

Emission Analysis in Diesel Engine with Blending of Diesel, Leishman's Stain Solution and Linseed Biodiesel

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Abstract

Pollution is one of the major parameter in our day to day environment. The pollution occurs due to the smoke produced by the engines and the industries. Due to this depletion in the ozone layer occurs. Thus to overcome this situation we are introducing linseed biodiesel to reduce the emission occurred in the diesel engine. The main objective of our project is to study the emission characteristics of direct injection diesel engine fuelled with blend of linseed oil biodiesel, leishman's stain solution and diesel fuel. The experiments were conducted with various blends of leishman's stain solution (2ml, 4ml, and 6ml) with diesel. Based on emission and physical properties of diesel, L2 is selected. The experiments were conducted for various blends of biodiesel (B10, B15, and B20) with L2 and diesel fuel. By using the blend of B10 we have been able to achieve a low emission when compared to other blends.

Keywords: Biodiesel, Linseed oil, Linseed biodiesel, Leishman's stain solution, Transesterification.

Introduction

Fuel is one of the major parameters that have to be considered in our life. Due to the meagre amount of Petroleum Diesel and natural gas and to withstand economic crisis it leads to the development of biodiesel. Biodiesel is a renewable, biodegradable and nontoxic fuel for diesel engines. It is derived from oils and fats by Transesterification with alcohols. As alternative fuel biodiesel has attracted considerable attention during the past decades.

During the past decades, there is a certain demand for the production of energy. Due to their climate and economy these energy can be consumed or produced in Asia and Middle east. As we discussed above that bio diesel can be used as an alternative fuel, environmental issues should also considered because of the pollution occurred due to the emission of diesel engine. Bio diesel plays a typical

role that their advantage is to reduce the toxic smoke produced by the diesel fuel and act as an eco-friendly by increasing the life of the engine.

Bio diesel is a renewable fuel used as an alternative for diesel fuel made from straight vegetable oils, animal oil/fats, tallow and waste cooking oil by Transesterification. Biodiesel has many beneficial environmental properties and is commonly called as 'carbon neutral'. Biodiesel is rapidly biodegradable and completely non toxic, meaning spillages represent far less of a risk than fossil diesel spillages. Biodiesel has a higher flashpoint than fossil diesel and so is safer in the event of crash. Biodiesel reduces net CO₂ emissions by 78 percent compared to petroleum diesel because of its closed carbon cycle. Of the major exhaust pollutants, both unburned hydrocarbons and nitrogen oxides are ozone or smog forming precursors. Biodiesel qualifies for both the biomass based diesel category and the advanced bio fuel category by achieving a lifecycle green house gas (GHS) emissions reduction of at least 50 percent compared to baseline petroleum. Bio diesel can be produced from different types of oil but, Linseed oil acts as a good property for producing bio diesel. Linseed oil has high FFA content; therefore, the biodiesel derived from that oil has viscosity comparatively similar to diesel fuel. Hence fuel viscosity should be the first preference for physical property to improve atomization characteristics in an engine. By using this we can also reduce the emission occurred by the diesel engine due to the presence of oxygen content.

Thus by using these substance we can blend together to produce biodiesel and mixed with diesel fuel. Thus it is then evaluated by the AVL Five Gas analyzer to analyze the emission produced by the diesel engine there are four emission occurs during the combustion process Hydro Carbons(HC), Carbon monoxide (CO), Carbon dioxide (CO₂) and Nitrous oxide (NO_x)

The main aim of the study is to characterize and experimentally investigate the Emission of a diesel engine by blending diesel fuel with linseed biodiesel and Leishman's stain solution and checking and comparing the results with diesel fuel.

Leishman's stain solution

Leishman's stain solution is also known as Leishman's stain which is used in microscopy for staining blood smears and it provides good stain quality. It is based on a methanolic mixture of "polychrome" methylene blue and eosin. This methanolic solution is stable and also serves the purpose of directly fixing the smear eliminating a prefixing step. The powder is to be mixed well into good quality anhydrous methanol in a proportion of 0.6g powder into 400 ml methanol. Using glass beads or a magnetic stirrer or carefully warming to 37 degrees C may help in dissolving.

PROPERTIES	VALUES
Molecular formula	C_3H_6O
Density ($g\ cm^{-3}$)	0.791
Boiling point ($^{\circ}C$)	57
Flash point ($^{\circ}C$)	20
Auto ignition temp ($^{\circ}C$)	465
Viscosity CP (25 $^{\circ}C$) mm^2/sec	0.295
Vapour pressure (KPa) (25 $^{\circ}C$)	30.6
Specific heat (J/mol-K)	125.45

Table 1. Properties of leishman's stain solution.

Linseed oil

Linseed oil is the oil which is extracted from flax seed. They are mostly grown in India because of their climatic and soil condition. They most often found in villages. Linseed oil contains high fatty acids and high viscosity. Therefore due to this they are used for the production of biodiesel. It is used in industry purposes and pain jobs. The name used for linseed oil is **linum usitatissimum**. It is yellow in colour. The main properties for using linseed oil is their drying factor, they dry slowly and uniformly. Usually linseed biodiesel is free water resistant, thus they will protect metals from corrosion. The main advantage in linseed oil is their binding property; they will bind with many products. Linseed oil is used for repairing bicycle,

wood finish and biodiesel. They will add glow when they use in wood.

Properties	Values
Density (kg/m^3)	812
Boiling point ($^{\circ}C$)	316
Flash point ($^{\circ}C$)	50
Fire point ($^{\circ}C$)	56
Viscosity CP (25 $^{\circ}C$) mm^2/sec	0.6

Table 2. Properties OF linseed oil

Transesterification

Linseed oil can be converted into biodiesel with the help of the Transesterification process. In this process linseed oil will be reacted with methanol and Sodium Hydroxide (NaOH) to obtain linseed biodiesel. At first 500ml methanol and Sodium Hydroxide is mixed and heated in a conical flask. Then linseed oil is added to that reaction and heated to a specific period of time. During this period the chemical reaction is stirred properly to produce biodiesel. After stirring and heating glycerin and biodiesel will be obtained in that chemical reaction, by using the filtration process biodiesel is separated from that reaction. After the separation process blending of biodiesel and leishman's stain solution takes place. This blending takes place at a proper proportion to mix with diesel fuel.

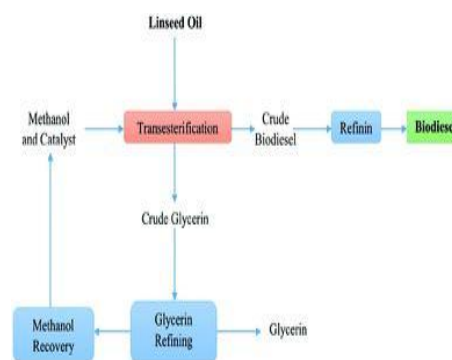


Figure 1. Transesterification Process.

Ratio of Blend

Test is been conducted with 3 blends in which diesel fuel is mixed with 3 blending ratios (B10, B15, B20). With this ratio a meager amount of leishman's stain solution of about 0.2% is added. These mixtures are then blended with diesel fuels.

Sample	Diesel	Biodiesel	Leishman's Stain
Blend I	90%	10%	0.2%
Blend II	85%	15%	0.2%
Blend III	80%	20%	0.2%

Table 3. Blending Ratio

Composition Properties

At first diesel is mixed with 0.2% leishman's stain solution. By using this blend some properties have been evaluated in which flash and fire point is recorded as 54°C and 56°C with a carbon residue of about 0.28%. Density properties as 841 Kg/m³. Kinematic viscosity and calorific value is registered as 3.34 mm²/s and 40,285 kJ/kg. Sample II is that diesel fuel is mixed with 0.4% leishman's stain solution. By using this blend flash and fire point is recorded as 56°C and 61°C with a carbon residue of about 0.28%. Density properties are evaluated as 842 Kg/m³. Kinematic viscosity and calorific value is registered as 3.41 mm²/s and 40,304 kJ/kg.

Properties	Sample I (Diesel +0.2%Ls)	Sample II (Diesel+0.4%Ls)
Flash point	54°C	56°C
Fire point	56°C	61°C
Carbon Residue	0.28%	0.28%
Density	841 Kg/m ³	842 Kg/m ³
Kinematic viscosity @40°C	3.34mm ² /s	3.41mm ² /s
Calorific value	40,285 kJ/kg	40,304 kJ/kg

Table 4. Properties (Sample I and II).

Next diesel is mixed with 0.6% leishman's stain solution. By using this blend some properties have been evaluated in which flash and fire point is recorded as 58°C and 61°C with a carbon residue of about 0.28%. Density properties are evaluated as 844 Kg/m³. Kinematic viscosity and calorific value is registered as 3.45 mm²/s and 40,251 kJ/kg. Sample IV is that diesel fuel is mixed with B10+0.2% leishman's stain solution. By using this blend flash and fire point is recorded as 61°C and 66°C with a carbon residue of about 0.43%. Density properties are evaluated as 861 Kg/m³. Kinematic viscosity and calorific value is registered as 3.62 mm²/s and 36,219 kJ/kg.

Properties	Sample III (Diesel+0.6%Ls)	Sample IV (B10+0.2%Ls)
Flash point	58°C	61°C
Fire point	61°C	66°C
Carbon Residue	0.28%	0.43%
Density	844Kg/m ³	861Kg/m ³
Kinematic viscosity @40°C	3.45mm ² /s	3.62mm ² /s
Calorific value	40,251kJ/kg	36,219 kJ/kg

Table 5. Properties (Sample III and IV)

Finally diesel is mixed with B15+0.2% leishman's stain solution. By using this blend some properties have been evaluated in which flash and fire point is recorded as 66°C and 69°C with a carbon residue of about 0.45%. Density properties are evaluated as 868 Kg/m³. Kinematic viscosity and calorific value is registered as 3.64 mm²/s and 33,219 kJ/kg. Sample II is that diesel fuel is mixed with B20+0.2% leishman's stain solution. By using this blend flash and fire point is recorded as 69°C and 76°C with a carbon residue of about 0.48%. Density properties are evaluated as 861 Kg/m³. Kinematic viscosity and calorific value is registered as 3.74 mm²/s and 32,101 kJ/kg.

Properties	Sample V (B15+0.2%Ls)	Sample VI (B20+0.2%Ls)
Flash point	66°C	69°C
Fire point	69°C	76°C
Carbon Residue	0.45%	0.48%
Density	868Kg/m ³	875Kg/m ³
Kinematic viscosity @40°C	3.64mm ² /s	3.74mm ² /s
Calorific value	33,219kJ/kg	32,101 Kj/kg

Table 6. Properties (Sample V and VI).

Engine Setup

The Setup Consists Of Single Cylinder, Four Stroke, Multi-Fuel, And Research Engine Connected To Eddy Current Type Dynamometer For Loading. The Operation Mode Of The Engine Can Be Changed From Diesel To Petrol Or From Petrol To Diesel With Some Necessary Changes. In Both Modes The Compression Ratio Can Be Varied Without Stopping The Engine And Without Altering The Combustion Chamber Geometry By Specially Designed Tilting Cylinder Block Arrangement. The Injection Point And Spark Point Can Be Changed For Research Tests. Setup Is Provided With Necessary Instruments For Combustion Pressure, Diesel Line Pressure And Crank-Angle Measurements.

Model & Make	Bharat Shakthi diesel engine
No of cylinders	Single Cylinder water cooled engine
Power	5 H.P
Torque	23.5 N-m @ 1500 rpm
Bore X stroke	85mm X 110mm
Dynamometer	Water cooled Eddy current Dynamometer
Brake drum radius	95mm
Emission Test	AVL Five Gas analyzer

Table 7. Engine Specification.

Analysis Report

Tests have been conducted at different speed of 1500 revolutions per minute and also with respective different loads. This test gives us the emission report of the given bio-diesel. The report consists of HC, CO, CO₂, NO_x emissions. We are using 6 samples for testing the emissions.

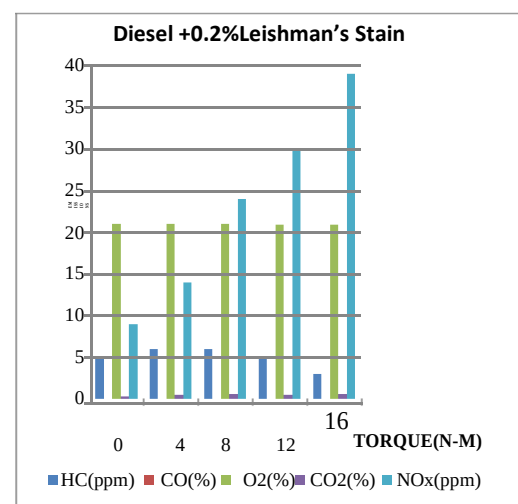


Figure 2.Diesel+0.2%LS

In Figure.2 it shows that by increasing the torque the emission of HC have been gradually reduced. Whereas CO is maintained constantly as 0.01%. CO₂ is recorded as a meagre amount of emission while NO_x is reduced by recording a high 37 ppm to low 7 ppm.

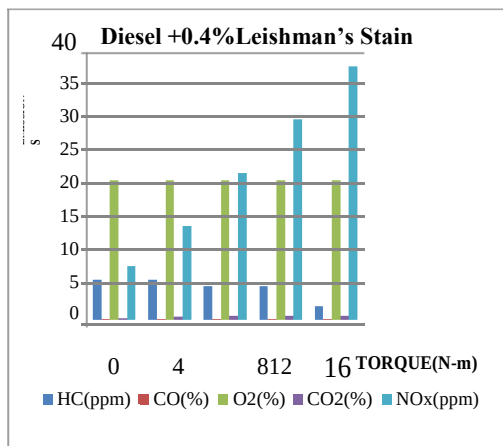


Figure 3. Diesel + 0.4% LS

In Figure.3 it shows that by increasing the torque the emission of HC have been gradually reduced. Whereas CO is maintained constantly as 0.01%-0.02%. CO₂ is increased as a meagre amount of about 0.50% emission while NO_x is reduced by recording a high 38 ppm to low 8 ppm.

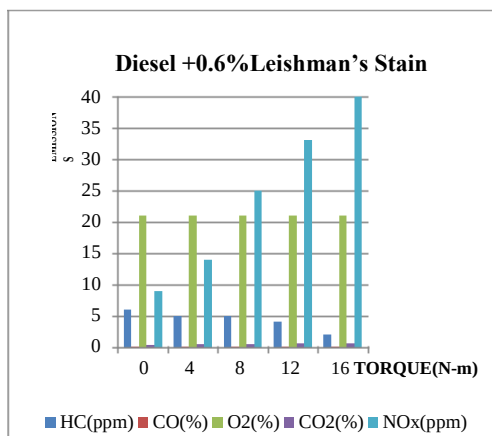


Figure 4. Diesel + 0.6% LS

In Figure.4 it shows that by increasing the torque the emission of HC have been gradually reduced. Whereas CO is maintained constantly as 0.01%-0.02%. CO₂ is increased as a meagre amount of about 0.60% emission while NO_x is reduced by recording a high 40 ppm to low 9 ppm.

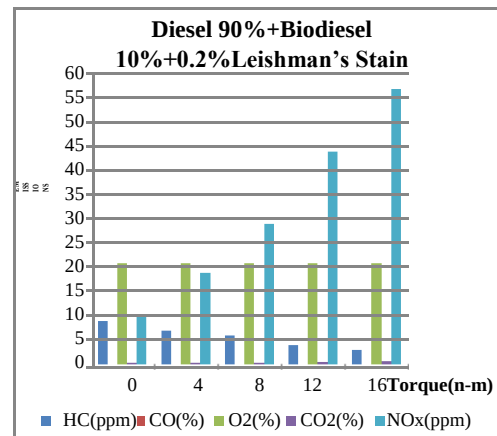


Figure 5. Diesel 90% + B10 + 0.2% LS

In Figure.5 it shows that by increasing the torque the emission of HC have been gradually reduced. Whereas CO is maintained constantly as 0.01%. CO₂ is increased as a meagre amount of about 0.60% emission while NO_x is reduced by recording a high 57 ppm to low 10 ppm.

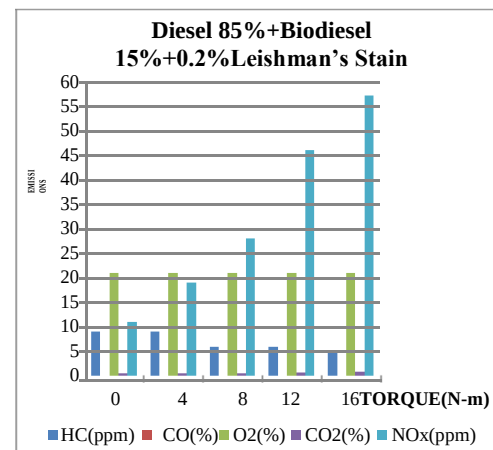


Figure 6. Diesel 85% + B15+ 0.2% LS

In Figure.6 it shows that by increasing the torque the emission of HC have been gradually reduced. Whereas CO is maintained constantly as 0.01%-0.02%. CO₂ is increased as a meagre amount of about 0.90% emission while NO_x is reduced by recording a high 57 ppm to low 11 ppm.

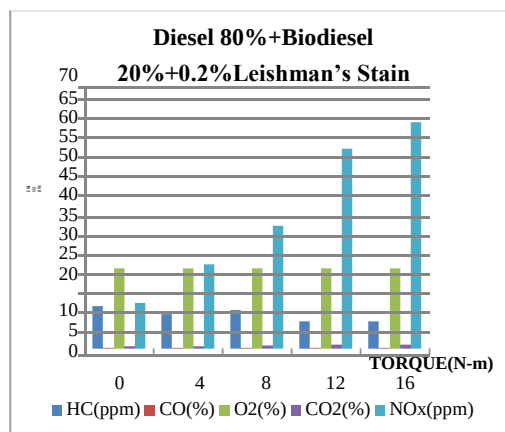


Figure 7. Diesel 80% + B20 + 0.2% LS

In Figure.7 it shows that by increasing the torque the emission of HC have been gradually reduced. Whereas CO is maintained constantly as 0.01%. CO₂ is increased as a meagre amount of about 0.90% emission while NO_x is reduced by recording a high 59 ppm to low 12 ppm.

Analysis

1. Emission of HC: It is seen from the above report that the emission of HC is gradually decreased when torque increases.

2. Emission of CO: It is seen that CO is normally emitted in a negligible amount and it remains more or less constant or slightly reduced.

3. Emission of CO₂: It is analyzed that CO₂ emission is increased when the torque increases and it rises to a maximum of 0.90%.

4. Emission of NO_x: Among the five emissions considered NO_x tends to be the highest with a maximum of 60 ppm. The emission is less when the torque is 0 and gradually rises as the torque is increased multiplicatively.

Conclusion

Experiments have been conducted with the help of diesel-blended biodiesel. Bio diesel is manufactured by using linseed oil. Blending proportion used in these experiments is 10%, 15%, 20%. The emission is evaluated by using this blended fuels. Then it is compared with diesel fuel. When torque increase HC decreases gradually and CO is maintained constantly. By increasing the torque load and speed of the diesel engine NO_x emission reduced gradually with a slight increase in the CO₂. This is occurred due to the enrichment of oxidation in the fuel. Thus compared to diesel engine emission is reduced at a meagre amount and thus producing the environment free from pollution in the atmosphere.

References

1. Performance and emission characteristics of a diesel engine fuelled with biodiesel by using linseed oil, L.Narsinga Rao, R.Shiva, T.Suneel, 2017
2. Investigation on the performance of flaxseed biodiesel blends with tio2 coated piston on a four stroke di diesel engine r. bhaskar reddy1* and s. sunilkumar reddy, 2017.
3. Effects of biodiesel blends on lubricating oil degradation and piston assembly energy losses, M. Gulzar, H.H. Masjuki, M. Varman, M.A. Kalam, N.W.M. Zulkifli, R.A. Mufti, A.M. Liaquat, Rehan Zahid, A. Arslan, 2016.
4. Use of Jatropha Biodiesel in C.I. Engines- a review Krushna A. Antarkar, J. J. Salunke, 2015.
5. An experimental analysis of biodiesel Production from linseed oil sandeepkumar, Dr. amitpal, anandbaghel, manish Jain, 2015.
6. Susceptibility of linseed, soybean, and olive biodiesel to growth of the deteriogenic fungus Pseudallescheria boydii, Juciana Clarice Cazarolli, Rafael Guzzatto, Dimitrios Samios, and Maria do Carmo Ruaro Peralba. 2014
7. Production characterization and efficiency of biodiesel: a review, R. Mythili, P. Venkatachalam, P. Subramanian and D. Uma,, 2014.

8. *Alkali transesterification of linseed oil for biodiesel production*, Rajeev Kumar, Pankaj Tiwari, Sanjeev Garg , 2013 .
9. *Performance of a diesel engine with blends of biodiesel (from a mixture of oils) and high-speed diesel*, Hifjur Raheman, Prakash C Jena and Snehal S Jadav , 2013
10. *A Comparative Study of Engine Performance and Exhaust Emissions Characteristics of Linseed Oil Biodiesel Blends with Diesel Fuel in a Direct Injection Diesel Engine* , B. L. Salvi • S. Jindal, 2013
11. *HC, CO, CO₂ and NO_x Emission evaluation of a diesel engine fuelled with waste frying oil methyl ester* Alireza Shirneshan, 2013.
12. *Linseed oil as a potential resource for bio-diesel: A review*, Savita Dixit, Sangeetakanakraj , A.Rehman , 2012
13. *Low temperature oxidation of linseed oil: a review*, Juita, Bogdan Z Dlugogorski, Eric M Kennedy and John C Mackie, 2012
14. *Non-Edible Karanja Biodiesel- A Sustainable Fuel for C.I. Engine* N.Panigrahi, M.K.Mohanty, A.K.Pradhan, 2012.
15. *Comments on the Use of Fatty Acid Methyl Esters of Linseed and Castor Oil as Biodiesel*, Ramasubramania Iyer, 2011

