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REVIEW ON EXHAUST GAS HEAT RECOVERY FOR IC ENGINE USING THERMOELECTRIC GENERATOR

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ABSTRACT

The increasingly ecumenical quandary regarding rapid economy development and a relative shortage of energy, the internal combustion engine exhaust waste heat and environmental pollution has been more accentuated heavily recently. Out of the total heat supplied to the engine in the form of fuel, approximately, 30 to 40% is converted into utilizable mechanical work; the remaining heat is expelled to the environment through exhaust gases and engine cooling systems, resulting in to entropy elevate and solemn environmental pollution, so it is required to utilized waste heat into subsidiary work. The recuperation and utilization of waste heat not only conserves fuel (fossil fuel) but additionally reduces the amount of waste heat and greenhouse gases damped to environment. The study shows the availability and possibility of waste heat from internal combustion engine, additionally describe loss of exhaust gas energy of an internal combustion engine. Possible methods to recuperate the waste heat from internal combustion engine and performance and emissions of the internal combustion engine. Waste heat instauration system is the best way to recuperate waste heat and preserving the fuel.

KEYWORDS: Efficiency, Emission, Potential Difference, Seeback Effect, Thermoelectric Generators, Waste Heat From I.C. Engine, Waste Heat Recovery System For I.C. Engine

I. INTRODUCTION

Automobiles are an example of high energy utilization with low efficiency. Roughly 75% of the energy engendered during combustion is disoriented in the exhaust or engine coolant in the form of heat. By utilizing a portion of the lost thermal energy to charge the battery in lieu of utilizing an alternator the overall fuel economy can be incremented by about 10%. Depending on the engine load the exhaust temperatures after the catalytic converter reach about 300-500 degrees Centigrade. Thermoelectric engenderers are ideal for such applications as they are minute, with no moving components, and relatively efficient at these temperatures. Thermoelectric technology can be acclimated to engender electrical power from heat, temperature differences and temperature gradients, and is ideally suited to engender low calibers of electrical power in energy harvesting systems. Thermoelectricity utilizes the Seebeck, Peltier and Thomson effects that were first observed between 1821 and 1851. Practical thermoelectric contrivances emerged in the 1960's and have developed significantly since then with a number of manufacturers now marketing thermoelectric modules for power generation, heating and cooling applications. Perpetual research and advances in thermoelectric materials and manufacturing techniques, enables the technology to make an incrementing contribution to address the growing requisite for low power energy sources typically utilized in energy harvesting and scavenging systems. Commercial thermoelectric modules can be habituated to engender a scintilla of electrical puissance, typically in the mw or µw range, if a temperature difference is maintained between two terminals of a thermoelectric module. Alternatively, a thermoelectric module can operate as a heat pump, providing heating or cooling of an object connected to one side of a thermoelectric module if a DC current is applied to the module's input terminals.

TABLE 1:- Examples of Waste Heat Sources And End Uses

Waste Heat Sources	Uses for Waste Heat
Combustion Exhausts: • Glass melting furnace • Cement kiln Fume incinerator • Aluminum reverberatory furnace Boiler Process off gases: 1. Steel electric arc furnace and aluminum reverberatory furnace 2. Cooling water from: 3. Furnaces, air compressors, IC engines 4. Conductive, convective, and radiative losses from heated products: • Hot cokes and blast furnace slag	Combustion air preheating Boiler feed water preheating Load preheating Power generation Steam generation for use in: 1. Power generation 2. Mechanical power 3. Process steam Space heating Water preheating Transfer to liquid or gaseous process streams

II. THERMO ELECTRIC-GENERATOR

Thermo electric-Engenderer are made from thermoelectric modules which are solid-state integrated circuits that employ three established thermoelectric effects kenned as the Peltier, Seebeck and Thomson effects. Their construction consists of pairs of p-type and n-type semiconductor materials composing a thermocouple. These thermocouples are then connected electrically composing an array of multiple thermocouples called as thermopile. They are then sandwiched between two thin ceramic wafers. When heat and cold are applied this contrivance then engenders electricity.

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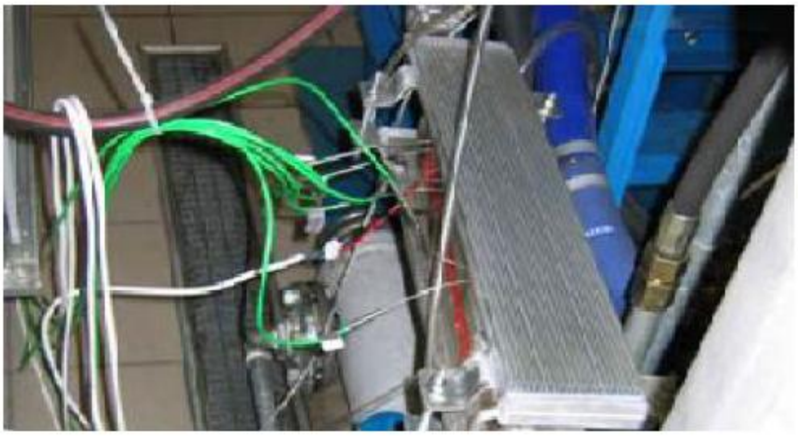

FIG.1:-Thermoelectric Generator Mounted On Exhaust System

The exhaust pipe contains a block with thermo electric materials that engenders a direct current, thus providing for at least some of the electric power requisites. In which two different semiconductors are subjected to a heat source and heat sink. A voltage is engendered between two conductors. It is predicated on the seeback effect. The Cooling and Heating is done by applying electricity. It is low efficiency approximately (2 to 5%) and high cost.

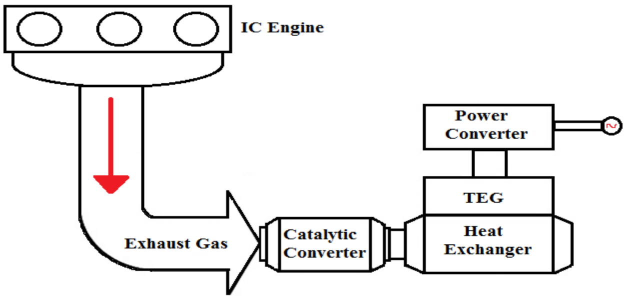

FIG.2:-Thermoelectric Generator

Fig.2 shows thermoelectric generator and its components. Thermoelectric contrivances may potentially engender twice the efficiency as compared to other technologies in the current market. Thermo Electric Engenderer is utilized to convert thermal energy from different temperature gradients subsisting between sultry and cold cessations of a semiconductor into electric energy .This phenomenon was discovered by Thomas Johann Seebeck in1821 and called the Seebeck effect. The contrivance offers the conversion of thermal energy into electric current in a simple and reliable way. Advantages of Thermo Electric Engenderer include free maintenance, silent operation, high reliability and involving no moving and involute mechanical components. Recycling and reusing waste exhaust gas can not only enhance fuel energy use efficiency, but additionally reduce air pollution. Thermal power technology such as the Thermo Electric Engenderer arises, consequently, paramount attention ecumenical. Thermo Electric Engenderer is a technology for directly converting thermal energy into electrical energy. It has no moving components, is compact, quiet, highly reliable and environmentally cordial. Because of these merits, it is presently becoming a conspicuous research direction. The mathematical model of a Thermoelectric Engenderer contrivance utilizing the exhaust gas of conveyances as heat source, and preliminary analysis of the impact of pertinent factors on the output power and efficiency of Thermo Electric Engenderer. Analysis of model simulates the impact of pertinent factors, including conveyances exhaust mass flow rate, temperature and mass flow rate of variants of cooling fluid, convection heat transfer coefficient, height of PN couple, the ratio of external resistance to internal resistance of the circuit on the output power and efficiency. The results of analysis shows that the output power and efficiency increase significantly by transmuting the convection heat transfer coefficient of the high-temperature-side than that of low-temperature-side. Pilot program is made to investigate the applicability of thermoelectric engenderers to the recuperation of medium-temperature waste heat from a low-power stationary diesel engine. Experimental investigation to the optimum operating conditions to achieve maximum power outputs from the waste heat instauration system. Study on waste heat recuperation system by utilizing thermoelectric engenderer from internal combustion engine reviews the main aspects of thermal design of exhaust-predicated thermoelectric engenderers (ETEG) systems. Analysis of thermoelectric engenderer for power generation from internal combustion engine shows results as 20% of energy relinquishing for the waste heat from engine. It is able to 30-40% of the energy supplied by fuel depending on engine load.

2.1. Thermoelectric Module Construction:-

A single thermoelectric couple is constructed from two 'pellets' of semiconductor material customarily made from Bismuth Telluride (Bi2Te3). One of these pellets is doped with acceptor impurity to engender a P-type pellet; the other is doped with donor impurity to engender an N-type pellet. The two pellets are physically linked together on one side, conventionally with a minuscule divest of copper, and mounted between two ceramic outer plates that provide electrical isolation and structural integrity. For thermoelectric power generation, if a temperature difference is maintained between two sides of the thermoelectric couple, thermal energy will move through the contrivance with this heat and an electrical voltage, called the Seebeck voltage, will be engendered. If a resistive load is connected across the thermoelectric couple's output terminals, electrical current will flow in the load and a voltage will be engendered at the load. Practical thermoelectric modules are constructed with several of these thermoelectric couples connected electrically in series and thermally in parallel. Standard thermoelectric modules typically contain a minimum of three couples, elevating to one hundred and twenty seven couples for more sizably voluminous contrivances. A schematic diagram of a single thermoelectric couple connected for thermoelectric power generation, and a side view of a thermoelectric module is shown in figure3.

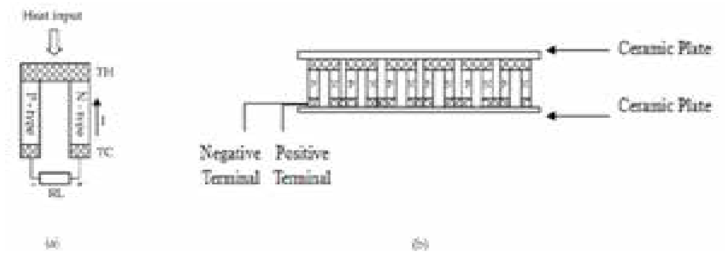

FIG.3:(A) Schematic Diagram Of A Single Thermoelectric Couple, (B) Side View Of A Thermoelectric Module

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III FABRICATION OF SECOND EXPERIMENTAL SETUP

FIG.4:-Experiment on Separate Setup With Heater And Dimmerstate

3.1 Schematic Diagram For Second Experimental Setup:-

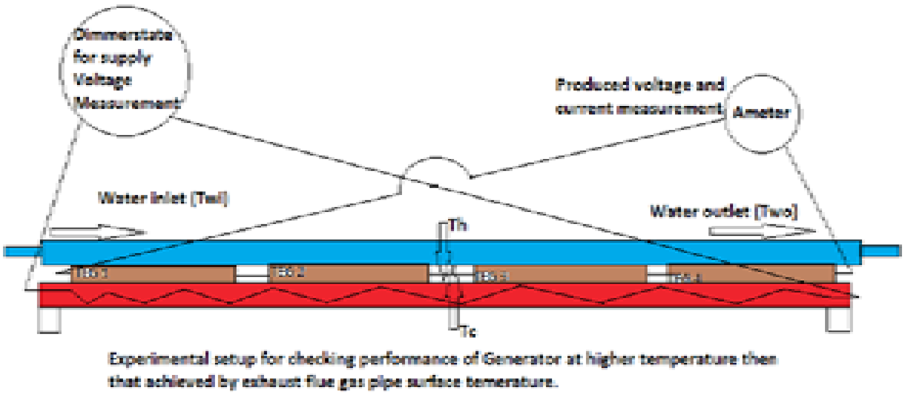

FIG.5:-Schematic Diagrams For Second Setup

In first setup value of sultry side temperature was 82C and available module can work up to 180C, so another setup is yare in which heater is utilized to provide sultry surface with seat for modules and on other side algid temperature is maintained utilizing a dihydrogen monoxide pipe having same material and cross section as utilized in first setup. Fabricated separate experimental setup is shown in figure 4 and schematic diagram of second setup is shown in figure 5. In both the setups the connection of thermoelectric module is in series, so both setups are electrically equipollent.

IV. RESULTS AND DISCUSSION

The waste heat recuperation is done utilizing the velocity and the temperature on the surface of the primary exhaust pipe. The potency is engendered instantaneously since the turbine and the engenderer are coupled together. In accordance with throttle input, the velocity of exhaust gases varies directly. This energy is used to run the turbine and the output is measured and tabulated in Table 2.

TABLE 2:-Experimental Results

S. No.	V (Volts)	I (Amps)	Power (Watts)	Speed rpm
1	0.80	0.47	0.376	46
2	1	0.5	0.5	50
3	0.16	0.68	1.09	315
4	3.5	0.7	2.45	435
5	3	0.8	2.4	470
6	4	0.9	3.6	700
7	4.6	1.1	4.76	900

V. CONCLUSION

The amalgamated heat and power system offers supplemental benefits like reduction in the emission of carbon dioxide (CO2), sulphur dioxide (SO2) and oxides of nitrogen (NOx) for the same power and heat generation. This is achieved by utilizing the waste heat recuperation system and can be installed on any equipment which engenders heat and needs heat dissipation to reduce the pollution during the operation of machines in additament to the auxiliary power generation. This auxiliary power can be utilized for the operation of main mechanism. The efficiency of the equipment increases considerably since the waste heat is being utilized for the subsidiary work. This system reduces the cost of operation by reducing the consumption of fuel. The size of all the flue gas handling equipment such as fans, stacks, ducts, burners, etc., is reduced. The consumption of auxiliary power is additionally reduced since the reduction in size of all the auxiliary equipment.

REFERENCES

[1] Basel I. Ismail, Wael H Ahmed (2009) Thermoelectric Power Generation Using Waste-Heat Energy as an Alternative Green Technology, Recent Patents on Electrical Engineering, 2, 27-39.

[2] Hou Xuejun, Xiao Peng (2012) Computational Models Analysis of Diesel Engine Exhaust Waste Heat Recovery, International Conference on Ecology, Waste Recycling, and Environment Advances in Biomedical Engineering,Vol.7, 227-239.

[3] J S Jadhao, D G Thombare (2013), Review on Exhaust Gas Heat Recovery for I.C. Engine, International Journal of Engineering and Innovative Technology (IJEIT), Volume 2, Issue 12, 147-159.

[4] Janak Rathavi, Amitesh Paul, G R Selokar, International Journal of Computational Engineering Research, ISSN:2250-3005, 7 Pages.

[5] S R Jumade, V W Khond,G. H. Raisoni(2012), International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 10, 6 Pages.

[6] Marian Brazdil, Jiri Pospisil (2013), Thermoelectric Power Generation Utilizing the Waste Heat from a Biomass Boiler, Journal of Electronic Materials, Vol. 42, No. 7, pp. 67-78.

[7] Mohd. Izam Abd, Jahariah Sampe (2013), Experimental investigation of thermoelectric generator modules with different technique of cooling system, American Journal of Engineering and Applied Sciences, 6 (1): 1-7.

[8] R Saidur, M Rezaei, W K Muzammil, M H Hassan, S Paria, M Hasanuzzaman (2012), Technologies to recover exhaust heat from internal combustion engines, Renewable and Sustainable Energy Reviews 16.

[9] N. Hossain And S Bari, "Effect Of Design-Parameters Of Heat Exchanger On Recovering Heat From Exhaust Of Diesel Engine Using Organic Rankine Cycle," Proceedings of the International Conference on Mechanical Engineering 2011 (ICME2011) 18-20 December 2011, Dhaka, Bangladesh.

[10] V. Johnson, "Heat-generated cooling opportunities in vehicles," SAE Technical Papers, No. 2002, 2002-01-1969.