Review of Thermoelectric Air To Air Cooling For Cars

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Abstract: **-Today, an automobile is a necessity for everyone. For a long or short journey people need car regard to the safety, environment and most important comfort. Owing to these reasons, many vehicles are equipped with heating, ventilating and air conditioning system. In today's world, no one feel comfortable in a vehicle without HVAC system. Therefore, HVAC becomes an integral part of human life. Today's present HVAC system is very efficient and reliable but it has some demerits. It has been observed during the last two decades that the O3 layer is slowly destroyed because of the refrigerant (CFC and HFC) leakage to atmosphere.**

Other demerits include. The compressor is driven by the crankshaft of the engine. So it consumes about 5 to10% power of the engine. The cost of present HVAC system is very high; Maintenance and repairing cost of this system is very high.

So to overcome these demerits by replacing the existing HVAC system by newly emerging thermoelectric couple or cooler. This works on peltier and seebeck effect. Thermoelectric cooling can be considered as one of the major applications of thermoelectric modules (TEM) or thermoelectric coolers (TEC). The main objective of this project is to design a cooling system installed on a conventional blower of car AC. The idea of cooling is based on Peltier effect, as when a dc current flows through TE modules it generates a heat transfer and temperature difference across the ceramic substrates causing one side of the module to be cold and the other side to be hot. The purpose of the project is to make use of the cold side to cool the ambient air to a lower temperature, so that it can be used as a personal cooler. Testing and measurements will be performed using on car (Maruti 800). the fact that the TE cooling for car can lower the ambient temperature by 7 degree Celsius.

The said dissertation is a Thermoelectric Air to Air cooling for car. And it can be used for personal cooling inside the car.

Keywords: HVAC, Peltier, Personal Cooling, Thermoelectric

I. INTRODUCTION

The concept of air to air cooling by using thermoelectric effect may be efficient in comparison to the existing HVAC system for cars. Since air to air cooling working on thermoelectric effect is more effective in terms of producing cooling effect as compared to HVAC system and more efficient in terms of saving Petrol/Diesel.

Regarding Environment, such as global warming, ozone depletion, and a lack of energy efficiency, it is necessary to investigate alternative cooling technologies to the refrigeration that uses refrigerants. Thermoelectric cooling and heat pumping are alternatives that have recently attracted attention. Thermoelectric devices are solid-state devices in which electrons or holes equivalent to refrigerants in traditional vapor-compression systems carry electricity and thermal energy under an electric field. Therefore, they have many inherent, attractive features such as a long life and no moving parts, and they don't emit toxic gases, are lightweight, are low-maintenance, and are very reliable. In the past decade, there has been rapid development when it comes to the fundamental theory, materials, and devices related to thermoelectric. Nowadays, thermoelectric technology is making its way into the civil market, especially for applications that require high quality temperature control, such as precision instruments for medicine and research. And several thermoelectric applications are attracting commercial attention owing to their great prospects for the future, such as dehumidifiers, for domestic sectors, portable and domestic refrigerators, transports for perishable goods, etc.

II. PROJECT OBJECTIVE

1. To study critically existing HVAC system for its advantage and disadvantages.
2. To explore various technological option to replace existing HVAC system.
3. To study TEC as a substitute for present HVAC system which will overcomes the all demerits of present HVAC system.
4. To fabricate working model of HVAC using TEC.

To test HVAC using TEC for its effectiveness, efficiency, environment friendliness, comfort and convenience

A. Scope of Project

Why Thermoelectric cooling for cars than

1. **HVAC. Power loss** Compressor is driven by the crankshaft of the engine. It consumes 5 to 10% of engine power.
2. **Electric loss** Battery provides 12V current to the blowers and electromagnetic clutch of compressor for engaging the compressor.
3. **Cost** of present HVAC System is very high.
4. **Hazardous refrigerant** HFC is quit hazardous for human body & ozone layer which leads to global warming.
5. **Repairing cost** Repairing cost of HVAC System is very high.

6. Maintenance Proper maintenance is very necessary because this system can affect human body & Environment.
7. Size Present HVAC system required very large space in the engine compartment and dashboard.
8. Designing of the cooling system
1. Selection of the TECs
2. Selection of Fans and Heat sinks
3. DC power supply design
4. Prototype Assembly and Fabrication.
5. Temperature measurements for testing.

III. METHOD IMPLEMENTED

The project implemented a structured system analysis and design methodology approach to achieve the project objectives. Block system analysis of the project is shown below (Figure 1) with the aid of a straightforward block diagram. Ambient air is blown out by the blower through a duct to the TECs. TECs are sandwiched in between heat sinks. Cold air is blown out from one end of the cold heat sinks. The TECs were powered by a power supply.

The cooling system mainly consists of the following modules Car Blower which acts as the primary source of air.
1. Duct which conveys the air from the blower to cluster of Al cold heat sinks.
2. One long heat sink is fitted to the hot side of TEC to absorb heat.
3.4 Aluminum heat sinks that are attached to the cold side.
4. Six TECs are sandwiched between cold and hot heat sinks.
5.An DC source which is used to power the fans and blower.(Car Battery)
6. Dc power supply is used to drive the TECs

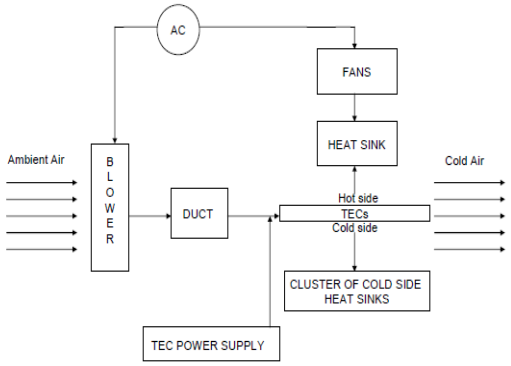

Figure 1: Block diagram of the thermoelectric cooled cooling fan.

A simple on off temperature controller is built in with the dc power supply Thermoelectric Air Cooling For Cars To design a cooling system using thermoelectric cooler (TEC) one has to know the basics of thermoelectric effect, thermoelectric materials and thermoelectric cooling. Thermoelectric effect can be defined as the direct conversion of temperature difference to electric voltage and vice versa. Thermoelectric effect covers three different identified effects namely, the Seeback effect, Peltier effect and the Thomson effect A thermoelectric device will create a voltage when there is temperature difference on each side of the device On the other hand when a when a voltage is applied to it, a temperature difference is created. The temperature difference is also known as Peltier effect. Thus TEC operates by the Peltier effect, which stimulates a difference in temperature when an electric current flows through a junction of two dissimilar materials. A good thermoelectric cooling design is achieved using a TEC, which is solid state electrically driven heat exchanger. This depends on the polarity of the applied voltage. When TEC is used for cooling, it absorbs heat from the surface to be cooled and transfers the energy by conduction to the finned or liquid heat exchanger, which ultimately dissipates the waste heat to the surrounding ambient air by means of convection.
Thermoelectric Module -
A standard module consists of any number of thermocouples connected in series and sandwiched between two ceramic plates By applying a current to the module one ceramic plate is heated while the other is cooled.


Figure 2: A typical single stage thermoelectric module.

A thermoelectric cooler has analogous parts. At the cold junction, energy (heat) is absorbed by electrons as they pass from p-type (low energy) semiconductor element, to the n-type semiconductor (high energy). The power supply provides the energy to move the electrons. At the hot junction, energy is expelled to a heat sink as electrons move from an n-type to a p-type. Figure 4 shows an illustration on the assembly of a Thermoelectric cooler.

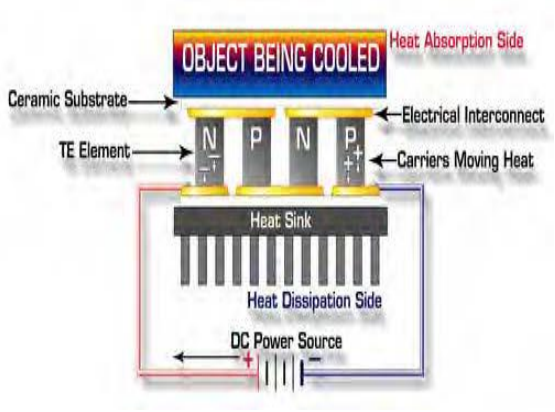

Fig. 3 TE Module Assembly

Before starting to design a TEC cooling system the designer have to take note the following into consideration.

1. Temperature to be maintained for the object that is to be cooled.
2. Heat to be removed from the cooled object.
3. Time required attaining the cooling after a DC power is applied.
4. Expected ambient temperature.
5. Space available for the module and hot side heat sink.

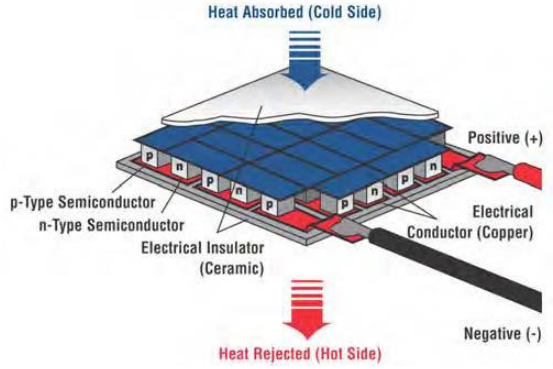

Fig. 4 A cutaway of thermoelectric module

Cold side temperature -

If the object to be cooled is in direct contact with the cold surface of the TEC, the required temperature can be considered the temperature of the cold side of TEC (*Tc*).Here in this project the object is air inside the car, which has to be cooled when passed through a cluster of four Aluminum heat sinks.. The aim is to cool the air flowing through the heat sinks. When this type of system is employed the cold side temperature of the TEC is needed to be several time colder than the ultimate desired temperature of the air.

Hot side temperature -

The hot side temperature (*Th*) is mainly based on the two factors. First parameter is the temperature of the ambient air in environment to which the heat is been rejected. Second factor is the efficiency of the heat sink that is between the hot side of TEC and the ambient.

4.6 Temperature difference -

The two temperatures *Tc* and *Th* and the difference between them ΔT is a very important factor. ΔT has to be accurately determined if the cooling system is expected to be operating as desired. The following equation shows the actual ΔT.

$\Delta T = Th - Tc$

Actual ΔT is not same as the system ΔT. Actual ΔT is the difference between the hot and cold side of the TEC. On the other hand system ΔT is the temperature difference between the ambient temperature and temperature of the load to be cooled.

IV. THERMOELECTRIC COOLING FOR CAR DESIGN

The thermoelectric cooling fan design was preformed based on certain mechanical and electrical calculations. The fan's design was compromised on the availability of parts in the market. The prototype assembly starts with a main fan which is used to blow the ambient air through a circular duct. The duct is attached to the blower fan and leads towards a group of three heat sinks. The air which is passed through the duct goes into the cluster of three heat sinks which are united together. These heat sinks acts as a channel for the air to pass through. There are six TECs that are sandwiched between a long heat sink and the bunch of two heat sinks. TEC cold side or the top side rests on the long aluminum heat sink. The hot side or the bottom sides of the TECs are fastened together with the two heat sinks which are the combination of aluminum and copper.

The TECs were installed between the heat sinks using thermal grease, which increases the thermal conductivity by balancing irregular surface of the heat sinks. When the TECs are in operation cold side of the TEC cools down the heat sink channel. Air which is coming out from the channel (i.e. long aluminum heat sink) is chilled air which is lower than the ambient. The two hot side heat sinks are the combination of aluminum and copper having internal fins/channels through which water is circulated which is coming from water cooling coil as it is having inlet and outlet port, due to this water circulation water absorbs the heat from hot side heat sinks and we get cold air from cold side heat sink which is below the ambient.

There is assembly of water cooling coil and one fan fitted on front bumper of car near the right side head light. The absorbed heat by the water from hot side heat sinks, this hot water is circulated in the water cooling coil and fan assembly to cool the hot water by forced convection, this cold water is recirculated by using a pump (which is inbuilt in the car for wiper water purpose) to the hot side heat sinks. Due to this or this helps the hot heat sinks to cool it down when the TECs are in operation. The whole assembly of the cold side heat sinks, hot side heat sink, TECs is fitted firmly on the place of dash board having connection with the duct of car blower. Water is circulated by using rubber pipes with proper connections to the hot side heat sinks – water cooling coil and fan assembly – water sump and pump assembly and again to the hot side heat sinks.

V. CONCLSION

Thermoelectric Air to Air Cooling can be used for personal cooling inside the car. TEC cooling will be able to cool an ambient air temperature from 32^0c to 25^0c

So it is very effective to save power of car engine with silent features.

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