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Generation of Electricity by Using Exhaust from Bike

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ABSTRACT: Here we are modifying an automobile for producing power using turbines. Nowadays in automobile field many new innovating concepts are being developed. We are using the power from vehicle exhaust to generate the electricity which can be stored in battery for the later consumption. In this project, we are demonstrating a concept of generating power in a moving vehicle by the usage of turbines. Here we are placing a turbine in the path of exhaust in the silencer. An engine is also placed in the chassis of the vehicle. The turbine is connected to a dynamo, which is used to generate power. Depending upon the airflow the turbine will start rotating, and then the dynamo will also starts to rotate. A dynamo is a device which is used to convert the kinetic energy into electrical energy. The generated power is stored to the battery. It can be stored in the battery after rectification. The rectified voltage can be inverted and can be used in various forms of utilities. The battery power can be consumed for the users comfort.

KEYWORDS: turbine, dynamo, battery, electrical generator

I. INTRODUCTION

In recent years the scientific and public awareness on environmental and energy issues has brought in major interests to the research of advanced technologies particularly in highly efficient internal combustion engines. Viewing from the socio-economic perspective, as the level of energy consumption is directly proportional to the economic development and total number of population in a country, the growing rate of population in the world today indicates that the energy demand is likely to increase. Substantial thermal energy is available from the exhaust gas in modern automotive engines. Two-thirds of the energy from combustion in a vehicle is lost as waste heat, of which 40% is in the form of hot exhaust gas. The latest developments and technologies on waste heat recovery of exhaust gas from internal combustion engines (ICE). These include thermoelectric generators (TEG), Organic Rankine cycle (ORC), six-stroke cycle IC engine and new developments on turbocharger technology. Being one of the promising new devices for an automotive waste heat recovery, thermoelectric generators (TEG) will become one of the most important and outstanding devices in the future. A thermoelectric power generator is a solid state device that provides direct energy conversion from thermal energy (heat) due to a temperature gradient into electrical energy based on "Seebeck effect". The thermoelectric power cycle, charge carriers (electrons) serving as the working fluid, follows the fundamental laws of thermodynamics and intimately resembles the power cycle of a conventional heat engine.

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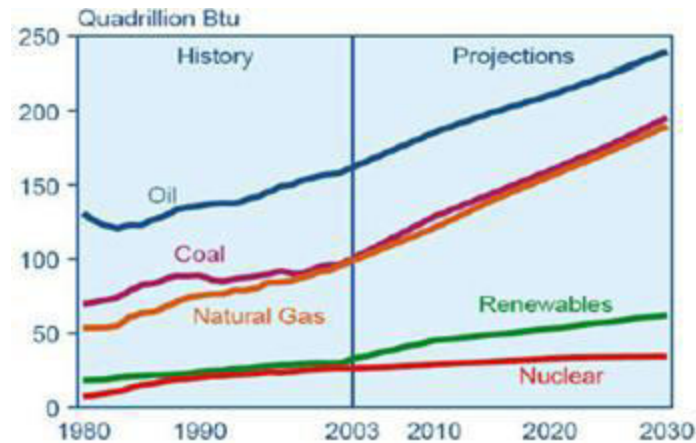


Fig 1.1 World Marketed Energy Use by Fuel Type 1980 – 2030

One potential solution is the usage of the exhaust waste heat of combustion engines. This is possible by the waste heat recovery using thermoelectric generator. A thermoelectric generator converts the temperature gradient into useful voltage that can be used for providing power for auxiliary systems such as air conditioner and minor car electronics. Even it can reduce the size of the alternator that consumes shaft power. If approximately 6% of exhaust heat could be converted into electrical power, it will save approximately same quantity of driving energy. It will be possible to reduce fuel consumption around 10 %; hence AETEG systems can be profitable in the automobile industry. The number of vehicles (passenger and commercial vehicles) produced from 2005 to 2010 shows an overall increasing trend from year to year despite major global economic downturn in the 2008–2010 periods. Note that China's energy consumption in transportation sector is the lowest (13.5%). Although the country produced the highest number of vehicles in 2009 to 2010 as compared to the other countries.

A number of irreversible processes in the engine limit its capability to achieve a highly balanced efficiency. The rapid expansion of gases inside the cylinder produces high temperature differences, turbulent fluid motions and large heat transfers from the fluid to the piston crown and cylinder walls. These rapid successions of events happening in the cylinder create expanding exhaust gases with pressures that exceed the atmospheric level, and they must be released while the gases are still expanding to prepare the cylinder for the following processes. By doing so, the heated gases produced from the combustion process can be easily channeled through the exhaust valve and manifold. The large amount of energy from the stream of exhausted gases could potentially be used for waste heat energy recovery to increase the work output of the engine. Consequently, higher efficiency, lower fuel consumption by improving fuel economy, producing fewer emissions from the exhaust, and reducing noise pollutions have been imposed as standards in some countries. Hatazawa et al., Stabler, Taylor, Yu and Chau and Yang stated that the waste heat produced from thermal combustion process generated by gasoline engine could get as high as 30–40% which is lost to the environment through an exhaust pipe.

In internal combustion engines a huge amount of energy is lost in the form of heat through the exhaust gas. Conklin and Szybist investigated that the percentage of fuel energy converted to useful work only 10.4% and also found the thermal energy lost through exhaust gas about 27.7%. The second law (i.e., exergy) analysis of fuel has been shown that fuel energy is converted to the brake power about 9.7% and the exhaust about 8.4% as shown in Fig. 3. In another research the value of exhaust gases mentioned to be 18.6% of total combustion energy. It is also found that by installing heat exchanger to recover exhaust energy of the engine could be saved up to 34% of fuel saving.

For example, the heat of the car's exhaust can be used to warm the engine coolant to keep the engine running warm, even when the motor has been turned off for a significant length of time. A vehicle's exhaust can actually be used to generate electricity. Although these technologies can be used in any car, truck or SUV with an internal combustion engine, they're particularly important to hybrid vehicles, which need to produce maximum fuel

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efficiency and minimal emissions. The potential cost savings, improved energy efficiency and broad application of such technology is enormous, experts say. The new systems now being perfected at OSU should be able to use much of that waste heat either in cooling or the production of electricity.

II. DESIGN OF EQUIPMENT AND DRAWING

2.1 COMPONENTS AND ITS FUNCTIONS

The generations of electricity using the flow or velocity of vehicle exhaust gas of the following components to full fill the requirements of complete operation of the machine.

1. Dynamo
2. Turbine
3. Battery
4. Engine

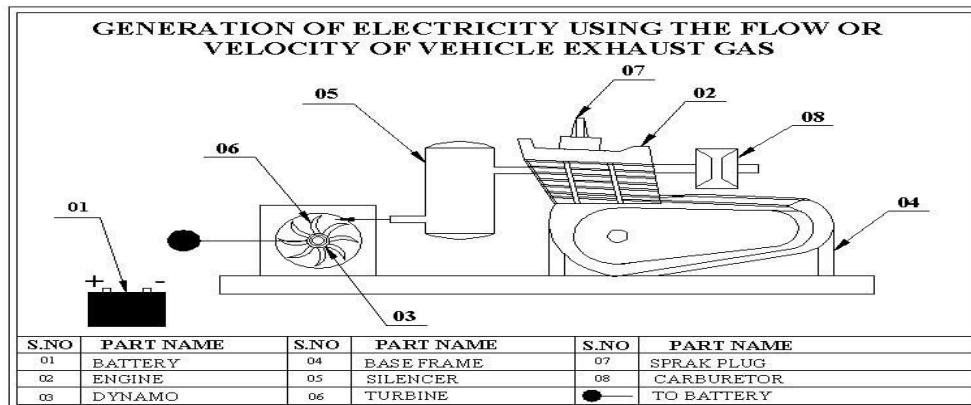


Fig.2.1 Drawing For Generation of Electricity Using the Velocity of Vehicle Exhaust Gas

TURBINE

A steam turbine is a mechanical device that extracts thermal energy from pressurized steam, and converts it into rotary motion. It has almost completely replaced the reciprocating piston steam engine primarily because of its greater thermal efficiency and higher power-to-weight ratio. Because the turbine generates rotary motion, it is particularly suited to be used to drive an electrical generator – about 90% of all electricity generation in the United States is by use of steam turbines.[2] The steam turbine is a form of heat engine that derives much of its improvement in thermodynamic efficiency through the use of multiple stages in the expansion of the steam, which results in a closer approach to the ideal reversible process.

DYNAMO

Dynamo is an electrical generator. This dynamo produces direct current with the use of a commutator. Dynamo were the first generator capable of the power industries. The dynamo uses rotating coils of wire and magnetic fields to convert mechanical rotation into a pulsing direct electric current. A dynamo machine consists of a stationary structure, called the stator, which provides a constant magnetic field, and a set of rotating windings called the armature which turn within that field. On small machines the constant magnetic field may be provided by one or more permanent magnets; larger machines have the constant magnetic field provided by one or more electromagnets, which are usually called field coils.

The commutator was needed to produce direct current. When a loop of wire rotates in a magnetic field, the potential induced in it reverses with each half turn, generating an alternating current. However, in the early days of electric experimentation, alternating current generally had no known use. The few uses for electricity, such as electroplating, used direct current provided by messy liquid batteries. Dynamos were invented as a replacement for

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batteries. The commutator is a set of contacts mounted on the machine's shaft, which reverses the connection of the windings to the external circuit when the potential reverses, so instead of alternating current, a pulsing direct current is produced.

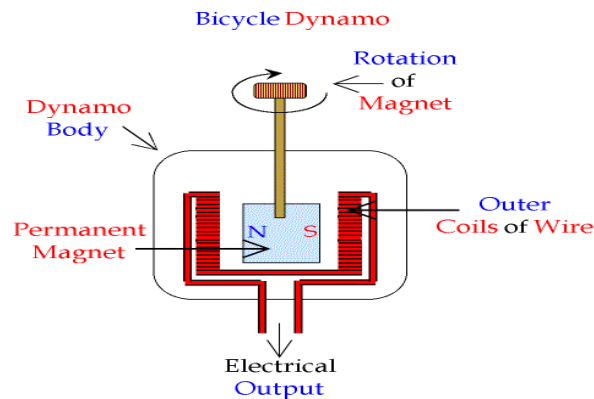
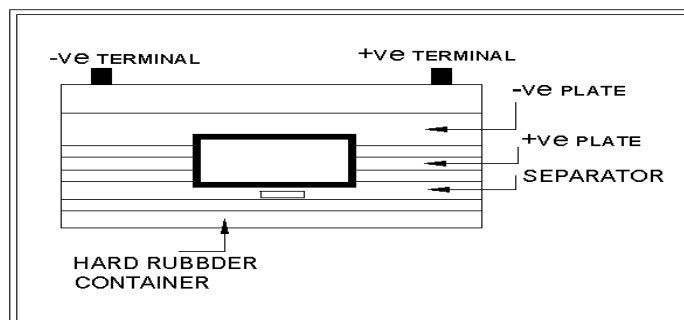


Fig 2.2 Bicycle Dynamo

BATTERY

In our project we are using secondary type battery. It is rechargeable type. A battery is one or more electrochemical cells, which store chemical energy and make it available as electric current. There are two types of batteries, primary (disposable) and secondary (rechargeable), both of which convert chemical energy to electrical energy.



ENGINE

An engine or motor is a machine designed to convert energy into useful mechanical motion. Heat engines, including internal combustion engines and external combustion engines (such as steam engines) burn a fuel to create heat, which then creates motion. The term internal combustion engine usually refers to an engine in which combustion is intermittent, such as the more familiar four-stroke and two-stroke piston engines.

III. EXPERIMENTAL SETUP

Here we are placing a turbine in the path of exhaust in the silencer. An engine is also placed in the chassis of the vehicle. The turbine is connected to a dynamo, which is used to generate power. Depending upon the airflow the turbine will start rotating, and then the dynamo will also starts to rotate. A dynamo is a device which is used to convert the kinetic energy into electrical energy. The generated power is stored to the battery. It can be stored in the battery after rectification. The rectified voltage can be inverted and can be used in various forms of utilities. The battery power can be consumed for the users comfort.

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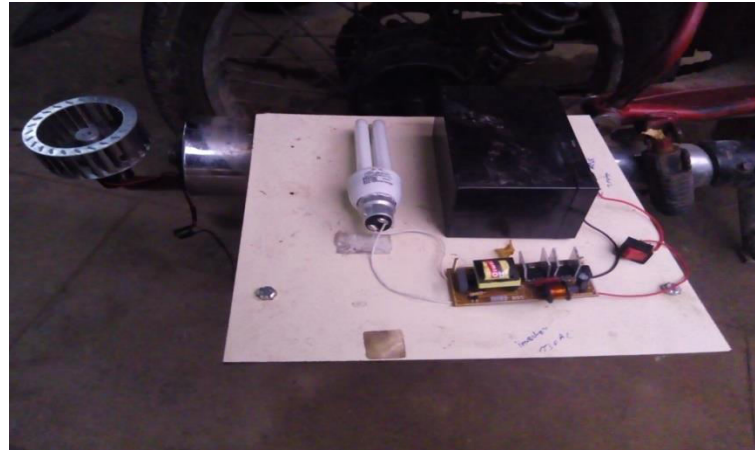


Fig. 3.1 Components of the Experiments



Fig 3.2 Experimental Arrangement in Two Wheeler Vehicle

IV. CALCULATIONS

Maximum Power of the Bike = 8.3bhp
Fuel Efficiency of Bike = 65.8km/h

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TURBINES

Number of Blades = 25
Diameter = 10cm

INVERTER

It Converts DC to AC (12Volts to 230 Volts)

BATTERY

12Volt Rechargeable Battery

FORMULA TO BE USED

Area of Swept, $A = (\pi/4) \times (\text{radius of turbine})^2$

Velocity of the Turbine = $((\pi/4) \times D \times N)/60$

Where

D=diameter of turbine

N=number of revolution per minute

POWER AVAILABLE AT THE TURBINE,

$P = (1/2) \times \text{Density} \times (\text{Velocity})^3 \times C_p \times \text{Area}$

MODEL CALCULATION

Swept area by the turbine, $A = (\pi/4) \times \text{radius}^2$
 $= 3.14 \times (0.05)^2$
 $= 0.00785 \text{ m}^2$

Velocity of the turbine, $V = ((\pi/4) \times D \times N)/60$
 $= (3.14 \times 0.10 \times 45)/60$
 $= 0.2357 \text{ m/s}$

Power available at the turbine

$= 1/2 \times \text{density} \times \text{area} \times (\text{velocity})^3 \times C_p$
 $= 1/2 \times 1.23 \times 0.00785 \times (0.2357)^3 \times 0.4$
 $= 2.57 \times 10^{-5} \text{ watts}$

Revolutions Per Minute for turbine	Speed of turbine in m/s	Power Available At The Turbine
45	0.2357	3.222×10^{-5}
48	0.2514	3.875×10^{-5}
54	0.2828	4.374×10^{-5}
57	0.2985	5.1365×10^{-5}

Tab.4.1 Estimate Power in Different Speed

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V.RESULTS AND DISCUSSION

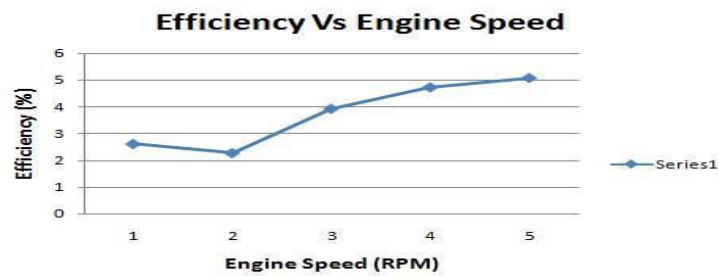


Fig 5.1 Efficiency Vs Engine Speed

The graph explains the relation between the overall efficiency of the system and engine speed. At 3970 RPM the efficiency obtained was 5.078%.

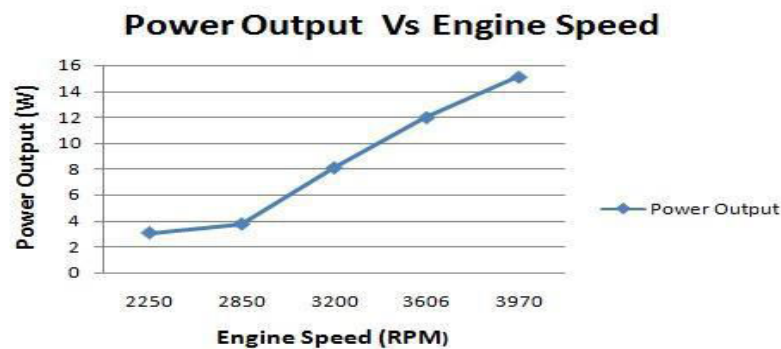


Fig.5.2 Power output Vs Engine Speed

The graph shows that the power output is function of engine speed. At the speed of 3970 RPM, the power developed by TEG was 15.225 W.

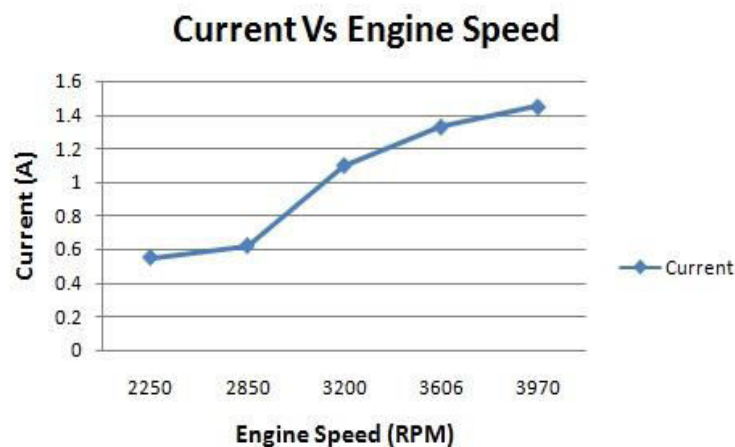


Fig 5.3 Current Vs Engine Speed

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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The graph explains that the current increases with the engine speed. It first increases gradually up to 2850 RPM then rapidly beyond that speed. At the speed of 3970 RPM the current was 1.45 A.

VI. CONCLUSION

From the study, it has been identified that there are large potentials of energy savings through the use of waste heat recovery technologies. Waste heat recovery entails capturing and reusing the waste heat from internal combustion engine and using it for heating or generating mechanical or electrical work. It would also help to recognize the improvement in performance and emissions of the engine if these technologies were adopted by the automotive manufacturers.

The study also identified the potentials of the technologies when incorporated with other devices to maximize potential energy efficiency of the vehicles. The project carried out by us made an impressive task in the field of mechanical department. It is used for to produce the current in vehicle exhaust unit.

This project has also reduced the cost involved in the concern. Project has been designed to perform the entire requirement task which has also been provided.

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