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SILENCER BASED POWER GENERATION USING PELTIER PLATE

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Abstract

Internal combustion engines have been used for conveyance and additional uses a very long time. such engines have established themselves as reliable sources of power. However, a significant amount of the energy generated by these engines is lost and not used. Waste of the energy produced by engines cannot be accepted in the current fuel crisis. This project tries to recover energy lost through engine silencers. The heat generated on the silencer is turned into useful electrical energy using devices known as Peltier Modules.

Key Words: Peltier Module, Thermoelectric Generator, waste heat recovery.

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I. INTRODUCTION

Extraction of thermal energy from engine exhaust and use of it to lower overall fuel consumption in the engine is one of several ways to maximize power output with little fuel input. By taking into account Considering that approximately 30 to 40% of the overall energy generated by a vehicle is used to run the vehicle and engine accessories, this is made possible. The remainder is squandered as exhaust heat and noise. A car's overall reliance on combustion for energy can be decreased by extracting heat from the exhaust fumes that would otherwise be wasted and using it to power various energy-consuming systems. A possible approach of producing power is to use components known as thermoelectric generators (Peltier Modules) to transform the thermal energy of the silencer into electrical energy.

Thermoelectric Generator (Peltier Module)

A solid-state device is a thermoelectric generator is, also referred to as a Peltier Module. Semiconductor materials of the P type then N types where arranged by arrays in it. Electrically and thermally connected material in the P then N type are coupled by sequence.The best Peltier Module material for a car application would be PbTe. A thermoelectric generator is made up of several P type and N type semi-conductor components alternately connected by series using metal connections.

Ceramic plates are used to create the thermoelectric generator's module. In addition to being electrically insulating, ceramic panels are thermally conductive. Maintaining a temperature differential throughout the module results in the production of electrical power.

Science has conducted extensive research on the numerous ways that power is generated for autos. Numerous academics have worked to develop strategies to maximize the amount of energy produced by the engine while minimizing power loss. To enable the operation of the vehicle electronics, dynamos are mounted onto the engine shaft. Researchers have used the approach covered in this paper in a similar vein. The papers' conclusions have been explored below.

[1] Investigated the possibility of generating electrical energy from exhaust gases using a Peltier module, a thermoelectric generator that operates on the see-back effect concept To do this, they used a battery, booster circuit, and a Peltier Module constructed of bismuth telluride (Bi2Te3). They conducted the research and discovered that the temperature difference across the Peltier Module is precisely proportional to the voltage generated at the output.

[2] The Peltier Module can use the heat energy contained in exhaust fumes to generate electrical energy. To do this, they used a power converter, a Peltier Module, a heat exchanger, and a catalytic converter. To generate power, they also experimented with a variety of techniques, including piezoelectric generation and thermionic generation.

[3]Discovered that a Peltier Module may produce electrical energy from exhaust fumes. They examined the effectiveness and suitability of numerous materials, including PbTe, FeSi2, Bi2Te3, and many others, for use in Peltier Modules.

[4] Discovered that utilizing water instead of air as the cooling medium can improve the Peltier Module's ability to produce electrical energy. This economical method of producing greener electricity may be utilized for both domestic and business needs. By adding more Ptelier Modules in series and parallel, more research can be done.

According to the aforementioned literature, it was determined that Peltier Modules could be used to create enough electrical power. Peltier modules can be used to extract heat from an IC engine's exhaust for later use. This aids in recover significant amount of energy that is wasted in the exhaust of an engine.

II. METHODOLOGY

The following parts were necessary to accomplish the methods that had been found to be the most successful and efficient for extracting energy from a vehicle's engine exhaust.

A. Four Stroke Petrol Engine

For the purposes of this investigation, a Royal Enfield 350 4 Stoke Petrol Engine is being used. The engine's specifications are listed here.

Engine specs.

* Vehicle used : Motor Bike
  * Segment : 350cc
  * Max power produce : 6100rpm
  * Max torque produce : 3000rpm
  * No of cylinders : 1

B. Thermoelectric generator (Peltier Module)

Thermoelectric generators are solid-state devices that convert heat into electrical current and are also referred to as Peltier Modules. Unlike classic dynamic heat engines, it has no moving components and is entirely quiet. With little heat sources and little temperature variations, it may be simply operated. There is a considerable potential for creating energy by using the heat from a car silencer due to the significant quantity of energy wasted released by running internal combustion engine. TEC1-12715 is the Peltier module that is being utilised for this project. Lead Tin (PbSn) makes up its composition. Table 2 contains the largest value of temperature difference that is conceivable Peltier.

Table 1
TEC1-12715 Specs

Th(^{O}C)	27	50	The environment's hot side of the temperature
DT_{max} in(^{O}C)	70	79	Temp difference between the module's Hot and cold sides
U_{max} in(Volts)	16.0	17.2	Applied volt at DTmax to this module
I_{max} in(Amps)	6.1	6.1	DC Power at Maximum by the Module
Qc_{max} in(W)	61.4	66.7	Cool capacity on The module's cold side in DT = 0^{0}C

C. Noncontact Thermo-meter

The infra-redthermos-meter a type of thermos-meter that determines temp using some of the thermal radiation generated by the object being measured, often known as "black-body radiation." Since a laser is used to help aim the thermometer, they are also sometimes referred to as laser thermometers, non-contact thermometers, or temperature guns to describe their capacity to measure temperature at a distance. The temperature of the object can frequently be estimated within a given range of its real temperature by knowing how much infrared energy it emits and how emissive it is. A subset of equipment referred to as "thermal radiation thermometers" includes infrared thermometers. The HTC MT4 non-contact thermometer was employed in this study. Table 2.2 contains a list of the same's specs.

Table 2
HTC Specs MT4

Temp in Range	Between -50^{0}C to 550^{0}C
Accuracy	± 2 Percentage
response in Time	< 500 ms
resolution	0.1^{0}C

D. Multi-meter.

A multi-meter, multitester, VOM is an electronic measurement tool that combines multiple measurement capabilities into a single device. Voltage, current, and resistance can all be measured using a conventional multimeter. Readings are displayed on an analogue multimeter's micrometer, which has a moving pointer. Digital multimeters (DMM) can offer a graphical bar to depict the measured value in addition to a numeric display. Due to their affordability and accuracy, digital multimeters are now much more widespread, yet analogue multimeters are still preferred in some circumstances, such as when seeing a value that changes quickly. DT-9205A was the multimeter employed in this project.

E. Heat Sink

The passive heat exchanger known as a "heat sink" transmits heat. from an electrical to a fluid medium, or mechanical device and enables it to disperse away by the device, allow the temperature in the device to be changed to the appropriate range. They are employed to enhance surface area, which accelerates the pace at which heat is transferred from the apparatus to the surrounding.

F. Thermal Paste

A material known as thermal paste is frequently utilized as a contact between heat sinks and heat sources because it is thermally conductive but electrically insulating Thermal paste's primary function is to close any gaps or voids in the contact that could increase insulation and reduce heat transfer.

Procedure

A non-contact thermometer was chosen to measure the temperature around the silencer's perimeter. When the engine was throttled to its full capacity, the temperature of the silencer was measured using a non-contact thermometer over a 2 inch interval. After allowing the car to run for five minutes, another test was run, and temperatures at key locations were recorded. This research helped to determine the best location on the silencer for the Peltier module placement. It is clear from the aforementioned tabulation that the front of the vehicle's vertical silencer extends between bends 1 and 2 produced the most preferable temperatures. . Additionally, air cooling would be the most efficient method of cooling this area.

The power output of a Peltier module needed to be in comparison to a single output one in order to see whether it would increase if many ones were connect to one another in either series or parallel. Initially, by a single Peltier module put atop by the heat sink to conduct a study. When the car is moving, the heat sink serves as a method of air cooling. Arrangement was mounted to the silencer in the location determined by the earlier analysis. A brass Gasket in the shape of a globe it was to hold the system in place, by a small gasket was fastened in a bottom of the apparatus by prevent a slippage while it was moving. The Peltier module's output voltage was measured using a multimeter. The prepared configuration is depicted in Figs. 1 and 2.

The study was conducted using all trials as a reference and keeping the initial silencer temperature at 1000C. Every 5 kmph increase in speed was followed by measurements of the setup's output. Both series and parallel configurations of

the experiment were carried out under the exact same conditions. To ensure that readings would not vary as a result of changes the road's surface and to prevent speed drops during tests, the tests were carried out on a straight section of highway. In the findings section, readings gathered during this analysis have been compiled.

Fig.1.vehicle equipped with a Peltier module installed on the silencer

Fig. 2 Detailed shot of the silencer's installed Peltier module configuration.

III. RESULTS

A research by the Peltier modules installed on a vehicle for a one, two in the series, then two in parallel Configuration is shown in Tables 3, 4, and 5, respectively.

Table 3
Speed:2000 rpm (25 to 35 km/hr)

Time (sec)	**Silencer (temp)**	**Heat Sink (temp)**	**Power generated By peltier Plate(v)**	**Voltage booster Output voltage(v)**
190	55	30	1.25	2.75
350	87	34	2.62	4.5
560	120	40	5.20	10.9

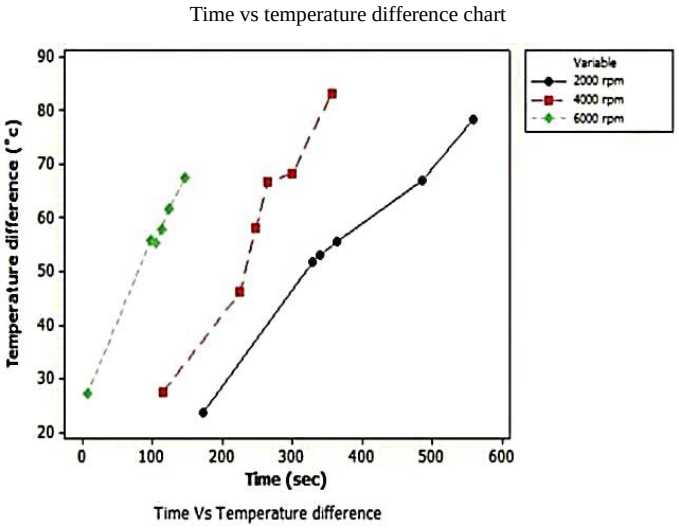
Table 4
Speed: 4000 rpm (50 to 65 km/hr)

Time (sec)	**Silencer (temp)**	**Heat Sink (temp)**	**Power generated By peltier Plate(v)**	**Voltage booster Output voltage(v)**
120	60	32.4	1.58	2.82
250	85	35.8	2.58	4.72
260	130	45.2	5.50	10.5

Table 5
Speed: 6000 rpm (70 to 100 km/hr)

Time (sec)	**Silencer (temp)**	**Heat Sink (temp)**	**Power generated By peltier Plate(v)**	**Voltage booster Output voltage(v)**
20	65	30.8	1.48	2.70
100	90	33.5	2.50	3.50
146	110	40.9	5.25	10.50

Graph:



The graph above shows that for all setups, As the vehicle's speed increases, the Peltier modules power output rises. When travelling at a high speed, the silencer warms up to greater temperatures, which is why there is an increase in power output. When travelling at a high speed, air from the vehicle's front efficiently cools the modules other surface. This results in the greatest temperature difference between the surfaces of the modules, producing the finest outcomes. Additionally, the graph demonstrates that using multiple Peltier modules significantly improves performance, with series combination performing significantly superior to the other two combos.

IV. CONCLUSION

Engines provide an enormous amount of power. Humans use this capability to suit their energy needs. However, a significant amount of energy is being lost and underutilized. This project recovers some of that lost energy. Through this work, it was possible to get the Peltier module arrangement to produce a maximum power output of about 1.25W.Any device having an engine can use the methods of this work. Every engine has a silencer and because emitted gases escape from them, it is simple to recover any energy lost silencer. The technique is applicable to all types of vehicles, including through the trucks, cars, bikes, and scooters.

Peltier modules are now employed aboard the extreme case is with satellites temperature differential between surfaces that face the sun and those that do not provide the ideal environment for their utilization.

The following changes can be made to the current work to significantly improve the output:

- Adding extra Peltier modules to the system.
- Using liquid cooling with a series of Peltier modules
- Use of Peltier modules made of PbTe up instead of air cooling.

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