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A Research Paper : "Performance and Emission Measurement of CI engine using Blend Of Biodiesel And Diesel with Additives system-D, Bardahl & Stadayne "

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Abstract

The depletion of world petroleum reserves and the increased environmental concerns have stimulated the search for alternative sources for petroleum-based fuel, including diesel fuels. Because of the closer properties, biodiesel fuel from non-edible oil is considered as the best candidate for diesel fuel substitute in diesel engines. With increasing demand on the use of fossil fuels, stronger threat to clean environment is being posed as burning of fossil fuels is associated with emissions like CO2, CO, HC, NOx and particulate matter and are currently the dominant global source of emissions. The harmful exhaust emissions from the engines, rapid increase in the prices of petroleum products and uncertainties of their supply have jointly created renewed interest among the researchers to search for suitable alternative fuels. The objective of this research is to determine the relationship between engine performance and emissions using diesel , volumetric blends of Neem bio-diesel and diesel , pure Neem bio-diesel and volumetric blends of Neem bio-diesel, diesel and additives (system-D,Bardahl and stadyne) as a fuel in a multi cylinder, four stroke,water cooled, direct injection CI engine. The objective of this research is to determine the relationship between engine performance and emissions using diesel, volumetric blends of Neem bio-diesel and additives as a fuel in a multi cylinder, four stroke, water cooled, direct injection CI engine.

***Keywords*- biodiesel,neem oil,additive.**

Introduction

Conventional energy sources such as oil, coal and natural gas have limited reserves that are expected not to lost for an extended period. World primary demand is projected to increase by 1.5% per year between 2007 to 2030, from just over 12,000 million tonnes of oil equivalent to16800 million tones-as overall increase of 40%. As world reserves of fossil fuels and raw material are limited, it has stimulated active research interest in non petroleum and non polluting fuels. Diesel engines are the major source of power generation and transportation hence diesel is being used extensively, but due to the gradual impact of environmental pollution there is an urgent need for suitable alternate fuels for use in diesel engine without any modification. There are different kinds of vegetable oils and biodiesel have been tested in diesel engines its reducing characteristic for green house gas emissions. Its help on reducing a country's reliance on crude oil imports its supportive characteristic on agriculture by providing a new market for domestic crops, its effective lubricating property that eliminates the need of any lubricate additive and its wide acceptance by vehicle manufacturers can be listed as the most important advantages of biodiesel fuel. There are more than 350 oil bearing crops identified, among which only Jatropha, ongamia, sunflower, Soyabean, cottonseed, rapeseed, palm oil and peanut oil are considered as potential alternative fuels for diesel engines. The present study aims to investigate the use of neem oil blend with diesel and with additives as an alternate fuel for compression ignition engine

Bio-Diesel

Bio-diesel is fatty acid methyl or ethyl ester made from virgin or used vegetable oils (both edible & non-edible) and animal fats. The main commodity sources for bio- diesel in India can be non-edible oils obtained from plant species such as Jatropha Curcas, Karanj, Neem, Mahua etc. Bio-diesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a bio-diesel blend or can be used in its pure form.

Bio-Diesel in India

About 400 wild species found in India produce non edible oils that can be converted to bio-diesel.[2] A salient feature of India's

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bio fuel program is to only utilize wastelands, degraded forest, and non-forest lands for cultivation of oil seed plants. Of about 55 million ha of wastelands in India, about 32 million ha are suitable for biodiesel production.[2] The available information about wasteland suitability for oil seed plantations is incomplete, and a proper wasteland mapping exercise should precede any major bio-diesel development program in India. The demand of diesel (H.S.D) is projected to grow from 39.81 Million Metric Tonne in 2001-02 to 52.32 MMT in 2006-07 @ 5.6% per annum.[2] Our crude oil production as per the TenthPlan working Group is estimated to hover around 33-34 MMT per annum even though there will be increase in gas production from 86 MMSCMD (2002-03) to 103 MMSCMD in (2006-07).[2] The estimated bio-diesel requirements for blending with petro-diesel over the period of next 5 years.

Neem Biodiesel

A neem tree can produce many thousands of flowers. In one flowering cycle, a mature tree may produce a large number of seeds. Neem trees start bearing harvestable seeds within 3-5 years, and full production may be started in 10 years, and this will continue up to 150-200 years of age.[4] A mature neem tree may produce 30-50 kg of fruit each year.[4] By rough estimate India has nearly 20 million neem trees. Indian neem trees have a potentials to provide one million tonnes of fruits per year and 0.1 million tons of kernels per years (assuming 10% kernel yield). Neem seeds yield 40-60% oil.[4] Neem oil can be used as fuel in diesel engines directly and by blending it with Methanol. Engine tests with neem oil and neem biodiesel were done in India and Bangladesh, showing satisfactory engine performance of neem biodiesel were found to be higher as compared to diesel.

Fuel Additives

Fuel additives are the chemicals that are used to enhance the properties of the fuel to which these are added these are mixed with fuel such as gasoline, diesel, aviation fuel, fuel oil, etc. to improve fuel efficiency and economy. These help the fuel in meeting environmental emission control standards and improve engine or vehicle performance. Apart from these qualities, the fuel additives serve other purposes such as reduction of corrosive effects, enhance combustion properties, and develop various grades of fuel blends required for various commercial, automotive, industrial, and aerospace sectors. Fuel additives are designed to meet the increasingly stringent environment norms as various countries are implementing regulations to control emissions. Stringent environmental regulations, increasing demand for clean and efficient fuel, and depleting crude reserves are the main market drivers of the fuel additives market.

LITERATURE REVIEW

Atul Dhar et al.[11] investigated performance of CI engine using non-edible oil and blend of oil with diesel produced from Neem. A wide range of engine loads and volumetric blends of 5% Neem bio-diesel and 95% diesel, 10% Neem bio-diesel and 90% diesel, 20% Neem bio-diesel and 80% diesel, 50% Neem bio-diesel and 50% diesel are used for performance measurement of vertical, four stroke, single cylinder, constant speed, direct injection, water cooled, compression ignition engine of Kirloskar oil engine model no. DM-10. **R.Senthilkumar et al.[12]** investigated the performance and combustion characteristics of Kirloskar made, single cylinder, naturally aspirated, water cooled, direct injection diesel engine running on diesel, volumetric blends of 10% Neem bio-diesel and 90% diesel, 30% Neem bio-diesel and 70% diesel, 40% Neem bio-diesel and 60% diesel, 50% Neem bio-diesel and 50% diesel. Nishant Tyagi et al.[13] evaluated the performance and emission characteristics of C I engine using diesel, 10% Neem bio-diesel and 90% diesel, 20% Neem bio-diesel and 80% diesel, 30% Neem bio-diesel and 70% diesel.The following performance and emission parameters investigated.

Brake Thermal Efficiency

Atul Dhar et al.[11] reported that brake thermal efficiency was highest among all test fuels. All blends showed higher brake thermal efficiency than mineral diesel. Researcher found 20% efficiency with mineral diesel, 23% efficiency with pure bio-diesel of 100% blend, which is 15% higher. They attributed this increase in brake thermal efficiency is due to presence of oxygen in the bio-diesel molecules which improves the combustion efficiency. **R.Senthilkumar et al.[12]** observed that the brake thermal efficiency of blends 10% Neem bio-diesel and 90% diesel, 20% Neem bio-diesel and 80% diesel are almost very close to brake thermal efficiency of diesel. Brake thermal efficiency found 24.7% brake thermal efficiency by using pure diesel while 25.1% brake thermal efficiency by using 30% Neem bio-diesel and 70% diesel, which is 1.63 % higher for blend 30% Neem bio-diesel and 70% diesel than pure diesel. They attributed this due to presence of increased amount of oxygen in respective fuels, which might have resulted in its improved combustion as compared to pure diesel**. Nishant Tyagi et al.[13]** observed that break thermal efficiency of B10 is very close to break thermal efficiency of pure diesel. Researcher found 28% brake thermal efficiency by using pure diesel while 31% brake thermal efficiency by using 20% Neem bio-diesel and 80% diesel. Brake thermal efficiency of B20 is

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14.2 % higher than break thermal efficiency of pure diesel due to the more oxygen content. Researcher attributed that an increase in break thermal efficiency may be attributed to the complete combustion of fuel because of oxygen present in blends perhaps also help in combustion of fuel.

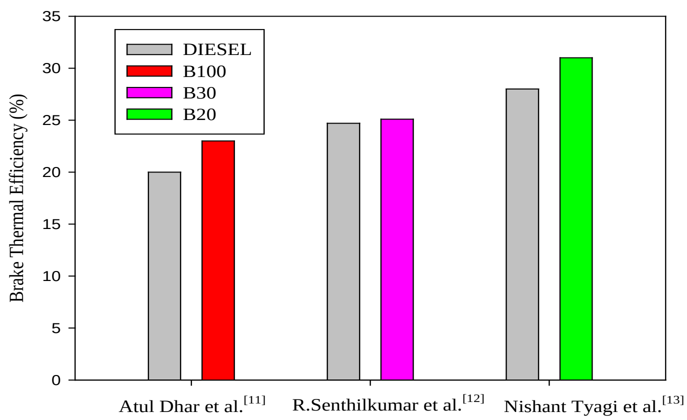

Figure 1 Variation in Brake Thermal Efficiency for different Fuel.

Brake Specific Energy Consumption

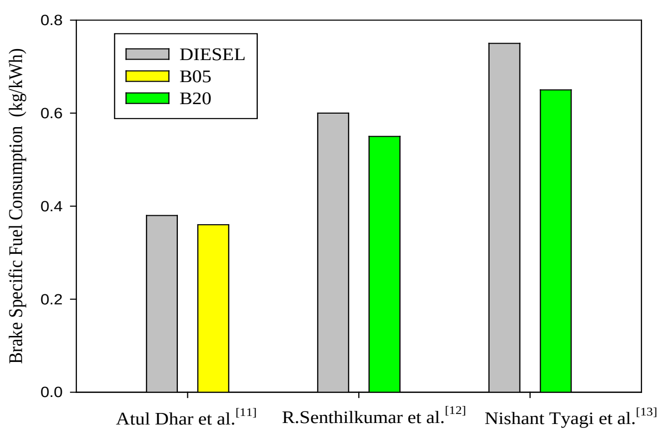

Figure 2 Variation in Brake Specific Fuel Consumption for different Fuel

Atul Dhar et al.[11] observed that BSFC for the bio diesel and its blend increase due to lower calorific value of bio-diesel in comparison with mineral diesel. Researcher found 0.38 kg/kWh BSFC with mineral diesel, 0.36 kg/kWh BSFC with blend 5% Neem bio-diesel and 95% diesel, 0.4 kg/kWh BSFC with blend 100% Neem bio-diesel, which is 5.5% lower Researcher attributed that as the percentage of bio diesel increases break fuel consumption also increases. **R.Senthilkumar et al.[12]** observed that the specific fuel consumption of blends 20% Neem bio-diesel and 80% diesel had 8.33 % lower than specific consumption of mineral diesel. Researcher found 0.6 kg/kWh BSFC with mineral diesel, 0.55 kg/kWh BSFC with blend 20% Neem bio-diesel and 80% diesel, Researcher attributed that this happened due to extra amount of oxygen present on the blend which is taking part in combustion process.

Nishant Tyagi et al.[13] investigated that specific fuel consumption of different load with all percentage of blending was found slightly decrease because of extra oxygen present on the blend which is taking part in combustion process. They observed that the specific fuel consumption of blends 20% Neem bio-diesel and 80% diesel had 13.33 % lower than specific consumption of mineral diesel. Researcher found 0.75 kg/kWh BSFC with mineral diesel, 0.65 kg/kWh BSFC with blend 20% Neem bio-diesel and 80% diesel Due to this extra amount of fuel is burning inside cylinder which improves the efficiency which result decrease specific fuel consumption. Researcher attributed that esterification also help to lower the temperature reaction and viscosity of fuel which result the better combustion. They also observed that we increase the percentage bio-diesel, viscosity start playing and important role in combustion. Because of higher viscosity fuel will not atomize well inside the combustion chamber and results in poor combustion efficiency. They also observed that in B30 blend specific consumption just start increasing because of viscosity comes in to picture at this moment in B10 and B20, viscosity is not predominate so it is found that B20 is having lower specific fuel consumption.

Exhaust Gas Temperature

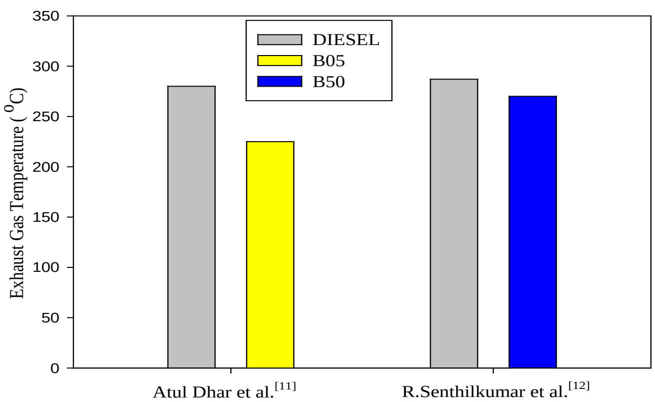

Figure 3 Variation in Exaust Gas Temperature for different fuel

Atul Dhar et al.[11] evaluated that exhaust gas temperature for all bio-diesel blends is lower than mineral diesel. Researcher found 280 oC EGT with pure diesel, 225oC with blend 5% Neem bio-diesel and 95% diesel, 260 oC with blend 100% Neem bio-diesel. Researcher found that 20 % exhaust temperature decrease with 5% Neem bio-diesel and 95% diesel blend compare to mineral diesel. They attributed that combustion of higher bio-diesel blends start relatively earlier and their combustion ends earlier also compare to lower bio-diesel blends R.Senthilkumar et al.[12] evaluated that exhaust gas temperature for all blends of diesel and bio-diesel are lower than the mineral diesel. Researcher found 287 oC EGT with pure diesel, 270 oC with blend 50% Neem bio-diesel and 50% diesel. Researcher found that 6 % exhaust temperature decrease with 50% Neem bio-diesel and 50% diesel blend compare to mineral diesel. Researcher attributed that this happen due to more oxygen present in the bio-diesel and due to that complete combustion is done.

Carbon Monoxide (CO)

Atul Dhar et al.[11] found 60 gm/kWh with pure diesel, 40 gm/kWh with blend 5% Neem bio-diesel and 95% diesel, 53 gm/kWh with blend 100% Neem bio-diesel. Researcher found that 33.33% CO decrease with 5% Neem bio-diesel and 95% diesel blend compare to mineral diesel. Researcher attributed that at higher engine loads, all the bio-diesel blends except 50% blend show significant reduction in CO emissions. Reduction in CO emission is caused by the presence of oxygen molecules in the bio-diesel blends, which facilitates the re burning of CO formed in the cylinder. **R.Senthilkumar et al.[12]** investigated that emission of CO for blends 20% Neem bio-diesel and 80% diesel is 16.67% lower than emission of CO for mineral diesel. They found 60 gm/kWh with pure diesel, 50 gm/kWh with blend 20% Neem bio-diesel and 80% diesel Researcher concluded that these lower emissions of CO may be due to their more complete oxidation as compared to mineral diesel. Nishant Tyagi et al.[13] observed that emission of CO for blends 20% Neem bio-diesel and 80% diesel is 22% lower than emission of CO for mineral diesel. They found 90 gm/kWh with pure diesel, 70 gm/kWh with blend 20% Neem bio-diesel and 80% diesel Bio-diesel produce less carbon monoxide than pure diesel because of better combustion due to extra oxygen present in the blend.

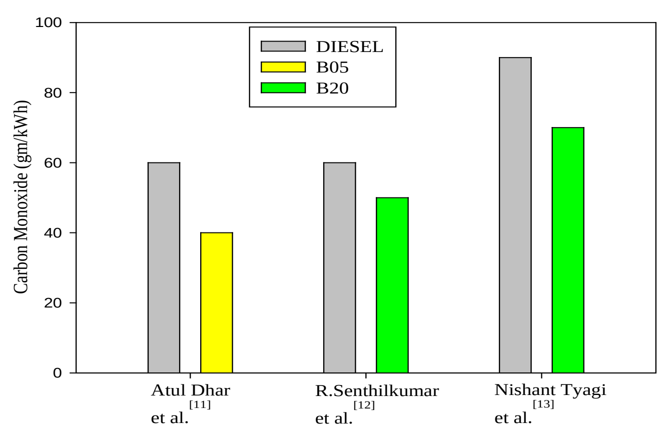

Figure 4 Variation in Carbon Monoxide for different fuel .

Hydrocarbon (HC)

Atul Dhar et al.[11] evaluated that emissions of hydrocarbon is 35.7 % decrease with blends of 20% Neem bio-diesel and

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80 % diesel. They found 70 gm/kWh with pure diesel, 45 gm/kWh with blend 20% Neem bio-diesel and 80% diesel, 50 gm/kWh with blend 100% Neem bio-diesel. They found that all bio-diesel blends exhibit lower the HC emission compared to mineral diesel this may be due to combustion of bio-diesel blends due to presence of oxygen. **R. Senthilkumar et al.[12]** investigated that emissions of hydrocarbons is 36% lower for blend of 20 % Neem bio-diesel and 80 % diesel. They found 50 gm/kWh with pure diesel, 35 gm/kWh with blend 20% Neem bio-diesel and 80% diesel. Compare to pure diesel they attributed that the less emission compare to diesel due to good mixture formation. Nishant Tyagi et al.[13] experimentally found that hydrocarbon emission is 24.24% lower for blends of 20% Neem bio-diesel and 80 % diesel compare to pure diesel They found 33 gm/kWh with pure diesel, 25 gm/kWh with blend 20% Neem bio-diesel and 80% diesel. For B10 and B20 percentage of hydrocarbons decreases because of better combustion which may be attributed to extra oxygen present in they blend but for B20 the percentage of hydrocarbons increases slightly due to insufficient combustion because of higher viscosity which may lead to poor mixture formation due to poor atomization.

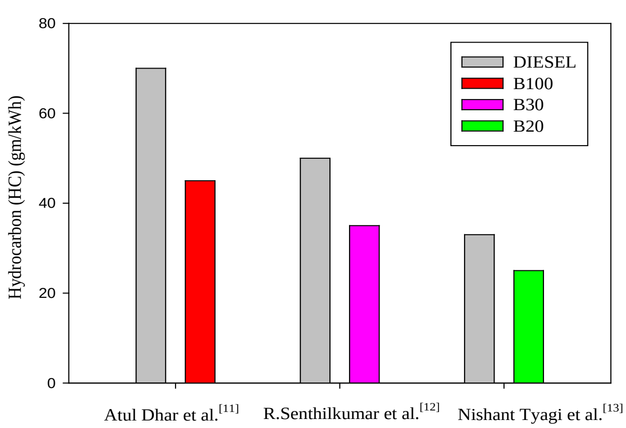

Figure 5 Variation in Hydrocarbon for different fuel .

Effect of Fuel Additive on Bio-diesel blend on Performance of CI Engine

H.H.Masjuki et al.[14] carried out experiment on an indirect injection (IDI) Isuzzu diesel engine which having bore 84 mm, stroke 82 mm, 4 cylinder, compression ratio 21 and maximum power 39 kW at 5000 rpm. They used pure mineral, diesel 20 % palm bio-diesel and 80% mineral diesel and 1% fuel additive octylated/butylated dipahenylamine antioxidant in blend of 20 % palm bio diesel and 80 % pure diesel. **M.Shahabuddin et al.[15]** investigated on diesel fuel powered Issuzu 4 FBI four cylinder diesel engine with the help of 20 % palm oil methyl ester (POME) and 80% diesel with 1% IRGANOR NAPA as corrosion inhibitor, 20 % palm oil methyl ester(POME) and 80% diesel with 2% IRGANOR NAPA as fuel additive and mineral pure diesel. The following results were found by both the experiments.

Brake Power Output

H.H.Masjuki et al.[14] investigated that 35% rise in brake power output using palm bio-diesel 20% and 80% diesel with 1% fuel additive. It is found that fuel PB20X produces of an average of 12.28 kW over the entire speed range while B0 produces 11.93kW over the entire speed range. This can be attributed due to the fuel additive in PB20 blend which influences the conversion of thermal energy in to work or increases the fuel conversion efficiency by improving the fuel ignition and combustion quality. M**.Shahabuddin et al.[15]** investigated that fuel PB20X produces higher brake power over the entire speed range in comparison to other fuels. It is found that fuel PB20X produces an average of 11.50 kW brake power over the entire speed range which is 1.68% higher than fuel PB20. Thus the result implies that the addition of some additive is more effective than additive less fuel and it's also shows that 1% of additive is exhibit higher performance than 2%.because of good combustion quality and reliable fuel viscosity.

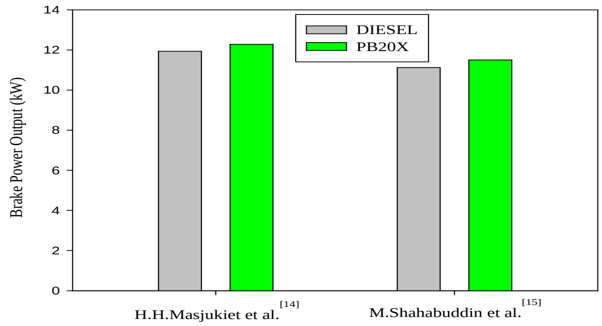

Figure 6 Variation in Brake Power Output for different Fuel with Additive

Brake Specific Fuel Consumption

H.H.MMasjuki et al.[14] investigated that the lowest BSFC is obtained from PB20X fuel followed by B0 and PB20 fuels The average BSFC value all over the speed range are 405 g/kWh, 426.69 g/kWh and 505.38 g/kWh for PB20X, B0 and PB20 fuels respectively. They found 5% lower BSFC with respect to B0, 25% lower BSFC with respect to PB20. **M.Shahabuddin et al.[15]** investigated that the fuel consumption in pure bio-diesel (PB100) is maximum and the bio-diesel PB20X (20% blended bio-diesel with 1% additive) is minimum. It is found that PB100 consumes an average of 711 g/kWh and for fuel PB20X the average consumption is 405 g/kWh and fuel PB20 consumes an average of 536 g/kWh, it clear that the addition of some additives are more effective than PB20. This is due to good combustion ability, reliable viscosity. and good wear properties

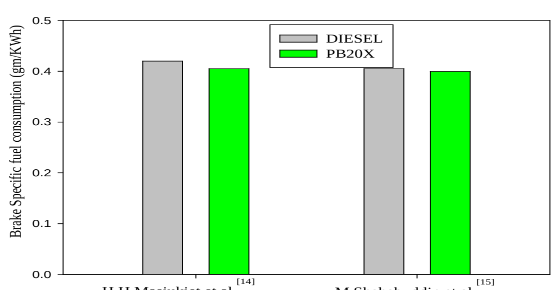

Figure 7 Variation in Brake Specific Fuel Consumption for different fuel with fuel additive

Oxides of Nitrogen (NO_x)

H.H.MMasjuki et al.[14] investigated that the NOx obtained from PB20X fuel is 20% lower than NOx obtained from pure diesel. Researcher found 115 ppm NOx with using pure diesel, while 92 ppm found with using PB20X. It can be examined that NOx increases due to high combustion temperature with lean condition. Hence, individual fuels combustion temperature is responsible to produce NOx emission. It can be revealed from test results that 1% additive is helpful to reduce combustion temperature by allowing high fuel conversion into thermal work as compared to PB20 fuel. **M.Shahabuddin et al.[15]** found 123 ppm with using pure diesel ,while 95 ppm with using B20X.They investigated that the NOx obtained from bio diesel PB20X (20% blended bio-diesel with 1% additive) is 29.47% lower than NOx obtained from pure diesel. This phenomenon shows that PB20X fuel is the optimum composition in order to achieve better fuel quality with less NOx formation. In addition, with the presence of additive, the combustion temperature could be reduced which cause to control the NOx, Moreover the flame temperature also reduced dramatically which cause complete fuel combustion. Another fact is, the blended fuel with additive reduces friction between the cylinder wall and piston thus the heat lose is controlled in the cylinder and result in considerable reduction in NOx. This condition was also observed by several researchers who conducted some studies in terms of flame and combustion stability of oxygenated and renewable fuels.

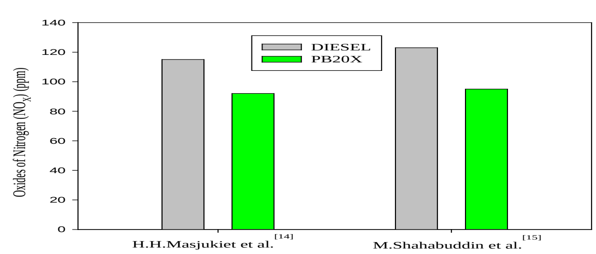

Figure 8 Variation in Oxides of Nitrogen (NO_X) for different Fuel with Additive

Conclusion

This paper presents an overview of the recent investigations in the study that additives are must for bio-diesel production, their storage, transportation in different climatic regions, and usage in a compression ignition engine to have a comparable fossil diesel performance and to realize the dream of using bio-diesels to extend the fossil fuel availability. Hence it is concluded that there is a benefit in addition of additive in neem bio-diesel in terms of better brake thermal efficiency, BSFC and emissions performance.

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