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Experimental Study of an Air Pre-Heater for Diesel Engine

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Abstract:
In a diesel engine, the fuel-air mixture is supplied at room temperature and burned inside the cylinder. After the fuel is burned, the combustion products are discharged at atmospheric pressure and high temperature. The heat generated during the combustion of fuel is partially converted into work to drive the any load and the remaining unburnt mixture is wasted to the atmosphere through exhaust gas . The heat generated by combustion of fuel is converted into the work because of the pressure created by the combustion process and efficiency of the engine is between 20 and 30 %. This experiment highlights provision for incorporating a heating coil for preheating air before admitting into the cylinder of a diesel engine and the coil will be powered by car battery(12V). The effect of preheated air on standard diesel fuel engine indicated a good result on emission control and a significant reduction in overall fuel consumption. Unburnt HCs, particulates and CO emissions at preheated intake air temperature is very less when compared at normal intake air temperature. 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.

Keywords: Air pre heater, Diesel engine, Emissions, performance

I. INTRODUCTION

Air Intake heaters are installed in the intake manifold and preheat the combustion air to the required temperature for ignition of fuel. Powered by the vehicle battery, air intake heaters provide an on-board, unplugged, cold weather starting aid. This type of engine preheating is cost-effective and good for the environment. In addition to producing fast starts, air intake heaters reduce white smoke (‘‘cold emissions’’), engine wear, battery consumption, and fuel consumption during start up. Lower temperature intake air leads to inadequate final compression temperature, increase in emission delay, longer time between the injection of the fuel to ignition, local over-enrichment, incomplete combustion, and high pressure gradients due to abrupt mixture conversion in the cylinder. These factors lead to knocking of the diesel engine, increase in emission of hydrocarbons in the exhaust gas leading to severe loading of the environment. In order to avoid these, a prefilter is introduced to heat intake air during start and/or warm running of the engine with the help of a electrical heating element. Heating period is selected on the basis of the temperature of the unheated air taken in by the internal combustion engine. Temperature controller is provided to control the outlet temperature at the downstream of heater. Based on air outlet temperature, the relay supplies current to the heater to attain desired temperature.

II. METHODOLOGY

The project is divided in 4 main phases; Pre-study, Concept Design, Developing Phase and Analysis. The Pre-study phase is aimed at analyzing the existing design’s function and exterior expressions. The concept design phase is aimed at defining the Intake Air heating system, many possible concepts are generated, further concept scoring and screening to be done to find the best possible concept. It utilizes the pre available sources like Computerized diesel engine test rig, Five gas analyzer and Smoke Meter. In the developing phase the concepts are developed to a complete design proposal and fabrication is done according to the specifications.

III. DESIGN AND FABRICATION

1. Design of Pre-heater: Air heater adapted to be positioned in communication with an intake passage way of an engine. Direct power supply to modulate power to the air heater by switching on and cutting of as when required. Thermocouple to provide a signal indicative of the air temperature located upstream of air heater

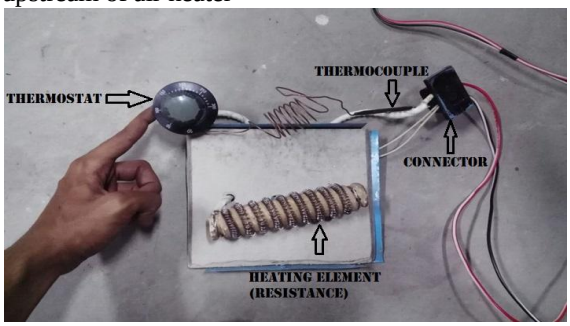

Figure.1. air heater

2. Fabrication of Pre-heater: The heating coil for the pre heater is fabricated using Iron Chromium and Nickel. Proper type of insulation is fabricated along with it to prohibit any short circuit. The setup is installed in mild steel box. A filter has been provided at the inlet of heater for removing the dirt present in the air. Temperature recorder have been incorporated at the inlet and outlet lines of the heater. In addition one more thermocouple is fixed to measure the exhaust gas temperature. The heating oil is installed in the box and electrically isolated from the surrounding. The outlet of heater is connected to the engine.

IV. EXPERIMENATION

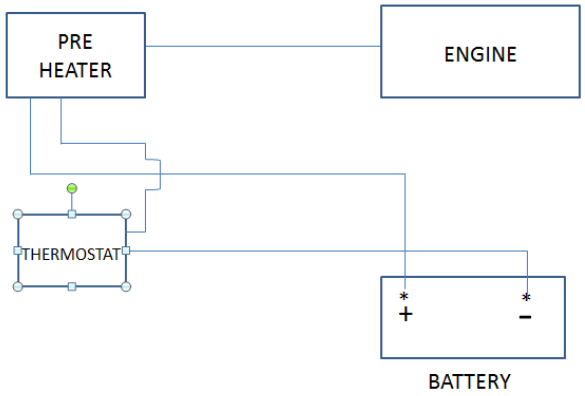

Figure.2. Experimenation

The following components are required to perform the following experimentation

- Single cylinder diesel engine
- Heating element
- Brake dynamo meter
- Thermocouples
- Temperature controller(Thermostat)

v. RESULTS AND CALCULATIONS

Table .1.(Without pre heater)

Sl. no.	Loading	RPM	Time taken for 10cc fuel	Air flow(cm)	Temp(°C)	
					T1	T2
1	0.5	1553	52	1.4	24	243
2	1	1569	44	1.5	24	287
3	1.5	1700	38	1.6	24	340

Table.2. (Without pre heater)

At 48°C						
Sl. no.	Loading	RPM	Time taken for 10cc fuel	Air flow(cm)	Temp(°C)	
					T_1	T_2
1	0.5	1553	63	1.4	48	257
2	1	1569	53.37	1.6	48	289
3	1.5	1700	44.28	1.6	48	292

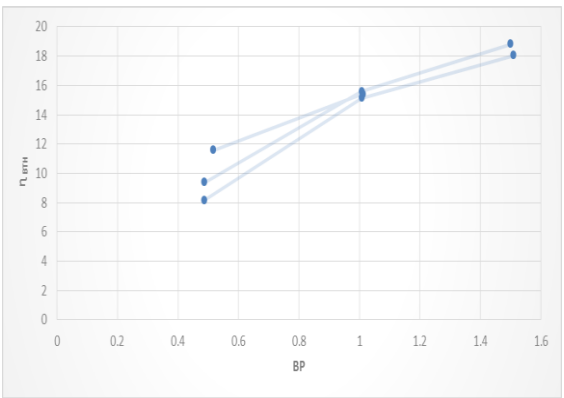

Figure .3. BP VS η_{BT}

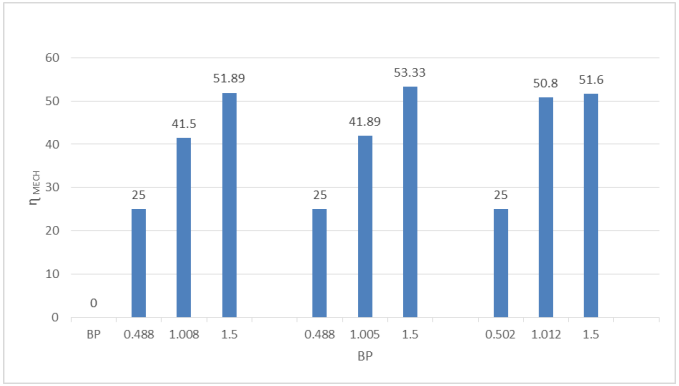

Fig 5.2:BP VS η_{mech}

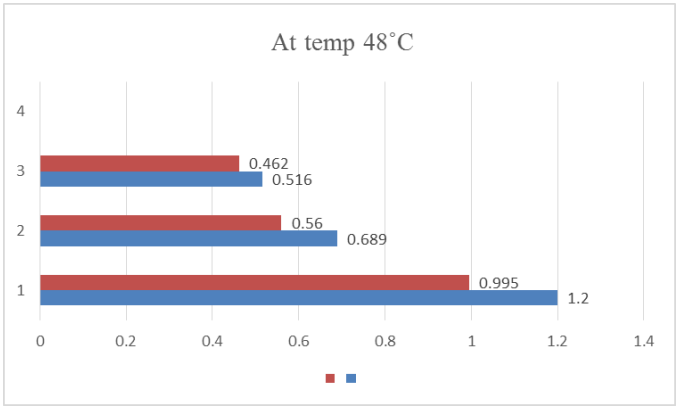

Fig. 5.3: Brake Thermal Efficiency (with and without preheater at 48˚C)

VI. CONCLUSION

The designed Inlet Air Preheater system can be incorporated in any diesel engine whether in mass production in factory or as well as in any existing engine. This system can help in decrease of emission to a higher extent by reducing the amount of Particulates Matter (PM), Smog and significant reduction in Unburnt hydrocarbons from exhaust thus helping in achieving cleaner and greener environment. One of the main concern for customer is increasing fuel price which can also be taken care by implementing this system, as it can reduce the rate of fuel consumption especially during slow speed driving or driving below cruising range.

V. REFERENCES

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