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Generation of Power using Heat from Exhaust Gas by Heat Generator

Sri Sabarinathan. R[1], Ramesh Raj. S[2], Ramesh. S[3], Sakthivel. M[4], Ranjith Kumar. K[5]
[1] Assistant Professor,
Department of Mechanical Engineering, Gnanamani College of Technology
[2,3,4,5] III year, BE,
Department of Mechanical Engineering, Gnanamani College of Technology

***Abstract*:- In this modern days we use lot of automation for transportation .We mainly use I.C engine to develop power. During the combustion process more amount of heat is produced, in that only a small amount of heat is used to generate power. Remaining energy is wasted in the form of exhaust gases. To attain a valuable power we can reuse the wasted heat from the exhaust gases to produce electrical power. Our project deals on this method of producing power. This power can be produced by the help of thermoelectric generator [TEG]. TEG is made up of two dissimilar metals. This generator converts the thermal energy into electrical energy. The conversation of thermal energy to electrical energy is low at first, when the temperature raises the rate of electrical energy produced raises gradually. Now the produced electricity can be stored in the battery for later use or it can be used at the time of production itself.**

Keywords:- Exhaust gas recovery,waste heat recovery, I.C Engine fuel economy,TEG Elements (Thermo-electricGenerator), Harnessing waste heat.

INTRODUCTION:

The automobile industry is one of the world's most important economic sectors. Automobiles use IC engines, which have huge amount of energy loss up to 70% in the form of heat. In the recent times, scientists have tried and refined the automobile technology appreciably, but could not control the loss in IC engine in the form of waste heat. This paper focuses its attention not to control the waste heat in IC engine, rather it focuses on trapping the waste heat to generate electricity by using a suitable device called thermoelectric generator (TEG).

Thermoelectric generator (TEG) is a device which converts thermal energy directly into electrical energy, using seebeck effect. The use of TEG in automobile IC engine is a revolutionary idea,it helps to produce power from the waste heat from the IC engine.The temperature of the 'exhaust bend pipe surface' through which exhaust gases are flowing, by attaching a aluminium plate to this bend pipe hot junction of the thermoelectric module is made, other cold junction is created by aluminium heat sink. As this potential difference is created, voltage is produced using seebeck effect. The produced voltage is further amplified by using booster. we concluded that a proper mechanical pressure applied on the module improves the electrical performance. The experimental results showed that the power loss of the modules in series connection is significant, 11% less than the theoretical maximum power, due to the temperature mismatch condition.

This situation is improved with thermal insulation on the modules and the power loss due to the inconsistent temperature distributions reduces to 2.3% at the same working condition. When TEG is sandwiched between hot junction and cold junction and speed of engine is increased the voltage is increased and when air is flowed on the aluminium fins the voltage produced is still more increased. Here we use Bismuth and telluride as TEG material and found that TEG system of charging the battery could reduce the fuel consumption and also battery life used in automobiles could be increased. T Stephen John (2014) [5] has studied High Efficient Seebeck Thermoelectric Device for Power System Design and Efficiency Calculation. A Review of Potential Household Appliances.

Here Bismuth telluride material is used and found that the thermoelectric power generated was more than 2.5 watt DC per TEG, which is economically attractive. R. Saidur et. al. (2012) [7] have studied on Technologies to recover exhaust heat from internal combustion engines. The study also identified the potentials of the technologies when incorporated with other devices to maximize potential energy.

Principle:

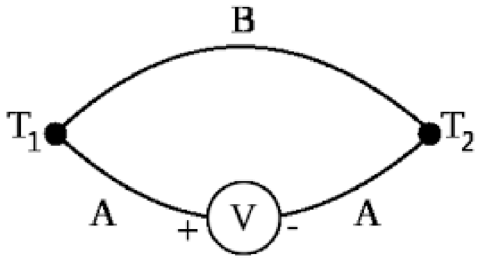

Figure 1: Seebeck effect

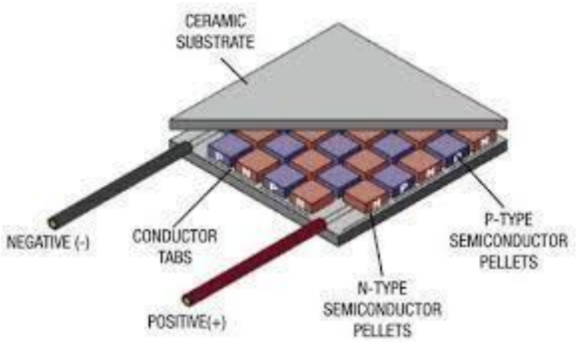

Figure 2: Thermoelectric generator

The Seebeck Effect is the conversion of temperature differences directly into electricity. It is a classic example of an electromotive force (emf) and leads to measurable currents or voltages in the same way as any other emf. Electromotive forces modify Ohm's law by generating currents even in the absence of voltage differences and hence seebeck formed a equation it is given as

The equation of Seebeck effect:

$$V=\alpha\ (T_h - T_c)$$

Where,
V – Voltage Generated in Volts α –
Seebeck coefficient in µV/K
Th-temperature of hot surface (silencer) in Kelvin Tc-temperature of cold surface (fins)in kelvin
α of Bismuth Telluride - 287µV/K

Jean C. A. Peltier discovered an effect inverse to the Seebeck effect: If a current passes through a thermocouple, the temperature of one junction increases and the temperature of the other decreases, so that heat is transferred from one junction to the other. The rate of heat transfer is proportional to the current and the direction of transfer is reversed if the current is reversed.

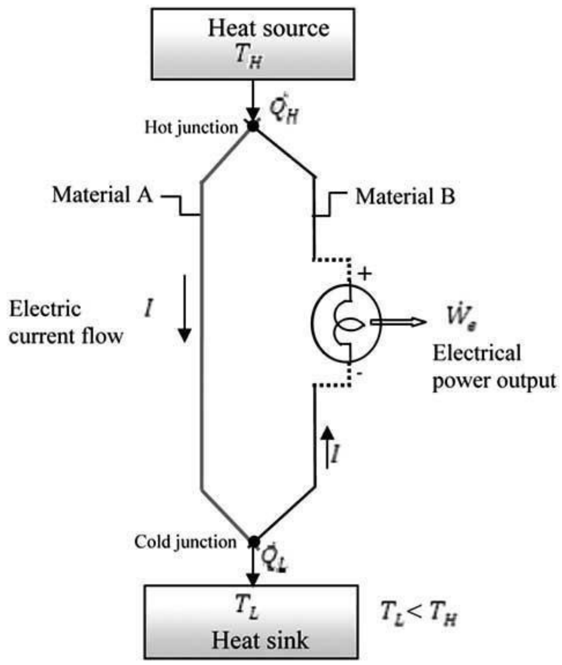

Figure 3: concept of seebeck effect

DESCRIPTION OF EQUIPMENTS:

[1].Peltier Module:

A thermoelectric (TE) module, also called a thermoelectric cooler or Peltier cooler, is a semiconductor-based electronic component that functions as a small heat pump. By applying a low voltage DC power to a TE module; heat will be moved through the module from one side to the other. One module face, therefore, will be cooled while the opposite face is simultaneously heated. Both N-type and P-type Bismuth Telluride Bi2Te3 thermoelectric materials are used in a TEG

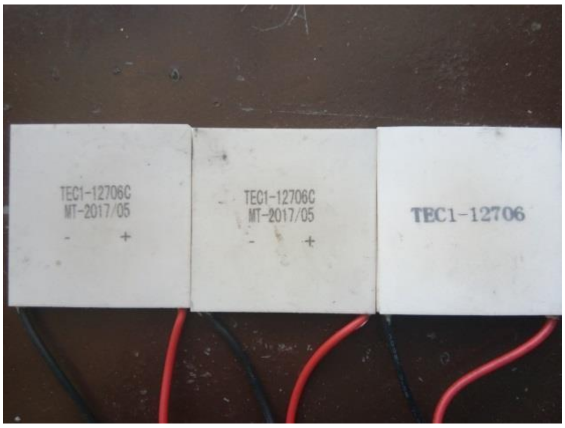

Figure 4: Peltier Module

[2].Thermal grease:

The main role of thermal grease is to eliminate air gaps or spaces (which act as thermal insulator) from the interface area so as to maximize heat transfer. Thermal grease is an example of a thermal interface material.As opposed tothermal adhesive, thermal grease does not add mechanical strength to the bond between heat source and heat sink. It will have to be coupled witha mechanical fixation mechanism such as screws, allowing for pressure between the two, spreading the thermal grease onto the heat source. Thermal grease consists of a polymer liquid matrix and large volume fractions of electrically insulating, but thermally conductive filler.we use nitro oxide type thermal grease

.

Figure 5: Thermal paste

[3].Booster circuit:

As the voltage regulated in the peltier module is low for the commercial usages we need to enhance the power produced in the module by connecting a booster circuit.The main purpose of using the Booster Circuit is to amplify the voltage obtained from TEG. From TEG we can get a maximum of 2V and 500mA current. The Booster circuit will amplify the voltage to 6V.

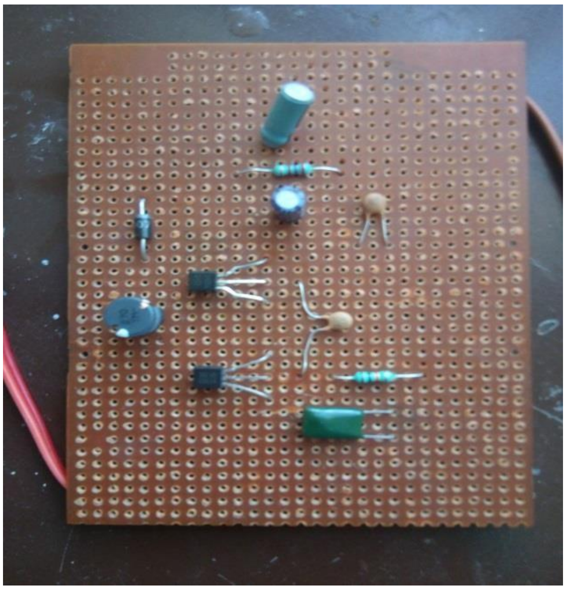

Figure 6: Booster circuit

[4].Aluminium plate and fin.

Aluminium is remarkable for its low density and its ability to resist corrosion.it can withstand the heat from -40 °C to 600 °C

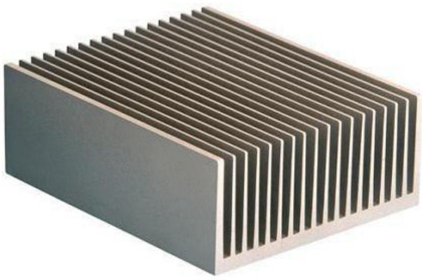

Figure7: Aluminium sink

[5] Multimeter:

Continuous monitoring of the system performance is necessary part of the experiment.One is connected after TEG module to monitor its output voltage. The second is connected after booster circuit to monitor booster voltage and the third one is connected across the load to monitor current flowing through the circuit. The DT830D digital type multimeter having dc voltage range 200 V having an accuracy ± 0.5% and dc current range 200 MA- 10 A, having accuracy ± 1.2% and ± 2.0.

LITERATURE SURVEY:

1. Jing-Hui Meng as performed investigation and design optimization of the thermoelectric generator (TEG) which is applied in automobile exhaust waste heat recovery . Their work develops a multiphysics thermoelectric generator model for automobile exhaust waste heat recovery, in which the exhaust heat source and water-cooling heat sink are actually modeled.

2. Gregory P. Meisner has developed a Thermoelectric Generator for automotive waste heat recovery. It includes the study of thermoelectric materials for development of TEG's. This model is capable of computing the overall heat transferred, the electrical power output, and the associated pressure drop for given inlet conditions of the exhaust gas and the available TEG volume.

3. C. Liu, Y.D. Deng, X.Y. Wang, X. Liu, Y.P. Wang, and C.Q. Su designed a heat exchanger for an automotive exhaust thermoelectric generator . They also evaluated the thermal properties and pressure losses of a heat exchanger. The horizontal temperature difference after optimization is reduced; the average temperature is improved from 222.46 degree Celsius to 226.4 degree Celsius, whereas the longitudinal temperature difference is decreased from 29.36 degree Celsius to 28.9 degree Celsius. Moreover, the pressure drop is decreased by approximately 20%, which may be significant for the global improvement of a thermoelectric generator system.

4. Young Kim, Assmelash A. Negash, Gyubaek Cho experimentally investigated the waste heat recovery performance of a thermoelectric generator (TEG). Customized thermoelectric modules (TEMs) were installed on the upper and lower sides of a rectangular exhaust gas channel. Water at an ambient temperature of 293 K was supplied from a cooling tower and was used to create a temperature difference across each TEM.

METHODOLOGY:

The vehicle is started and the acceleration is to be given, so that the amount of heat leaving the exhaust will be increased. Due to this heat, the surface of the exhaust pipe and the silencer will be heated to very high temperatures. These hot surfaces will try to liberate the heat to the atmosphere, which acts as a Heat Sink.

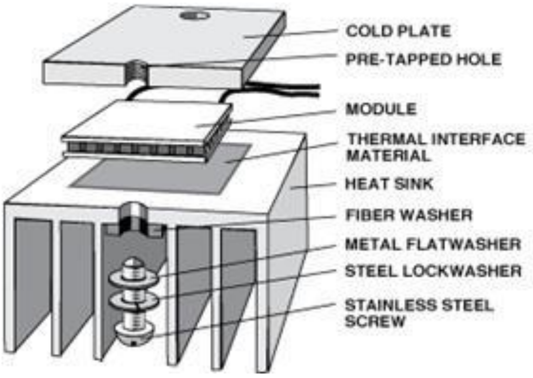

Figure8

Since the atmospheric temperature is less than that of the silencer surface, a temperature difference is created and hence the surface tries to attain the equilibrium state through the heat transformation process. But this will take much longer time. Hence in order to increase the rate of heat transfer the Thermal Grease is used. The Thermal Grease is coated on the hot surface of the silencers and also in the inner surface of the fins which are present in the upper part. The fins are also used to increase the heat transfer rate. As the vehicle moves, the air flow will take place between the fins and it acts as the sink.

Temperature difference (T_h-T_c) (k)	Voltage without boosting (volt)	Voltage after boosting (volt)
80	0.02296	1.44
100	0.02870	2.53
120	0.03444	3.21
140	0.04018	3.85
150	0.04305	4.43
160	0.04592	4.94
180	0.05166	5.37
200	0.05740	6.10

Table 1: Voltage generated and boosted for different temperatures

Based on the Seebeck effect, thermoelectric devices can act as electrical power generators. A schematic diagram of a simple thermoelectric power generator operating based on Seebeck effect.As the surface of the silencer gets more and more heated the heat transfer rate will increase due to the increase in the temperature difference. The Peltier module is placed between the Heat Source (Hot Silencer Surface) and the Heat Sink (atmosphere) and the fins are placed above the module.

The module is made of semiconducting materials. Hence by the principle of Seebeck Effect, the temperature difference can be directly converted into voltage by using some thermoelectric materials. Based on this effect, when the surface heat of the silencer is passed on to the atmosphere, the electrons and holes of the thermo electric semiconductors will try to move towards the junction and make the flow of electric current to be possible.

Figure9: Experimantal Setup

CONCLUTION:

The electrical power generation of the thermoelectric generator is observed to be a strong function of flow rate and inlet exhaust temperature. The temperature difference between the hot and cold junctions of TEG increased as the engine speed or the coolant temperature increase. The output voltage, according to the Seebeck effect, also increased as the temperature difference increase. Therefore, the output power and thermal efficiency can be improved. The parametric evaluation of the longitudinal model indicates that TEG performance improves for configurations that have minimum TEG height and maximum TEG width. The high-efficiency heat exchanger is necessary to increase the amount of heat energy extracted from the exhaust gas. It is found that exhaust gas parameters and heat exchanger structure have a significant effect on the system power output and the pressure drop. The study also identified the potentials of the technologies when incorporated with other devices to maximize the potential energy efficiency of the vehicles. Due to this heat, the surface of the exhaust pipe and the silencer will be heated to very high temperatures. These hot surfaces will try to liberate the heat to the atmosphere, which acts as a Heat Sink.

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