International Journal of Advance Research in Science and Engineering
Vol. No.5, Special Issue No. (01), February 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

UTILIZATION OF LOSSES IN THE HEAT ENGINE TO INCREASE THE AMOUNT OF USEFUL POWER

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ABSTRACT

Today the efficiency of an automobile is quite less due to the number of losses are more when compared to the other systems as because of the entropy, number of accessories, frictional losses, standby/idle losses all these together effect the overall efficiency of an automobile, hence reaching maximum efficiency in automobile is little bit complicated and there are some ways to increase the efficiency of the engine. Using TEG modules along with dynamos connected by a power amplifiers can harness the waste energy which is being wasted during the cycle this energy is used to increase the efficiency of the heat engine.

Keywords: Dynamo, Efficiency, Exhaust, Heat engine, power amplifiers, thermoelectric generators, TEG, Turbine.

I. INTRODUCTION

Heat engines are designed to deliver mechanical energy from heat energy but due to the number of losses the engine efficiency is decreased. The major heat loss in the heat engine is loss through exhaust. The modern combustion engine efficiency is 37% and the remaining 63% is all wasted in many forms. The losses cannot be controlled at all the times hence without controlling the losses in this experiment we are trying to utilize the losses which are being wasted. The major losses of any heat engine is the pressure energy of the exhaust gas along with the heat loss through the exhaust system.

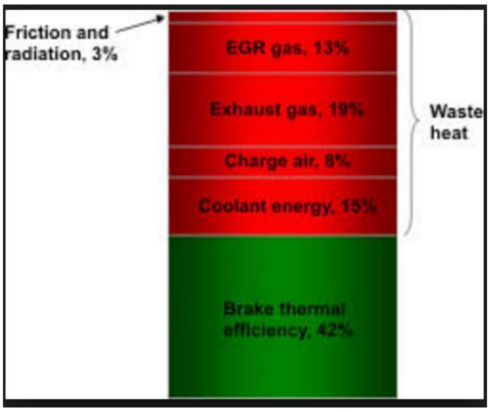

Fig 1.1 Percentage of heat losses through different ways

When an IC engine is subjected to working environment its parameters are all monitored carefully and the temperature is also calculated at different components of the system and it is clearly shown in the fig 1.1 that the heat loss is more through the exhaust system. That heat energy along with pressure energy should be harness in order to produce the electricity.

Hence in order to utilize those two loses two different systems are used and the efficiency of the individual harnessing system must also be high in order to harness most of the energy but due to the unavailability of the desired products along with the cost factor this project is progressed with the available and economical priced components

The two harnessing systems which have the capability to harness the energy are the TEG and turbo generators, with the help of these two systems we are trying to harness the power and then the power is passed through the power amplifiers and dc converters for increasing the quality of the current and then the produce power is stored in a 12 v batteries.

The stored electricity is used to power the head lights or even to run superchargers and with that the performance of the engine will also increases hence with the help of these two systems we can increase the engine efficiency.

Today many automotive engines are all internal combustion engines and in them 90 % of them don't have any power recovery systems and in the remaining 10% also, only one type of recovery systems are employed no automobile have two or more energy recovery systems.

Hence by using this unit we can harness more energy than other recovery systems which allows to increase the efficiency or performance of engine or to power up the accessories without using an alternator. This paper demonstrates the potentiality of the thermoelectric generator. The evolution of several thermoelectric materials gave an opportunity to create an efficient way to harness more amount of heat energy.

II. EXPERIMENTAL SETUP:

In this experiment we are using HERO HONDA CD Deluxe bike engine for harnessing the heat energy and pressure energy from the exhaust. The TEG and Turbo generator are attached to the exhaust and both are test individually as because to record the values individually. The specifications of the engine which is used in the experiment are tabulated below

Displacement	97.20 cc (59.3 cubic inches)
Bore * stroke	50.0 * 49.5 mm(2.0 * 1.9 inches)
Power	7.80 HP(5.7 KW) @ 7500 RPM
Torque	8.0 nm (0.8 kgf-m) @ 4500 RPM
Compression	8.8:1
Engine type	Single cylinder, four stroke
Ignition	Digital CDI

Table 2.1 Specifications of an Engine

Now the total power collected from the TEG and Turbo generator are made to pass through the amplifier circuits to amplify the 6v into 12 volts and then it is stored in the battery for powering the other accessories which rely on engine. Hence by reducing the accessories burden over engine by supplying this energy the overall efficiency of the engine increases. The description on producing power from both the systems are

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IJARSE
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detailed in the below sections.

2.2 Power by thermoelectric generators

Thermoelectric generators convert's heat energy into electricity but it needs both high temperature and low temperature on both side of TEG to create current, hence the only disadvantage with this module is that to create a colder side than the other side. There are wide range of TEG's are available in the market. The most efficient TEG so far manufactured are the germanium and silicon based TEG. The size of the TEG is depend upon the application type and the maximum area of the TEG is not more than the 8 cm*cm. hence these modules can be easily fit into the engine anywhere and this compatibility gives the advantage because placing an alternator to an engine occupies more space and it additionally requires mechanical energy from the engine to run, hence it also adds some mechanical burden to the engine which results in decrease the overall efficiency of the engine.
So using the TEG is the beast alternative and best efficient way to harness the power from the exhaust system, In this experiment we used the Teg1-12610-4.3 it can produce 5.3 watts and its specifications are mentioned in the table 2.2.1 and its model is shown in the fig 2.2.1 its dimensions are 40*40mm, 40*44mm/50*50mm

Fig 2.2.1 TEG Module

Hot side Temp©	300
Cold side temp©	30
Open circuit voltage(v)	10.7
Matched load resistance(ohms)	5.4
Matched load output voltage(v)	5.3
Matched load output current(A)	1.0
Matched load output power	5.3
AC Resistance(ohms) measured under 27 at 1000 HZ	2.7 to 3.6

Table 2.2.1 Specifications of TEG module

In the experiment setup which is shown in Fig2.2.3 used 8 TEG modules and together they are all connected in series in order to produce a quality current without any fluctuations and they are mounted in the cylinder shape aluminum chamber where all these modules are fitted in the circular direction and the colder side of the modules are all faced upwards so that the air flow act as a cold sink and the other side is automatically heated because of the conduction through the hot surface, the exhaust gas is made to pass through the modules and the temperature of the exhaust at the initial starting stage of the engine is shown in the figure 2.2.2 from the figure we can say that the temperature at the exhaust is more than 140 degrees which is enough to produce sufficient power to power up the accessories of the automobile. The experiment values are observed at three different temperatures i.e 30, 50, and 80c degrees and then the voltage values, amperes values and the total power produced are calculated. First the engine is run up to some idle time and whenever the exhaust temperature reaches 30c degrees the observation started and the values recorded at those temperatures are indicated in the graphs. The TEG generated 1 amp at the temperature 280 degrees and the material load voltage at that same temperature is 5 V, the curve gradually increase form the 0.5 volt to 5.5 volt it is shown in the Fig 2.2.4 and as shown in the Fig 2.2.5 the material load current also showed the similar phenomenon at that temperature, it started at the 0.5

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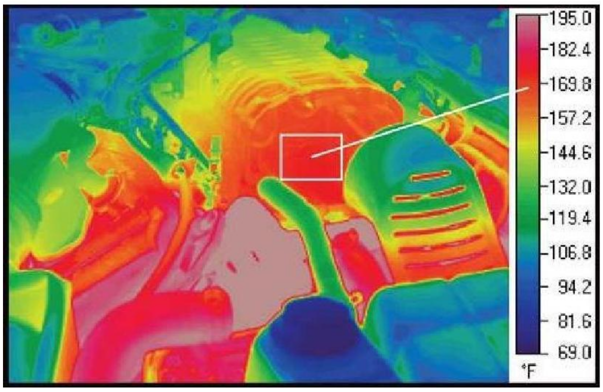
amperes and it gradually increases with increase in temperature and finally it delivered a maximum current of 1 amp.



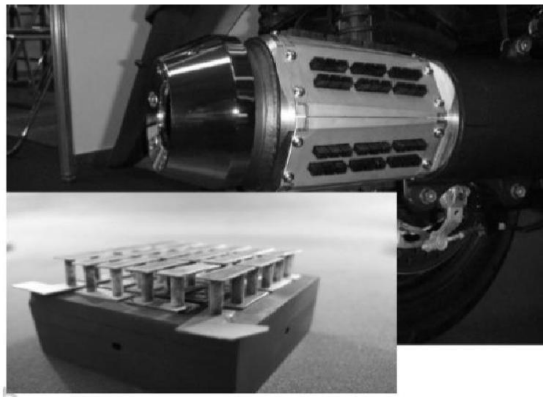
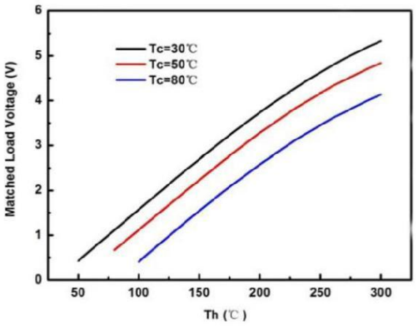


Fig 2.2.2 Temperature of the engine at initial Stage **Fig 2.2.3 TEG modules mounting to the exhaust**



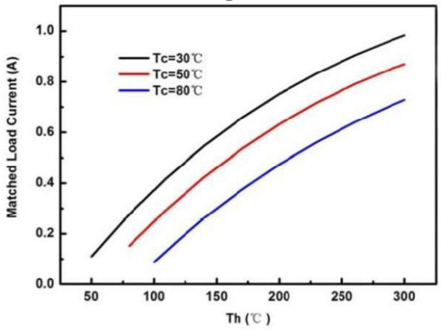


Fig 2.2.4 Graph for matched load voltage VS various temp

Fig 2.2.5 Graph for load current VS various temp

Even though the power produced is 5.3 watts, the obtained amount of power will not maintain a constant output as because of the speed variations of the engine and changes in the exhaust temperatures along with the ambient temperature hence in order to stabilize the output power it have to pass through booster, then the power will stabilized. The production of power with respect to the current and with the material load voltage is calculated and thus the values of current, voltage and power is calculated and tabulated in the form of graph as shown in Fig 2.2.6.

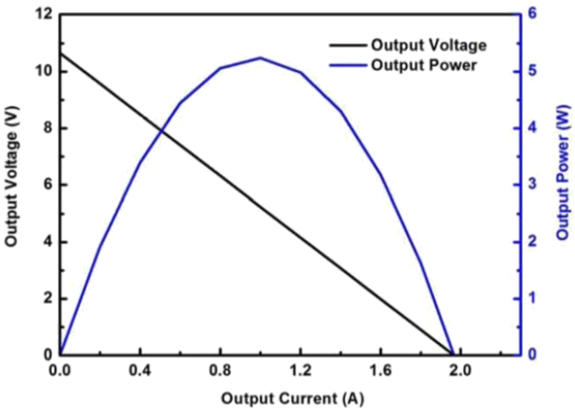


Fig 2.2.6 Graph for output Voltage, current VS output power

Power produced by the electrical machine Power (P) = Voltage x Current = 5 V x 1 A

= 5 watts

This power is further boosted using an electric booster so that the fluctuations are filtered and a constant power is maintained this filtered power is stored in battery.

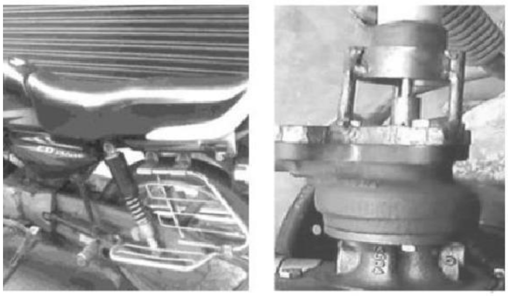
2.3 Power by Turbo-generators

Turbo generators are the devices which convert pressure and kinetic energy into mechanical energy. These are widely used in many industrial applications. With improvement in the manufacturing technology these turbines are also being manufacturing in smaller area so that these can be used in smaller components.

Hence these turbochargers takes their places as power generators in many applications and now it is used in this experiment as a power generator in the automobile.

IC engines remain the crucial power plant for vehicles up to few Megawatts. Till circa 25% to 32 % percentage of the energy is lost through exhaust system. Hence by using different recovery systems that loss may be utilized in a proper way. Hence in this experiment we try to recover that heat energy which is being wasted through the exhaust system.

In the experiment setup a small turbine blade along with the dc alternator are connected together to harness the pressure and kinetic energy of the exhaust and the specifications of the engine are shown in the Table 2.1 as because both the recovery systems are tested on the same vehicle. The experiment setup is shown in the figures Fig 2.3.1 and Fig 2.3.2



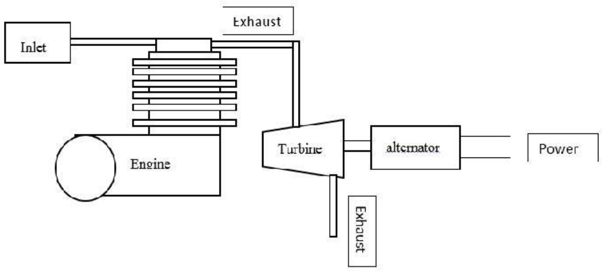


Fig 2.3.1 Experimental setup **Fig 2.3.2 Experimental setup model outline**

And the turbine and the dynamo used in the experiment setup are shown in the Fig 2.3.3 and Fig 2.3.4

Fig 2.3.3 Turbine of turbo generator **Fig 2.3.4 Alternator of the turbo generator**

The alternator of the turbo generator can produce 6v to 12 v depending upon the speed and the current can vary from 0.2 to 1 amp, the amount of power produced is dependent on the speed of the vehicle hence sometimes the power generation is more and sometimes the power generation is low but it does not goes under the 10 volts and 0.48 and an average the power production is calculated below. Thus the power generated is furtherly stored in the battery for the further use and small accessories of the vehicle can be power up with this power.

The system is tested under different conditions at different rpm. After the ignition of the engine it is allowed to run for some time and whenever it reaches rpm 1250 the performance parameters are all noted and again the parameters are noted at 1750 rpm and again at an regular intervals of 500 rpm the parameters are noted and calculated and then these parameters are tabulated in the tabular form and that tabular form is shown in the table

SI.NO	RPM	Alternator voltage
1	1250	-
2	1750	-
3	2250	8.5
4	3250	10.8
5	3750	-

Table 2.3.1 Alternator Voltage with respect to RPM

Power produced by the electrical machine Power (P) = Voltage x Current = 10 V x 0.73 amp

= 7.3 watts

Hence using the turbo generator we can generate power of an average is = 7.38 watts

Now the power produced through by this system is showed in tabular form and for better view of power generation and variation between the system installation and after system installation are compared in the tabular forms.

S.NO	Description	Energy (%)	BHP(Watts)
1.	Total power given by fuel	100	20472.2
2.	Useful power at crank shaft	22	4505.6
3.	Frictional losses	7	1433.6
4.	Cooling losses	32	6553.6
5.	Exhaust gases	39	7979.4176

Table 2.3.2 Before installing Turbo generator

S.NO	Description	Energy (%)	BHP(Watts)
1.	Total power given by fuel	100	20472.2
2.	Useful power at crank shaft	22	4505.6
3.	Frictional losses	7	1433.6
4.	Cooling losses	32	6553.6
5.	Exhaust gases	38.962	7971.6352
6.	Power recovered	0.038	7.7824

Table 2.3.3 After installing Turbo generator

Hence it is proved that by installing the turbo generator the useful amount of work is increased and it recovers heat energy through the exhaust system.

III. CONCLUSION

In an attempt to heat recovery in an IC engine, the TEG and Turbo generator has been proved by running an alternator coupled to a turbocharger. TEG module generated 5.3 watts of power and Turbo generator generated 7.78 watts of power so together these two systems generator 13.08 watts. By using these two recovery systems the useful work of an engine is increased from 22.0083% to 22.0463%. As the turbo generator in this system used here is not particularly designed one for this engine, but by designing an alternator to this engine, the amount of power which is recovered through this system can be improved. Recent studies suggested that Engine compounding can create a fuel economy improvements in engines and turbines. Regeneration will also significantly enhances the level of performance of the heat engines because of the low temperature content in the exhaust of an engine.

IV. ACKNOWLEDGEMENTS:

I wish to thank Hepsiba seeli, Sri Harsha Dorapudi and other college Faculty member's along with our lab technicians.

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