Maximum Potential of the Car Cabin Temperature in the Outdoor Parking Conditions as a Source of Energy in Thermoelectric Generator

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Abstract. Cars using the principle of converting heat energy into mechanical energy, but a lot of wasted heat energy not entirely transformed into mechanical energy, studies have been conducted that converts the heat energy into electrical energy using the principle thermoelectrically. However, there are many other energies that can be harnessed from the car, such as when the car is parked in the sun or driving in the heat of the sun, the temperature in the cabin can reach 80 degrees Celsius. The heat can be harmful to humans and the children immediately into the vehicle, as well as for the goods stored in the cabin if it contains toxins can evaporate because of the heat and dangerous. The danger can be prevented by reducing the heat in the cabin and transform into other forms of energy such as electricity. By providing a temperature difference of 40 degrees on the cold side of the module can be acquired electricity thermoelectrically up to 0.17W for one of its module, if it is made a module block the energy produced is enough to lower the temperature and charge batteries for further cooling. This study will use experiment method to get the maximum drop in temperature in the car cabin

1. Introduction
Where Is in motion or stationary, the car is always exposed to the sun, when it in motion, the heat will be reduced by cooling systems or air conditioning, but when stationary heat entry will be trapped and will increase in temperature, the heat can cause damage to materials inside the cabin and even can arise due to toxic chemicals or materials upholstery perfume evaporates due to the heat.[1] Many people who are often waiting in the vehicle in the parking lot for a long time, to dissipate heat, the driver tends to turn the car cooling system at its maximum, which would certainly make a lot of wasted fuel consumption.

Research conducted [2] in a car parked in the open showed an increase in temperature rise to reach above 60° C ambient temperature range of 30° C within 15 minutes. By lowering the glass slightly for air circulation, it could reduce the temperature of the room cabin with an average of 10° C compared to vehicle glass sealed, yet the temperature is still too high and the risk to the security of the vehicle itself.

In the development of technology, many are already doing research on the heat in the car and how to model the accumulation and distribution of heat [3] to obtain the data how to reduce the heat. Because the heat has a significant effect on driver fatigue [4] researchers vying how to make an air conditioning system in a vehicle that is able to regulate the circulation of air getting smarter, one of them [5] create a design system that can reduce the effects of heat in vehicle by modeling in order to
obtain the right temperature for humans, but the energy that is used to help reduce the heat on when the car is parked is still the energy that comes from engines that consume fossil fuels.

Car cooling systems that exist today are generally still use freon compressor to pump so that there will be cold at the evaporator and the cold will spread into the cabin when blown by the blower. The system uses energy as a driver of a car engine compressor so that the required fuel is quite a lot especially when first turned on and want to quickly get the temperature cool. One method of cooling the room is to utilize the module thermoelectrically, which is a tool that generates the temperature difference when no current is flowing over it, using the principle of peltier [6,7] Module thermoelectric can also be used as power generation (TEG) is a source of energy utilizing waste heat from a car [8] while increasing the efficiency of solar modules can be enhanced with the incorporation of thermoelectric modules, which can be increase up to 10.1% [9].

2. Special purpose
The specific objectives of this study are:
Improve the effectiveness of a decrease in vehicle cabin temperature when parked diterik sun by utilizing the available energy in the form of heat in both trapped in the cabin as well as existing from direct sun.

Analyzing the amount of heat that arises when the car is dried in the sun and how long the temperature drops with the existing cooling system, as well as determine the size of thermoelectric modules and solar cells thus helping to decrease the temperature of the vehicle when it is used.

2.1. Reducing fuel consumption by reducing the air conditioning load of the cooling system
Heat is trapped inside the car can be detrimental to health and cause damage to the vehicle, if storing food or heat sensitive objects. Meanwhile in a car parked there remains the potential energy is great, especially when parked in conditions of sun, solar thermal energy trapped in the car can be used as another energy such as electricity, using thermoelectric obtained that the temperature inside the vehicle can generate electricity up to 0.17W, while using solar cells obtained up to 10W of energy, with an energy that can be used to help circulate the heat in the vehicle so that the room temperature inside the vehicle can be kept cool.

The cooling system in general use car driving a car engine in the form of a compressor, using the driving force of the engine cooling system will consume fuel as well, according to research [10] a cooling system would burden amounting to 12-17 percent of vehicle fuel consumption, by helping with lowering the temperature of the air conditioning system work will be reduced and will help lower fuel consumption anyway.

This study will find the potential of electricity that can generate by using the heat inside car with the thermoelectric and using the energy to cooling down the cabin.

2.2. Heat which can take advantage
Utilization of heat as an energy source to activate the cooling module based thermoelectrically have been done, some variation of applications that might be examined presented by Xongxia Xi them for refrigeration, air conditioning and power generation, but it can also be used to meet the load demand for energy conservation [11].

One example of research for conditioning the temperature of the room, namely as a heater during the winter or as conditioning when summer by utilizing two function modules thermoelectrically, modules thermoelectrically by the voltage of the sun will be cooling the room, and when reversed polarity will provide heat difference to warm the room [12] developed another model is to add water to warm the water reservoir on the hot side thermoelectrically order to obtain the hot springs in addition to cool the room [13].

Other research is a refrigerator or a small cooling are suitable for use in remote areas by using modules thermoelectrically powered by solar energy during the day and use the battery at night conditions and cloudy weather [14, 15].
Another model that has been studied using solar modules single connected with a battery to power the refrigerator in the scale house with power consumption of 520Wh, the cooling rate reached an average temperature of 4 °C [16]. In addition to cool the room or create a coolant refrigerator, thermoelectrically module powered by the solar module can also be used as a coolant headwear, studies conducted have shown that protective head mounted cooling module has a temperature drop of around 4-5 °C which cause a sense of comfort for its users [17]. A source of heat energy in the thermoelectric generator can come from various sources such as a hot room or gradient soil temperature or a steam condenser and the heat of the asphalt highway. Thermoelectric modules are installed on the car of which are used as well as the generation of electrical energy by making use of waste gas and heat from the exhaust of vehicles [18, 19].

2.3. Hot on the car
Vehicles, especially cars, is inseparable from its usefulness as a means of transportation, that every day can be exposed to sunlight, when in running condition and the engine, the air conditioning in the car using the compressor driven by the engine, but when the parking condition certainly the machine will dead and compressor cannot work.

When the car is parked under the blazing sunlight, will take place greenhouse effect, research revealed that a significant rise in temperature can be harmful to human health, especially children or pets are present in the vehicle. [20, 21] and but it also can cause the toxins that may arise because of the evaporation of compound plastic materials and upholstery in the interior car [1].

When the car is parked in a sweltering with the condition of the engine died and the air conditioning system the car is off, the car's cabin will experience temperature increases significantly in figure 1, in testing involving differences in color of the vehicle, the cabin temperature can rise to twice the temperature conditions outside [2].

By opening a window slightly for air circulation, obtained a difference of temperature decrease, but not significantly, and is still quite high compared to the outside temperature.

![Figure 1. Cabin Temperature](image)

The cooling system on the car began to increase efficiency, per the calculation method to determine the point heat source from outside the vehicle [22] determine how much cooling is needed [10] the amount of energy needed to cool the car based on road conditions and time [23, 24], all predictions to provide an overview of energy needs in a car's cooling system. Existing research suggests that by making a condition of using thermoelectrically cooling and solar cells can both lower the temperature of 4 °C [25] but not found how much increased efficiency in fuel consumption and a decrease in their use when the car is used for walking.

2.4. Efficiency Thermoelectric Generator (thermoelectric plants)
Thermoelectric modules are integrated circuits in the form of a solid which uses three principles of thermodynamics which is known as the Seebeck effect, Peltier and Thompson. Its construction consists of pairs of p-type semiconductor material and n-type thermocouples formed that has a shape like a sandwich between two thin ceramic wafers. This module can be used to produce heat and cold
on each side if the electric current is used. Typically applied as a cooling system for example cooler vaccines or to generate electricity when heat and cold is used as a temperature difference [26].

The advantages of this module are no moving parts so maintenance is easier, does not pose a danger of carbon, temperature regulation can be more flexible, smaller in size than regular cooling, have a service life of relatively longer up to 100,000 hours of work and setting it easier for just about changing A voltage or current input.

The maximum power of thermoelectrically modules can be written as follows [27]:

$$P_m = \frac{1}{4} (a \Delta T)^2$$

Where

- $P_m$ = Maximum power of thermoelectric
- $a$ = coefficient of material
- $\Delta T$ = difference of temperature
- $R$ = material resistivity

In power generation, carnot efficiency used as energy parameters, carnot efficiency is the efficiency with theoretical calculations, is considered the most ideal circumstances, then a machine will have an efficiency of 100% carnot. Unlike the thermal efficiency is almost always less than ideal carnot efficiency. In the second law of thermodynamics, which states that not all the heat in a heat engine will be used to do work, carnot efficiency set a limit on the value of the fraction of the heat that can be used.

Compared with other power generating devices, the efficiency of the peltier element is still low, with an efficiency rate is only about 5-8% while the Rankine cycle power generation, such as gas turbines, has carnot efficiency by 30%, diesel generator or motor fuel have an efficiency of around 10 -15%, due to the efficiency of thermoelectric temperature depends on the ZT and given to him.

2.5. Potential Solar cells
The solar cell is a form of energy generation is still a phenomenon with the increased efficiency and power output as well as the modest price of solar cells to encourage more research to explore deeper, ranging from materials (materials), design, placement location, until the position angle of inclination of the solar panel [28]. The solar cells able to be combined with other plants and is also capable of standing alone as an energy source, can be used in vehicles, lights and other sources. By searching some models can increase the maximum efficiency that can be provided by using the iteration method [29].

The solar cell itself is not without its shortcomings, the weather and geographical location greatly affects the efficiency of the solar cell module [30], one of the ways to improve efficiency is by reducing the surface temperature of the solar cells in order to obtain increased efficiency, the other way is the method on -off depending on the illumination of solar rays, which are intended to reduce the load so as to obtain an increase in efficiency [31]. According to the projections made swanson that increase the efficiency of solar cell efficiencies approaching the higher and lab scale within the last 10 years [32].

3. Research Design
This study measures the magnitude of the temperature inside a parked vehicle at 08:00 am until 4:00 pm as compared to the outdoor temperature, the placement of the first sensor temperature in the area around the steering wheel and a temperature sensor outside placed outside the driver's door, assuming that the location where the driver is first entered into by driver. the car's position on the conditions laid open spaces away from the roof or shade trees. The placement of sensor is as in Figure 2.
Figure 2. The study design

The process of data collection is done in 5-minute intervals using temperature data logger RC-05 were placed inside and outside the car, the test results obtained in figure 3, where the maximum temperature obtained in the cabin reaches 64.3 degrees Celsius at 11 am, the temperature varies depending on the weather and cloud covering the sun, it can be seen that the average temperature rise begins immediately when the car starts in the parking lot, the temperature continues to rise until then slowly began to stabilize and fall, but the final drop temperature is still well above the temperature starting in the morning.

Figure 3. Temperature inside car cabin

From the results of temperature measurements daily, made an average of measurements to look for patterns maximum temperature at any hour and compared with the outdoor temperature so as to obtain the value of Δt temperature inside and outside, as shown in Figure 4, the maximum value Δt there in the morning before noon by 20 degrees and then went back down and rise at noon and then stabilized at a temperature of about 10 degrees.
Figure 4. Average and Δt Temperature

Using the measurement data have been obtained, the calculation to estimate the potential amount of power that can be generated by the generator thermoelectrically, by substituting into the equation (1) obtained power forecast data in Figure 5, where maximum power is obtained 0.14W, which is an approximate power only the temperature difference obtained at 22 degrees, if obtained temperature difference of 40 degrees can be obtained by calculating the power 0.41W, but the results of the calculation may differ from reality due to many factors that affect the temperature.

Figure 5. Calculation of thermoelectric power output
4. Conclusion
From the above test result it’s still required a longer development in order to obtain the maximum value of the voltage to charge the battery as the output of the generator thermoelectrically, due to very low heat so cannot give much different in temperature $\Delta T$, and also heat spreading and could not be gathered in entirely, so for cooling using thermoelectrically still need the help of batteries charged from other sources such as solar power or from other sources.

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