

# DESIGN AND FABRICATION OF THERMOELECTRIC REFRIGERATOR USING PELTIER MODULE

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**Abstract:** In this project, we are excluding the Conventional mechanical components to avoid vibrations, noise, and pollution due to harmful refrigerants from the existing mode of refrigeration systems. Instead of these components, we are using the Peltier module to produce the Refrigeration effect and thereby protecting the environment. It is compact, light in weight, high reliability. A Peltier module with water blocks is more efficient than using Peltier module with the aluminium heat sink(fins). In this project, we are using three layers concept i.e., Iron casing, Thermocol insulation and Aluminium cabin which acts as a cooling chamber. As per our knowledge, it is one of the most cost-effective, clean and environment-friendly systems to preserve food items, medical applications, and other different things that can be stored in it and It also acts as a portable refrigerator.

**Index Terms – Peltier module, Refrigeration, Water blocks.**

## I. INTRODUCTION

There are several types of Refrigeration systems that are designed to produce cooling. Thermoelectric refrigeration is a new alternative method. Thermoelectric cooling is also known as "The Peltier Effect". The main objective of our project is to produce the cooling effect by using the "Peltier Module" by the application of water pockets. By using this type of Refrigeration system, we are avoiding the conventional mechanical devices, usage of harmful refrigerants and usage of green-house gases thereby protecting our environment.

In thermoelectric materials, electrical energy can be directly converted into thermal energy and thermal energy into electrical energy. Direct conversion between electrical and thermal energy is possible because of two important thermoelectric effects: The Seebeck effect and the Peltier effect. When a circuit of two dissimilar metal and two junctions are formed, a current will flow between the junction or the circuit. This phenomenon is known as the see back effect. C. Peltier, a French watchmaker, and an amateur scientist discovered a reverse effect of the See back. whenever electrical current flows through two dissimilar conductors, depending on the direction of current flow, the junction of the two conductors will either absorb or release heat it is known as "Peltier Effect".

The thermoelectric modules are made of several P-type and N-type semiconductor couples which are electrically connected in a series configuration and thermally in parallel to create cold and hot surfaces. The heat pumping direction can be altered by altering the polarity of changing DC current. Heat will be rejected through the module from the inner side to the outer surface. The inner module face will be cooled while the outer face is simultaneously heated. Although they are less efficient than the vapour compression system, they are very light, low in cost, silent in operation, and are Eco-friendly. Usually, TEC's refrigeration will work by using the Aluminium Heat-sink and cooling fans. But, in our project, we used water pockets for the TEC's refrigeration to improve the efficiency of the system.

## II. OBJECTIVES

The main purpose of this project is to analyse the working of thermoelectric Refrigerator in addition to water-block. The Scope of this work includes:

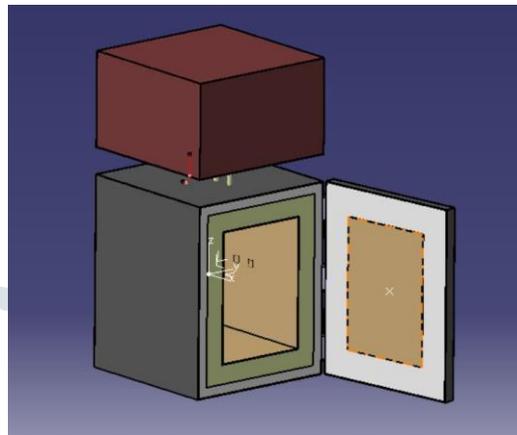
- Study of the principles, working of Peltier refrigerator and its working and performance parameters
- Exploring methods to improve the efficiency of the Peltier cooling systems and study the advancement in the field of thermoelectric
- Studying water blocks, which improves the Refrigeration effect and to increase the life span of the Peltier module
- To increase the cooling rate of the Peltier module with water blocks by constructing three layers such as metal, thermocol, and aluminium sheets for better cooling
- Here, we are using a surge tank to provide working fluid i.e., Pre-cooled water, normal tap water or any other coolant.
- We are using hydraulic pumps to improve the flow of working fluid in the circuit to improve the performance of the refrigerator
- To provide a cooling system in rural areas and also to reduce the overall cost of refrigeration to cool water and also to use in medical applications

The Material used in our project is lower grade and economical because to reduce the cost of the product, which will play a crucial role in this product. To obtain 2°C in the refrigerator by using the Peltier module with water blocks with a water fluid circulating system. Also, to serve the refrigerator to poor people at low cost.

### III. DESIGN AND COMPONENTS OF THERMOELECTRIC REFRIGERATOR

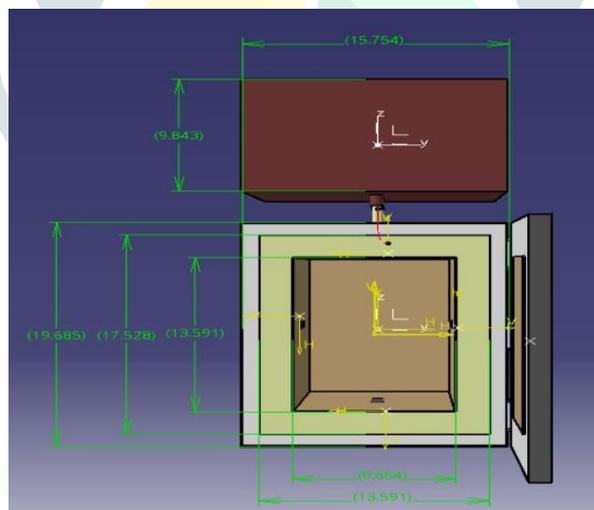
#### 3.1 Design

##### 3.1.1 Refrigerator Cabinet

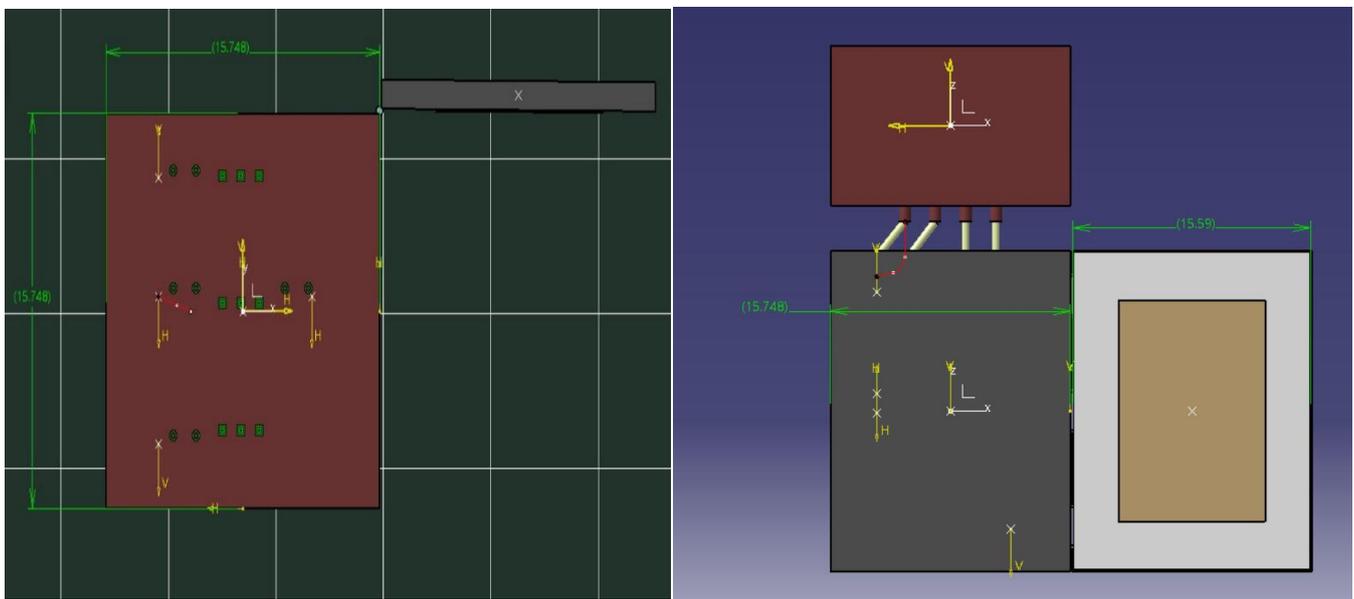


**Fig.3.1.1(a) Refrigerator Cabinet**

For the efficient cooling purpose, the cabinet is Design with Three layers concept i.e., Iron casing, Thermocol Insulation, and Aluminium insulation and above figure Shows the Schematic diagram of the refrigerator cabinet. To fabricate the refrigerator the below diagram, help to the arrangement of the components at their positions. The insulation is used to protect the absorption of heat from the outer environment. Heat is rejected from the inner surface and rejected to the surrounding but if the heat from the surrounding will gets absorbed in the inner side the performance of the system will poor.



**Fig.3.1.1(b) Refrigerator Dimensions in Front View**



**Fig.3.1.1(c) Refrigerator Dimensions in Top and Side View**

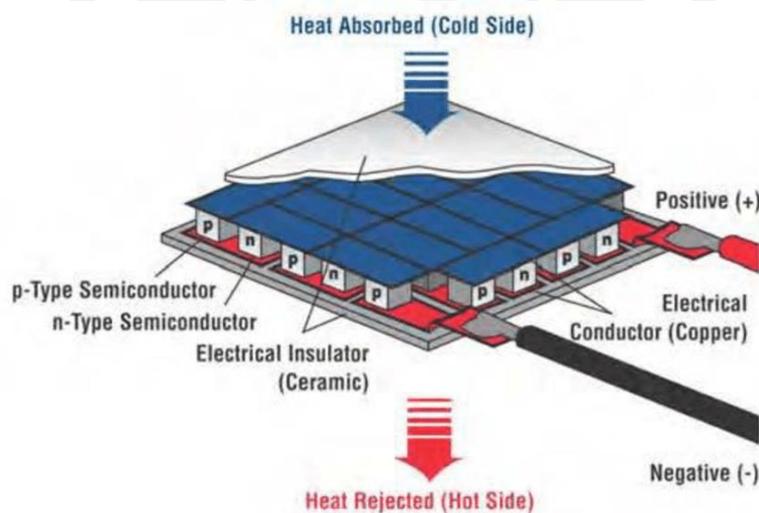
The above figure shows the isometric views of the CAD Model of Refrigerator which helps in the fabrication process. In this figure, the views provide an overall idea about the layout of our project. CATIA software increases the accuracy and productivity of the design. CATIA is used to create the 3D-model and to know Whether is it possible to fabricate or not.

### 3.2 Components of Thermoelectric Refrigerator

#### 3.2.1 Peltier Module

The Peltier module consists of P-type and N-type semi-conductor couples and they are connected electrically in series and thermally in parallel. It is a solid-state construction due to its highly reliable components. For most applications, they will provide long, trouble-free service. The DC electrical current is supplied to the Peltier module, then the heat is transferred from one side to another side acting as a heat exchanger thereby one side of Peltier module gets cooled and another side will be hot.

The Peltier module is manufactured by using Bismuth telluride material and it has a specification i.e., TEC1-12706 and its properties are 127 P and N-type semiconductor couples, 6 A Bismuth Telluride. Peltier module is a D.C electric device and its performance can be varied by varying the power supply



**Fig.3.2.1(a) Peltier Module with Working Principle**

#### 3.2.2 Water Blocks

Water blocks are the most efficacious method of heat removal. They are often 4-5 times more efficient when compared to an air-cooled aluminium heat sink and fan. The Principle is providing a source of cool liquid or normal water to the inlet of the water block and the liquid through the various chambers of the water block and return thereby it will absorb heat from the TECs or

electronics. And the TECs i.e., Peltier Module which is attached to the water block gets cooled by heat-absorbing on one side and heat-rejecting on another side. And we have designed the water block i.e., Fig.3.2.2(a)

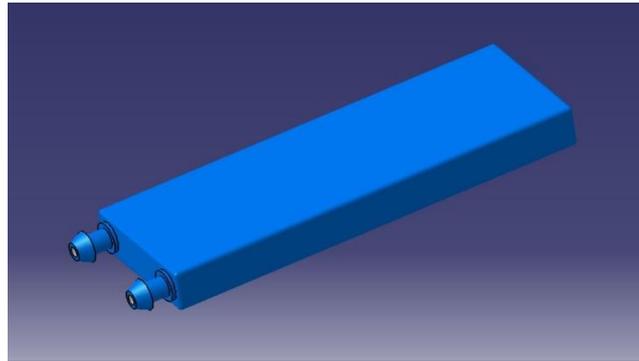


Fig.3.2.2(a) Water Block

## IV. CONSTRUCTION AND WORKING PROCESS

### 4.1 Construction

The construction setup of the refrigerator consists is as follows

- (a) Iron casing (Outer Layer)
- (b) Thermocol Insulation (Middle Layer)
- (c) Aluminium Insulation (Inner Layer)
- (d) Peltier module (Model No-TEC1-12706)
- (e) Water blocks
- (f) Water surge tank (Inlet & Outlet)
- (g) DC power supply 12V,6A

Construction Process as Follows:

The cabinet is made up of three layers of insulation. Now, the refrigerator cabinet which is made up of aluminium is fabricated as the inner layer in required dimensions i.e., 30.48cm\*35.56cm\*38.1cm. and now the Peltier module is attached to the water block with the help of thermal paste for the four sides of and another side of the Peltier module is attached for the four sides of aluminium insulation. Now, DC power supply is connected to Peltier module and then we have to create a fluid flow circuit thorough pipes in which one end is fixed with inlet of water block and another end is fixed in the inlet water surge tank, and another pipe is fixed with outlet of water block to the outlet water surge tank in same way all four sides of refrigerator is connected. pumps are fixed to each pipe in inlet water surge tanks and the tank is fixed at top of the refrigerator. Finally, the first and second layers of insulation i.e., Iron casing and Thermocol layer should be fabricated in required dimensions.

### 4.2 Working Process

The working of this project is purely based on Peltier Module with a water block. The entire refrigeration process takes place within the cabinet of 30.48cm\*35.56cm\*38.1cm. In this project, we are using 4 Pairs of Peltier modules. Each pair of Peltier modules are attached to a single Water block. Each water block is attached to each side of the cabin. So, 4 Pairs of modules with 4 water blocks are arranged in the 4 sides of the tank. These Modules and water blocks are attached to the Aluminium cabin. We are using Aluminium material for this layer, because of its nature of highly reactant material to heat at a low price.

Whenever DC power supply 12V,6A is given to the Peltier module and pump the working fluid is supplied to the Water pockets with the aid of hydraulic pumps from the surge tank and the water pockets acts a heat sink from the refrigerator. The heat inside the Refrigerator cabin absorbs by the Peltier module and to water pockets. The working fluid which is passing through the water pockets absorbs the heat from the Peltier module and sends back to the surge tank and in this way, heat is removed and the refrigerator gets cooled.

Mainly Project depends on the selection of correct Peltier module and power supply as it varies the refrigeration effect also increases by increasing the voltage and current to a certain limit according to Peltier. For selection of Peltier Module, the following factors should be considered:

- The operating temperatures must be in the required limits
- Heat rejected by the hotter side of the Peltier module should be less than its total power capacity
- According to the volume which has to be cooled, the Peltier module should be selected
- For desiderate cooling the proper water block should be selected

## V. CONCLUSION

From this project, we can conclude that without the use of Mechanical Parts and refrigerants it is possible to cool the system. There are several different types of cooling devices available to remove the heat. But thermoelectric refrigeration plays a crucial role in its efficiency, cooling rate, low cost, and high reliability. We have been successfully designed the thermoelectric refrigerator that fulfills the objectives of our project.

However, we used water pockets instead of aluminium heat sink with cooling fans for efficient heat transfer from the cabinet and hydraulic pumps-for the efficient flow of working fluid from the surge tank to water pockets. We are concluding that the efficiency and life of the Peltier refrigerator are maximized by using these water pockets and the temperature was controllable by changing the input voltage and current so we can maintain the things in the required temperature. Finally, it has been recorded the minimum temperature i.e., 2°C in the refrigerator. In particular, it is compact, weight so it is handy for travellers to store the medical equipment and also to use in remote areas. For these reasons, it is most effective for poor people and also for travelling.

## VI. ACKNOWLEDGEMENT

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