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Converting Waste Heat from Automobiles to Electrical Energy

[1] Aravind satheesh, [2]Magnus Philip, [3]Rittomon Thomas
Guided by-Mr Aju s Nair,Assistant proffessor of Electrical and Electronics Engineering
Amal Jyothi College of Engineering,Kanjirappally
[1] aarisatheesh@gmail.com, [2]magnusphilip@gmail.com, [3]rittothomas001@gmail.com

Abstract: **The world is facing energy crisis and with our fuel resources coming to end, 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 while developing alternative renewable sources. One way to do this is by waste heat recovery. Most of the techniques currently available recover waste heat in the form of thermal energy which is then converted to electricity in a conventional steam power plant. [3] Our main aim is to explore the potential of heat energy across systems, to help in producing the all time need of human life-energy/power and reduce environmental effects of heating from vehicle pollutants, using the less explored concepts of TEG. Today, 70% of produced energy in automobiles is wasted in form of heat by exhaust gases. The paper tries to prove the technical feasibility of conversion of heat energy radiated from automobile engines to produce power equivalent to a 35Amp-hr battery, using thermoelectric generators applying Seebeck principle, discovered in early 19th century. The method is based on basic theoretical concepts, and in practice shows similar results.**

Keywords: **Heat radiation, Seebeck Effect, Temperature gradient, Thermoelectric generator(TEG),Power generation**

I. INTRODUCTION

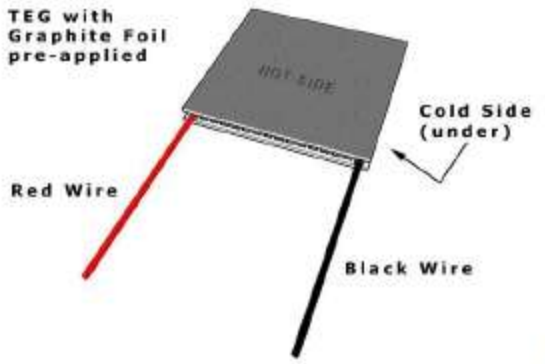
Energy is an important concern for the development of human civilization, but we need to confront the problem of fast exhaustion of fossil fuels for producing electricity, petroleum, etc. The number of motor vehicles on world's roads and the number of miles driven by those vehicles continue to grow, resulting in increased air pollution, increased petroleum consumption, and increased reliance on foreign sources of petroleum, 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.

Heat engines are designed to give useful work of driving the vehicle only. Waste heat is a by-product resulting from irreversibility of process involved in conversion of fuel energy to mechanical/electrical energy. There is an alternative way to prevent the 70% of wasted petroleum energy in automobiles by the use of thermoelectric generators (TEG). [4] By far, very less practical implementation of the basic principle of TEG is made, to prevent wasted energy. The basic principle of thermoelectric generator (TEG) is production of voltage based on temperature difference between two surfaces. Using the TEG has many advantages, like these generators have no moving parts and can run unattended for thousands of hours. For example, the Voyager spacecraft launched in 1977 was powered by 159 W Radioisotope Thermoelectric Generator (RTG) heated by radioactive isotopes as a power source. Mission controllers report that all 1200 generators on board were still functioning normally after 250 million hours of operation.[6] Utilizing the above mentioned simple concept, we can do a big task of generating energy and using the wasted heat (which is a potential source of natural energy). The temperature near the car engine is around 1500C and that outside the insulation is still 1200C. One can imagine the amount of heat produced by such large temperatures, which in automobiles today is cooled down using coolants, which consumes around 25% of fuel energy, out of the total 70% wasted (mostly cold fluids in tubes) This energy which amounts to a total of large amount was unnoticed and hidden till some 5 years back, when people started thinking about use of TEG in automobile industry. Though heating is a common phenomenon in any energy producing system, here the amount of heat is tremendous and can be put to some efficient use. Using the Seebeck effect of temperature difference between bodies, the paper explores the feasibility of energy conversion technically. 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.

THERMOELECTRIC GENERATORS

Principle and Application An important way of utilizing heat energy in automobiles is to convert heat to electrical energy through a convertor. Thermoelectric convertors were made with the aim to do the same, but application of it in automobiles is not yet undergone. When a heat gradient is applied to a thermoelectric material or convertor, 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 says that:
Vout = ∫ (SB – SA) dT



(1) Where, S is thermo power/Seebeck Coefficient of a material. 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 thermo power, then the Vout may be a useful amount with the high temperature difference we can get around and away from car engine.

Problems Currently thermoelectric generators are not used in any electronic devices of daily use (they are used in space shuttles, etc) due to the following problems:
1. They are quite costly.
2. The maximum efficiency they can give is around 510% due to which the output voltage gets much lower than predicted.
3. You need a high difference in S of the materials on two plates, for which you will need a metal and insulator on the two plates, making it heavy and difficult to design.

OUR APPROACH - TO PROVE FEASIBILITY

A. Technical Details

Schematic of proposed mechanism to extract heat from automobiles, and convert to electric power

1.Mobile charging slots

2. To light on the headlights of the bike, when needed. We look at the technical possibility of producing energy sufficient to light the headlights of the car, or else store the generated energy in another rechargeable battery that could be used in motorcycles, etc which use batteries of around 10-14 Amp-hr, and higher.

Also, we know that the temperature on the exhaust is 150oC. We use a thermoelectric convertor having two parallel plates like a capacitor, one just attaching to the exhaust having temperature of 150oC and other to the outside room temperature 30oC.

To apply Seebeck principle, we place one plate near the exhaust 150 oC and other at around 30 oC by coolant application. The concept also has to change the way coolant cools the other side from within, rather now it should cool the area where we have the other plate of thermoelectric convertor. The coolant should not absorb energy from the exhaust, as that will be utilized for electrical conversion using the convertor. Hence, the coolant needs to provide cooling only in one region and the other region

Thermo electric generator working efficiently at a temperature difference of 120 degree efficiently and producing a voltage of 4v and current of 0.6 ampere thus producing a power of 3.2 watts.

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. We have proved that it is feasible to use thermoelectric convertors to light up the headlights. 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

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