As a control, ice packs were used with a concentration of 10 ice packs. At this stage, a study was carried out on Phase Change Material (PCM) made from Lauric Acid and de ice pack as a controlThe first step before carrying out an experiment to see the performance of the PCM being made is to determine the location of the thermocouple in the coller box. In this research, Laurid Acid can be used as a coolant that is able to maintain room temperature. Based on tests carried out for 2 hours, laurid acid was able to maintain a temperature of up to -1.8^{0}C, while at room temperature the cooler box can reach a temperature of -11.0^{0}C. So laurid acid is worthy of being used as an alternative as a cooling medium besides ice packs because it is able to stabilize temperatures.

Key words: cooler box, lauric acid, ice pack, peltier.

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1 Introduction

Technological progress is currently starting to develop rapidly in Indonesia, especially industrial technology and is starting to become more modern. This is marked by many changes in all business fields, such as the refrigeration industry using cooler boxes. Of course, this has a positive impact, especially in the industrial sector, currently many industries are starting to compete fiercely. To achieve maximum or best results, many industries are now starting to be more careful in selecting and determining their machines and production equipment. Meanwhile, the cooling technique using ice cubes is a method that from the past until now is still widely used by the general trading community. In fact, the costs incurred for these ice cubes are very inflated due to the limited durability of the ice cubes and their single use[1].

Currently, there are many who offer a variety of cooling equipment, including cooler boxes. The general use of this cooler is to store food ingredients such as vegetables, food and drinks so that they maintain their freshness. Leaf vegetables are vegetables that very quickly decline in quality or freshness. Based on research that has been conducted, the decline in the quality of vegetables in developing countries can reach 40% to 50% because temperature is the most important environmental factor that influences damage**[**2]. One treatment that can be done is by conditioning the temperature of fresh vegetables[3]. Storing vegetables at a temperature of 7-10^{0}C can maintain vegetable freshness for 2.3 days[4]. Apart from that, even in the food industry, transport vehicles such as (trucks, box cars) are equipped with refrigerators. however, some refrigerators use a compression system, for example household refrigerators. The compression system has a high COP (coefficient of performance), but its compactness is still low, it is heavy because it consists of large components, and it consumes very high power[5].To provide a different impact, this cooler box technology uses materials called lauric acid, ice pack, and peltier as cooling efficiency media for cooler boxes and provides resistance to the temperature of a cooler box, and these components are starting to be widely used because the indoor temperature can stay awake. Lauric acid (Fatty Acid) here can be used as a fungus inhibitor, because of the ability of fatty acids to inhibit fungi without having an effect on the organism[6].

Actually, there are also materials for cooling, namely ice packs, which are good for cooling products or food and drink ingredients because they have a freezing temperature that is much lower than the freezing point of water. To get a decrease in the freezing point of water, you can take advantage of the colligative properties of solutions where the influence of dissolved substances such as salt in the water solvent can lower the freezing point and raise the boiling point of water[7].

*Ice packs*or what is usually called a gel pack is a portable plastic bag filled with water, or gel or liquid refrigerant. For use, ice packs are frozen in the freezer. Both ice and other non-toxic refrigerants (mostly water) can absorb large amounts of heat before the temperature rises above 0^0C, due to the high latent heat of water[8].

The amount of heat load that will be absorbed by the ice pack cooling media is. The total heat load comes from 3 heat sources, namely heat load from the product, convection heat load due to air infiltration, and heat load through the walls.

Meanwhile, the Peltier element is a thermoelectric component that can pump heat from one side to another according to the direction of the given current. The working principle of the Peltier element is based on the Peltier effect, Joule effect, Seebeck effect and Thomson effect. When DC current is applied to the Peltier element, it will cause one side of the Peltier element to become cold (heat absorbed) and the other side to become hot (heat released). Pertier elements can be used as heaters and coolers depending on the direction of the current provided. The Peltier element has a compact shape with low power, so it is very suitable for use as a cool box cooling tool[9].

In recent years, many types of research and studies on TEC have been carried out to improve TEC performance[5]. This Thermo-Electric is wrapped in thin ceramic containing Bismuth Telluride rods. A Peltier consists of P and N type components, which have two sides with different temperatures when on one voltage is 12-15V dc with a current of 5 – 7 Amperes. Currently, peltiers are quite popular for cooling processors. Based on the working principle and materials of the peltier, it has an environmentally friendly effect[10].

This research aims to find out the effect of lauric acid and ice pack on the coller box media and how efficient the peltier is in maintaining cold temperatures in the coller box.

2 Formulation of the problem

2.1 Cooler box

The box used for the coller box media is made from Styrofoam as a place to store food and drink ingredients[7].

The design of this cooler box was carried out by considering material properties, ease of finding the required components and feasibility in the production process[10].

2.2Lauric acid

Lauric acid($C_{12}H_{24}O_2$) also known as dodecanoic acid, is a saturated fatty acid with a chain of 12-carbon atoms. A white, powdery crystalline acid that occurs naturally in a variety of plant and animal fats and oils. Lauric acid is the main component of coconut oil and palm kernel oil[11].

Fig.1 laurid acid

Source: Author documentation, 2023

Lauric acid has superior bonds such as melt congruence, good chemical stability, non-toxicity, good thermal reliability, availability and relatively lower costs when compared to other phase change materials (PCM). Thermo-physical properties of Lauric acid are shown in the following table:

Table 1. Thermo-Physical Properties of Lauric acid

No	Properties	value
1	*Melting point*	40 – 43.9 °C
2	*Latent heat of fusion*	180 kJ/kg
3	*Thermal conductivity*	0.16 Wm-1 °C -1
4	*Specific heat*: *Solid at 25oC*	2.1 kJ/kg.K -1°C -1
	Liquid at 43.9oC	3 kJ/kg.K -1°C -1
5	*Density solid liquid*	1007 kg/m3 862 kg/m3

2.3Thermoelectric

Thermoelectric technology is a refrigerator technology without using a compressor and refrigerant. The Peltier element or Thermo Electric Cooler (TEC) is an electrical component that can produce cold temperatures[12]. This refrigeration system works by converting electrical energy to produce cold and heat in one part of the thermoelectric module[13]. 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[14]. 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 have a higher energy level[15].

2.3.1Type of thermoelectric used

The thermoelectric (TEC) applied means the greater the heat load that can be or is absorbed so that the temperature in the room becomes lower[16]. Or the peltier element used in this research is TEC which is widely sold on the market, namely single stage thermoelectric/peltier with type 12706. This thermoelectric with good performance can produce temperatures below zero degrees Celsius on the cold side. For data and specifications, see Figure 2.

Hot Side Temperature (° C)	25° C	50° C
Qmax (Watts)	50	57
Delta Tmax (° C)	66	75
Imax (Amps)	6.4	6.4
Vmax (Volts)	14.4	16.4
Module Resistance (Ohms)	1.98	2.30

Figure 2. Peltier element specifications/thermoelectric cooler (TEC)
Source: https://j5d2v7d7.stackpathcdn.com/wp-content/uploads/2021/02/TEC1-12706-specifications.gif

2.3.2 HE Equipment On The Hot Side

Thermoelectric components are combined with a heat sink where a large fan is placed outside, and another fan is installed inside the cooler[17]. The hot side of the peltier is attached to a heat exchanger, namely the Deep Cool Gammaxx 400 Type CPU Cooler which has fins, heat pipes and fans. The better the performance or the amount of heat absorbed by the CPU Cooler, the cooler the temperature produced on the cold side peltier (Figure 3).

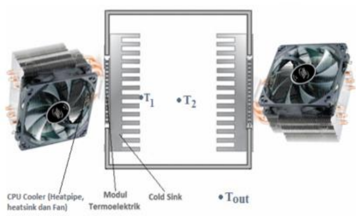

Figure 3. Heatsink on the hot side and cold side.
Source:[18]

2.3.3 HE Equipment On The Cold Side

On the cold side of the peltier element, a heatsink is attached. A heatsink is a device that functions to help transfer heat in a system. The main component of the heatsink is the fin. This is an area that is usually structured structurally and has its own thickness and distance.

2.3.4Power supplies

Power Supply or in Indonesian called a power supply is an electrical device that can provide electrical energy for other electrical or electronic devices[19]. As a power source for the cooling box, a power supply is used which has a voltage output of 12-15 VDC and a max current output of 15 Amps in accordance with the specifications of 2 thermoelectric units connected in series[10].

2.4 Temperature coefficient

Heat pump,air conditioner, Andrefridgeratoruses work to move heat from a cooler area to a hotter area, so its work function is the opposite of a heat engine. Their efficiency is measured byperformance coefficient(COP). Since heat pumps are essentially a heat engine concept in reverse, their efficiency is also limited by the efficiency of the Carnot cycle. However, because heat pumps transfer heat using work, rather than using heat to produce work, their efficiency can exceed 100%[20].

$$Cp = \frac{T^2}{T^1 - T^2} \quad (1)$$

Cp = Performance efficiency
T2 = high temperature
T1 = low temperature

2.5Power Gain

Power or Power is the ability to do work expressed in units of Nm/s, watts, or HP. Power can also be defined as work or energy done per unit time. To find out the amount of power produced, you can find out using the following equation:

$$p = IV \quad (2)$$

$$P = W/T \quad (3)$$

$$Q = I/T \quad (4)$$

With :
P = Power (Watts)
V = Voltage (Volts)
I = Current Strength (Amperes)
Q = Electric Charge (columbs)
T = Time (seconds)
W = Energy (Joules)

3 Problem solution

The research method used in this work was to carry out an experiment using a factorial design with the independent variable: lauric acid concentration with variations (100g, 150g, 200g, 250g) and (time 2 hours) with 2/3 replications. The dependent variable is the cooler box temperature. As a control, ice packs were used with a concentration of 10 ice packs.

The steps that will be taken are as follows:

3.1Empirical Study

At this stage, a study was carried out on Phase Change Material (PCM) made from Lauric Acid and with an ice pack as a control with a mixing composition that could be influenced for the experiment. At this stage, researchers identify the experimental configuration for Phase Change Material (PCM) and the components needed.

3.2 Planning

At this stage a cooler box is designed that is suitable for the PCM experiment that will be carried out as shown in Figure 4. The PCM that will be tested is a PCM made from lauric acid. Conditions for the cooler box used:

Material	: styrofoam
Dimensions	:
Long	: 54 cm
Wide	: 39.5 cm
Tall	: 30 cm
Thickness	: 3.5 cm
Depth	: 27 cm

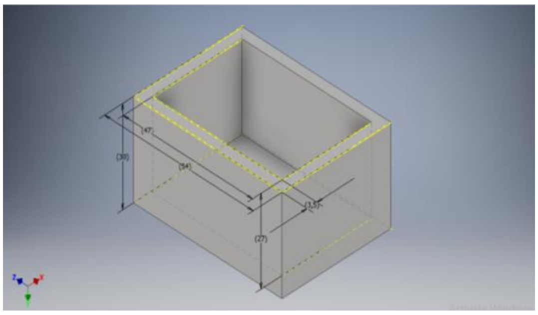

Figure 4. Styrofoam box

The first step before carrying out an experiment to see the performance of the PCM being made is to determine the location of the thermocouple in the coller box. There is no specific reference for the placement of thermocouples, but to see the distribution of air in the coller box, in general the thermocouple placement is on the sides of the coller box.

In this cooler box design, the plan for placing thermocouples for data collection is to place 3 thermocouples in the cooler box at points with the following conditions:

1. Two thermocouples to see the temperature distribution in the cool box.
2. One thermocouple is placed in the PCM to see the PCM temperature.After the PCM is formed and the heat load generated by the coller box and the product is known. The next step is to see the performance of the PCM by conducting

experiments using a previously planned coller box. The range of coller box settings used is -11.0^{0}C to see the performance of the PCM. The PCM experiment was carried out for 2 hours, starting when the temperature in the cool box had reached -11.0^{0}C.

Figure.5 Cooler box tool

Figure 6. Images from each experiment for a cooler box equipped with Phase Change Material (PCM)

3.3 Place and Time of Implementation

This cooler box research will be carried out for approximately one week starting, May 2023, from 08.00 am until finished, at the Laboratory of the Faculty of Mechanical Engineering, Muhammadiyah University of Pontianak which is located at the University of Muhammadiyah Pontianak Jalan Jendral Ahmad Yani No. 111, Pontianak, West Kalimantan .

3.4Experimental Procedures

In this experimental procedure, a cooler box device was designed as shown in Figure 4. In carrying out this experiment the first thing the tester did was check the power supply to see if it was functioning properly, then check the Styrofoam box to see if there were no leaks in the box, then check the thermoelectric device. Is it stable in taking temperatures, after checking all the equipment used by the tester? Next, the tester carries out the test. The first thing to do is turn on the power supply and then turn on the thermoelectric device and then put the lauric acid into the Styrofoam box. After all the procedures have been carried out, the temperature results from the cooler box will be obtained.

3.5Experimental principle

In this research, tests will be carried out on a coller box device with lauric acid which will be tested three times and ice packs as a comparison control for each PCM. These include a comparison of 20%, namely 200g lauric acid and an ice pack control, 30%, namely 300g lauric acid and an ice pack control, 40%, namely 400g lauric acid and 50%, namely 500g lauric acid and an ice pack control, for the control, namely using an ice pack. and media using peltier

The PCM data can be seen in the following table;

Table 2. PCM data

comparison	Lauric acid	Ice packs
20%	200g	-
30%	300g	-
40%	400g	-
50%	500g	-
control	-	Ice packs

4 Results and Discussion

This cooler box research was carried out from 08.00 am to completion. By observing several temperatures, such as the cooler box room temperature and the lauric acid temperature, with a thermocouple.

4.1 Testing

The cooler box research results are displayed in graphical form to make it easier to read and analyze. Sequentially, data from cooler box research without and using lauric acid with ice packs as control

4.1.1 Cooler box performance without lauric acid

The results of the cooler box performance test for 120 minutes experienced a very significant temperature increase which can be seen in Figure 7.

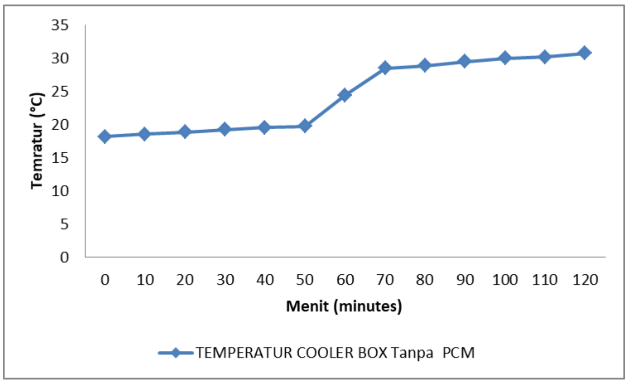

Figure 7. Cooler box graph without PCM.

Figure 7 shows that all test points show relatively the same trend of increasing and decreasing temperature in the room relative to the cooling time. Testing in this box without using lauric acid and ice packs started from the 0th minute with an initial room temperature reaching 18.1^{0}C for 120 minutes of testing. The first stage graph shows the results from the 0th minute to the 20th minute, the temperature increase in the cooler box room starts to appear from the initial temperature of 18.1^{0}C to 18.8^{0}C and the results from the 20th minute to the 60th minute tend to be room temperature. started to increase, while from the 60th minute until the specified time limit, namely the 120th minute, the temperature increase tended to be very significant from a temperature of 24.40C to 30.70C.

4.1.2 Cooler box performance with ice pack

The results of the cooler box performance test for 120 minutes experienced a relatively rapid temperature increase due to the unstable temperature, which can be seen in Figure 8.

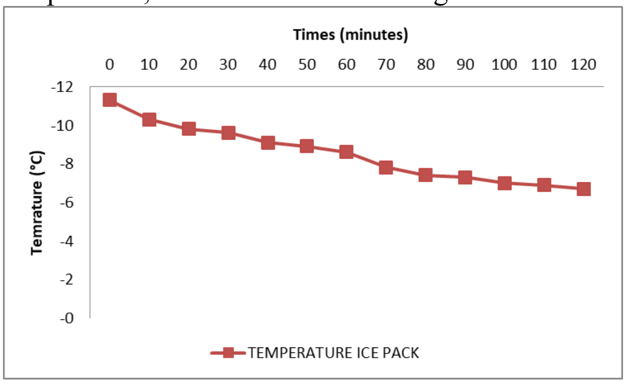

Figure 8. Graphic of cooler box using ice pack

From the graph Figure 8 shows that all test points show a trend of increasing temperature after the tool*thermoelectric*turned off for 30 minutes, the temperature in the cooler box that only uses ice packs from the 0th minute to the initial room temperature reaches-11.3^{0}C and for room temperature with lauric acid and ice packs with an average initial temperature of -11^{0}C. Testing for 120 minutes. This graph shows the results from the 0th minute to the 60th minute showing a significant decrease in temperature in the cooler box from the initial temperature-11.3^{0}C to -8.6 and the results from the 60th to the 120th minute can be seen at the point where the graph experiences a decreasing trend, the results of the temperature in the cooler box using ice packs will be used as a reference for making observations using lauric acid, so whether This lauric acid can lower the temperature in the cooler box.

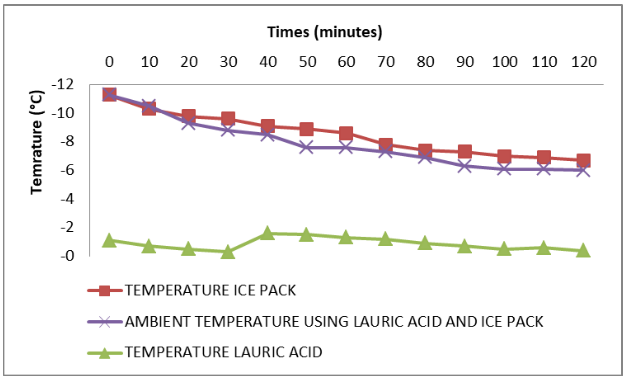

Figure 9. Cooler box graph using 250 gram lauric acid and ice pack as control

Based on Figure 9, the test results show temperatures including lauric acid temperature, ice pack temperature and room temperature using lauric acid and ice pack as controls, with 50% lauric acid, namely 250 grams. It can be seen in the graph above that the test points show a trend of rising and falling temperatures inside. The cooler box room with an initial temperature reaching -1.10C from the 0th to the 30th minute experienced a decrease in temperature from the initial temperature of -1.1^{0}C to -0.3^{0}C, while from the 30th to the 70th minute it tended to decrease The temperature rose from the initial temperature of -0.3^{0}C to -1.2^{0}C after experiencing temperature fluctuations, while the trend from the 70th minute to the 120th minute tended to experience a decrease in temperature. For the ice pack itself, from the initial temperature of -11.3^{0}C, the temperature decreased from the 0th minute to the 120th minute, namely -11.3^{0}C to -6.7^{0}C. Meanwhile, for room temperature using lauric acid and ice packs as controls, the test results are relatively the same, only the cooler box using lauric acid experiences a trend of decreasing and increasing temperature, this is due to the temperature of the lauric acid being stable, so there is a difference in the room temperature of the cooler box. . Meanwhile, the ice pack itself is experiencing a trend of decreasing temperature because the longer the ice pack is used, the more it will melt and experience a decrease in temperature. And why lauric acid is better than ice packs is because lauric acid experiences a decrease and increase in temperature and the longer it is used, the more stable the temperature.

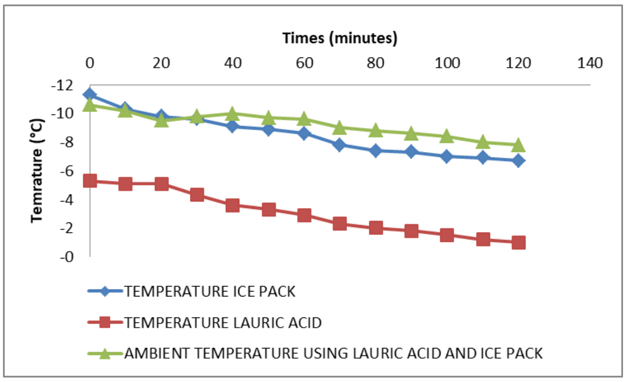

Figure 10. Cooler box graph using 200 gram lauric acid and ice pack as control

Based on Figure 10, it can be seen that the test results show temperatures including lauric acid temperature, ice pack temperature and room temperature using lauric acid and ice pack as controls, with 40% lauric acid, namely 200 grams. It can be seen in the graph above that the test point shows a trend. mines which is quite low until it reaches a temperature of -5.5^{0}C after the toolThe thermoelectric is turned on for 30 minutes. After the thermoelectric device is turned off from the 0th minute to the 20th minuteshows temperature stability in lauric acidwith the initial temperature-5.5^{0}C to -5.1^{0}C, while from the 40th minute to the 120th minute the temperature began to show a decrease from -4.3 to -1. And for the ice pack itself, from the initial temperature of -11.3^{0}C, the temperature decreased from the 0th minute to the 120th minute, namely -11.3^{0}C to -6.7^{0}C. Meanwhile, for room temperature using laurid acid and ice packs, from the 0th to the 60th minute the temperature decreases and increases, while from the 70th minute to the 120th minute the room temperature begins to stabilize so that the temperature does not experience a significant decrease due to temperature The room from start to finish experienced a tendency towards stability.

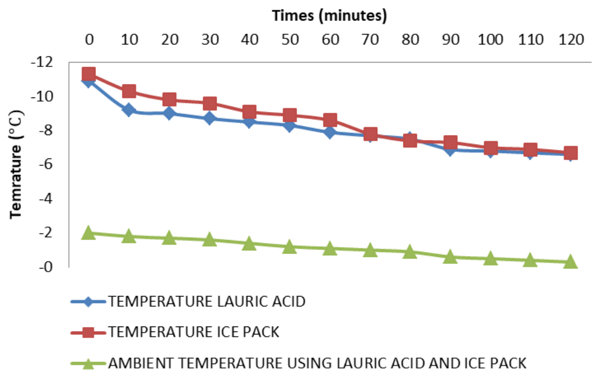

Figure 11. Cooler box graph using 150 gram lauric acid and ice pack as control

Based on Figure 11, this is different from Figure 9 and Figure 10 because there is no decrease or increase in temperature after the thermoelectric device is turned off. It can be seen from the results of testing the temperature of lauric acid as much as 30%, namely 150 grams. It can be seen in the graph above showing the trend of increasing temperature by minute. -0 to the 60th minute, namely -2^{0}C to -1.1^{0}C, although there is not a very significant decrease, but the temperature drops can also be seen from the 70th minute to the 120th minute from a temperature of -1^{0}C to -0.3^{0}C. Meanwhile, the ice pack itself, from an initial temperature of -11.3^{0}C, experienced a decrease in temperature from the 0th minute to the 120th minute, namely -11.3^{0}C to -6.7^{0}C. And for room temperature using lauric acid and ice packs, there is stability in the cooler box room, which can be seen from the point in the diagram which experiences stability from the 0th minute to the 60th minute from the initial temperature of -10.9^{0}C to -7.9^{0}C. from the 70th minute to the 120th minute, the same only experienced stability from a temperature of -7.7^{0}C to -6.6^{0}C, so we can see from the graph that lauric acid can maintain the temperature because it can stabilize the space in the cooler box.

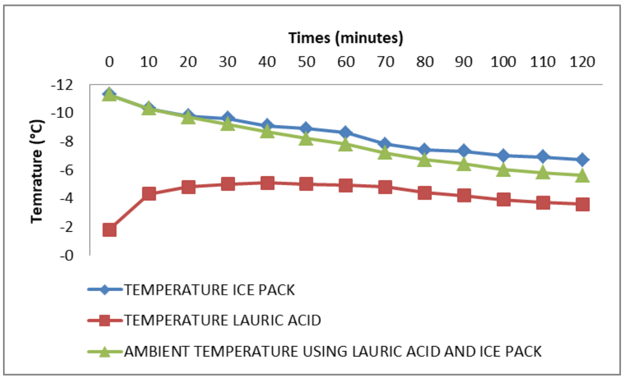

Figure 12. Cooler box graph using 100 gram lauric acid and ice pack as a control

Based on Figure 12, it can be seen that the test results experience an increase and decrease in temperature after the thermoelectric device is turned off. From the results of testing the temperature of 20% lauric acid, namely 100 grams, there is a difference from the previous graph, namely the temperature experiences a stagnation in the 0th minute, namely -1, 8^{0}C and experienced a very significant increase in temperature in the 10th minute, namely -4.3^{0}C, and began to continue to increase until the 40th minute, namely -5.1^{0}C, then from the 50th minute to the 120th minute, the temperature slowly began to decrease This is because the cooler box space is stable. And for the ice pack itself, from the initial temperature of -11.3^{0}C, the temperature decreased from the 0th minute to the 120th minute, namely -11.3^{0}C to -6.7^{0}C. Meanwhile, for room temperature using laurid acid and ice packs, from the 0th to the 60th minute, the temperature showed stability in the sense that it decreased but was not significant, namely -11.3 to -7.8, whereas from the 70th minute to the 60th minute. 120, namely -7.2 to -5.6.

4.2Efficiency

The efficiency in this diagram shows the number of grams of lauric acid and from the results of comparing the temperature of lauric acid, the graph in Figure 13 is obtained.

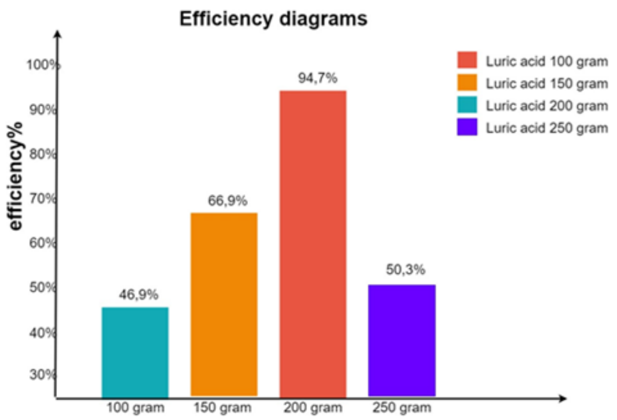

Figure 13. Cooler box efficiency with PCM lauric acid and ice pack.

The results of the efficiency analysis (Figure 13) in this diagram show that the efficiency value using lauric acid is based on the amount of weight / gram of lauric acid. From the results of the temperature comparison it shows that lauric acid from these 4 tests has the best efficiency at 200 grams of lauric acid at 94.7 % of the cooler box when using Lauric. For the 4th efficiency value of lauric acid is 50.3% at 250 grams, 94.7% at 200 grams, 66.9% at 150 grams, 46.9% at 100 grams.The longer you use lauric acid, the more stable the temperature will be.

5 Conclusion

Based on the results of research that has been carried out, it can be concluded that lauric acid is able to maintain temperatures as follows:

This research was carried out using a tool called a thermoelectric cooler box. This tool uses a peltier to change the temperature from hot to cold and requires a tool called a power supply, which is an electrical tool that can provide electrical energy for electrical or electronic devices. In the tests carried out on this cooler box, we carried out tests and looked at changes in lauric acid. In this research, lauric acid can be used as a coolant that is able to maintain temperature. Based on tests carried out, lauric acid can reach -110C and was able to stabilize the temperature for 2 hours. Testing the best efficiency is 200 grams of lauric acid, which is 94.7% of the cooler box when using lauric.So laurid acid is worthy of being used as an alternative as a cooling medium besides ice packs because it is able to stabilize temperatures.

Reference:

[1] AK Tegal, "PORTABLE COLD STORAGE CONTAINERS WITH ICE JELL FOR IMPROVING THE FISH SUPPLY CHAIN IN MUNJUNG AGUNG VILLAGE, TEGAL DISTRICT,"*J ournal of T echnical Community Service*, vol. 5, no. 1, pp. 31–37, 2022, doi: 10.24853/jpmt.5.1.31-37.

[2] AA Kader, "Postharvest Technology of Horticultural Crops - An Overview from Farm to Fork,"*J. Appl. Sci. Technol.*, vol. 1, no. 1, pp. 1–8, 2013.

[3] A. Lal Basediya, DVK Samuel, and V. Beera, "Evaporative cooling system for storage of fruits and vegetables - A review,"*J. Food Sci. Technol.*, vol. 50, no. 3, pp. 429–442, 2013, doi: 10.1007/s13197-011-0311-6.

[4] M. TAMPUBOLON, IM SUKEWIJAYA, and IGA GUNADI, "The Effect of Pre-cooling and Storage Temperature on Postharvest Quality of Gonda Plants (Sphenoclea zeylanica Gaertn),"*Trop Agroecotechnology.*, vol. 6, no. 2, pp. 194–205, 2017, [Online]. Available: http://ojs.unud.ac.id/index.php/JAT.

[5] M. Mirmanto, S. Syahrul, and Y. Wirdan, "Experimental performances of a thermoelectric cooler box with thermoelectric position variations,"*Eng. Sci. Technol. an Int. J.*, vol. 22, no. 1, pp. 177–184, 2019, doi: 10.1016/j.jestch.2018.09.006.

[6] A. Novilla, P. Nursidika, and W. Mahargyani, "Fatty Acid Composition of Virgin Coconut Oil which has Potential as Anti-Candidiasis,"*EduChemia (Journal of Kim. and Education)*, vol. 2, no. 2, p. 161, 2017, doi: 10.30870/educhemia.v2i2.1447.

[7] "Design of Fresh Fish Distribution Tools Using Ice Pack Cooling Media for Mobile Fish Traders,"*Nyoman Dhira Pray. I Wayan Widia, I Made Anom S. Wijaya Progr. Stud. Tech. Agriculture, Fak. Technol. Agriculture, Unud*, vol. 7, no. September, pp. 218–227, 2019.

[8] TA Nugroho, Kiryanto, and BA Adietya, "Experimental Study of Media Use"Fish Coolers in the Form of Wet Ice and Ice Packs as an Effort to Improve the Performance of Fish Storage Places Catched by Fishermen," J. Tek. Shipping, vol. 4, no.

4, pp. 889–898, 2016.

[9] J. Brahmbhatt, “A Design of Thermoelectric Coolers and Optimization,” no. March, pp. 1–8, 2016.

[10] YBHMunnik [1], D.Yohannes[2], "USE OF PELTIER FOR MINI COOLER BOX,"*Univ. Dirgant. Marshal Suryadarma*, vol. 10, no. 1, pp. 1–52, 2022, doi: 10.21608/pshj.2022.250026.

[11] A. Human*et al.*, "Online Journal Available at: https://jurnal.polines.ac.id/index.php/eksergi Copyright © EKSERGI Journal of Energy Engineering Vol.17 No.3 September 2021 201," vol. 17, no. 3, pp. 201–212, 2021.

[12] T. Nugroho and C. Mahendra, "Performance of Arrangement and Number of Peltier Elements on Refrigerated Fish Container TEC," pp. 75–84, 2019.

[13] D. Situmeang and A. Syuhada, "Study of the Heat Absorbing Equipment System in Blood Storage Boxes," vol. 1, no. June, pp. 111–118, 2013.

[14] M. Kumar Rawat, H. Chattopadhyay, and S. Neogi, “Presented at International Conference on Energy Resources and Technologies for Sustainable Development, A REVIEW ON DEVELOPMENTS OF THERMOELECTRIC REFRIGERATION AND AIR CONDITIONING SYSTEMS: A NOVEL POTENTIAL GREEN REFRIGERATION AND AIR CONDITIONING TECHN, ”*Int. J. Emerg. Technol. Adv. Eng.*, vol. 3, no. 3, pp. 362–367, 2013, [Online]. Available: www.ijetae.com.

[15] R. Wahyu and C. Rangkuti, "The Effect of Canned Drink Cooling Load on the Temperature in a Thermoelectric-Based Cooling Box Using Electricity from an Accumulator,"*Pros. Semin. Nas. Expert*, no. Cl, pp. 247–252, 2018, doi: 10.25105/pakar.v0i0.2632.

[16] A. Aziz, J. Subroto, and V. Silpana, "Application of thermoelectric cooling modules as a cooling medium for beverage boxes,"*Technology*, pp. 1–7, 2015.

[17] TB Sitorus, Z. Lubis, F. Sembiring, B. Christopel, and JAR Siagian, “Utilizationof peltier cooling systems driven by solar power for storing vegetables and fruits,” IOP Conf. Ser. Mater. Sci. Eng., vol. 725, no. 1, 2020, doi: 10.1088/1757-899X/725/1/012014.

[18] D. Wahyu, Andriyanto, Hanif, R. Sukma, and Y. Rosa, "Experimental Study of Multi-Function Devices with Thermoelectric Power Supply for Cooling and Heating,"*J. ROTOR*, vol. 1, no. 2, pp. 46–51, 2016.

[19] C. Cholish, R. Rimbawati, and AA Hutasuhut, "Comparative Analysis of Switch Mode Power Supply (SMPS) and Linear Transformer in Audio Amplifiers,"*CIRCUIT J. Ilm. Educator. Tech. Electro*, vol. 1, no. 2, pp. 90–102, 2017, doi: 10.22373/crc.v1i2.2079.

[20] Howell John R and Buckius Richard O. 1987. Fundamentals of Engineering Thermodynamics. New York: McGraw-Hill