iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** IV **Month of publication:** April 2022

DOI: https://doi.org/10.22214/ijraset.2022.41937

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IV Apr 2022- Available at www.ijraset.com

Peltier Air Conditioner using Peltier Effect

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Abstract: ***As we are moving towards the future the problem of global warming is emerging as one of the most important issues which concern the whole world. In recent years the world has come to a realization that if this problem is not dealt with now it will have devastating effects later. Nowadays we are experiencing the changes in the climate right before our eyes - unexpected climate change, rainfalls, Landslides, Air pollution reaching dangerous levels, melting off glaciers, Ozone Depletions, there are many such examples which are caused due to the increasing Global warming. To combat it we are switching to green infrastructure to mitigate its influence and that's where the Peltier steps in Conventional AC make use of harmful gasses like CFC, HCFC, Ferons, R22, R410A but in the case of Peltier AC, it makes use of the intrinsic property of the Peltier chips which utilizes the Peltier effect to provide cooling. One of the most important advantages of the Peltier modules is that It doesn't release any harmful gasses whatsoever. Peltier AC can be considered as the future of air cooling due to its advantage over its predecessors and can play a vital role in mitigating the problem which concerns the whole world.***
Keywords: Peltier Effect, Seebeck effect, Air conditioner, Green infrastructure, Global Warming, Peltier AC

I. INTRODUCTION

The science of controlling the parameters of the atmosphere within the desired space in terms of air humidity, the temperature of the room, Air quality according to human comfort is known as Air conditioning. Although the conventional methods of air cooling are more than sufficient to effectively provide a comfortable environment but it is not without its faults, as we are aware that these Appliances release harmful gases which have been continuously damaging the environment over the years.[7] Nowadays we are seeing the drastic effect due to these gases in form of Global warming. As an emerging alternative of cooling using Peltier technology by making use of Peltier and Seebeck effect for cooling applications. In Peltier, we make use of Peltier chips which make use of thermoelectric material to convert the electrical energy to obtain different temperatures across the two ceramic surfaces of the Peltier 12706 modules.[1] Peltier chips are solid-state devices that consist of a large no of p-n junctions(thermocouples) which are sandwiched between the two layers of the ceramics. A single thermocouple constitutes a pair of p-n semiconductor materials and together are known as a thermo-element. The arrangement of the thermocouples is such that they are connected thermally in parallel and electrically in series. These thermocouples are spread in between the two ceramic plates. [3] By making use of thermoelectric materials, electrical energy can be directly converted into thermal energy alternatively, if we give the two parallel surfaces a temperature gradient it produces electrical Potential. The direct conversion between electrical and thermal energy is made possible because of two important thermoelectric effects like the Seebeck effect and the Peltier effect. According to the Seebeck effect there always exists an electric potential when a thermoelectric material is subject to a temperature gradient. The Peltier effect refers to the absorption of heat into one end of the thermoelectric material and the release of heat from the opposite end when a current is passed through.[4]

II. THERMOELECTRIC MATERIAL

The increasing demand for an alternative that supports recovery, conversion, storage, and transfer efficiently. The thermoelectric material is promising a better alternative to the utilization of the gradient of the temperature to provide an alternative to a more sustainable and greener infrastructure which is a need of both present and the future. Some of the most common materials used for thermoelectric Peltier chips are bismuth telluride, Caesium Sulphide, and Germanium Telluride. Although all materials have a non-zero thermoelectric effect but, in most cases, it is too small to be useful practically.[3]

Table 1: Seebeck Coefficient of various thermoelectric materials

S.no	Material Description	Seebeck Coefficient
1	Germanium Telluride	1.5×10^{-3}
2	Bismuth Telluride	41×10^{-8}
3	Lead Telluride	1.5×10^{-3}
4	Caesium Sulphide	1×10^{-3}
5	Polycrystal	$1.3xe^{-5}$

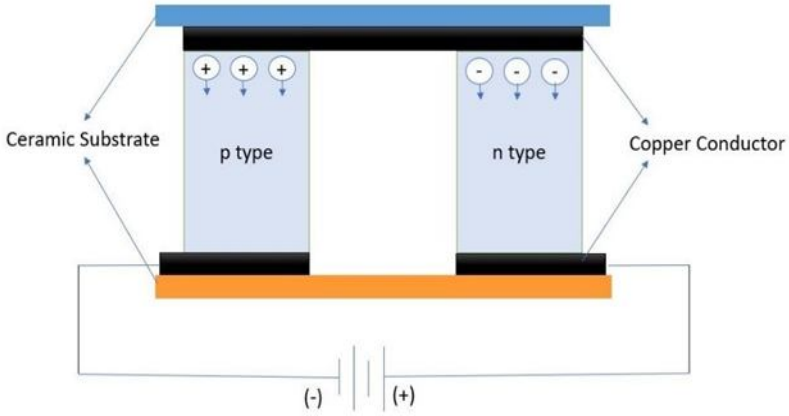

Fig. 1 Peltier Module Construction

III.MATERIAL REQUIRED

Table 2: Component Specifications

S.no	Component	Use	Specification	Quantity
1	Peltier Module 12706	To generate cooling	12V	4
2	CPU Cooler	To dissipate heat from Peltier Module	5A	4
3	120mm Fan	To exhaust cool air in Atmosphere	5A	4
4	Adapter	For DC Supply to Peltier Chip	12V	1
5	Aluminium Heatsink	To absorb cold	10”X10”	1
6	Temperature Sensor	To measure temperature	-60 to+50	1
7	Thermal Paste	To connect CPU Cooler to Peltier Module	Grade A	1
8	Aluminium Casing	For Casing	Opaque	1

A. Peltier Module

In our project, we made use of the Peltier 12706 module which works on the Peltier effect under which when an electrical current is passed through a Peltier module it produces heat on one side and cools the opposite under the influence of the Peltier effect. These modules consist of sensitive circuits which can get damaged if it stays at extreme temperature for a long period of time. An advantage of making use of the Peltier chip is it is small in size, has no moving parts, less consumption, efficient power conversion, etc. [2]

B. CPU Coolers

A CPU cooler is a single module that consists of a heat sink upon which a fan is mounted to remove heat from sensitive electronic circuits. It is commonly used in Cooling Processors to limit the temp rising beyond critical temperature. The speed range of the CPU Cooler lies between 1200 – 2800 RPM of Hydromantic Bearing Type. The CPU Cooler has a rated voltage of 12 V DC and 0.6A Current and a span area having a diameter of 180mm.

C. Fan

We made use of 120mm DC brushless fans which can operate on 12v voltage and 6A to be used to send the cooled air into the atmosphere. We made use of polypropylene fans for better durability. These are usually employed in computer cabinets to maintain continuous airflow. We have employed DC Brushless fans which employ 4 pin wires to achieve speed control.

D. Adapter

Many electronic components run on DC power but as an alternative, we can make use of an AC TO DC Adapter which can be plugged into an electrical outlet, AC adaptors are used to convert alternating current into direct current. The adapter used supports the input of 100 - 240 V AC, 50/60Hz, and provides us a stable output of 12Volt 2Amp, 24Watt.

E. Aluminum Heatsink

We make use of the aluminum heat sink for increasing the surface area of the cooled side of the Peltier chip to enhance the effect of cooling. Aluminum is chosen due to its availability as well as its inherent properties like good thermal conductivity, resistance to corrosion, and nonmagnetic nature.

F. Temperature Sensor

The temperature sensor module is used in Peltier ac to measure the temperature attained by the air conditioner while running. The temperature sensor can measure any temperature in the range of -50 to +110 degrees Celsius. The Temperature sensor uses a pair of LR44 button batteries as a power source.

G. Thermal Paste

The thermal paste is used to efficiently transfer the heat from the hot surface of the Peltier chips to the heat sink. The thermal paste we have used for cooling is of Deep cool Z3 which has a thermal conductivity >1.134 W/m-K.

H. Aluminum Casing

We made use of aluminum because of its inherent properties such as durability, flexibility, lightness of the material, resistance to corrosion, and insulating nature. Apart from its inherent properties it also has an elegant silver-white surface area which provides a very

IV. METHOD OF CONSTRUCTION

All the Peltier 12706 chips are connected in parallel to the adapter which gives a steady 12v supply. As we know Peltier chips are sensitive solid-state devices and cannot bear excessive temperature. When the Peltier chips start operating one side gets heated and the other side's temperature drops rapidly.[6] The Peltier chips may get damaged if it sustains high temperature for a long duration, hence we make use of CPU Coolers in the Peltier AC at the hot side which is connected to the heatsink which is separated by a thin layer of Thermal paste which efficiently transfers heat to the Heat sing and exhausted by the fans embedded in the CPU Cooler. The hot end cold side of the Peltier chips is separated by a metallic sheet which separated both sides from interfering with the working of the other. A big heat sink is attached to the cold side to provide more cooling area for the Peltier chips for enhancing its cooling property. The fans take the air surrounding the big heat sink and release it into the cooling space. The temperature sensor is placed beside the big heat sink to accurately measure the Temp of the cold air. The Aluminum frame is used for the cabinet to provide better separation between the exhaust and cooling side of the cabinet as well as providing an insulated case for protection against electrical discharge in case of faults.[1]

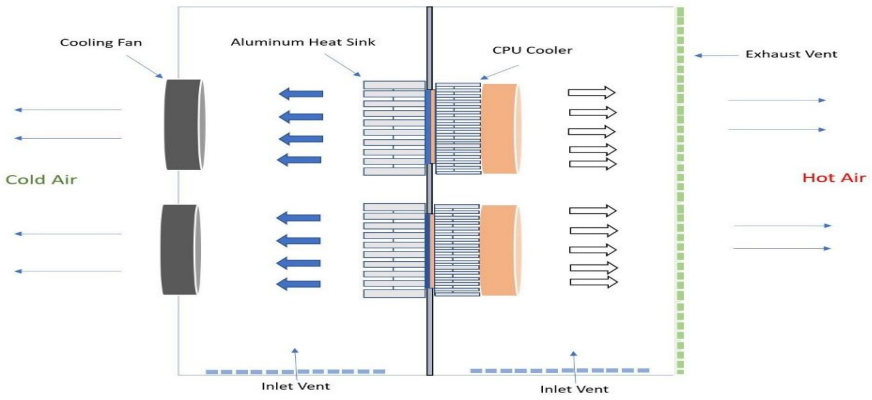

Fig. 2 Construction of Peltier Air Conditioner

V. WORKING OF PROTOTYPE

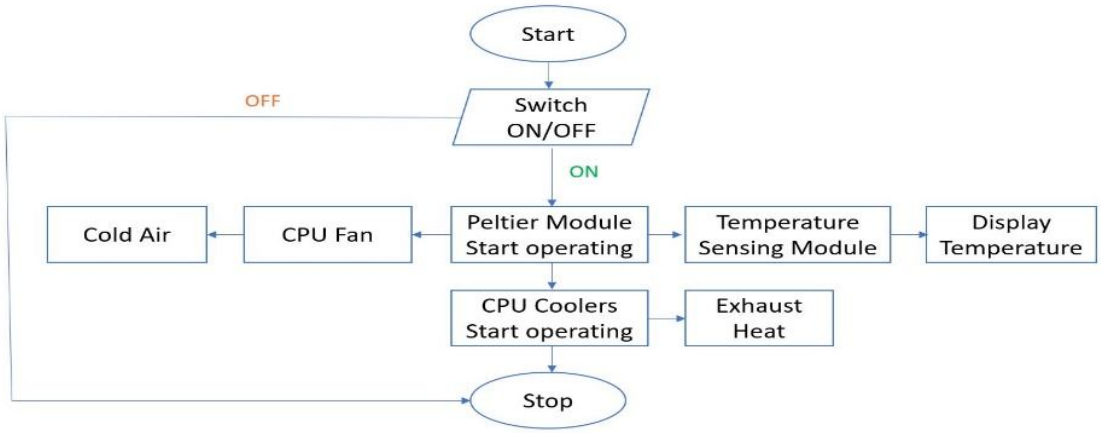

Fig. 3 Peltier Operation Flow Chart

There are two circuits used for designing of Peltier air conditioner, the first one is used to connect the Peltier chips in parallel to maintain the alignment of all the chips in such a way that all the cooling and heating sides are present on the same side. The second circuit consists of the fans and CPU coolers connected in parallel. When we power up both the circuits using an adapter the Peltier chip starts operating and generates a different temp on both sides. The fans of CPU cooler start cooling the hot end of the Peltier and the Cabinet fan starts exhausting the cold air in the atmosphere. As soon as the Peltier chip start cooling this temperature drop is detected by the temperature sensing module.[4]

VI. RESULT AND DISCUSSION

Thermoelectric coolers are slowly gaining popularity and are been readily used in a variety of uses and hold immense potential for our future. Conventional Air Conditioners needs to be replaced due to the pollutants it releases into the atmosphere. Peltier air conditioners are a very suitable and reliable alternative to the air conditioning system currently in the use. The future belongs to the Peltier Technology which and is yet to achieve its peak.

VII. CONCLUSION

Peltier Air Conditioner finds a wide range of both domestic and industrial applications owing to their silent operation, lesser power consumption, faster operation, and absence of any moving parts and with further ongoing research, the day is not far when conventional ACs would be a thing of the past. Also due to the increasing trend of electric vehicles these days, Peltier-based air conditioning can be suitably implemented in both conventional and new-generation electric vehicles which will not only help in cutting down power consumption but also augmenting engine performances, thus aiding in bringing a revolution in the automotive sector.

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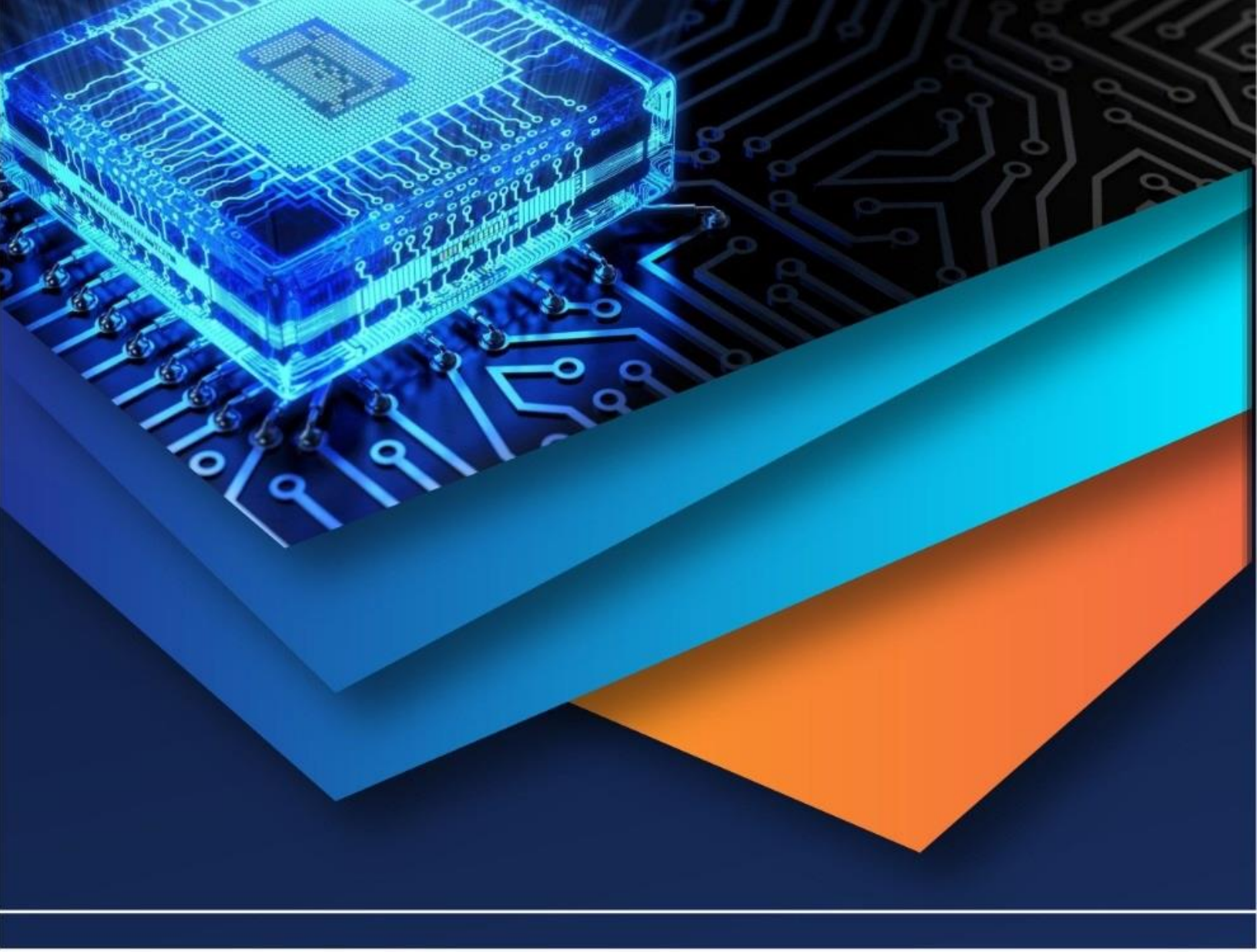

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