Fuel Efficiency and Exhaust Emission Test Using Blending of Soybean Biodiesel in Tractor

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Abstract

Agriculture plays a vital role in the Indian economy. Over 70 per cent of the rural households depend on agriculture. As India is an agricultural country, there is a wide scope for the production of vegetable oils (both edible and non-edible) from different oily seeds. The main objective of this paper is to reduce the cost and exhaust emissions from diesel engine with using biodiesel as a fuel and compared with the diesel fuel. In this experiment, soybean biodiesel is used as fuels in four stroke, three cylinder, water cooled diesel tractor. An experimental investigation has been carried out to evaluate the emission characteristics of a diesel engine fuelled with soybean biodiesel-diesel blends (25%) and important fuel properties have also been determined. The exhaust emissions include hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxide (NO_x) and smoke density. The results shows that the fuel consumption and $NO_x$are increased and the other exhaust emissions are reduced when used biodiesel as a fuel compared with the diesel. Fuel efficiency is also decreased while used biodiesel. The other advantage is that the cost of this blending fuel is also reduced due to the low cost rate of the soybean biodiesel.

KeyWords: Diesel, Soybean biodiesel, Exhaust emissions, Diesel tractor

1.Introduction

Today farmer's condition is very pathetic. Major portion of today's energy demand in India is being met with fossil fuels. So, finding the alternative fuels is the right time in the engine. There are many types of alternative fuels can be used like biofuel, biodiesel, LPG, CNG, Biogas etc. which can be used in diesel engine. Due to more oxygen availability, biodiesel gives better result using in diesel engine. Previously vegetable oils were not acceptable due to its expensive price. But due to the recent increase in petroleum prices and uncertainties concerning petroleum availability renewed the interest in non-edible vegetable oil fuels for diesel engines.Biodiesel can be used with or without modification in the engine. Biodiesel is made entirely from vegetablesources, it does not contain any sulfur, aromatichydrocarbons, metals or crude oil residues.There are many types of biodiesels like sunflower, soybean, jatrofa, cotton seeds, sunflower, palm, etc. which can be used in diesel engine by partially or fully replaced to diesel. The concept of blending the biodiesel with diesel is to reduce the exhaust emissions level of a diesel engine. Generally, diesel engine contains exhaust emissions like NO_x, HC, CO etc.

2. Literature Survey

Jiantong Songet al. (2013) [1],it is investigated that biodiesel is a renewable and environmentally friendly alternative fuel derived from natural fats or vegetable oils and it is considered as an attractive alternative to replace diesel fuels. Experimental results show that, compared with diesel fuel, with increase in the biodiesel in the blends, the brake power and torque and the brake specific energy consumption increase. The trade-off relationship is clear between the NO_X and smoke density when the diesel engine fueled with different biodiesel percentage in the blends. From the trade-off relationship between NO_X and smoke density, the optimum blend ratio is B20 in the experimental study.

Chandragowda Met al. (2014) [2], have focused only on non-edible oils like rubber seed oil as fuel for C.I engine. The main objective of this paper is to study the performance and emission characteristics of a multi cylinder, constant speed diesel engine using rubber seed oil & compared with the diesel fuel. A four stroke multi cylinder diesel engine was used to study the brake thermal efficiency, brake specific fuel consumption and emissions from zero loads to full load for both diesel and rubber seed oil. From this experiment, the results show that the rubber seed oil shows better performance characteristics like Brake thermal efficiency, and decrease in the emission parameters like CO, HC.

B.L. Maharana,et al. (2015) [3], have studied the palm oil is effectively converted to bio-diesel and its blending with pure diesel has been taken for the experimental work to evaluate the performance of four stroke diesel engine. The experimental result shows that the performance of diesel engine was satisfactory with the use of biodiesel in contrast to pure diesel.

Vaneet Bhardwaj,et al. (2013) [4]. In this research work, waste mustard biodiesel-diesel fuel blends as alternative fuels for diesel engines were studied. An experimental investigation has been carried out to evaluate the performance and emission characteristics of a diesel engine fuelled with waste mustard biodiesel-diesel blends (10%, 15% and 20%) and important fuel properties have also been determined. The waste mustard biodiesel-diesel fuel blends were tested in a single cylinder direct injection diesel engine. Engine performance and exhaust emissions were measured while the engine running at no, part and full load condition. It concluded that B10 blend of waste mustard biodiesel act as best alternative fuel among all tested fuel at full load condition.

Simit B. Prajapatiet al. (2012) [5], have investigated Dimethyl carbonate (DMC) and ethylene glycol mono-acetate (EGM) are two hopeful alternative fuels as well as fuel additives to improve performance and emissions in CI engine, due to their high oxygen content. This paper presents an experimental study on their effects on the performance and emissions characteristics of CI engine. Test results show that brake thermal efficiency for the DMCEGM05 blends is higher than that of diesel blend while in the case of DMCEGM10 and DMCEGM15 blends it is lower. The blends of diesel with 10% DMC and EGM by volume is the best fraction for reduction of smoke and CO emissions. The obtained results show that the fuel which effectively reduces the CO emissions is less effective in reducing the NO_X emissions. All these results indicate the potential of the DMC-EGM-diesel blends for clean combustion in diesel engine. The blends of diesel with 15% DMC and EGM by volume is the best fraction for reduction of smoke and CO emissions.

3. Experimental Set Up and Procedure

The experimental work is carried out on three-cylinder, four stroke, water cooled, 35 HP kirloskar diesel engine tractor. The tractor was manufactured by swaraj 735 FE as shown in following figure 1.

Figure 1. 3-Cylinder, Kirloskar Diesel Engine Tractor

3.1 Specification of Tractor

Table 1. Tractor Specification

Engine Type	4-stroke, Direct injection, Diesel engine
Displacement	2734 CC
RPM	2000
HP range	35 HP
No. of cylinders	3
Fuel Tank Capacity	47 liters
Cooling system	Water cooled

The experimental set up is shown in the figure 2. The engine specifications are shown in table 1. In this test, soybean biodiesel have been taken with partially replace the diesel fuel at variable engine speed ranging from 800 rpm to 2000 rpm. The fuel consumption, average and exhaust emissions reading has been measured at every speed. At each speed, reading is taken three times and the result of the three repetitions were averaged.

Figure2. Test Setup

At each speed, the time has been measured after burning 1 liter fuel as calculate the fuel consumption and average of that tractor [2]. The exhaust emissions are measured by the multi-gas analyzer. The smoke density is measured by the smoke meter.

4. Properties of Fuels

Table 2. Properties of Fuels[16]

Sr No.	Properties	Diesel	Soybean Biodiesel	D75B25
1	Calorific Value (kJ/kg)	43200	38080	40820
2	Density (kg/m^3)	832	900	844
3	Flash Point (℃)	70	164	79
4	Fire Point (℃)	72	166	81
5	Kinematic Viscosity @40℃ (mm^2/s)	2.63	4.21	4.13

5.Results and Discussion

[1] Fuel Consumption (F.C.) :

Figures 3, shows the variation in F.C. level with respect to diesel, soybean biodiesel and at different speeds. From the graph it is clear that the F.C. level increases when soybean biodiesel as a fuelcompared with the diesel.

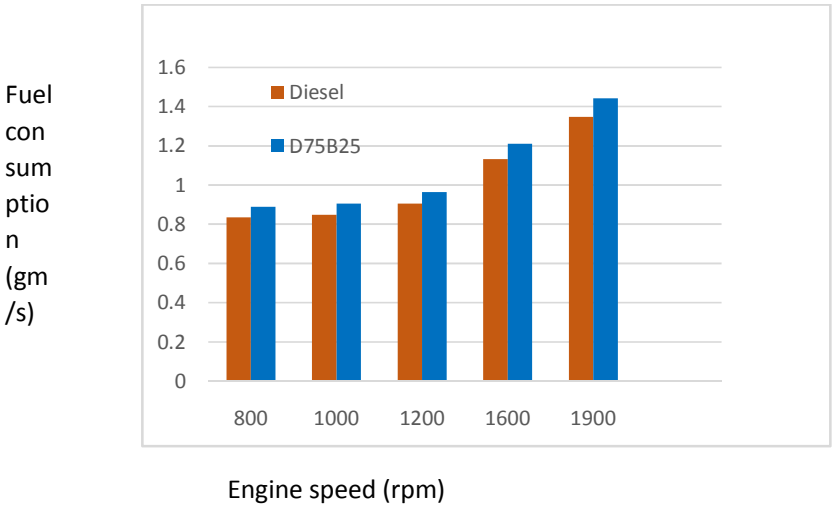

Figure 3. Comparison of F.C. vs Engine Speed

[2] Fuel efficiency:

Figures 4, shows the variation in distance level (km/lit) with respect to diesel, soybean biodiesel at different speeds. From the graph it is clear that the distance level decreases when soybean biodiesel as a fuel compared with the diesel.

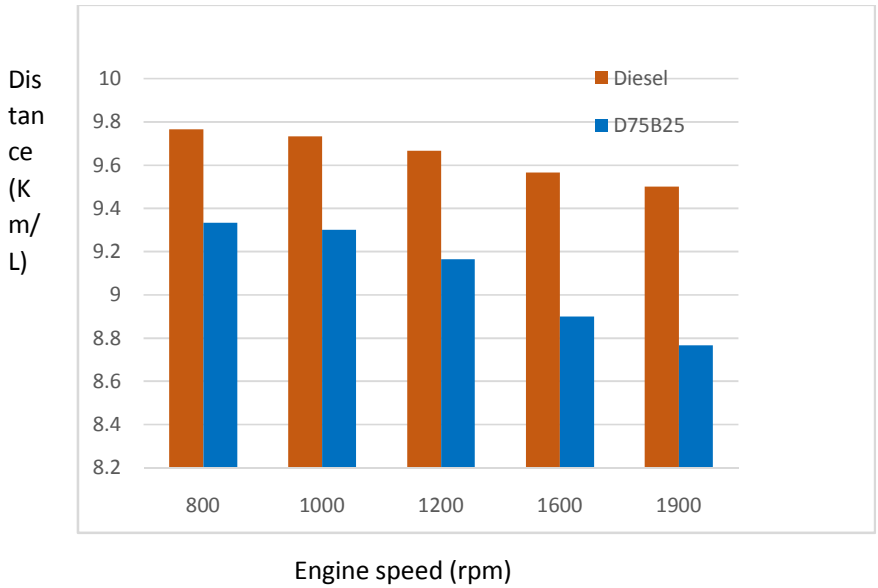

Figure 4 Comparison of Distance vs Engine Speed

[3] Hydrocarbon (HC):

Figures 5, shows the variation in HC level with respect to diesel, soybean biodiesel at different speeds. From the graph it is clear that the HC level decreases when soybean biodiesel as a fuel compared with the diesel.

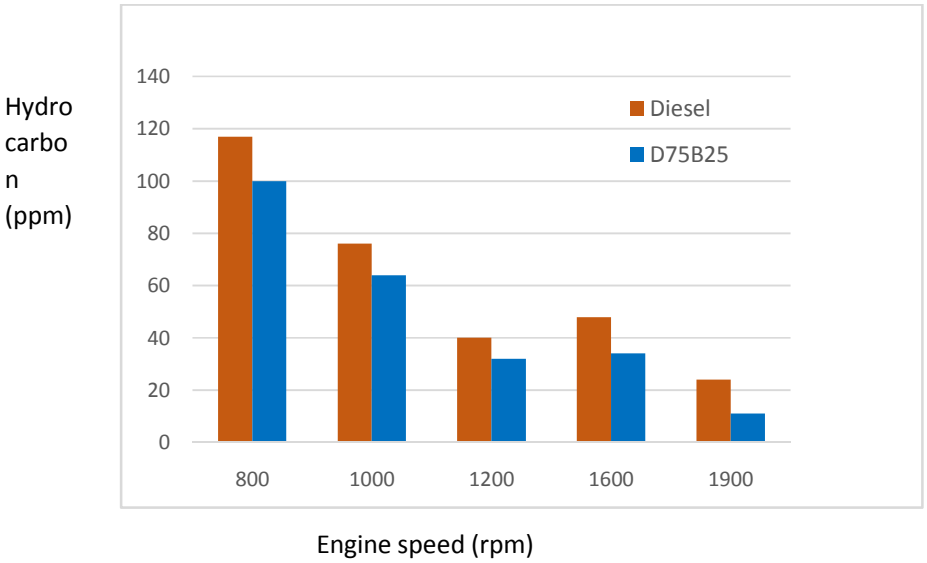

Figure 5. Comparison of HC vs Engine Speed

[4] Nitrogen Oxide (NO_X):

Figures 6, shows the variation in NO_X level with respect to diesel, soybean biodiesel at different speeds. From the graph it is clear that the NO_X level increases when soybean biodiesel as a fuel compared with the diesel.

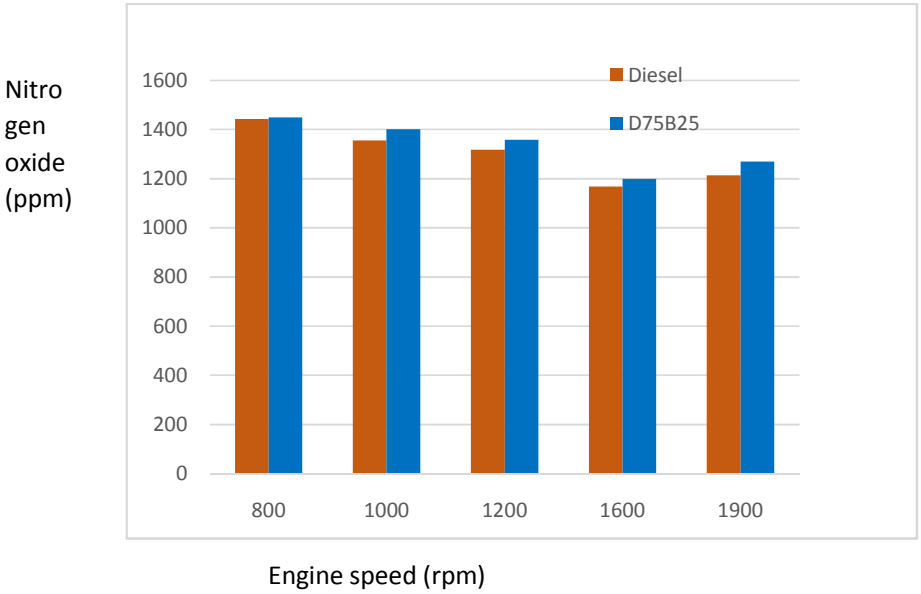

Figure 6. Comparison of NO_X vs Engine Speed

[5] Carbon Monoxide (CO):

Figures 7, shows the variation in CO level with respect to diesel, soybean biodiesel different speeds. From the graph it is clear that the CO level decreases when soybean biodiesel as a fuel additive compared with the diesel.

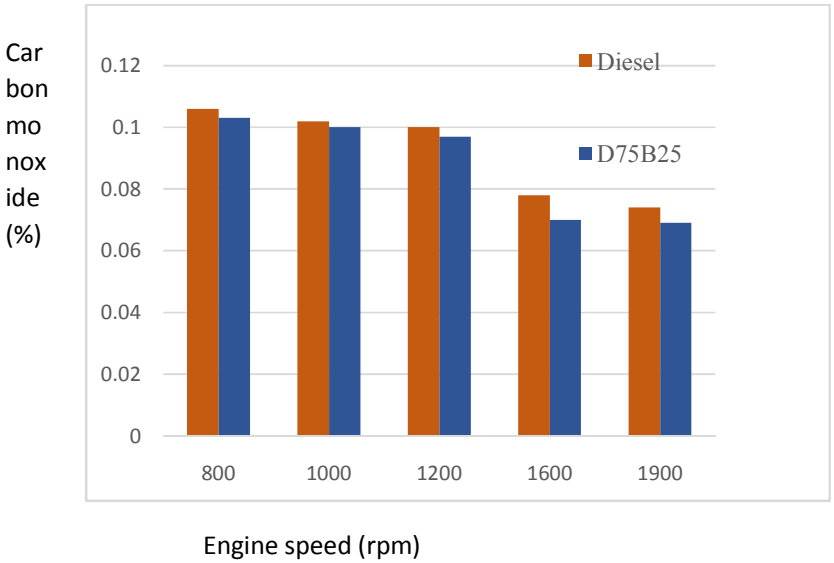

Figure 7. Comparison of CO vs Engine Speed

[6] Carbon Dioxide (CO_2):

Figures 8, shows the variation in CO_2 level with respect to diesel, soybean biodiesel at different speeds. From the graph it is clear that the CO_2 level decreases when soybean biodiesel as a fuel compared with the diesel.

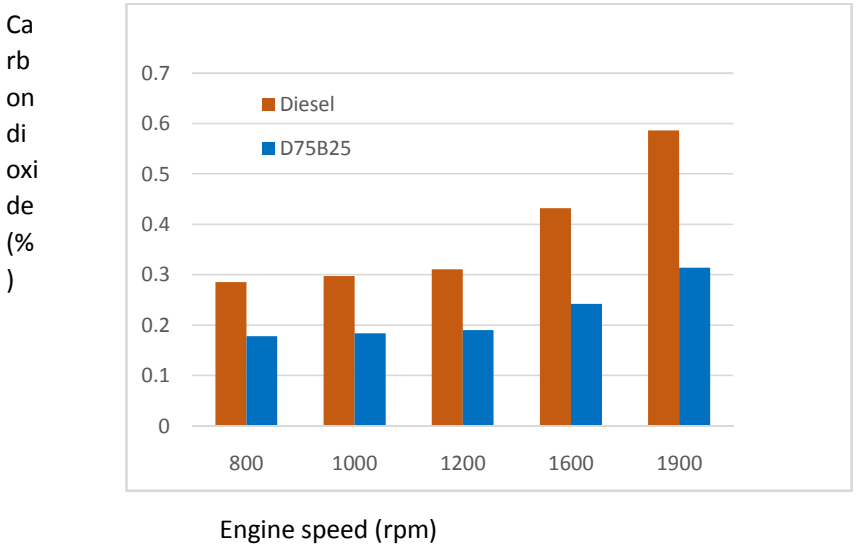

Figure 8. Comparison of CO_2 vs Engine speed

[7] Smoke Opacity:

Figures 9, shows the variation in smoke opacity level with respect to diesel, soybean biodiesel at different speeds. From the graph it is clear that the smoke opacity level decreases when soybean biodiesel as a fuel compared with the diesel.

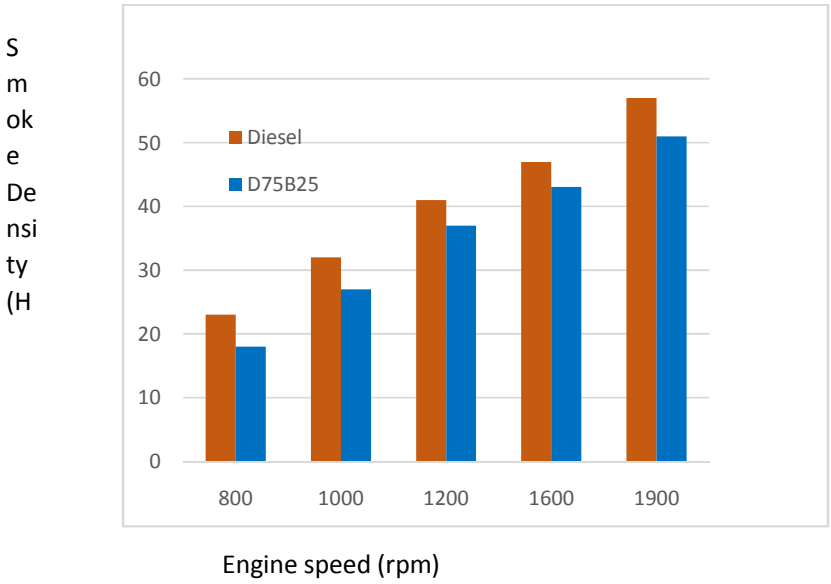

Figure 9. Comparison of Smoke Opacity vs Engine Speed

6. Conclusion

From this experiment, it is concluded that the diesel engine tractor run on blending of diesel-biodiesel as a fuel results better improvement on the exhaust emissions like HC, CO, CO_2 and smoke opacity. The NO_X increases by using diesel-biodiesel blends and another emissions decreases. The HC, CO, CO_2, emissions are reduced by 21.1%, 18.4% and 19% in diesel-biodiesel blends Cost is also reduced of that blending fuels than the diesel. The fuel consumption is increased by using biodiesel.

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