

# A Review on Utilization of Waste Heat from Automobile Based on Thermoelectric Generator

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**Abstract** - Today, the need of energy increases day by day but only few sources are available to produce energy as our fuel resources coming to end. There are needs to be ways to use waste heat energy. There are some technologies which implement the recycling of waste heat by which waste heat can be trapped and recycle into useful work. Most of the techniques currently available recover waste heat in the form of thermal energy which is then converted into electricity in a conventional thermal power plant. This production of energy efficiently from waste heat, thermoelectric generator module is used which works on Seebeck Effect. Here, the power generation is simple, as there is need of only temperature difference to produce power. Today, 70% of produced energy in automobiles is wasted in form of heat by exhaust gases. This paper tries to prove the feasibility of conversion of heat energy radiated from automobile engine to produce electricity. Furthermore, the electrical energy generated could be supplied to the LED lights of the electrical vehicle or to charge the battery.

**Key Words:** Thermoelectric generator (TEG), Heat energy, Seebeck effect, Heat radiation, Thermoelectric power.

## 1. INTRODUCTION

Energy plays an important concern for the development of human civilization, but we need to confront the problem of fast exhaustion of fossil fuels for producing electricity. The recently, we are depending upon fossil fuels mainly coal, gases and oils for maximum electricity generation. However, the reserves of fossil fuels will be goes on decreasing, since oil, coal & gas are present on the earth in least amount. Today, number of motor vehicles on world's roads are increased, resulting in increased air pollution, increased petroleum consumption, despite improvements in vehicle emissions control and fuel efficiency. To counter these trends, new vehicle technologies must be introduced that can achieve better fuel economy without increasing harmful emissions.

In automobile waste heat is a by-product involved in conversion of heat energy into electrical energy. [1] Presents the motor is the main part of electric vehicle (EV), and when the vehicle is in acceleration, the motor will produce certain amount of thermal energy ignored by the system from the coils of motor. Moreover, the efficiency of motor will be influenced by the waste heat. An idea is proposed for turning the waste heat into a useful treasure. Here, the core technology is the TE

generation that converts the waste heat of motor to the electrical energy, and then it can be utilized for battery charging of vehicles.

[2] The basic principle of working of thermoelectric generator (TEG) is production of voltage based on temperature difference between two surfaces of the thermoelectric generator. Here heating is a common phenomenon energy producing system can be put to some efficient use. Using the Seebeck effect of temperature difference, the aim is to produce energy from waste heat in car engines, sufficient enough for use within the car, to be able to replace the current rechargeable batteries in electric vehicles. [3] Presents a methods of generating electricity using car engine heat. Thermoelectric generator is the new alternative energy that will produce electricity by using waste heat. The car engine produces waste heat when the car is on acceleration or moving. To recycle the waste heat, Thermoelectric Generator (TEG) is used to converting it to electrical energy.

### 1.1 Heat Energy

The heat is a form of energy that is used in our daily life. This heat energy can be seen in engines in automobiles, compressors, gas stove at homes and other various equipment. In the heat energy, when there is a suitable physical pathway for flowing heat, the heat flows from the hot surface to the cold surface. The pathway of heat can be direct, as in conduction and radiation, or indirect, as in convection. The quantity of heat is measured in terms of Joules (J) in SI units. This quantity can be determined by the calculations based on other quantities, which rely on the first law of thermodynamics.

The magnitude of heat generated at various sources is different; thereby the temperature of these operating equipment is not the same and hence produces power of different ratings. The transfer of heat energy involves three different types, which include conduction, convection and radiation. All devices under the heat energy follow the laws of thermodynamics including heat engine and heat pump.

### 1.2 Thermoelectric Power

The thermoelectric power is the power obtained by the conversion of the generated heat energy into electrical energy using thermoelectric generator (TEG). It works on

the principle of Seebeck effect, and can be stated as, “When two ends of the conductor are held at different temperatures levels, the electrons at the hot junction at higher thermal velocities diffuse into the cold junction.” This defines that the thermal electrons move from the junction in the hot region to the junction in the cold region, the voltage produced in the thermoelectric module which is proportional to the temperature difference two sides of thermoelectric generator (TEG).

## 2. ANALYSIS OF THERMOELECTRIC GENERATOR

### A. Abbreviations and Acronyms

TEG - Thermoelectric Generator  
Amp-hr - Ampere hour rating of battery

BMW - Bayerische Motoren Werke (German Automobile Company)

### B. Working Principle

An important way of utilizing heat energy in automobiles is to convert heat to electrical energy through a thermoelectric convertor. Thermoelectric convertors were made with the aim to do the conversion of heat energy into electrical power. When a heat gradient is applied to a thermoelectric material, a flow of electrons from hot side to the cooler side takes place, hence converting heat to electrical power. Thermoelectric generators use the simple Seebeck principle which states as:

“When two ends of the conductor are held at different temperatures, the electrons at the hot junction at higher thermal velocities diffuse into the cold junction”. Fig.1(a) and (b) show the schematic of TEG elements and the system diagram of a TEG system, respectively. In order to maintain and stabilize the output voltage under different environments and temperatures, a voltage regulator circuit has been connected to the TEG in the output port. The concept of thermo generators is to have two plates (one hot And other cool) creating a temperature difference having different material on both, to give a high difference in thermopower, then the voltage may be a useful amount with the high temperature difference that we can get around and away from car engine.

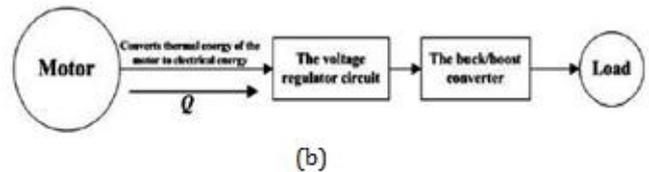
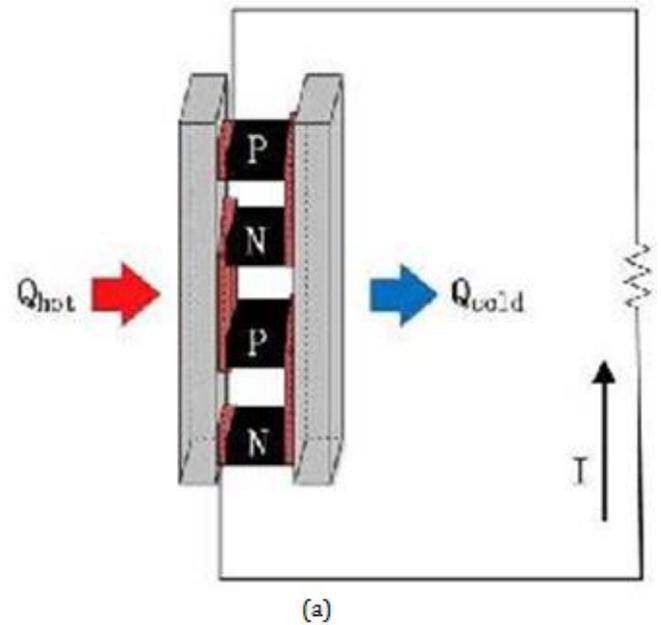


Fig. -1: (a) Schematic of TEG elements, and (b) system diagram of a TEG system.

## 3. OUR APPROCH - TO PROVE FEASIBILITY

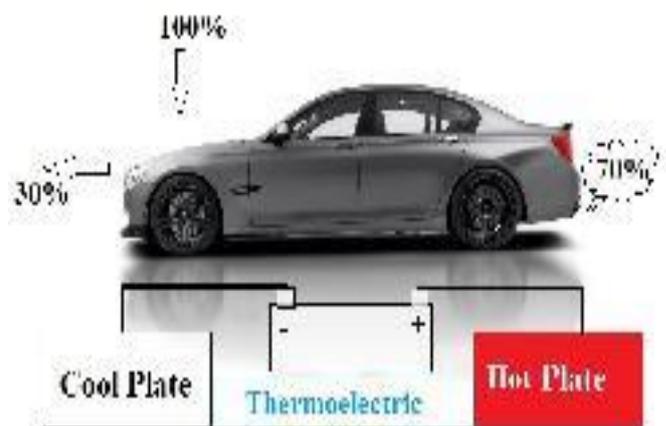


Fig. -2 : Schematic of proposed mechanism to extract heat from automobiles, and convert to electric power

In some vehicles like BMW, rechargeable batteries are used. This battery is used mainly for two purposes in the car:

- 1) To start the car by powering the starter motor (giving a spark).
- 2) To light on the headlights of the car.

Generally rechargeable batteries used in automobile are of rated 12V and 10-14 Amp-hr, and higher. Fig. 2 shows schematic diagram of proposed mechanism to extract heat from automobiles, and convert to electric power.

To apply Seebeck principle, we place one plate of TEG near the car engine surface and other plate at some distance. However there must be temperature difference between two sides of TEG. The coolant should not absorb energy from the engine, as that will be utilized for electrical conversion using the thermoelectric convertor (TEG). Hence, the coolant needs to provide cooling only.

So, comparing this with the rechargeable car batteries of 80Amp-hr rating, this energy would be good to efficiently light up the headlights of the car, use for charging other batteries, like that of motorcycles and if we use different materials on the convertor plates we can also, increase the Amp-hr rating, making the engines completely based on heat consumption system.

## CONCLUSION

To conclude, it is clear that TEG waste heat recovery technology could potentially offer fuel economy significantly. Also it is feasible to use thermoelectric generator to light up the headlights of car. The conversion rate from heat to electrical energy can be increased by using materials with better Seebeck coefficient. In this way we can conserve the electrical energy to some extent, by trapping the waste heat from the heat source in automobiles. This technology can also be applicable in home appliances, where the heat from gas stoves can be trapped for producing electrical energy based on same principle. By the efficient use of waste heat energy, we can save some amount of energy for operating appliances.

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