Investigation of Pine Oil-Gasoline Blends through Performance and Emission Analysis on Petrol Engine

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Abstract

In this study, pine oil is used an alternative fuel for petrol in gasoline engine. Results compared the performance and emission characteristics of gasoline engine with the blend of sole fuel with pine oil. The investigation was carried out in the Tata nano engine with multipoint fuel injection (MPFI) system, twin cylinder water cooled gasoline engine. The investigations were carried out by the pine oil gasoline blends varying percentage of P10%, P20%, P30% and P40%. From the results it was observed that the brake thermal efficiency increased for P20% blend by 1.64% when compared to that of sole gasoline fuel. The CO, HC, are found decrease and increase in NO_x emission with the P20% of pine oil blend compared to that of gasoline sole fuel. The CO, HC are decreased by 31%, 8% respectively for the P10 blend and 17% increases of NO_x emission.

Key Words: Gasoline engine, Cyclohexylamine, *n*-butyl alcohol, Performance, Emission.

NOMENCLATURE

BTE	Brake Thermal Efficiency
SFC	Specific fuel consumption
°C	Degree centigrade
BP	Brake Power
CO	Carbon Monoxide
CO_2	Carbon Di-oxide
HC	Hydro Carbon
NO_x	Oxides of nitrogen
ppm	Parts per million
P10	Pine oil 10% + Petrol 90% (Pine oil 100ml + Petrol 900 ml)
P20	Pine oil 20% + Petrol 80% (Pine oil 200ml + Petrol 800 ml)
P30	Pine oil 30% + Petrol 70% (Pine oil 300ml + Petrol 700 ml)
P40	Pine oil 40% + Petrol 60% (Pine oil 400ml + Petrol 600 ml)
kW	Kilo Watt

1. INTRODUCTION

As the time passes, it is understood that the petroleum products and crude oil will be not enough and will be costly. Various researches are going on for the improvement of fuel economy of engines [1-4]. However as the demand and availability for petrol and diesel is somewhat unbalanced and there is a need to balance since that is mainly happened due to enormous increase in number of vehicles. If the similar situation continues then the scenario will be more disastrous and petrol and diesel will be more costly and limited [5]. With increased use and the depletion of fossil fuels, today more emphasis is given on the alternate fuels. There is a crucial need of alternate fuels in a way or other. Today intensive search for the alternative fuels for both spark ignition (SI) and compression ignition (CI) engines and it has been initiate out that the biomass derived fuels are suited for the alternate fuels [6]. In spark ignition engines fuels like eucalyptus oil and orange oil are the appropriate substituents for the petrol. They can be blended with petrol over a wide range of percentage according to the requirement [7]. Another reason for the need of alternate fuels for IC engines is the emission complications. Combined with other air polluting factors, the large number of automobiles is a major contributor to the air quality problems of the world [8-10]. As these fuels cannot be run directly in the engines therefore these are blended with gasoline at various percentage. One of the main reasons for choosing these fuels is the similarity in the properties of these with gasoline and they are miscible with gasoline without any phase separation [11]. The engines used for these blending or for alternate fuels are modified engines which were initially designed for gasoline fuelling [12]. The eucalyptus oil can be used in spark-ignition engines with very little engine modification as a blend with gasoline [13]. Since the octane number of eucalyptus oil is more than gasoline, so it enhances the octane value of the fuel when it is blended with low octane gasoline. At the same time the compression ratio (CR) which is dependent on knock can be enlarged when these fuels are blended with gasoline.

2. FUEL MODIFICATION

Pine oil was extracted using water distillation method. In this method, the material is completely immersed in water, which is boiled by applying heat by direct fire, steam jacket, closed steam jacket, closed steam coil or open steam coil. The main characteristic of this method is that there is direct contact between boiling water and plant material. When the still is heated by direct fire, adequate precautions are required to prevent the charge from overheating. When a steam jacket or closed steam coil is used, there is less danger of overheating; with open steam coils this danger is avoided. But with open steam, care must be taken to avoid accumulation of condensed water within the still. Therefore, the still should be well insulated. The plant material in the still must be agitated as the water boils, or else agglomerations of dense material will settle on the bottom and become thermally degraded. Certain plant materials like cinnamon bark, which are rich in mucilage, must be powdered so that the charge can easily disperse in the water; as the temperature of the water increases, the mucilage will be leached from the ground cinnamon. This greatly raises the viscosity of the water-charge mixture, thereby allowing it to char. Consequently, before any field distillation is done, a small-scale water distillation in glassware should be performed to perceive whether any changes take place during the distillation process. From this laboratory trial, the yield of oil from a known weight of the plant material can be determined. The laboratory apparatus approved for trial distillations is the Clevenger system.

Table 1 Properties of petrol and pine oil blends

Property	Petrol	P10	P20	P30	P40
Specific gravity	0.72	0.7622	0.7704	0.7868	0.8114
Kinematic viscosity	1.37	1.42	1.47	1.53	1.59
Flash point°C	-43	-4	1	3	8
Fire point °C	-13	-2	2	5	10
Pour point °C	-32	-18	-17	-15	-12
Gross calorific value (kJ/kg)	45525	45537	45600	44453	44089
Acidity as mg of KoH/gm	0.024	0.051	0.077	0.13	0.15
Density@ in gm/cc	0.71	0.7614	0.7698	0.7859	0.7940

Source: ETA Laboratory, Chennai

3. EXPERIMENTAL SETUP

The experimental setup is display in Figure 1. The level of the fuel and lubricating oil were checked before starting the engine. The eddy current dynamometer control unit panel is switched "ON' to note down the load, speed and temperature from the indicator given in the panel board. Now the ignition switch is turned "ON" position. The fuel flowed from the fuel tank over the electronic fuel injection pump and at that time started the engine at no load condition. The engine was allowed to run with sole fuel at a constant speed of 2500 rpm for nearly 30 minutes to obtain steady state condition. The cooling water temperature extended 50°C. Fuel consumption was measured by stop watch for one minute of fuel. In the same readings for 20%, 40%, 60%, 80% and full load were observed. After taking the essential readings the ignition switch is turned "OFF" position to stop the engine and the eddy current dynamometer control unit panel was also switched "OFF".

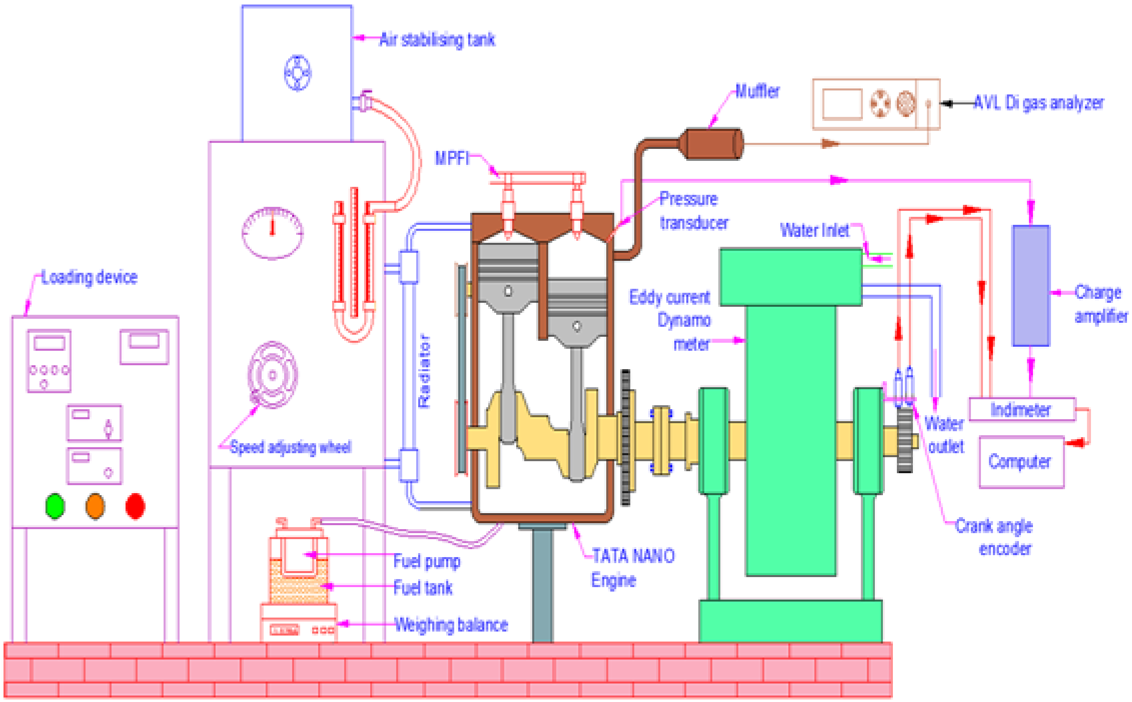

Figure 1 Experimental setup

Table 2 Specification of the test engine (TATA NANO)

Type	Vertical In-line Engine with MPFI
No. of Cylinder	2
Displacement	624 cc
Bore	73.5 mm
Stroke	73.5 mm
Compression Ratio	9.5:1
Fuel	Petrol
Cycle	4-Stroke
Max. Engine output	25.74 kW @ 5250 rpm
Max. Torque	48 Nm @ 3000 rpm
Speed	2500 rpm
Orifice Diameter	20 mm
Cooling System	Water
Loading Device	Eddy current Dynamometer

4. RESULT AND DISCUSSION

The experimental investigations were conducted by various pine oil blends (P10%, P20%, P30% and P40%) compared with gasoline fuel. The experiment investigations were conducted with pine oil gasoline blends and analyzed the performance, and emission characteristics. The pine oil was blended with gasoline fuel and investigated by TATA NANO gasoline engine by various load condition at constant speed (2500 rpm) of the engine.

4.1 PERFORMANCE CHARACTERISTICS

4.1.1 BRAKE THERMAL EFFICIENCY

Figure 2 shows the variations of brake thermal efficiency against brake power for pine oil gasoline blends. At full load condition the sole gasoline fuel has reported the 24.8% of brake thermal efficiency. The brake thermal efficiency is increased 1.64% for the pine oil blend P20% when compared to that of sole gasoline fuel. The pine oil blend P20 has 26.4% brake thermal efficiency at full load condition. The reason for increasing brake thermal efficiency for the pine oil blend P20 having high calorific value, lower viscosity which improves the fuel atomization and increase the combustion temperature.

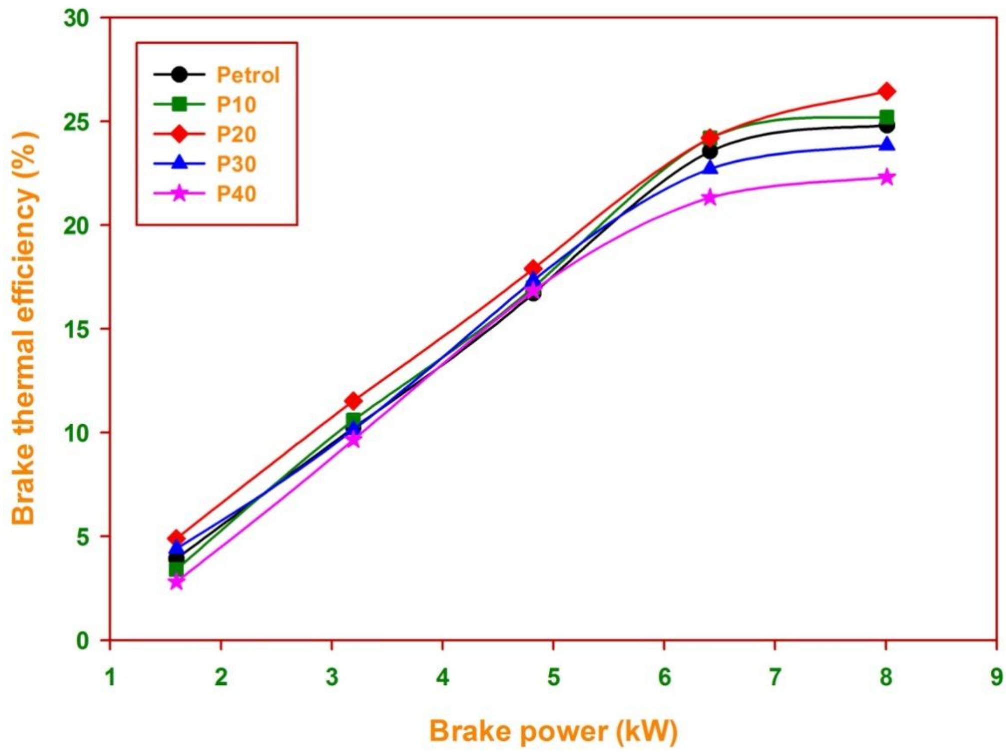

Figure 2 Variations of brake thermal efficiency with brake power

4.1.2 SPECIFIC FUEL CONSUMPTION

Figure 3 shows the variations of specific fuel consumption against brake power for pine oil gasoline blends. Among the pine oil gasoline blends specific fuel consumption has decreases for P20 blend. This may due to the effect of higher viscosity and poor mixture formation of pine oil fuel.

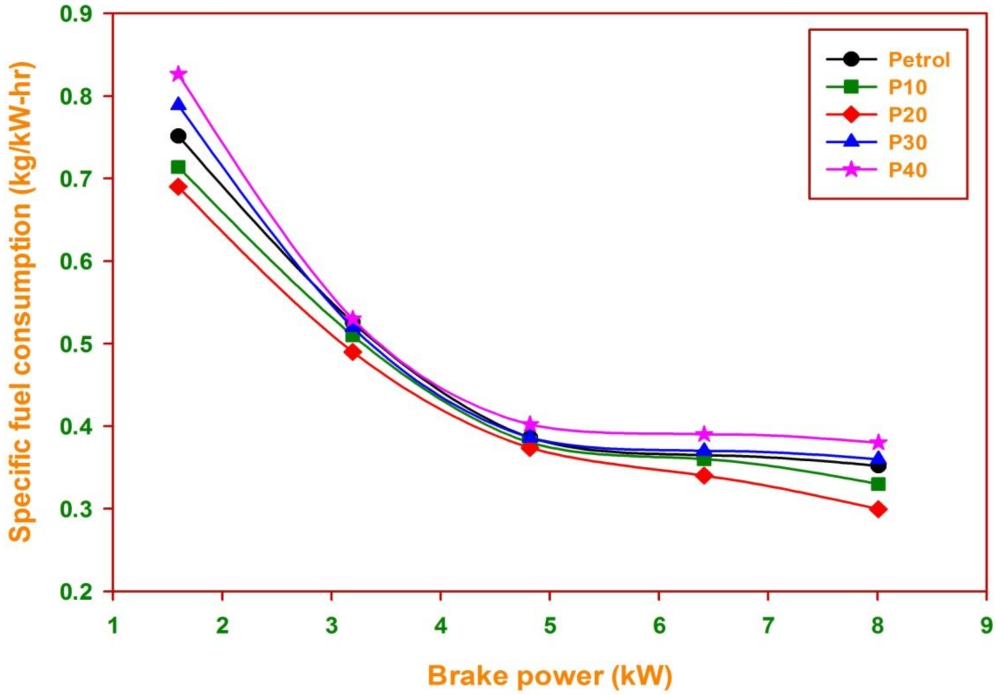

Figure 3 Variations of specific fuel consumption with brake power

4.2 EMISSION CHARACTERISTICS

4.2.1 OXIDES OF NITROGEN (NOx)

Figure 4 shows the variations of NO_x emission against brake power of pine oil gasoline blends. The NO_x emission of the blend P20 is higher that of when compare to standard sole gasoline fuel. The blend P40 show lower value when compare to sole gasoline fuel. The reason for increases of NOx emission for the blend P20 is complete combustion which increases the cylinder temperature. The NOx emission of the blend P20 is 17% increases when compare to sole gasoline fuel.

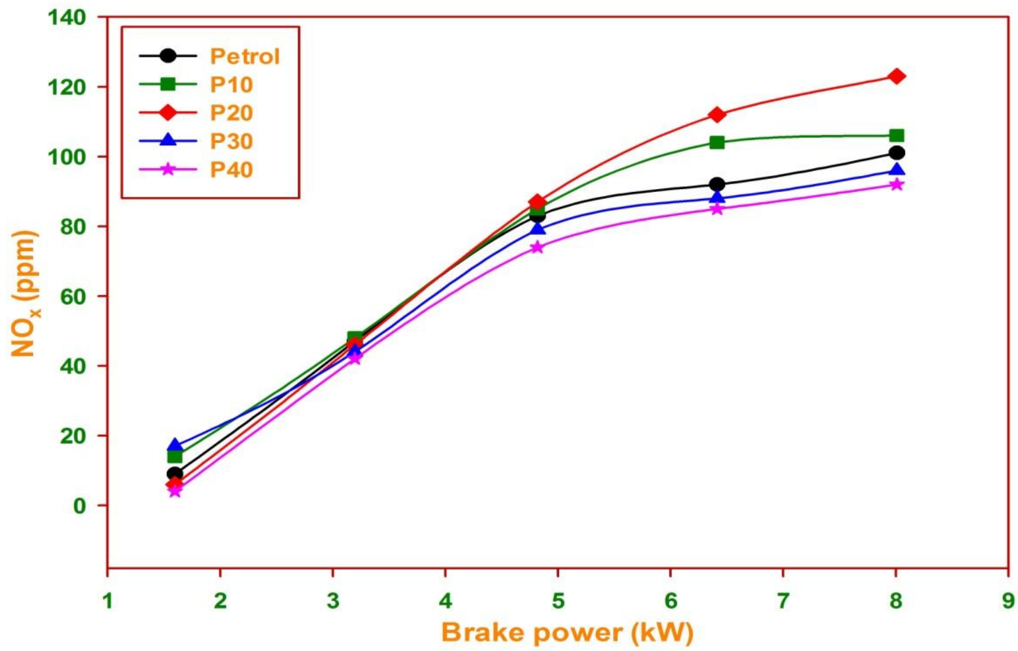

Figure 4 Variations of oxides of nitrogen with brake power

4.2.2 CARBON MONOXIDE (CO)

Figure 5 shows the variation CO against brake power for pine oil gasoline blends. From the graph all pine oil blends are lower CO emission when compare to sole fuel without any engine modification. The CO emission for the blend P20 is decreased when compared to sole fuel and other pine oil blends. It has a decrease of 31% when compare to sole gasoline fuel. The reason is expected due to the oxygen amount of pine oil molecules, which complete the fuel combustion and helps to oxidize CO into CO_2.

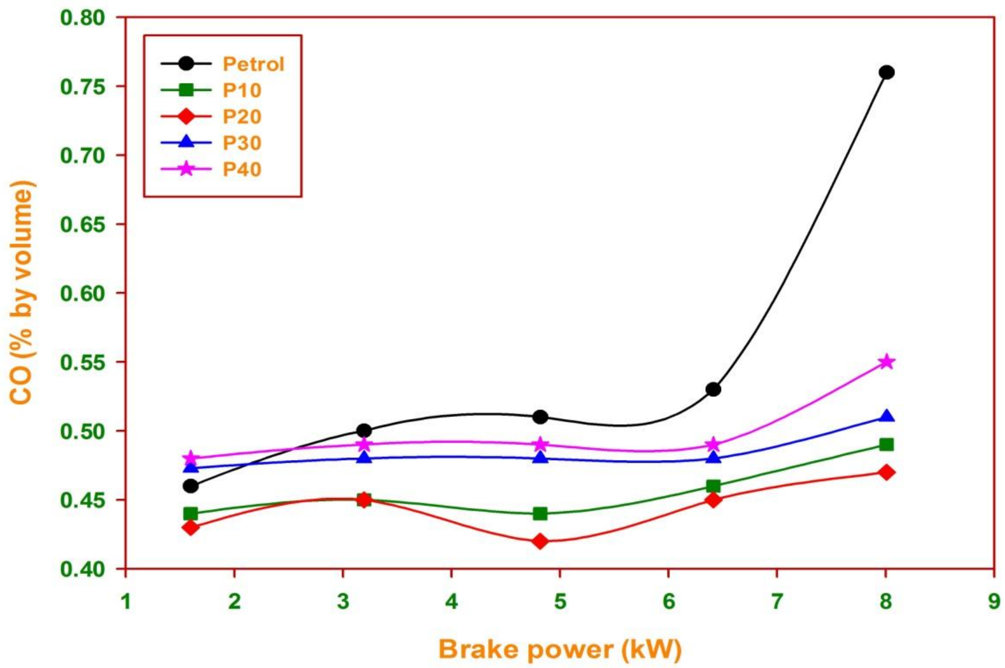

Figure 5 Variations of CO with brake power

4.2.3 HYDROCARBON (HC)

Figure 6 shows the variations of HC emission against brake power for pine oil gasoline blends. From the graph it is seen that all the pine oil gasoline blends have lower HC emission when compare to sole gasoline fuel. In this case of pine oil blend P20 shows 8% HC emission decreases when compared to that of gasoline sole fuel. The reason is low viscosity and boiling point of pine oil. The lower molecules present in the pine oil this has resulted in decreased HC emission.

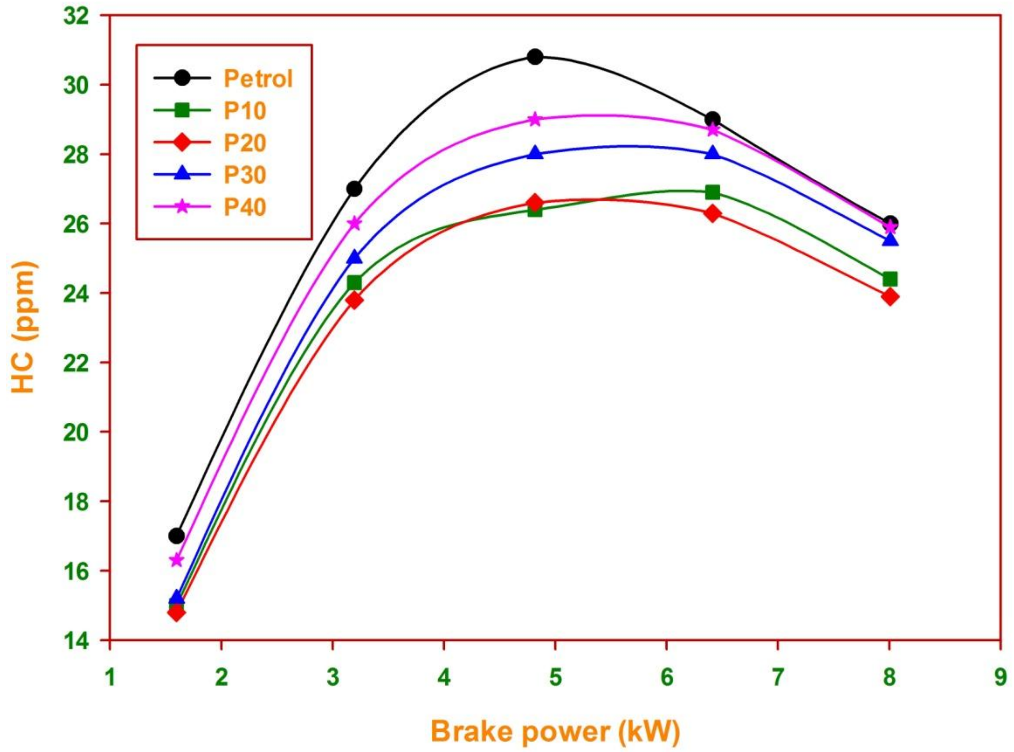

Figure 6 Variations of HC emission with brake power

CONCLUSION

The main conclusions of this study are;

1. The pine oil was blended with gasoline fuel (petrol) by varying percentage P10%, P20%, P30% and P40%.
2. The P20 pine oil gasoline blend is shows 1.64% brake thermal efficiency increases when compared to sole fuel.
3. The CO, HC emission are decreased by 31%, 8% respectively and NO_x emission is 17% increased for the pine oil gasoline blend P20.

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