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Performance Evaluation of IC Engine with Preheated Diesel

[1]Mahesh Bhairu Mali
[1]M.E. (Thermal), student, Nagesh Karajagi Orchid College of Engineering & Technology, Solapur, Maharashtra, India

[2]S. S. Kale
[2]Assistant Professor, Mechanical Engg. Department of Nagesh Karajagi Orchid College of Engineering & Technology, Solapur, Maharashtra, India

Abstract:- Knocking is one of the unwanted phenomena takes place in the compression ignition engine. It has number of bad effects on the engine life and performance. If ignition delay is long, more fuel is accumulated in combustion chamber and burning of fuel produces more rate of pressure rise, resulting in more forces on the piston. Properties of fuel like viscosity, compression ratio etc. affect the knocking and hence engine performance and exhaust emission. Knocking is also affected by intake Temperature and auto ignition Temperature of the fuel. If fuel Temperature is high, then ignition delay period will be reduced and the performance of engine will be improved In the present work fuel is heated to different temperature as 30°C, 35°C, 40°C, 45°C, 50°C, 55°C, 60°C. Compression ration is maintained at 17.5. Result is found out at different loads. 50°C temperature has given optimum results with concerned of performance and exhaust gas.

Keywords:- *Fuel Preheating, Knocking, Ignition Delay, CI Engine.*

I. INTRODUCTION

Knocking is one of the unwanted phenomena takes place in the compression ignition engine. It has number of bad effects on the engine life and performance. In C.I. engine, combustion takes place at the end of compression stroke, during compression stroke air is compressed at high Temperature; fuel is admitted in the hot air but it does not get ignite. The period between first droplet of fuel admitted in combustion chamber and starting of its actual burning is known as delay period. If ignition delay is long, more fuel is accumulated in combustion chamber and burning of fuel produces more rate of pressure rise, resulting in more forces on the piston. if ignition delay is longer, more and more fuel is accumulated in the chamber, burning of fuel produces instantaneous pressure rise, this process produces more pressure difference, resulting in gas vibrations known as knocking and is evidenced by audible knock. Properties of fuel like viscosity, compression ratio etc. affect the knocking and hence engine performance and exhaust emission. Knocking is also affected by intake Temperature and auto ignition Temperature of the fuel. Due to knocking, more stress is exerted on piston-cylinder, therefore engine life is reduced. Due to vibrations more fuel is required, vibrations produce unbalancing in engine. Generally knocking will be reduced by more compression ratio, high engine speed, more output, atomization-more fineness and duration of injection, injection timing- 20^{o} before TDC generally, quality of fuel-low self-ignition Temperature, more intake pressure. Fuel intake Temperature also affect on the knocking and ultimately on the engine performance. If fuel Temperature is high, then ignition delay period will be reduced and the performance of engine will be improved. The present work is to find out the performance of the internal combustion engine using preheated fuel. Performance evaluation includes determination of thermal efficiencies, brake power, fuel consumption etc. preheating of fuel will be done by heater or exhaust gasses also can be used. Preheating of the fuel is used to reduce delay period.

II. HYPOTHESIS

The combustion in a CI engine is considered to be taking place in four stages. it is divided into ignition delay period, the period of rapid combustion ,the period of controlled combustion and period of after burning.

- *Ignition Delay Period*

Ignition delay period is also called preparatory phase during which some fuel has already been admitted but has not yet ignited. This period is counted from the start of injection to the point where pressure –time curve separates from motoring curve indicated as start of combustion. The delay period in the CI engine exerts a very great influence on both engine design and performance. It is of extreme importance because of its effect on both the combustion rate and knocking and also its influence on engine starting ability and the presence of smoke in the exhaust.

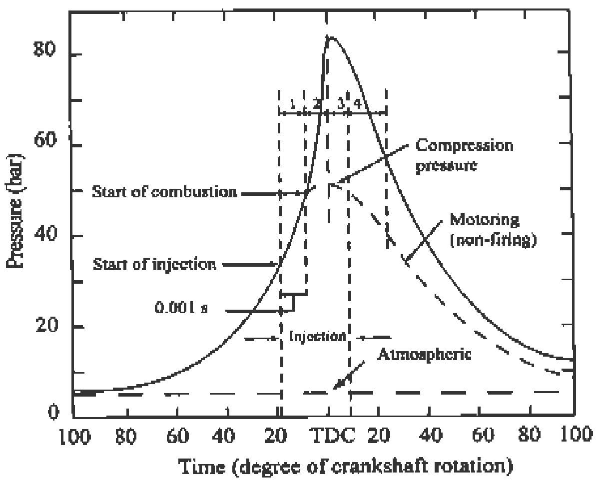


Fig 1:- Stages of Combustion in CI engine

The fuel does not ignite immediately upon injection into the combustion chamber. There is definite period of inactivity between the time when the first droplet of fuel hits the hot air in the combustion chamber and the time it starts through actual burning phase. This period is known as ignition delay period. in above figure delay period is shown on pressure crank angle diagram between point a and b. point a represent the time of injection and b represent the time at which the pressure curve first separate from motoring curve .the ignition delay period can be divided into two parts, the physical delay and the chemical delay.

III. METHODOLOGY

In the current research CI engine is used for testing. Figure 2 shows Experimental set up.Procedure for the experimentation is given below-

1) Ensure that all the nut bolts of engine, dynamometer, propeller shaft, base frame are properly tightened.
2) Ensure that sufficient lubrication oil is present in the engine sump tank. This can be checked by marking on the level stick.
3) Ensure sufficient fuel in fuel tank. Remove air in fuel line, if any.
4) connect the heater to power supply though temperature indicator, keep the heater in fuel tank, keep measuring probe of temperature indicator in fuel tank, switch ON power supply. Wait until required temperature is reached.
5) Switch on electric supply and ensure that PPU (Piezo powering unit), DLU (Dynamometer loading unit), Load indicator and Voltmeter are switched on.
6) Start Computer and open "Engine Soft LV" (Double click "Engine Soft LV" icon on the desktop) Select "Engine Model" open "Configuration" in View. Check configure ration values & system constants with the values displayed on engine setup panel. "Apply" the changes, if any. Click on "PO- PV Figures" tab.
7) Start water pump. Adjust the flow rate of "Rotameter (Engine)" to 250-350 LPH and "Rotameter (Calorimeter)" to 75-100 LPH by manipulating respective globe valves provided at the rotameter inlet. Ensure that water is flowing through dynamometer at a pressure of 0.5 to 1 Kg/cm2.
8) Keep the DLU knob at minimum position.
9) Change the Fuel cock position from "Measuring" to "Tank"
10) Start the engine by hand cranking and allow it to run at idling condition for 4-5 minutes.
11) Click on "Scan Start" on the monitor.
12) Wait till computer indicate that readings are noted.
13) Click on “Generate Report” button and save report files
14) after report generating, achieve next temperature of fuel and take reading

Fig 2:- Experimental Test Set Up

Particulars	Specifications
Product	VCR Engine test setup 1 cylinder, 4 stroke, Diesel (Computerized)
Engine	Make Kirloskar, Type 1 cylinder, 4 stroke Diesel, water cooled, power 3.5 kw at 1500 rpm, stroke 110 mm, bore 87.5 mm.661 cc, CR range 12 to 18
Dynamometer	Type eddy current, water cooled, with loading unit
Propeller Shafts	With universal joints
Fuel Tank	Capacity 15 lit with glass fuel metering column
Calorimeter & Pump	Pipe in pipe, Mono-block Pump
Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load sensor	Load cell, type strain gauge, range 0-50 Kg
Rota meter	Engine cooling 40-400 LPH; Calorimeter 25-250 LPH
Overall dimensions	W 2000 x D 2500 x H 1500 mm

Table 1:- Engine Specifications

Figure 3 shows Cartridge Heater with temperature controller used for preheating of fuel.

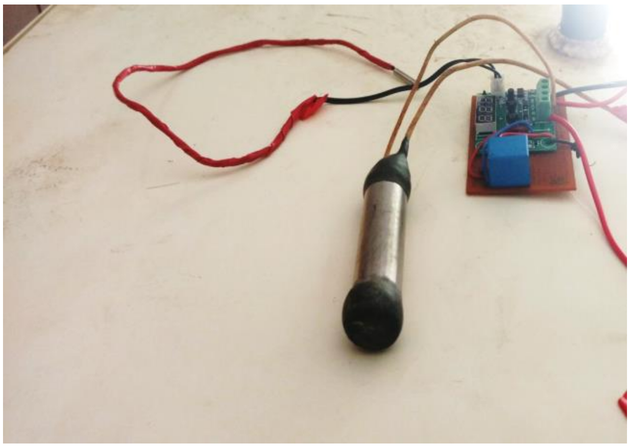
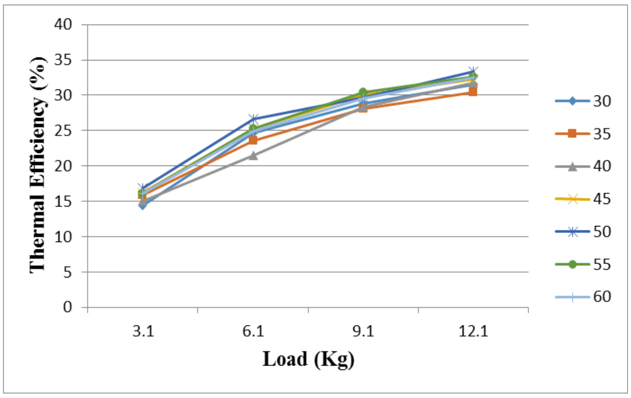


Fig 3:- Cartridge Heater with temperature controller

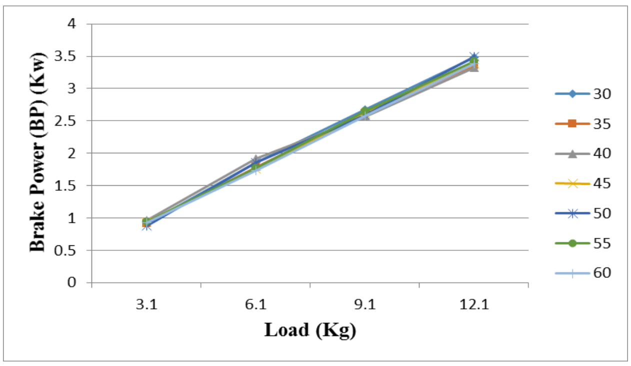
IV. RESULT AND DISCUSSION

Performance and Exhaust emission is tested at different load and Temperature at constant compression ratio. Following are some graphs drawn for study



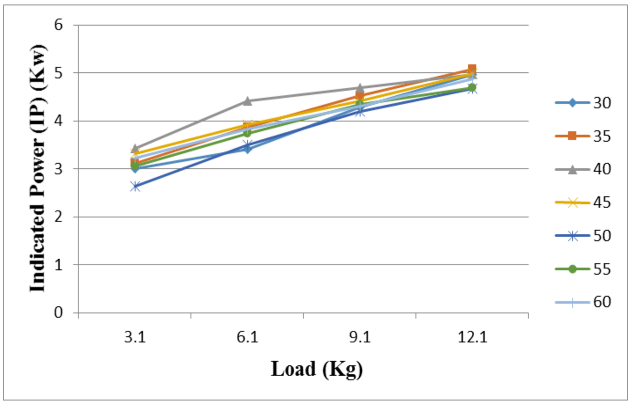
Graph 1:- Load Vs. Thermal Efficiency at Various Temperatures (° C)

Graph 1 is about load vs. thermal efficiency. Thermal efficiency is maximum at 12.1 kg load at temperature 50°C (33.36%) and minimum at 3.1 kg at 40°C (15.06%), at compression ratio 17.5



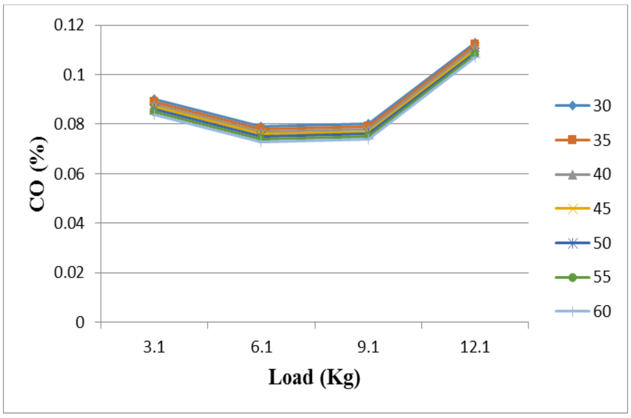
Graph 2:- Load Vs. BP at Various Temperatures (° C)

Graph 2 is about load vs. BP. BP is maximum at 12.1 kg at 50°C (3.49 kw) and BP is minimum at load 3.1 kg at 50°C (0.88 kw), at compression ratio 17.5



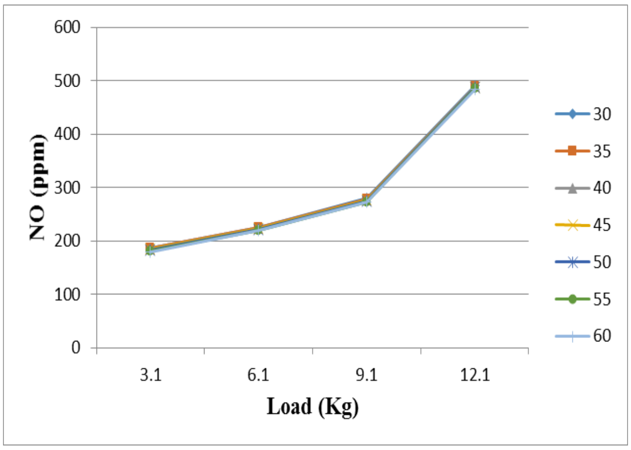
Graph 3:- Load Vs. IP at Various Temperatures (° C)

Graph 3 is about load vs. IP.IP is maximum at load 12.1 kg and at 35°C (5.07 kw) minimum at 50° C at 3.1 Kg load (2.64 kw), at compression ratio 17.5.



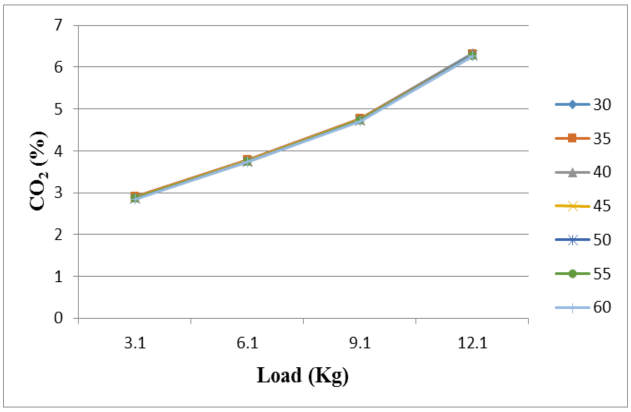
Graph 4:- Load Vs. CO At Various Temperatures (° C)

Graph 4 Shows Maximum CO is at load 12.1 kg and temperature 30°C (0.113%), minimum at load 3.1 kg and temperature 60°C (0.084%), at compression ratio17.5



Graph 5:- load vs. NO at Various Temperatures (° C)

Graph 5 shows Maximum NO is at load 12.1 kg and temperature 30°C (492 ppm), minimum at load 3.1 kg and temperature 60°C (180 ppm), at compression ratio.17.5



Graph 6:- Load Vs. CO_2 At Various Temperatures (° C)

Graph 6 shows Maximum CO_2 is at load 12.1 kg and temperature 30°C (6.32%), minimum at load 3.1 kg and temperature 60°C (2.85%), at compression ratio.17.5.

V. CONCLUSION

We have found that preheating of the fuel enhances performance of the engine. Following are the conclusion of the research work-

1) Thermal efficiency is maximum at 12.1 kg load at temperature 50°C (33.36%) and minimum at 3.1 kg at 40°C (15.06%), at compression ratio 17.5.
2) BP is maximum at 12.1 kg at 50°C (3.49 kw) and BP is minimum at load 3.1 kg at 50°C (0.88 kw), at compression ratio 17.5.
3) IP is maximum at load 12.1 kg and at 35°C (5.07 kw) minimum at 50° C at 3.1 Kg load (2.64 kw), at compression ratio 17.5.
4) Maximum CO is at load 12.1 kg and temperature 30°C (0.113%), minimum at load 3.1 kg and temperature 60°C (0.084%), at compression ratio17.5.
5) Maximum NO is at load 12.1 kg and temperature 30°C (492 ppm), minimum at load 3.1 kg and temperature 60°C (180 ppm), at compression ratio.17.5.

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