Power Generation from Exhaust Gas and Engine Heat using TEG

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Abstract - *Most of the vehicles which is commercially available use internal combustion engines. The ICE engine use only small share of the fuel primary energy converted to kinetic energy however, majority of fuel primary energy is wasted while dissipated in the ambient air as hot exhaust gases and waste heat. The recovery of waste heat gives the remarkable potential for improving the efficiency of the ICE system This paper present an overview of the waste heat recovery system. Utilizing thermoelectric generators (TEGs) and also it provides state of art of current research. This system provides the direct heat-to-electric energy conversion without moving parts to vehicle and it allows building the exhaust energy recovery system. Thermoelectric generator is one of the method which help to recover waste heat, designing of thermoelectric generator based on range of temperature. This paper is based upon the theoretical concept and present work improves the efficiency of the existing system by introducing structural changes in system.*

Keywords- Internal combustion engine; thermoelectric generator; waste heat; exhaust energy; efficiency.

1. INTRODUCTION

While recent developments in electric vehicle deployment have brought various non-petrol and hybrid vehicles to the markets, the major share of transportation, especially for heavy vehicles are still carried out by efficient internal combustion engines (ICE). It has been estimated that as little as 12% of fuel primary energy could be utilized by an ICE vehicle in average. Unused energy is in this case dissipated as heat in exhaust gases (temperatures 300...700ºC) and engine coolant (temperatures 60...100ºC). The thermoelectric waste heat energy recovery systems have been shown to be beneficial for a variety of ICEs and vehicles ranging from motorcycles to heavy cargo trucks.

TEG based systems provide a solid-state energy conversion system with least moving parts and complexity, making them one of the more feasible and reliable options for waste heat recovery. On the other hand, the TEGs provide rather low overall efficiency ratings. To achieve a noteworthy benefit from added TEG energy recovery system, many aspects of performance and operation of TEGs needs to be taken into account when designing such systems. This seminar aims to summarize the general outlines of the exhaust energy recovery systems build up, basically, the domestic heating boilers but also stationary ICE power production systems would follow the same principles considering building combustion exhaust energy recovery systems for vehicles.

Heat exchanger to collect the heat from the exhaust gas are one of the key aspects in waste heat harvesting, where the geometry and assembly position overview and analysis will be provided. The TEG output source characteristics and voltage conversion options are discussed with maximum power point tracking operation specification to achieve highest output. In this seminar, examples of the practical heat recovery systems implemented for different vehicles and ICEs are provided.

1.1 Principle behind thermoelectric generator

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. One important reason for it is the question of feasibility for enough power to do some functioning in a car, reducing the consumption of rechargeable batteries which consume electric power.

Thermoelectric generators use the simple See beck principle which says that:

$V_{out} = \int (SB - SA)\, dT$

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 V_{out} may be a useful amount with the high temperature difference this can get around and away from car engine.

The internal combustion engine energy usage profile is then described briefly, followed by exhaust parameters overview.

Heat exchangers to collect the heat from the exhaust gas are one of the key aspects in waste heat harvesting. The TEG output source characteristics and voltage conversion options are discussed with maximum power point tracking operation specification to achieve highest output. Seebeck effect, thermoelectric devices can act as electrical power generators. A thermoelectric power generator operating based on Seebeck effect.

When electrons are in motion, we have an electrical current usually is the driving force but other forces like temperature difference flow of thermal energy can drive the electrons. If the temperature is increases the voltage is also increases vice versa in such a way that the other side of thermoelectric generator is cold because heat transform is uniform then only electron will flow and voltage is developed at the output side of the thermoelectric generator.

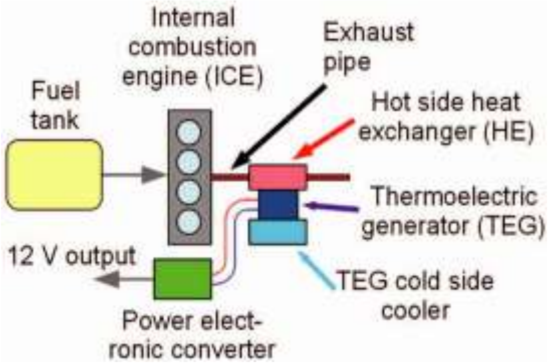

Fig -1: Layout of the Main Components of the Vehicular Exhaust Gas Heat Recovery System with Thermoelectric Generator.

2. Thermoelectric Materials

Thermoelectric (TE) impact has been known for just about 200 years (found by Estonian-German physicist Thomas Seebeck in 1822) and is broadly executed in thermocouples for temperature estimation. A Seebeck coefficient S is utilized to determine the electromotive power (emf) delivered inside the material per unit of temperature distinction dT between the hot side of the material (Th) and cool side of the material (Tc) connected.

$eTE = \alpha \cdot T = \alpha (Th - Tc)$

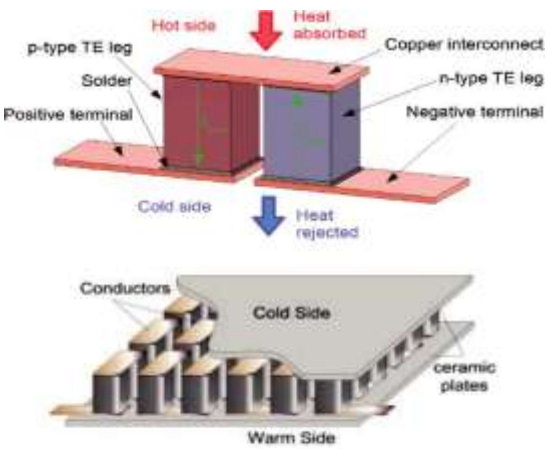

Fig -2: Thermoelectric Couple (Top), and 18-Couple TE Module (Bottom)

2.1 Proposed Model in Automobiles

Thermoelectric generators can be put in the radiators of the autos. Fuel is continually consuming inside the vehicle. A ton of the warmth from this burning goes ideal out the fumes framework. Indoor regulator is set in the middle of the radiator and the motor of all fluid cooled vehicle motor framework. It is around 2 crawls in measurement, used to obstruct the stream of coolant to the radiator till the motor has warmed. Coolant does not move through the motor, when the motor is chilly. At the point when the motor temperature achieves 2000 F, the indoor regulator opens. The indoor regulator decreases motor wear, stores and emanations by giving the motor a chance to heat up at the earliest opportunity.

2.2 Positioning of the TE Energy Harvesting System and Cooling

As a rule, 3 areas for vitality reaping framework have been proposed: behind the ventilation system, among complex and ctalyst converter, directly after the impetus converter and at last appeared. For the task of the impetus converter, the favored area is after the impetus converter, where the fumes temperatures still remain rather high, yet the impetus converter activity isn't influenced. As the areas vary by the separation from the motor so do likewise the parameters of fumes gases that are passing these districts appeared in fig. 3.

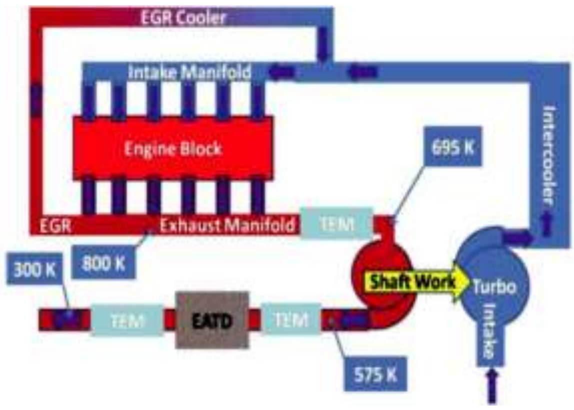

Fig -3: Diesel Engine Possible Energy Harvesting Heat Exchanger Locations for TEG Systems

It must be considered likewise that the warmth exchanger would cause the weight drop in the warmth exchanger, yet the decline of temperature of the gas could likewise prompt volume decline of the fumes leaving the warmth exchanger. The weight drop has been demonstrated to shift from 45 to 10 000 Pa and past. It is viewed as very critical factor in a few workshops and even it is professed to require mechanical vitality from camshaft to push out the gases. This can't be concurred with as the weight of the fumes is high.

3. Practical Applications

"Vitality spared is Energy produced." these are making a model through this course to change over the waste warmth vitality of car fumes gases into electrical vitality. In spite of the productivity being somewhat low (between 5-10%), this model has a two-way benefits. Right off the bat, it will get a proper measure of electrical vitality which can be used to serve some fundamental necessities of a vehicle. Along these lines, it can cut out something compelling from finish squander. In addition, this are decreasing the expense of coolants by aiding in lessening the temperature of fumes gases.

4. CONCLUSION

In this paper, execution of thermoelectric generators (TEG) and its model for the assessment is produced. In this model which related with the warm contact opposition of TEG of best and base fired plates is connected to business TEG. The TEG module conveys 1.7w of intensity, when hot side temperature was 750c and cool side 30 which is likeness about 1.4% of effectiveness on a normal temperature contrast of60 degree celcius. In the event that this module set up in arrangement, it could create more measure of power. The waste warmth recuperation innovation could offer enhancements in efficiency. In the event that it is exhibited on extensive scale application, for example, car, a sparing in fuel utilization in vehicle part can be accomplished.

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