Solar Powered Air-Cooling system for Idle Parked Cars

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Abstract - *When a car is parked under the sun for longer time, the car cabin gets heated up. The temperature inside may rise to around 60 to 70 degrees, which makes the passengers feel uncomfortable inside the car moreover these high temperatures cause health problems. In order to overcome these problems, the passengers switch on Air Conditioner which leads consumption of fuel energy or open up all the doors and windows and waste time. To eliminate these problems a SOLAR POWERED AIR-COOLING SYSTEM can be installed in the car. This system uses a solar panel to capture the sunlight and convert the Solar energy into the Electrical energy which is used to recharge the 12V battery, which then gives necessary power for the cooling module which consist of Peltier Thermoelectric cooler and fan motor. The cool air is blown inside the car which reduces the temperature in the car cabin. The system is controlled by using a switch device. The installation of SOLAR POWERED AIR COOLING SYSTEM in the cars, would be a better solution as it uses solar power to cool down the inside temperature of the car which is parked in the hot sun to more acceptable temperatures that would give more comfort to the passengers and pose significantly less health risks and material damages.*

***Key Words*: Car-Cabin, Fuel energy, Time, Solar Energy, Peltier Thermoelectric Cooler, Acceptable Temperature, Less health risks.**

1. INTRODUCTION

The common problem encountered in the car is the rise in temperature in the car cabin, when the car ideally parked in the open environment, under the sun. When a car is parked under the sun for longer time, the inside of the car gets heated up. When the passenger return back to their car, experience a hot temperature in the cabin which makes the passengers feel uncomfortable inside the car. Moreover regular exposure to this high temperature may cause health problems.

A car parked outside on a hot summer's day can turn into a scorching oven. To investigate this matter, we took readings by parking the car under the sun. The findings were sobering. Within 1 hour, the temperature inside of a car parked in the sun on a day that reached 45 degree Celsius or hotter, hit an average of 47 degrees Celsius. The cars' dashboards got even hotter, reaching 69 degrees Celsius, on average; the steering wheels climbed to a temperature of 53 degrees Celsius, on average and the temperature of the seats hit 51 degrees Celsius, on average.

Cars parked in the shade on a hot day had lower but still scorching temperatures. After 1 hour, the interior temperature of these cars reached an average of 38 degrees Celsius. The dashboards of these cars averaged 48 degrees Celsius, the steering wheel averaged 42 degrees Celsius and the seats averaged 41 degrees Celsius. Anybody sitting in a car would, of course, breathe, and that each breath would introduce humidity into the vehicle.

1.1 Problems caused

By being exposed to an extremely hot environment for an intolerable length of time, anyone is susceptible to a heat stroke. A person trapped in a rapidly heating car is at risk for heatstroke, which can be deadly. It is difficult to predict when heatstroke will strike largely because the condition involves many factors, including a person's age, weight and existing health conditions. But most cases happen when a child's core body temperature rises above 40 degrees Celsius for an extended period of time. Pediatric deaths due to children being left in hot cars remain a significant yet preventable public health concern. Over last 18 years, between 30 and 60 children per year have succumbed to extreme heat from being left unattended in a parked vehicle. In 2017 alone, 42 children were victims of pediatric vehicular hyperthermia (PVH) deaths in the United States, which persist as the leading cause of non-crash, vehicle-related deaths in children and results in preventable illness in hundreds of children annually.

1.2 Technical Details of the Problem

The outer environment is considered as the surrounding, and the car is considered as the system. Since the system and the surrounding are of different temperature, heat transfer takes place from hot body to cold body, that is the surrounding environment to the system (car) until the equilibrium is attained between the two. The heat flows from the outer environment to the car, in addition the black surfaces in the car absorbs more heat. These factors cause the heat inside the car. This is also a greenhouse effect scenario.

1.3 Proposed solution

The SOLAR POWERED AIR-COOLING SYSTEM serves a better option for reducing the heat inside the car. The system can be controlled with the help of a switch device. As the car is parked, the driver switches on the system. The cool-air is blown into the car cabin which reduces the temperature rise in the cabin and bring down to acceptable temperatures. Furthermore the cooling device is assigned in such a way that it uses solar energy and rechargeable battery as its power supply. The solar energy is abundant in India and is pollution free. In addition it does not produce any Greenhouse gases which makes it more practical for use.

2. CONCEPTS USED IN THE SYSTEM

2.1 Solar Energy

Solar energy is radiant light and heat from the sun that is harnessed using a range of ever evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. In the Air-cooling system the solar energy is directly captured using P-V cell and hence is a Active Solar Technique.

2.2 Peltier Effect

Peltier effect, the cooling of one junction and the heating of the other when electric current is maintained in a circuit of material consisting of two dissimilar conductors; the effect is even stronger in circuits containing dissimilar semiconductors. In a circuit consisting of a battery joined by two pieces of copper wire to a length of bismuth wire, a temperature rise occurs at the junction where the current passes from copper to bismuth, and a temperature drop occurs at the junction where the current passes from bismuth to copper.

This effect was discovered in 1834 by the French physicist Jean-Charles-Athanase Peltier.

The Peltier effect is the phenomenon that a potential difference applied across a thermocouple causes a temperature difference between the junctions of the different materials in the thermocouple.

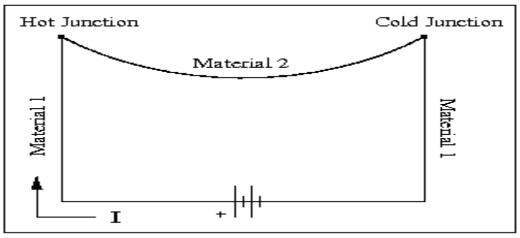


Fig-1: Peltier Effect

Since the hot junction can be placed outside of an insulated area, and the cold junction can be placed inside the region, the Peltier effect can be used to cool a region (or an object).

2.3 Peltier Elements (Thermo Electric Coolers)

The method of thermoelectric cooling (using the Peltier effect) is useful because it can cool an object without any moving pieces or other complex machinery that isolates the cooler from its ambient surroundings. The devices that are constructed to take advantage of this phenomenon are known as Peltier elements, or thermo-electric coolers (TECs). The basic ideas from the simple Peltier elements can be connected in series to construct far more complicated Peltier modules (also known as practical TECs), which have greater cooling capabilities. However, the greatest temperature difference between the heat sink and the cool region for a Peltier device is on the order of 50°C.

The most common combination of materials in the thermocouples of Peltier elements (TECs) are the two semiconductors Bismuth and Telluride. Generally, a TEC has an array of cubes or pellets made of the semiconductors, each of which is in contact with the radiators on the hot and cold side of the Peltier element. These cubes are "doped" that is to say that extra impurities are added so that there are extra or fewer free electrons in each cube.

The semiconductor cubes with extra free electrons (and thus carry mainly negative charge) are known as N-type semiconductors, while those with few free electrons (and carry mainly positive charge) are P-type semiconductors. The pairs of P and N semiconductor cubes are set up and connected in an array so that the pairs have an electrical series connection, but a thermal parallel connection. When a current is applied to this system (the TEC), the way the current flows through the semiconductors induces a temperature difference, and causes the heat-sink side of the Peltier element to heat up, and the cold side to cool (or cooling whatever is in thermal contact with that side).

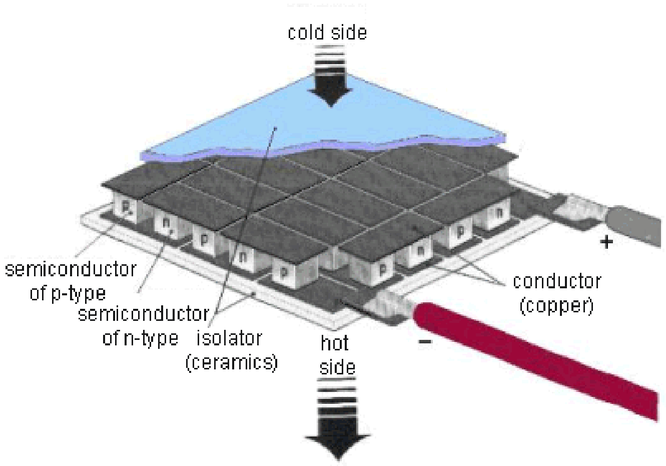


Fig-2: Peltier Element structure

3. COMPONENTS USED IN THE SYSTEM

Semi Flexible Solar Panel - For this system, a 40 W Semi Flexible (So that it fits easily on Car roof) is used to ensure the maximum power production during sunlight.

Solar charge Controller - The solar energy that is captured using solar panels will be stored in batteries and for powering the DC load. A charge controller circuit is required to regulate the voltage and current that is coming from the solar panels and entering into the battery. The correct operation of a charge controller will prevent overcharging or over-discharging of a battery regardless of the load design and operating temperatures. They are designed to extract the maximum power from the panel and deposit it in the battery. Lack of a charge controller circuit will damage the battery due to over-discharging.

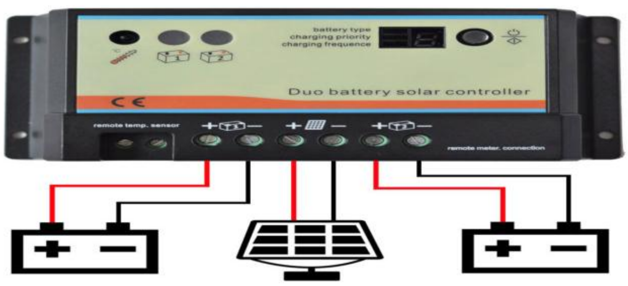


Fig-3: Solar Charge Controller

Rechargeable battery - Based on the power consumption of the cooling system, two 12Ah, 12V rechargeable battery are used. The type of battery used is VLRA battery which is valve-regulated lead acid battery, most commonly known as sealed battery. It is suitable for the proposed system, as it meets the required specifications of the hardware components and its self discharge is lowest among all the rechargeable battery systems.

Cooling Module - The cooling module used for the system; it comprises of a thermoelectric cooling device (TEC), heat sink and three brushless motors. Its power consumption is about 240W. The thermoelectric device is an active cooling device which creates a temperature difference on two dissimilar materials when a voltage is applied. As a result, there is a hot side and cold side where the hot side is attached to a heat sink (passive cooling) otherwise it will be damaged. The reason for choosing TEC device compared to other cooling technologies such as compressors is that TEC consists of no moving parts thus it is maintenance free, has small size and weight, does not require coolant unlike compressors. Hence, it is also environmentally friendly.

Fig-4: Cooling Module with Heat sink and Cold sink

Peltier Thermoelectric Cooler – The thermoelectric cooling device is an active cooling device which creates temperature difference on two dissimilar materials when voltage is applied. As a result there is a hot side and cold side where the hot side is connected to the heat sink. The reason for using TEC device compared to other compressors is that TEC consists of no moving parts and is maintenance free, small size and weight, does not require any coolant.

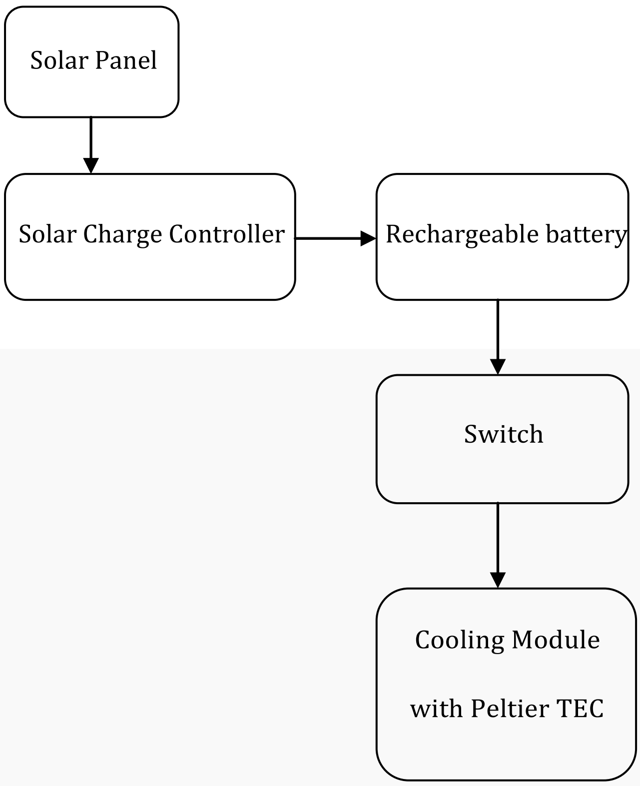
Fig-5: Peltier Thermoelectric cooler

Temperature Sensor - To capture the accurate temperature reading inside the car DHT11 sensor is used. It is a simple low cost capacitive humidity sensor and thermistor. It operates between 3-5V and can measure temperature with the accuracy of 2degree. It is connected to a digital display which gives the reading about the room temperature.

Wires and switch – The wires are used to connect the individual components to each other or to battery and to complete the circuit. The switch is used to block or allow the current from the battery to the cooling module and Peltier Thermoelectric cooler.

Thermal Paste - Thermal Paste is a thermally conductive compound, which is commonly used as an interface between heat sinks and heat sources such as high-power semiconductor devices. The main role of thermal grease is to eliminate air gaps or spaces (which act as thermal insulation) from the interface area in order to maximize heat transfer and dissipation.

4. BLOCK DIAGRAM



5. WORKING PROCEDURE

1. When the Car user parks the car in an open atmosphere under the sun, he switches the SOLAR POWERED AIR COOLING SYSTEM.
2. The Solar Radiation from the sun is captured by the Solar Panel and is passed to the Solar Charge Controller.
3. Regulated amount of solar energy is passed through Rechargeable Lead Acid Battery (i.e 18V from Solar Panel is regulated to 12V) which converts solar energy to electric energy and passes it to the cooling module.
4. The Cooling module consists of two fans with heat sink and a cold sink, the Peltier Thermoelectric cooler is placed in between the two sinks, as the current is passed through the Peltier thermoelectric cooler one side of the device gets cooled and the other side gets hot.
5. The cool side gets to the temperature around -6 Degree Celsius, this cooling effect is passed through the cold sink and is blown out from the fan inside the Car cabin. This reduces the temperature inside the Car cabin.The other side of the Peltier thermoelectric cooler is hot, this heating effect is passed through the heat sink and is blown out of the car with the help of fan.
6. The switch device is used to allow the electricity to the cooling module.

This process cools down the temperature inside the Car to a reasonable extent, and gives comfort to passengers.

6. TESTING

The heat generated inside the car cabin, when the car is parked under the sun, **without** the installation SOLAR POWERED AIR-COOLING SYSTEM.

Test time: 2hours
Checking Intervals: 15minutes

Time	Temperature inside the car cabin (Degree Celsius)
1:30PM	30.6
1:45PM	38.3
2:00PM	45.3
2:15PM	46.6
2:30PM	48.5
2:45PM	49.9
3:00PM	50.7
3:15PM	51.2
3:30PM	51.5

Average rise in Temperature inside the car cabin for
2 Hours: 51.5 – 30.6 = 20.9 Degree Celsius

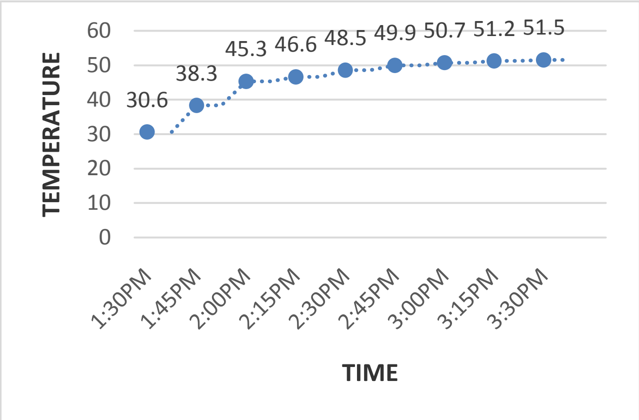


Chart-1: Temperature variation over Time

The heat generated inside the car cabin, when the car is parked under the sun, **with** the installation of SOLAR POWERED AIR-COOLING SYSTEM.

Test Time: 2 hours
Checking Interval: 15 minutes

Time	Temperature inside the car cabin (Degree Celsius)
1:30PM	30.2
1:45PM	34
2:00PM	38.2
2:15PM	40.6
2:30PM	41.2
2:45PM	41.1
3:00PM	41.1
3:15PM	41.5
3:30PM	41

Average rise in temperature inside car cabin for 2 hours:
41 – 30.2 = 10.8 Degree Celsius

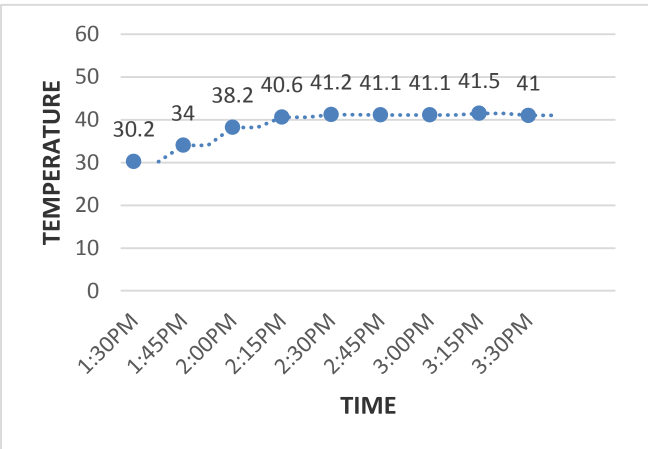


Chart-2: Temperature variation over Time

7. ADVANTAGES

1. The proposed project differs from the existing commercial products as the driver can control the fans and moniter the temperature inside the car by using a switch.
2. The system uses solar energy and rechargeable battery as a power supply.
3. The system does not produce any greenhouse gases which makes it more practical for use.
4. The installation of the system in the car, saves the time wasted for leaving the car with all windows and doors opened. It reduces the fuel consumption that is caused by switching on the car's air conditioning to remove the heat in the car.
5. The system has high efficiency for small cars.
6. Construction and maintenance are easy.

8. CONCLUSIONS

Due to increasing pollution and cutting of trees in the country, the heat waves coming from the sun is more nowadays. The temperature in the atmosphere is increasing day by day. The car cabin of the parked car gets exposed to extreme temperature due to sealing.

We implement a prototype system of SOLAR POWERED AIR COOLING SYSTEM, which works on Solar energy and reduces the heat inside the parked cars and give comfort to the passengers. The result obtained from the project is a heat reducing system which operates on renewable source of energy.

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