International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

SMART WAY TO REDUCE CAR CABIN TEMPERATURE BY USING THERMOELECTRIC COOLER

M. Shanmugaraja[1], R. Jeipraveen[2], R. Ashith raj[3], M. Brian joel[4]

[1]HOD, Assistant Professor, Dept.of Automobile Engineering, SNS College of Technology, Coimbatore, Tamil Nadu, India
[2,3,4]UG Scholars, Dept. of Automobile Engineering, SNS College of Technology, Coimbatore, Tamil Nadu, India

---

Abstract - : *Car owners especially in Asian countries are facing more problems as the temperature here is too high, when parked under the scorching sun. In this paper, the design and development of a cooling system is described briefly . A new ventilation system has been designed that employs exhaust fan and blower, peltier cells, temperature sensors and electronic control circuitry to automatically control the temperature inside the car cabin under the constraint that ignition system is off. This system has a separate circuit board which controls the TEC. The system starts when the temperature reaches 35 degree and stops when the temperature comes below 28 degrees. This simple proposed system provides comfort to users due to its capability in improving the quality of air and moisture in the car's cabin. Two experiments were conducted with different ambient temperature and the targeted temperature at which the smart system should be activated. It was observed that the temperature inside the car dropped significantly when the smart ventilation system was on.*

Key Words: **TEG cooling system, comfort, temperature reduction.**

1. INTRODUCTION

In India the production of car started increasing day by day. Every year the statistics of car production increased a lot .In 2006 the production of car were 1.4 million, but now India is the third largest car market in Asia-pacific

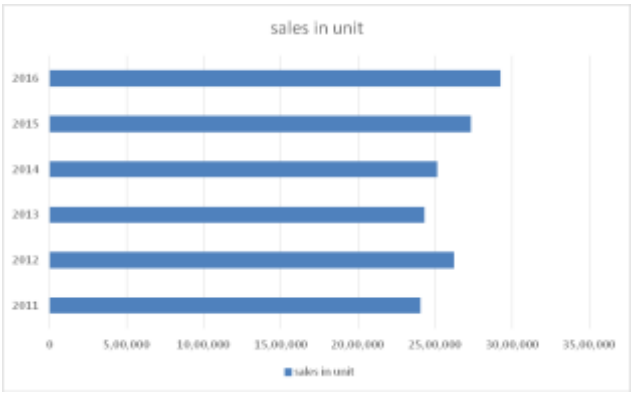

Chart -1: Car Sales Graph

In India temperature will be between 30-45 degree Celsius in summer. When the car is directly parked under the sun, the temperature inside the car cabin increases. Such drastic rise in temperature levels inside the cabin can be attributed conduction, convention, radiation. The interior of the car is made up of plastic materials made out of certain harmful chemicals. When the temperature rises the chemicals starts to emit some harmful gases. Because of no ventilation in the parked car these gases stays inside until the windows of the car is opened. The primary pollutant that are produced inside the car cabin due to the temperature rise are: particulate matter, volatile organic compounds including benzene and styrene, carbon monoxide, nitrogen oxide, ozone.

These gases will stays inside the cabin, when humans are exposed to these gases it will affect our health. When humans inhale these gases in large amount it may lead to death also. People who breathe in high levels of benzene may develop the following symptoms. Some of the symptoms due to the inhale of these gases are drowsiness, unconsciousness, rapid or irregular heartbeat, even death. Women who breathe a high level benzene have irregular menstrual periods.

To avoid these impacts, a new technique is used to reduce the temperature inside the car cabin. A new system will be designed that employs temperature sensors, thermoelectric cooler, aluminium heat sink, solar panel, battery, boost invertor, fan, electronic control circuitry to automatically control the temperature inside the cabin under the constraint that ignition system is off. When the temperature increases this system will gets on and gets off only after the temperature decreases. An external solar panel and battery is used to run the thermoelectric cooler, fans and circuit.

2. LITERATURE COLLECTION

M.S.F. Mansor, et al. (2014) In the past few years many fatalities have been reported as the result of internal car heat. Problems arise when the temperature in a car cabin is too hot when parked under direct sunlight. The trapped and accumulated heat causes the temperature inside a car to reach up to 36˚C and even up to 50˚C. The objectives of this paper are to study and analyze the behaviour of car cabin temperature influenced by ventilation under direct sun exposure. The performance of the proposed mathematical

modelling was compared to data collected in real time from the car cabin. The simulation model was used to study the behaviour of cabin temperature by investigating the ventilation mass flow rate as its parameter. An experimental result was obtained from measurements on a salon car parked in the direct sun. It is hoped that this study will be able to provide beneficial information for car interior design and material selection in order to improve comfort levels in cars.

M.F. Basar, et al. (2013) Until now, car owners especially in ASEAN countries are facing problems where the temperature is too hot in the car when they park their cars under the scorching sun. Various problems will arise caused by this situation. In this paper, the design and development of portable car cooling system is described briefly. Electrical Motor, rechargeable battery, Peltier cell, rotating cloth; these are the components that have been combined in order to complete a simple cooling system. Based on the experimental activities' result, it is proven that the conducted research has a positive impact where it has successfully maintain the temperature inside the car at room temperature. For comparison, the temperature inside the car can achieve up to 70°C without the proposed system. Furthermore, the simple proposed system provides comfort to users due to its capability in improving the quality of air and moisture in the car's cabin.

Akshay Thalkar, et al. (2018) 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.

Vrushali Deshmukh, et al. (2017) In present scenario, hvac system (commonly used in the air conditioners) is very efficient and reliable but it has some demerits. It uses refrigerants like Freon, ammonia, etc. Due to the use of such refrigerants maximum output can be obtained but it leads to much harmful effect to our environment i.e. The global warming. That leads to the emergence of finding an alternative of the conventional hvac system, i.e. Thermoelectric cooling and heating system. The present paper deals with the study of thermoelectric air conditioner using Tec module. Thermoelectric cooling system have advantages over conventional cooling devices, such as compact size, light in weight, low cost, high reliability, no mechanical moving parts and no working fluids.

3. MATERIALS AND METHODOLOGY

A new design of cooling system based on the problem identification and literature review. The proposed desing consist of thermoelectric cooler, aluminium heat sink, fans, micro controller, temperature sensors and battery.

3.1 THERMOELECTRIC COOLER

Thermoelectric cooling uses the Peltier effect to create a heat flux between the junction of two different types of materials. A Peltier cooler, heater, or thermoelectric heat pump is a solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy, depending on the direction of the current. Such an instrument is also called a Peltier device, Peltier heat pump, solid state refrigerator, or thermoelectric cooler (TEC). It can be used either for heating or for cooling,[1]although in practice the main application is cooling. It can also be used as a temperature controller that either heats or cools.

Fig -2: Thermoelectric cooler

Table -1: Specification of Thermoelectric cooler

S.NO	DESCRIPTION	SPECIFICATION
1	Operating Voltage:	12V.
2	Maximum Voltage- Umax (V)	15.4V
3	Maximum Current- Imax (A)	6A.
4	Maximum Power	92 W
5	Maximum Temperature	138°C

3.2 MICROCONTROLLER

The thermoelectric cooler will controlled by micro controller. It is powered by battery. Microcontroller will control temperature inside the cabin. In this project we use microcontroller 16F877A because very convenient to use, the coding or programming of this controller is also easier. One main advantages is that it can be write erase as many times as possible because it use flash memory technology. It

has total number of 40 pins and there are 33 pins for input and output.

3.3 TEMPERATURE SENSOR

In this project we use LM35 Temperature sensor The LM35 is one kind of commonly used temperature sensor that can be used to measure temperature with an electrical o/p comparative to the temperature (in °C). It can measure temperature more correctly compare with a thermistor. This sensor generates a high output voltage than thermocouples and may not need that the output voltage is amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C.

Fig -3: Temperature sensor

3.4 RELAY

Relays are essential for automation systems and for controlling loads. Also, relays are the best way for galvanic insulation between high and low voltage portions of a circuit. There are hundreds of different relay types. Let's find out first how a relay operates. Before extending to the various types of relays, i will first explain what and how the basic relay operates. Each relay has two mechanical parts inside. The first one is the contact(s) of the relay. The contacts operate similarly to the contacts of a simple switch or pushbutton**.**

Fig -4: Relay

3.5 ALUMINIUM HEAT SINK

A Aluminium heat sink is a passive heat exchanger that transfers the heat and cold generated by an thermoelectric cooler device to a fluid medium, often air, where it is dissipated away from the device, thereby allowing regulation of the device's temperature at optimal levels.

Fig -5: Aluminium heat sink

3.6 FAN

The fan exhausts the hot air formed inside the cabin through aluminium heat sink . On the other side the air from the cold side is sent into to cabin. Based on the calculation we used 12V 0.21A DC fan attached at both side of the heat and cold sink.

Fig -6: Fan

3.7 SOLAR PANEL

This solar panel will produce power of about 12v, 10w connected to battery. When sunlight falls on solar panel it will generate DC electric power and recharge the battery.

Fig -7: Solar Panel

3.8 BATTERY

Battery is used to power the whole circuit. Battery is connected to the controller circuit. The battery is

charged using the solar panel. Solar panel is directly connected with the battery. In this project ,we have used 12volt 7Ah battery. The watt hour of the battery is given by

$$Ah * v = Wh$$

Where
Ah = ampere hour
V = voltage
Wh = watt hour

(i) 12v 7Ah battery

$$= 7 * 12$$
$$= 84 \text{ wh}$$

Fig -8: Battery

3.9 CONRTOLLER CIRCUIT

This control circuit was designed to automatically control car cabin temperature when temperature is increased. This system works when the vehicle in off condition for that we have separate battery for this system. This battery is charged by solar panel. Then battery is connected to microcontroller. The two temperature (inside and outside) sensor is connected to microcontroller and also thermoelectric cooler, fans are connected to micro controller. When temperature is increased in cabin inside temperature sensor sends signal to micro controller, then microcontroller turn on the thermoelectric cooler. When cabin temperature reach to ambient temperature (measure by outside temperature sensor) controller cut off power supply to thermoelectric cooler.

Fig -9: Controller circuit with relay switch

4. COMPUTATION OF COOLING LOAD

TEC is the amount of heat to be removed or absorbed (Qc) by the cold side of the TEC. In this project Qc was calculated by finding the product of finding the product of mass flow rate of air, specific heat of air and temperature difference. Here the temperature difference system ΔT in the difference between the inlet temperature and outlet temperature of the cooling system. The mathematical equation for Qc is as shown below.

$$Qc = mCp\Delta T$$

m - mass flow rate of air
C_p - specific heat of air
ΔT – temperature difference

Mass flow rate (m) of air and is the product of density of air (ρ) and volume flow rate (Q).

$$m = \rho * Q$$

Density of air at 35 $°C$ was taken as1.1455 kg / m^3.

Q was obtained by multiplying velocity of air pass through the rectangular duct of heat sinks and the cross section area of a heat sink. It is denoted by the equation.

$$(Q = V \times A).$$

Velocity of the air passing through the duct was of $3m / s^2$.

Cross sectional area of the rectangular duct ($W \times H$) was calculated as 0.0054128$m2$

$$Q = 3 * 0.0054128$$

$$Q = 0.0216512 \text{ m}^2/\text{s}$$

Mass flow rate (m) of air $m = \rho * Q$

$$m = 1.1455 * 0.0216512$$

$$0.02480144 \text{ kg/s}$$

ΔT is the difference between the ambient temperature and the temperature of the load
to be cooled. It had been targeted to attain a temp of 28$°C$ form the ambient temperature (35 $°C$). In other words the input temperature from the blower fan is 35 $°C$ and the expected output is 28$°C$

$$\Delta T = T_{in} - T_{out} = 35°C - 28°C = 7^oC$$

Specific heat of air (Cp) at 35 $°C$ was taken as 718 J / kgK .

$$Qc = m\ Cp\ \Delta T$$

$$= 0.02480144 * 718 * 7$$

$$= 124.65W$$

COEFFICIENT OF PERFORMANCE

The Coefficient of performance (COP) of a thermoelectric module which is the thermal efficiency must be considered for a TE system. The selection of TEC will also be based on the COP factor. COP is the ratio of the thermal output power and the electrical input power of the TEC. COP can be calculated by dividing the amount of heat absorbed at the cold side to the input power.

$$COP=Q_c/P_e$$

Q_c = 124.65W

P_e is Electrical input power for TEC = 144w

$$COP=124.65/144$$
$$=0.86$$
$$=86\%$$

5. WORKING PRINCIPLE

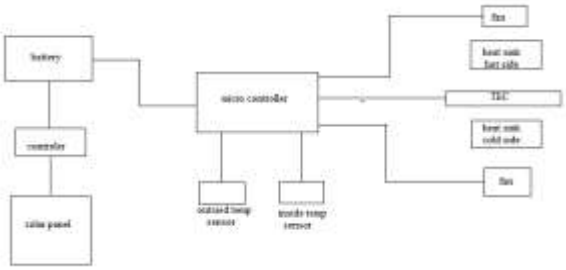

Fig -10: Layout of controller circuit

The above figure shows the layout of the Controller Circuit. From the solar panel the battery is getting charged. Microcontroller is that which controls the total working of the circuit. Two temperature sensors are used to check the temperature, one is used to check the outside temperature and other sensor is used to check the inner temperature of the car cabin. Another device named Thermoelectric cooler is used to cool down the car cabin temperature by desipating the heat from the heat sink to cold sink which is connected to controller circuit.

Fig -11: Proposed design of car cabin with circuit

When the vehicle is placed under the sun light , the temperature inside the car cabin temperature increasing .Due to temperature increase it may lead to produce some harmful gases inside the car cabin, which will cause breathing to avoid this our project is developed . TEC is the device which is used to cool the interior of the car cabin when temperature increases. The TEC system is connected to the microcontroller .when the temperature increases above 35 deg the system starts to work and the hot side of the TEC absorbs the hot air inside the car cabin and sends it via the aluminium heat sink to the exhaust fan. Now the cool side of the TEC circulates the cool air inside the car cabin by the help of the blower fan. Temperature sensors are connected with the micro controller and then it is connected with the LCD display. when the temperature comes below 28 ^{0}C the system automatically stops. The power for working the circuit is used from the battery. Solar panel is connected with the battery which will charge the battery.

6. RESULT AND DISCUSSION

This system will start to work in 35 degree so that the temperature will not increase inside the cabin so that the harmful gases formation will be reduced. At 28 degree this system will stop working by cooling down the temperature inside the cabin. A Thermoelectric Air cooling for car prototype was designed and built which can be used for maintaining normal temperature inside the car. Two TECs are used for achieving the room temperature with a DC power supply through bike battery.

6.1 CONDITION 1.

In morning Hours prototype is placed under sun light the Thermoelectric Cooling system achieved 28 Degrees within 45 min. (Outside Temp was 36)

Time (min)	Temperature ^{0}c
5	35
10	34
15	34
20	33
25	33
30	32
35	31
40	30
45	28

6.2 CONDITION 2.

In Afternoon Hours outside temp was 40. In This temperature thermoelectric cooling system reached 34^{0}C at the time of 45 min.

Time (min)	Temperature ^{0}C
5	40
10	39
15	39
20	38
25	37
30	36
35	35
40	34
45	34

7. CONCLUSION

As a conclusion, the thermoelectric cooling system was successfully developed and it is functioning very well. The main objective of the research is to propose a cooling system that able to control and maintain temperature inside the car at the range of 28 to 33 when parked under very hot condition. This system will stop the production of harmful gases and keeps the cabin cool. As there is no harmful gas produced and which will prevent from causing cancer. Breathing problems can be reduced.

REFERENCES

[1] Buist, RJ & Streitwieser, GD March 16-18,1988, The thermoelectricly cooled helmet, The Seventeenth International Thermoelectric Conference, Arlington, Texas.

[2] Bulat, L & Nekhoroshev, Y 2003, Thermoelectric cooling-heating unit for thermostatic body of pickup refrigerated trucks, 22nd international conference on thermoelectrics.

[3] Harrington, SS 2009, Thermoelectric air cooling device, Patent Application Publication, US Patent Number 5623828.

[4] Harvie, MR 2005, Personal cooling and heating system, Patent Application Publication, US Patent Number 6915641.

[5] R. Saidur, H.H. Masjuki, M. Hasanuzzaman. (2009). Performance of an Improved Solar -Car Ventilator. International Journal of Mechanical and Materials Engineering (IJMME), Vol. 4, No. 1, pp 24-34, 2009

[6] M.A. Jasni and F.M. Nasir. (2012). Experimental Comparison Study of the Passive Methods in Reducing Car Cabin Interior Temperature. Proceedings of the International Conference on Mechanical, Automobile and Robotics Engineering (ICMAR'2012), pp. 229-233, December 14-15, Penang, Malaysia.

[7] M.H. Salah, T. H. Mitchell, J.R. Wagner and D.M. Dawson. (2009). A Smart Multiple-Loop Automative Cooling System – Model, Control and Experimental Study. IEEE/ASME Transactions on Mechatronics, Vol. 15, Issue 1, pp. 117-124.

[8] Al-Kayiem, H. H., Sidik, M. F., & Munusammy, Y. R. (2010). Study on the thermal accumulation and distribution inside a parked car cabin. American Journal of Applied Sciences, 7(6), 784-789.

[9] "Thermoelectric Air Cooling For Cars"- Manoj S. Raut, Dr. P. V. Walke: International Journal of Engineering Science and Technology (IJEST) ISSN: 0975-5462 Vol. 4 No.05 May 2012.

[10] "Study and Fabrication of Thermoelectric Air Cooling and Heating System" Prof. N. B. Totala, Prof. V. P. Desai, Rahul K. N. Singh, Debarshi Gangopadhyay, Mohd. Salman Mohd. Yaqub, Nikhil Sharad Jane: International Journal of Engineering

BIOGRAPHIES

M. Shanmugaraja, HOD, Assistant Professor, Department of Automobile Engineering, SNS College of Technology.

R. JeiPraveen, B.E Automobile Engineering at SNS College of Technology.

R. Ashith Raj, B.E Automobile Engineering at SNS College of Technology.

M. Brian Joel, B.E Automobile Engineering at SNS College of Technology.