

Mini Refrigerator Using Peltier Module

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ABSTRACT

This paper presents the design and development of a mini refrigerator based on thermoelectric cooling using a Peltier module. The main aim of this work is to study an alternative cooling method that does not use a compressor or harmful refrigerant gases. The system works on the Peltier effect, where heat is transferred from one side of the module to the other when direct current is supplied. Due to this effect, one surface of the Peltier module becomes cold while the opposite surface becomes hot. The cold surface is placed inside an insulated cooling chamber to reduce the internal temperature, whereas the hot surface is connected to a heat sink and cooling fan to remove excess heat efficiently. A 12V DC power supply is used to operate the system, making it suitable for portable and low-power applications. Temperature monitoring can be done using a temperature sensor, and control can be achieved with the help of a microcontroller if required. This type of cooling system is simple in construction, lightweight, and easy to maintain as it has no moving mechanical parts. Compared to conventional refrigeration systems, the proposed mini refrigerator is environmentally friendly and suitable for small-scale uses such as medicine storage, beverage cooling, and electronic component cooling. The experimental results show that thermoelectric cooling can provide effective temperature reduction for limited space when proper heat dissipation is ensured. This project highlights the practical use of solid-state cooling technology and its potential for future compact refrigeration applications.

Keywords: - Peltier Module, Thermoelectric Cooling, Mini Refrigerator, Heat Sink, Eco-Friendly Cooling

1. INTRODUCTION

Refrigeration plays an important role in daily life for preserving food, medicines, and other temperature-sensitive items. Conventional refrigerators mainly use compressor-based systems, which consume more power, produce noise, and use refrigerant gases that are harmful to the environment. Due to these drawbacks, there is a growing need for alternative cooling technologies that are compact, eco-friendly, and energy efficient.

Thermoelectric cooling is one such method that works on the Peltier effect. In this method, electrical energy is directly converted into a temperature difference without using any moving mechanical parts. When current flows through a Peltier module, heat is absorbed from one side and released on the other side. This makes the system suitable for small cooling applications.

The mini refrigerator using a Peltier module is designed for portable and low-power use. It is useful in places where traditional refrigeration is not practical. This project focuses on the construction, working principle, and performance of a thermoelectric mini refrigerator.

1.1 Working Principle of Peltier Module

The Peltier module works on the principle of thermoelectric effect. When DC current passes through the junction of two different semiconductor materials, heat transfer takes place. One side of the module becomes cold as it absorbs heat, while the other side becomes hot as it releases heat. The direction of heating and cooling depends on the direction of current flow.

In this project, the cold side of the module is placed inside the cooling chamber, and the hot side is connected to a heat sink and fan. Proper heat removal from the hot side improves the cooling performance.

1.2 Advantages of Thermoelectric Cooling

Thermoelectric cooling systems offer several advantages over conventional systems:

No moving parts, hence less wear and tear

Compact and lightweight design

Silent operation

No use of refrigerant gases

Easy temperature control

These features make thermoelectric cooling suitable for small refrigeration applications.

2. SYSTEM DESIGN AND COMPONENTS

The mini refrigerator system consists of electrical, thermal, and control components. All components are selected to ensure proper cooling and safe operation.

2.1 Main Components Description

Peltier Module (TEC1-12706):

It is the main cooling element responsible for heat transfer.

Heat Sink and Fan:

They are used to remove heat from the hot side of the Peltier module.

Cooling Chamber:

An insulated box made of thermocol or plastic to reduce heat loss.

Power Supply:

A 12V DC source supplies power to the system.

Temperature Sensor and Controller:

Used to monitor and maintain the required temperature.

2.2 Control and Safety Features

- To avoid overheating and excessive power consumption, a temperature sensor can be used along with a controller. A relay or MOSFET driver controls the ON/OFF operation of the Peltier module. This improves efficiency and protects the components.

3. EXPERIMENTAL RESULTS AND OBSERVATIONS

The system was tested by measuring the temperature inside the cooling chamber at regular intervals. It was observed that the temperature gradually decreased when the Peltier module was powered. Proper heat dissipation on the hot side played a major role in achieving better cooling.

Table-1: Temperature variation with time

Time (min)	Chamber Temperature (°C)
0	28
10	23
20	18
30	14

4. CONCLUSIONS

This project successfully demonstrates the working of a mini refrigerator using a Peltier module. The system is simple, compact, and environmentally friendly. Although the cooling capacity is limited, it is suitable for portable and low-power applications. With improved insulation and better heat dissipation, performance can be further enhanced.

5. REFERENCES

- [1]. D.M. Rowe, Thermoelectrics Handbook, CRC Press.
- [2]. Riffat S.B., Ma X., "Thermoelectrics: a review of present and potential applications," Applied Thermal Engineering.
- [3]. TEC1-12706 Datasheet.
- [4]. Arduino UNO Technical