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Development of Thermoelectric Air Cooler

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Abstract-
Cooling can be defined as the process of obtaining and maintaining a temperature below that. Natural air cooler is available at low cost but the reduced temperature is therefore very small. Reducing the temperature of the air conditioner is used. In the normal cooling process used refrigerators may cause environmental pollution due to the production of CFCs, which may cause health problems such as dizziness, headaches, irritation of the eyes and other environmental effects. To reduce pollution and achieve effective cooling such as conventional air conditioners, we are introducing a new type of thermo-electric cooling system using thermo-free cooling modules such as air-conditioners and chlorofluorocarbons. The main purpose of this current work is to design and make a thermoelectric air cooler in which 4 liters of water is used to cool the air and create a cooling effect. It works with a sufficient amount of power supply. The desired design is intended to provide an alternative to Air Conditioners that are powerful enough for a very large initial investment. We can extend this project to commercial purpose by increasing the volume of thermoelectric modules and machine size.
Keywords: Fans, Forced Convection, Peltier Module, TEC (Thermo-Electric Cooling) etc.

1. Introduction

A thermoelectric cooler (TE), sometimes called a thermoelectric module or Peltier cooler, is a semiconductor-based electronic component that acts as a small heat pump. By using a DC power source low in the TE module, the heat will be transferred through the module from one side to the other. The surface of one module, therefore, will be cooled while the different faces are heated simultaneously. If a single-stage thermoelectric module is placed in a heat sink stored at room temperature and the module is connected to a suitable battery or other DC power source, the "cold" side of the module will cool down. At this point, the module will be pumping almost no heat and will have reached its maximum limit of "Delta T (DT)." If the temperature were gradually increased on the cold side of the module, the cold temperature would rise steadily until it finally equaled the temperature of the heat source. At this point TE cooling would have reached its maximum "heat pump capacity" (Q max). Seebeck, Peltier, and Thomson Effects, as well as a few other events, form the basis of effective thermoelectric modules.

The practical principles on which modern thermoelectric coolers are based actually date back to the early 1800's, although commercial TE modules were not available until around 1960. The first significant discovery related to thermal energy occurred in 1821 when the German scientist, Thomas Seebeck, discovered that electricity would flow continuously in a closed space made up of two different metals as long as the metals are stored at two different temperatures. In 1834, French watchmaker and temporary physicist Jean Peltier, while investigating the "Seebeck Effect," discovered that there was something wrong with the thermal energy that could be absorbed from one metal joint and extracted from another source where electricity was strong. flowing inside a closed circuit. At the time, however, these events were still regarded as laboratory interests and had no practical application. In the 1930's, Russian scientists began studying one of the first thermal power plants in an effort to build power generators for use in remote areas of the country.

2. Objectives

It is important to note the key aspects of the project and the final outcome of the project. Therefore, it is important to clearly state and accept the purpose of the project. In all this work, these are the objectives that will illuminate this thesis;

• An in-depth study of the air conditioning system for both good and bad.
• Exploring various technical options for changing the existing air conditioning system.
• Study TEC instead of the current air conditioning system that will overcome all the problems of the current air conditioning system.
• Build an operating model for the air conditioning system using TEC.
• Check the air conditioning system using TEC for its efficiency, efficiency, environmental friendliness, comfort and convenience.

3. Structural Diagram

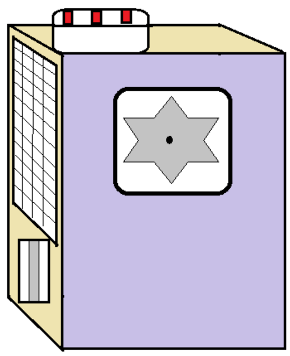

Fig. 1. Structural Diagram

The performance of a TE cooler is similar to that of a standard cooler. Normal cooling water is distributed without cooling but in this TE cooler water cooled by the setting of the Thermo electric cooling module, this cooling water is distributed over the cooling pad with the help of a pump installed in an aluminum container, for us. the effect of cooling more by circulating cooler water. In the cooling pad of cooling water and warm air from the atmosphere by indirect contact. On the cooling sheet the heat is removed from the air and the cooling air is blown out with the help of fans or blowers.

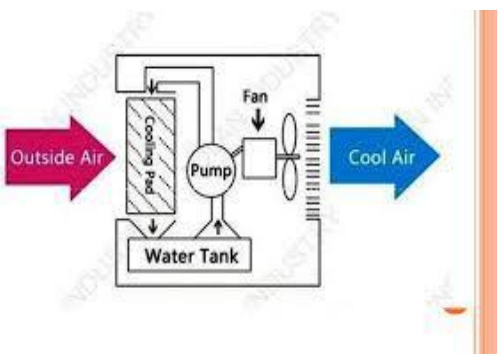

Fig. 2. Experimental Diagram

The test setup shown in Fig. 1 contains the following sections:
1. Thermo Electric Module
2. Heat sink,
3. Protective material,
4. Aluminum Sheet and Block,
5. Anabond Paste,
6. Honey Comb
7. MS ubakaki,
8. DC fan,
9. DC Pump
10. Exhaust Fan.

4. Thermoelectric Module Selection

Selecting the appropriate TE Cooler for a specific system requires an inspection of the entire system in which the cooler will be used. In most systems it is possible to use a single standard module configuration while in some cases a special design may be required to meet the rigid electrical, mechanical, or other requirements. Table 1 shows the specifications of the module we used in this project to build the TE cooler. Provides details such as voltage, current, module resistance and power requirement as well as the temperature difference of the heat sink and the cold side of the module.

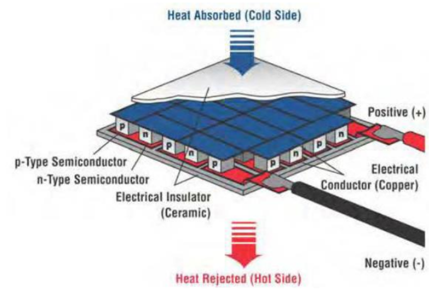

Figure 1. A Cutaway of Thermoelectric Module

Table 1 Module Specifications

MODEL	TEC 1 12706 MODULES
Q_{MAX}	**60** Watts
Δ_{MAX}	**70** ^{o}C
I_{MAX}	**6.1** Amps
V_{MAX}	**15.9** Volts
Resistance	**2.05** Ohms

5. Other Components of Air-Cooler

Table 2 shows an aluminum container designed for 4.5 lit capacity. It is made of aluminum due to its low weight and high thermal conductivity. The container is prepared with a 1.2mm thick aluminum sheet through the TIG welding process. The module, heat sink and DC fans will arrange this container. For this purpose a 24.5 mm thick aluminum block should be arranged at the bottom of the container.

Table 2 Details of Aluminum Container.

Table 2 Specifications of Aluminium Container

CAPACITY	4.5 LITRES
MATERIAL	ALUMINIUM
SIZE	300X 100 X 150 (mm)
THICKNESS	1.2 mm
THERMAL CONDUCTITY	205 W/mk

The fabricated part of the thermo electric cooler is shown in Fig. 2, which includes Aluminum container, heat sink, TE modules and fans as well as cooling pad and cooling pump. Details of the external body are shown in Table 2.

Fig. 2 Pictorial View of TE Cooler

6. Calculation

Here model no. is -12706 , which indicates its maximum voltage 12V and maximum current 6A. These values are theoretical but in actual it is found that maximum voltage will be around 11.06 V and maximum current be 5.27A. For the sake of calculation we take the theoretical values. Therefore, we find the resistance to be 2Ω(ohm) but in actual it is around 2.1Ω. As the main motto of this research paper is to dissipate the heat to achieve the optimum cooling. So, we here only calculate the heat emission from the hot side.

$$Qem = \alpha ITh - \Delta T/\theta + .5I^2R$$

For example, if we take , $\Delta T = 40°\mathrm{C}$ R=2Ω ,we get the total heat emission to be 21.33 W. As we are going to increase the temperature difference the heat emission will increase according to the equation. Hence, it is proved that the Peltier Module is efficient in lower thermal gradient. In this experimental setup , Peltier Module is attached with voltage controller whose resistance is found to be 0.24Ω when applied to 220V AC to 24V,6A DC . So, accordingly heat emission will also increase.

Table 3: Calculative Values

Hot Side Temperature	Cold Side Temperature	ΔT	Heat Emission (Qem)
60°C	20°C	40°C	21.33W
80°C	10°C	70°C	21.44W

Hot tank is made up of GI Sheets and sand filled , we calculate the heat transfer rate of both the material in order to get the proper arrangement . After calculating we get the heat. transfer rate of sand with GI Sheet is 6.61 W. The surface area of the hot tank is found to be .025 m2 multiplied by heat conductivity of sand and GI Sheet we get the heat transfer rate.

We see that the heat transfer rate of the system is lesser than the heat emission rate of the peltier module. So to combat with this problem we apply thermal paste.

$$Q = KA(Th - Tcold)/D$$

Table 4: Calculation After Thermal Paste Application

ΔT	Heat Emission (Qem)	Heat transfer rate(Q)
40°C	21.33 W	10.27 W
70°C	21.44 W	10.63 W

7. Design Optimization

In the previous design there was a separate cold tank and casing of fan but in the new one a combined chamber for cold tank with fan casing is to be made so that it can withstand the vibration during motion of fan and no separate joining is required and no chance of effective loosening of the joints. Apart from that a honey comb structure is to be made alongside the casing of fan to absorb the moisture of the air which increase the degree of comfort. Moreover, An outer cover is made covering the hot tank and other static components. All the electrical wiring is covered properly to avoid accidents. Proper coating of the material is needed for effective heat insulation of the hot tank. And all the electrical connections are taped to provide effective shock proof cooler in case of any emergency.

8. Advantages

We believe that thermoelectric cooling offers fewer benefits than traditional cooling methods:

1. No moving parts, eliminating vibrations, noise and wear issues.
2. No Freon cooler or other liquid or gas is required,
3. High reliability and durability.
4. Size combined with low weight,
5. Low cost compared to high impact,
6. Eco-friendly C-Pentane, CFC free installation
7. The cooling unit becomes a heater by reversing the current mode.

9. Disadvantages

1. COP is lower than traditional refrigeration systems.
2. Only suitable for low cooling capacity.

10. Conclusion & Future Scope

Thermoelectric coolers are used to remove heat from two watts to a few thousand watts. It can be used for a variety of purposes such as a small refrigerator as large as a submarine. Although TECs are low in health, and their cooling capacity is measured by changes in their AC resistance. But the findings of a product designed in such a way showed a trend that cooling often decreases to higher temperatures which results in the loss of high temperature performance. With the additional problem arising in producing a completely leaky area that is almost impossible for a device with a long cycle while thus leading to certain mechanical problems thus the state of operation of the project is still in the process of being developed due to problems. in production. The following is the future scope of the project:

• Rust-resistant materials for me selected for easy use of materials such as used aluminum sheets.

• The need for the development of a highly efficient thermal cooling system to extend the COP of current equipment to compensate for losses in operation at high temperatures.

• A powerful COP connected to a power controller to increase cooling temperature change with a system power switch.

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