ELECTRICAL POWER GENERATION BY USING WASTE HEAT FROM IC ENGINE

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ABSTRACT

Energy from waste heat is one of the non-conventional energy generation technique in contrast to the conventional energy generation system, energy from waste heat system(EFWHS) does spent any money for raw material it utilizes the waste heat from automobile, power generator, boilers etc.,

This paper discusses the feasibility of power recovery from a low grade heat source. In this work, a thermo electric generator is used to generate the electricity from the exhaust of an automobile it produces 3.5 to 4W. This will useful in making a LED bulb to glow or recharge mobile phone, this work will be useful in the field of thermo electric generation. The principal followed in this project is seebeck effect principle.

KEYWORDS: Thermoelectric Power, IC Engine, Waste Heat, Exhaust & See beck Effect

Received: May 25, 2020; **Accepted:** Jun 15, 2020; **Published:** Jun 30, 2020; **Paper Id.:** IJMPERDJUN2020157

1. INTRODUCTION

Electricity plays a greater role in our daily life. Among the other source of energy generation, thermo electric energy generation is easy and requires very less energy extraction equipment's. The techniques to get energy from waste heat such as energy generation from IC engines are most popular now a days. In the present life style of people, IC engines like bike, scooters and cars etc., are become essential, also the technical institutions are having IC engine labs. Hence trapping energy from the IC engine considered in this work.

1.1 Power Generation Due to Heat

Two metal plates are joined together and heating, for purpose of producing electricity. This is called "thermo coupling method". On heat we can use only waste heat to recover and produce electricity.

2. WASTE HEAT RECOVERY SYSTEM

Squander recuperation units, for example, recuperators and regenerators are one of the most broadly utilized warmth recuperation units yet for low temperature working liquids these warmth trades become incapable. In this way there is a need of a warmth recuperation unit which can work at moderately lower temperatures. Various strategies, for example, Natural Rankine cycle which changes over poor quality warmth source to power and piezoelectric generators which straightforwardly changes over mishappenings created in piezoelectric materials into power are proposed for optional warmth recuperation however confinements being their high speculation cost or high hardware weight and expanded multifaceted nature. TE gadgets then again are light weight and don't require any moving parts. Execution of TE gadgets is spoken to by a dimensionless amount known as "figure-of-merit" and indicated by "ZT". It's characterized as: $\alpha ZT = \frac{2 \lambda T}{\sigma}$ "is electrical conductivity of material σ Where, 'seebeck coefficient of the

material is α' and 'warm conductivity of the material is λ' '.

2.1 Types of Waste Heat Recovery Systems

- Heat recovery from geothermal sources
- Heat recovery from I.C engine
- Industrial waste heat recovery
- Heat recovery from solar energy sources

2.1.1. Heat Recovery from I.C Engine

Usually Engine losses account for 70-72 % of total energy, Out of which thermal (such as radiator), exhaust heat account for 60-62 %. Due to this the atmospheric temperature is increasing by Approx 0.5^0-1^0C . On an average a car runs about 20,000kms per year. So we can assume how much heat is given away to atmosphere daily. So cashing the heat i.e., converting to electricity and using that is we are getting "FREE ELECTRICITY" and also control Global warming. On this line we worked and built up a framework to produce power from squander warmth of Vehicle exhaust. Out of all the accessible sources, the inner ignition motors are the significant purchaser of non-renewable energy source far and wide. The rest of the warmth is removed to the earth through fumes gases and motor cooling frameworks, coming about in to entropy rise and genuine natural contamination, so it is required to used waste warmth into helpful work. The recuperation and usage if squander heat moderates fuel, normally petroleum derivative yet in addition diminishes the measure of waste warmth and ozone depleting substances damped to condition. The Inward Burning Motor has been an essential force hotspot for autos and automotives over the previous century.

Most of vehicles are as yet controlled by either flash start (SI) or pressure start (CI) motors otherwise called diesel motors have a wide field of utilizations and as vitality converters they are portrayed by their high productivity. Little air-cooled diesel motors of up to 35k W yield are utilized for water system reason, little horticultural tractors and development machines though huge homesteads utilize tractors of up to 150k W yield. Water or air-cooled motors are utilized for a scope of 35-150k W and except if carefully air cooled motor is required, water-cooled motors are favored for higher force ranges. Earth moving hardware utilizes motors with a yield of up to 520k W or significantly higher, up to 740k W. Marine and train applications for the most part utilize motors with a yield scope of 150k W or more. Trucks and street motors as a rule utilize fast diesel motors with 220k W yield or more. Diesel motors are utilized in little electrical force producing units or as reserve units for medium limit power stations.

3. THERMO ELECTRIC CONCEPTS

Thermo electric modules are devices that either convert thermal energy from a temperature gradient into electric energy into a temperature gradient. Thermoelectric concepts are the combination of seebeck effect, peltier and Thomson effect.

4. THERMO ELECTRIC GENERATORS

Thermoelectric power generation is a device which converts temperature gradient or temperature difference into Electricity, by using thermoelectric modules as shown in figure 1 such as Pb-Te, Bi-Te. In those materials Pb-Te, can provide only limited power generation efficiency, typically as low as 4-7 %. Recently discovered advanced TE materials that have been characterized in the last 5-7 years and continue to be developed are projected to provide a much higher

efficiency (typically 12-20 %). By using those materials we can achieve good efficiency.

Figure 1

5. RESULTS & DISCUSSIONS

In this chapter we are going to discuss about procedure of thermo electric cooler and performance calculation and results obtained by doing experiments on thermo electric power generation.

5.1 Design Procedure

- Calculating the voltage that can be produced due to temperature difference.
- Power generating capacity of each module.
- Total Power output.
- Number of modules required.

5.1.1 Calculating the Voltage That Can Be Produced Due to Temperature Difference at Exhaust Pipe

To calculate the power that can be produced due to temperature difference let assume that the temperature at the exhaust pipe is about 160°C and the temperature at the cold junction is at 45°C then the power produced is can be calculated as follows.

First the voltage produced can be calculated as follows.

$$V = \alpha_m (T_1 - T_2)$$

Where

V=Voltage produced in the circuit.

T₁=Initial temperature of atmosphere

T_2 =Final temperature of air.

α_m = seebeck coefficient of module.

5.1.2 Calculate of α_m Value

Figure of merit $Z = \alpha^2 / TE$

$$= 0.82 \text{ (TGM127-1.0-1.3 module)}$$

Where

T =thermal conductivity for thermo electric module=1.1 W/mk.

E =electrical resistivity of module=0.5 Ohm-mt.

$$0.82 = \alpha^2 / (1.1 \times 0.5)$$

$$A = 0.0666$$

The voltage produced can be calculated by using the following formula.

$$V = 0.06666(160-45) = 7.66 \text{ Volts.}$$

5.1.3 Power Generation Capacity of Each Module

Calculation of E value for single thermoelectric module

$$R = 2EL/A_p$$

$$4.2 = 2 \times E \times 3.6 / (30 \times 30)$$

$$E = 0.5 \text{ Ohm-meter}$$

Where

R =electrical resistance of module = 4.2 Ohm (constant for TGM 127-1.0-1.3 module)

E =electrical resistivity of module.

L =thermo electric module length=3.6mm²

A_p =cross sectional area of module=30x30 mm²

α = Seebeck coefficient = 0.066 v/⁰ C

The current developed in the circuit can be calculated by using the following formulae.

$$I = \alpha (T_2 - T_1) / (R_L + R)$$

$$= 0.066(160-45) / (4.2+4.2)$$

$$= 0.90357 \text{ amps}$$

Where, R_L =External Load resistance. In Ohms

R = Resistance of the thermo electric module Ohms

Here for getting maximum output $R_L = R = 4.2$ which is constant for specific module.

$$P_m = (\alpha (T_2 - T_1))^2 R_L / (R_L + R)^2$$

$$= (0.066(160-45))^2 4.2 / (4.2+4.2)^2 = 3.8 \text{ watts}$$

P_m = the power generation capacity of each module

5.1.4 Power Output

The total power which is generated from the engine exhaust can be calculated by using the following formulae.

$$P = V \times I$$

$$= 7.66 \times 0.90357 = 6.92 \text{ Watts}$$

5.1.5 Number of Modules Required

The number of modules which can be used can be calculating by using following formulae.

$$N = \text{Total power output} / \text{power produced from each module}$$

$$= 6.92 \text{ watts} / 3.8 \text{ watts}$$

$$= 1.82 = 2 \text{ (approximately).}$$

Figure 2: Voltage Vs Temperature of Exhaust Gases Plot

We have fabricated the thermoelectric power generator as per design and tested it. We have tested the thermoelectric power generator, from waste heat of IC Engine exhaust pipe and plotted the graphs by taking the readings of temperature V_s voltage developed. Those are explained as follows in the figure 2.

Similarly the current developed is also varies with temperature of the exhaust gases of IC Engine. That can be explained and plotted in the figure 3 as shown in below.

Figure 3: Current Vs Temperature of Exhaust Gases Plot.

Similarly the power developed is also varies with temperature of the exhaust gases of IC Engine. That can be explained and plotted in the figure 4 as shown in below

Figure 4: Power Vs Temperature of Exhaust Gases Plot.

In the way the power generated is varies according with the temperature of the exhaust gases, number of modules used, type of modules used and efficiency of the module used. If the heat energy availability is high then by using high capacity modules, increasing number of modules we can generate more power.

6. CONCLUSIONS & FUTURE SCOPE

By studying various papers and journals we had done the project on thermo electric power generation from waste heat of an exhaust gases of an IC engines, to convert waste heat energy into the electrical energy, for this we have taken two thermo electric modules aluminum block, and heat sinks. Here the heat from exhaust pipe is transferred to aluminum block the heat transferred to TEG modules now due to heat conduction of heat two temperature junctions are formed one is hot and another is cold junction at the two sides of the thermo electric modules due to heat temperature difference electricity is generated.

The power generated is about 8 watts we designed a small prototype of power generator, to generate electricity from waste heat. The power generated can be varied based upon the amount of heat energy liberated, number and type of modules used, efficiency of modules used. Here we have investigated the reflection between the temperature of the exhaust gases and also the power developed.

Present project has a great scope in future because of the demand of power supply this may be a distant dream and by the efforts of various works this technology is going to be ecofriendly project and it cannot cause any harm to the environment based on heat energy available it can be used in various applications like industries, boilers to generate power up to 1MW.

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