Hypothetical Model of Eco-Exhaust WithThermo-Electric Generator

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Abstract **In an internal combustion engine efficiency of engine is around 35%, roughly 25%-35% of fuel energy is waste in exhaust gasses25-30%. In cooling water 5-10% are un-accountable losses effort are made to catch this 25-35% energy of exhaust gasses. If these waste heat energy is tapped and convert into usable energy the overall efficiency of an engine can be improved in EETEG system are using thermo-electric generator which is solid state device that are used to convert waste thermal energy into to electricity and it work on principle of see beck effect. In thermo-electric generator we using stainless steel as a hot side heat exchanger and aluminum as a cold side heat exchanger the heat transfer between hot exhaust gas and TEMs is in hence with the use of a flat fin heat exchanger.**

Keywords: - Thermo-electric generator, heat exchanger (hot and cold), axial turbine, centrifugal compressor, catalytic convertor (CRT and SCR)

I. INTRODUCTION

The energy consist has become a major challenge in front of engineer across the global due to rapidly increasing demand and consumption of energy for almost 200 year the main energy resource has been fossil and will continue supply much of the energy for the next two and half decades. The world over all oil consumption is expected to rise 98 million banal per days in 2016.The most world wild increase demand will come from transport section.

A. Exhaust gases emission

The heavy duty commercial vehicle having major outlet product/outlet diesel engine. Nitrogen-oxide (NOx) - 67%, Carbon mono-oxide - 12% And Sox, hydrocarbon, water, PM, vapors, and etc.

When the emission Sox at less percentage is not much harmful but the emission of Cox, NOx, and PM particle are more dangerous not for only human body but also harmful for environment. Session an emission from diesel engine attracted storing interest are main obligation as an engine designer is to ensure the highest level of safety and reliability of equipment installed an vehicle experience form operation provide to fulfill these obligation and a design basis for emission control method so the exhaust gases plum visible for various reason due to particulate matter and NOx, and condensing water vapors and these smokes are much harmful. To control these we are using SCR and CRT system. To control the particulate matter form exhaust Gasses using CRT or DOC system and to control NOx using SCR system over all we proposed a system called EETEG. Utilizing the accesses by heat of catalytic burner.

B. The EETEG system consists of following components

1. Auxiliary burner or thermo-electric generator.
2. Compressor.
3. Axial flow gas turbine.
4. Catalytic emission control system (SCR and CRT).

B.1 Thermo-electric generator

Thermo-electric generator are all solid state device that convert heat in to electricity unlike tradition dynamic heat engine thermo-electric generator certain no moving element and are completely silent such generator have been used reliable for over a 32 year of maintenance free operation. As compare to large tradition heat engine thermo-electric generator have lower efficiency but for small application thermo electric can become competitive because they are compact simple and scalable.In EETEG system we are using high temp thermo-electric generator. In commercial catalytic burner the exhaust gasses are heated up to temperature. When till the NOx, Sox will come at exiting stage they it further go to purification or pass through emission reducing system. Heat energy of hot flue gas left in environment but EETEG system utilize waste heat to convert into electricity.

B.1.1 LEAD TELLURIDE

The basic concept of thermoelectric power generation is simple. When a temperature difference exists across a TE material a proportional voltage is generated between opposing ends of the material, which can be connected to a load to provide electrical power. Because the charge carriers are directly driven by the flow of heat through the material, thermoelectric generators have a distinct advantage over other heat engines by operating without moving parts, thus

providing a device that is robust and requires no maintenance. While the heat in a typical generator is provided by burning a fuel, or through radioactive decay, the possibility of renewable sources of heat such as energy harvesting from waste heat recovery from industry or automobiles has renewed interest in thermo-electrics to target energy sustainability.

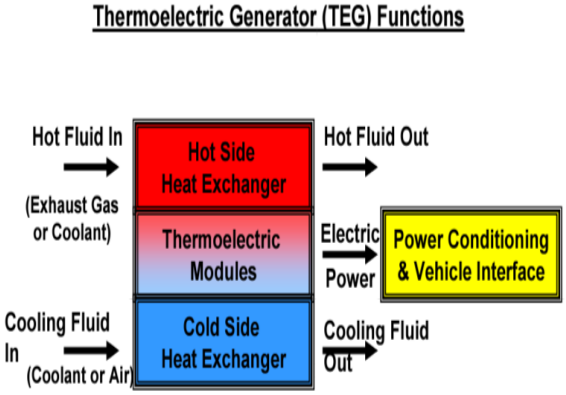

Figure 1. Thermo-Electric Generator Function

B.2 Catalytic emission control system

In commercial heavy duty vehicle the total efficiency of fuel used up to 60% by using this system. This will not only reduce the CO2 but amount of emission of NOx, Sox, PM, CO, and HC. Now the recent advance our exhaust emission control system using DOC, CRT, and SCR… etc. The controlling of Cox, NOx, HC, and PM most important. When in EETEG system the Cox and HC emission is reduced at auxiliary burner but we have more challenge to reduce NOx and PM particle so here we are using CRT and SCR.

TABLE 1. EMISSION DATA OF HEAVY DUTY VEHICLE

Load 100%	g/kwh
Co2	537
O2	1379
CO	0.84
NOx	11.38
HC	0.168
Sox	10.237
PM (mg/m3)	0.58

B.2.1 Selective Catalytic Reduction System

The selective catalytic reduction for NOx emission reduction used on EETEG system. SCR system is best suitable for high load conduction. And this system is able to reduce emission of NOx up to 96%.This system work at temp range 250*C - 400*C. NOx reduced to N2 and H2O. SCR technology is one of the most cost effective and fuel efficient technologies available to help reduce emission. SCR can reduce NOx emission up to 90 percent. While simultaneously reducing HC and CO emission by 45-92 percent and PM emission by 30-55 percent. SCR system can also be combined with a diesel particulate filter to achieve even greater emission reduced for PM. SCR technology may play a key role in achieving emission reduction that allow light duty diesel vehicle to meet the new lower EPA emission regulation to be phased in through 2009 and potentially expand the diesel vehicle sales market to all 50 states.

II. LITERATURE SURVEY

Pre.Thamesh Remade, et al In this paper Automobile exhaust thermo-electric generator design and performance analysis. In internal combustion engine the efficiency is about 50% - 40% and there are some losses and effort made to catch this 40% lost energy of exhaust gas. Two thermo-electric module were selected (Bi2Te3) according to temp difference. The study show that energy can be tapped efficiency from the energy exhaust also near future TEG reduces size of alternator.

G. Jeffery sryder In this paper Small thermo-electric generator. The thermo-electric generator are solid state device that convert heat energy to electricity and TE contain HO moving part and has long life but small application of T.E. can become they compact simple (inexpensive) and escapable. Thermo-electric has even been minimized to have west body for powering a wristwatch.

Jorge martini et al This paper report in recovery of waste thermal energy using thermo-electric generator for application in hydride, extended range electric vehicle and reduced alternator operating time various type of HPs were designed manufacture tested and improved with the aim of enhancing the overall heat transfer process.

III. PROBLEM IDENTIFICATION

1. In conventional heavy duty diesel vehicle the exhaust gas emission is controlled by using catalytic emission control system. In this system lots of sub system like CRT, SCR, DOC etc. So that the overall system is to be large to control emission of Nox, Sox, HC, PM and COx etc. but the reduction of SOx is not desirable because it is not much harmful for human body as well as environment and the quality of Sox percentage is very less amount.
2. No need to install a separate equipment to eliminate Cox.
3. In conventional system to run the compressor it need power source. Which is either connected to the main shaft with some arrangement or separate motion is provided and electricity given by the alternator.

IV. METHODOLOGY

In EETEG system we using thermo-electric generator which consist of high temp thermo-electric material. It converts the large % of heat energy coming out from auxiliary burner and help to reduce fuel consumption around 8-16%. Hence the TEG can be profitable at automobile industry.

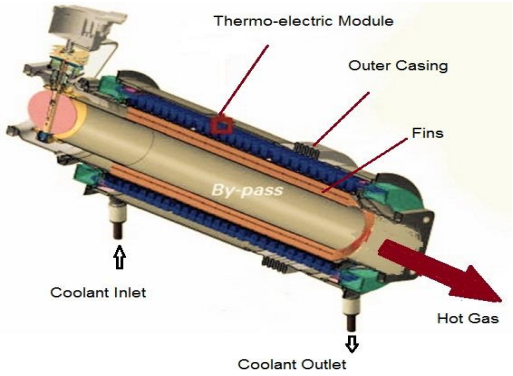

Figure 2. Thermoelectric generator

The driving principle behind the thermo-electric generation is known as see beck effect. When even a temp gradient is applied to thermo-electric material the heat passing through is conducted by some particles that carry charge. And the movement of charge produce a voltage the function of different conductors are kept at different temp which causes as open circuit electromotive force to develop follow = α (-). When α is see beck co efficient of two log material and has unit of V/ K and one hot, cold side absolute temp both measured in Kelvin. A German physicist tom's john see beck discovered this effect in early 1800.

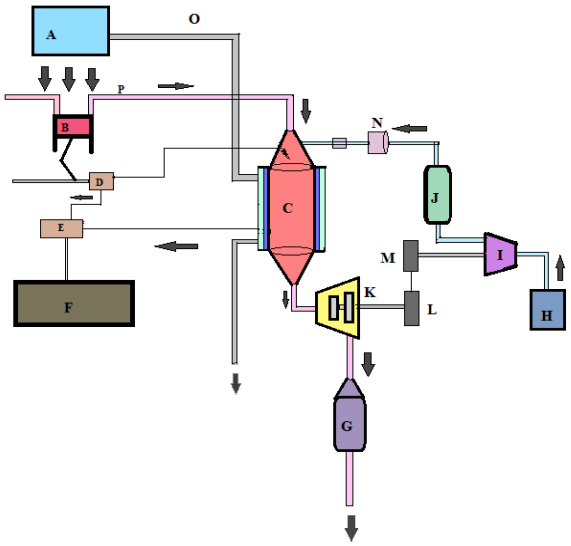

Figure 3. EETEG system

Where –

- A = Radiator
- B = Engine
- C = Thermo-electric generator (Auxiliary Burner)
- D = Alternator connected with main shaft
- E = Electric distribution system
- F = Battery
- G = Catalytic Emission Reduction System
- H = Air filter
- I = Compressor
- J = Fresh air cylinder
- K = Axial turbine
- L = Gear of chain drive
- M = Pinion of chain drive
- N = Fresh air inlet system
- = Cooling pipe line
- P = Exhaust gas pipe line

A. *The main challenge of SCR*

SCR method for NOx reduction on diesel engine today can give the congest reduction. But it more difficult to apply SCR on main vessel in service. These make it unfeasible to remove more than 90% - 95% NOx due to the risk of ammonia.

B. *Catalytic Reduction Technology*

As shown in table the limit for particulate matter emission for mist current level of 0.5 g / kWh nearby and the PM particle from the hot flue gasses remove by filter and the filter need to preventive maintains at after much long time.

V. RESULT AND CONCLUSION

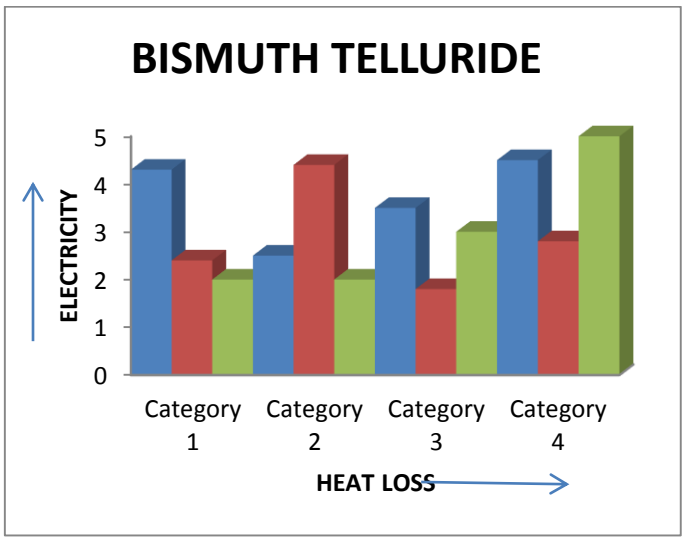

Figure 4. Bismuth Telluride used in conventional or low temperature TEG

Category 1 = heat loss at TEG, Category 2 = electric power output, Category 3 = heat loss at coolant, Category 4 = heat loss by radiation.

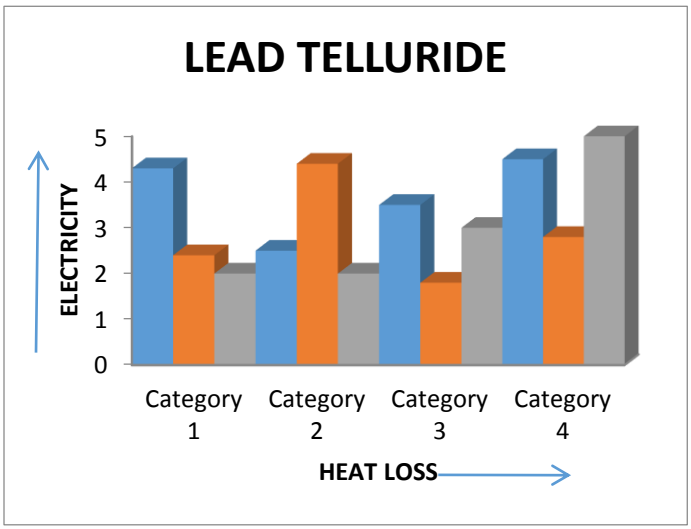

Figure 5. Lead Telluride used in conventional or low temperature TEG

Category 1 = heat loss at TEG, Category 2 = electric power output, Category 3 = heat loss at coolant, Category 4 = heat loss by radiation

1. Project increase from current 8% to 23% efficiency.
2. An EETEG thermo electric system was designed and developed waste heat recovery of an automobile engine.
3. It was form to get improve the efficiency of this system thermal management is very important double staked type cold side heat exchanger give better temperature gradient across the TEG counter flow type arrangement enhance effective heat transfer also insulation used for area not covered by TEG module avoid the heat loss.

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