Application of Thermo Electric Cooler for controlling temperature rise inside parked cars

Submitted in partial fulfillment of the requirements
Of the degree of

MASTER OF TECHNOLOGY
IN
CAD/CAM
By

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GREATER NOIDA
2020

CERTIFICATE

This is to certify that the Research work titled **Application of Thermo Electric Cooler for controlling temperature rise inside parked cars** that is being submitted by **Alok Bharti** is in partial fulfillment of the requirements for the award of **Master of Technology**, is a record of bonafide work done under my guidance. The contents of this research work, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma.

Supervisor

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This dissertation report entitled **Application of Thermo Electric Cooler for controlling temperature rise inside parked cars** by **Alok Bharti** is approved for the degree of bachelor of technology in mechanical engineering.

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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Alok Bharti
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Date: ___________

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The contributions of many different people, in their different ways, have made this possible. I would like to extend my gratitude to the following.

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(Alok Bharti)

ABSTRACT

Parking a vehicle under the sun for a short period of time can rapidly increase the interior air cabin temperature no matter in clear sky days or even in partially cloudy days. These circumstances can be anxieties to car occupants upon entry. Also the heat radiation coming from the sun enters the car cabin may affect the car interiors badly, due to which the lifespan of some component decreases rapidly. When the passengers enters into the vehicle and start the AC system, for some time after turning on the AC there is thermal discomfort that passengers can feel. The duration of discomfort depends upon the AC system.

The main objective of this dissertation work is to develop a system with application of Thermo Electric Cooler to control the inside temperature of a parked car. In this work, we performed transient thermal analysis with the help of commercial software ANSYS on a car standing under the direct sunlight to get the approximate increase in temperature inside a car. Based on the amount of increase in temperature inside a car compartment, we selected the peltier and form a TEC module. After getting the number of TEC modules that should be used we will calculate the power required to run the system which will help us in selecting the PV module.

The main focus of this work is to develop a system which will be efficient and easy to install in comparison to already developed systems to control the ascend in temperature inside the car compartment.

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List of abbreviations

1. TEC	Thermo electric cooler.
2. PV	Photo voltaic.
3. BTU	British thermal unit.
4. AC	Air conditioner.

List of figures

1
Introduction

1.1 Project background

On a hot day, when a vehicle is parked without shade, the temperature of the car compartment will increase. Because of ascend in temperature, sometimes it becomes life-threatening for the children and pet and also create lots of thermal discomfort for the travelers. According to the reports, around one billion units of cars travel the street and road in the world. But due to lack of shaded covered parking space most of the time, many cars are directly parked under direct sunlight. Due to parking in an open area without shade, the car compartment temperature ascends. Temperature increases in car cabin is basically due to convection, conduction and sun rays are the most effective elements which play a vital role in ascending the temperature of the car cabin. Because of ascending in the temperature of the car compartment passengers feel very uncomfortable and also it reduces the quality of rubber, seat, plastic, etc. According to the reports, turning on ACs while driving consumes 25% of the total fuel used to travel. This implies that the average of the car also decrease due to ascend in temperature inside the car compartment. Hence it is very much important to have a good oxygenating system to decrease the temperature of the parked car compartment. Researchers had developed various systems to manage the compartment temperature of the vehicle either via solar reflective cover or solar-based oxygenating system. To overcome this issue, systems like the solar car ventilation system and solar reflective cover had been developed. The solar ventilation system is not able to meet the cooling required and also it is unable to provide the same temperature throughout the cabin. The solar reflective cover has a drawback that it requires a lot of time to cover the car by solar reflector. Instead of these systems we can use automatic solar-powered thermoelectric cooling so that we can manage the temperature of the car compartment. This system is easy to adopt as well as efficient to use because of dependency on solar energy.

1.2 Aim and Objective

The aim of this dissertation work is to develop thermoelectric cooling system for car to control the temperature inside the car cabin. Also the thermoelectric cooling system will not dependent on battery. This system will rely on solar energy which it will get with the help of solar panel. In this work, we will do transient thermal analysis with the help of commercial software ANSYS on a car standing under the direct sunlight to get the approximate increase in temperature inside a car. Based on the amount of increase in temperature inside a car compartment we will select the peltier and form a TEC module. After getting the number of TEC modules that should be used we will calculate the power required to run the system which will help us in selecting the PV module.

2

Literature review

2.1 Introduction

During summer, the temperature in many countries mainly in gulf countries reaches up to 55 ºC. But now in India also mercury is touching 50 ºC mark in some parts of the country. According to the reports, around one billion units of cars travel the street and road in the world. But due to lack of shaded covered parking space most of the time, many cars are directly parked under direct sunlight. Due to parking in an open area without shade, the car compartment temperature ascends. Temperature increases in car cabin is basically due to convection, conduction and sun rays are the most effective elements which play a vital role in ascending the temperature of the car cabin [4, 5]. Because of ascending in the temperature of the car compartment passengers feel very uncomfortable and also it reduces the quality of rubber, seat, plastic, etc. According to the study published in the online journal "TEMPERATURE" an average of 37 children die after being left in hot cars. To reduce the heating some people use to cover their car and some use to leave a small gap in the car window. However, study [6] shows that these type of measures was very less effective in improving the situation. It also increases the chances of theft. Hence it is very much important to have a good oxygenating system to decrease the temperature of the parked car compartment. Researchers had developed various systems to manage the compartment temperature of the vehicle either via solar reflective cover or solar-based oxygenating system. This work deals with the investigation of the already developed systems available for managing the temperature of the car compartment and also factors that are responsible for the rise of temperature of the car compartment.

2.2 Reviews

In this paper researchers did an experiment that was performed on a car that was parked in a certain direction and location. The researchers did an experiment by parking a car without shade for a long time on a hot day in Muscat. The study showed that, with the ventilation device, the time taken to lessen the temperature also become less within the car compartment. With advanced ventilation device, the internal temperature of the car cabin reached to the desired degree in lesser than the half of the time in comparison to the ones values tested without ventilation gadget. The developed ventilation system increases the total average of the car due to a decrease in fuel consumption for cooling purpose. However, the decrease in temperature was not the same throughout the car. Figure 1 showing the overall rise in temperature in the front zone of the car at 12 noon. The graph showing that the ambient temperature was 40^{o}c and car without ventilation system, the temperature reaches to around 65^{o}c in just 15 minutes whereas, a car with ventilation system, the temperature reaches to 50^{o}c in 15 minutes.

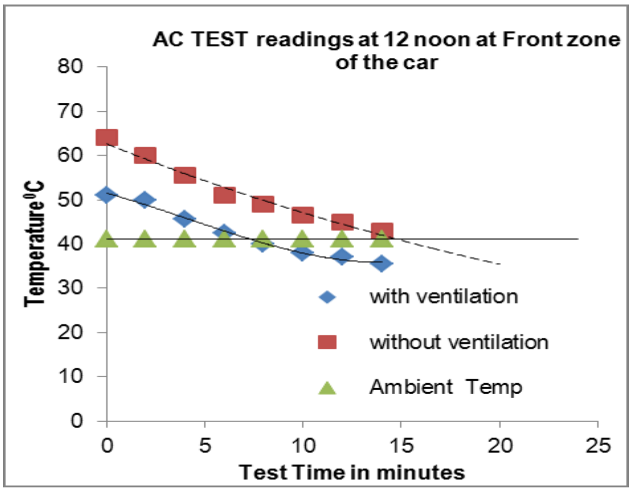

Figure 1: AC test reading at 12 noon at front zone of the car

Figure 2 showing the overall rise in temperature in the middle zone of the car at 12noon. The graph shows that the car without ventilation system, the temperature reaches to 55^{o}c in first 15 minutes whereas in car with ventilation system the rise in temperature was very low i.e. around 42ºc when the ambient temperature was 40ºc.

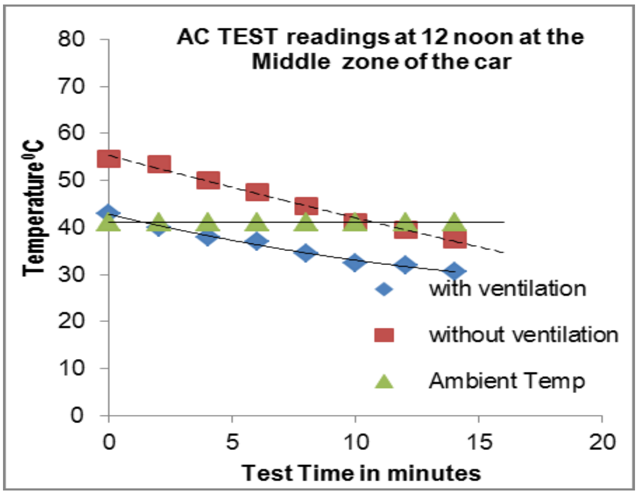

Figure 2: AC test reading at 12 noon at front middle zone of the car

Figure 3 showing the overall rise in temperature in the rear zone of the car at 12 noon. The graph shows that the car without ventilation system, the temperature just exceeds to 60ºc whereas in car with ventilation system the temperature reaches close to 50ºc when the environment temperature was 40ºc.

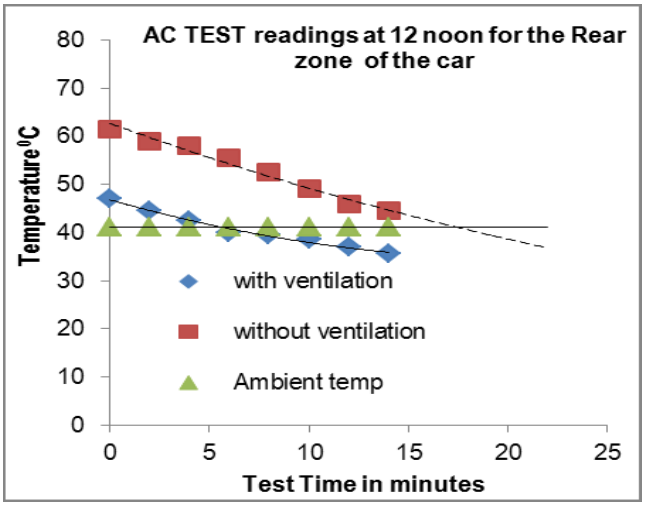

Figure 3: AC test reading at 12 noon for the rear zone of the car

It became cited that the car cabin with a ventilation device was around 10ºC cooler than a car without a ventilation device.[1]

In this paper researchers did a test that was implemented on a car to assess the effect of solar reflective cover on vehicle compartment temperature. This test was performed in UKM, Bangi city, Malaysia. Where the ambient temperature was 33°C with partly clouded day. There were four cases considered in this experiment: first case: car with and without SRC (at different measurement time) the investigation showed (figure:4) that 39.6°C temperature was observed within the car compartment with SRC which was lower than the car without SRC nearly by 19°C ; second case: usage of two similar cars concurrently (SRC as opposed to baseline) investigation showed (figure:5) that when two identical cars were exposed under the direct sunlight for 75 minutes the temperature within the car compartment increases rapidly for initial 15 minutes and then in next 60 minutes it touches the temperature value of 55.4°C. The result of this experiment showed that there was approximately 13.4°C temperature distinction between SRC and baseline.; third case: usage of two similar cars concurrently (solar reflective film (SRF) as opposed to baseline) investigation showed (figure-6) that in the beginning the temperature inside a car with SRF was more in comparison to the baseline and after 18 minutes the temperature inside a car with SRF and with baseline become almost same. The result of the experiment showed that the SRF was not able to decrease temperature up to the expectation and the difference between SRF and baseline was not that significant. Fourth case: usage of two similar cars concurrently (SRF versus SRC) it was observed (figure-7) that the compartment temperature of the car rises rapidly with SRC for first the 7 minutes and then continue to reach the maximum value of 45.9°C. In-car cabin with SRF the temperature increase rapidly for 14 minutes and then continues to ascend till it reaches the maximum value of 60.1°C. Overall investigation showed that SRC is cooler then SRF by approximately 14°C. [2]

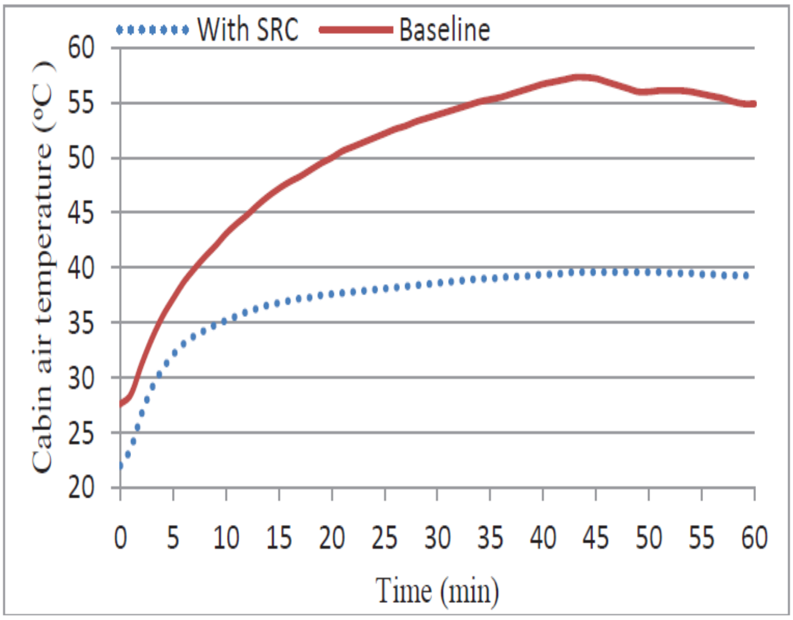

Figure 4: Comparison of cabin soaks air temperature at breath level (SRC versus baseline) using one car with measurements at different time

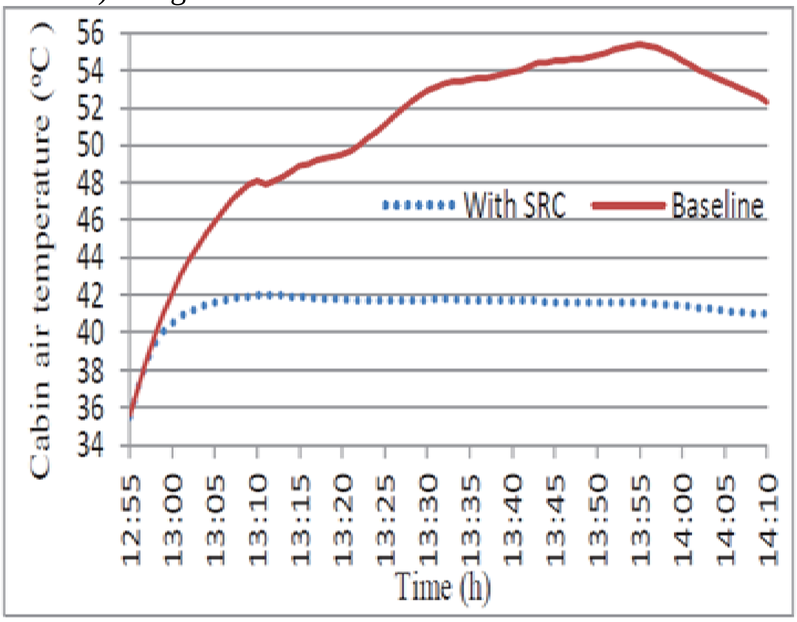

Figure 5: Comparison of cabin soaks air temperature at breath level (SRC versus baseline) using two identical cars concurrently

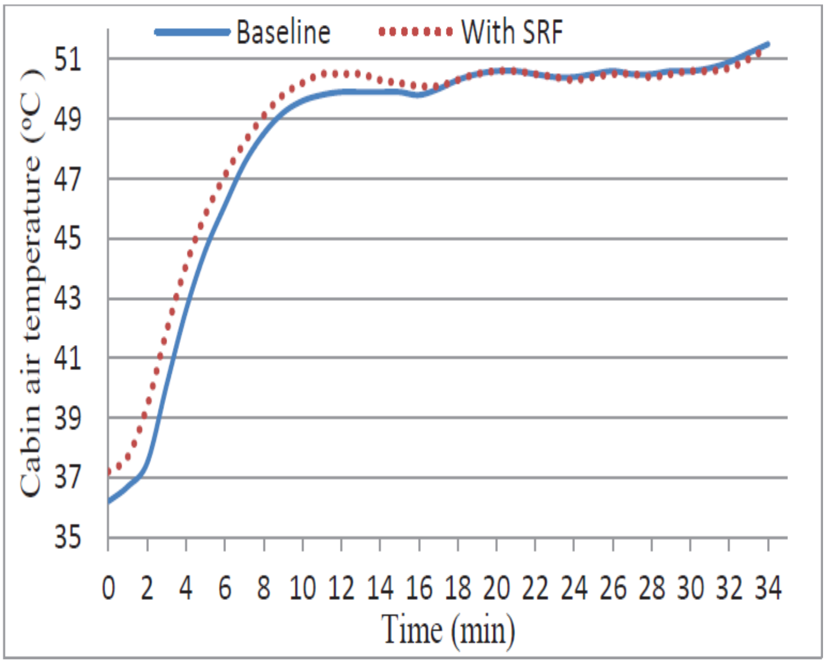

Figure 6: Comparison of cabin soaks air temperature at breath level (SRF versus baseline) using two identical cars concurrently

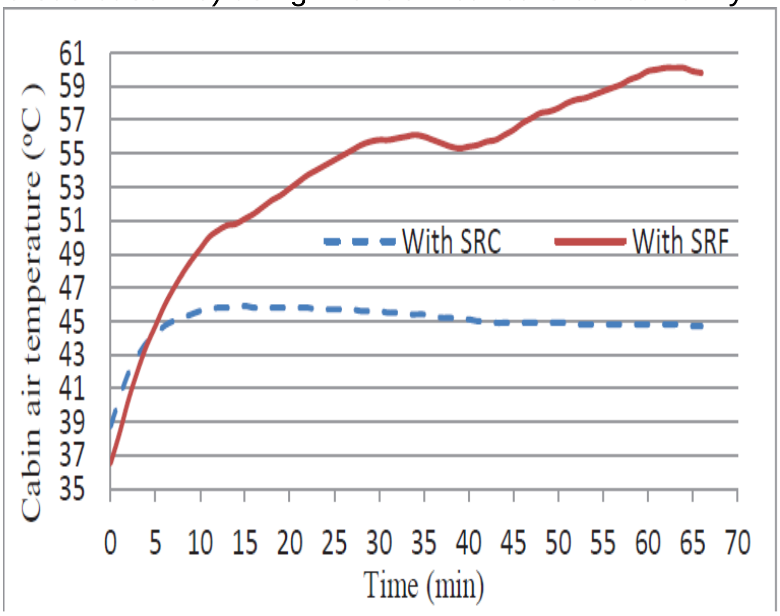

Figure 7: Comparison of cabin soaks air temperature at breath level (SRC versus SRF) using two identical cars concurrently

In this paper researchers demonstrated that when the car is parked below the direct sunlight the temperature within the car compartment can be greater than 20°C in comparison to the ambient temperature. During summers the temperature within the vehicle compartment can be more than 70°C when the vehicle is standing below direct sunlight with close windows. Basically due to the close windows of cars the greenhouse effect came into the picture and due to this temperature rise sharply inside the cabin. This much rise in temperature within the car compartment can be life-threatening for children left unattended inside the car. The overall rise in temperature within the car compartment depends upon the weather condition and season. Summers with clear days, the temperature within the car compartment ascends with an average value of 68 degrees C and 61°C in the spring season. Cloudy days were recorded nearly 10°C cooler than clear days in both summer and spring. According to the investigation it was found that even during cloudy days the temperature rise in the car cabin can be life- threatening. This paper also showed that the rise in temperature also depends upon the color of the car. It was observed that the rise in temperature within the dark color cars was more than light color cars by nearly 5%. This research paper also concluded that, due to the rise in temperature above 65°C which is not suitable for children and pets. This research paper also advise some prevention method like solar wall exhaust to extract heat from the cabin, steering cover, etc.[3]

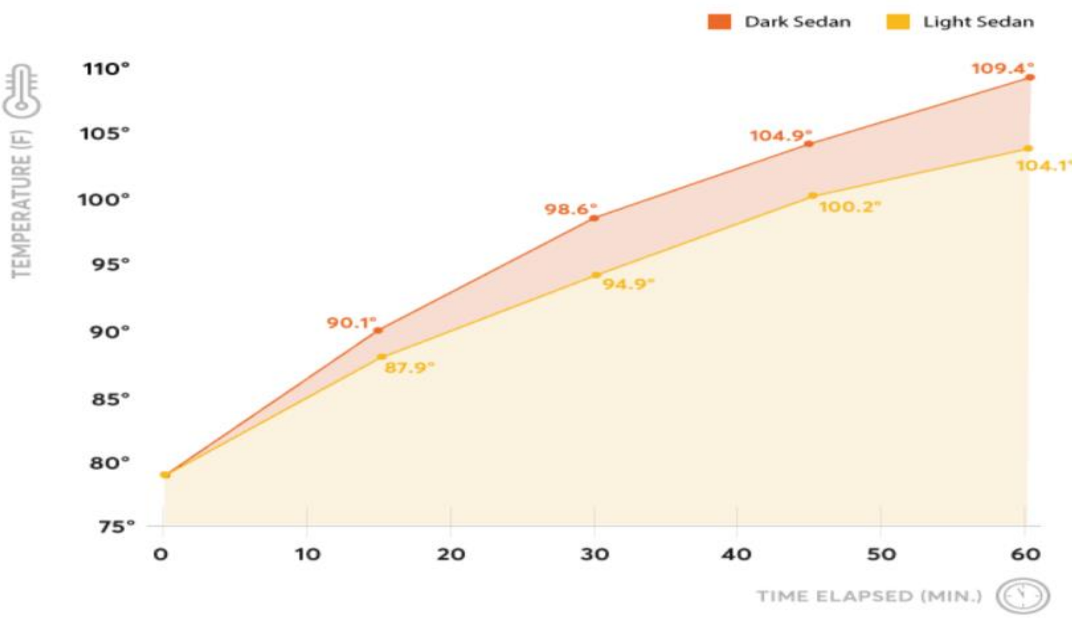

Figure 8: vehicle temperature rise in one hour

3
Problem description

During a hot day when cars parked without shade under the sun with closed windows, experience rapid increase in temperature inside the compartment.

Radiation energy coming from the sun are absorbed by the cars which are parked without shade under the sunlight, due to which the temperature of the car compartment increases at a faster rate resulting in health problem for the minors and old people. During a hot day, the temperature inside the car compartment increases up to 45ºC.

Countries which are in Middle East experience a drastic increase in car compartment temperature when a car is parked in an open area under direct sunlight and hence it becomes intolerable to touch the steering and dashboards.

Due to this much increase in temperature inside the car cabin, high amount of thermal discomfort to the passengers initially after entering in to the car compartment.

In general during such rise in temperature, the driver of the car turn on the AC when enters into the car. The turning on the AC reduces the temperature inside the vehicle but this cooling process takes sometimes and in that time drivers and passenger feels uncomfortable inside the compartment.

Also the turning on the AC means that drivers has to start the engine, resulting in reduce in overall mileage of the car.

There are several problems occurs due to rise in the temperature inside the car compartment like; life of the component will reduce, dangerous fumes will be ejected, decolourisation of interior, weathering effect, broken glasses due to excessive heating etc.

According to the study published online in journal “Temperature”, every year in the United States, an average of 37 children die after being left in hot cars. This report shows that how deadly this problem is.

As we saw above that many problems are occurring due to the temperature increase in the car compartment when the vehicle is parked under the direct sunlight causing many health risk to the passengers and car components.

And also it is not possible for everyone to find the space under the shade to overcome this issue.

So we need to find an alternate method to overcome the problem of heating even when the car is parked under the direct sunlight without the shade.

4
Methodology

4.1 Existing Methodology

Solar reflective cover

Here in this method of overcoming the heat generated inside the car cabin, solar reflective cover is used. In this method a solar reflective cover is used to cover the car from outside when a car is parked under the direct sunlight. This method is a good technique to overcome the heat generated but at the same time it is a time taking process to cover the car whenever parked under direct sunlight. This is system is also not that efficient at high temperature that is above 40^{o}c.

Solar ventilation system

In this method of overcoming the heat generated inside a car compartment, solar ventilation system is used. In this system a fan is used to circulate the fresh air from into the cabin. This system is efficient because it is based on solar energy that means no battery power is used by this system. But this system is not able to provide same cooling throughout the cabin and also efficiency is low when it comes to cooling the cabin.

4.2 Proposed Methodology

Here we are going to use thermoelectric cooling method to control the temperature of a car compartment when parked under the direct sunlight for long hours. In this method we have selected Mazda car for which design is made using a 3d modelling software catia V5. Now we know that we have a defined volume of the compartment which we have to cool.

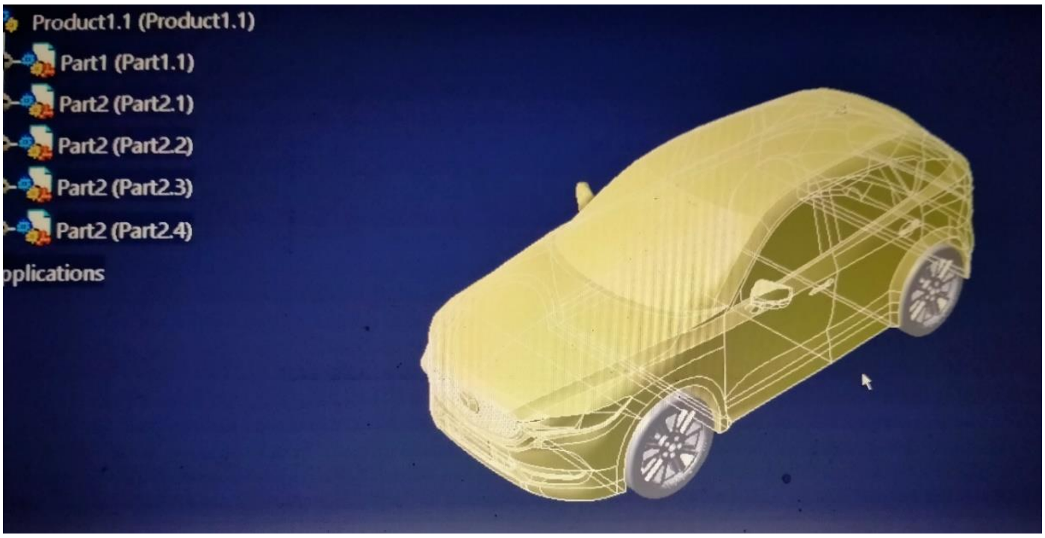

Figure 9: Tata Mazda modelling on catia V5

Now to get the total heat load inside the car cabin we had also design a cabin of same volume we did above. This design help us to calculate the heat load manually because of simplified design.

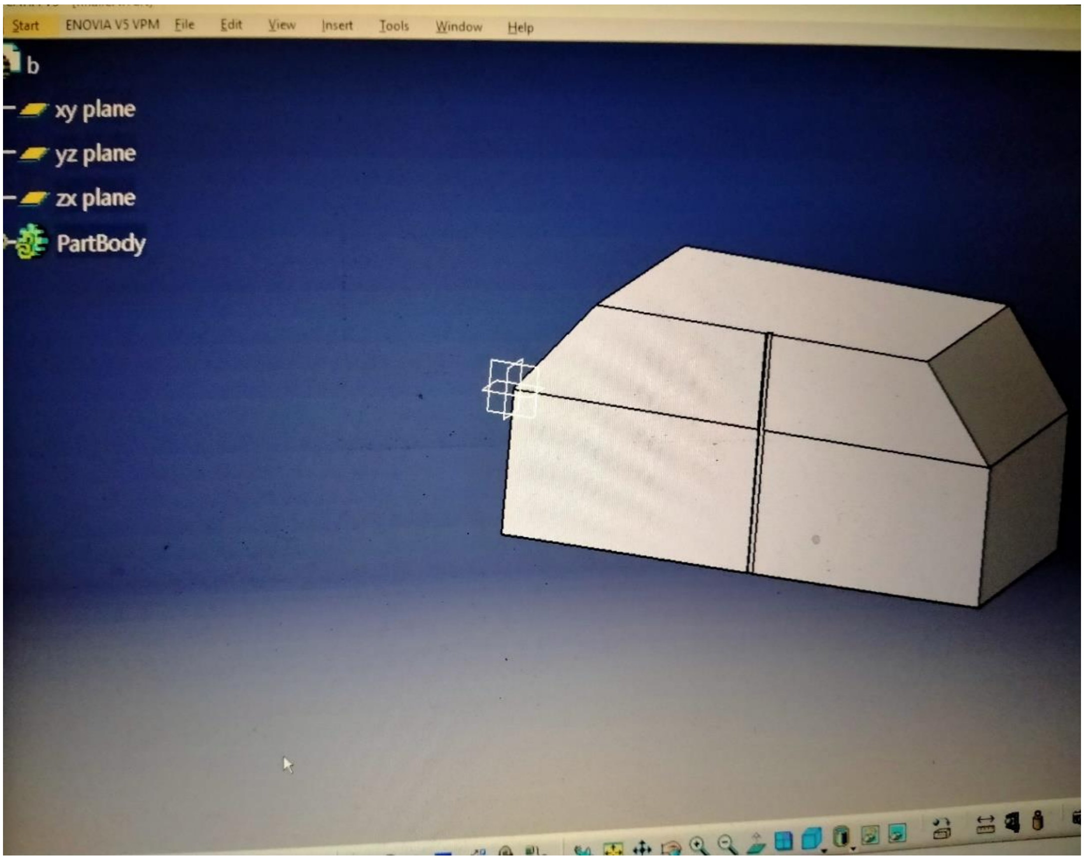

Figure 10: modelling object similar to car cabin on catia V5

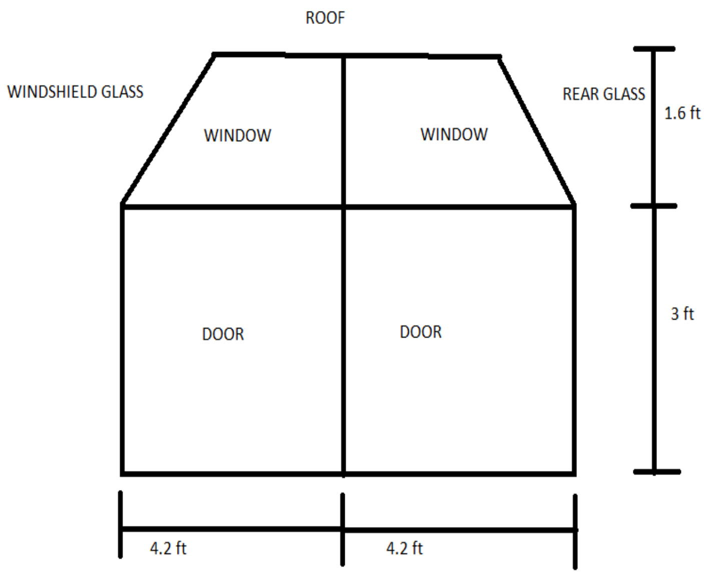

Figure 11: dimensional drawing of object similar to cabin.

Heat load calculation

Here while doing heat load calculation the assumption taken is:

Cabin temperature = 25 degree Celsius

Environment temperature = 40 degree Celsius

Equation for calculating heat load is, Q=U.A.ΔT

Where,

U= coefficient of heat transfer

A= surface area

ΔT= outside temperature-inside temperature

Heat load calculation for doors

Q=U.A.ΔT

Q=1.2*(4.2*3)*(104-77) {U=1.2: for steel}

Q=408.24 BTU/HR

Now, from all 4 doors

Q= 408.24*4

Q= 1632.96 BTU/HR

Hence, heat entering rate through all four doors of car at 40 degree Celsius is 1632.96 BTU/HR.

Heat load calculation for roof

Q= U.A.ΔT

Q= 1.2*(5.2*3.3)*27 {U=1.2: for steel}

Q= 555.984 BTU/HR

Hence, heat entering rate through roof of a car at 40 degree Celsius is 555.984 BTU/HR.

Heat load calculation for windows

Q= U.A.ΔT

Q= .5*(.5*1.6*1.6)*27 +(.5*(2.6*1.6)*27) {U=0.5: for glass}

Q= 73.44 BTU/HR

Now from all four windows,

Q= 73.44*4

Q= 293.76 BTU/HR

Hence, heat entering rate through all four windows of car at 40 degree Celsius is 293.76 BTU/HR.

Heat load calculation for windshield glass and rear glass

Q= U.A.ΔT

Q= 0.5*(4.1*2)*27

Q= 110.7 BTU/HR

Now from both windshield and rear glass,

Q= 110.7*2

Q= 221.4 BTU/HR.

Hence, heat entering rate through both windshield and rear glass of car at 40 degree Celsius is 221.4 BTU/HR.

Overall heat load of car cabin

Q (overall) =Q (doors) +Q (roof) +Q (windows) +Q (windshield +rear glass)

Q (overall) = 1632.96+555.984+293.76+221.4

Q (overall) = 2704.104 BTU/HR

So the heat entering into the car cabin at 40 degree Celsius when inside temperature of car cabin is 25 degree Celsius is = 2704.104 BTU/HR.

2704.104 BTU/HR= 792.49W

Rate of heat flow inside the cabin from the outside environment is 792.49W.

Transient thermal analysis

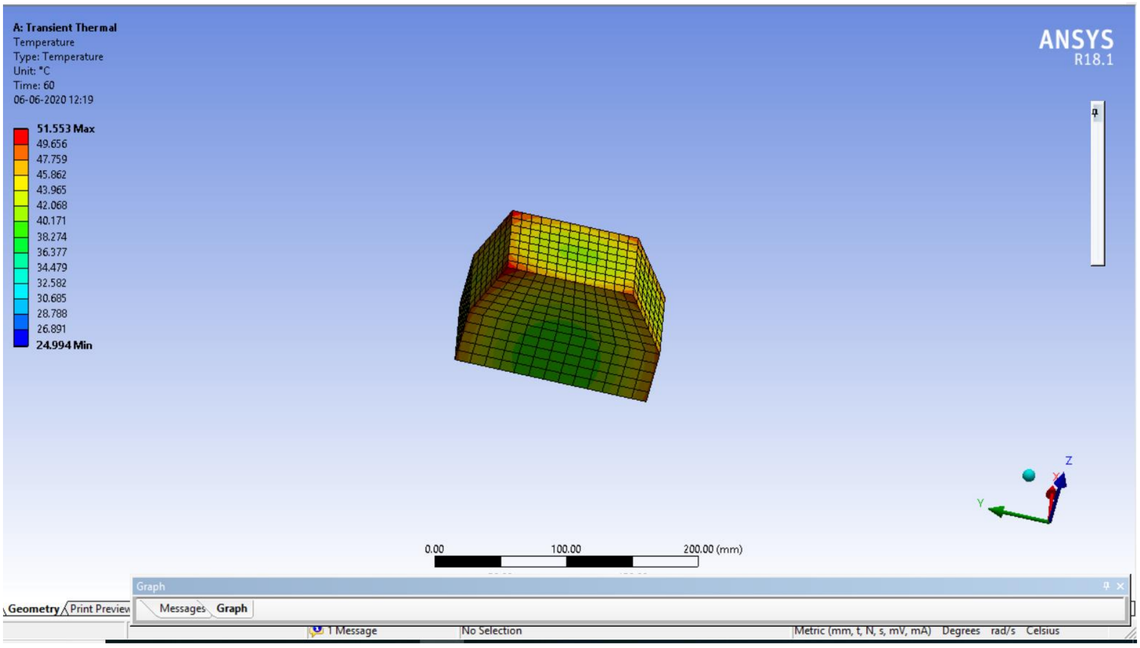

Figure 12: transient thermal analysis of car compartment when ambient temperature is 40ºc and compartment initial temperature is 25ºc.

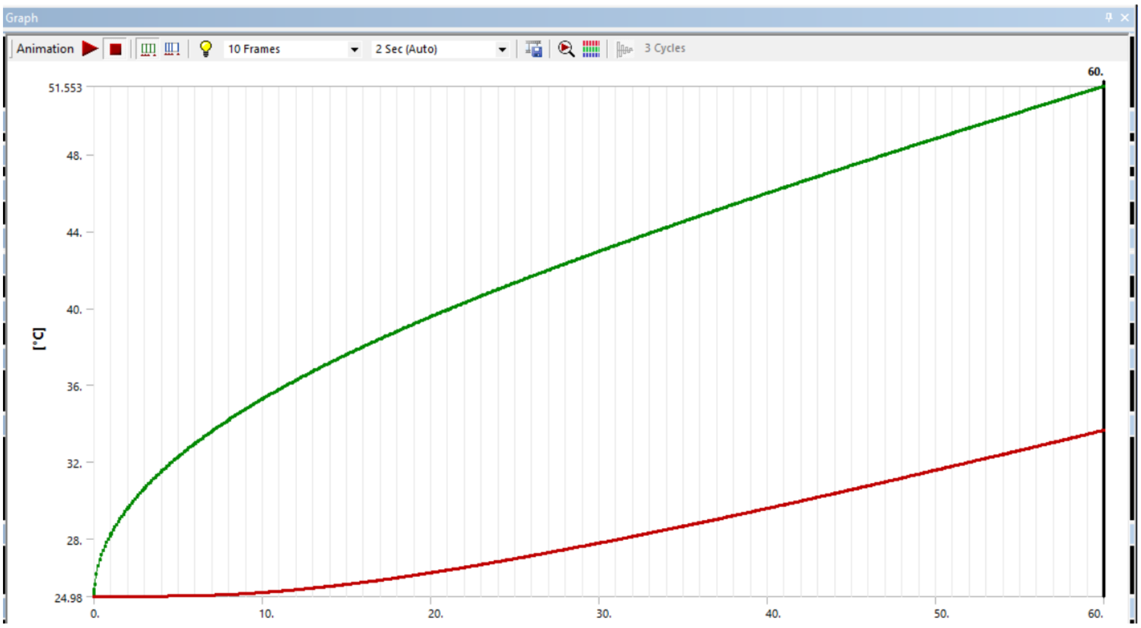

Figure 13: graph showing increase in temperature inside the compartment when ambient temperature is 40ºc and compartment initial temperature is 25ºc.

The transient thermal analysis of a car compartment when inside temperature is 25°c and ambient temperature is 40°c and rate of heat flow inside a car compartment is 790W shows that the maximum temperature of the compartment will be around 51.5°c in one hour whereas the minimum will be close to 34°c.

Thermoelectric data

Family	Cooling cap.	input voltage
150	100 BTU/HR	12/24 VDC

100 BTU/HR = 29.307W

family	Cooling capacity	Input voltage
300	210 BTU/HR	12/24/48 VDC

210 BTU/HR = 61.54W

family	Cooling capacity	Input voltage
470	315 BTU/HR	24 VDC

315 BTU/HR = 92.31W

family	Cooling capacity	Input voltage
590	460 BTU/HR	24VDC

460 BTU/HR = 134.81

family	Cooling capacity	Input voltage
1200	530 BTU/HR	24 VDC

530 BTU/HR = 155.32W

family	Cooling capacity	Input voltage
1400	850 BTU/HR	120 VAC

850 BTU/HR = 249.10W

Selection of TEC module

Based on the requirement we are selecting TEC of 530 BTU/HR capacity. The major criteria taking into consideration is the cost of single module and also least number of TEC module we can use.

Figure 14: peltier (TEC1-12715)

The technical term for TEC of capacity 530 BTU/HR is TEC1-12715 which we can easily get from the e-commerce sites.

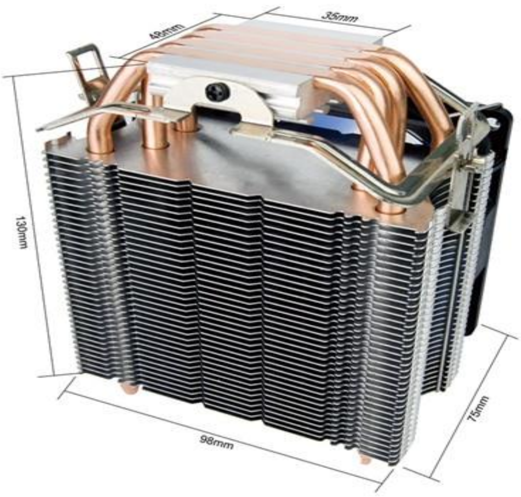

Figure 15: heat sink

To create a thermo electric cooling module we need to have a heat sink connected with a fan on the top of which we can fix our peltier. This heat sink also we can easily get from e-commerce sites.

<u>Transient thermal analysis with TEC module</u>

In this section we will do the analyses by using 2 TEC modules, 3 TEC modules, 4 TEC modules, 5 TEC modules and 6 TEC modules.

<u>Effect on temperature on using 2 TEC modules</u>

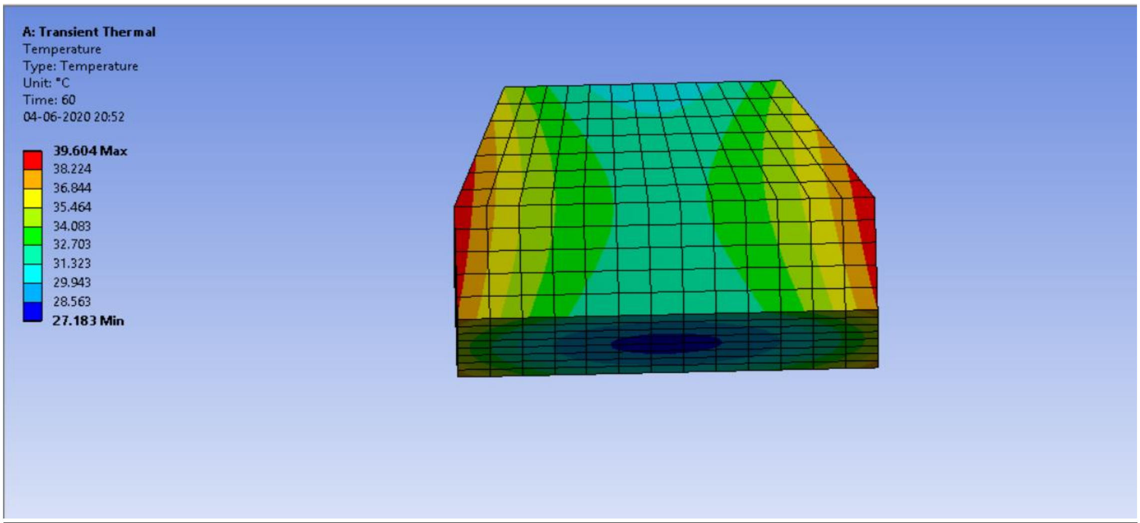

Figure 16: transient thermal analysis of car compartment when ambient temperature is 40°c, compartment initial temperature is 25°c and 2 TEC modules applied.

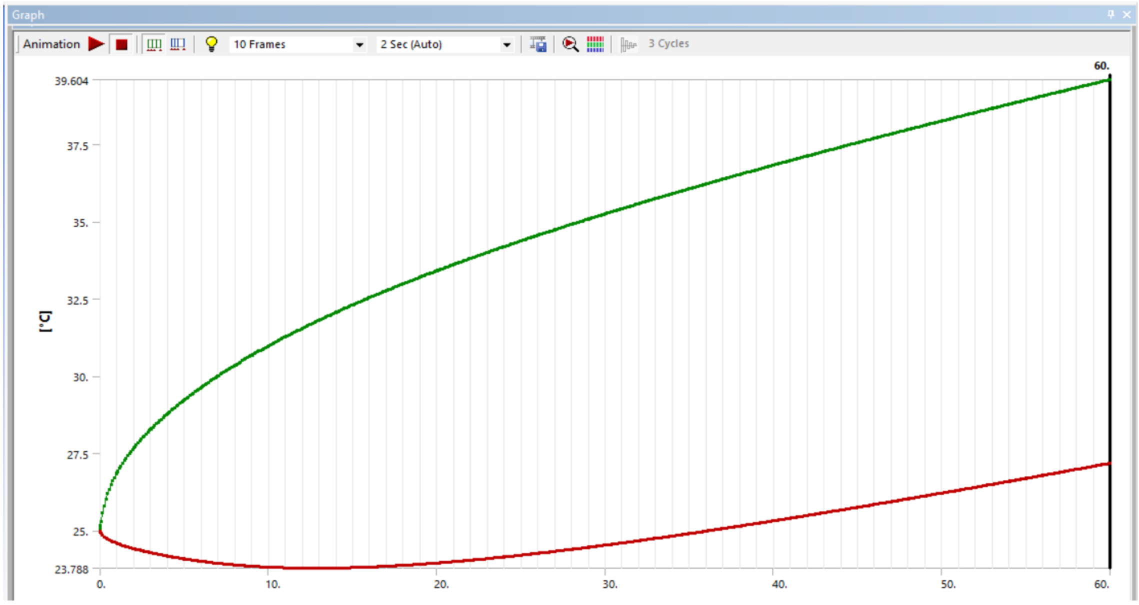

Figure 17: graph showing increase in temperature inside the compartment when ambient temperature is 40°c, compartment initial temperature is 25°c and 2 TEC modules applied.

On using 2 TEC module of capacity of 530 BTU/HR we can see that the temperature of cabin drop down to 39.6ºc in one hour which was earlier found to be 51.55ºc without TEC module.

Effect on temperature on using 3 TEC modules

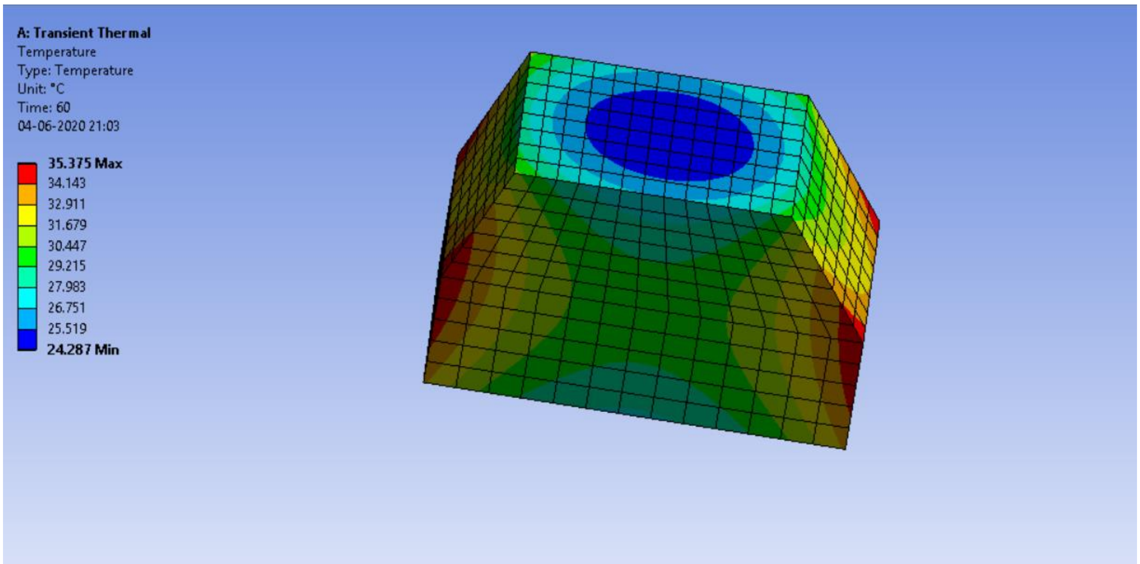

Figure 18: transient thermal analysis of car compartment when ambient temperature is 40ºc, compartment initial temperature is 25ºc and 3 TEC modules applied.

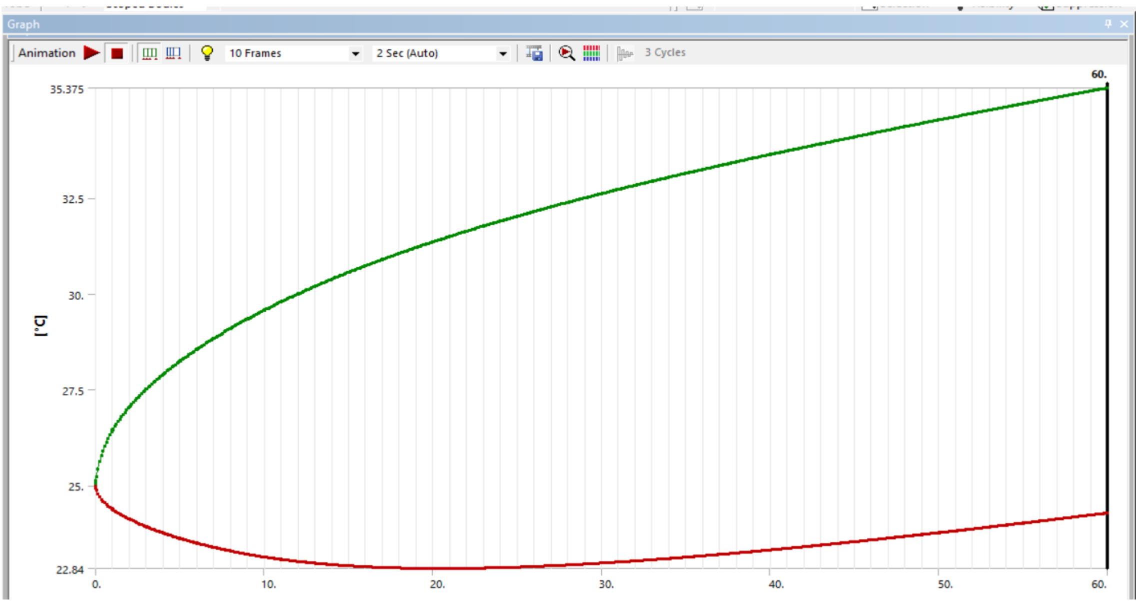

Figure 19: graph showing increase in temperature inside the compartment when ambient temperature is 40ºc, compartment initial temperature is 25ºc and 3 TEC modules applied.

On using 3 TEC module of capacity 530 BTU/HR, the temperature inside a car compartment drop down to approximately 35⁰c in one hour.

<u>Effect on temperature on using 4 TEC modules</u>

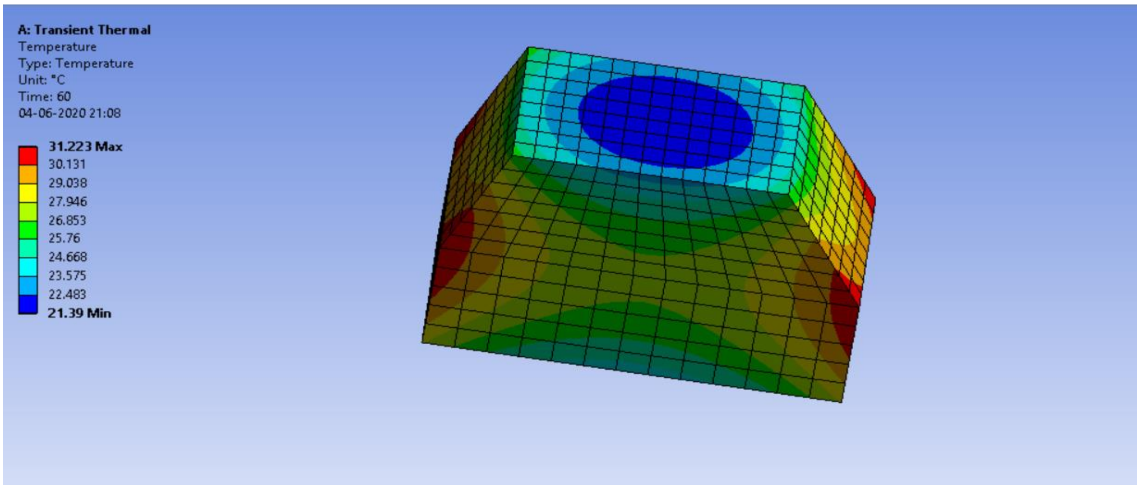

Figure 20: transient thermal analysis of car compartment when ambient temperature is 40⁰c, compartment initial temperature is 25⁰c and 4 TEC modules applied.

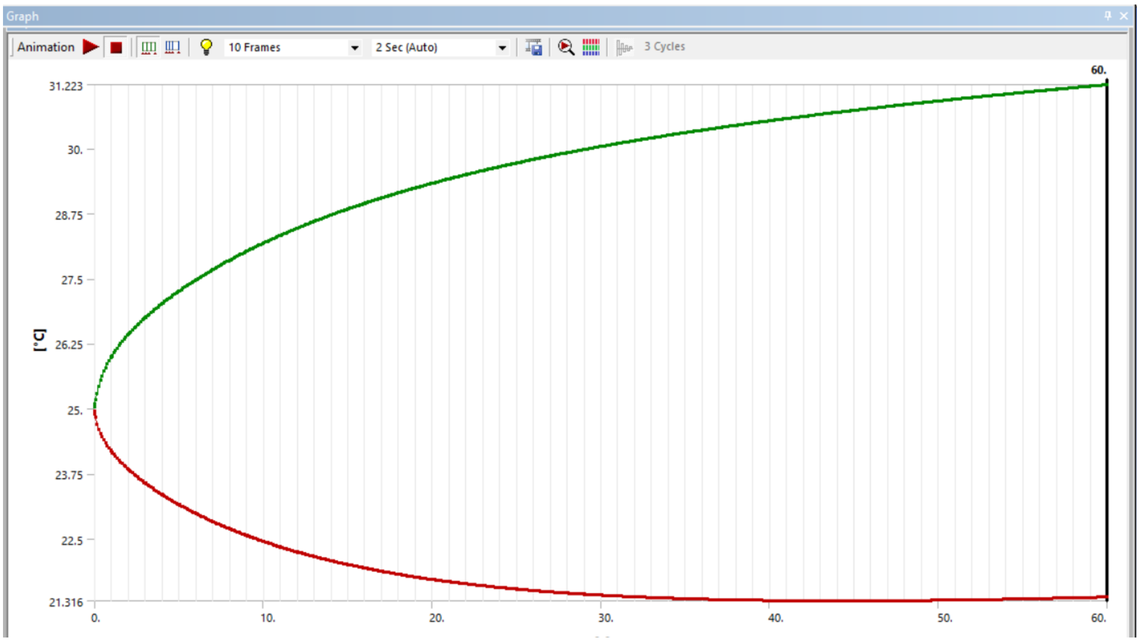

Figure 21: graph showing increase in temperature inside the compartment when ambient temperature is 40⁰c, compartment initial temperature is 25⁰c and 4 TEC modules applied.

On using 4 TEC modules of capacity 530 BTU/HR we observe that a car with 4 TEC modules is around 20⁰c cooler than a car without TEC module.

Effect on temperature on using 5 TEC modules

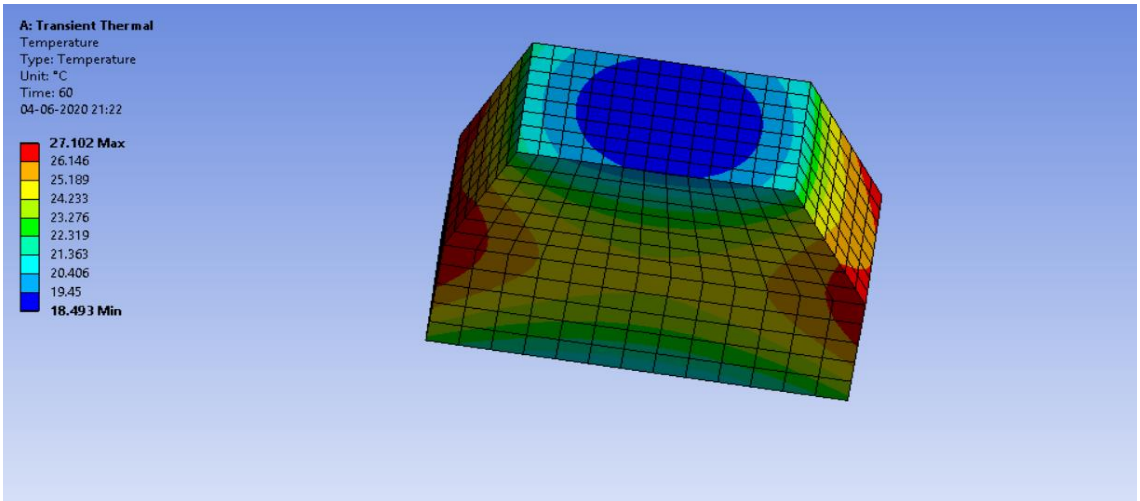

Figure 22: transient thermal analysis of car compartment when ambient temperature is 40^{o}c, compartment initial temperature is 25^{o}c and 5 TEC modules applied.

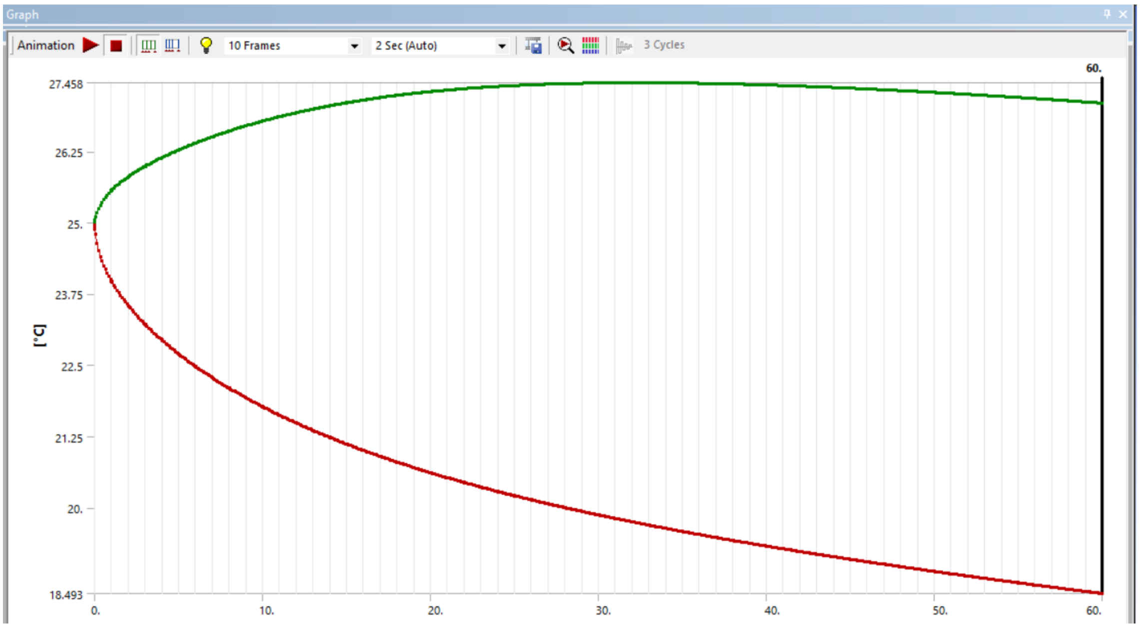

Figure 23: graph showing increase in temperature inside the compartment when ambient temperature is 40^{o}c, compartment initial temperature is 25^{o}c and 2 TEC modules applied.

On using 5 TEC modules of capacity 530 BTU/HR we can observe that there is only 2^{o}c approximately temperature increases in one hour inside a car compartment.

Effect on temperature on using 6 TEC modules

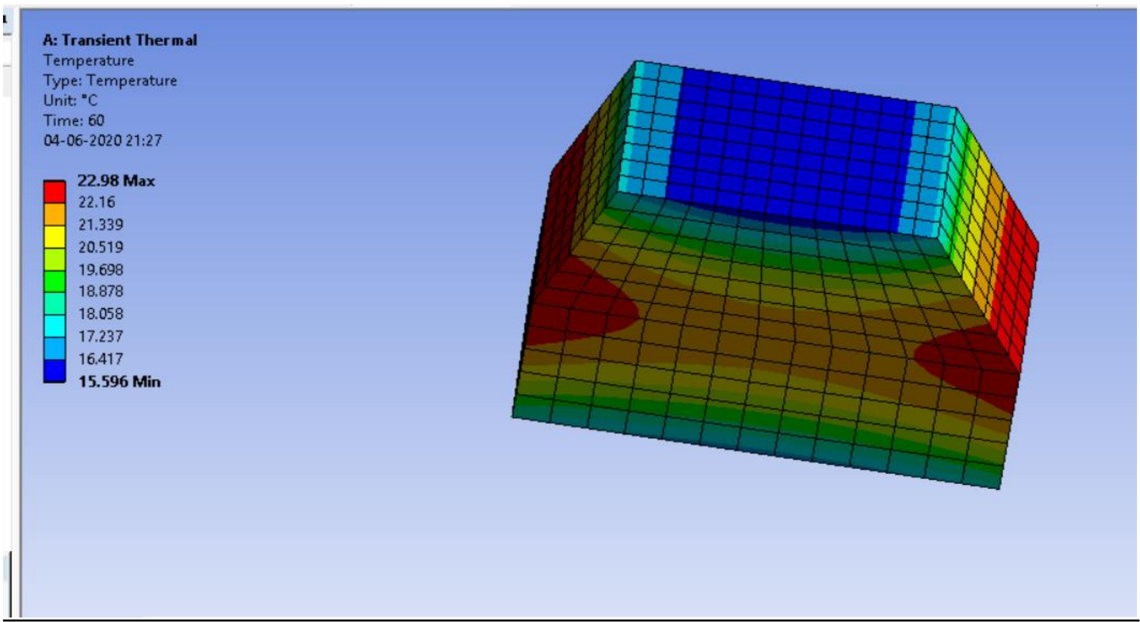

Figure 24: transient thermal analysis of car compartment when ambient temperature is 40°c, compartment initial temperature is 25°c and 6 TEC modules applied.

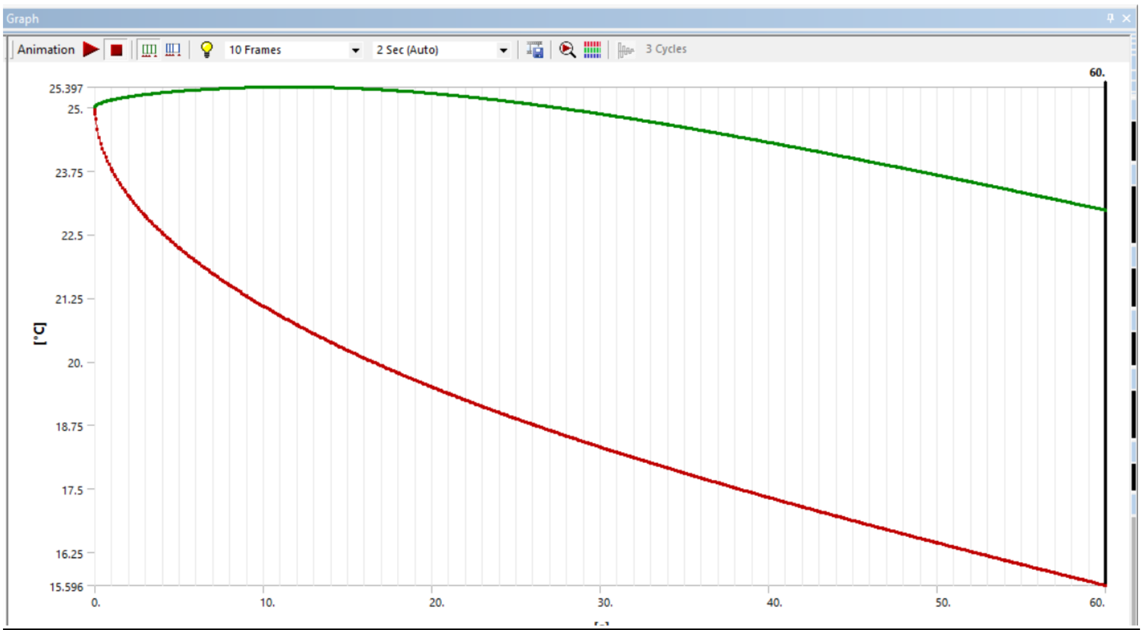

Figure 25: graph showing increase in temperature inside the compartment when ambient temperature is 40°c, compartment initial temperature is 25°c and 6 TEC modules applied.

On using 6 TEC modules of capacity 530 BTU/HR it is observed that the temperature inside the compartment decreases down to around 22^{o}c which is even lesser than the initial temperature inside a car compartment by 3^{o}c.

Selection of pv module

Basically we have two types of solar panels available in the market i.e. monocrystalline solar panel and polycrystalline solar panel.

In **monocrystalline solar panel** single silicon ingot is used and through a single silicon number of cells are developed. This type of solar panels are more purer because to make cells single silicon source is used. As a result monocrystalline solar panels are more efficient and the performance of this type of solar panels in high heat is better. Generally the look of this type of solar panel is black in color and have a sleeker aesthetic.

Monocrystalline solar panels are costly in comparison to polycrystalline.

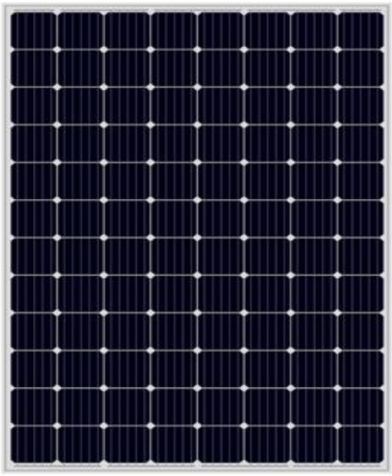

Figure 26: monocrystalline solar panel

Polycrystalline or Multicrystalline solar panels are made up of multiple pieces of silicon that are blended together. This type of solar panels are not purer as it is made out of multiple silicon pieces. As a result the efficiency of this solar panel is also less in comparison to monocrystalline solar panels. In general, polycrystalline solar panels looks blue in color.

Polycrystalline solar panels are cheaper than the moncrystalline solar panels.

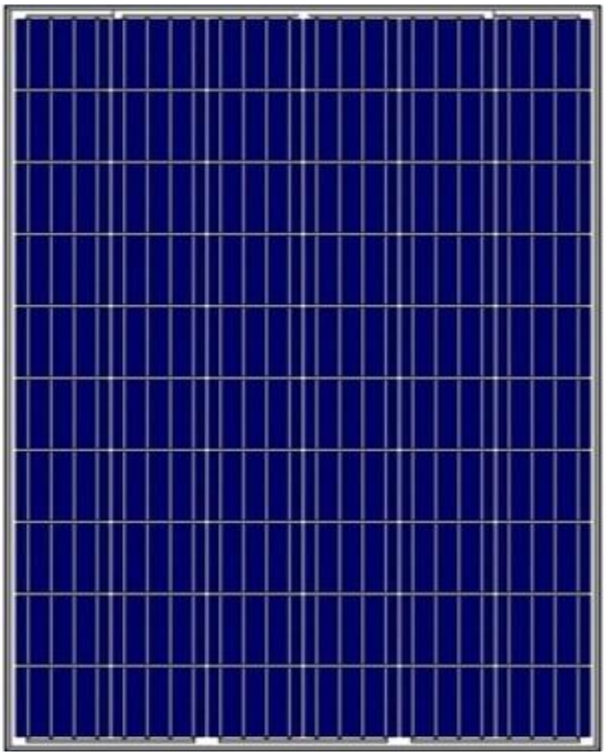

Figure 27: polycrystalline solar panel

While selecting the type of PV module we need to consider the total power requirement to run the system and the area available for setting up the solar panel.

<u>Power required</u>
Power required to run 1 TEC module is = 12*6=72 W
Power required to run 6 TEC module is = 72*6=432W

Total power required by the TEC system is 432 W in one hour.

We assume that on average 3 hours daily TEC system will be used i.e. 432*3= 1296W

We also assume that on an average daily solar panel will get the sunlight for 5 hours
Power generated by monocystalline solar panel of 280W in 5 hours= 280*5= 1400W

<u>Area calculation for setup the solar panel</u>

Car roof area= 1.44 meter sq.
Area of 1 monocrystalline solar panel of 280W=1.06*.064= 0.067 meter sq.
So, we will use monocrystalline solar panel here because of higher efficiency and also due to sleeker aesthetic in comparison to polycrystalline solar panel.

Cost

Cost of one peltier of TEC1-12715= Rs.600

Cost of heat sink =Rs.1400

Total cost of 1 TEC module = 600+1400= Rs. 2000

Cost of 6 TEC module = 2000*6= Rs.12000

Now, cost of pv module of 280W = Rs.8000

Total cost of the system = 8000+12000= Rs.20000

So, the total expected cost for the system will be around Rs.20000.

[Note: cost of fitting is not included here.]

5
Result and Discussion

5.1 Result

When the ambient temperature was 40ºc and inside temperature of car compartment was 25ºc we observe with the help of transient thermal analysis that overall temperature of a car compartment rise from 25ºc to 51.5ºc.

This much increase in temperature will lead to lot of thermal discomfort for the travellers. So to avoid the increase in temperature we used the TEC modules.

In first case we used 2 TEC modules and found that the temperature increase in compartment was around 40ºc which is almost 11ºc lesser than the compartment without TEC module.

In second case we used 3 TEC modules and found that the increase in temperature was only 10ºc from the initial temperature of a car compartment.

In third case we used 4 TEC modules and found that the temperature after one hour was just above 31ºc, which is almost 20ºc lesser than the temperature of the compartment without TEC module.

In fourth case we used 5 TEC module and found an impressive result. We observe that only around 2ºc of temperature was increasing after one hour from the initial temperature i.e. 25ºc.

In fifth case we used 6 TEC module and found that the temperature of a car compartment decreases from initial temperature 25ºc to around 22ºc in one hour i.e. there is decrease in overall temperature by 3ºc in the compartment.

5.2 Discussion

In this report while doing the transient thermal analysis we observed that he temperature inside the car compartment after 1 hour increased by 26ºc from the initial temperature when the ambient temperature was 40ºc. After applying the TEC module we observed that temperature was decreasing. Here in this report when 5 TEC module was applied we observed that the compartment temperature dropped down to 27ºc and when 6 TEC module was applied temperature dropped down to approximately 22ºc. So, we recommend to use 5 TEC module as it is also giving the encouraging result and not much increase in temperature is observed after 1 hour.

5.3 Conclusion

In this report we used the TEC modules to overcome ascend in temperature inside a car compartment. We found an impressive effect of TEC modules for decreasing temperature inside a car compartment. We observe that the temperature of the compartment decreases rapidly in one hour as the number of TEC modules we increased. Finally we saw that by using 6 TEC modules we can decrease temperature from the initial temperature of the compartment i.e. 25^{o}c to 22^{o}c.

5.4 Future work

In future we can do the actual testing of the system proposed in this report and can find the exact outcome of this system which will help us to make the system more efficient and can commercially use in cars.

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