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Performance Analysis of an Engine by Fabricating an Air Pre Heater for Petrol and Diesel Engine

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ABSTRACT

For a petrol engine Air-fuel mixture is supplied into the combustion chamber during the suction stroke and during the compression stroke the mixture getting compressed. At the end of the compression stroke a spark is supplied so that the combustion takes place. Similarly In a diesel engine only air is introduced and at the end of compression stroke we inject the fuel so that combustion takes place inside the cylinder. As the temperature of air at the inlet to engine is low there is no complete combustion of the fuels. To ensure the complete combustion of the fuel the temperature of the air at the inlet should be improved and this can be done by means of an air-preheater at the inlet of the air flow to the engine. So that we can increase the efficiency of the engine and we can avoid the cold starting problem. After the fuel is burned, the combustion products are discharged at atmospheric pressure and high temperature. We can use heat of the exhaust gas or an electronic heater to increase the temperature of the air at the inlet to the engine. Or we can use a electric heater to increase the temperature of the air at the inlet to the engine.

Keywords: *Petrol Engine, Diesel Engine, Air pre-heater, Efficiency*

1.0 INTRODUCTION

Engine efficiency depends on a number of parameters like heat losses during cooling of engine, exhaust gases, friction loss etc. so for achieving better efficiency the intake air temperature plays a very important role. So Air-preheaters are widely used in diesel and petrol engine applications for quick, reliable, and environmentally friendly starts. Air-preheaters are installed in the intake manifold to pre-heat the combustion air to the required temperature for ignition of fuel. Air-preheaters can work by using the temperature of the exhaust gas or by using an electronic heater powered by the vehicle battery. So this arrangement provides a good cold weather starting capability. The type of preheater used for engine preheating depends upon cost-effectiveness and goodness for the environment. The effect of preheated air on a standard engine results emission control. NOx and CO emissions can be reduced. Higher inlet air temperature causes lower ignition delay, which is responsible for lower NOx formation. Uniform or better combustion is occurred due to pre-heating of inlet air, which also causes lower engine noise. Easy vaporization and better mixing of air and fuel occur due to warm up of inlet air, which causes lower CO emission.

2.0 FABRICATION OF AIR PRE-HEATER

The fabrication of the air preheater is as shown in the figure given below. The air preheater consists of the preheater box, heating coil, hanging of heater coil arrangement, filters, inlet pipe, outlet pipe and the insulator

Figure: 1 air pre-heater with switch

3.0 COMPONENTS USED FOR PERFORMANCE ANALYSIS

1. Twin cylinder diesel engine
2. Single cylinder petrol engine
3. Air-Preheater
4. Piping arrangement
5. Brake dynamo meter
6. Electrical dynamometer
7.

4.0 INSTRUMENTATION USED FOR PERFORMANCE ANALYSIS

1. Thermocouples
2. Temperature controller
3. Emission checking instrument
4. Tachometer
5. Stopwatch

5.0 ENGINE SPECIFICATION

5.1 Petrol Engine Specification

Engine type	: Spark Ignition
Engine Make	: Greaves
Engine Speed	: 3200 RPM
BHP	: 2.5 kW

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Lubrication Oil	: SAE-20W40
S.F.C	: 475g/kWh
Bore Diameter	: 70 mm
Stroke	: 66.7 mm
Orifice Diameter	: 20 mm
Method Of Starting	: Manually Started
Method Of Cooling	: Air Cooled
Compression Ratio	: 4.67:1
Supplier Name	: Mechanical Lab

Figure: 2 Petrol Engine With Air Pre-Heater

5.2 Diesel Engine Specification

Engine Type	: Compression Ignition Type
Engine Make	: Texvel
Engine Speed	: 1500 RPM
BHP	: 10
Bore Diameter	: 80 mm
Stroke	: 110 mm
Orifice Diameter	: 25 mm
Method of Loading	: Electrical Dynamometer
Method of Starting	: Manually Started
Method of Cooling	: Water Cooled

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Figure: 3 Diesel Engine with air pre-heater

6.0 EXPERIMENTAL PROCEDURE

- Connect the air preheater with the engine setup for both diesel and petrol engine.
- Then run the engine without switching on the electrical heater by fixing some parameters. Engine was run and data was collected without switching on the heater.
- After that do the same by making the switch on and recorded the data.
- By varying the heater temperature different data were collected
- In each load, the heat input was calculated based on the fuel consumption.
- Using these data, brake thermal efficiency was calculated.

7.0 OBSERVATION TABLE

In our performance test the temperature of air at the inlet is 150ºC

7.1 For Diesel Engine: (RPM=1500)

Sl No	Load (Watt)	Time For 5 Rev Of Energy Meter(Sec)	Time For Cc Fuel Consumption (Sec)	Fuel Consumption In (Kg/Hr)	Brake Power (KW)	Brake Thermal Efficiency (%)
Without air pre-heater						
1	1000	35	25.4	1.21	2.28	16
With air pre-heater						
2	1000	33.12	27.12	1.14	2.42	18.26

Table: 1 diesel engine observation table

7.2 For Petrol Engine: *(RPM=3200)*

Sl No	Load (Kgf)	Time For Cc Fuel Consumption(Sec)	Specific Fuel Consumption (Kg/KW.Hr)	Brake Thermal Efficiency (%)
Without air pre-heater				
1	5.0	11.3	0.70	11.31
With air pre-heater				
2	5.0	12.43	0.644	12.46

Table: 1 Petrol engine observation table

8.0 CALCULATION

8.1 For Petrol Engine:

Brake power = $\frac{2*\pi*RPM*load*length*9.81}{60000}$

Mass of fuel consumed = $\frac{cc\ of\ vfuel\ consumed*specific\ gravity*3600}{time\ for\ fuel\ consumption*1000}$

Specific fuel consumption = $\frac{mass\ of\ fuel}{brake\ power}$

brake thermal efficiency = $\frac{brake\ power*3600*100}{mass\ of\ fuel\ consumed*calorific\ value}$

Without Air Pre-heater

B.P=3.28kw

Fuel Consumption = 2.32kg/hr

SFC =0.70 kg/kwh

Efficiency = $\frac{BP}{IP}$ = 11.31%

With Air Pre-heater

BP= 3.28 kW

Fuel Consumption=2.11 kg/hr

SFC = 0.644Kg/kWh

Efficiency= $\frac{BP}{FP}$ =12.46%

8.2 For Diesel Engine:

- Electrical energy generated = $\frac{no.of\ revolution*3600}{time\ for\ no.of\ revolution*energy\ meter\ constant}$
- Brake power = $\frac{electrical\ eenergy\ generated}{alternator\ efficiency}$
- Fuel consumption in kg/Hr = $\frac{cc\ of\ vfuel\ consumed*specific\ gravity*3600}{time\ for\ fuel\ consumption*1000}$
- Fuel power = mass of fuel consumed * calorific value

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- Efficiency = $\frac{\text{brake power}}{\text{fuel power}}$

Without Air Preheater	With Air Preheater
Electrical energy = 1.71 kW	Electrical energy = 1.81 kW
B.P=2.28 kW	B.P = 2.42 kW
Fuel Consumption =1.21 kg/hr	Fuel Consumption=1.24 kg/hr
Fuel Power = 14.13 kW	Fuel Power =13.25 kW
Efficiency =16%	Efficiency = 18.26%

9.0 DISCUSSION

The following observations were made from the analysis

- Brake thermal efficiency increases by increasing the inlet temperature
- CO content in the exhaust gas slightly reduces with increase in intake air temperature.
- fuel consumption reduces by increasing the inlet temperature
- The heat input required for the engine reduces with increase in intake air temperature.

10. CONCLUSION

From the above calculation and analysis it is clear that with increase in the temperature of inlet air, the fuel consumption reduces and brake thermal efficiency increases. Carbon monoxide content in the exhaust gas slightly reduces with increase in intake air temperature. Whereas NOx content in the exhaust gas slightly increases with increase in the temperature of inlet air. Hence the analysis shows that we are getting more advantages by using the air preheater and the advantages gained are more with increase intake air temperature as compared to some disadvantages.

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