An Experimental Investigation on Cloud and Pour point properties of Linseed Biodiesel and analyze the performance and emission characteristics with diesel engine.

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Abstract. As countries adopting the industrialized social structures are being increased recently, the global focus on sustainability has been also intensified. This transpose has provoked the need to identify accessible and reliable energy sources to handle the rising demands. Comprehensively, transportation is the largest consumer of fossil fuels which is also going to face an upcoming energy crisis. It's the key area of concern in the adaptation toward sustainable energy solutions. There are multiple researches focused on the alternative fuelsby taking the environmental sustainability, energy security, of conventional fuels into consideration. This investigation analyzes the emission characteristics and performance of linseed biodiesel with diesel engine. It also studies the properties of density pour point and cloud point etc. Cloud point states the crystal begins in the biodiesel and pour point states the least temperature of biodiesel where it gets changed into wax formation. The linseed biodiesel and diesel combination was analyzed with different proportions like 5% of biodiesel with 95% diesel, 10% of biodiesel with 90% diesel, 15% of biodiesel with 85% diesel and 20% of biodiesel with 80% diesel. The pour and cloud point were found for each combinations and the same was compared with ASTM standard. The Specific fuel consumption (SFC), brake thermal efficiency (BTE) for performance analysis along with carbon monoxide (CO), Hydro carbon (HC), Smoke Opacity, Nitrogen oxide (NO_x) for emission analysis were also performed. Through transesterfication method the biodiesel was processed from linseed oil.

Keywords: pour point, cloud point,biodiesel, transesterfication

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1.INTRODUCTION

Alternative fuels are necessary for dimensioning the pollution, specifically in industrial and transportation segments, jointly addressing the world's growing energy demand. Traditional fossil fuels are significant participators to climate pollutant, air contamination and deterioration of environment. On the other hand alternative fuels like biofuels, proposes cleaner energy possibilities.These fuels help in mitigated greenhouse gas emissions, thus extenuating the atmospheric position and enhance the quality of the air. By minimizing the conventional resources, now countries can expand their energy sources, improving energy guarantee and endurance against diplomatic and economic breakdowns. Additionally, the transfer to alternative fuels supports inventive thinking and economic development. It enables growth for emerging industries and employment insustainable energy production, infrastructure construction, and green technology. This change is beneficial and efficient in both ways like environmentally and economically.

Renewable powers are low-emission combustion, which are a byproduct during combustion from in-edible sources such as non-usable forest materials, narrow strips and water hyacinth which pollutes water etc. As biodiesel are perishable and nontoxic, they naturally become the highest recommendable option to cut back the dominationon usual fuels. Renewable fuels can be utilized in the purest form or by incorporating along with the usual conventional fuels by any proportion. This versatility nature of these fuels makes them to be incorporated smoothly in the already available diesel engines without requiring any extensive alternation. It also results as a pragmatic and supportable fuel option for transportation and industrial applications.

1.1 INTERNATIONAL SCENARIO OF BIODIESEL

Biodiesel are inexhaustible and low-emission replacement for the usual conventional gasoline. It have already regained a major attention worldwide due to its eco-friendly advantage and availability locally making to diminish the dependency on imports. The global outline scene of biodiesel includes multiple policy making, strategic planning and manufacturing technique across various regions, resulting in multiple commitment level when it comes to sustainable fuel.

I. **United States**: U.S.is the superior producer of biodiesel. This is majorly since both their State and Federal policies put forward the renewable fuel production in the first place.

   The Renewable Fuel Standard (RFS) provides the direction on the proportion of mixing of renewable energy and other recyclable oils. Among many oil, Soybean oil is used as the main feedstock in U.S biodiesel industry along with other oils like animal fats and recycled cooking oils.

II. **European Union**: The EU is a prime user of biofuels with strong environmental policies and energy targets. This government has already made an aspiring goal towards the alternative fuels used in the vehicle which are produced from feedstock. These feedstocks are majority from rapeseed and also produced in Germany, France and Italy in a large scale.

III. **Germany**: Germany is the highest manufacturer of biodiesel in the European courtiers. They are supported by a strong policy by the government and aentrenched biodiesel industry. This nation has prioritised the legitimate feedstock and advanced biofuels to satisfy the environmental targets.

IV. **Indonesia**: Indonesia is recognised as the highest producer of the palm oil, It is also the major participant in the biodiesel industry. This nation has already implemented the compulsory target of biodiesel blending (B30) to reduce the imports of petrol and diesel and encourage the palm oil industry. Still they also face challenges like deforestation and sustaining of palm oil production.

V. **South Africa**: South Africa is currently focusing on the biofuel industry, developing the feed stock manufacturing like non-edible food crops and waste oils. This nation prioritises the job creation in the biodiesel production which will also reduce the decency on the imported fuels.

1.2. Challenges and Opportunities

I. Challenges

1. **Feedstock Sustainability**: Deforestation and environmental degradation are major challenge for the existence of the feedstock. This mainly goes with the palm oil.
2. **Economic Feasibility**: As the producing cost of biofuel is huge while compared to the usual oil, this makes the economic feasibility challengeable.

II. Opportunities

1. **Advanced Biofuels**: Research and development in advanced biofuels, such as algae-based biodiesel, offer potential for sustainable and efficient production.
2. **Government Policies**: Supportive policies and incentives can drive the growth of the biodiesel industry and encourage investment.

2.BIODIESEL PRODUCTION :

The biodiesel prepared from linseed, it is also known as flaxseed, the biooil of linseed is colorless and it is converted to biodiesel through transesterification method after that the color of biodiesel is changed in to yellow it shows.

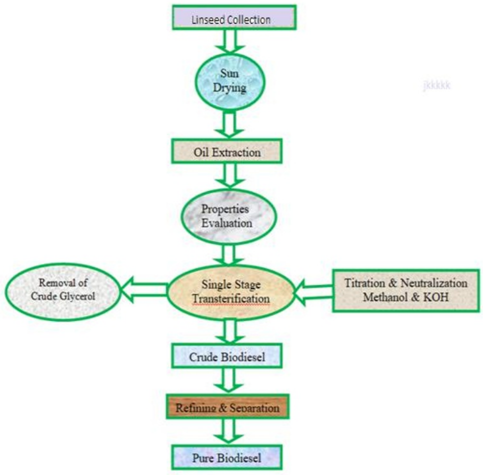


Fig.1. Production of biodiesel

The above diagram **Fig.1** shows the biodiesel produced by transesterification process. The biodiesel is generally produced from various animal fats and vegetable oils, it is known as FAMS which is also known as fatty acid methyl esters. The linseed oil extracted from seed initially all the water particles are removed from seeds at drying process then oil is extracted through hand impeller or motorized impellers based on the quantity, the fats and oils generally known as triglyceride. Then the oil is ready for transesterification method. During the process the add-ons like potassium hydroxide (KOH) and sodium hydroxide (NaOH) are added for the oil. Temperature is maintained at 60 °C to 65 ° the magnetic stirrer is used for continuous mixing; usually the stirrer is rotating at 600 to 800 rpm. The process continuously going to 24 hours, the crude biodiesel and glycerol is received from the output.

Fig.2. Linseed

Fig. 3. Linseed oilBLENDS

The biodiesel prepared through transesterification method and it is mixed with diesel at different ratioslike (5%, 10%, 15%, and 20%). 5% of linseed biodiesel with 95% diesel, 10% of linseed biodiesel with 90% diesel,15% of biodiesel with 85% diesel, 20% of biodiesel with 80% diesel. These combinations are taken for the single cylinder diesel engine. The emission characteristics and performance of linseed biodiesel are analyzed, and it is compared with diesel characters.

Magnetic stirrer

The Magnetic stirrer is the device used to mix the solutions, in the biodiesel preparation it is giving the constant mixing with uniform temperature. Usually the magnetic stirrer fixed with beaker, the heat added the beaker through hot plate it is maintained at 55° to 65° constantly, and the stirrer is used to mix solution continuously. The temperature is measured through thermometer the magnetic stirrer is rotating 700 to 1000 rpm constantly.

Fig. 4. Magnetic stirrer

Each blend were mixed in beaker and put on the magnetic stirrer for 4 hours and speed was 2000 rpm. Before starting the apparatus, a small magnetic pallet was put in the beaker. Which rotates and mixes oil at 60^{o} C temperature was applied too

BEFORE

AFTER

Fig. 5. Preparation of linseed oil and its blends

Measuring of density

In this approach, initially we calculated the weight of the beaker one by one after which we calculated the beaker after filling the bottle with linseed oil, and its blends. Then we took the distinction of values to get the mass of the oil after which divide the mass by using manner of extent i.e. 100ml to get the density.**Table 1. Density for blends**

BLENDS	VOLUME (ML)	DENSITY (Kg/Lit)
B5	100	0.8192
B10	100	0.8250
B15	100	0.8291
B20	100	0.8315

Measurement of Cloud and Pour point:

The cloud point indicates to starts for freezing point of biodiesel and diesel combinations. The thermometer is used for measure the temperature. The temperature is starting to reduce the biodiesel with diesel combinations due to the formation of insoluble components. First we have added the biodiesel combinations in the glass tube and it is covered with cork. The thermometer is inserted for measuring the temperature, each and every temperature changes is monitoring, the cloud point is varies from different feed stocks, the weathering condition is also playing important role for cloud point formation. The haziness indicates the reduces of fluidity in the fuel. The pour point is known as the biodiesel ceases stage, and also the least temperature where the biodiesel retains the pourable condition.

The below mentioned pour and cloud point apparatus has been utilized to measure the properties, the auto freezing system with digital controller was used, up to -40⁰C temperature can be measured in this system. The digital temperature indicator shows the change of temperature.

Fig. 6. CLOUD POINT

Fig 7: POUR POINT

Table2. Cloud and Pour point

SN	COMBINATION	CLOUD POINT	POUR POINT
1	BIODIESEL 5% WITH 95% DIESEL	-4⁰C	-10⁰C
2	BIODIESEL 10% WITH 90% DIESEL	-3⁰C	-9⁰C
3	BIODIESEL 15% WITH 85% DIESEL	-2⁰C	-8⁰C
4	BIODIESEL 20% WITH 80% DIESEL	-1⁰C	-7⁰C

2.1.EXPERIMENTAL SETUP

Engine Specifications:

Stroke	**4**
Cylinder	**1**
Speed	**1500rpm**
Cooling	**Water cooling**
Dynamometer	**Eddy currentdynamometer**
Temperature sensor	**K-Type**
Stroke length	**110mm**
Diameter	**87mm**

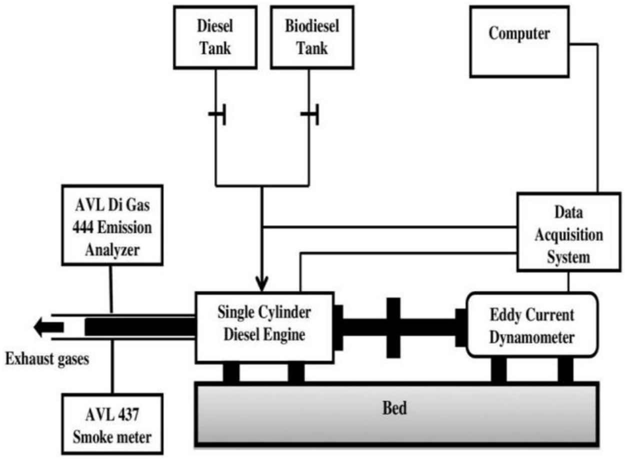


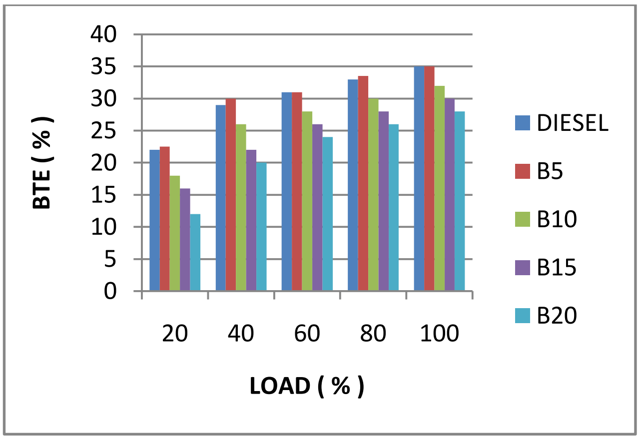
Fig. 8. Schematic diagram of four strokes - single cylinder diesel engine

Fig. 9. Four stroke - single cylinder diesel engine

3.RESULTS AND DISCUSSION

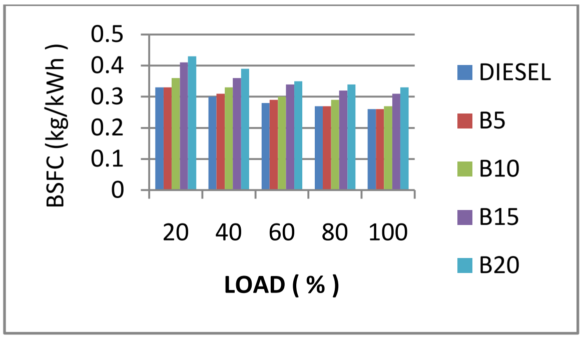
3.1.PERFORMANCE ANALYSIS

3.1.1.BRAKE THERMAL EFFICIENCY Vs LOAD



The combinations of biodiesel with load are shown in figure. Here the linseed biodiesel with diesel combinations are taken for running conditions like (5%,10%,15%,20%). Each and every combinations used for five iterations. It is noticed that 5% with 95% of biodiesel and diesel combination shows better BTE comparatively diesel at full load conditions for engine performance. Because of this combination enhances the combustion on addition of oxygen, and also it leads the complete combustion. The cetane number of biodiesel is higher than a diesel and also linseed biodiesel calorific value is very nearer to the diesel calorific value may be its also helps to get the BTE higher than the diesel. In the other combinations like 10%, 15%, 20% linseed biodiesel with diesel combination, the BTE is decreasing compared with diesel. As it is taking the partial combustion, the viscosity of biodiesel is very high and oxygen proportion is also high in biodiesel. Hence the BTE is decreasing with load at the higher combinations.

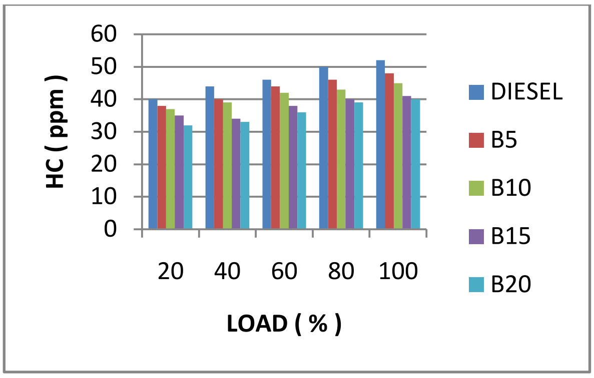
3.1.2.SPECIFIC FUEL CONSUMPTION Vs LOAD



The specific fuel consumption (SFC) of biodiesel from linseed when compared with diesel at various load shown on this graph. The SFC of 5% of linseed biodiesel with 95% of diesel is slightly decreasing with load, because of BTE is increasing with this combination so automatically the SFC is decreasing and also this combination viscosity is very low, it is not affecting the combustion process, so complete combustion have done on this stage. The oxygen content is improve the combustion process on this stage. On the other side the higher combinations like 10%, 15%, 20% the SFC is increasing with load. Because the oxygen content is increasing almost 12% of oxygen is mixed with diesel, high viscosity is there, so the incomplete combustion is possible in the combustion chamber.

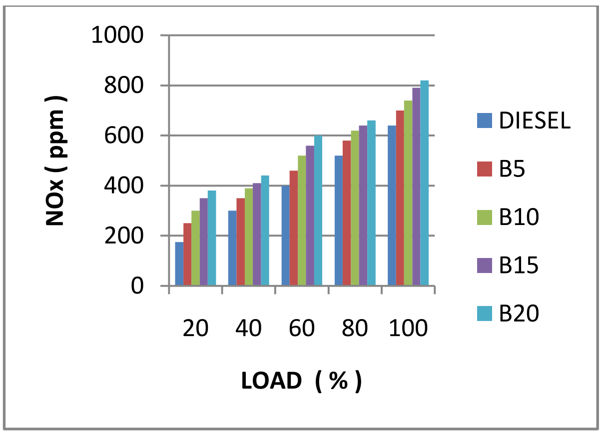
3.2.EMISSION ANALYSIS

3.2.1.HYDRO CARBON Vs LOAD



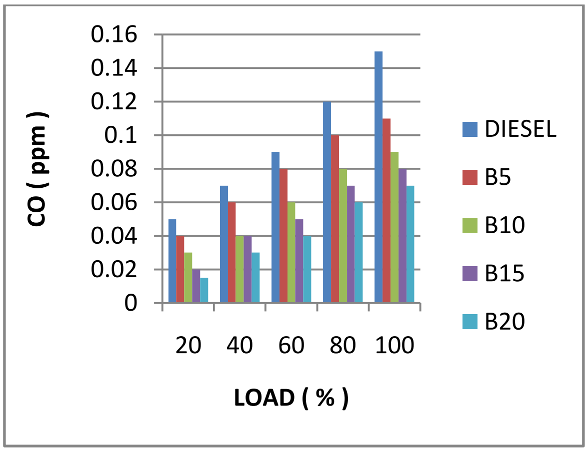
The above graph indicates hydro carbon emission compared with diesel. It shows the linseed biodiesel emission is low compared with diesel. The HC emission continuously reducing with load, because of high oxygen content is available in biodiesel; it increases the combustion characteristics, while mixing with biodiesel and diesel the oxygen transferred in to diesel also, it is increasing the combustion chamber's combustion. Once the full combustion is taking in chamber automatically the emissions is very low in the output and also the biodiesel having high cetane number it is used to break down the higher molecules in to smaller molecules, it gives the better combustion.

3.2.2.NOx Vs LOAD



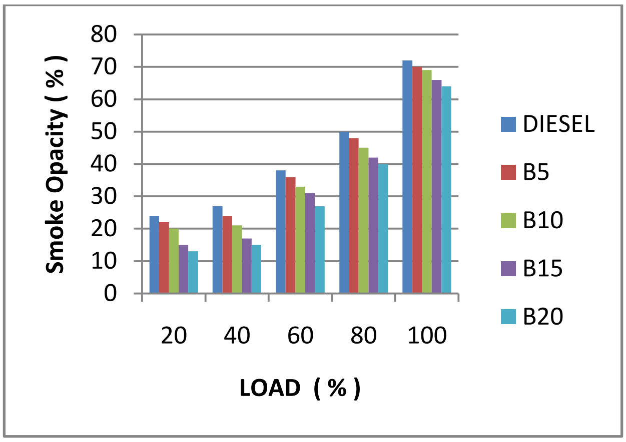
The above graph illustrates the emission analysis of alternative fuel with fossil fuel combinations. The high oxygen content of linseed biodiesel almost 12% of oxygen is available at biodiesel. In combustion chamber, excess oxygen creates in-complete combustion. This huge oxygen existence in the combustion procedure will react with the nitrogen and the NOx will be produced at highest point of temperature along with peak pressure. High viscosity of the biodiesel is also one of the reasons to produce the NOx .In this graph indicates the NOx emission is low at diesel only because there is no oxygen content. 5% of biodiesel with 95% of diesel value is very close to the values of diesel. In this case biodiesel and diesel combinations emits very low amount of oxygen in the combustion process, due to the very minimum amount of partial combustion that occurs at this combinations. The other combinations emit high oxygen at high pressure and it gives the maximum NOx emissions.

3.2.3.CARBON MONOXIDE Vs LOAD



In this graph illustrates the carbon monoxide emission compared with diesel. Biodiesels have better cetane number compared to diesel and hence it is used to convert the bigger molecules to the smaller molecules, which helps for better combustion. If we are providing the additional oxygen into the chamber of combustion the CO converts into CO_2.In this graph shows the CO is very low compared with diesel, when we have increased the load the emission also increases, B5 with diesel combination emits 11%,it is less than diesel emission and also B10,B15,B20 emits very low CO compared with diesel.

3.2.4.SMOKE OPACITY Vs LOAD



Biodiesel has lower smoke opacity because it has higher oxygen content, if the combustion process properly done in the chamber of combustion automatically reduces soot and scale formation. Above graph shows the particulate matter is very low compared in the diesel. We are increasing the biodiesel with diesel combination the Smoke is decreasing continuously. Diesel with 5% of linseed biodiesel combination shows 70% at full load conditions and then it reduces 48%, at 80% load, 36% at 60% load, 24% at 40% load and 22 at 20% load. The other combinations like10%, 15%, 20% combinations with diesel also very low emissions of smoke the graph shows.

4.CONCLUSIONS:

1. In the Emission and performance analysis of linseed biodiesel along with diesel combinations we are selecting the B5 with 95% of diesel as the optimum solution.
2. The Brake thermal efficiency at B5 is 35% while the engine running at maximum load condition it is moderately high at diesel maximum load condition
3. The specific fuel consumption of B5 with diesel combination is slightly low compared with diesel, 0.24 Kg/kwh shows the full load condition, it is also very low compared with B10, B15, B20% of combinations.
4. The hydro carbon (HC) of B5 with diesel combination is 38 parts per million (ppm) is operated with full load condition. Comparatively it is very low at diesel
5. The Nitrogen oxide (NO_X) is high compared with diesel at B5 with diesel combination, it will be reduced through EGR system.700 ppm shows the full load condition.
6. The CO emission for B5 is 0.11% operated at full load operating conditions
7. The smoke opacity for B5 is 70% at maximum load condition, comparatively very low at diesel

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