REDUCTION OF FUEL CONSUMPTION USING SEEBACK EFFECT IN IC ENGINE EXHAUST

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Abstract

As current internal combustion engine has the ability to convert 25% of heat into mechanical work under normal driving condition. Nearly 55 to 80% of the heat is carried away by the coolant and the exhaust. Where the electrical energy needed in the vehicle alternator is also consuming the particular amount of fuel indirectly. So, by using seeback effect the exhaust heat is converted into electricity which will reduce the load on the alternator where fuel consumption is reduced. But as the overall conversion efficiency of thermoelectric generator by using seeback effect is only 5%.It can be improved by optimizing the parameter such as temperature difference of hot exhaust and water inlet junctions, Load on the engine, Speed of the engine, Thermoelectric material.

Since the material is fixed as J type material (chromel- constantan) due to its low cost it can't be changed. Where by optimizing the best parameter for single module thermocouple. The total emf on series connection is increased considerable amount. Thus in this paper, the best operating parameters for single J type thermocouple are analyzed and the maximum emf generated in using seeback effect is identified and the total fuel consumption saved by seeback effect in diesel engine is calculated.

Index Terms - Seeback effect, thermoelectric generator, Electromotive force (emf), Thermocouple and Optimization

1. INTRODUCTION

Since, there are many types heat recovery methods for producing electricity in engine exhaust they are all used for different purpose lie irrigation purpose, energy storage which broadly classified into direct and indirect methods. One of the Direct methods is thermoelectric generation is chosen since it is passive, solid state and cheap one compared to other methods. In which the electrical energy required for producing 1 watt is measured for the J type thermocouple by using the seeback effect in the engine exhaust by optimizing the parameters load on the engine, speed of the engine among which the max.emf is calculated at the two distance from the exhaust in which the required no. series connection of the thermocouple must be connected for the required output of 770 watt which is the average load on the alternator.

2. PROPOSING MODEL

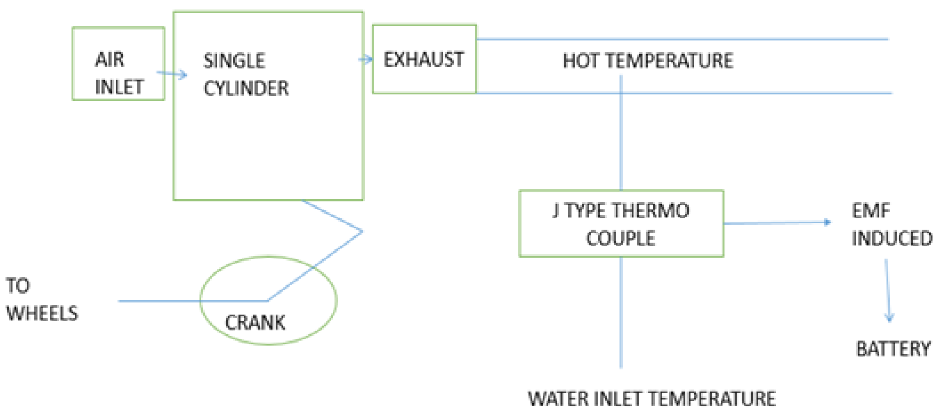

Fig.1. Proposing Diesel Exhaust System

Where in the current model,

The crank shaft is connected to the regulator and to the alternator which is coupled to the generator to produce emf for usage in system

Where in the proposing model. Fig.1,

- The crank is connected directly to the crank power which is not connected to the regulator or the alternator
- Instead by using seeback effect, the hot temperature junction is placed on the hot exhaust and the cold or low temperature junction is placed on the cooling water inlet
- Due to temperature difference between 2 dissimilar metal, the emf will be induced due to seeback effect
- On which, the induced emf will be used to store electrical energy in battery.
- Which can be used as a substitute for the electrical energy taken from the crank power
- So, by using seeback effect in engine exhaust, instead of producing electrical energy from the crank shaft by using fuel. The electrical energy produced by seeback effect i.e., thermo electric generator will save the fuel which deals in producing emf in alternator
- So, by reducing the load on the alternator the fuel in consequently reduced.

3. PURPOSE OF SELECTING THERMOCOUPLE

As the exhaust temperature of the engine varies less than 750^0c the J type thermo couple is selected in which less cost is also added as an advantage to the system. Also its max.emf of the system is very less compared to the other thermocouple due to low temperature limits. The emf will be higher if the thermocouple was replaced by other types.

In which, the less efficiency by J type thermo couple is identified. So, that the emf by generated by other thermocouple at the same no. of thermocouple will be considered higher.

4. EXPERIMENTAL SETUP

Fig. 2. Experimental 4 Stroke TEXVEL Diesel Engine

The image of the experimental engine is shown in Fig.2.The specification of the engine is,

Name of the engine : TEXVEL
No. of cylinder : 1
Type of fuel : HSD (high speed diesel)
Power : 6.5 HP
Speed : 1500 rpm
Bore diameter : 85 mm
Stroke length : 110 mm
Type of loading : rope brake dynamometer

5. Operating parameters

Table 1. Operating parameters to be optimized at the two distance 7cm and 26cm

Parameters	Junction of parameters
Speed of the engine	• 1100 rpm • 1300 rpm • 1500 rpm
Load of the engine	• Empty load • 3 kg • 6 kg • 9 kg • 12kg

Where, the experiment is carried out at the 2 junction for the 3 operating speed of 1100, 1300 and 1500rpm for 5 loads 0,3,6,9 and 12 kg.

6. Experimental results on parameters

6.1. Conclusion from the distance of 26 cm from the hot junction

The emf induced by varying the distance is plotted with the load as,

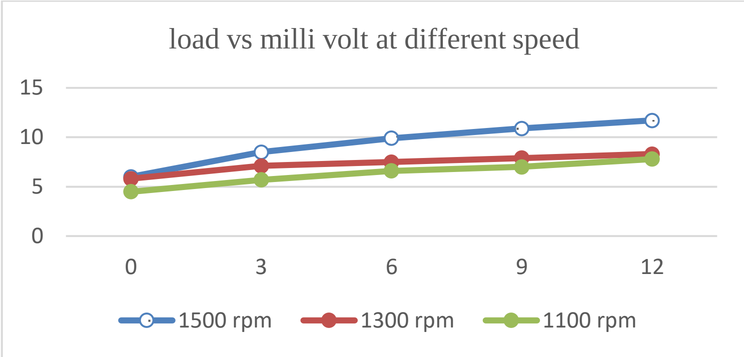

Fig.3. load Vs millivolt at different speed at 26 cm distance from the exhaust

From the experiment at the distance 26 cm shows that,
The maximum emf is induced at

- 1500 rpm i.e., the maximum speed and
- At the load of 12kg i.e., the maximum of load.

6.2. Conclusion from the distance of 7cm from the hot junction

The emf induced by varying the distance is plotted with the load as,

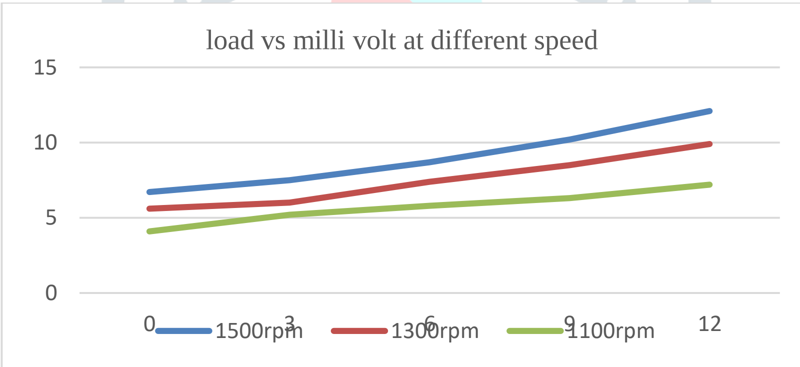

Fig 4. Load Vs millvolt at different speed at 7 cm distance from the exhaust

From the experiment at the distance 7 cm shows that,
The maximum emf is induced at

- 1500 rpm i.e., the maximum speed and
- At the load of 12kg i.e., the maximum of load.
-

7. Emf at the optimized parameters

At the optimized parameters i.e., at the speed of 1500rpm and 12kg load the emf induced in the single type thermocouple is 12.1mW/A. In series connection of 2 thermocouple, at the optimized parameters the volt induced is

Fig.5. Voltmeter in series connection of 2 thermocouple

On series connection,

2 J type thermocouple is connected which shows the increased emf of 36 millivolt.

8. Result

The power of the exhaust, $Q_{exhaust} = m \times c_p \times (t_{hot} - t_{cold})$

$= 1 \times 1.005 \times (230 - 26) \times 3600$ / (Time for cooling water (110 sec))

= 13419.49 KJ/Hr = 3.7 KW

The fuel consumption for the load on the alternator as,

At the load of 12kg at 1500 rpm is

Brake power, $BP = 2 \times \pi \times N \times T/60$

$= (2 \times 3.14 \times 1500 \times 12 \times 9.81 \times .0925)/ 60 = 1.710$ KW

Total fuel consumption, $TFC = (V_{cc} \times 3600 \times s.g \text{ of oil})/ (t \times 1000)$

$= (10 \times 3600 \times 0.833)/ (55 \times 1000) = 0.545$ kg\hr

Which means 0.545 kg of fuel is consumed per hour at the 1500 speed at the 12kg load.

Specific fuel consumption, SFC = TFC/BP

= 0.545/1.71 = 0.32 kg/kWhr

The average load on the alternator of a car takes 770 watts. Which the fuel consumed on producing the 770 watt is

SFC = 0.32/1000 kg/Whr.

= 0.00032 kg/w hr.

$= 0.00032 \times 770$ kg/hr. = 0.2464 kg/hr.

Where,

q	heat (w)
C_P	constant specific heat(kJ/kg k)
T	time (sec)
T_{hot}	exhaust temperature (k)
T_{cold}	room temperature (k)
rpm, N	revolution per minute
m	mass of air in exhaust
kg	kilogram
emf	electro motive force
HP	horse power
cm	centimeter
mm	millimeter
^{o}c	degree centigrade
ml	milliliter
v_{cc}	volume of ml
s.g	specific gravity
bp	brake power
tfc	total fuel consumption
sfc	specific fuel consumption

9. Conclusion

From the optimized parameters J type thermocouple induces,
1 thermocouple= 12.1 milli volt = 12.1 mW/A
2 thermocouple = 36 milli volt = 36 mW/A

On extrapolating. We need 50 thermocouple for producing 1W/A. similarly for producing 770 Watt 38500 single J type thermocouple are to be connected in series which can save 0.2464kg/hr of fuel on saving 770 W. Since, the experimental results show that the use of thermo electric generators proves to be best method in reducing fuel consumption.

By increasing the thermo couple category from J TO K, E and S. the temperature limit is raised on which the conversion efficiency can be reached with minimum no. of thermocouple. Where with minimum number of thermocouple in K, E and S the required power can be produced which reduces the fuel consumption.

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