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Power generation from exhaust of Internal combustion engine

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ABSTRACT

Power generation is done through various methods, some of which uses Renewable energy sources and some use Non Renewable Energy Resources. WE are building a new Innovative method of power generation using exhaust gas of Internal combustion engine to construct our model. Energy demand is increasing day by day with rapid growth in industrial as well as house hold utilization. But the energy resources are gradually decreasing at a higher rate. The main motive or objective of our project is to produce power using energy/heat liberated from the exhaust gases of the Internal engine, in this we are using method of producing power through p-n junction methods and the force due to exhaust gases to run the turbine.

Keywords: I.C. Engine, Exhaust gases, Exhaust Gases Temperature, Thermoelectric generators &, Booster Circuit.

I. INTRODUCTION

Heat engine: It can be defined as any engine that converts thermal energy to mechanical work output. Examples of heat engines include: steam engine, diesel engine, and gasoline (petrol) engine.

• On the basis of how thermal energy is being delivered to working fluid of the heat engine, heat engine can be classified as an internal combustion engine and external combustion engine.

• In an Internal combustion engine, combustion takes place within working fluid of the engine, thus fluid gets contaminated with combustion products.

– Petrol engine is an example of internal combustion engine, where the working fluid is a mixture of air and fuel .

• In an External combustion engine, working fluid gets energy using boilers by burning fossil fuels or any other fuel, thus the working fluid does not come in contact with combustion products.

– Steam engine is an example of external combustion engine, where the working fluid is steam.

Internal combustion engines may be classified as:

– Spark Ignition engines.

– Compression Ignition engines.

• Spark ignition engine (SI engine): An engine in which the combustion process in each cycle is started by use of an external spark.

• Compression ignition engine (CI engine): An engine in which the combustion process starts when the air-fuel mixture self ignites due to high temperature in the combustion chamber caused by high compression.

– Spark ignition and Compression Ignition engine operate on either a four stroke cycle or a two stroke cycle.

2. METHODS AND MATERIAL

Thermoelectric Principle of Operation

Thermoelectricity means the direct conversion of heat into electric energy, or vice versa. According to Joule's law, a conductor carrying a current generates heat at a rate proportional to the product of the resistance (R) of the conductor and the square of the current (I). A circuit of this type is called a thermocouple; a number of thermocouples connected in series are called a thermopile.

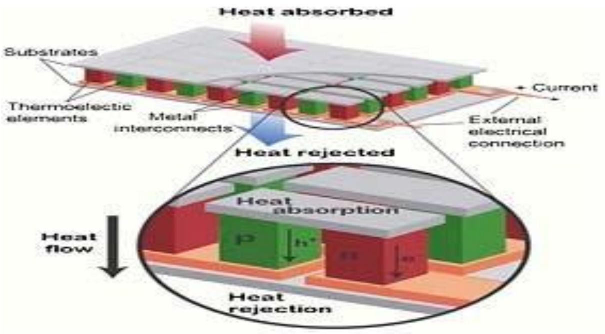

Figure 1: Thermionic Principle of Operation

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.

Description of the Equipment

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,

Figure 2: Peltier Module

2. TE- Generator

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.

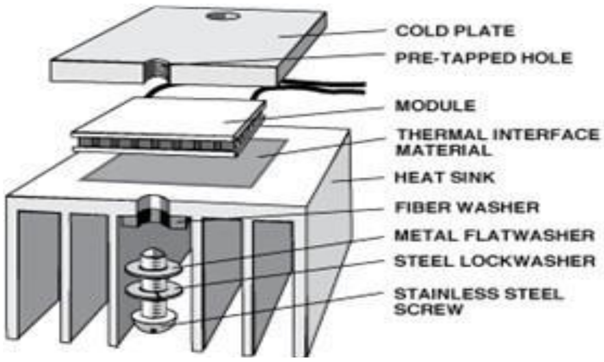

Figure 3: TE-Generator

3. Thermal Grease

Thermal grease (also called thermal gel, thermal compound, thermal paste, heat paste, heat sink paste or heat sink compound) is a viscous fluid substance, originally with properties akin to grease, which increases the thermal conductivity of a thermal interface by filling microscopic air-gaps present due to the imperfectly flat and smooth surfaces of the components; the compound has far greater thermal conductivity than air (but far less than metal). In electronics, it is often used to aid a component's thermal dissipation via a heat sink.

4. Booster Circuit

Figure 4: Booster Circuit

This is based on the theory that inductor holds current and passes in opposite direction. This is a DC to DC converter and it has a poor efficiency of 60-80%. So we can't use it for a large project. We can use it for low power consuming models like 12 V and 3 V models which requires 250 mA current. We have to spend 650 mA with 80% efficiency. In this circuit we are going to put DC pulse of around 2V through TEG and amplifying to 12 V as output. We need to fallow the below for expected voltage range. 6 V to 12 V @1 A: 80 turns of 24swg wire in a 0.5 mm ferrite core.

6 V to 12 V @500 mA: 60 turns of 36swg wire in a 0.5 mm ferrite core

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 12V and there is a digital display is provided in it which can display the amplified voltage.

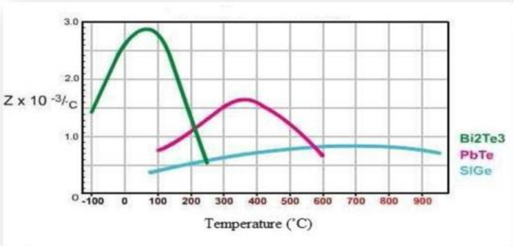

Figure6: Performance of Thermoelectric Materials at various temperatures

The figure of merit Z describes material performance. It depends on the thermoelectric material properties.

Where, α =Seebeck coefficient, σ = electrical conductivity, k = thermal conductivity.
Single pair of thermoelectric couple contains one p and n type of semiconductor legs and a module has number of couples electrically connected in series and thermally in parallel. The enclosed parallel plates are made up from ceramic substrate which is electrical insulators.

(ii) Heat source and heat sink:

- A heat source is an object that produces or radiates heat.
- 1)Copper heat source

Figure 5 Copper heat source fabricate for the present study

Copper has the high thermal conductivity and melting point easy to weld at silencer bend pipe which transmit heat to the thermoelectric generator. Therefore in this experimental setup, copper plate as a heat source at hot side is used. The hot junctions of the TEGs are connected to the copper plate needed to the bend pipe of I.C. engine carrying the hot exhaust gases. This copper plate have a smooth surface and dimensions 185mm x75mm x6mm acts as a heat source.

- A heat sink is an object that absorbs and dissipates heat from another object using thermal contact.

DESIGN CALCULATION

1) 1 Specification of Petrol Engine

Type	Two stroke
Cooling System	Air cooled
Bore/Stroke	50 X 50 mm
Compression Ratio	98.2 cc
Piston Displacement	6.6 : 1
Maximum Torque	0.98 kg-m at 5500RPM

2) 2 Calculation for Voltage generated

From the equation of Seebeck effect,

$$V=\alpha (Th - Tc)$$

Where,

V – Voltage Generated in Volts α – Seebeck coefficient in μV/K T_h-temperature of hot surface (silencer) in Kelvin T_c-temperature of cold surface (atmosphere) in Kelvin α of Bismuth Telluride - 287μV/K

T_c = 303 k

A few temperatures of the hot silencer is taken into consideration and the corresponding voltages that are expected to be generated according to the Seebeck equation

Is calculated as follows,

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

Case 1:

T_h= 403 k

V= $(287 *10^{-6})* (403-303)$

= $(287 *10^{-6})*(100)$

= 0.0287 V Case 2:

T_h= 453 k

V = $(287 *10^{-6})* (453-303)$

= $(287 *10^{-6})*(150)$

= 0.04305 V

These voltages are meager in value .This can be boosted up using the booster circuit. The experimental results obtained are tabulated as follows:

Temperature difference δt (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 I: Voltage generated and boosted for different temperatures

CONCLUSION

In this project we have successfully fabricated an exhaust gas heat recovery power generator. Thus the eco-friendly power generation method can be implemented for domestic and commercial use at an affordable cost. The efficiency of the engine will not be affected because only the surface heat of the silencer is drawn out. The main objective of this paper is to recover the surface exhaust heat to avoid the accidents (Burn-outs) caused by the overheated silencers, and to convert the recovered heat to useful electric energy. This objective has been successfully accomplished in this paper. The output could be increased by connecting a number of TEGs in series, so that the voltage gets added up leading to increased power. The energy produced from this system could be used to power any auxiliary devices in an automobile directly or it could be stored in a battery and then used later.

1. This project aims to find a possible way to recover the waste heat from the exhaust of I.C. engine as well as to design and fabricate one such system to serve the aim.
2. Experimentally it is found that when two thermoelectric generators are connected in series. This generated power either directly used to run some auxiliary devices of an automobile or may be stored in the battery and used later.
3. These auxiliary loads can be supplemented from battery to this system thereby reducing load on alternator.
4. The study also investigates the effect of engine speed on temperature difference and voltage generated.
5. The engine performance is unaffected by the designed system because heat extracted from the surface of the bend-pipe of the exhaust manifold which does not affected the working of engine.
6. If higher temperature range is required then TEG module must be changed to higher temperature range (200˚C). Thus, the above stated system may be successfully implemented in different automobile engines, with slight changes.

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