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ELECTRICITY GENERATION FROM HEAT EXHAUST OF MOTORCYCLE

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ABSTRACT: - Most commercial vehicles use internal combustion engines. ICE engines use only a small portion of the fuel's primary energy, which is converted into kinetic energy, but most of the fuel's primary energy is wasted when it escapes into the atmosphere as hot air and waste. Internal combustion engines are energy-intensive and inefficient because approximately 75% of the energy produced during the combustion process is lost as heat in the exhaust gases and engine coolant. Garbage recycling has the potential to increase the efficiency of ICE systems. This article provides an overview of electronic waste. This article proposes and realizes a waste generator using a thermoelectric generator (TEG) designed for four-stroke internal combustion engines. The system enables electricity to be converted directly into electricity without being transported to the vehicle and allows exhaust gas recycling. Experimental results show that the proposed process recovers a large amount of energy that can be used to power some automotive equipment.

Keywords: IC engine; waste heat recovery; TEG; waste heat; efficiency.

1. INTRODUCTION

Although recent advances in the deployment of electric vehicles have brought many non-gasoline and hybrid vehicles to the market, most transportation, especially heavy vehicles, is still efficient with the use of internal combustion engines (ICE). It is estimated that the average combustion engine car uses only 12% of the oil's original power. In this case, the unused energy is dissipated as heat in the exhaust gases (temperature 300 ... 700 ° C) and the engine coolant (temperature 60 ... 100 ° C). Thermoelectric waste heat recovery systems have proven useful for a variety of applications, including engines and vehicles, from motorcycles to heavy loads.

Thermoelectric generator (TEG) is a device that uses the Seebeck effect to convert thermal energy directly into electrical energy. The use of TEG in automobile internal combustion engines is an innovative concept that reduces the load on the alternator to replace the battery, thus helping to reduce fuel consumption. The temperature of the "elbow heat" from the exhaust is between 200°C and 300°C. By connecting the copper plate to the elbow, the temperature of the connection point of the electrical equipment was created and another cold connection was created. Aluminium heatsink is discussed in detail in this article. When this potential difference occurs, a voltage is produced using the Seebeck effect. The generated voltage is further amplified by an amplifying circuit and tested on the load. Zheng Zing et al. get. studied the design, fabrication, and performance evaluation of thermoelectric generator for waste heat recovery engine.

Today, many applications of electrical energy have been developed, such as benefiting from the difference in sea and land temperature or utilizing geothermal energy. The biggest problem in the production of these electronic devices is the availability of electronic devices with high switching power. Thermoelectric data are not determined by the quality of the product. Ideally, thermoelectric materials have high electrical conductivity and low thermal conductivity. However, in reality, this information is difficult to obtain because most materials have high electrical conductivity and high thermal conductivity. In this article, we propose that the electricity produced by the thermoelectric generator originates from the

Seebeck effect, which occurs due to the temperature difference between the heating side of the module and produces electricity by the rapid change of electricity. The greater the temperature difference (ΔT) between the hot and cold sides, the greater the power. Details in this study demonstrate the use of thermoelectric generators to generate electricity using a thermoelectric cooler made of aluminium mounted in the car. Since the Seebeck coefficient is required for adequate cooling (3.5 mV/K), aluminium Peltier modules are generally used for cooling. In this study, an aluminium Peltier module was used as the power plant based on the Seebeck effect. The aim of this research is to use a generator that can convert the thermal energy in the engine into electrical energy using air conditioning.

2. BACKGROUND OF INNOVATION

In recent years, global warming and the limitations in use of energy resources increase environmental issues of emissions. The possibilities of thermoelectric systems' contribution to "green" technologies, specifically for waste heat recovery from silencer exhausting flue gases. Vast quantities of waste heat are discharged into the earth's environment much of it at temperatures which are too low to recover using conventional electrical power generators. The proposed structure is a distributed multi-section and multi-stage network. The target is to tackle problems facing the traditional single-stage system and to advance TEG application in automotive settings.

3. PROBLEM DEFINITION

Energy-intensive industries require heat for their production processes, often resulting in the release of thermal energy, which is typically considered waste, into the atmosphere. Similarly, hot air from a car's muffler escapes into the environment, contributing to pollution. Technologies that have the potential to control pollution and convert waste heat into electricity can play a crucial role in addressing these issues. Thermoelectric generators (TEG) are highlighted as a promising avenue, offering the prospect of "green" technology, specifically in recovering energy from waste gas. However, a significant portion of waste heat is released at temperatures too low to be effectively utilized as a generator.

- Industrial Manufacturing
- Automobiles System
- Steel, Chemicals, Paper, Cement, Glass, Food Processing
- Oil and Gas Processing
- Gas Compressor Stations
- Refineries etc

The proposed solution involves the development of a decentralized, multi-hole, multi-layer network architecture. This design aims to overcome challenges encountered by traditional single-stage processes, particularly in the automotive environment. The ultimate goal is to advance the utilization of TEGs, leveraging their potential to transform waste heat into electricity and contribute to more sustainable practices in energy-intensive industries and automotive systems.

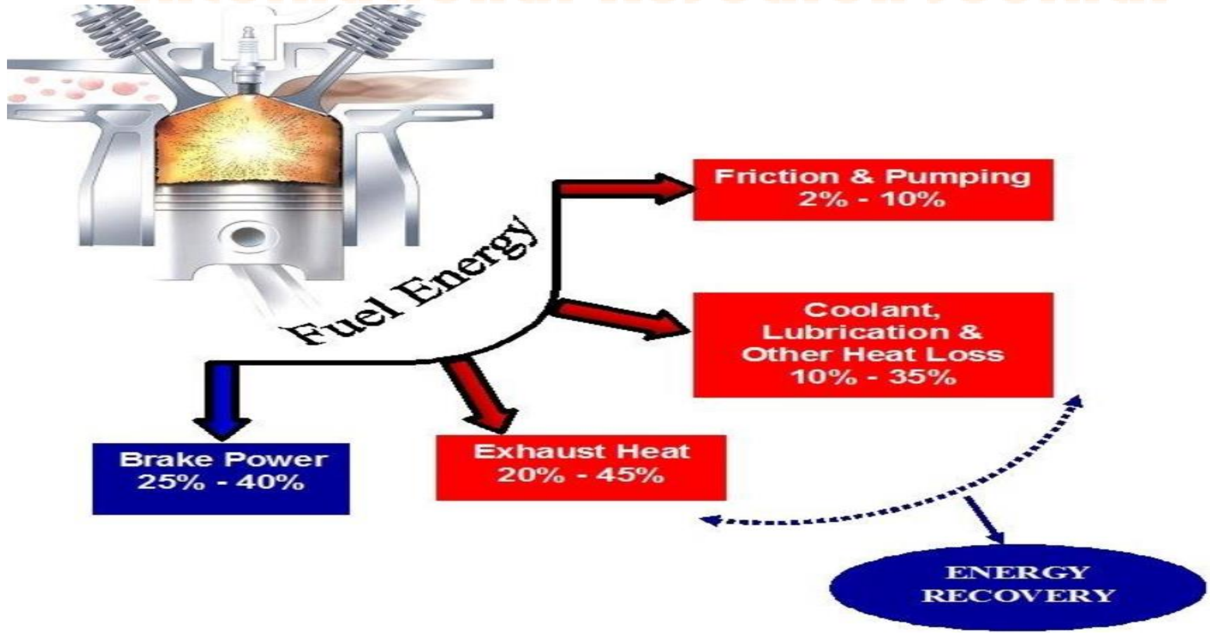


Fig.1 Total Fuel Energy distribution in IC Engine

Table1. Types of Engines and Their Waste Heat Energy

Sr. no.	Engine Type	Power Output KW	Waste Heat Energy
1	Small air-cooled diesel engine	35	30-40% of energy waste loss from I.C. engine
2	Small agricultural tractors and construction machines	150	
3	Water cooled engine	35-150	
4	Earth moving machineries	520-720	
5	Marine applications	150-220	
6	Truck and road engine	220	

Table 2. Output Exhaust Heat of Motorcycle As per Their CC rating.

Sr. No.	CC Rating of Motorcycle/ Bike	Exhaust Temperature in Degree Fahrenheit	Exhaust Temperature in Degree Celsius
1.	Less than 100 CC	302-660	150-350
2.	100<CC rating <300 (125, 150, 220, 250 cc)	400-900	200-480
3.	300CC	500-1000	260-540
4.	350< CC rating<689 (350, 400, 470, 689 CC)	500-1100	260-590
5.	720< CC rating < 998 (759, 948, 998 CC)	500-1200	260-650

Waste heat is heat resulting from the combustion of fuel or chemical reactions during a process that is then "discharged" into the environment but can still be reused for some benefit and economy. This heat depends partly on the temperature of the flue gas and the size of the flue gas. Heat loss is caused by both mechanical inefficiencies and thermodynamic limitations of materials and processes. For example, consider that the internal combustion engine converts 30% to 40% of its energy into efficient operation. The remaining heat is released to the environment through exhaust and engine cooling. This means that approximately 60% to 70% of the energy lost from exhaust gas is lost as waste energy (30% from air conditioning, 30% to 40% from emissions as environmental loss). Exhaust gas temperature immediately leaving the engine can be as high as 842-1112°F [450-600°C]. Therefore, the temperature of this oil is high, and it is taken as a gas. Efforts can be made to develop more fuel-efficient engines with better heat transfer and lower heat dissipation; however, the laws of thermodynamics place a lower limit on the temperature of the exhaust gas. Photograph. 1.1 shows the total power distribution of the internal combustion engine.

4. WORKING PRINCIPLE OF PROJECT

Seebeck Effect **-** The Seebeck Effect is the direct conversion of a temperature difference into electric current. It is a classic example of electric power (emf) and produces current or voltage, which is measured in the same way as other emfs. Even though there is no difference in voltage, the voltage will change Ohm's law by producing current (or vice versa); The local current density is given by:

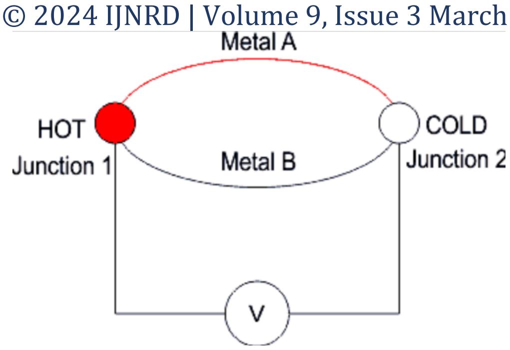
$$J = \sigma (-\Delta V + E_{emf})$$

where V is the Local voltage, σ is the local conductance. Generally speaking, the Seebeck effect is described locally by electrical signals.

$$E_{emf} = -S \, \Delta T$$

where S is the local material Seebeck coefficient (also known as thermoelectric potential) and ΔT is the temperature. Seebeck found that when a temperature gradient was placed at the junction of two different electrodes, electric current would flow.

The effect is as shown below.



Thermoelectricity means the direct conversion of heat into electric energy, or vice versa. According to Joule's law, a conductor carrying a current generates heat at a rate proportional to the product of the resistance (R) of the conductor and the square of the current (I). A circuit of this type is called a thermocouple; several thermocouples connected in series are called a thermopile.

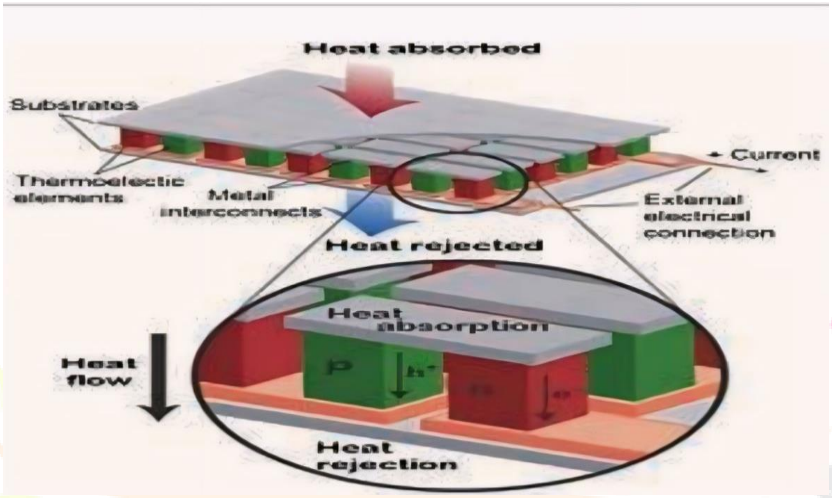


Figure 2: Thermoionic Principle of Operation

Jean C. A. Peltier discovered an effect inverse to the Seebeck effect: If a current passes through a thermocouple, the temperature of one junction increases and the temperature of the other decreases, so that heat is transferred from one junction to the other. The rate of heat transfer is proportional to the current and the direction of transfer is reversed if the current is reversed.

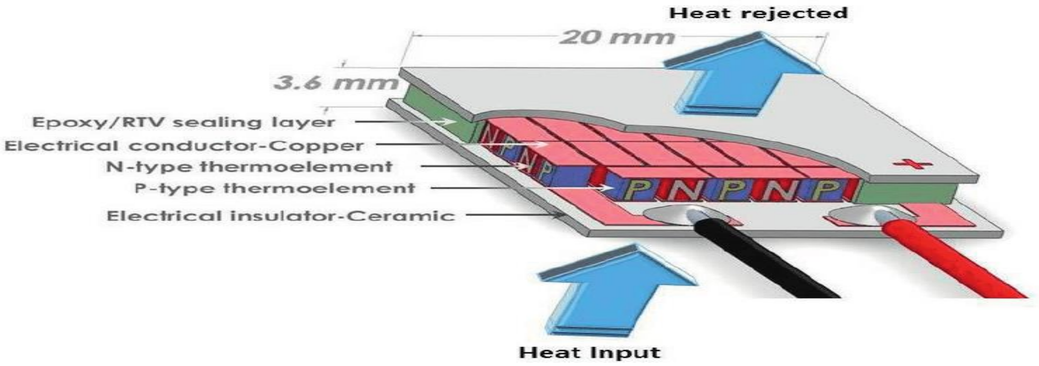


Figure 3: Internal construction and working of thermo- electric module

Automobile: -The main purpose of energy conversion in automobiles is mainly at three exchange points: exhaust gas pipe (EGP), exhaust gas recirculation (EGR) cooler and retarder. The most important factors affecting waste energy are energy density and temperature. EGP is the target of most waste heat recovery research. The exhaust system creates a large portion of the car's total waste heat. The gas flow in the discharge pipe is stable. A TEG powered by natural gas is shown here. When the exhaust temperature reaches 973 K and above, the temperature difference between the exhaust and the cold side is close to 373 K. This temperature difference can produce 10W of power.

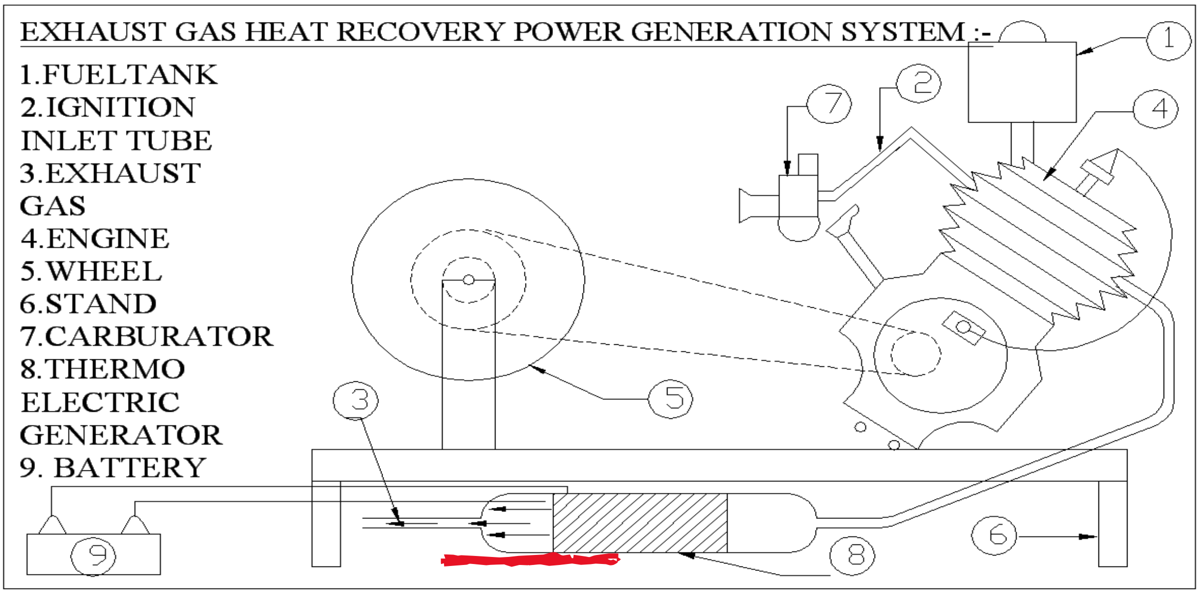
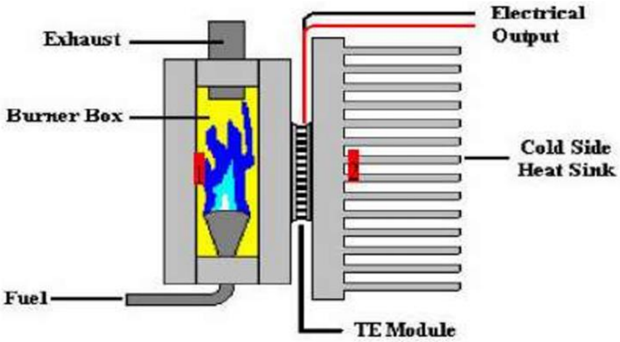


Figure 3 and 4: Working diagram of TEG



5. PROJECT WORKING

Non-traditional energy use is the conversion of all energy into electrical energy. Electricity production planning is being done in this project. The use of thermoelectric technology makes this process efficient and reliable. In a car, the engine is constantly running for work. It gives off too much heat. This is bullshit. We use this waste to generate electricity. This way we can also reduce pollution. When we apply TEG with a heat pump, the heat is thrown out through the heat pipe drawn by the pump. Then, at the same time, the TEG begins to convert thermal energy into electrical energy. We can measure the temperature with the help of a thermometer connected to the system. A DC fan is connected to the system to control the flow of thermal energy and convert it into electrical energy. As the temperature increases, fan flow also increases. The electricity produced is stored in the battery. This stored energy is fed to an inverter, which converts DC power into AC power. Take the AC load at the output. This AC load includes fans, AC, lights, etc. in the same business. It is used to operate multiple loads such as We also connected the 8051 microcontrollers (AT89S52) to the LCD display to measure the voltage stored in the battery and the remaining voltage. This is how the whole system works. Start with the waste of heat coming out of your car's muffler. Thermal energy is then converted into electrical energy. Instructions for converting electrical energy from DC fans and motors. Storing electricity in batteries. DC voltage is converted to AC voltage with the help of the inverter. Connect the microcontroller to detect the voltage of the battery. The final AC load is connected to the inverter.

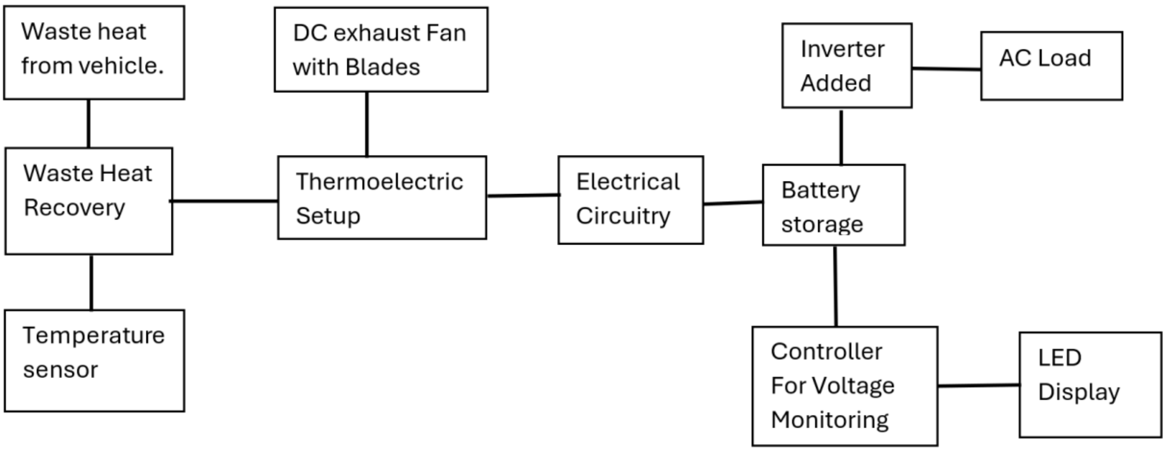


Figure 5: Block Diagram

6. DESIGN CALCULATION

Specification of 4 stroke petrol Engine

Type	4 strokes
Cooling System	Air Cooling
Compression ratio	149.5CC
Maximum power	10.3 kW (14 PS) @ 8500 rpm
Maximum torque	13.25 Nm @ 6500 rpm
Maximum exhaust Temperature (Th)	650kelvin

Generated Voltage Calculation:

According to the Seebeck effect equation,
V = α (Th - Tc)
where, V - generated voltage (in volts)
α - Seebeck coefficient (in µV/K)
Th - Kelvin of the hot place temperature (silencer)
Tc - Kelvin temperature of cold place (atmosphere)
α of Bismuth Telluride - 287µV/K
Tc = 303 k
Many temperatures will be used for: thermal silencer and Seebeck Taking into account the corresponding voltage, whic h should be calculated according to the equation
V = α (Th - Tc)

Case 1: Th= 403k, V= (287 *10-6) * (403-303) = (287 *10-6) *(100) = 0.0287 V

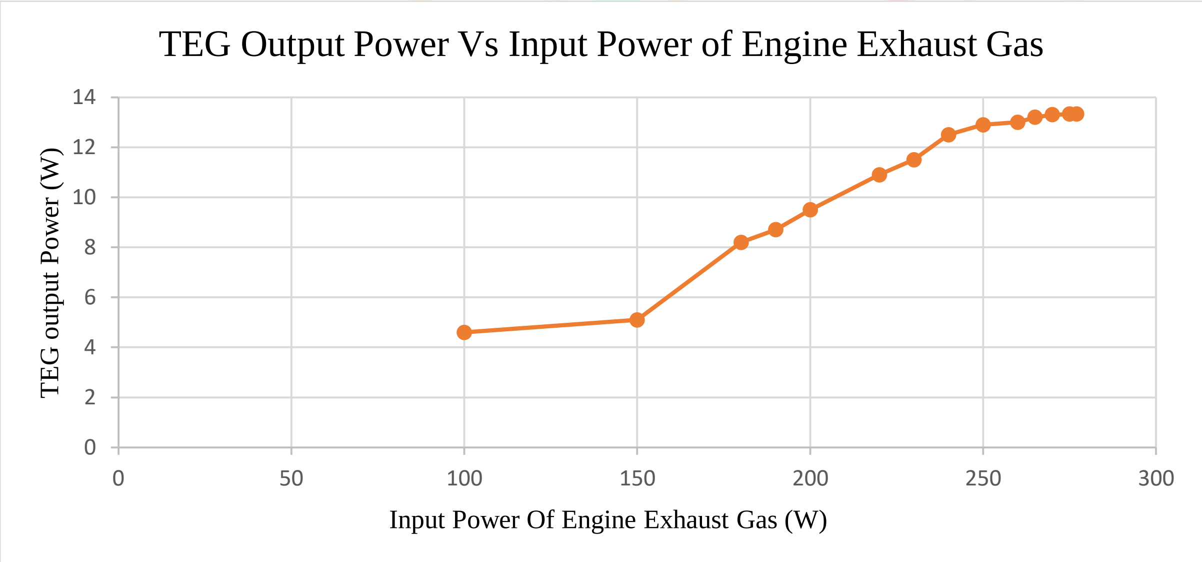
Case 2: Th=650k, V= (287 *10-6) * (650-303) = (287 *10-6) *(347) = 0.0995 V

These voltages are very small in magnitude and can be boosted using booster module.

Table 1. Voltage Generated and Boosted for Different Exhaust Temperature

Temperature difference across TEG	Original Voltage Generated (volt)	Boosted Voltage (Volt)
80	0.02269	1.44
100	0.02870	2.53
120	0.03444	3.21
160	0.04592	4.94
200	0.05740	6.10
250	0.07175	7.21
325	0.09327	8.28
370	0.10619	9.654

Total power
T1 = hot side inlet temperature, T2 = hot side outlet temperature
T3 = cold side inlet temperature, T4 = cold side outlet temperature
Tin = TEG exhaust system temperature Inlet
Tex = exhaust gas temperature at the exit of the TEG system



Graph 1: TEG Output Power Vs Input Power

The graph shows that at the engine speed of 6500 rpm, input power of engine exhaust gas is 280 W & the TEG output power is 13.34 W, hence the overall efficiency obtained is 4.64%.

7. ADVANTAGES

- ✓ Clean, Noise less, Cost is less.
- ✓ This is a non-conventional system; no fuel is required.
- ✓ Easy maintenance, portable, charging time is less (maximum temp)
- ✓ Promising technology for solving power crisis to an affordable extent.
- ✓ Simple in construction, Pollution free, Reduces transmission losses.
- ✓ Wide areas of application# Required less space.
- ✓ It can be use at any time when it necessary.
- ✓ Less number of parts required.
- ✓ we can charge any electronic devices.
- ✓ Electricity can used for many purposes.
- ✓ Efficient and eliminate the grid searching.

8. APPLICATIONS

- ✓ In many businesses, large amounts of heat are used, and time is wasted. We can use TEG to generate el ectricity from this furnace.
- ✓ In cars, TEG is used to generate heat that can be used to generate electricity.
- ✓ Fix the TEG to the radiator or two-wheeler muffler pipe to charge the battery by itself.
- ✓ Thermo

9. CONCLUSION

Waste energy is the capture and reuse of waste energy from industries to generate electricity. The manufacturing industry's use of this technology will also help increase the efficiency and output of the machines. If this thermoelectric concept is put into practice, it will be possible to produce enough electricity to power the products on their own. Additionally, the emission of a small amount of waste heat helps prevent environmental pollution to some extent.

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