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Fabrication of exhaust GAS heat recovery by TEG

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ABSTRACT

Nowadays in automobile field many new innovating concepts are being developed. Electricity is the basic need for automobiles. By using indirect methods (fossil fuel, oil, gas, etc.,) and direct method, electricity can be generated. The Indirect methods include Rankine cycles, Sterline Cycle and Refrignation. Indirect methods causes environmental pollution, so the direct method is implemented by using Thermo Electric Generator (TEG), it can be convert engine heat exhaust into electrical energy, which can be stored in a battery for later consumption. By using this energy, Thermo Electric Cooler (TEC) is implemented in engine blocks to reduced exhaust heat of the engine. The application of this concept is the overall efficiency of the energy conversion system to improve.

Index Words: Electricity, Rankine cycle, Sterline cycle, Refrignation, Thermo Electric Generator, Thermo Electric Cooler.

INTRODUCTION

Today, the need of energy increases day by day but only few sources are available to produce energy as our fuel resources coming to end. There are needs to be ways to use waste heat energy. There are some technologies which implement the recycling of waste heat by which waste heat can be trapped and recycle into useful work. Most of the techniques currently available recover waste heat in the form of thermal energy which is then converted into electricity in a conventional thermal power plant. Mostly these techniques would harm the environment like radio activity pollution, global warming etc. So that these (coal, oil, gas) are the limiting resources hence resulting new technology is needed for electricity generation, by using thermoelectric generators to generate power as a most promising technology and environmental free and several advantages in production. Thermo Electric Generator converts heat energy directly to electricity. This energy can be stored in battery for further usage. In vehicle radiator plays an important role for cooling the engine heat in all over the world. The heat transfer from the hot coolant coming from the engine cooling water jacket, flowing into the tubes via the inlet tank. Heat is rejected to the air blown through it by the fan. It has the critical function of reducing the temperature of the passing coolant. The cooled coolant continues recirculation throughout the engine and thus removing the waste heat. The types of radiator used are copper tube and aluminium tube. Copper is a good conductor of heat than aluminium. But the copper is mixed with lead, brass and steel. Whereas the aluminium radiator is 100% aluminium furnaced. This makes the copper tube have less efficiency than aluminium. If radiator gets damaged total cooling system gets malfunction. To reduce that insufficient situation, we use TEG.

LIST OF COMPONENTS

1. XL Engine
2. TEG
3. TEC

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4. Battery
5. Aluminum plate
6. Silencer
7. Frame

XL Engine

The Extra light Fusion Engine (often shortened to XL Fusion Engine) is mechanically similar to a Fusion Engine but uses much lighter radiation shielding. Replacing the dense tungsten carbide of standard fusion engines with a crystalline polymer similar to that of double heat sinks, the XL fusion engine is half the mass for the same performance.

Table.1 Specifications of XL Engine

Engine Description	2 Stroke, Single Cylinder
Cooling	Air Cooling
Displacement	69.9 cc
Maximum Power	3.5 Bhp @ 5000 rpm
Maximum Torque	5.0 Nm @ 3750 rpm
Number of Cylinders	1
Ignition	Fly Wheel Magnese 12V x 50W Electronic Ignition
Bore	46 mm
Stroke	42 mm

Thermoelectric generator (TEG)

A Thermoelectric device is a solid state, semi-conductor based electronic component capable of converting a voltage input into a temperature difference which can be used for either heating. Its size is 40X40mm.

Thermoelectric cooler (TEC)

It is also a thermoelectric device is a solid state, semi-conductor based electronic component capable of converting a voltage input into a temperature difference which can be used for either heating. Its size is 40X40mm.

Battery

The basic electrochemical current-producing unit in a battery, consisting of a set of positive plates, negative plates, electrolyte, separators and casing. In a lead-acid battery, the cell has an open-circuit voltage of approximately 6 volts.

Silencer

It can be a detachable accessory to, or integral part of, the muzzle or barrel. A typical silencer is a metal cylinder with internal sound baffles that slow and cool the escaping propellant gas, which decreases both sound volume and muzzle blast. Its length is 610mm.

Frame

A vehicle frame, also known as its chassis, is the main supporting structure of a motor vehicle, to which all other components are attached, comparable to the skeleton of an organism. Its Length is 610mm, Breadth is 304.8mm, and Height is 457.2.mm.

Aluminium Plate

Aluminium Plate is used to observe the cooling process which is fitted in the side of the engine. Its size should be around 127mm to 152.4mm.

LITERATURE REVIEW

Boris Arkadyevich Papkin et al, they show the test of ICE thermoelectric cooling radiator. This was aided by specially developed and fabricated experimental stand for studying operational features and adjustment of mockup of ICE thermoelectric cooling system. The obtained specifications, corresponding to previously obtained calculations evidence that the ICE thermoelectric cooling system in general and the thermoelectric radiator in particular can be used on modern vehicles, since they are capable to provide efficient ICE cooling. Herewith, the thermoelectric radiator with hydro- and aerodynamic properties conforming the specifications of serial radiators

can generate about 815 W of electricity in ICE nominal operation mode [1].

Donkyu Baek et al, they introduces a novel system-level solution for thermoelectric generator (TEG) modules attached to a vehicle radiator. TEG energy harvesting has been mainly driven by material science and device research groups, and therefore, the proposed dynamic reconfiguration is the first attempt to enhance the power efficiency using a system-level solution while it offers significant performance enhancement at low development cost. Such a system-level solution can be hardly achieved by conventional material and device research. The practical aspects of the proposed research has been strongly backed up by actual vehicle radiator measurement demonstrating up to a 34% performance enhancement compared with common practices [2].

Jacks delightuspeter.A et al,Include Fin Effect to increase cooling rate (cold end side temperature). By reducing the temperature as we can increase the (Th-Tc). Using long fin and avoid accumulation of heat in between fins (Gape between fins). Coupling more TEG in SERIES connection to increase the voltage generated by TEG. Increase no of modules in TEG to increase power generation and Increase the size to increase heat withstanding capacity. By using multiple stages of TEGs both the high temperature with standing TEG and low temperature with standing TEGs. Use different types of heat with standing materials for making TEG modules. For example Bi2Te3,PbTe,CMO. Bi2Te3- Bismuth Telluride PbTe-Led Telluride CMO- Calcium Manganese Oxide. Bi2Te3 module TEG is high efficient in room temperature (50 c-200 c, 4.5%-6%). But heat withstanding capacity of Bi2Te3 is less than PbTe and CMO. PbTe and CMO modules less efficient than Bi2Te3. So use combination of both material, Which means multistage Hot side Th area use PbTe and CMO modules after that less temperature area Tc use Bi2Te3 module TEG [3].

Jadhao.J.Set al, they tells about that there are large potentials of energy savings through the use of waste heat recovery technologies. Waste heat recovery defines capturing and reusing the waste heat from internal combustion engine for heating, generating mechanical or electrical work and refrigeration system. It would also help to recognize the improvement in performance and emissions of the engine. If these technologies were adopted by the automotive manufacturers then it will be result in efficient engine performance and Low emission. The waste heat recovery from exhaust gas and conversion in to mechanical power is possible with the help of Rankine, Sterling and Brayton thermodynamic cycles, vapour absorption. For waste heat recovery thermoelectric generator is use low heat, which has low efficiency. It is helpful for the same amount of increases in thermal efficiency and reduction in emission [4].

Kiran A. Gajabeet al, the TEG waste heat recovery technology could potentially offer fuel economy significantly. Also it is feasible to use thermoelectric generator to light up the headlights of car. The conversion rate from heat to electrical energy can be increased by using materials with better Seebeck coefficient. In this way we can conserve the electrical energy to some extent, by trapping the waste heat from the heat source in automobiles. This technology can also be applicable in home appliances, where the heat from gas stoves can be trapped for producing electrical energy based on same principle. By the efficient use of waste heat energy, we can save some amount of energy for operating appliances [5].

Mochizukil.M et al, they identified that there are two ways to use the waste heat recovery that are TEGs and heat pipes. Both TEGs and heat pipes are solid state, passive, silent, scalable and durable. Heat pipes can reduce the thermal resistance between the TEG and gases Heat pipes can reduce the pressure losses in the gas stream due to a reduced fin surface area. The use of heat pipes allows for more design flexibility because TEG placement is not limited to the exhaust pipe surface. Heat pipes can be used for temperature regulation of the TEGs. TEGs have limitations such as relatively low efficiency and maximum surface temperatures. Heat pipes have limitations such as maximum rates of heat transfer and working temperature ranges. A completely passive and solid state exhaust heat recovery system can be developed using both TEGs and heat pipes [6].

Nikolay Anatolyevich Khripach et al, they show the step-by-step development of thermoelectric cooling radiator starting from

designing, calculations development and fabrication of 3D model. Preliminary tests were performed after fabrication of the model used for development of specifications of thermoelectric radiator, which validated calculations with minor error. Electric power of thermoelectric radiator according to the results of preliminary tests was 815.4 W, aerodynamic resistance of thermoelectric radiator was 2374.8 Pa, and deviation from calculations was less than 5% [7].

Prashantha. K et al, they gives the best economical pollution free, required energy solution to the people. In this there are two power generators have been built using TEG modules and tested. The power of the first one could reach about 500 W (predicted using experimental data) with a temperature difference of about 200°C between hot and cold sides. This work can be used for many applications in urban and rural areas where power availability is less or totally absence. By making this system generates and charge 12v which is capable to recharge a mobile. It avoiding dependency of grid supply. This is a Promising technology for solving power crisis to an affordable extent [8].

Steven O'Halloran et al, it describes a Lab view based experimental setup for measuring the instantaneous power generation and efficiency of a commercial thermoelectric device. Results are presented for a particular Bismuth Telluride thermoelectric device (TEC1-12706). The load resistance is variable in the experimental setup and the power generation and efficiency are both plotted versus the voltage produced. The maximum temperature difference tested was 68.1°C and this produced an efficiency of 2.22% and an output power of 1.17 watts. While this efficiency might seem low, thermoelectric generators are noted for their relatively low conversion efficiency. Also, the maximum temperature difference tested (68.1°C) is fairly modest, higher temperature differences would result in higher efficiency. Typical thermoelectric devices require a temperature difference of approximately 500°C to achieve an efficiency of 10%. Testing is planned for the future with higher temperature differences, but the current testing has been successful for the conditions tested [9].

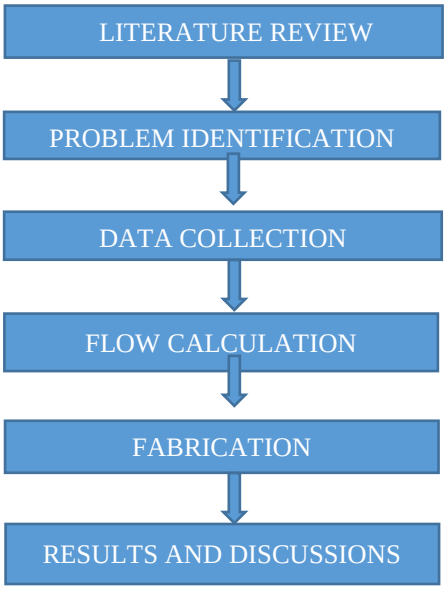
SUMMARY OF LITERATURE SURVEY

1. It avoiding dependency of grid supply. This is a Promising technology for solving power crisis to an affordable extent.
2. For waste heat recovery thermoelectric generator is use low heat, which has low efficiency. It is helpful for the same amount of increases in thermal efficiency and reduction in emission.
3. A completely passive and solid state exhaust heat recovery system can be developed using both TEGs and heat pipes.
4. TEG waste heat recovery technology could potentially offer fuel economy significantly.
5. The actual vehicle radiator measurement demonstrating up to a 34% performance enhancement compared with common practices.

PROBLEM IDENTIFICATION

1. Legislation of exhaust emission levels has focused on carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter (PM).
2. The main energy resources are fossil fuel, atomic power, hydroelectric power and solar energy.
3. Shortage of fossil fuel and coal i.e. about 60% of electricity is generated from fossil fuels. So that pollution also may occur due to the combustion of this fossil fuel.

METHODOLOGY



LAYOUT OF THE PROJECT

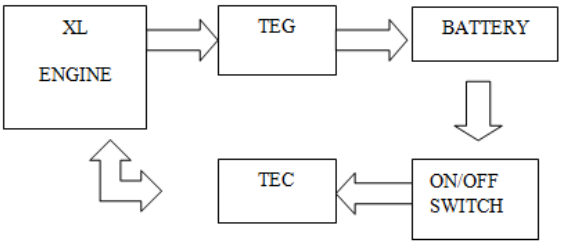


Fig.1 Layout of the project

WORKING PRINCIPLE

An important way of utilizing heat energy in automobiles is to convert heat to electrical energy through a thermoelectric convertor. Thermoelectric convertors were made with the aim to do the conversion of heat energy into electrical power. When a heat gradient is applied to a thermoelectric material, a flow of electrons from hot side to the cooler side takes place, hence converting heat to electrical power. Thermoelectric generators use the simple Seebeck principle.

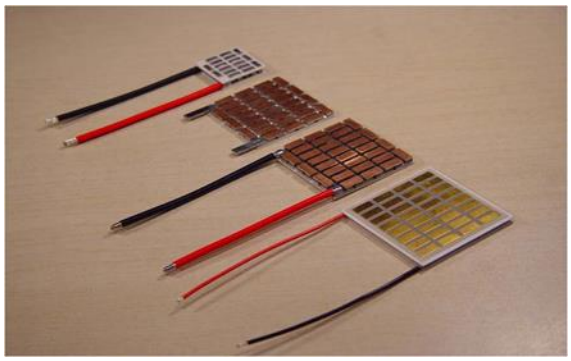


Fig.2 Thermo Electric Generator

Thermoelectric Generator (TEG) which take a thermal energy and turn it into electrical energy. These materials can also run in reverse, if radiator gets damage it cannot work properly and it emits some heat energy. By using of TEG we can convert that heat energy into electrical energy and stored in a battery this TEG is fixed in the engine block and then we use Thermo Electric Cooler (TEC) that cools the engine by using of that stored electrical energy.

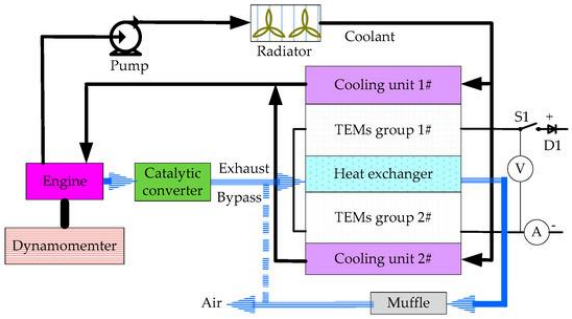


Fig.3 Working Principle of TEG & TEC

EXPERIMENTAL SETUP

A dynamometer is used to driving cycles of vehicles by adjusting the operation condition of engine such as torque and revolution rate. When the engine works exhaust gas flows into the heat exchanger to provide hot side temperature and the engine cooling water is pumped into each cooling box to form cooled side. Then electrical energy is generated due to temperature difference between both sides each TEG. When the engine coolant temperature is around 90^{o}C, temperature difference of each TEG is proportional to its hot side temperature. For attain high temperature difference in the setup radiator should be precool the inlet coolant of the cooling system in engine.

CONCLUSION

The waste heat is used to save the energy the battery. The system is tested to meet the desired objectives and the analysis a T.E.G was putted on a hot chamber (Engine). I amusing here to get fast output and the aluminium plate is placed on the top side (127mm to 154.2mm) dimension. The Engine is stated at different temperature ranging from 30℃to220℃ to produce 500W. So that to know the voltage and current by using multi meter that was produced by this TEG. By using thermometer to determine the applied temperature exactly on the hot side of the TEG and cold side. The Thermo Electric Cooler (TEC) is used to reduce the engine heat by direct cooling method.

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