Thermoelectric Refrigerator by Using Peltier Effect

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ABSTRACT

As we know that refrigerator and air conditioners are the most energy consuming home appliances and due to this many researchers had come up with plenty of researches in this field to overcome these issues, so we have come up with thermoelectric refrigerator as an advancement in this field. It has resolved the problems of power consumption, cooling performance, vibrations and maintenance. It has been proved to be one of the finest advancement in this scenario, which has overcome the above mentioned issues.

Keywords: Refrigeration, Thermo-electric Cooler Module, Peltier Device etc

I.INTRODUCTION

The fundamental segment of this framework is the "Thermoelectric Cooler Module". The module operates by the Peltier Effect". The device has two sides, hot and cold and when a D.C. electric current flows through that module, it brings heat from one side to the other, so one side gets cooler and the other side gets hotter. The hot side is attached to a heat sink so that it remains at ambient temperature whileone goes below room temperature. Thermoelectric cooler modules consist of an array of p-type and n-type semiconductor elements that are heavily doped with electrical carriers. The elements are arranged into array that is electrically connected in (parallel) series and thermally connected in parallel. This array is then affixed to two ceramic substrates, one on each side of the elements.

II. LITERATURE REVIEW

There were many researchers conducted researches on thermoelectric refrigerator some of which are:

RESEARCHER	RESEARCHES
Manoj KumarRawat*et al. [Feb- 2013]	The researchers did an experimental study of comparing novel potential green refrigeration and air-conditioning technology. They are enumerating the cause and effect of air conditioning and came to the result that thermoelectric cooling provides a promising option for R&AC technology. They concluded that thermoelectric cooling is generally 5-15% as efficient compared to 40-60% conventional compressor cooling.
Kirti Singh* et al. [April-2015]	The researchers carried out the work on the development of portable cooler cum heater that utilizes solar energy with the use of thermoelectric module and photovoltaic module for generation of energy which could be further used for cooling and heating effect. They concluded that thermoelectric cooler serves the purpose of pumping heat and its misuse can heat up the CPU instead of cooling it down. Thermoelectric cooler needs to have high heat capacity.
Meghali Gaikwad* et al. [Mar-2016]	The researchers carried out the work on the development of thermoelectric R&AC system. They compared the cost and efficiency of vapour compression, thermoelectric absorption refrigerator. They concluded that vapour compression system was the most energy efficient as well it has the lowest operating and purchasing cost.
G. Lavanya* et al. [Oct-2016]	The researchers carried out the work on the development of cooling and heating of refrigerator jacket by using peltier effect. They came on the conclusion that the cooling jacket is able to deliver a cooling air temperature of 18^{o}C in static condition, this result was obtained in the period of 20 min.
Vivek Vaidya* et al. [2017]	The researchers carried out the work on thee experimentation of thermoelectric refrigerator using solar Solar energy for cold storage application. They concluded that the refrigerator can be used onlyfor light load to lower its temperature to a particular temperature. Further the system is unable to handle fluctuate in load.

Dr. S. Sreenath Reddy* et. al [April-2019]	The researchers carried out thee work on design and fabrication of thermoelectric refrigerator using germanium and its alloys. They concluded that thermoelectric refrigerator with interior Cooling volume of 0.0258 m^3which is far better in comparison to conventional refrigerator.
Harvind Yadav* et al. [Apr 2019]	The researchers carried out the work on thermoelectric refrigerators with multiple modules. They concluded that thermoelectric refrigerators are compact and consumes less energy Which use of renewable energy resources such as solar, tidal, wind power, medical uses etc.

The main purpose of using thermoelectric refrigerator is it's eco-friendly behaviour, cheap, compact, better cooling performance and it has low running cost as compared to conventional refrigerators. A thermoelectric refrigerator is light in weight and hence easy to car.

III. OBJECTIVE:

The objective of this research is to design and develop a device named Thermoelectric Refrigerator, which operates on peltier effect that produces maximum cooling with minimum power consumption and thus enhancing its efficiency. Moreover, it also requires less maintenance and has a low running cost and has a pollutants free behaviour.

IV. COMPONENTS

A. DC Battery:

It is a device which converts chemical energy into electrical energy with the help of a chemical reaction. It produces direct current electricity which flows in one direction and does not switch back and forth. Batteries are classified into primary and secondary type.

Fig1: DC Battery

B. Acrylic Sheets:

These are transparent thermoplastic frequently used in the form of sheets as a lightweight or screed-resistant alternative to glass. This material can also be used as a casting resin in inks and coatings and many more. It has low cost and thus it is used in a variety of fields.

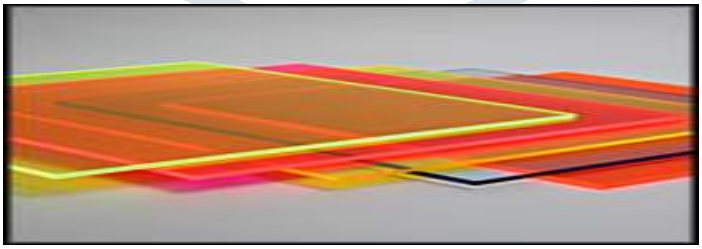

Fig 2: Acrylic Sheet

C. Heat Sink

It transfers the heat generated by the electronic/mechanical device to the fluid medium from where the heat is dissipated out of the system. Heat sink is often termed as a heat reservoir which absorbs some amount of heat from the system without changing the significant temperature.

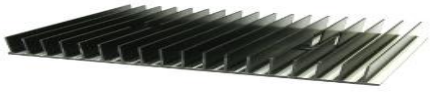

Fig 3: Heat Sink

D. Insulation Material

For effective cooling, we have insulated the sides of the device with thermocol or foams. It reduces the chances of emission of carbon dioxide and other greenhouse gases which turns out to be a major cause for the ozone depletion and other environment related problems.

Fig 4: Insulation Material

E. Plastic Tubes:

It transports the water from the sump to the peltier device; one end of the tube is connected to a section attached to the peltier. Even in most of the applications they serve the purpose of insulating the walls or sides of the body and thus prevent condensation, corrosion.

Fig 5: Plastic Tube

F. Peltier Device

These are the devices used for cooling below the ambient temperature at a specific temperature by controlled cooling/heating. It works on the phenomenon of peltier effect. This device uses electrical energy for transferring heat from the other side.

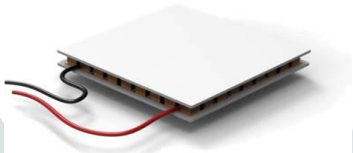

Fig 6: Peltier Device

G. DC Fan

This device is used to create a flow within the fluid. It operates using battery or some other power source. It has vanes/blades to which acts on the fluid. These are pretty noiseless and offer the choice of regulating the speed according to the requirement.

Fig 7: DC Fan

V.MECHANISM USED

V.1 Thermocouple:

It is based on Seebeck Effect. According to Seebeck Effect if two different metals are joined to form two Junctions and if these junctions are maintained at different temperature then an emf is generated which is directly proportional to temperature difference. Emf is thermometric property.

V.1.1 Peltier Effect:

It is opposite of Seebeck Effect i.e. when an emf is applied to two joined conductors to create an electric current which when flows through the junctions of the two conductors, heat is dissipated at one junction and cooling occurs. This heat is collected at other junction.

VI.METHODOLOGY

Using the dimensions of any material (e.g. Coke can), we would need 6 sheets, and few extra sheets for different compartments.Cutsheets using Rockwell blade runner/inverted jigsaw. Measure the dimension of cold side plastic radiator and mark the outlines on the sheet and drill a hole in the marked area. Cut the marked/outlined portion from the sheet and glue the module with the sheet. It's optional to paint or not. To dissipate out the heat from the heat sink of the cooler, we make holes on the sheet and put it in front of the heat-sink portion. The size of the circular hole should be same as the size of the fan. Keep any side wall on table and measure the length of the cooling side and mark a line for separation between the two sides. Applying hot glue and place the separator sheet. Glue the two side walls to the earlier made structure. The heat sink along with fans is really heavy, as this glued part may come off from the sheet, so we provide support at its base using foam/thermocol sheet. In the back panel, we have installed one switch, LED, DC I/P jack. By making slots of their sizes and placing them in and glue them to the sheet.We soldier two wires to DC I/P and two wires to LED (resistor + and -). Cut the two wires for power supply to Peltier module. Cut small strips of sheets and glue them to the side walls and leave some space between them and the insert the tray. In the lower part, the heat sink and fans are there and in the top part electronic circuit is there and same procedure for cold side compartment. Forimproved cooling effect, we glue foam boards on acrylic surface. Using acrylic protective paper for the door and mounting the hingeand handle by super glue. Glue the foam board strips in the door border area. For controlling the temperature, we will use "Arduina"which has waterproof temperature sensor. If the temperature falls below 3^{o}C, a relay will cut out the supply and when the temperaturereaches 7^{o}C, again the cooler unit will be switched "ON". This will maintain the refrigerator temperature and will save a lot of power.These sheets are slippery, so attach 4 anti-skid rubber

VII.DESIGN

The design of the thermoelectric module is created with the help of the Solid Works software for the proper and efficient analysis of the respective module design. The gives option of analyzing the problems related to the design and provides us the solutions to overcome them and come up the best efficient module design possible.

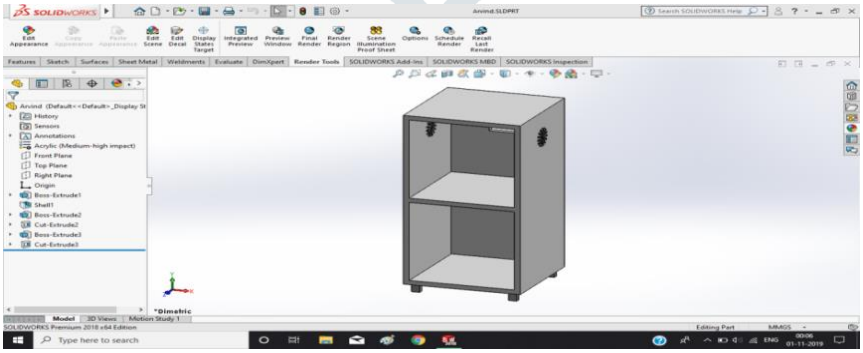

Fig: Solid works Design of Interior of Refrigerator

VIII.EXPECTED OUTCOMES

For sustainable and production which is very profitable, efficient cooling system is required in the metal cutting industry, new cooling strategies are necessarily required with the hike of demands on machining. Thermoelectric cooling is one such system which has a new cooling strategy and it competes with the existing conventional cooling systems. Due to increase in friction

during the machining process there are problems like decreased surface finish of workpiece and reduction of tool life. Designing of thermoelectric refrigeration to cool the coolant before introducing it on workpiece is the better way to facilitate ease of experimentation on selected lathe machine. Further, it can be used as a multi-purpose device as the heat coming from the device can be used to hot objects placed in the separate insulated chamber, due to which it might be called as "Thermoelectric Refrigerator Cum Oven".

IX.CONCLUSION

On the basis of the study of all the researchers in thermoelectric refrigeration, it has been seen that this device has a great scope in future. It offers many advantages like compact size, noiseless and provides high quality temperature with less power consumption. Since thermoelectric refrigerator has covered all the major areas of application except the manufacturing and production. Hence it can be concluded as an innovative idea of using this device as an alternative to cool the coolant which will help in reducing tool wear, improving surface finish and tool life.

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