

# Analysis of Energy Generation from Exhaust of Automobile using Peltier (Thermoelectric Generator)

Naveen Kumar<sup>1</sup>, Vaibhav Setia<sup>2</sup>, Sunil Kumar Patel<sup>2</sup>,  
Satyam Upadhyay<sup>2</sup>, Saurabh Chauhan<sup>2</sup>, Prakhar Bajpai<sup>2</sup>

<sup>1</sup>Assistant Professor, <sup>2</sup>Student

<sup>1,2</sup>Department of Mechanical Engineering, ABES Engineering College, Ghaziabad, Uttar Pradesh, India

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## ABSTRACT

In recent past days, big deal of the automobile industry's RESEARCH & DEVELOPMENT Practicing on improving overall efficiency of vehicle. It has brought a major interest in the field of making internal combustion engines highly efficient [1]. In past days, only 25-30% energy is used in the vehicle and rest is exposed to surroundings. The useful energy is used to run the engine as well as generator. So the efficiency of those engine were very less. But the efficiency can be improved by utilizing waste heat that is exhaust of vehicle. One of the best technology that was found to be useful for this purpose were thermoelectric generator. In this, we study and investigated the use of thermoelectric generator for power production [2]. Thermoelectric generator works by imparting exhaust's gas stream on its surface and small D.C. electric current developed due to difference in temperature across heat exchanger that is put in the pathway of exhaust gas i.e. working on seebeck effect principle. An output Voltage of 200mV was generated using a single Bi<sub>2</sub>Te<sub>3</sub> thermoelectric module for a temperature difference of about 40o C which can be used in charging battery, headlight, G.P.S. systems, etc. Such that it can reduce the level of alternator's frictional power that is used to save fuel and also in automotive industry to increase the efficiency of engine [1].

**KEYWORDS:** Thermo electric generator (TEG), Exhaust of an IC engine, Peltier Module

## INTRODUCTION

The car world is very nearly a noteworthy move in worldview, trying a restoration of the finish of the nineteenth century, where electric vehicles were the ruler anther than the special case. You can see much examination in ongoing year has concentrated on better eco-friendliness in car industry. About 40% of the warmth vitality provided to an IC motor is dismissed in the fumes as waste warmth. On the off chance that roughly 6% warmth can be recouped from the motor fumes, it can meet the electrical prerequisite of a vehicle and it is conceivable to diminish the fuel utilization around 10%. Warmth is rejected idea exhaust gases at high temperature when contrasted with warmth rejected idea coolant and greasing up oil. This demonstrates the likelihood of vitality change utilizing a thermoelectric generator (TEG) to top the fumes heat vitality[1]. TEG resembles a warmth motor which changes over that heat vitality into electric vitality and it chips away at the standard on seebeck impact. In this venture we are exhibiting for better effectiveness investigation of intensity age utilizing thermoelectric plate for fumes gas on 4 stroke oil motor. Demonstrate that the variety of intensity by utilizing the no of barrel done by the morsh test. In this procedure we need

to demonstrate this is a beneficial innovation in now days situation in light of the fact that the fuel asset are getting low so such sort of innovation will spared fuel[3].

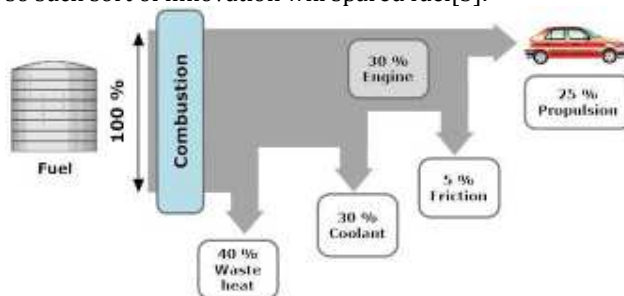


Fig. 1: Energy path flow in internal combustion engine vehicle (gasoline fueled) [10].

## A. Working Principle:

The difference in temperature of surfaces in thermoelectric module(s) creates power utilizing Seebeck Effect principle. At the point when, hot fumes from motor goes to a fumes of ATEG, the charged particles of semiconductor in the TEG diffuses from hot-side to the cool side of exchanger as sown

in Fig.2 [10]. The development of charge bearer's outcomes a net charge, delivering electrostatic potential while the warmth exchange, drives current. With fumes temperature of 700°C or high, the contrast in temperature between fumes gas on hot side and coolant on the other side is of hundred degree. This contrast in temperature is fit for producing power of 500-750 W [4]. In ATEGs, materials of thermoelectric are stuffed in between chilly side and hot-side warmth exchanger. The materials of thermoelectric are comprised of n-type and p-type semiconductor, while the warmth exchangers have conductivity of metal plates [5].

**B. Operating principle:**

Thermoelectric cooler works on Peltier impact (which additionally passes by more famous name of thermoelectric impact). The module has opposite side, and when a Direct current electric flow courses through it; transfers heat from one side to other, which make one side gets cooler and different get more sultry. The hot side is joined to warmth sink with the goal that it will stay at surrounding temperature, while the other side gets beneath room temperature. In certain application, numerous coolers can fell together for temperature (lower) [6].

**C. Peltier device:**

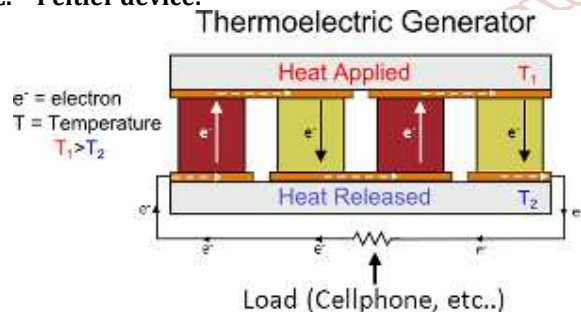


Fig 2: Peltier schematic element. Thermoelectric legs are electrically in series and thermally in parallel [10].

**D. Design:**

Two semiconductors, one p-type & one n-type, utilized on grounds that they distinctive electron densities are needed [1]. The semiconductor put electrically in arrangement and thermally in parallel to one another; afterward united with a leading plate (thermally) on each side. At point, when a voltage is connected to finishes that are free of the two semiconductors there is a flow of DC current over intersection point of the semiconductor (causing temperature contrast) [3]. The cooling plate side retains heat after which it is moved to the other side of the module where there is warmth sink. Thermoelectric Coolers, likewise condensed to TEC's are normally related next to other & sandwiched in between two earthenware plates. The capacity of cooling of all unit is then corresponding to quality of TEC's in it [7].

**E. Materials:**

Currently semiconductors that are being investigated for TEC's applications are bismuth and antimony alloys [2]. Also, these materials have prompted biggest effectiveness for TEC frameworks. This is on the grounds that they have mix of high electrical conductivity and low warm conductivity. These two components, when consolidated, increment the framework's figure for legitimacy ZT, which is proportion of framework's productivity. Condition for ZT may be found beneath, where alpha is Seebeck coefficient.[3]

$$Z = \frac{\alpha^2 \sigma T}{\kappa}$$

There were not many different materials that can be utilized for TEC application since connection among electrical and warm conductivity is generally not a negative relationship. On the off chance that these two qualities lessening or increment together, in any case, the general net impact is zero and ZT esteem would be unreasonably less for business application.[3]

**F. Benefits:**

A standout amongst the most noteworthy advantages of frameworks for TEC is, they have no parts moving. This of mechanical wear's absence expands life expectancy of framework and brings down upkeep necessity. Advances in Current demonstrate the interim among disappointments i.e. (MTBF) to surpass 100,000 hours at surrounding temperatures [4]. Additionally concern, for example, weakness and break become more less relevant to stationary framework.

Other advantage of TEC is, it doesn't utilize refrigerants in its activity. A few refrigerants for example, (CFCs) chlorofluorocarbons were utilized once generously in much more cooling innovations, & preceding their phase out lead altogether to ozone consumption. Numerous refrigerants likewise have noteworthy a dangerous atmospheric potential [5].

The way that TEC frameworks are current controllable lead to another arrangement of advantages. The first is the temperature control of inside parts to a degree may be accomplished.

**G. Thermoelectric Principle of Operation:**

TEG (Thermoelectric Power Generator) is a strong state gadget that changes over Heat source into Electrical source of Energy [1]. All energizing traditional power generators converts the heat Energy to Mechanical Energy & then into Electrical source of Energy. So here, there is no moving parts so mechanical work is absent. Therefore it produces less clamor and zero contamination when contrast with traditional power generator [5].

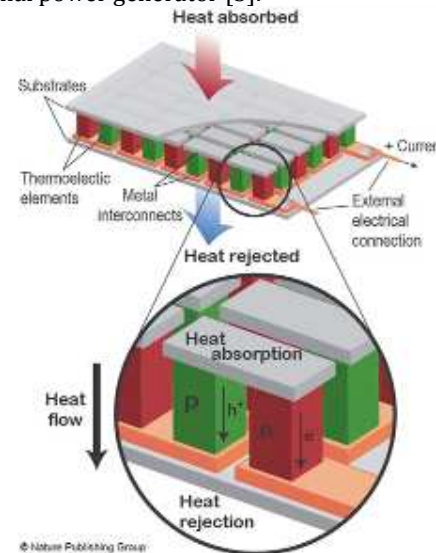


Fig. 3: Thermoelectric principle of operation

**COMPONENTS OF TEG**

1. Heat sink / Thermal fin
2. Thermoelectric Module
3. Thermoelectric shield

**A. THERMAL FIN / HEAT SINK:**

These fins comprises of metal i.e. of aluminum. Thermal gradient value is increased & hence increases the Seebeck voltage generated by TEG.

**B. THERMOELECTRIC MODULE:**

Thermoelectric module is planned and made for changing over warmth source legitimately into power. It is Bismuth-Telluride based thermoelectric module that can work safely at the temperature of 3300C (626K) heat source persistently, and an up to 4000C (752K) discontinuously.



Fig. 4: Thermoelectric module or Peltier Module

**C. THERMOELECTRIC SHIELD:**

Material that saves the modules from damage because of rise in Temperature. Mostly used materials are Ceramics. It transfers temperature from hot side to modules.

**ADVANTAGE & DISADVANTAGE OF TEG****ADVANTAGES:**

- More reliable.
- Mechanical moving parts involved are less.
- Environmentally friendly.

**DISADVANTAGES:**

- Low conversion efficiency up to 5 % only.
- Slow Progression technology.

**CONCLUSION**

The age of electrical power of the TEG is seen to be solid capacity of stream rate & bay fumes temperature. Distinction of temperature between the cold & hot intersections of thermoelectric generator expanded as motor speed increment. The yield voltage level, as indicated by Seebeck impact, additionally expanded as temperature contrast increment. Along these lines, the yield power and warm proficiency may be better. Parametric assessment of the model demonstrates that (TEG) execution improves with setups that has least TEG tallness & most extreme TEG breadth. The high-productivity heat exchangers are important in order to expand the measure of warmth vitality extricated from fumes gas. It has discovered that fumes gas parameters and thermal exchanger structure significantly affect the framework control yield and the weight drop. The examination likewise distinguished the possibilities of the advances when fused with different gadgets to amplify the potential vitality effectiveness of the vehicles.

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