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Study of Thermoelectric Air Conditioning for Automobiles

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Abstract – *Air conditioning systems is used in many automobile applications. The conventional process using refrigerant can cause serious problems to the environment. In this study we developed the air conditioning system based on thermoelectric properties. In this air conditioning, there is no use of compressor and pump for the refrigeration. Thermoelectric module is an electrical module, which produces a temperature difference while current flow. The emergence of the temperature difference is based on Peltier effect. The thermoelectric module is a heat pump and has the same function as a refrigerator. The heat flow can be turned by reversal of the direction of the current. Our aim is to introduce the new HVAC system using thermoelectric module which shall overcome all the disadvantages of existing HVAC system.*

Key words: Thermoelectric module, Peltier Effect, Seebeck effect, HVAC, Thermoelectric generator.

1.INTRODUCTION

1.1 what is thermoelectric module?

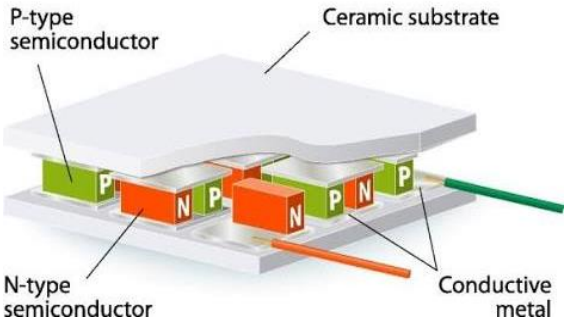

Fig. Thermoelectric module

A thermoelectric module is an electrical module, which produces a temperature difference with current flow. The emergence of the temperature difference is depending on the Peltier effect designated after Jean Peltier. The thermoelectric module is a heat pump and has similar function as a refrigerator. It gets along however without mechanically small construction units (pump, compressor) and without cooling fluids. The heat flow can be turned by reversal of the direction of current. Thermoelectric cooling provides an alternative solution to the common compressor and absorber cooler. Thermoelectric coolers are used especially if small cooling power is required up to 500 W.

Our goal is to define the new HVAC system using thermoelectric couple which shall overcome all the drawback of current HVAC system. If this system comes in present HVAC system, then revolution will occur in the automobile. With rising population and pollution at an alarming rate this system has come to rescue as these are environment friendly and compact. 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. Although researches are going on, best alternatives for the CFC refrigerants is still on the hunt. So instead of using conventional air conditioning systems, other products which can efficiently cool a person are to be planned. By using other efficient cooling device, we can save the electricity bills as well as control the greenhouse gases that are currently released into the surrounding atmosphere.

Although thermoelectric property was discovered about two centuries ago thermoelectric device save only been commercialized during current years. The applications of thermoelectric varies from small refrigerator.

1.1 Need of Thermoelectric Air Conditioning

Now a day, an automobile is a necessity for everybody. For a far or near travelling people need car regard to the safety, environment and most important comfort. Due to these reasons, many vehicles are equipped with heating, ventilating and air conditioning system. In vehicle without HVAC system no one feel comfortable so, HVAC together with part of people life. This HVAC system is more efficient and reliable but it has some limitations. It has been seen during the previous two decades that the ozone(O3) layer is slowly destroyed because of the refrigerant like CFC and HFC used for the refrigeration and air conditioning. The refrigerant used is HFC's which are leaked into the atmosphere. When they reach to ozone(O3) layer they act on O3 –molecules and the layer of O3 is destroyed.

It includes demerits like, the compressor is driven by the crankshaft of the engine. So, it consumes about 5 to10% power of the engine. This consequently reduces mileage of the vehicle. An Air-conditioning system consumes as much as 8h.p. with a unit capacity of 3 tons or 9072 kcal/hr. approximately. So, due to these the pickup of vehicle decreases. The cost of present HVAC system is more; it may

vary depending upon price and model of vehicle. Maintenance and repairing cost of this system is more. Each component of HVAC is very costly. This system occupies very large space in engine compartment and dashboard. In this system, if any component fails to perform well then, the whole system either will not function properly or will not function at all. Instead of this, today's electronically and computer controlled HVAC system has sensors. If somebody wants to start an AC system, but due to high power requirement of an engine, the AC system will not start and person will need to wait for the starting of the HVAC system.

As a mechanical engineer we are trying to overcome these demerits by replacing the existing HVAC system by newly emerging thermoelectric couple or cooler which 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 ceramics 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 are also performed using on car. A simple temperature controller to interface with the cooling system has also been incorporated. Based on an analysis of sizing and design of the TEC air cooling for car, it can be deduced that the cooling system is indeed feasible Readings taken during testing also testify to the fact that the TE cooling for car can lower the ambient temperature by 7degree Celsius.

1.2 Methodology

In order to determine the feasibility and economic practicality of using thermoelectricity for large scale waste heat and energy recovery.

FLOW DIAGRAM OF METHODOLOGY

Methodology used for whole processing of thermoelectric air condition is given below; this methodology gives way about how work is to be carried out in systematic way. It is standard process of describing process, how it is done in simplest manner.

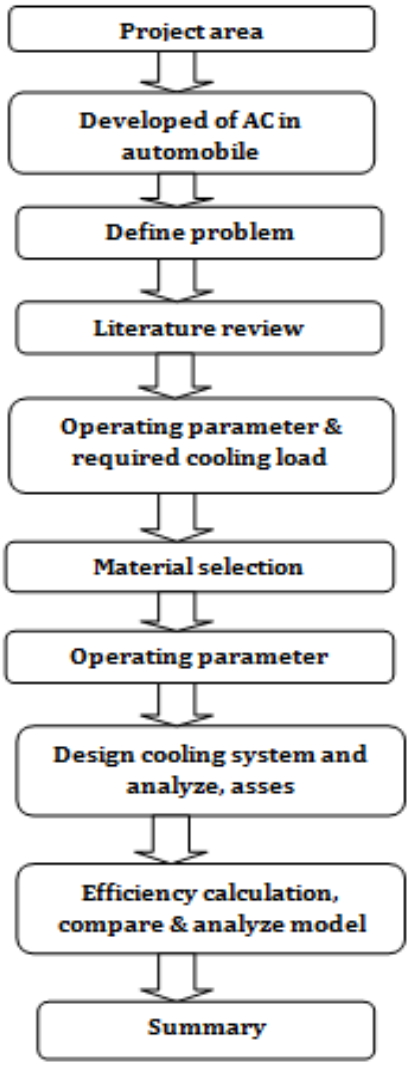

Fig. Flow Diagram of Methodology

1.3. WORKING PRINCIPLE

The working principle based on following;

1) Peltier effect
2) Seebeck effect

1.3.1 Peltier effect

It works on a principle that "When a Current (I) is made to flow through the circuit, heat is evolved at the lower junction (T2) and absorbed at the upper junction (T1). Peltier heat is reversible, when the direction of current is reversed; the Peltier heat is the same, but in opposite direction. Peltier coefficient depends on the temperature and materials of a junction. Fig.1 Illustrates the Peltier Effect. Fig.1. Note that this effect will be reversed whereby a change in the direction of electric current flow will reverse the direction of heat flow.

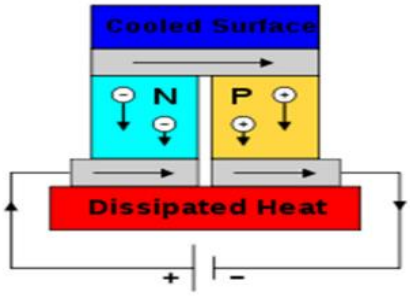

Fig.1.3.1 Peltier effect

1.2.2 Seebeck effect

Discovered by Thomas Johann Seebeck in 1821.He accidentally found that a voltage existed between two ends of a metal bar when a an electrical current. The voltage is proportional to the temperature gradient existed within the bar. A temperature difference causes diffusion of electrons from the hot side to the cold side of a conductor. The motion of electrons creates an electric current. The voltage is proportional to the temperature difference as governed by:

$$V = \alpha(Th - Tc)$$

where,

Th = temperature of hot side of the module.

Tc =temperatures of cold side of the module.

α = coefficient of heat transfer.

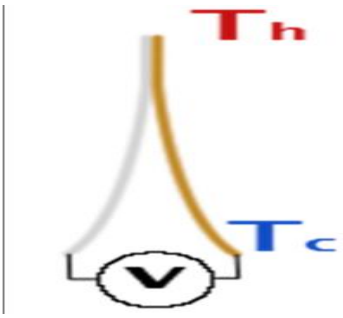

Fig.1.3.2 Seebeck effect

1.4. Thermoelectric Module Basic Configuration

The Peltier effect occurs when a voltage is applied to two connected electrical conductors made of different materials. When the voltage is applied, a circuit can be created that allows for continuous heat transport between the conductor's junctions the opposite also applies such that a voltage can be generated by applying a temperature difference to the two connected electrical conductors, which is known as the Seebeck effect.

This temperature difference results in a transfer of thermal energy across the electrical conductors and causes charge carriers to also diffuse through the materials. These charge carriers can be either electrons, or electron deficiencies called holes, and move within the crystals of the materials by way of electron flow from the cold side to the hot side of the TE couple. The heat is transferred in the same direction as the charge carrier flow, from the cold side of the TE couple to the hot side. By leaving positively charged nuclei to collect on the cold side of the TE couple while the charge carriers move towards the hot side, a thermoelectric voltage is generated. This results in the potential to generate an electrical current if a complete circuit can be created, as seen in Fig.

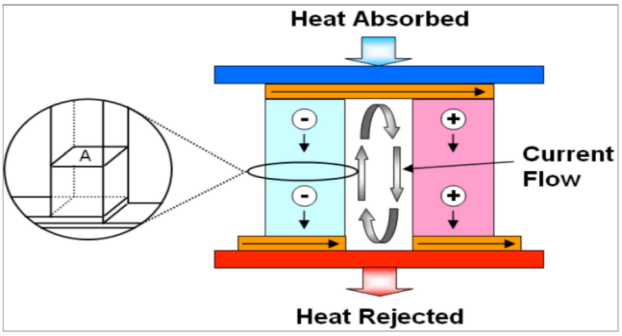

Fig.1.4. Thermoelectric Couple Basic Configuration

CONCLUSION

A Thermoelectric Air cooling for car prototype was designed and built which can be used for personal cooling inside the car. Six TECs were used for achieving the cooling with a DC power supply through car battery. Accomplishing the set target establish the success of the project.

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