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Air conditioning using Peltier effect

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ABSTRACT

The current air-conditioning system does cool by refrigerant gases such as Freon, CFCs, etc. While these refrigerants provide good output, their major disadvantage is the emission of harmful gases that damage the ozone layer. A way to overcome this issue is by making use of air conditioners that use thermoelectric modules for cooling, which work by Peltier effect. These models do not emit any harmful agents, thereby protecting the environment. This project discussed in the paper deals with the study of those thermoelectric air conditioners using Peltier module. Conventional compressor run cooling equipment have more limitations related to energy efficiency and Chloro-Fluro Carbon (CFC) refrigerants use. Both these factors indirectly point to the impending scenario of global warming. As most of the electricity generation relies on the coal power plants, which add greenhouse gases to the atmosphere is the more cause of global warming. Thermoelectric air conditioners have multiple advantages over conventional air conditioners, like, they are smaller in size, they weigh less, have high reliability, have no mechanically moving parts and no working fluid. This paper focuses on a Peltier Based Air conditioner which will be easily potable.

Keywords— *Chloro-flouro carbon, Die-electric Semiconductors, Peltier Effect, Seebeck Effect, Thermoelectric Module*

1. INTRODUCTION

Air Conditioning is the science of controlling primarily three parameters of human comfort, temperature, relative humidity and air quality. Air conditioners, dehumidifiers and evaporative coolers serve the purpose however air conditioners are termed expensive and coolers prove ineffective in humid conditions. The study conducted in the work aims at developing a Peltier operated air cooler coupled with a dehumidifier to achieve dual objective of dehumidification and sensible cooling. The work aims to performance testing of Peltier operated air conditioner for indoor cooling. The desired design is intended to provide a good alternative to present Air Conditioners which consume sufficiently high electricity with very large initial investment.

The Peltier effect thermoelectric coolers operate according to the Peltier effect. By transferring heat between two electrical junctions it creates the temperature difference. A voltage is applied between joined conductors to create an electric current. When the current flows through the junctions of the two conductors, heat is removed at one junction and cooling occurs. Heat is deposited at the other junction. The main application of the Peltier effect is cooling. However the Peltier effect can also be used for heating. In both cases, a DC voltage is required.

Cooling effect occurs when the current passes through one or more pairs of elements from n-type to p-type; there is a decrease in temperature at the junction ("cold side"), resulting in the absorption of heat from the environment. The heat is carried along the elements by electron transport and released on the opposite side as the electrons move from a higher-energy state to lower energy state. The Peltier heat absorption is given by

$$Q = P^* I^* t.$$

Where P is Peltier coefficient, I is current and t is time. A single stage thermoelectric cooler can produce a maximum temperature difference of 70°C.

2. LITERATURE REVIEW

Matthieu Cosnier presented an experimental and theoretical study of a thermoelectric air-cooling and heating system. They have reached a cooling power of 50W per module, with a coefficient of performance between 1.5 and 2, by supplying an electricity of 4A and maintaining the 5°C temperature difference between the hot and cold sides.

Wei He presented Numerical study of Theoretical and experimental investigation of a thermoelectric cooling and heating system driven by solar. In summer, the thermoelectric device works as a Peltier cooler when electricity applied by PV/T modules. The minimum temperature 17-degree C is achieved, with coefficient of performance of the thermoelectric device higher than 0.45. And comparing simulation result and experimental data.

Riff and Guoquan Conducted an experimental study of thermoelectric air conditioners versus vapour compression and absorption air conditioners. Three different types of domestic air conditioners are compared and compact sized air conditioner was fabricated. Astrin, Vian & Domınguez conducted an experiment on the coefficient of performance in the thermoelectric cooling by the optimization of heat dissipation. In thermoelectric cooling is based on the principle of a thermo syphon with phase change is presented. In the experimental optimization phase, a prototype of thermo syphon with a thermal resistance of 0.110 K/W has been developed, dissipating the heat of a Peltier pellet with a size of 40*40*3.9 cm, experimentally proved that the use of thermo syphon with phase change increases the coefficient of performance up to 32%.

3. DESIGN OF THE PROJECT

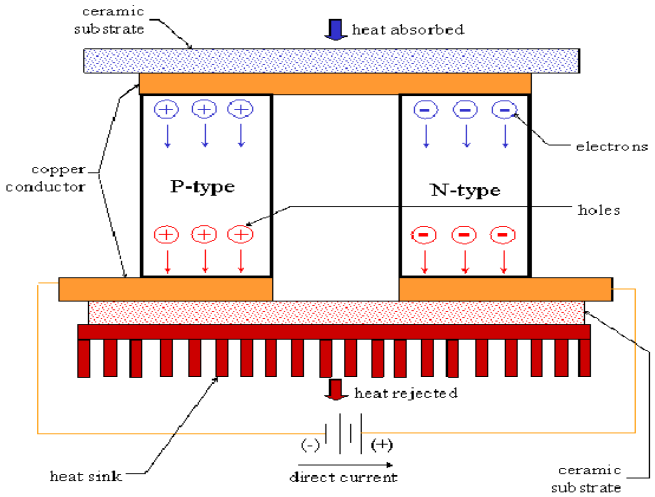

Fig. 1: Schematic diagram of the model to be made

Two semiconductors, one n-type and another p-type has been used because of the difference in the electron densities. The semiconductors are placed thermally in parallel to each other and electrically in series and then joined with a thermally conducting plate on each side. When a voltage is applied to the free ends of the two semiconductors, there is a DC current flow across the junction of the semiconductors causing a temperature difference. The side with the cooling plate absorbs heat and transfers to heat sink. Thermoelectric coolers are placed between two ceramic plates. The cooling increases with increase in the thermoelectric modules.

4. RESEARCH METHODOLOGY

The research Methodology of this paper focuses on the basis problems encountered during the research of the project and the solutions of overcome them.

4.1 Air conditioning system using Peltier effect targets on the following issues

It was observed that the conventional system of air conditioning is Heavy and Non-Transportable. The portable coolers don't provide with air conditioning with great temperature differences but just and adequate environment. Air Conditioners need separate electrical connections to be made, in order to distribute the load efficiently. Air conditioners use compressors and refrigerant which are more complex to design.

4.2 Aim of this research:

The main of this research is to come up with a solution that is light weight, portable and very easy and safe to move around. To come up with a solution that is not only portable, but also provides with a cooling effect that is pleasant for human satisfaction and to develop a prototype that doesn't requires any sort of separate electrical connections to be made, rather, it can be plugged directly into the power supply are the prime objectives of this research. This paper also focuses on developing a prototype that is easy to maintain and doesn't requires complex designing or production process.

4.3 Approach Towards the Problem

A solution to all the above-mentioned problems is follows:

Air Conditioning using Peltier Effect, which includes the use of Peltier modules and the primary cooling element and water as the secondary refrigerant. When Peltier module is provided with voltage difference, it develops temperature difference of both sides. The heating side can be attached to the heat sink for heat dissipation. Cool side can be attached to a water cooling system which

results in cooling down the water temperature to a considerably low temperature. This cooled water can be used to cool the surrounding by blowing air over it using a blower and a piping system.

5. DESIGN AND DEVELOPMENT OF THE MODEL

This article covers all the details about the construction of the prototype of Air Conditioning Unit using Peltier Modules.

5.1 Method of construction

All the Peltier Modules are connected to the 12v Power supply module in parallel. 2 heat sinks are placed on top(heating side) of 4 Peltier each and attached using thermal paste for efficient heat transfer. Water cooling case is attached at the cooling side of the Peltier's. Cooling case is attached to the heat exchanger. Exhaust fans are assembled over the heat exchanger for blowing of air over the heat exchanger. Temperature sensor is installed at appropriate position for temperature measurement. Acrylic is used to make the case of the Prototype to keep it safe and portable and also so that the process is clearly visible to everyone.

5.2 Materials required

Sr. No.	Component	Qty.	Specification	Use
1	Peltier Module	6-8	12V Module	To create Temperature Difference
2	Heat Sink	2	8cm x 8cm	For heat dissipation
3	Exhaust Fan	2	12V Fan	For Air Flow
4	Power Supply Module	1	12V Power Supply	To maintain 12V voltage
5	Water Cooling Case	1	Brass	To carry away heat
6	Air – Water Heat Exchanger	1	12" x 12"	For heat transfer between air and water
7	Pump	1	Appropriate Head	To create circulation of water
8	Temp. sensor	1	-10C to +50C	Temp. measurement
9	Acrylic	1	Transparent	For Casing
10	Thermal Paste	1	Grade A	For connection of Peltier to heat sink

5.3 Design of the prototype

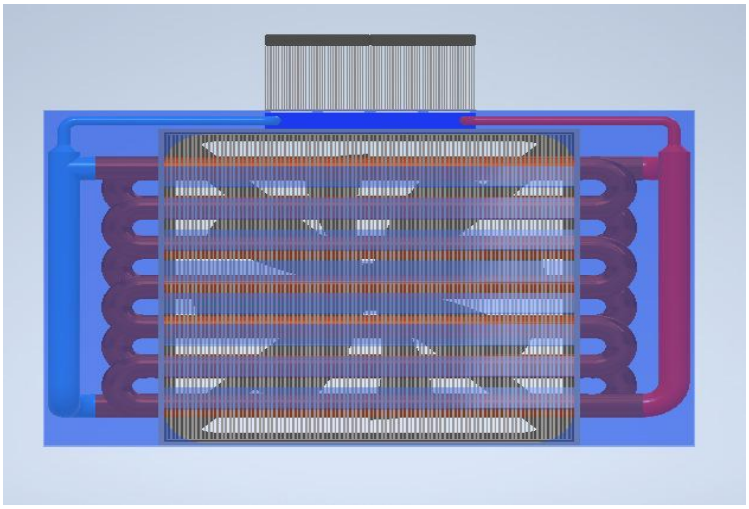

Fig. 2: CAD design of the proposed project

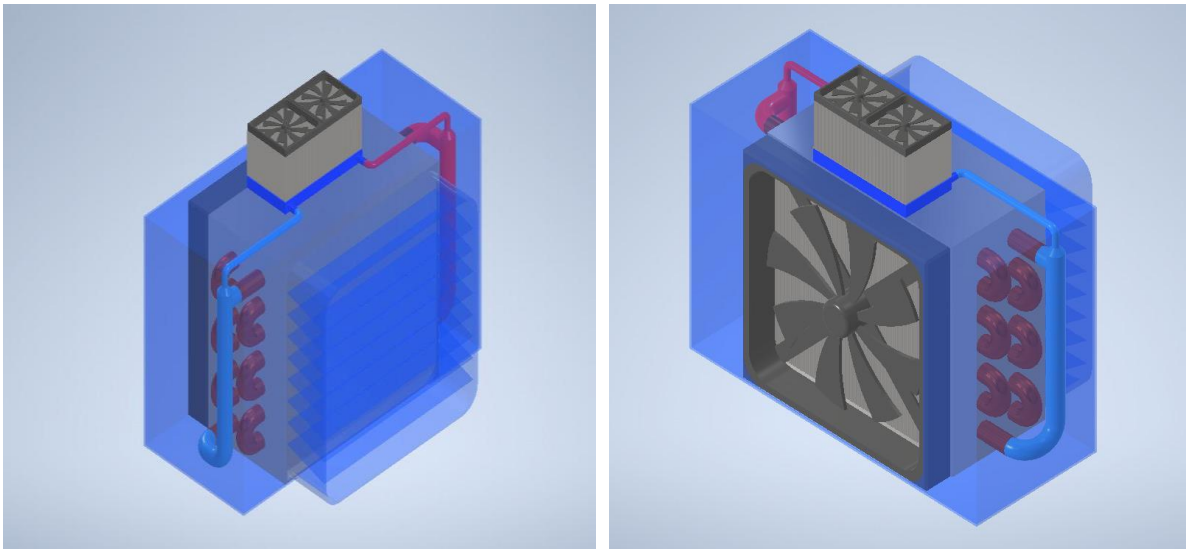

Fig. 3: Isometric Views of the Model

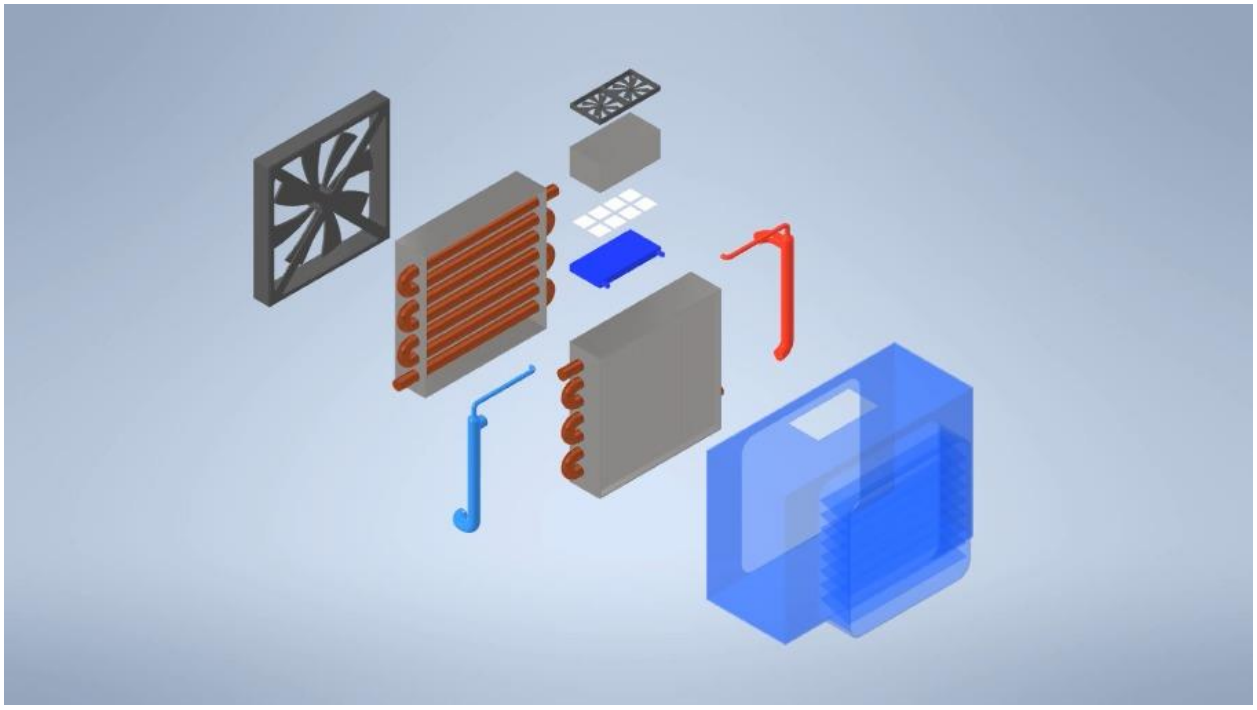

Fig.: Exploded View of the Model

5.4 Components of the Model

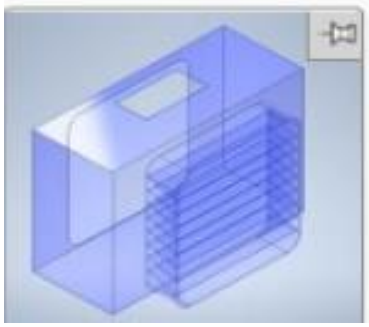

Fig. 4: Body

Fig. 5: Connector (L.H.S.)

Fig. 6: Connector (R.H.S.)

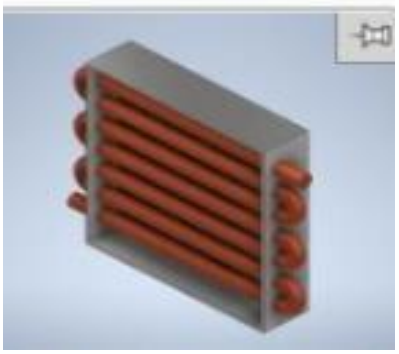

Fig. 7: Heat Exchanger

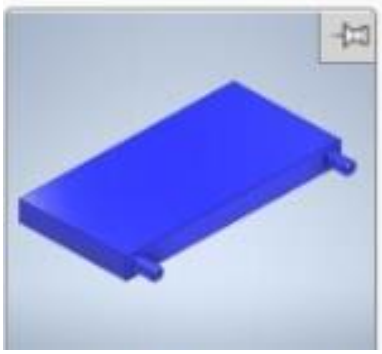

Fig. 8: Cooling Case

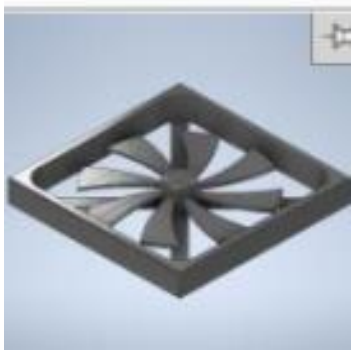

Fig. 9: Fan (Top)

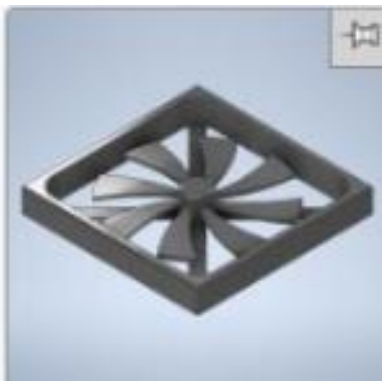

Fig. 10: Fan (Back)

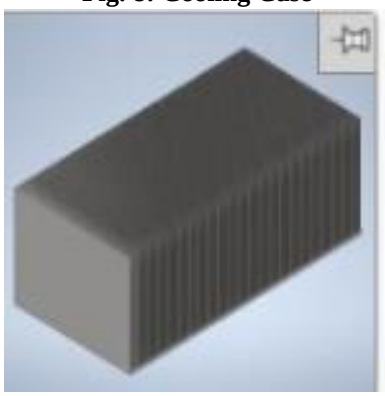

Fig. 11: Heat Sink

Fig. 12: Peltier

6. RESULTS

The following results can be expected from our Project Air Conditioning using Peltier Modules which is discussed in this paper:

The Air-Cooling Unit Test can obtain the following results. Table 1 shows the Temperature of air and water before and during the Test. The temperature of air in the Ambient condition, after the Dehumidifier and after the Heat Exchanger are to be noted. Test will be conducted using Normal Tap Water and Cold Water.

Table 1: Effect by using Tap Water

Sr. No.	Description	Temperature (°C)
1	Ambient Air Temperature	~25
2	Temperature at the outlet of Air Conditioner	~32
3	Temperature of water in tank before operations	~24
4	Temperature of air coming out of Heat Exchanger	~26

Table 2: Effect by using Cold Water 13°C

Sr. No.	Description	Temperature (°C)
1	Ambient Air Temperature	~36
2	Temperature at the outlet of Air Conditioner	~40
3	Temperature of water in tank before operations	~13
4	Temperature of air coming out of Heat Exchanger	~25

7. APPLICATIONS OF THE PROJECT

To achieve the goal that in spite of using harmful gas, the project works on simply electricity and uses minimal amount of electricity as compared to modern air conditioner is the main objective of this models discussed in the paper It will find its application in electronics cooling etc. But there is a huge scope of research in this field of improvement about thermoelectric materials, its fabrication, heat sink design etc.As electrical vehicles are the trends of today, peltier based air conditioners will find its application in electric vehicles as well as conventional vehicles, thereby reducing load on the engine and will bring revolution in the entire automobile industry air conditioning system.

8. CONCLUSIONS

This Portable Air Conditioning System discussed in this paper can be used in dual mode operation, heating and cooling. This system achieves minimum temperature 16 Degree Celsius and maximum around 40 Degree Celsius and maximum voltage occurs in about 30 minutes. For future development, this system can be used as a replacement for conventional air- conditioning systems that use coolant that can be harmless for humans in the long term. there is a huge scope of research in this field of improvement about thermoelectric materials, its fabrication, heat sink design etc.

In future, a thermoelectric module-based cooling can cool 10x10 rooms with only a few modules in a very less time. The Peltier module will prove sufficient in air conditioning for indoor applications as desired. Peltier effect has an efficiency of around 10 – 15% compared to the refrigerants 40 – 60 % efficiency. 70 °C temperature difference of heat absorption can be obtained using Peltier Effect. More thermal mass of the sink is generally good for the efficiency of the effect in air conditioning Air conditioning operation can be controlled by a boost converter which controlled the current supplied to manage temperature differences. Air conditioning work or efficiency can be improved by creating electricity from the temperature difference with the application of Seebeck effect.

From all the above discussions, it can be seen that thermoelectric module cooling is more advantageous than the conventional air conditioner.

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