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Tec Air Conditioning

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ABSTRACT

In this work, conventional air conditioning system is replaced with the innovative system of air conditioning. The new system is based on Peltier effect that uses DC power supply to run thermoelectric cooler (TEC) to get desired cooling. TECs are common place for electronic gadget cooling systems. Earlier refrigerants that were used for AC system contributed to environmental effects, also the new echo friendly refrigerants which are presently used have a compressor unit as an essential component. The proposed a/c system without compressor has no running cost. In recent years, demand for small size active cooling for stationary equipment was realized which requires a/c systems comprising TEC and water cooled heat sinks. The project work attempts to employ TEC in mobile applications. It is proposed to use ten modules of thermoelectric cooler for assessing the performance of cooling system. Aprototype is constructed that works on Peltier effect for performance evaluation of the a/c system for 1 cubic meter space.

Keywords— **Peltier effect, thermoelectric cooler, cooling system, automobile air conditioning**

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I. INTRODUCTION

In recent year demand of fossil fuel is increases day by day, so we need to save the fossil fuel in all manners. In automobile **A**ir **C**onditioning (AC) system, the main part is compressor which compresses the gas and the gas undergoes cyclic changes to get desired cooling effect. Here compressor is driven by engine so that it's consuming more fuel and thus affects the mileage of vehicle. In this project conventional air conditioning system is replaced with new **T**hermo**E**lectric **C**ooler (TEC) system. This TEC system works on Peltier effect. By applying DC power supply to the TECs it gets cooler on one side and other side gets heated up which means it transfers the heat from one surface to other [4]. Thus it can be in Air conditioning system to get desire effect for cooling. Conventional air conditioning system required compressor and refrigerant which cause fuel consumption and environmental ozone depletion. But in TEC system, compressor and refrigerant not required. So it is echo friendly and fuel efficient system.

II. LITERATURE REVIEW

Manoj S. Raut and Dr. P. V. Walke has investigated and shown that thermoelectric module can be usedcooling of air in the cars. They have taken 6 TEC in series and parallel arrangement so that each module will take 12V and 4A means near about 48 watt power and analysed at different condition and temperature. It was concluded that it is possible to cool the car around 30ºC but with higher climatic temperaturescooling will not be effective [2]. Other researchers Suwit Jugsujinda, AthornVora-ud, and Tosawat Seetawan investigated that refrigerator can be made with thermoelectric cooler. They have fabricatedthermoelectric refrigerator (TER: 25 × 25 × 35 cm^3) by using a thermoelectric cooler (TEC: 4 × 4 cm^2) and applied electrical power of 40 W. The TER did not comprise of a cooling fan for the cold air circulation in the refrigerator. The temperature of TER was measured at ten points to check the cooling system. The current, differential temperature, time, and coefficient of performance (COP) were analysed. TEC cold plate temperature was decreased from 30 ºC to –4.2 ºC for 1 hr and continuously decreasing

to –7.4 ºC for 24 hrs and 50 ºC for hot plate temperature. The TER temperature was decreased from 30 ºC to 20 ºC in 1 hr and slowly decreasing temperature for 24 hrs. The maximum COP of TEC and TER were 3.0 and 0.65, respectively [3].

A. TEC

In this work TEC module TEC1-12706 is selected for Experiment.

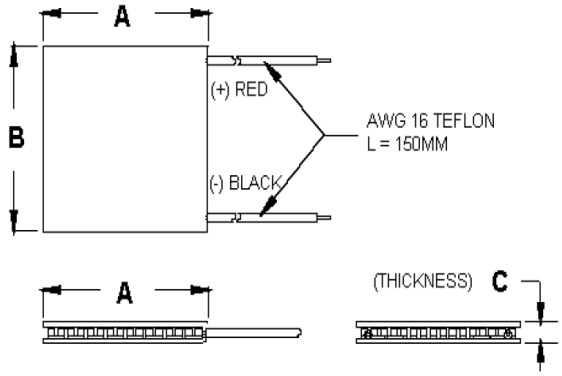

Fig.1. Schematic Diagram of a Thermoelectric Cooler (TEC)

Ceramic Material: Alumina (Al2O3) white in color
Solder Construction: 138ºC, Bismuth Tin (BiSn)
Marking is present on the cold side surface of TEC.
Following tablegives dimension in mm.

A	B	C
40	40	3.9

TABLE I SIZE TABLE

TABLE II

Hot Side Temperature (ºC)	25ºC	50ºC
Qmax (Watts)	50	57
Delta Tmax (ºC)	66	75
Imax (Amps)	6.4	6.4
Vmax (Volts)	14.4	16.4
Module Resistance (Ohms)	1.98	2.30

PERFORMANCE TABLE(SUPPLIER'S)

B. Working Principle of TEC

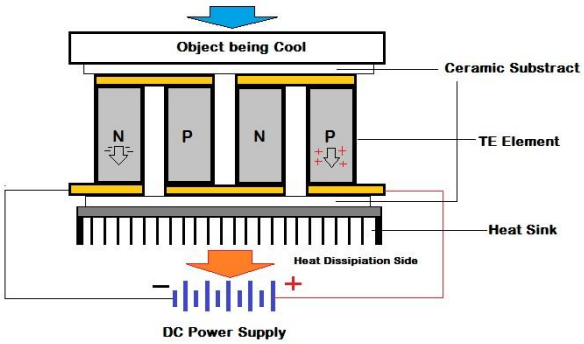

Fig. 2 working principle of TEC module

By applying DC power supply to the TE module electrons move toward negative pole and holes move toward positive pole which carry heat from one face to other face [1].

C. TEC System

This system consists of TEC modules, battery power, water-pump and radiator fan assembly. A sandwich is made of Ten TEC module and air cooling duct powered by battery power supply. Water is circulated with the help of pump that extracts heat from hot side TEC and transport to radiator for cooling. As shown in Figure.

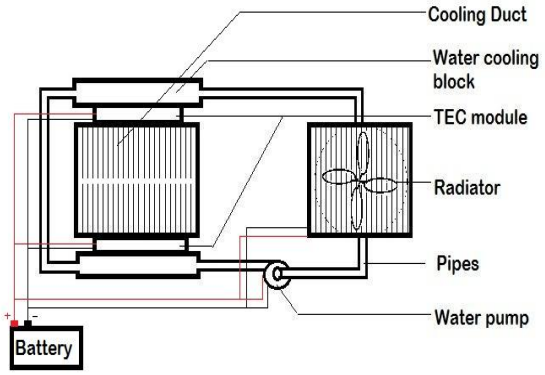

Fig.3TEC system

Initially in theproposed system battery provided power, but it was noted that distribution of current is not accurate. So power supply (converter) is usedin the system to obtain better distribution of current in TEC. In this work ten TECs used to get cooling effect for 1 cubic meter space at 24˚C from 35˚C.

With the help of prototype, it is verified that cooling can be done with TECs for cabinet box having 1 cubic meter space equivalent to that of the "TATA Ace" mini truck. As per ASHRE Comfort chart 20˚C to 26˚C temperature range is comfortable zone for human being. For higher ambient conditions, TEC must be of high qualityand more wattage to get required cooling.

III. RESULTS AND DISCUSSION

In this work two power supply units of 12 volt rating havebeen used with maximum output power of 720 watts. This is able to supply 10 TECs with 48 watts Peltier cooler connected in parallel.

Each Peltier cooler has a dimension 40 x 40 x 3.9 mm, rated maximum current 6A (although it never exceeds 4A) and rated maximum temperature difference as ΔT 66˚C (Max .ΔT obtained however 15˚C).The hot side of TECs attached to the water cooled aluminium block to circulate water, has a dimension 50 x 260 x 25 mm. The air is supplied to cabin space at 4 m/s velocity through 0.00308 square meter ductoverduct fins at17˚C surface temperature. The output air from duct enters the cabin at 23˚C. Fan is provided for air supply of 1.17 kg/min at 23˚C temperature to the cabin, which cools cabin in 2 min at average 26˚C. Further with recirculation the cabin air gets cooled to average 24˚C within 5 min. In TECs assembly hot side temperature rises to 33˚C and it cools down in radiator fan assembly. All instruments work on 12 V battery power, only currents vary from instrument to instrument. In automobiles, dynamo charges the battery while in this invertor is used.

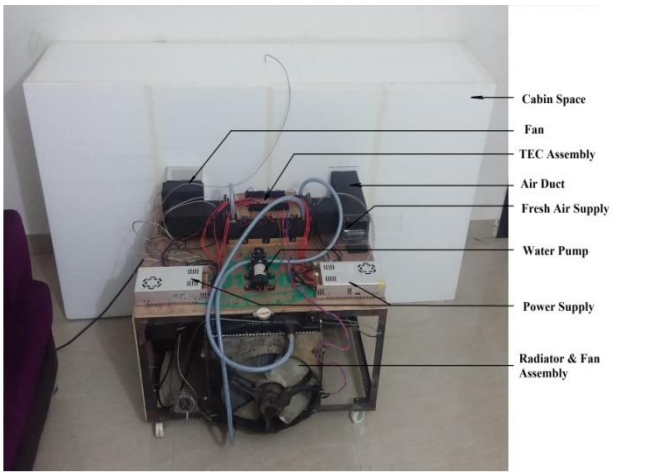

Fig. 4 Actual Prototype

In this work Total heat load is 8195 kJ which is cooled in 2 min for115W cooling capacity.

D. Calculation

Heat load can be calculated by

$Q_L = mCp\Delta T_b$

There is no mass transfer so considering unit mass

Where Q_L – heat load,

Mass, $m=V*\rho = 1.165$ kg

(Volume $V=1m^3$, Density $\rho=1.165kJ/kgK$)

Cp– Specific heat of air at mean Temperature 28˚Cis 1005 J/kg-K,and

ΔT_b- Temperature difference between inside the box and outside climate Temperature

So Q_L is 8195KJ

And cooling load can be calculated by

$Q_s = hA\Delta T$

Where h- heat transfer Coefficient,

A-Effective Surface Area,

ΔT- Temperature difference between mean Temperature and cooling surface temperature and Q_s is 115W. With this value of cooling box is cooled within 2 min.

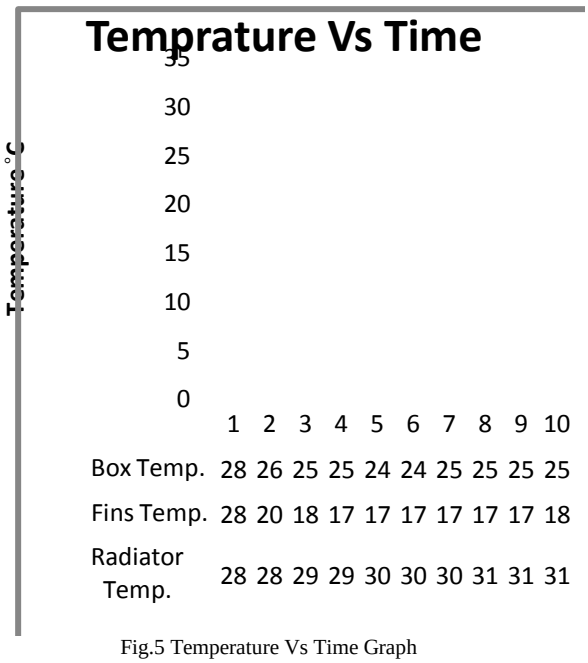

Fig.5 Temperature Vs Time Graph

IV. Conclusions

With the help of above graph it is clear that temperature drops in 2 minutes only; further as temperature of TECs of hot side increases then slight increase in temperature of cold side is observed.Temperatureresponseof cooling fins is good.If temp at hot side remains constantthen it gives constant cooling effect. So it is concludedthat TECs system can be used for automobileair conditioning.In this work a prototype was made for 1 m^3space to check cooling effectand with aheat load of 8195 KJ,coolingis obtained in 1 - 2 min. It is thereforeconclude that it is good for automobile Air Conditioning system. Also it has various advantages of TEC, such as small and lightweight, reliable, free from noise and vibration, portable, precise temperature control, environmental friendly, no moving parts, localize cooling, fast temperature response, nearly infinite life(2,00,000 hrs). Hence TEC can become the best alternative to the refrigerants in a conventional R&AC system.

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