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Design and build mini refrigerator with VDI 2222 method

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ABSTRACT
Mini refrigerator are now starting to be in great demand among people nowadays because they are easy to carry/place where we want and maintenance is quite easy, the more there are developments starting from the technology used and the varied designs. The development of the mini refrigerator uses the method used in designing the mini refrigerator test equipment using the VDI 2222 design method. By using this method we can find out more clearly the use of this mini refrigerator, such as maintenance of the mini refrigerator, the use of the mini refrigerator itself, how to operate it properly and correctly, getting to know the components of a mini refrigerator, knowing the uses of mini refrigerator components. The general image of a refrigerator is a tool that is used to cool or also to preserve food or drinks because at low temperatures the growth of bacteria will be inhibited. The components of this mini refrigerator consist of a frame to support the styrofoam and the electrical consists of what will be used, namely the switch and power supply, the module used is a pro module which only has one set of thermoelectric modules which will then work with the electrical then transferred to the switch. and later it goes to the power supply which will be processed into a mini refrigerator where the test results are carried out.

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INTRODUCTION

Refrigeration has many benefits for human life, such as preserving food and drinks[1], [2]. Refrigeration has become a basic need for modern society because it improves the quality of the taste of food and drinks. The cooling process which is often used in conventional refrigerators uses a compressor system and refrigerant.[3], [4][5][6]. The design of this thermoelectric mini refrigerator includes. In general, this component can be used as a cooler and can also be used as a heater[7][8].[9]Previous research regarding the use of peltiers in cooling systems has been carried out a lot[10]

A refrigerant is a substance that functions as a coolant where it absorbs heat from the air and the air that comes out becomes cold[11][12]. Refrigerants have the advantage that their elemental content is stable and this substance is easy to obtain. Apart from that, refrigerants also have a weakness, namely that this substance can damage the earth's ozone layer which causes the temperature on earth to increase, resulting in an increasing need for a cooling system.[13][14]. Peltier is a thermoelectric component that can replace the function of a refrigerant. Peltier has unique characteristics that can cool without damaging the environment by utilizing the Peltier effect[15].

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METHODS

Research Flow Chart

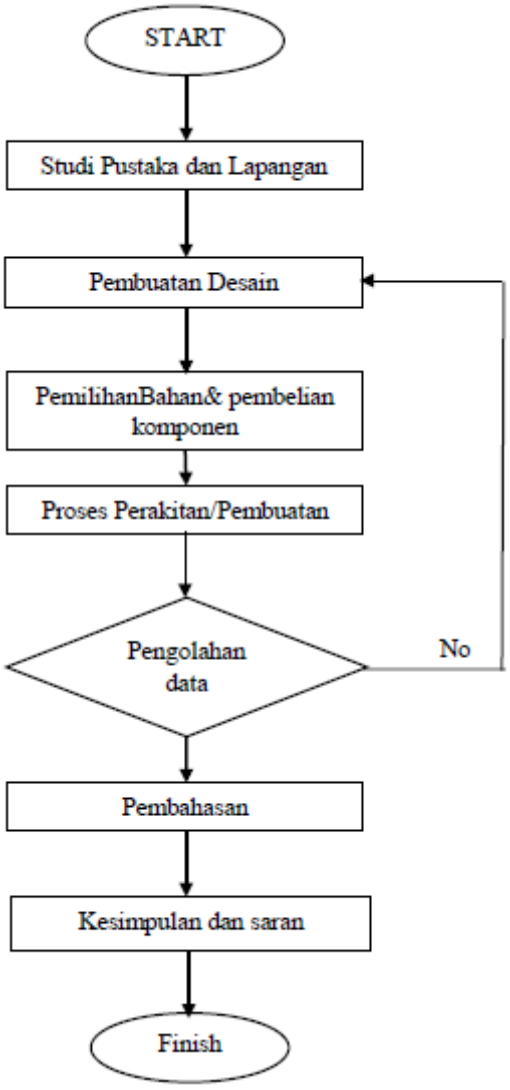

Figure 1. Research Flow Diagram

Based on figure 1, the flow diagram of the research can be explained as follows:

a. Literature and Field Studies
   At this stage, literature studies and field studies are carried out[16]
b. Design Creation
   At this stage, create a model or blueprint of the application that will be created, so that the manufacturing process will be effective and efficient. And also the final result of making the application is expected to be in accordance with what has been planned[17]
c. Material Selection and Component Purchase
   The process is related to the form where the process will determine the shape, size, precision and cost. Two-way interaction: shape specifications limit the choice of materials and processes, but process specifications limit the materials used and the

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shapes taken. The more sophisticated the design, the tighter the specifications and the greater the interaction. The interaction between function, material, form and process lies in the material selection process[18].

d. Assembly and Manufacturing Process
assembly is the process of combining two or more components to create a new entity. Assembly is the process of combining or arranging several components into a tool or machine with a certain function

e. Data processing
Data processing is a process of receiving data as input, processing using a certain process, and producing the results of the data processing in the form of information (output).[19]

f. Discussion
In this process, a system design proposal will be explained which is expected to overcome several problems that have been mentioned in the system evaluation[20]

g. Conclusions and recommendations
From the explanation and analysis explained in the previous discussion, it can be concluded that the existing problems have been answered[21]

RESULTS AND DISCUSSION

At this stage the designer looks for the most profitable alternative combination in making a mini refrigerator. There are several stages in making this design, namely as follows:

1. Creating alternative functions
2. Working principles and combination of working principles
3. Creation of concept variants

The creation of alternative functions is as in table 1 below:

Table 1. Alternative Functions

No	Frame Alternatives	Excess	Lack	Picture
A1	Equilateral Angle Iron	1. The welding process is very easy 2. Light material 3. Resistant to pressure 4. Easy maintenance	1. The price of iron is very expensive 2. Weight tends to be heavy	
A2	Non-equilateral perforated angle iron	1. The welding process is very easy 2. Light material 3. Resistant to pressure 4. Easy maintenance	Prices are still relatively cheap on the market	

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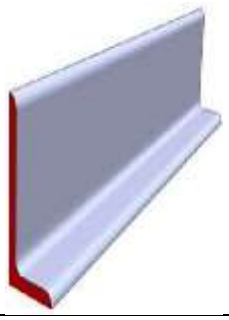
A3	Angle iron is not equilateral	1. The welding process is very easy 2. Light material 3. Resistant to pressure	1. Weight tends to be heavy 2. The price of iron is very expensive	

No	Alternative Connection	Excess	Lack	Picture
B1	SMAW welding And GMAW	Can process various kinds of materials	1. There is Slag in the Welds 2. The number of welding sparks	
B2	Nuts and Bolts	1. Connections are easier to install and adjust 2. The connection can be disassembled and installed.	1. If one of the nuts or bolts is damaged, the opening process will be very difficult.	
B3	TIG welding	Can produce good and quality welds	1. Expensive welding services 2. The power used for welding is wasteful	

No	Alternative Box	Excess	Lack	Picture
C1	Container (Plastic Box)	Stronger	1. Heavier 2. Less Affordable Prices	

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C2	Cooler Box	1. Stronger 2. Thicker in terms of material	1. Heavier 2. Kuramg's price is affordable	
C3	Styrofoam	1. Lighter 2. Longer cold retention 3. Very affordable price	The materials are easily damaged	

No	Alternative Hardware Module	Excess	Lack	Picture
D1	Basic Module	More affordable prices	Cannot freeze or cool	
D2	Pro Module	1. Easy to operate 2. Has waterblock assistance	Low price	
D3	Arduino	Production prices are more expensive	Another additional component that is difficult to find	

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The calculation formula used in this design is as follows:

1. Shear stress of nuts and bolts in unequal-sided perforated angle iron

   $\mathbf{F_g}$=.d2..n$\frac{\pi}{4}\boldsymbol{\tau_g}$ (1)

   Where :

   $\mathbf{F_g}$ = Shear Force

   $\boldsymbol{\tau_g}$ = Shear stress

   $\mathbf{n}$ = Number of bolts

   $\mathbf{d}$ = Diameter of the inner bolt

   $\mathbf{F_g}$= . d2..n where =$\frac{\pi}{4}\boldsymbol{\tau_g}\boldsymbol{\tau_g}\frac{\mathbf{F_g.4}}{\mathbf{d^2.n}}$

   $\boldsymbol{\tau_g}$= = 55.4 N/mm2$\frac{10863.4}{14^2.4}$

2. Volume in Cooler Box

   V = L x W x T (2)

   Where :

   V = Volume

   P = Length

   L = Area

   T = Height

   V = L x W x T

   = 75 cm x 42 cm x 26.4 cm

   = 83,160 cm3

3. Cooling Box Surface Area

   L = 2 x (pl + pt + lt) (3)

   Where :

   L = 2 x [(75 cm x 24 cm) + (75 cm x 26.4 cm) +(24 cm x 26.4 cm)]

   L = 2 x (1,800*c*m2 + 1,980 cm2 + 633.6 cm2)

   L = 2 x 4,413.6 cm2

   L = 8,827.2 cm2

4. Cooling Box Load Against Iron Plate

   Where ,

   w = m . g (4)

   w_0= 0.60 x 9.8 = 5.88 N

   w_1= 0.82 x 9.8 = 8.036 N

   w_2= 0.92 x 9.8 = 9.016 N

   w_3= 1.22 x 9.8 = 11.956 N

   Where:

   w = cooler box load on iron

   m = mass of object (kg)

   weight of cooler = 0.60 kg

   load 1 = 0.82 kg

   load 2 = 0.92 kg

   load 3 = 1.22 kg

   g = acceleration due to gravity (m/s^2) = 9.8 m/s^2

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Tool Working Principle

The working principle of the mini refrigerator test equipment is as follows:

1. Van LGA 775 will receive the cool side of the peltier.
2. Headsing is useful for circulating cold with the help of vans.
3. Furthermore, the peltier is useful in the cooling system.
4. The water block will process/eliminate the heat system in the pelier.
5. After receiving information on test results, this principle has been completed.

CONCLUSION

The conclusions obtained are as follows: 1). In making the mini refrigerator test equipment, a thermoelectric module is used with a frame using unequal-sided perforated angle iron for the reason that the material is strong and sturdy. 2). The components/equipment used must be checked first before turning it on.

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