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COOLING USING THERMOELECTRIC COOLER WHEN VEHICLE IS PARKED

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Abstract

This study aims to facilitate successfully in automobile air conditioning system using Thermoelectric Cooler for its effectiveness, comfort, efficiency environmental friendliness and convince .Heating up of vehicle cabin parked under direct sunlight causes discomfort to the passenger when they enter the cabin. The design analysis the heating methodology of a passenger car parked under direct sunlight by doing some experiment methods taking into consideration, the solar radiation, temperature in the cabin. On the basis of which, design an air conditioning system by the use Thermoelectric Cooler and make effective use to perform more efficiently with less power consumption. Suited for coming technology in automotive industry. If we use the convention cooling system to keep vehicle cabin cool we have to leave the vehicle engine running. This is not possible when we keep vehicle in parking. So to overcome this problem we are specially designing a cooling system for vehicle. Which is parked in direct sunlight. In this design we are using a solar panel to power the cooling system and for cooling purpose we are using Thermoelectric Cooler, Heat sink, and fans/blowers. This system will only use renewable source of energy i.e. it's run free of cost and the system is reliable and maintenance free. To design a cooling system, the program's used in this project for designing are SolidWorks and ANSYS for analysis. Consequently, of using these programs, this project allows us to apply, learn and link technical knowledge of automobile and Electrical knowledge.

Keywords: TEM (Thermo Electric Module), TEC (Thermo electric cooling)

1. INTRODUCTION

Nowadays, thermoelectric technology has wide application in commercial as well as domestic sectors such as high-quality temperature control, such as precision instruments for medicine and research. In automotive sectors thermoelectric cooler are future of tomorrow due to portability, low power consumption, durability and economically viable solution as compared to conventional devices. Thermoelectric cooler is a device that can be used for cooling purposes and it is referred to as thermoelectric refrigeration. Thermoelectric refrigeration offers several advantages with respect to conventional vapour compression technology, since thermoelectric devices are more compact, free of noises and vibrations, provide high-quality temperature control and require far less maintenanceThe design should achieve the primary goal of maintaining ambient temperature in the cabin and and also maintain minimum space requirements. The secondary goal is to maintain the interior parts and to protect the goods and products kept at the cabin from aging and damage respectively.

2. RESEARCH METHODOLOGY

We are using renewable source of energy that is solar energy, as explained earlier when vehicle is parked under the sun using that sunlight we will power are cooling system by means of solar panel. This solar panel will power the whole cooling system. By this way we have zero load on vehicle's battery. The module will contain Peltier modules specifically cooling modules. Which are also known thermoelectric cooler, this modules act like cooling coils when we supply electricity to its positive and negative terminals its starts absorbing heat from one side and pump it to other side. Now the side from which the heat is getting absorb it will start getting cool. Now on other side to which the heat is pumped will start getting hot. To keep hot side at operating temperature we need to use heat sinks, and fan's so it doesn't get overheated an burn itself. Now other side that is cool side the temperature can go below 5 degree Celsius. Now on cool side we will mount blower fans so that we can blow the cool air into the vehicle's cabin. In this we way we can maintain the vehicle's cabin temperature at an ambient temperature. We will also design a breaker circuit which will automatically shut down the circuit as the temperature on hot side goes above operating temperature. In this way we can achieve a long lasting circuit which we increase the overall life of the cooling module.

3. EXPERIMENTAL SURVEY

The temperature range inside the cabin due to radiations incident on glass and heating up of cabin space are recorded for over a period of Week. During this period we measured the temperature inside the cars cabin. The temperature was measured during afternoon hours that is between 12:00PM to 03:00PM. Reason being that heat radiation from the sun is at max during this period. We got an average temperature reading of 45-50 degree Celsius. Ambient outside temperature ranging between 34 to 38 degree Celsius.

4. CALCULATION

4.1 Cooling load calculation

$Q_c = mC_p\Delta T$

$m = P.l$ Where, P=1.455 kg/m^3 at 34°C

$a = v.A$

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

Cross section area of the rectangular duct (W×H) was calculated as 0.0054128 m^2

$\therefore l = 0.0216512\ m^2$/s

Mass flow rate of air(m)=$P.l$

m = 0.02480144 kg/s

$\Delta T = T_{in} - T_{out}$ (Assumed)

It is assumed that there will be drop in temperature of air from 35°C to 28°C. When it passes thru the cooling fins.

$\therefore \Delta T = 7°C$

C_p at 35°C is taken 718 J/Kg.k

$\therefore Q_c = mC_p\Delta T$

$\therefore Q_c = 124.65\ W$

Therefore based on calculations we have selected Peltier module

4.2 Selection of Peltier

Thermoelectric Cooler -12706 operates with an optimum voltage of 12V. It has maximum voltage of 15.4V. At 12V it draws and maximum DC current of 6A. The maximum power is 92W. It has a maximum operating temperature of 138 °C. The charts from the Peltier module manufacture were also analysed while choosing the Peltier module. It had been decided to choose 2 Peltier modules of the same model so that when the power of all the 4 Peltier modules is higher than the calculated cooling load. The minimum power rating for 2 Peltier modules added together was more than the cooling load calculated. So it was acceptable to select the 92W × 2= 184W > 124.65 W. The Peltier module was selected considering few factors such as dimensions, Qc, power supply and etc. The model no. of Peltier module is Thermoelectric Cooler 1-12706. The idea was to select a Thermoelectric Cooler which has a cooling power greater than the calculated Thermoelectric Cooler

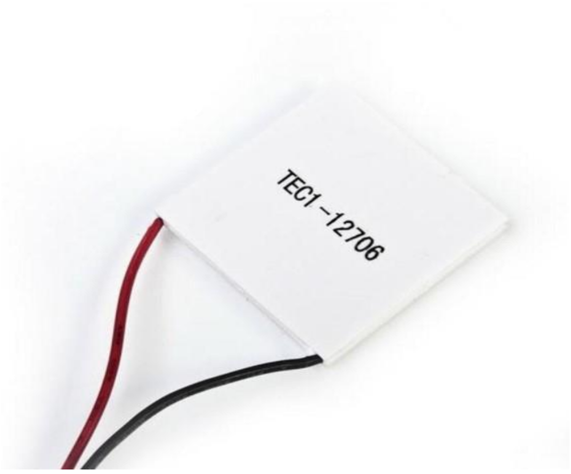


Fig 1: Peltier module

4.3 Design analysis and calculation of heat sink and cooling fins

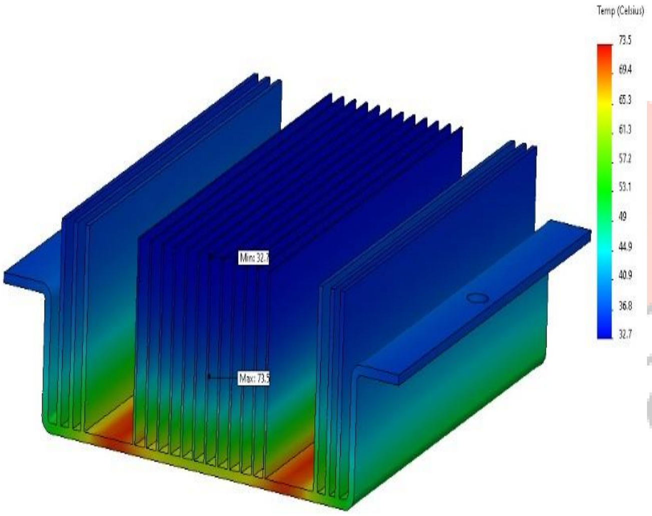


Fig 2: Heat sink

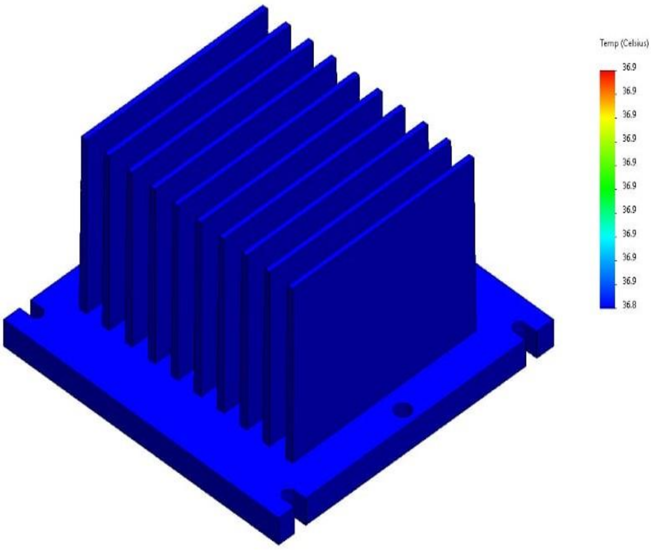


Fig 3: Cooling fins

N = 21 fin

L = 2 cm = 20 mm

W =10 cm = 100 mm

T = 1 mm

T_B = 70℃

T_A = 34℃

h = 210 W/m^2k

k = 205 W/mk

$$m=\sqrt{\frac{2h}{kT}}$$

m = 45.2634 m^{-1}

L_c = 0.0205

$$n_{eff} = \frac{\tan h(m.Lc)}{m.Lc}$$

n_{eff} = 0.786 = 78%

∗Calculating area of fin

Area of fin = 2.w.L_c

Area of fin = 4.1×$10^{-3}$$m^2$

∗Rate of heat transfer at (T_A = 34℃)

$\dot{Q}$= n_{fin} .h_a. A_{fin}(T_B-T_A)

$\dot{Q}$ = 24.36 W

∗Rate of heat transfer at (T_A =36℃)

$\dot{Q}$ = 23.009 W

∗Rate of heat transfer at (T_A =38℃)

$\dot{Q}$ = 21.65 W

∗Rate of heat transfer at (T_A =40℃)

$\dot{Q}$ = 20.30 W

4.3.1 Now for complete heat sink

Consider h = 154 W/m^2k

$$m = \sqrt{\frac{hP}{kA}}$$

= 38.95

∗Efficiency of fin

$$n = \frac{\tan h(m.L_c)}{m.L_c}$$

= 0.830

= 83%

∗Effective area, A_{ea}

$A_{ea} = A_b + (n_a \times A_f \times N)$

$= 8.59 \times 10^{-3}\ m^2$

$\dot{Q} = h \times A_{ea} \times (T_B - T_A)$

= 47.62 W

Now, T_A = 36℃

= 44.98 W

Now, T_A = 38℃

= 42.33 W

Now, T_A = 40℃

= 89.68 W

4.3 Cooling fan

Fig 4: Cooling fan

Cooling fan Dimensions: 40×40×40 mm

Airflow: 20CFM

No. of fans: 2

These will be mounted on the heat sinks of the hot side their purpose is to blow cool air onto the heat sink so that the Peltier module doesn't gets overheated and burn itself.

5. DESIGN OF HOT AIR OUTLET

Fig 5: Rear passenger window

Fig 6: ventilation duct

Fig 7: ventilation duct

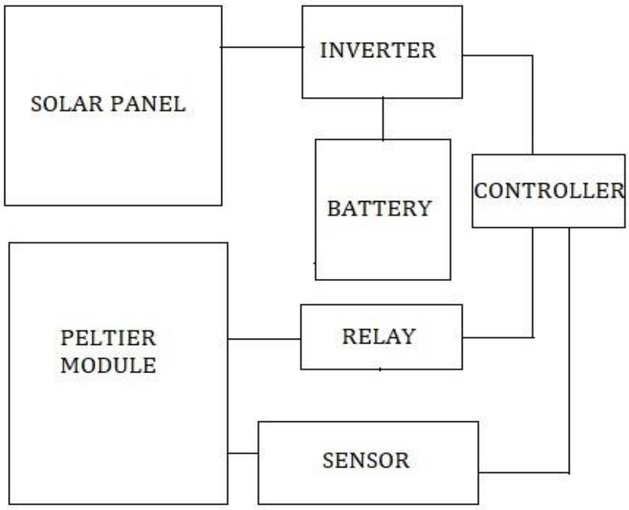
This will be used for removing the hot air that would be generated on the hot side of the Peltier module. This will be mounted on rear passenger window. First the window needs to be rolled down partially and then place the ventilation device between the glass and the glass seal of the window. A cooling module is placed inside cooling chamber. This will throw cool air inside the cars cabin.

6. DESING OF COOLING UNIT

Fig 8: cooling unit

The design of the cooling unit it is designed using solid works this is how the setup is of the cooling unit will look after its complete fabrication. It will be placed inside the ventilation duct the cool side will be inside the cars cabin and hot side will be outside the cars cabin. The cooling side consist of two small DC fans that will blow cool air inside the cars cabin to achieve maximum cooling of the cabin air and reduce the cabin temperature

7. BLOCK DIGRAM OF CIRCUIT



8. RESULTS

The system as per our calculations will be able to maintain temperature close to ambient temperature. The system is power efficient and reliable as well. It will meet the expectations of the consumer requirements. The implementations and ergonomics of the system are easy. This project was just an effort to demonstrate how Thermo electric cooler can be used for cooling in a non-conventional way and there is a future scope for this technology with new and more efficient Peltier modules.

9. CONCLUSION

As per the decided aim the system was able to achieve acceptable results of maintaining ambient temperature. By the method of air recirculation air was drawn into the cooling chamber and passed over the cooling fins where the temperature of the air dropped and then the air by means of blower fans again thrown back into the cabin. On the other side the cooling fans blow air onto the heat sink and kept the Peltier module in operating temperature. The system used two thermos electric cooling unit running in parallel to achieve maximum cooling. System has efficiency of 80-85 percent with all the accessories included. This system works on solar power. So there is no stress on any of the cars electric component.

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