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Research paper

Load and Emission Characteristics of Pongamia Pinnata Oil in ACI Engine

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Abstract

As the world is running on fossil fuels there has been an ever increase in the depletion rate of these fuels. A promising and a best alternate to the fossil fuel is vegetable oils. Pongamia Pinnata oil is non edible in nature and is available abundantly in India. An experimental investigation is made to evaluate the performance, emission and combustion characteristics on a compression ignition engine by using methyl ester of pongamia with mineral diesel in different proportions. Pongamia methyl ester was blended with diesel in proportions of 50% and 100% by mass and the results are tabulated and evaluated under various test conditions. The performance parameters were found to be very close to that of mineral diesel. The brake thermal efficiency and mechanical efficiency were better than mineral diesel for some specific blending ratios under certain loads. The Efficiency and emission characteristics were also studied and levels of carbon dioxide, carbon monoxide, nitric oxide and hydrocarbons were found to be equal than pure diesel.

Keywords: *Alternate Fuels, Biodiesel, Alternate fuels in CI engine, Pongamia Pinnata oil, Methyl esters.*

1. Introduction

The increased demand of petroleum derived fuel as well as their resulting environmental concerns provides the incentives for the development of alternate fuels from renewable resources. Biodiesel derived from animal fat and vegetable oils can be used as diesel fuel substitute. The conventional method for the preparation of Biodiesel consists of alkali catalysed transesterification of the low free fatty acid (FFA) oil with methanol (Malaya Naik et al, April 2008) [1] and (R. Sathish Kumar et al, 2015) [8]. Karanja is a non-edible oil seed grown throughout India is presently being underutilised (Gaurav Dwivedi et al, August 2011) [9]. Blended and transerterified Pongamia methyl ester is taken for experimental study in a CI engine by taking various blends of biodiesel (S.N Bobade et al, August 2012) [3] and (Arun K. Vuppaladadiyam et al) [4]. The present work has been undertaken with the following objectives:

- To extract oil from karanja seeds,
- To find the constituents of the oil,
- To explore the preparation of biodiesel,
- To find performance and emission parameters.

2. Problem Analysis

In few years the fossil fuels like petrol, diesel, are going to be very demand. Non-renewable sources of energy are derived from pre-historic fossils and are no longer available if once used. Their source is limited and are depleting at a faster rate. When extracted it poses a severe damage to the landscape as they are to be dig out from underground wells. So we need to find an alternate solution for this issue.

2.1 Demerits of Fossil Fuels

- environmental hazards
- rising prices
- acid rain
- non-renewable
- impact on aquatic life by oil spill

3. Bio Diesel

Transesterification or esterification of triglycerides or fatty acids gives Biodiesel that are renewable, biodegradable, eco-friendly and non-toxic fuel. In the recent years Biodiesel is considerably used as substitute for diesel due to depletion of fossil fuels like petroleum and coal. In India considerable efforts are being taken on the production and utilization of biodiesel. Methyl esters though being less combustive than diesel is a clean burning fuel with nil sulphur emission. No engine adjustments or modifications are needed to use this fuel and efficiency obtained is nearly similar to that obtained by using conventional diesel. Methyl esters produced at low pressure and low temperature conditions are non-corrosive in nature. Bi-product during the transesterification process is 80% concentrated glycerine. Biodiesel produced using base catalysed transesterification process is the most economical process of all. It requires low temperatures and pressures for a conversion yield 98%.

3.1 Transesterification Process

Transesterification is process the commonly used to produce bio diesel. Transesterification process is the reaction of a triglyceride with an alcohol to form esters and glycerol (Arun K. Vuppaladadiyam et al,) [4]. A triglyceride has a glycerine molecule as its base with three long chain fatty acids attached. The characteristics of the fat are determined by the nature of the fatty acids attached to the glycerine. The nature of the fatty acids can in turn affect the characteristics of the biodiesel. During the esterification process, the triglyceride is reacted with alcohol in the presence of a catalyst, like sodium hydroxide or potassium hydroxide (M H Attal et al, Oct 2016) [10]. The alcohol reacts with the fatty acids to form biodiesel and crude glycerol (M Rakib Uddin et al, 2017) [2]. In this research work potassium hydroxide has been used for the ethyl ester biodiesel production. Controllers for non-linear systems has been reported [11-20]

3.2 Experimental set up for Esterification

The experimental set up for esterification is as shown in figure 1. Three 2000ml round –bottom necked flask was used as a reactor. The setup is equipped with a controllable mantle in which the temperature could be controlled within +2^{0}C is used for heating the flask. The side necks of the flask was equipped with a condenser and a thermo well. For temperature measurement of glycerol inside the reactor a thermometer was placed in the thermo well. A motor powered stirrer with a speed regulator was used for mixing purpose.

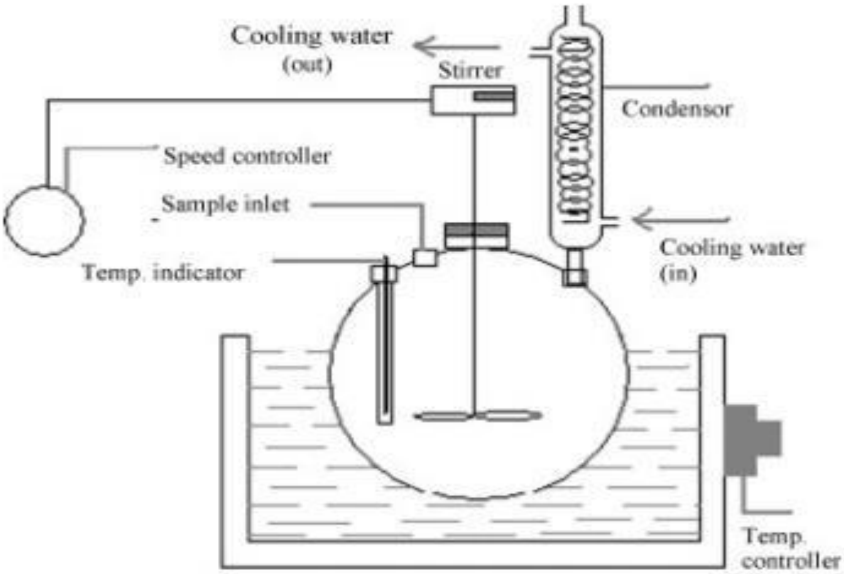


Fig. 1: Experimental setup for preparation of pongamia oil methyl ester (Biodiesel)

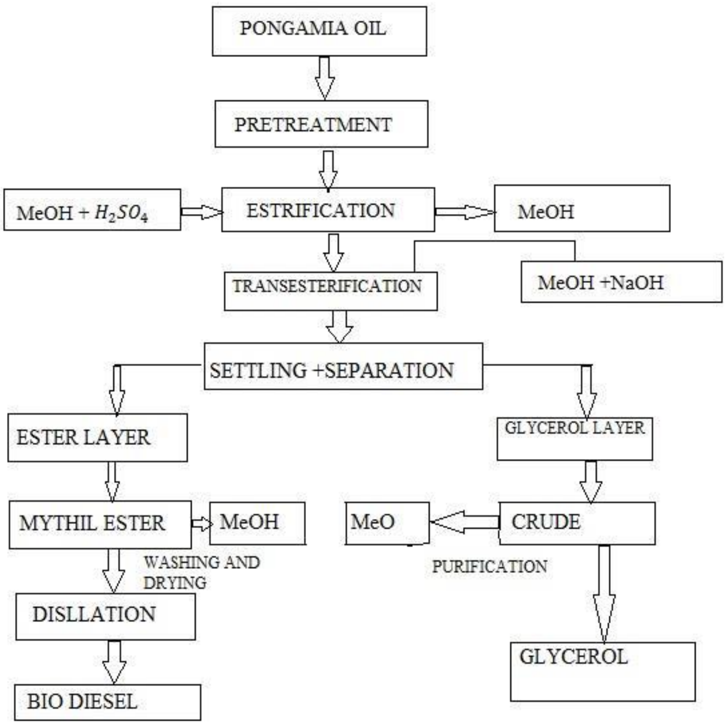


Fig. 2: Flow chart of esterification

4. Experimental Setup of Diesel Engine

4.1 Dynamometer

Dynamometer is used to measure the fuel consumption timing .The fuel passed through dynamometer to the engine, finds the consumption timing of 50ml fuel in engine. In this way dynamometer and monometer readings are taken.

Fig. 3: Dynamometer

4.2 Engine

This engine we used a single cylinder water cooled engine. In this engine load act to electrical load due to it create potential difference. The fuel take from tank is passed through dynamometer for reading and to the engine for the cycle process. The exhaust gas is passed into an oxygen cylinder to measure the emission.

Fig. 4: Diesel Engine

4.3 Load Controller

In this we use a digital type load controller. The input is taken by potential electrical load method. The load indicator shows applied load to engine in kg. We apply 0kg,1.8kg,3.6kg,5.4kg,7.2kg and 9kg. According to it the readings are taken for fuel consumption and its emission readings are noted.

Fig. 5: Digital Load Controller

4.4 Emission Sensing Unit

In diesel engine, particulate matter a major role in exhaust pollutants. Particulate matter consider of substance, particles and water. The substance are removed of by filtering the gas the particular consider of carbon particles and unburned hydrocarbons which are absorbed by some organic compound, which we use

Fig. 6: Emission Sensing Unit

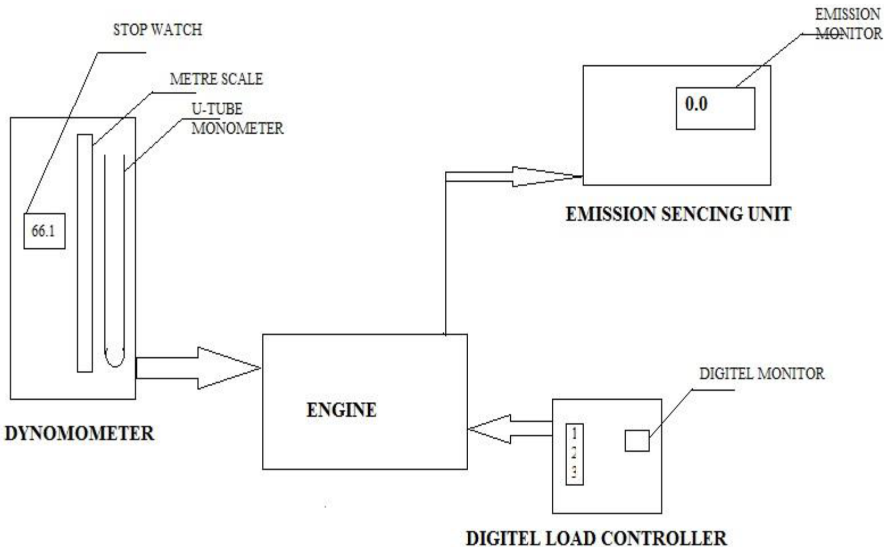


Fig. 7: Block Diagram of Experimental Engine setup

5. Experimental Setup of Diesel Engine

We are used in the alternative fuel select the pongamia Bio diesel with diesel in different blending ratios. The ratios are

- Diesel 100%
- Pongamia bio diesel 50% and Diesel 50%
- Pongamia bio diesel 100%

In this project we used single cylinder four stroke diesel engine. This engine cooled by the water. This engine connected with dynamometer. Also connected with emission sensor unit

5.1 10.1 D 100

Diesel is filled in the fuel tank. Now the engine started. Initial load is 0 kg selected in the digital load controller. The fuel passed from the tank into the engine through the dynamometer. In the dynamometer the fuel consumption and the monometer reading are noted. Exhaust gas from the engine is passed to the oxygen cylinder through the drum. The oxygen cylinder connected to the emission control meter used to the exhaust gases and their particulate. Co, $Co2$, Nox, and smoke readings.

Then add load 1.8 kg to the load control then take above readings repeat the same procedure for different load conditions. The load conditions are, 1.8 kg, 3.6 kg, 5.4 kg, 7.2 kg and 9 kg.

5.2 10.2 B 50

The above same procedure repeat for the B50 composition and also noted the speed and emission parameters.

The load conditions are, 1.8 kg, 3.6 kg, 5.4 kg, 7.2 kg and 9 kg.

5.3 10.3 B 100

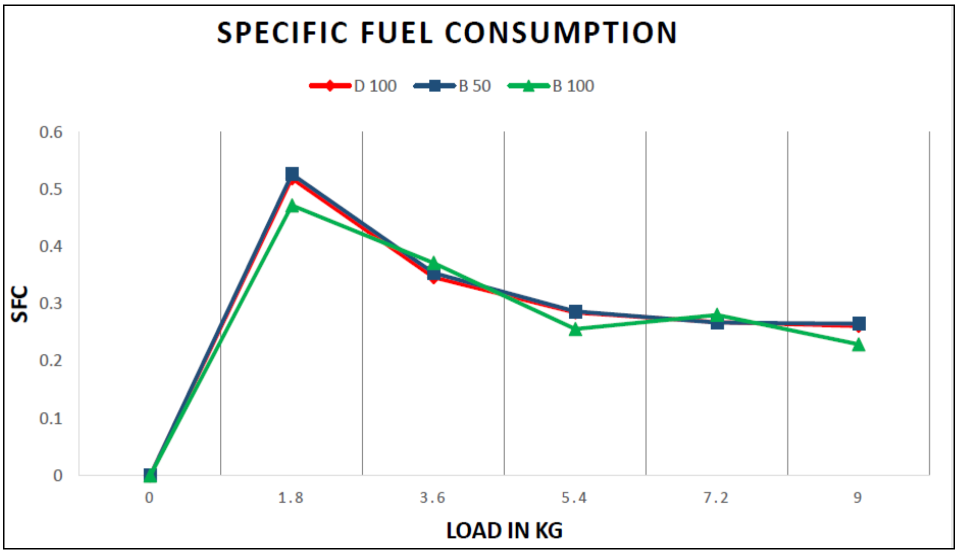
Pongamia is filled in the fuel tank. The above same procedure repeat for the B100 composition and also noted the speed and emission parameters (K.Nantha Gopal et al, March 2015) [5] and (K.Nantha Gopal et al, June 2014) [6] and (S.V Baste et al, August 2013) [7].

Fig. 8: Pongamia bio diesel

6. Results and Discussion

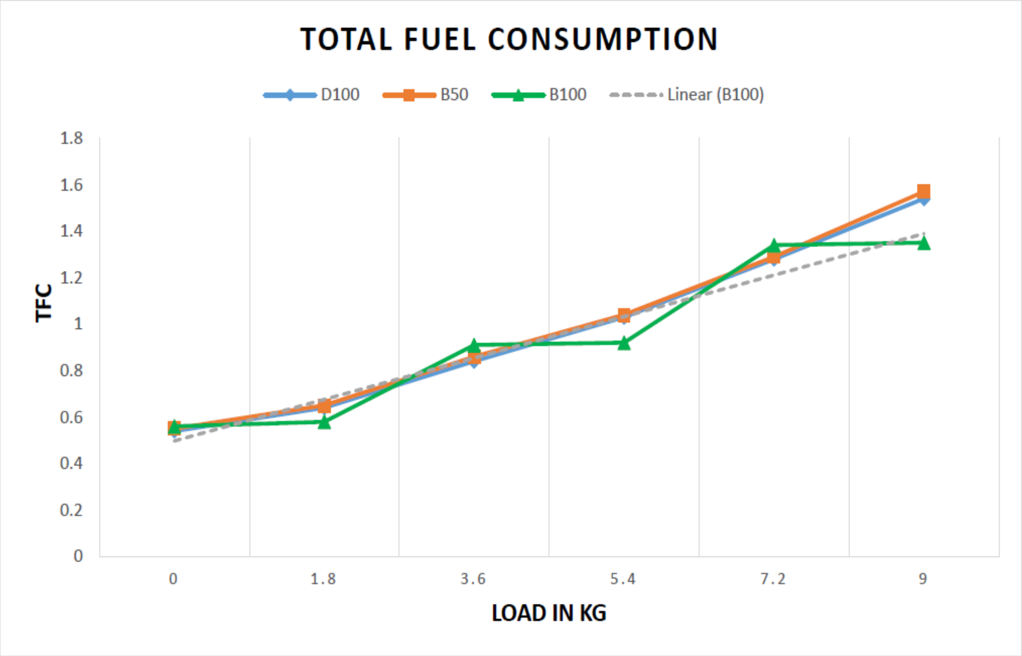
6.1 Load vs Specific Fuel Consumption (D100, B50& B100)

In diesel engine consumption of the alternative fuel about D100, B50 and B100.In D100 at the engine runs at a load about 1.8kg in that load the specific fuel consumption is 0.5.In D50 the engine runs at same load of 1.8kg in this specific fuel consumption is 0.51 but B100 composition the engine runs at the same load the specific fuel consumption is reduced to 0.45 due to this composition smoke and emission range is high.



6.2 Load vs Total Fuel Consumption (D 100,B 50, B100)

The total fuel consumption B100 is 0.5 at the 1.8 kg and it is increase step by step for various load change up to 9kg of load the total fuel consumption is 2.4.In B50 fuel tfc is 0.5 at 1.8kg and increase 2.6at the load of 9kg.But D100 tfc is same as B50 tfc at 1.8 kg of load and its increase to 2.5 at the load of 9 kg. It is slightly less than B100 at 9 kg of load. The total fuel consumption B100 is 0.5 at the 1.8 kg and it is increase step by step for various load change up to 9kg of load the total fuel consumption is 2.4.In B50 fuel tfc is 0.5 at 1.8kg and increase 2.6at the load of 9kg.But D100 tfc is same as B50 tfc at 1.8 kg of load and its increase to 2.5 at the load of 9 kg. It is slightly less than B100 at 9 kg of load.

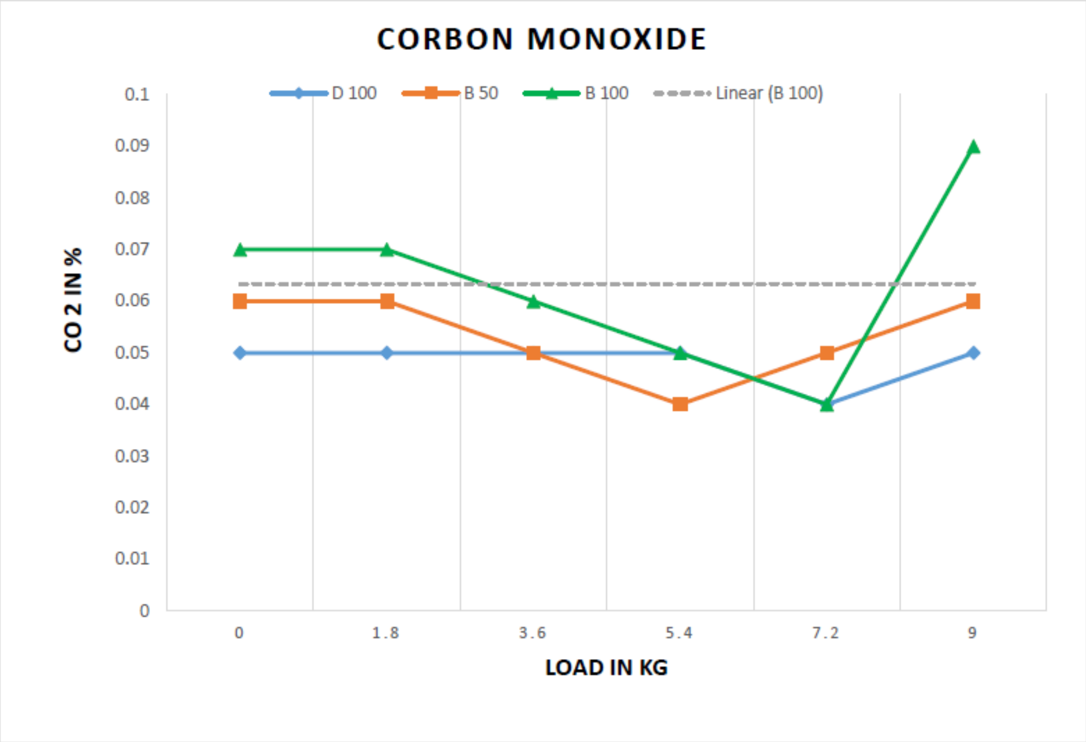


6.3 Load vs Efficiency (D 100,B 50,B 100)

In B100 the efficiency 17% of load at 1.8 kg and at 9 kg it is increase to 35%.In B50 the efficiency is 15% at the load 1.8 kg and it is increase 30% but in D100 efficiency is 15% of at the load 1.8 kg and it is increase 32% at the load 9kg.

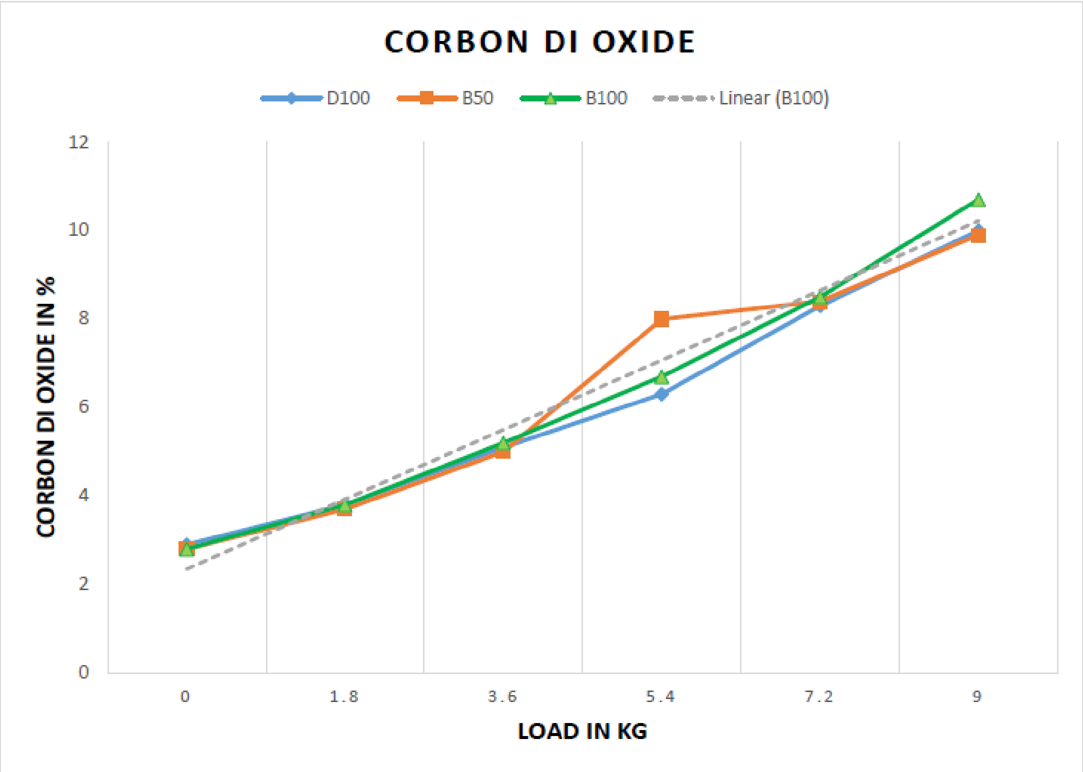
6.4 Carbon Monoxide for D100,B50 AND B100

Carbon monoxide is 0.07ppm at the load of 1.8 kg in B100and its increase to 0.09 ppm at the load 9 kg. In B50 ratio the carbon monoxide is less than B50 in 0.06 ppm and decreased in 5.4kg.The B100 carbon monoxide value is high compare to B50 and D100.



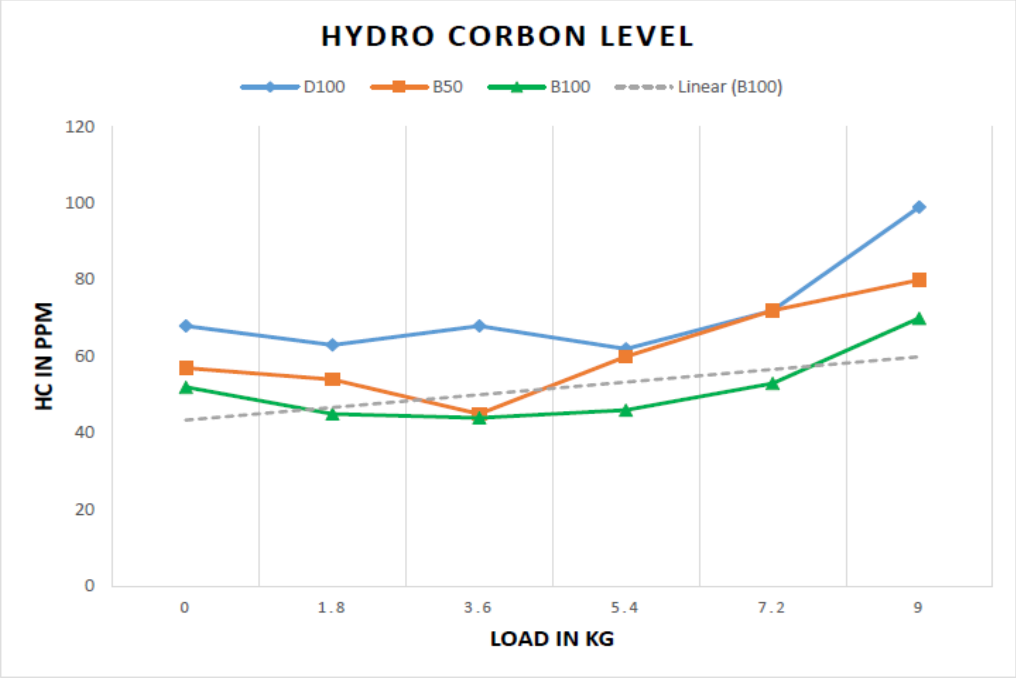
6.5 Carbon Dioxide for D100, B50 and B100

Carbon dioxide is 2.5 ppm for 1.8 kg and increase to 10.5 ppm at the load of 9 kg for B100.In the B50 carbon dioxide is 2.5 ppm at the load of 1.8 kg and it increase 10 ppm at the load of 9 kg .But D100 the carbon dioxide level is 3 ppm at the load 1.8 kg and it is increase 10 ppm at the load of 9 kg.



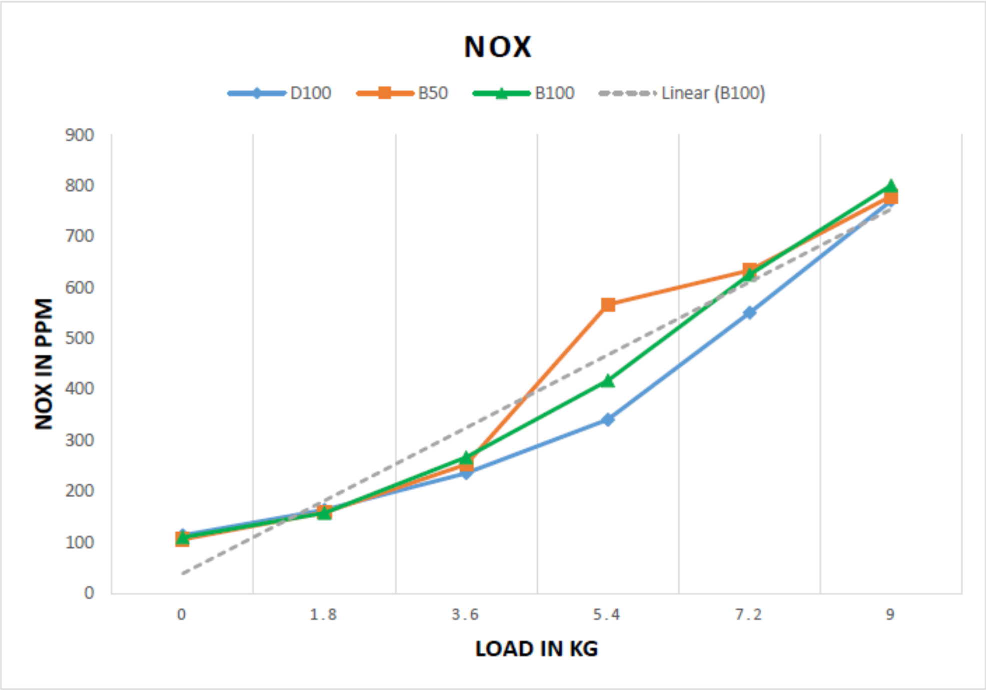
6.6 Hydro Carbon for D100,B50 and B100

In the B100 hydro carbon in 52 ppm at the load 1.8 kg and it is increase to 70 ppm at the load 9 kg. In the B50 hydro carbon in 57 ppm at the load 1.8 kg and it is increase to 80 ppm at the load 9 kg. In the D100 hydro carbon in 68 ppm at the load 1.8 kg and it is increase to 99 ppm at the load 9 kg.



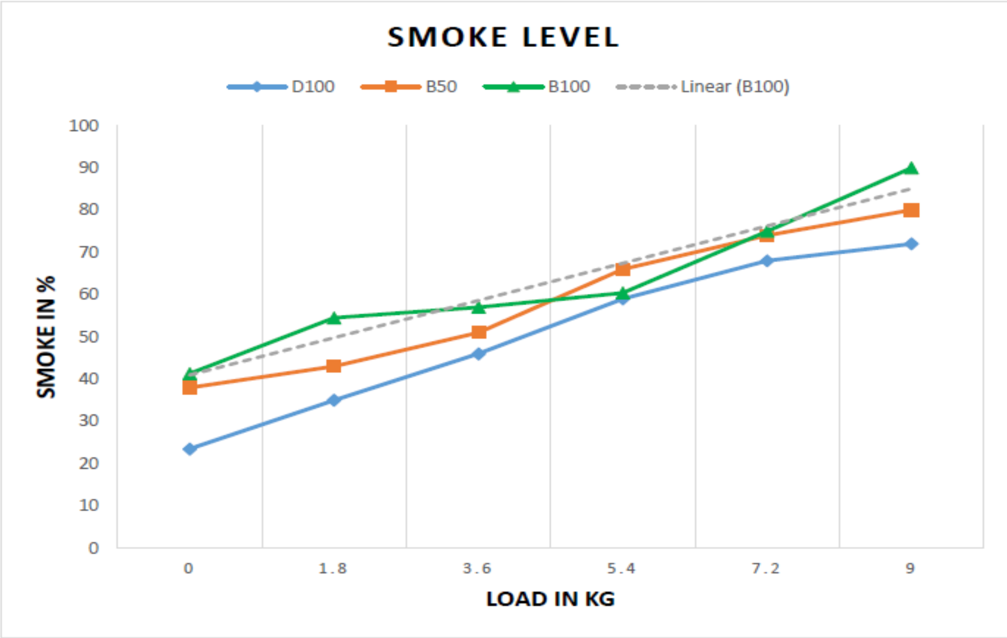
6.7 Nox for D100, B50 and B100

In the B100 Nox in 110 ppm at the load 1.8 kg and it is increase to 801 ppm at the load 9 kg. In the B50 Nox in 110 ppm at the load 1.8 kg and it is increase to 780 ppm at the load 9 kg. In the D100 Nox in 110 ppm at the load 1.8 kg and it is increase to 711 ppm at the load 9 kg.



6.8 Smoke for D100,B50 and B100

In the B100 smoke percentage is 41.3% at the load 1.8 kg and it is increase to 90% at the load 9 kg. In the B50 smoke percentage is 38% at the load 1.8 kg and it is increase to 80% at the load 9 kg. In the D100 smoke percentage is 23% at the load 1.8 kg and it is increase to 72% at the load 9 kg.



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