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INCREASING THE EFFICIENCY OF IC ENGINE AND THERMAL COMFORT USING THERMOELECTRIC GENERATOR

S.Nandhakumar[1], K.Dinesh[2]

[12]*Department of mechanical engineering,*

[1]*Jeppiaar engineering college,RajivGandhisalai, Chennai(India).*

[2]*Dhanalakshmi college of engineering,Tambaram,Chennai(India).*

ABSTRACT

The internal combustion engine does not convert completely the chemical energy into mechanical energy.Around 60-70% energy is wasted as heat source.A device which converts thermal energy into electrical energy is called Thermo Electric Generator.It works on the principle of Seebeck effect.These electrical energy along with the energy derived from alternator is stored in a battery and used to run a compressor of an air-conditioning system.Air conditioning system is the biggest auxiliary load in a vehicle where the compressor consumes the largest energy from engine. Problem with conventional compressor is the cooling capacity cannot be controlled directly to fulfill the demand of thermal load inside vehicle cabin.Electrically driven compressor(EDC) can control the cooling capacity directly and hence gives more human comfort.An EDC not only gives human comfort,but it increases the efficiency of an engine by running without depending on engine power.Hence by controlling the compressor of air-conditioning system electrically,the engine performance and human comfort is enhanced.

Keywords:Automobiles,Electricity,Icengines,Thermoelectric generator,Wasteheat energy.

I. INTRODUCTION

In todays world the common means of transportation is by automobiles such as cars,bikes,buses,etc.,The power delivered to the wheels is by a combustion process taking place in an engine.This process uses a chemicals and converts it into a mechanical energy.he setup is collectively called IC engines.This ic engines is responsible for delivering the power to the transmission system,which then transmits to the wheels. An Internal combustion(IC) engine is a heat engine where the combustion of fuel occurs with an oxidizer in a combustion chamber.In an IC engine the combustion process produces excess power and coverts linear motion of piston into rotatory motion.But it does not converts completely the chemical energy into mechanical energy.About 55%–80% will be wasted as heat in both the coolant and the exhaust gases. A majority of this energy is dissipated as heat in the exhaust and coolant.The efficiency of an ic engine varies from 40-45%.Thus in order to increase the efficiency of an engine the heat energy which is wasted should be usefully converted into useful work.

The another way of increasing the efficiency is to disengage the external load from the engine.The loads which are using the engine power are Alternator,which recharges the battery,flywheel which stores energy and transmits to the transmission system or to the wheel through the shaft and various mechanism.The Major load

which using the engine power is the airconditioning compressor,which is directly connected to the crank shaft through belt.Thus this airconditioner should be run by an any external source to increase the efficiency.

II. HEADINGS

1.Thermoelectic generator

An Thermo Electric Generator (TEG) is a device which converts the heat or thermal energy into electricity.In other words,it is also called as Seebeck Generator,a solid state device that coverts heat flux directly into electrical energy. It Works on the principle of Seebeck Effect. The heat energy which is wasted from the engine exhaust can be usefully converted into electricity and stored in a battery.The TEG consists of thermoelectric modules made of n-type and p-type semiconductors which are electrically in series and thermally in parallel respectively.

The TEGs have many advantages such as no moving mechanical parts, long-lived, quiet, environmentally friendly and requiring little maintenance.As a significant cause for the fuel crisis and environmental pollution, the internal combustion engine (ICE) drives vehicles with only 30% of the total heat generated by the gasoline used. During this process, the other 40% of the heat is lost through waste gas exhaust and 30% by the coolant. The TEG using automobile waste exhaust as heat source is believed a new way to reduce ICE loads as well as the alternator and then decrease fuel consumption and environmental pollution. Typically the TEGs are placed on the exhaust pipe surface and they are cooled with cold blocks using engine coolant.

2.Working of thermo electric generator(TEG)

The thermoelectric generators consists of thermoelectric modules of n-type and p-type semiconductor.The connections of p-type and n-type semiconductors are should be electrically in series and thermally in parallel. The hot side of TEG receives heat from the heat source and the heat then transfers to the modules(Fig.1).

The electrons and holes from the p-type and n-type modules are then exicted and move towards cool side and hence movement of electrons takes place and they electrically connected through wires to a battery or charge storage device.The heat is then transfers to the colder side.It is made to cool by external source like coolant or air cooler.Hence the temperature difference between both the sides makes the electrons to move faster and large amount of current can be produced.Normally the semiconductors should be made of high temperature absorbing capacity,hence Lead Telluride or Bismuth telluride can be used.Larger the temperature difference ,more the amount of electricity will be produced.The main disadvantage of this TEG is its efficiency,it ranges from 6% to 12%.Its efficiency can be increased by larger Temperature gradient.Lead telluride can absorb 200-600°C,and silicon germanium upto 900°C, hence it can be chosen as a semiconductor.

In order to get additionally higher temperature on hotter side,a heat pipe can be used to transfer the heat from exhaust to thermoelectric modules. The setup is placed at an over exhaust pipe.Now there will be a maximum temperature difference between hotter side and colder side. Finned air cooled heat sinks were proposed for cooling of the TEGs.The heat pipe (Fig.2) on the exhaust side will be in direct contact with the heat source from the exhaust.A heat pipe is a metallic pipe that is sealed at both ends and is partially filled with a fluid at vacuum pressure. Heat pipes have a very high effective thermal conductivity therefore they are used to transfer heat

relatively long distances with minimal thermal resistance.Their thermal conductivity can be magnitudes higher than copper. A heat pipe is a completely passive heat transfer device.

Heat pipes consist of an evaporator section, an adiabatic section and a condenser section. As the pressure inside the pipe is nearly at vacuum pressure, the liquid changes phase to vapour at relatively low temperatures. When heat is applied to the evaporator section, the liquid turns to vapour and travels up to the condenser section.The colder condenser section condenses the vapour back to liquid, consequently removing heat. The liquid then returns to the evaporator in a wick using capillary action. The cycle then repeats itself. Water heat pipes typically have a working temperature range from room temperature to approximately 300°C but thick walled heat pipes need to be used to increase the working temperature range of the water heat pipes upto 300°C.If temperatures above that limit are required, then different working fluids are to be used. Naphthalene has a working temperature range from 250 °C to 450°C and liquid metals such as potassium and sodium have even higher working temperature ranges. Unfortunately, compared to heat pipes using water, heat pipes using other working fluids are expensive.Hence now the heat absorbed by the semiconductors will be high.Now it can be performed more efficiently to around 15-20%.Usually the Heat transfer coefficient is larger for the liquid medium than gaseous medium.

3.Air Conditioning System in Automobiles

The airconditioning system in the vehicles gives a comfort for the passengers.But the majority of the engine power was used by this airconditioning system by using a belt driven compressor from crank power.Fuel consumption of a vehicle can be affected by up to 20% for AC system.Reducing the consumption of energy and ensuring thermal comfort are two important considerations in designing airconditioninng system.The alternate approach to run an air conditioner is by a Battery powered by an alternator and additionally here by an energy derived from Thermo electric generator.The main advantage of using battery to run airconditioning is the efficiency of an engine can be increased.Simultaneously the thermal comfort of human can be enhanced.

3.1 Electrically Driven Compressor

This system is proposed so that the compressor speed is independent to the engine crankshaft speed, thus better energy efficiency and temperature control inside vehicle cabin. The electric compressor (Fig.3) is powered by direct current (dc) so that it does not need a power inverter that alternate current compressor would require. Electric compressor is easy to maintain and install to a compact system and offers low energy consumption.Just there is a need of Dc-Dc converter which will boost the output voltage to the electric compressor. It is found that the usage of DC compressor can be employed for energy-efficient refrigeration systems as these compressors do not require additional power inverter. The comparison showed that operation of the EDC system can be much more efficient than conventional compressor system especially at high and low speed. We can conclude that using the direct current compressor has high possibility in reducing the load of engine system and will result in the higher coefficient of performance and lowering the fuel consumption. This can help in fuel saving of the vehicle.

As the compressor is driven electrically there is no need of fuel supply to the compressor and it doesn't share any load output from the engine.Hence automatically the cop of an engine is increased.The Fig.4showing relation between Cop of an engine to the vehicle speed when using a electric compressor

III.INDENTATIONS AND EQUATIONS

The figure of merit ZT describes material performance.

It depends on the thermoelectric material properties Seebeck coefficient(S), Electricalconductivity(σ),and thermal conductivity k,

$ZT = S^2\sigma T / k.$

where T is the temperature of the material.

The heat source temperature istypically higher (~1000 °C) resulting in the use of thermoelectric materials such as silicon germanium which are suitable for high temperature power generation.

IV.FIGURES AND TABLES

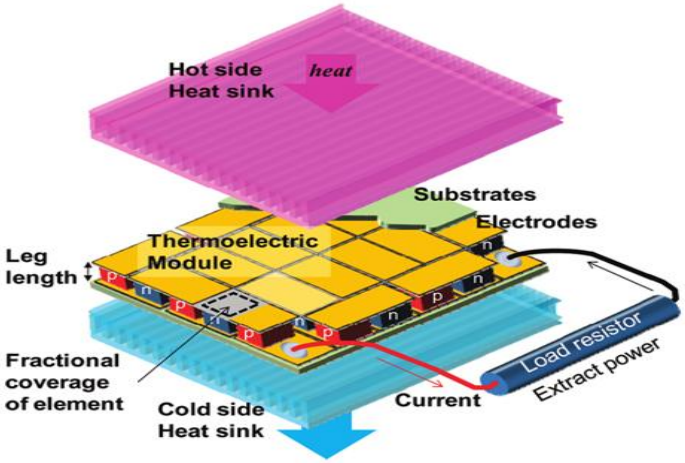


Fig.1 shows TEG has a thermo electric modules of p-type and n-type semiconductors of Lead telluride.

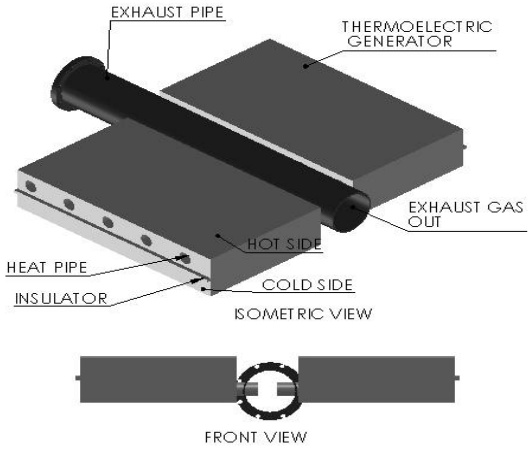
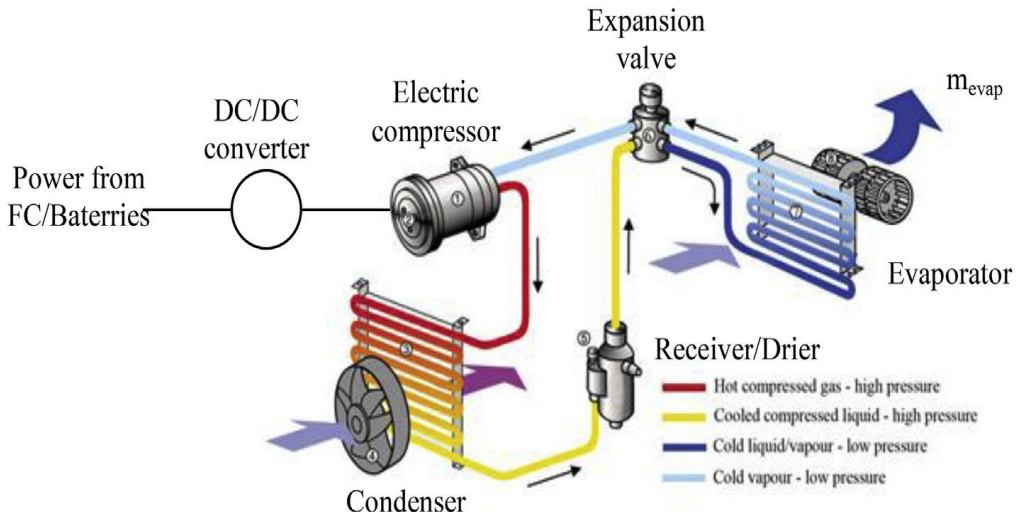


Fig.2 shows the thermoelectric generator setup in exhaust pipe.



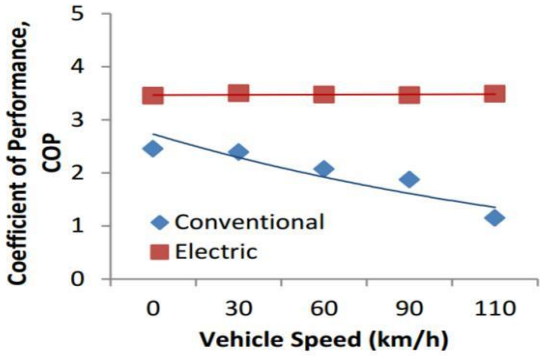


Fig.3 shows the electrically driven compressorFig.4 shows comparision between cop of an of an airconditioning system.Conventional and electric compressor.

V. CONCLUSION

Hence by using a ThermoElectric Generator in the exhaust pipe,the waste heat is recovered and converted to electricity gets stored in a battery.And by using an electrically driven compressor the thermal comfort for humans get enhanced and the major load from the engine is removed.Hence the efficiency of an engine is improved.Although the energy from the battery is not fully enough to run the compressor continuously,the research are still in progress to remove the compressor load from the engine to improve the engine performance.But still there are TESLA cars which run their full vehicle by means of battery.The technology is still developing to replace the every existing technology.

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KeyLaboratoryofAdvancedTechnologyforAutomotiveComponents,AutomobileEngineeringInstitute,Wuhan Univ-ersityof Technology,China.