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Evaluation of CI Engine Performance and Emission Strategies by Heat Recovery Techniques

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***Abstract:* - Today the world is running on engines. Internal combustion engines are used more than other type of engines because of their advantages. The use of these has been increasing day by day. But pollution caused by these engines is making them an environmental problem and the reason for this, is usage of fossil fuels which are rich in hydro carbons. The burning of these fuels will release unburnt hydro carbons because of incomplete combustion of fuel inside the engine cylinder. The performance of the engine is also affected because of this.**

Minimization of this incomplete combustion is done by pre heating of fuel. Pre-heating means heating the fuel before going in to the combustion chamber. The heat required for preheating is taken from exhaust gases by placing a heat exchanger at the preheating point. As the fuel temperature is increased, incomplete combustion of fuel is avoided. Therefore performance is increased and emission of polluting gases is also reduced. In order to evaluate the effect of pre heating tests were carried with and without preheating under constant speed of 1300 R.P.M and also at variable speed ranging from 1450 to 1600 R.P.M.

Keywords ***: Preheating, Brake specific fuel consumption, brakeThermal efficiency.***

I. INTRODUCTION

By preheating the fuel, we can increase the fuel temperature so that ignition delay can be reduced. This in turn reduces the incomplete combustion of fuel. Ultimately the power produced by the engine increases and specific fuel consumption decreases. This also results in increase in brake thermal efficiency of the engine. Out of the total heat supplied to the engine in the form of fuel, approximately, 30 to 40% is converted into useful mechanical work and 60-70% of the fuel energy is still lost as waste heat through exhaust gases and engine cooling systems, serious environmental pollution, so it is required to recover this waste heat. The various ways in which this recovered can be used is for heating purpose, powergeneration, preheating of bio fuels in the case of using them as bio fuels are more viscous compared to diesel,for refrigeration purpose, turbocharging [1].

The use of preheating of fuel is mostly applied to bio fuels like vegetable oils as there are problems in using them directly because they are viscous and less volatile. So by preheating them the above mentioned problems can be overcome.[2].by using these vegetable oils the net co_2 emissions can be reduced. Research is being carried on jatropha oil, manhua oil and blending it with diesel, Neem, Linseed and Castor oil. [2][3][5]. this process of “transesterification”[5] is used to reduce the viscosity of above mentioned vegetable oils. The preheating of fuel is done using the waste heat from exhaust gases.[5].The performance of engine and the reduction in pollution can also be obtained by using HHO generator for existing diesel engines [4].by varying fuel injection pressures to 230 bar pure palm oil bio diesel shows best results both in performance and emissions than regular engines[6].

In this work diesel oil is preheated and the performance of the engine is evaluated and the emissions are tested.the experiments are conducted and constant and varying speeds.

II. ENGINE SPECIFICATIONS

TABLE I
SPECIFICATIONS OF ENIGNE

Parameter	Specification
Engine type	4 stroke single cylinder diesel engine
Bore	86 mm
Stroke	68 mm
Cubic Capacity	395 cc
Power	8 HP
Max. Speed	3600 rpm
Cooling system	Air cooled

III. EXPERIMENTAL SETUP

Experimental set up for conducting performance test on four stroke diesel engine involves following equipment

A. Four stroke diesel engine

B. Brake dynamometer

C. Fuel measuring equipment

D. Heat exchanger.

A) Four stroke diesel engine:-

A four-stroke engine is an internal combustion engine in which the piston completes four separate strokes—intake, compression, power, and exhaust—during two separate revolutions of the engine's crankshaft, and one single thermodynamic cycle.

Fig. 1 Experimental Setup

Fig. 2 Experimental Setup

B) Rope brake dynamometer:-

It is a type of absorption dynamometer used for the measuring brake power of the engine. It consists of one, two or more ropes wound around the brake drum which is rigidly fixed to the output shaft of the engine. The upper end of rope is attached to a spring balance while lower end of the rope is kept in position by applying a dead weight.

C) Fuel measuring equipment:-

This equipment is used for the measurement of fuel consumption of the engine on time basis. It consists of burette and electronic stop watch. Fuel from the fuel tank will enter into the engine through the burette which will indicate the amount of fuel consumed by the engine.

D) Heat exchanger (Preheater):-

A heat exchange**r** is a piece of equipment built for efficient heat transfer from one medium to another. The media may be separated by a solid wall, so that they never mix. In this experiment we used shell and tube heat exchanger.

TABLE II
DESIGN CONSIDERATIONS OF HEAT EXCHANGER

S.No	Name	Details
1	Heat exchanger	Shell and tube
2	Type of flow	Counter flow
3	Reynolds number, Re (inside tube)	15
4	Nusseltnumber, Nu(inside tube)	31.125
5	Convective heat transfer coefficient, h_i	44.46 W/m^2K
6	Reynolds number, Re (for exhaust gas)	15431.92
7	Nusselt number, Nu (for exhaust gas)	67.06
8	Convective heat transfer coefficient, h_o	258.21 W/m^2K
9	Velocity of fuel	0.018m/sec
10	Velocity of exhaust gases	31.67m/sec
11	Overall heat transfer coefficient, U	12.816 W/ m^2K
12	Surface area of tube	$4.71\times10^{-3} m^2$
13	Logarithmic mean temperature difference, LMTD	12.09
	Effectiveness of heat exchanger, Ɛ	0.36

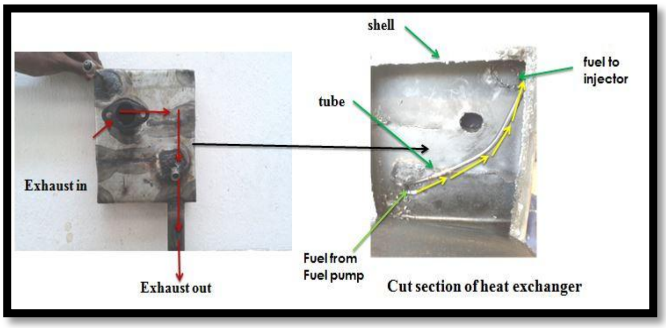

Fig.3 Heat exchanger (preheater)

IV EXPERIMENT PROCEDURE

- Initially, the engine was run without pre-heater sometime to reach steady state conditions.
- Now, at no load condition we noted time taken for 10ml of fuel consumption and speed, is measured using a tachometer.
- Now by applying different loads we noted time taken for 10ml of fuel consumption and speed.the test is conducted within the speed range of 1400 to 1600 R.P.M.
- We repeated the similar procedure for variable load and at constant speed of 1300 R.P.M..
- Then we replaced original fuel pipe with a heat exchanger and repeated the same procedure at variable speed and constant speed.
- The observations were tabulated and the results were evaluated.

V. EXPERIMENTAL RESULTS AND DISCUSSIONS

A.Variable load and variable speed

1) Brake Power vs Specific Fuel Consumption:

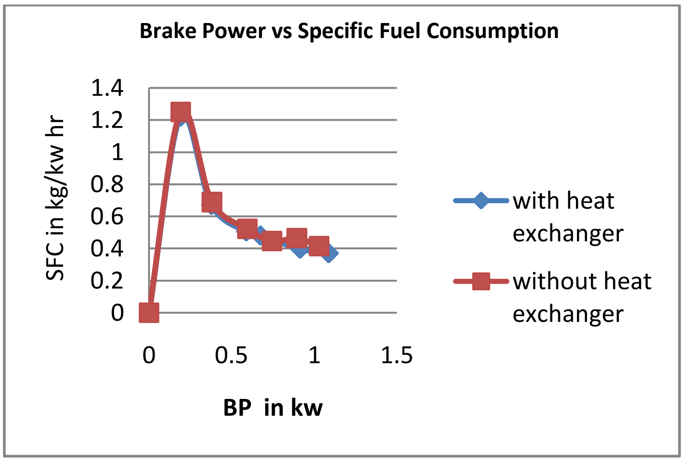

Fig.4 BPvsSFC

- The *fig4* shows the relationship between Brake power and Specific fuel consumption Under variable speed condition.
- From *fig.4*It is clear that as B.P is increasing, SFC is increasing initially and then decreasing.
- The reduction in SFC is more when a heat exchanger is used than in normal operation.

2) Load vs Brake thermal Efficiency:

- The *fig.5* shows the relationship between Load vs Brake thermal efficiency Under variable speed condition.
- From *fig.5* It can be observed that as load is increases the Brake thermal efficiency also increases.
- The increase in Brake thermal efficiency is more when a heat exchanger is used than in normal operation. Under similar loading conditions.

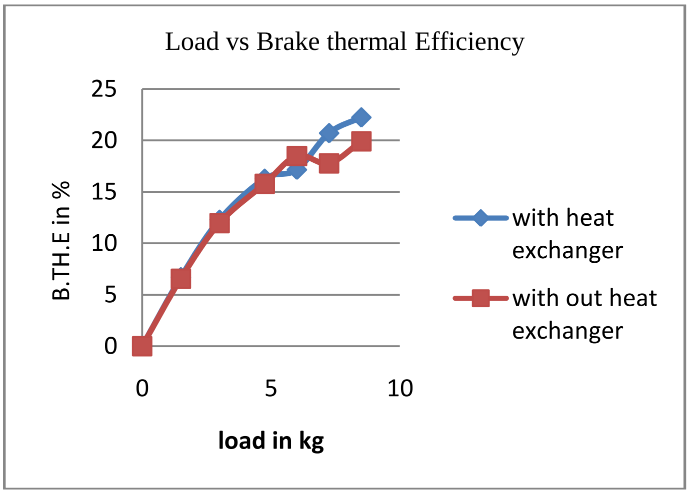

Fig. 5 Load vsB.TH.E

3) Brake Power vs Brake thermal Efficiency

- The *fig.6* shows the relationship between Brake power and Brake thermal efficiency. Under var. speed condition.
- From the *fig.6*,it is clear that the Brake power increases the Brake thermal efficiency also increases.
- The increase of Brake thermal efficiency is more constituent and higher in the case when a heat exchanger is used, than in normal operation.

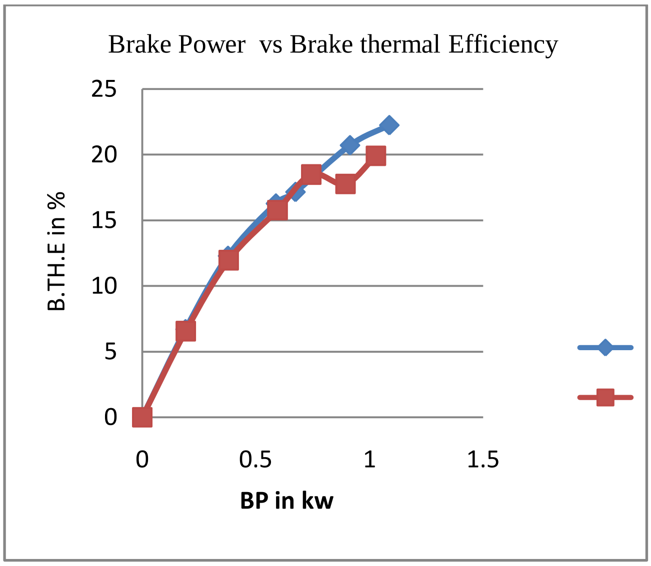

Fig. 6. BPvsB.TH.E

4) *Speed vs. Specific Fuel consumption:*

- The *fig.7* shows the relationship between speed and specific fuel consumption. Under var. speed condition.
- From the *fig.7* as the speed is increasing the specific fuel consumption is increasing.
- The increase is specific fuel consumption is more in the case of normal operation than in the case, when a heat exchanger is used.

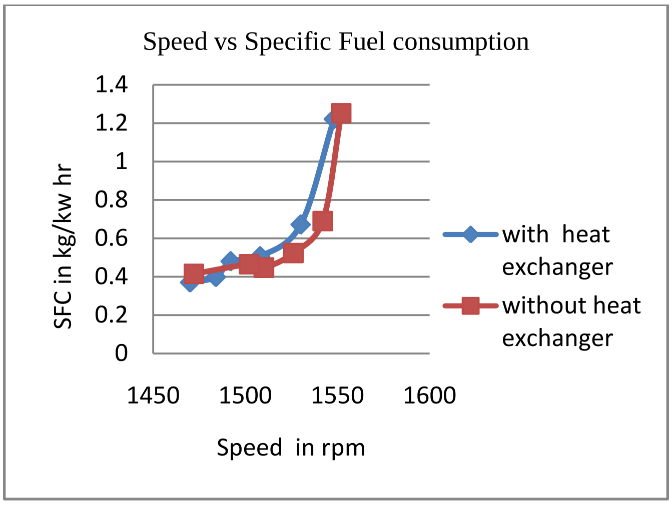

Fig.7. Speed vsSFC

B.Constant Speed and variable load:

1) *Brake power vs specific fuel consumption*

- The *fig.8* Shows the relationship between Brake power and Specific fuel consumption. Under constantspeed condition.
- The SFC is decreasing as the B.P. is increasing.
- The increase in BP associated with decrease in SFC is more constituent when using a heat exchanger can be seen from graph.

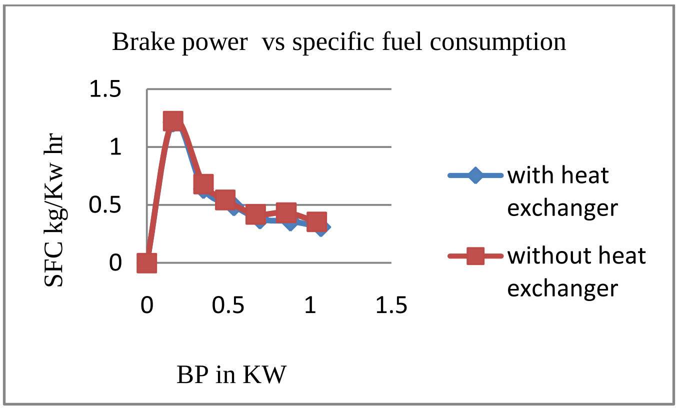

Fig. 8 BPvsSFC

2) *Load vs. Brake thermal Efficiency:*

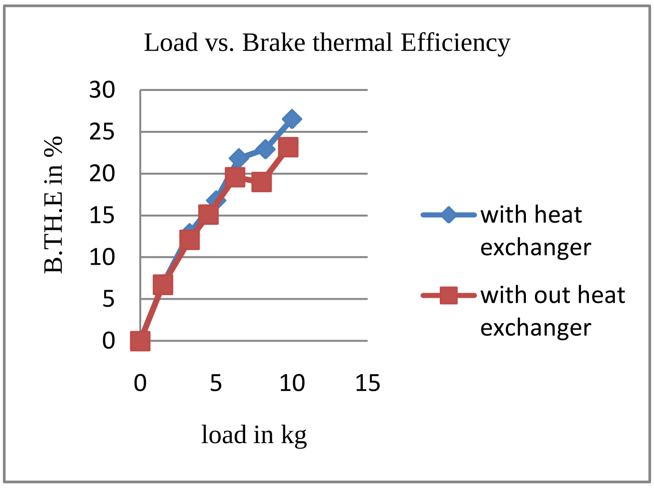

Fig.9. Load vs. B.TH.E

- The *fig.9.*shows the relationship between Load vsBrake thermal efficiency. Under constant speed condition.
- As the load is increases the Brake thermal efficiency also increases as seen in the figure.
- When a heat exchange is used, the increases in Brake thermal Efficiency are higher than in normal operation.

4)Brake Power vs Brake thermal Efficiency:

- The *fig.10*. shows the relationship between Brake power and Brake thermal efficiency. Under constant speed condition.
- As the BP is increasing the Brake thermal Efficiency also increases as can be seen in the figure .
- The increase in the brake thermal efficiency is more in the case when heat is used in the exchanger in the normal condition.

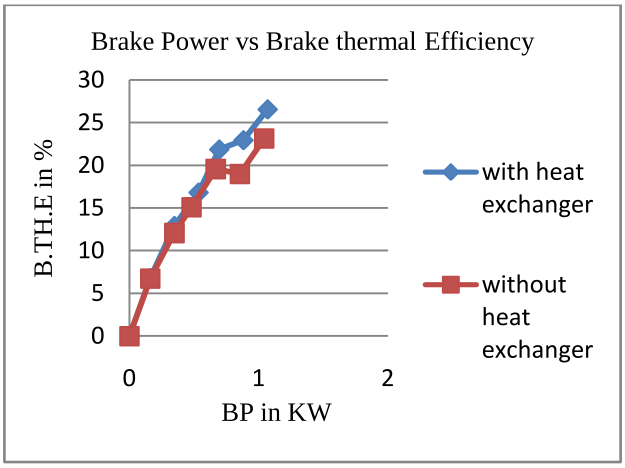

Fig. 10.BPvsB.TH.E

C. Effect of fuel temperature:

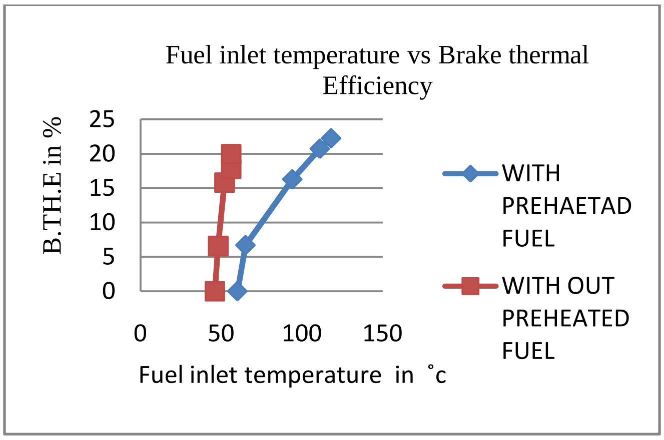

Fig. 11. Fuel inlet temperature vs B.TH.E

- From the *fig.11*. Conclusion can be made that as the fuel temperature is increasing the brake thermal efficiency is increasing.
- The increase is more in the case of preheated fuel than under normal working condition.
- From the *fig 12*. Conclusion can be made that the specific fuel consumption is less in the case of preheated fuel than under normal working condition.

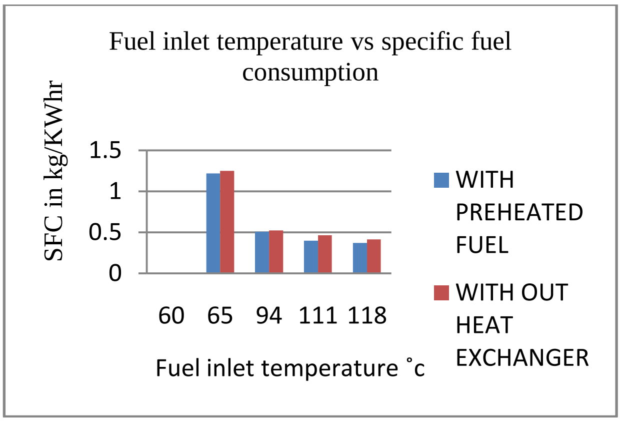

Fig. 12. Fuel inlet temperature vs SFC

D. *Emission control:*

1. There is a reduction in the percentage of co when preheated fuel is used by 26.66%.
2. There is a slight decrease in the no_2 level when compared with un-preheated fuel.
3. The level of oxygen is maintained more or less constant.
4. The level of $co_2$is maintained more or less constant.
5. There is a slight increase in the hydrocarbon level in the emissions.

Conclusion

1. From the experimental results, the following conclusions are made:
2. Under variable speed condition the efficiency of the engine is increased by 1.2%.
3. Under constant speed condition the efficiency of the engine is increased by 2.03%.
4. There is a reduction in the percentage of co by 26.66%.when preheated fuel is used.

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