# Utilization Waste Heat for Power Generation

[1]Priyam B. Patel,[2]Hemal J. Patel,

1PG student, ME THERMAL, LDRP ITR, KSV University, Gandhinagar, India,
2Professor, ME THERMAL, LDRP ITR, KSV University, Gandhinagar, India.

***Abstract :*** The current worldwide fashion of growing delivery is responsible for increasing the usage of internal combustion engines. The internal combustion engine does no longer successfully convert chemical strength into mechanical strength. Of the entire heat furnished to the engine in the shape of gasoline, approximately 30 to 40% is transformed into useful mechanical work, the final warmness is expelled into the surroundings through the exhaust gases and the engine cooling structures. More than two thirds of the gasoline electricity consumed through a automobile is discharged to the environment as waste warmth. The promising generation that changed into observed useful for this motive were thermoelectric turbines. The thermoelectric module converts this residual warmness into useful paintings achieved as electrical energy. The device converts waste heat from the exhaust manifold into electric strength the usage of a thermoelectric generator. Experimental results display that the proposed system recovers a large amount of residual warmness that can be used to energy a few auxiliary gadgets of automobiles.

***Keywords*- IC engine, exhaust gas, heat energy recovery, heat transfer, thermoelectric generator, silencer.**

## I. INTRODUCTION

The car enterprise is one of the maximum crucial monetary sectors inside the global. Cars use IC engines, which have a massive amount of electricity lack of as much as 70% within the shape of heat. In recent times, scientists have attempted and refined automobile era substantially, however couldn't manage the lack of the IC motor inside the shape of residual warmth. Out of all available assets, internal combustion engines are the main customers of fossil fuels worldwide. Out of the entire warmth supplied to the engine inside the form of gasoline, about 30 to forty% will become beneficial mechanical work. The last warmth is expelled into the surroundings through the exhaust gases and engine cooling structures, the inner combustion engine (ICE) drives vehicles with only 30% of the total warmth generated through the fuel used. During this manner, the alternative forty% of the heat is misplaced through the escape of waste gases and 30% by way of the refrigerant, so it's miles necessary to apply the residual heat in a beneficial task. This focuses on not controlling the residual warmth in the IC motor, however alternatively focuses on trapping the residual warmth to generate energy via the use of a suitable tool called a thermoelectric generator. The thermoelectric generator is a device that converts thermal power at once into electrical energy, the use of the seebeck effect. The Seebeck effect is the conversion of temperature variations at once into energy. The thermoelectric module has a cold aspect and a warm aspect. By using the modules in reverse, in which a temperature differential is implemented across the faces of the module, it is viable to generate electrical energy. Some of the houses of thermoelectric mills are, environmentally friendly, use residual warmth, scalability, dependable power supply, low noise operation, can be used as chillers / heaters, without moving elements.

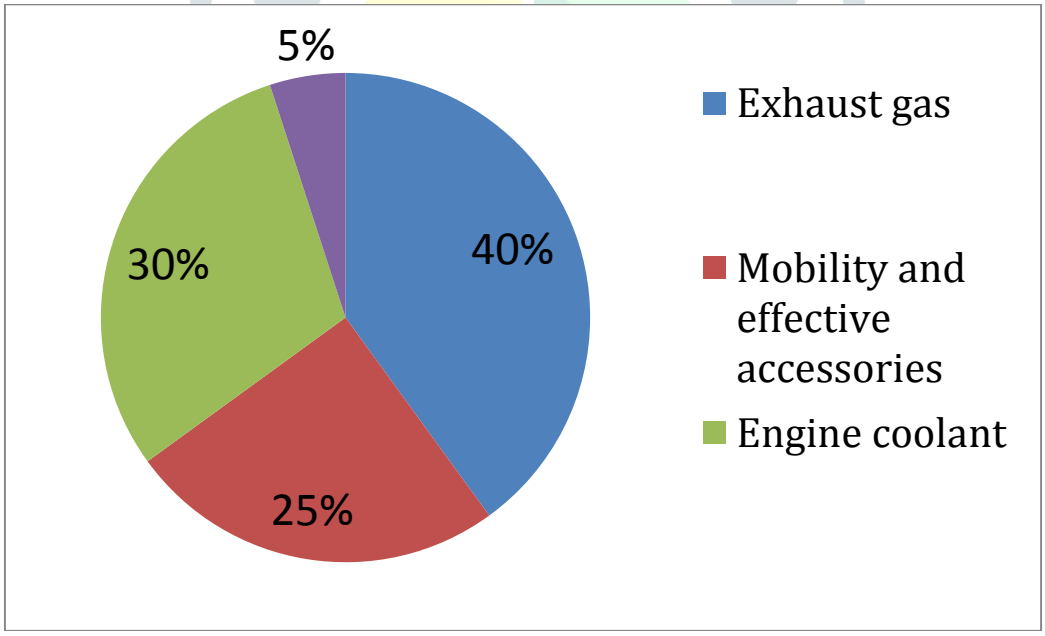


Figure1: Total fuel energy content in I. C. engine

### 1.1 Working Principle of Thermoelectric Generator

The EMF cause through temperature gradient throughout the junctions of distinct conductors, which shape a closed loop, is the seebeck effect shown within the parent.

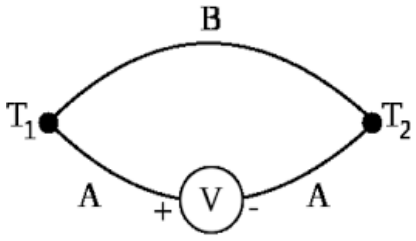


Figure 2: Seebeck effect

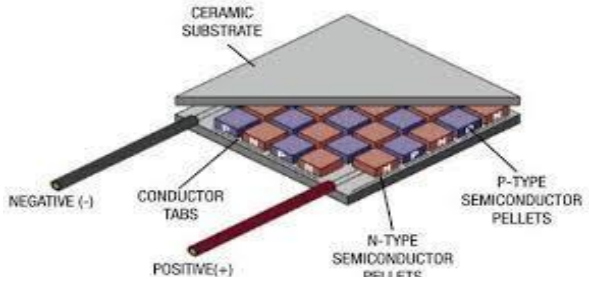


Figure 3: Thermoelectric generator

A single thermoelectric pair is constructed from two "pellets" of semiconductor material generally made from bismuth telluride (Bi2Te3). One of those granules is doped with acceptor impurity to create a granule of kind P; the alternative is impregnated with the impurity of the donor to produce an N-kind pill. The two granules are physically joined on one side, generally with a small strip of copper, and installed among outside ceramic plates that offer electrical and structural insulation inside the thermoelectric generator. For the semiconductor fabric for thermoelectric power technology, joints A and B collectively are shown in Figure 1, if a temperature difference between two facets of the thermoelectric pair (T1 and T2) is maintained, thermal energy will pass thru the device with this warmness and an electrical voltage. , known as Seebeck voltage, might be created. If a resistive load is connected thru the output terminals of the thermoelectric pair, the electric cutting-edge will float inside the load and a voltage (V) might be generated in the load. The sensible thermoelectric modules are constructed with numerous of these thermoelectric pairs electrically related in collection and thermally in parallel.

## II. EXPERIMENTAL STUDY

### 2.1 Line Diagram of Experiment

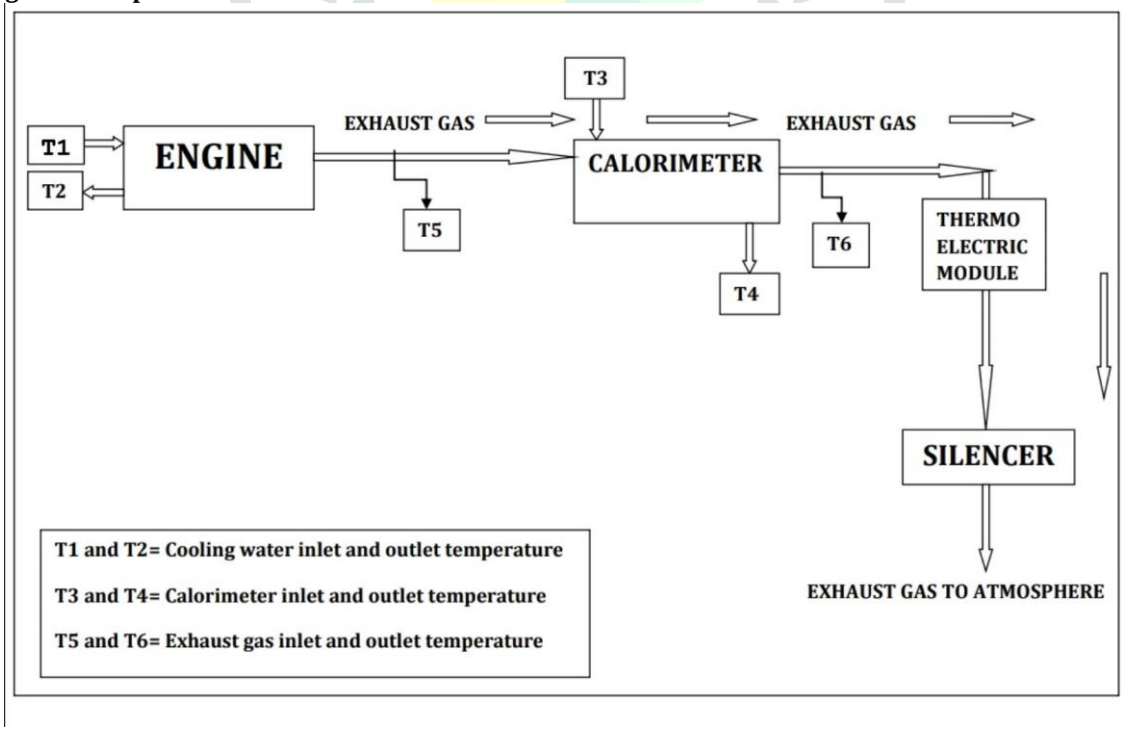


Figure 4: Line diagram of experiment

The experiment consists of a 4-stroke multi-gas engine and a single cylinder that is related to the calorimeter. The calorimeter reduces the temperature of the exhaust gases. In this device, T1 and T2 are cooling water inlet and outlet temperature, T3 and T4 are calorimeter inlet and outlet temperature, T5 and T6 are exhaust gas inlet and outlet temperature. After producing electricity,

the temperature of the exhaust gas is reduced by way of cooling the coil this is installed at the engine. This exhaust gas enters the calorimeter and then the calorimeter also reduces the temperature of the exhaust gases. Then, the exhaust gases outside the calorimeter enter the exhaust manifold and cross into the atmosphere.

**2.2 Equipment and Their Specification**

**2.1.1Single cylinder four stroke multi-fuel engine**

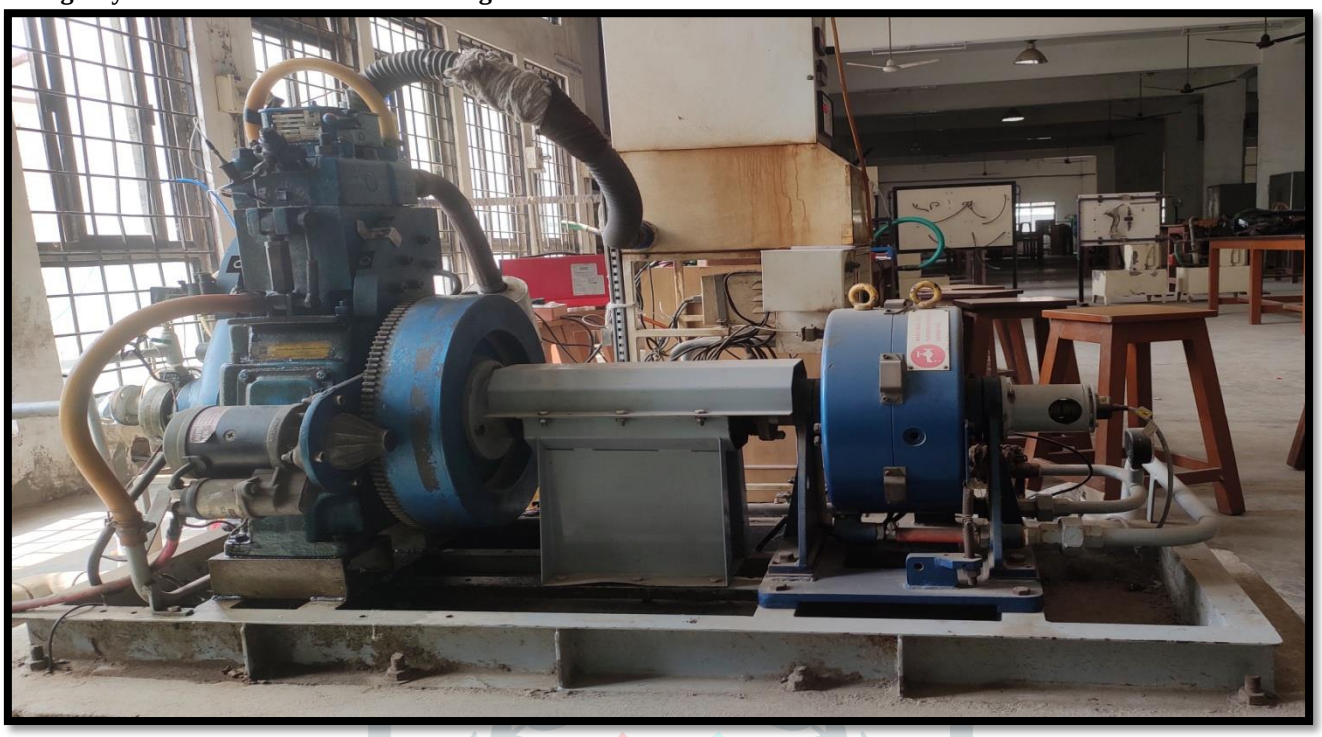

Figure 5:-Test engine setup

Table 1:- Specification of test engine setup

| Particular | Specifications |
|---|---|
| Engine | 1 cylinder, 4 stroke, water cooled engine |
| Bore and stroke | 87.5 mm by 110 mm |
| Rated power | 3.5 KW at 1500 rpm |
| CR range | 12:1 to 18:1 |

| Injection Variation | **0-25 degree BTDC** |
|---|---|
| Dynamometer | Eddy current type, water cooled with load unit |
| Propeller shaft | With universal joints |
| Air box | M S Fabricated with orifice meter and manometer |
| Calorimeter | Pipe in pipe type |
| Temperature sensor | RTD type PT100 and Thermocouple, type K |
| Load sensor | Load cell, type strain gauge, range 0-50 kg |
| Load indicator | Digital, range 0-50 kg, supply 230V AC |
| Fuel tank | 15 liter capacity with fuel metering pipe of glass |
| Rotameter | Engine cooling 40-400 LPH, Calorimeter 25-250 LPH |

### 2.1.2 Thermoelectric Generator


Figure 6:-Thermoelectric generator

Table 2:-Specification of thermoelectric generator

| Model | SP1848-27145 |
|---|---|
| Operating Temperature | -40 to 150°C |
| Principle | Seebeck effect |
| Raw material | Bismuth telluride |
| Size | 40mmx40mmx3.4mm |

**2.1.3 Aluminium heat sink**

The flat-lower back aluminium heat sink is used within the present investigation. We are three aluminium sinks.

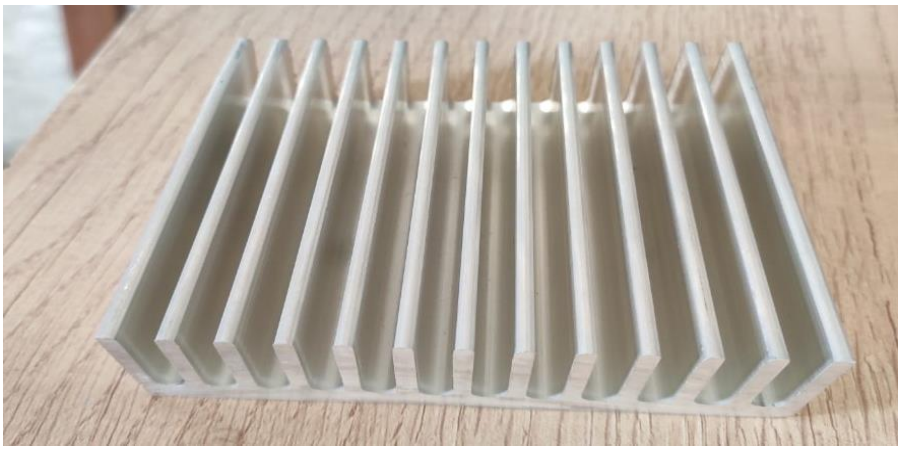

Figure 7:-Aluminum heat sink

Size:- 110mmx100mmx34mm
Fin thickness:- 3mm
Fin spacing:- 5 mm

**2.1.4Copper plate**

It is use for heat source in thermoelectric module.
Size:- 360mmx75mmx6mm

Figure 8:-Copper plate

**2.1.5 Heat Paste**

Use of smooth and proper heat transfer and increases thermal conductivity.


Figure 9:-Heat Paste

### 2.1.6 Glass Wool Insulation

Glass wool reduces the temperature of the cold junction and increases the temperature difference among the bloodless and the new junction. It remains between the bloodless and hot junction.

Figure 10:-Glass Wool Insulation

### 2.1.7 Digital Multimeter

Multimeter is used to measure current and voltage.


Figure 11:-Digital multimeter

Table 3:-Specification of digital multimeter

| Specification | Range |
|---|---|
| DC Voltage | 200mV/2V/20V/200V/600V |
| AC Voltage | 200V/600V |
| DC Current | 200µA/2mA/20mA/200mA/10A |
| Resistance | 200Ω/2KΩ/20KΩ/200KΩ/2MΩ |

### 2.1.8 Infrared Thermometer

Infrared thermometer is non contact type thermometer which is used to measure temperature. It can measure temperature between -18°C to 400°C and accuracy -2 to +2.


Figure 12:- Infrared thermometer

**2.3 Experimental Setup:-**

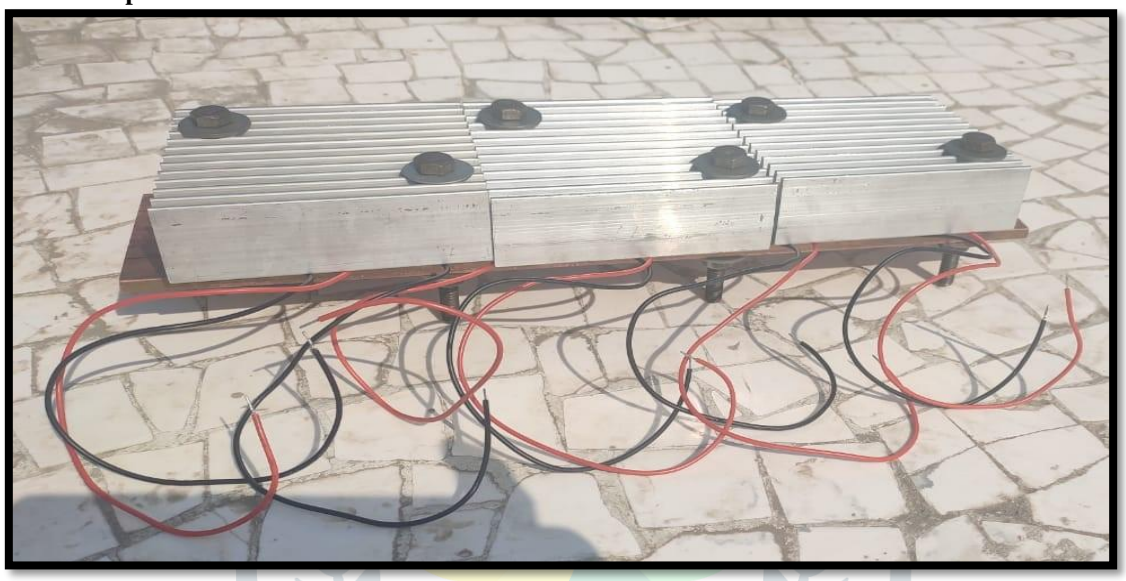

Figure 13:-Thermoelectric module

To the exhaust pipe of the IC engine specific above, a 6 mm thick copper plate is connected to shape the thermoelectric generator junction. Five thermoelectric turbines linked in series, are positioned on the copper plate that acts as a warm junction, on the opposite facet of the bloodless junction of the TEG's, the three aluminium heat sinks are related as shown in the figure 13. Between the hot and cold junction, the TEG's are prepared with nuts and bolts shown within the figure13. The temperature of the hot and cold junction of TEG's is constantly monitored the use of an infrared thermometer. The thermal paste is applied at the joint to make certain right touch between surfaces and warmth conduction.

Our thermoelectric module set on the exhaust pipe after calorimeter outlet exhaust pipe. When the engine starts, the hot junction heats up and the warmth transfer pace increases via the thermoelectric generator, now with the Seebeck effect it starts off evolved to generate voltage. The virtual multimeter is hooked up to continuously monitor the generated voltage. An essential issue that is worth citing is that, if this system is attached to a automobile, while the automobile actions the air flowing over the fins of the aluminum sink it is going to be speedy growing more cooling of the sink, thus maintaining a greater temperature difference in the TEG and More voltage technology.

Figure 14:-Experimental Setup

## III. RESULT AND DISCUSSION

### 3.1 Results

This bankruptcy describes the consequences of the experiments and the dialogue by way of using the graphs derived from the information. The objective of the experiment is, which temperature of the gasoline exhaust gas is the first-rate result to generate voltage. Then, this objective become first executed the test and takes readings for diesel, diesel + pyrolysis and diesel + palm biodiesel mixture and write down the temperature and voltage difference in the experimental setup.

Table 4:- :- Results of Diesel

| Diesel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sr. No. | Load | RPM | Ext. Tem.( | T1(Source)(°C) | T2(Sink)(°C) | T1-T2(°C) | Voltage(V) | Current(I) |
| 1 | 3.23 | 1580 | 152.17 | 103.7 | 30.3 | 73.4 | 2.63 | 0.07 |
| 2 | 4.03 | 1571 | 161.73 | 109.6 | 33.2 | 76.4 | 2.87 | 0.08 |
| 3 | 5.03 | 1565 | 172.37 | 112.3 | 34.7 | 77.6 | 2.92 | 0.09 |
| 4 | 6.03 | 1562 | 183.78 | 116.8 | 37.9 | 78.9 | 3.26 | 0.1 |
| 5 | 7.12 | 1559 | 194.86 | 123.8 | 39.8 | 84 | 3.85 | 0.13 |
| 6 | 8.09 | 1553 | 206.05 | 127.5 | 40.6 | 86.9 | 4.42 | 0.15 |
| 7 | 9.06 | 1552 | 220.01 | 131.4 | 41.7 | 89.7 | 4.92 | 0.17 |
| 8 | 10.29 | 1545 | 232.17 | 136.6 | 42.3 | 94.3 | 5.83 | 0.21 |
| 9 | 11.11 | 1530 | 244.74 | 140.2 | 44.7 | 95.5 | 6.73 | 0.25 |
| 10 | 12.16 | 1519 | 262.66 | 143.4 | 44.8 | 98.6 | 7.67 | 0.29 |

Table 5:-Results of 90%Diesel+10%Pyrolysis Oil

| 90% Diesel+10%Pyrolysis Oil | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sr. No. | Load | RPM | Ext. Tem.(°C) | T1(Source)(°C) | T2(Sink)(°C) | T1-T2(°C) | Voltage(V) | Current(I) |
| 1 | 3.05 | 1595 | 140.05 | 96.8 | 26.8 | 70 | 2.52 | 0.06 |
| 2 | 4.06 | 1590 | 151.2 | 102.6 | 30 | 72.6 | 2.72 | 0.07 |
| 3 | 5.01 | 1580 | 160.5 | 107.7 | 31.7 | 76 | 2.79 | 0.08 |
| 4 | 5.98 | 1570 | 170.89 | 109.8 | 33.6 | 76.2 | 2.87 | 0.08 |
| 5 | 7.08 | 1555 | 182.51 | 115.6 | 36.7 | 78.9 | 3.26 | 0.1 |
| 6 | 8.07 | 1533 | 192.5 | 123.8 | 39.9 | 83.9 | 3.47 | 0.12 |
| 7 | 9.01 | 1525 | 199.45 | 124.8 | 40.2 | 84.6 | 3.85 | 0.13 |
| 8 | 10.09 | 1521 | 210.35 | 128.2 | 40.8 | 87.4 | 4.42 | 0.15 |
| 9 | 11.02 | 1518 | 222.65 | 131.7 | 41.6 | 90.1 | 4.99 | 0.18 |
| 10 | 12.06 | 1516 | 231.63 | 137.4 | 42.8 | 94.6 | 5.85 | 0.22 |

Table 6:-Results of 80%Diesel+20%Pyrolysis Oil

| 80%Diesel+20%Pyrolysis Oil | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sr. No. | Load | RPM | Ext. Tem.(°C) | T1(Source)(°C) | T2(Sink)(°C) | T1-T2(°C) | Voltage(V) | Current(I) |
| 1 | 3.11 | 1596 | 138.84 | 95.7 | 27.2 | 68.5 | 2.41 | 0.06 |
| 2 | 4.12 | 1590 | 151.5 | 102.7 | 29.9 | 72.8 | 2.77 | 0.08 |
| 3 | 5.09 | 1582 | 165.4 | 110.5 | 34.2 | 76.3 | 2.89 | 0.09 |
| 4 | 6.06 | 1576 | 180.8 | 114.6 | 35.5 | 79.1 | 3.36 | 0.12 |
| 5 | 7.08 | 1568 | 189.8 | 120.4 | 36.7 | 83.7 | 3.44 | 0.12 |
| 6 | 8.09 | 1558 | 197.2 | 124.4 | 37.9 | 86.5 | 4.38 | 0.14 |
| 7 | 9.03 | 1544 | 211.54 | 128.2 | 40.6 | 87.6 | 4.45 | 0.16 |
| 8 | 10.09 | 1531 | 220.7 | 134.6 | 42.7 | 91.9 | 5.2 | 0.18 |
| 9 | 11.08 | 1527 | 232.7 | 138.7 | 43.2 | 95.5 | 6.72 | 0.22 |
| 10 | 12.08 | 1519 | 242.68 | 140.5 | 44.6 | 95.9 | 6.79 | 0.25 |

Table 7:-Results of 70%Diesel+30%Pyrolysis Oil

| 70%Diesel+30%Pyrolysis Oil | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sr. No. | Load | RPM | Ext.Tem.(°C) | T1(Source)(°C) | T2(Sink)(°C) | T1-T2(°C) | Voltage(V) | Current(I) |
| 1 | 3.05 | 1601 | 154.17 | 99.8 | 27.3 | 72.5 | 2.76 | 0.07 |
| 2 | 4.07 | 1596 | 162.56 | 110.2 | 33.6 | 76.6 | 2.88 | 0.08 |
| 3 | 5.02 | 1589 | 171.73 | 111.9 | 34.5 | 77.4 | 2.9 | 0.09 |
| 4 | 6.12 | 1580 | 179.38 | 113.8 | 35.2 | 78.6 | 3.27 | 0.1 |
| 5 | 7.03 | 1571 | 183.43 | 116.4 | 37.6 | 78.8 | 3.29 | 0.11 |
| 6 | 8.07 | 1567 | 194.55 | 123.7 | 38.7 | 85 | 3.9 | 0.13 |
| 7 | 9.09 | 1562 | 210.63 | 126.6 | 39.9 | 86.7 | 4.39 | 0.14 |
| 8 | 10.02 | 1556 | 220.76 | 137.2 | 42.8 | 94.4 | 5.84 | 0.21 |
| 9 | 11.04 | 1547 | 232.98 | 138.9 | 43.5 | 95.4 | 6.72 | 0.25 |
| 10 | 12.05 | 1541 | 245.07 | 140.2 | 44.2 | 96 | 7 | 0.27 |

Table 8:- Results of 60%Diesel+40%Pyrolysis Oil

| 60%Diesel+40%Pyrolysis Oil | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sr. No. | Load | RPM | Ext.Tem.(°C) | T1(Source)(°C) | T2(Sink)(°C) | T1-T2(°C) | Voltage(V) | Current(I) |
| 1 | 3.05 | 1598 | 147.21 | 98.4 | 27.2 | 71.2 | 2.62 | 0.07 |
| 2 | 4.02 | 1596 | 152.65 | 103.1 | 30.2 | 72.9 | 2.57 | 0.07 |
| 3 | 5.06 | 1593 | 163.76 | 109.6 | 33.5 | 76.1 | 2.86 | 0.08 |
| 4 | 5.96 | 1590 | 175.27 | 112.4 | 34.9 | 77.5 | 2.92 | 0.09 |
| 5 | 7.05 | 1587 | 182.95 | 115.8 | 36.9 | 78.9 | 3.3 | 0.11 |
| 6 | 8.04 | 1585 | 193.6 | 120.8 | 37.2 | 83.6 | 3.8 | 0.13 |
| 7 | 8.95 | 1583 | 204.07 | 124.8 | 37.8 | 87 | 4.44 | 0.16 |
| 8 | 10.04 | 1570 | 217.96 | 128.4 | 39.5 | 88.9 | 4.92 | 0.17 |
| 9 | 11.07 | 1555 | 226.74 | 134.7 | 41.8 | 92.9 | 5.86 | 0.22 |
| 10 | 12 | 1541 | 236.91 | 139.1 | 43.6 | 95.5 | 6.72 | 0.26 |

Table 9:-Results of 90%Diesel+10%palm Bio Diesel With Magnetic Effect

| 90%Diesel+10%Palm Biodiesel with magnetic effect | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sr. No. | Load | RPM | Ext. Tem.(°C) | T1(Source)(°C) | T2(Sink)(°C) | T1-T2(°C) | Voltage(V) | Current(I) |
| 1 | 4.15 | 1534 | 164.86 | 110.9 | 33.6 | 77.3 | 2.89 | 0.09 |
| 2 | | | | 111.4 | 33.9 | 77.5 | 2.91 | 0.09 |
| 3 | 6.13 | 1510 | 178.31 | 114.3 | 35.3 | 79 | 3.27 | 0.1 |
| 4 | | | | 114.8 | 35.7 | 79.1 | 3.29 | 0.1 |
| 5 | 7.83 | 1495 | 194.95 | 123.4 | 39.2 | 84.2 | 3.84 | 0.13 |
| 6 | | | | 123.7 | 39.8 | 83.9 | 3.82 | 0.13 |
| 7 | 9.74 | 1481 | 215.77 | 128.9 | 40.8 | 88.1 | 4.86 | 0.16 |
| 8 | | | | 129.5 | 41.1 | 88.4 | 4.88 | 0.16 |
| 9 | 11.97 | 1475 | 239.78 | 138.2 | 43.3 | 94.9 | 5.89 | 0.22 |
| 10 | | | | 138.6 | 43.7 | 94.9 | 5.92 | 0.22 |

Table 10:-Results of 80%Diesel+20%palm Bio Diesel With Magnetic Effect

| 80%Diesel+20%Palm Biodiesel with magnetic effect | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sr. No. | Load | RPM | Ext. Tem.(℃) | T1(Source)(℃) | T2(Sink)(℃) | T1-T2(℃) | Voltage(V) | Current(I) |
| 1 | 4.07 | 1527 | 159.72 | 108.2 | 32.3 | 75.9 | 2.82 | 0.08 |
| 2 | | | | 108.7 | 32.6 | 76.1 | 2.84 | 0.08 |
| 3 | 6.08 | 1524 | 172.78 | 112.3 | 33.9 | 78.4 | 3.24 | 0.1 |
| 4 | | | | 112.6 | 34.3 | 78.3 | 3.23 | 0.1 |
| 5 | 7.97 | 1504 | 190.29 | 121.4 | 37.5 | 83.9 | 3.84 | 0.13 |
| 6 | | | | 121.9 | 37.9 | 84 | 3.86 | 0.13 |
| 7 | 9.84 | 1492 | 214.26 | 128.2 | 40.2 | 88 | 4.49 | 0.16 |
| 8 | | | | 128.5 | 40.5 | 88 | 4.49 | 0.16 |
| 9 | 12.07 | 1474 | 238.32 | 137.2 | 42.6 | 94.6 | 5.85 | 0.21 |
| 10 | | | | 137.6 | 42.9 | 94.7 | 5.86 | 0.21 |

Table 11:-Results of 70%Diesel+30%palm Bio Diesel with Magnetic Effect

| 70%Diesel+30%Palm Biodiesel with magnetic effect | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sr. No. | Load | RPM | Ext.Tem.(℃) | T1(Source)(℃) | T2(Sink)(℃) | (T1-T2)(℃) | Voltage(V) | Current(I) |
| 1 | 3.98 | 1535 | 151.66 | 103.2 | 30.3 | 72.9 | 2.57 | 0.07 |
| 2 | | | | 103.6 | 30.6 | 73 | 2.6 | 0.07 |
| 3 | 5.86 | 1521 | 169.01 | 110.9 | 34.2 | 76.7 | 2.89 | 0.08 |
| 4 | | | | 111.4 | 34.7 | 76.7 | 2.89 | 0.08 |
| 5 | 7.79 | 1497 | 186.58 | 118.3 | 38.4 | 79.9 | 3.3 | 0.11 |
| 6 | | | | 118.7 | 38.9 | 79.8 | 3.28 | 0.11 |
| 7 | 9.83 | 1486 | 212.06 | 127.2 | 40.2 | 87 | 4.44 | 0.15 |
| 8 | | | | 127.6 | 40.6 | 87 | 4.44 | 0.15 |
| 9 | 11.84 | 1473 | 241.72 | 139.3 | 43.3 | 96 | 6.77 | 0.25 |
| 10 | | | | 139.7 | 43.8 | 95.9 | 6.75 | 0.25 |

**3.2 Discussion**

**3.2.1Voltage (V) VS Temperature Difference (T1-T2)(℃)**

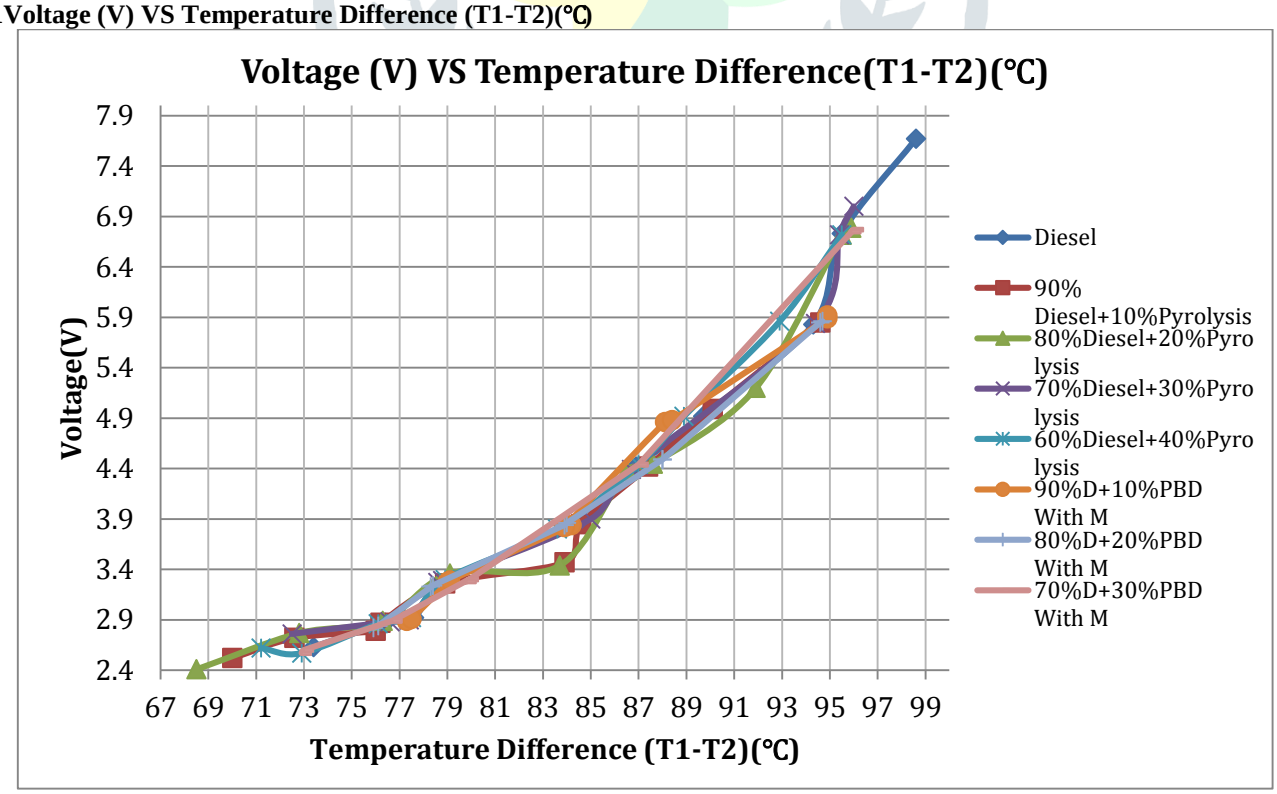


Figure 15:-Voltage (V) VS Temperature Difference (T1-T2)(℃)

The figure15 shows the difference between the temperature distinction ℃ and the voltage (V). From the Figure15 we are able to see that in diesel due to the more temperature distinction, we reap a most voltage of up to 8V. In the aggregate of pyrolysis and

diesel, we gain a higher voltage than that of the combination of palm and diesel biodiesel because within the mixture of palm and diesel biodiesel we use a magnetic area in the fuel deliver valve.

### 3.2.2 Load VS Exhaust Gas Temperature (℃)

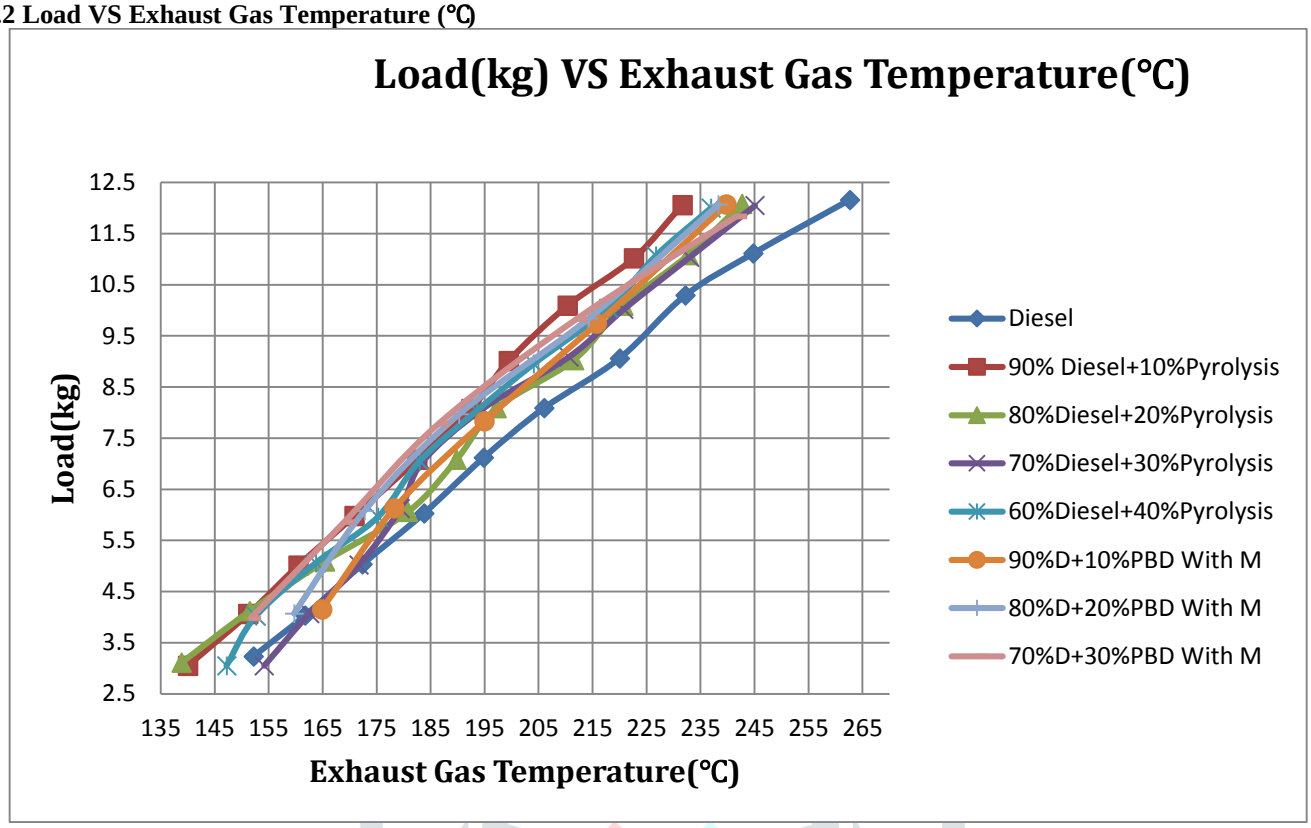


Figure 16:-Load VS Exhaust Gas Temperature

The figure16 shows the distinction among the weight (kg) and the temperature of the exhaust fuel (℃). In the Figure16 we can see that during diesel we obtain the most temperature of the exhaust gases than that of the combination of pyrolysis and diesel and the aggregate of biodiesel and palm diesel because of the most load of up to 12 kg. Also the break out of the combination of pyrolysis and diesel offers us a decrease lower temperature in comparison to diesel. Then we can also use this aggregate within the experiment.

### 3.2.3Performance of thermoelectric generators

The performance of the thermoelectric material can be expressed as,

$$Z=\alpha 2/kR$$

Z = Performance of thermoelectric material

α= see beck coefficient(v/K)

$$\alpha = -\{\Delta V/\Delta T\}$$

Where, ΔV is change in voltage. ΔT is change in temperature.

R is the electric resistivity and k is the thermal conductivity is of bismuth tellurium 1.20W/mK and The thermal electrical resistivity of bismuth tellurium is = 1.29μΩm

Table 12:-Performance of thermoelectric generators

| fuel | Z=α2/kR |
|---|---|
| Diesel | $1.28\times10^{-3}$ |
| 90%Diesel+10%Pyrolysis Oil | $0.585\times10^{-3}$ |
| 80%Diesel+20%Pyrolysis Oil | $0.967\times10^{-3}$ |
| 70%Diesel+30%Pyrolysis Oil | $0.911\times10^{-3}$ |
| 60%Diesel+40%Pyrolysis Oil | $0.867\times10^{-3}$ |
| 90%Diesel+10%palm Bio Diesel With Magnetic Effect | $0.537\times10^{-3}$ |
| 80%Diesel+20%palm Bio Diesel With Magnetic Effect | $0.538\times10^{-3}$ |
| 70%Diesel+30%palm Bio Diesel With Magnetic Effect | $0.943\times10^{-3}$ |

By this experiment we can say that Diesel gives best performance than that of other fuels. And we can also say that the Pyrolysis oil gives better performance so we can also use this oil in some experiments.

## IV. CONCLUSION

In order to broaden a new form of energy generation, we've got studied the thermoelectric module. It is done with a designed shape and a great voltage is received. The thermoelectric module may be used to generate a small amount of electrical energy, usually within the variety, if a temperature distinction between terminals of a thermoelectric module is maintained. The maximum voltage generated befell at a most temperature difference. Through the use of glass wool insulation we will reap the most temperature difference among warm and bloodless joints due to the fact glass wool reduces warmth switch among joints. Through this experiment, we are able to finish that we acquire the maximum exhaust temperature and the temperature difference in diesel with the identical most load of 12 kg as that of pyrolysis oil and the aggregate of palm biodiesel with diesel. In this test, we attain a most voltage of up to 8 V with a temperature distinction of 99 ℃in diesel and a aggregate of pyrolysis. If the car is strolling we get the maximum temperature distinction due to the fact the aluminium warmth sink is cooled by the air go with the flow after which the voltage output will increase. We get the most diesel voltage, so we will run a DC motor. We get less practical voltage (V) and current (I) compared to theoretical voltage (V) and current (I) due to the lesser effect of heat loss and power loss.

## REFERENCES

(1) M G Jadhav J S Sidh u, "Design and Fabrication of Silencer Waste Heat Power Generation System Using Thermo-Electric Generator ", International Journal of Advanced Mechanical Engineering. ISSN 2250-3234 Volume 7, Number 1 (2017), pp. 1-14

(2) B. Orr a, A. Akbarzadeh,M. Mochizuki,R. Singh," A review of car waste heat recovery systems utilising thermoelectric generators and heat pipes", (IJEIT) Volume 2, Issue 12, June 2013

(3) Y.Y Hsiao, W.C. Chang, S.L. Chen, "A mathematical model of thermoelectric module with application on waste heat recovery from automobile engine", Energy 35 (2010) 1447–1454

(4) K. Zeb, S.M. Ali, B. Khan, C.A.Mehmood, N. Tareen, W. Din, U. Farid, A. Haidera "A survey on waste heat recovery: Electric power generation and potential prospects within Pakistan", Renewable and Sustainable Energy Reviews (2016), http://dx.doi.org/10.1016/j.rser.2016.11.096

(5) Hsiao-kang Ma,Ching-Po Lin, How-Ping Wu, Chun-hao Peng, Chai-Cheng Hsu," Waste heat recovery using a thermoelectric power generation system in a biomass gasifier",Applied Thermal Engineering (2014), http://dx.doi.org/10.1016/j.applthermaleng.2014.09.070

(6) M.A. Karri, E.F. Thacher, B.T. Helenbrook, "Exhaust energy conversion by thermoelectric generator: Two case studies", Energy Conversion and Management 52 (2011) 1596–1611

(7) Mohiuddin A K M, Muhammad Yazid Ameer, Ataur Rahman, Ahsan Ali Khan, "Investigation of aluminum heat sink design with thermoelectric generator", IOP Conference Series: Materials Science and Engineering 2017

(8) P. Mohamed Shameer, D. Christopher, "Design of Exhaust Heat Recovery Power Generation System Using Thermo-Electric Generator ", International Journal of Science and Research (IJSR) · February 2013

(9) Alvin P Koshy, Bijoy K Jose, Jeffin Easo Johnson ,K Navaneeth Krishnan ,Bijeesh P, "Exhaust Gas Waste Heat Recovery and Utilization System in IC Engine", IJIRST –|Volume 1 | Issue 11 | April 2015

(10) J. S. Jadhao ,D. G. Thombare, " Review on Exhaust Gas Heat Recovery for I.C. Engine", Iternational Journal of Engineering and Innovative Technology ,Volume 2, Issue 12, June 2013

(11) M.V.Harsha Vardhan, Prashanth.K.P, Venkatesha B K, "Conversion of waste heat energy from internal combustion engine using thermoelectric generator ", International Journal Of Core Engineering & Management , Volume 3, Issue 4, July 2016

(12) Z.B. TANG,Y.D. DENG, C.Q. SU, W.W.SHUAI, C.J. XIE, "A Research on Thermoelectric Generator's Electrical Performance under Temperature Mismatch Conditions for Automotive Waste Heat Recovery System ", Case Studies in Thermal Engineering 5 (2015) 143–150144

(13) X. Liu, Y.D. Deng, Z. Li, C.Q. Su, "Performance analysis of a waste heat recovery thermoelectric generation system automotive application" Energy Conversion and Management 90 (2015) 121–127

(14) Eid S. Mohamed, "Development and Performance analysis of a TEG system using exhaust recovery for a light diesel vehicle with assessment of fuel economy and emissions", Applied Thermal Engineering (2018), doi: https://doi.org/10.1016/j.applthermaleng.2018.10.100

(15) Alexander S. Rattner, Tyler J. Meehan," Simple analytic model for optimally sizing thermoelectric generator module arrays for waste heat recovery", Applied Thermal Engineering (2018), doi:https://doi.org/10.1016/ j.applthermaleng.2018.10.00

(16) Ding Luo, Ruochen Wang, Wei Yu, Zeyu Sun, Xiangpeng Meng," Theoretical analysis of energy recovery potential for different types of conventional vehicles with a thermoelectric generator", Energy Procedia 158 (2019) 142–147