Utilization of Waste Heat from Automobile using Thermoelectric Generator

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Abstract*—The world is facing energy crisis as our fuel resources coming to end, so there need to be ways to use wasted and available forms of energy to produce electricity or utilize them to reduce usage of other power hungry devices. To meet the increasing world demand for energy, the rate of depletion of non-renewable energy sources must be reduced and need of developing alternative renewable sources. And also *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 using device called thermoelectric generator and recycle into useful work. Most of the techniques currently available to 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 in car engine, 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 and this is pollution free green technology. Today, 70% of produced energy in automobiles is wasted in form of heat by exhaust gases. This paper tries to prove the feasibility of converting waste heat from automobile to electrical energy. Furthermore, the electrical energy being generated could be supplied to the LED lights of the electrical vehicle (EV) or to charge the battery.

***IndexTerms*— Thermoelectric generator, Waste heat, Seebeck effect, Electrical vehicle, Power generation**

I. INTRODUCTION

Energy plays an important concern for the development of human civilization, but we need to face the problem of fast exhaustion of fossil fuels for producing electricity. Today, 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 percentage. With the energy and environmental issues increasingly prominent, the challenge of fossil energy depletion and environmental pollution, the renewable energy has become more and more important to human. The thermoelectric (TE) generation technology as one of the renewable generation methods has widely been used in various industries and situations. If the waste heat could be utilized effectively by the TE generation technology as the thermal energy, that will break the routine energy utilization and create a new sight of energy storage. In recently years, with the improvement in the efficiency of TE energy conversion, TEGs interest us through the implementation to solar energy and automobile.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 power. The motor is the main part of electric vehicle (EV), and when the vehicle is in running condition, the motor will produce certain amount of thermal energy from the coils of motor. Moreover, the efficiency of motor will be influenced by the waste heat amount. An idea is proposed for utilizing 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 according to Seebeck principle and then it can be utilized for battery charging of vehicles [1]. The basic principle of working of thermoelectric generator (TEG) is production of potential difference 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 between cold and hot side of TEG module, 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 and also to start the LED of EV [2]. Converting waste heat from car engine to electrical energy can be become efficient method for power generation. Thermoelectric generation 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 [3]. Figure 1 shows a layout of the main components harvesting energy from car engine heat by using TEG.

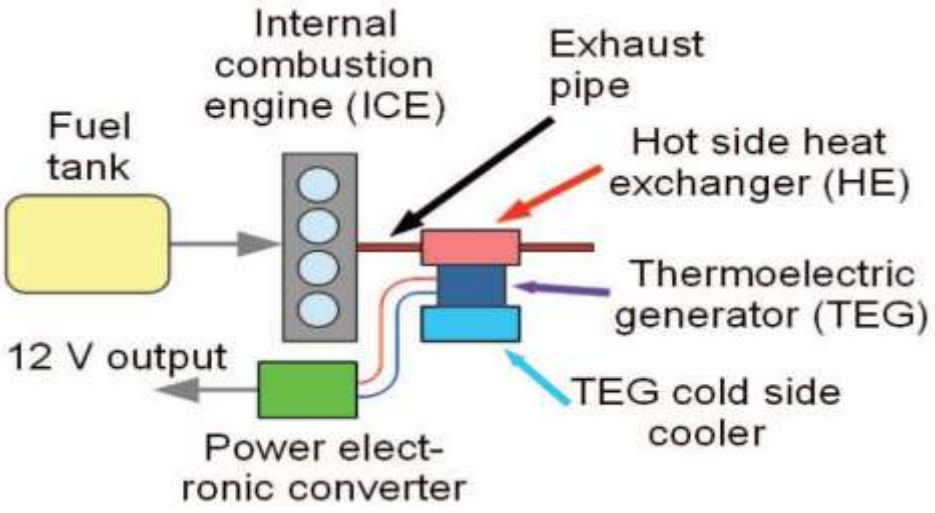

Fig. 1 :Layout of the main components harvesting energy from car engine heat by using TEG.

II. ANALYSIS OF THERMOELCTRIC MODULE

A. Abbreviations and Acronyms

S - Seebeck Effect
Amp-hr - Ampere hour rating of battery
TEG - Thermoelectric generator
EV - Electrical vehicle
LED - Light emitting diode

B. Working principle of TEG

An important way of utilizing heat energy in automobiles is to convert heat energy to electrical energy through a thermoelectric convertor. Thermoelectric convertors were made with the aim to do the conversion of heat energy into electrical energy. 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 waste heat into electrical power.

Thermoelectric generators use the simple Seebeck principle which says that:

$$V_{out} = \int (S_B - S_A)\, dT$$

Where, S is thermoelectric Coefficient of a material.

The working principle of thermoelectric generators can be stated 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".The concept of thermo generators is to have two plates made of up semiconducting materials eg. Bismuth Telluride (one hot and another cool) creating a temperature difference having different material on both, to give a high difference in thermo power, then the Vout may be a useful amount with the high temperature difference we can get around and away from car engine as shown in following fig. 2.

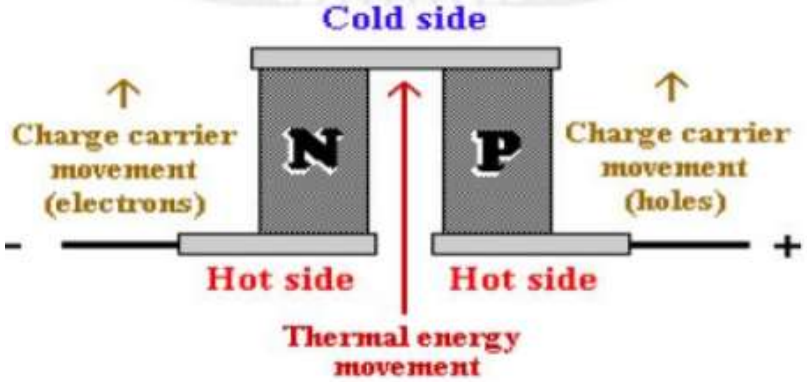

Fig. 2: Diagram for thermal energy movement

III. OUR APPROCH –TO PROVE FEASIBILITY

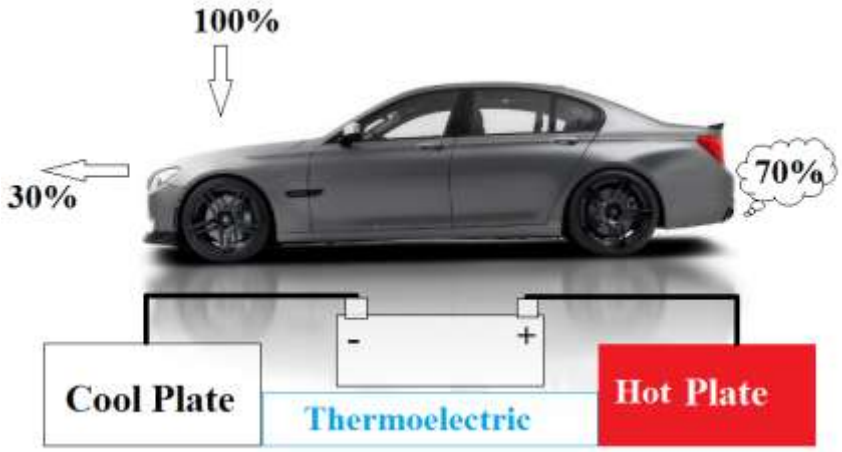

Fig. 3: Schematic of proposed mechanism to extract heat from Automobiles, and convert to electric power.

The rechargeable car batteries used in automobiles like SUV's which are high power consumption automobiles (BMW, Audi, etc.) today is rated at 12V, 80 Amp-hr and higher. The battery used in car is for purpose of:
1.) To start the car by powering the starter motor (giving a spark).
2.) To light on the headlights of the car, when needed.
We look at the technical possibility and feasibility of producing energy sufficient to light the headlights of the car when needed, or else store the generated energy in another rechargeable battery so, that could be used in motorcycles, etc. which use batteries of around 10-14 Amp-hr, and higher rating also.

An internal combustion engine (ICE) used as automotive power source which utilizes typically diesel or petrol fuel. Out of this 100% of fuel, 70% of fuel is exhausted in atmosphere as a heat. So, by utilizing waste heat we can convert it into electrical energy. To apply Seebeck mechanism, 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 thermoelectric and 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 purpose only.

So, generated 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.

IV. RESULT

The magnitude of the output voltage from the TEG module depends upon the temperature of the heat source. The voltage obtained from TEG module is boosted up to 15 -18 volts using boost up convertor. So maximum amount of voltage obtained experimentally is 18volts.

V. CONCLUSION

To conclude, it is clear that TEG waste heat recovery technology could potentially offer significant fuel economy improvements. If this is demonstrated feasibly on large scale applications such as automotive, a significant savings in fuel consumption can be achieved by applying it in automobile sector. There is potential to increase the conversion rate from heat to electrical energy, by using materials with better Seebeck coefficient difference and increasing efficiency of TEG's. This application, on a real scale would help in prevention of large amount of heat, preventing the environment also from damage.

VI. ACKNOWLEDGEMENT

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