A Study On Properties Of Pongamia Pinnata And Waste Cooking Oil Mixture.

Sriharsha H M[1], Dr G M Satyanarayana[2]

[1]Department of Mechanical Engineering, Adichunchanagiri Institute of Technology, Chikmagalur, VTU, India.

[2]Department of Mechanical Engineering, Adichunchanagiri Institute of Technology, Chikmagalur, VTU, India.

Abstract: Biodiesel is renewable fuel and it can replace Petro-Diesel ever demand of the fuel supply with environmental concern of pollution, A need of production and utilization of Biodiesel are of great concern. Biodiesel contains similar properties of Petroleum Diesel with improved environmental benefits. The usefulness of Biodiesel production from Pongamia oil and waste cooking oil have been examined with respect to its fuel properties and blending characteristics with Petro-Diesel. In this study Pongamia and waste cooking oil Biodiesel mixture is prepared in the ratio of P50%+V5%, P75%+V25%, P25%+V75% and Blends of these Biodiesel (B10,B20,B30) These blends were tested for various Properties like flash and fire point, Calorific value , density and viscosity. The different blends of biodiesel are used to test the properties evident from the experiment that B10(P50+V50) shows the most of the properties nearer to that of Diesel B20(P25+V75) give highest calorific value among all the blends .

Index Terms: P-Pongamia Pinnata biodiesel,V-used Vegetable oil biodiesel, B10-Biodiesel mixture 10%, B20-Biodiesel mixture 20% , B30-Biodiesel mixture 30%

1.INTRODUCTION

The whole world is facing the crises of depletion of fossil fuels as well as the problem of environmental degradation. The rapid depletion of fossil fuel reserves with increasing demand and uncertainty in their supply, as well as the rapid rise in petroleum prices, has stimulated the search for other alternatives to fossil fuels. In view of this, there is an urgent need to explore new alternatives, which are likely to reduce our dependency on oil imports as well as can help in protecting the environment for sustainable development. Many alternative fuels are being recently explored as potential alternatives for the present high-pollutant diesel fuel derived from diminishing commercial resources.

Biodiesel emerges as one of the most energy-efficient environmentally friendly options in recent times to full fill the future energy needs. Biodiesel is a renewable diesel substitute that can be obtained by combining chemically any natural oil or fat with alcohol. During the last 15 years, biodiesel has progressed from the research stage to a large scale production in many developing countries. In Indian context, non-edible oils are emerging as a preferred feedstock and several field trials have also been made for the production of biodiesel.

Vegetable oils either from seasonal plant crops or from perennial forest tree's origin, after being formulated, have been found suitable for utilization in diesel engines. Many traditional oil seeds like pongamia, jatropha, mallous philippines, garcinia indica, thumba, karanja and madhuca indica etc. are available in our country in abundance, which can be exploited for biodiesel production purpose. Many vegetable oils, animal fats and recycled cooking greases can also be transformed into biodiesel. Biodiesel can be used neat or as a diesel additive in compression ignition engines.

Fossil fuels are non-renewable energy resources. Although, these fuels are contributing largely to the world energy supply. It has been shown that 98% of carbon emissions are resulted from fossil fuel combustion .The need of energy is increasing continuously due to rapid increase in the number of industries and vehicles owing to population explosion. The sources of this energy are petroleum, natural gas coal, hydrocarbon and nuclear.

Several alternative fuels have been studied to either substitute diesel fuel partially or completely. Vegetable oils are proposed to be promising alternatives to diesel, as they are produced in rural areas. The oil produced from seeds can provide self employment opportunities. Manufacturing biodiesel from used vegetable oil is relatively easy and possesses many environmental benefits. The use of vegetable oils as frying oils produces significant amounts of used oils which may present a disposal problem. Their use for biodiesel production has the advantage of their low price.

To overcome this ever rises in energy demands and to replace, reduction of petroleum reservoirs, fuels of biomass such as biodiesel and bio-ethanol are alternative technologies. The most reasonable way to meet this ever growing demand is by using alternative fuels and one such fuel is a Biodiesel, an alternative fuel for compression-ignition engines.

Biodiesel acts as a petro-diesel engines. It burns similar to petro-diesel as it decrease pollutants and shows greater potential in compression-ignition engines. It is usually produced from vegetables oils and animal fats.

Biodiesel are mainly produced from soybean, rapeseed, and palm oils.

Viscosity of vegetable oil ranges from 30-200 centistokes. This higher viscosity causes unfavorable pumping, poor supply of oxygen leads to incomplete combustion of fuel and high flash point resulting in increase in carbon deposition. Because of this issue biodiesel is blended with petro-diesel.The calorific value of biodiesels is higher than of coal and lower than diesel. Biodiesel blended with any other oil fuel are indicated by BYY, where YY indicates the volume percentage of biodiesel in the blend. Ex: B10, 10% of biodiesel and 90% of petro diesel.

Today most of the energy used in running the world are from fossil fuels. Almost most of the heavy vehicles are driven by oils and its availability is limited. Most carbon and NOx emissions are from combustion of fossil fuels. The emission of these harmful gases from vehicles, manufacturing plants, power plants leads to global warming. NOx and carbon-dioxide emitted to atmosphere can be reduced by reducing the usage of fossil fuels.

The technologies cost to reduce carbon emissions are high and the technology is yet to find solution to reduce carbon emission to minimum extent. The studies have proposed to use of biodiesel produced from by blending waste cooking–oil biodiesel, Pongamia biodiesel and milk scum biodiesel. To vehicles powered with diesel engines, an elective substitute of diesel fuel need been produced namely, biodiesel. It will be handled from that concoction holding of liquor with oils, fats, greases or synthetically known alkyl esters. These esters bring comparable properties Likewise that mineral diesel fuel furthermore actually finer As far as its cetane amount. On addition, biodiesel will be superior to diesel fuel As far as sulfur content, blaze point and fragrant content. Concerning illustration, a fluid fuel, biodiesel may be straightforward to utilize Furthermore cam wood be utilized within layering ignition loop (diesel) engines without adjustments. It likewise could be mixed during any level for petroleum diesel on make a biodiesel mix.

1.1 Procedure for Production of Bio-diesel

Fig.1 Transesterifiction unit.

- Now take 1 liter of sample oil.
- That oil is to be heated up to 55 to 60 c temperature but not exceed 70 c.
- Now take 200 ml of methanol or ethanol in to that add 4.5 grams of KOH.
- Shake that mixture well up to KOH dissolved fully. It will become potassium meth oxide solution.
- Now add that solution to 1 liter sample oil with constant stirring of row oil. Stir up to 10 to 15 minutes.
- Leave that solution to settle down up 8 to 10 hours.
- It will form two distinct layers.
- That upper layer is called Bio-diesel and lower dark and thick layer called glycerol which is used to make soap

1.2 Reaction of transesterification Process

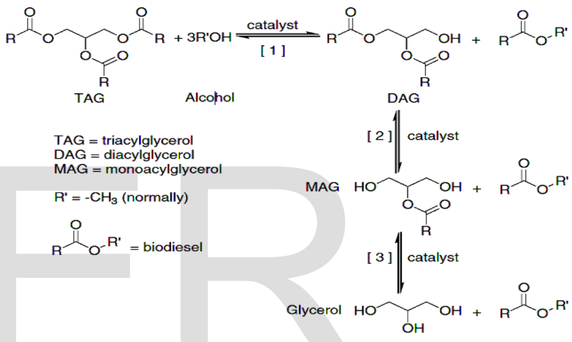


Fig.2 Transesterification reaction.

1.3 SOURCES OF PONGAMIA PINNATA

Fig.3 Pongamia Pinnata seeds.

Pongamia pinnata native to humid and subtropical environments, and thrive in areas with annual rainfall ranging from 500 to 2500 mm. in its natural habitat, Matured trees can withstand water logging and slight frost is not found above 600 m. Pongamia can grow on most soil types ranging from stony to sandy to clay, including Himalayan foothills and so is common along waterways or seashores, with its roots in fresh or salt water. Highest growth rates are observed on well drained soils with assured moisture.

1.4 Sources of waste cooking oil

Waste cooking oil refers to the used vegetable oil obtained from cooking food. Repeated frying for preparation of food makes the edible vegetable oil no longer suitable for consumption due to high free fatty acid (FFA) content.Waste oil has many disposal problems like water and soil pollution, human health concern and disturbance to the aquatic ecosystem so rather than disposing it and harming the environment, it can be used as an effective and cost efficient feedstock for Biodiesel production as it is readily available. Furthermore, Animal fats with high acid value and fat-containing floating sludge discharged in water systems are subject to environmental concern due to their high pollutant potential and it is a challenge for wastewater treatment plants to purify it. Therefore, conversion of low quality lipid-rich sources from slaughterhouses into commercial grade biodiesel is an opportune strategy for minimizing environmental damages while it can help meeting the energetic challenge. WCO collected can also be used to prepare soaps and additive for lubricating oil. Many researchers have successfully converted used vegetable oil into biodiesel.

Acid value of the oil is determined by the titration of mixture of oil with methanol against NaOH using phenolphthalein as indicator

2. LITERATURE SURVEY

Fengxian Qiu , Yihuai Li , Dongya Yang , *et al.*,[1] Here Soybean oil and Rapeseed oil are mixed equally in beaker and heated about 60-70°C. This mixed oil is subjected to transesterification, where oil is converted into biodiesel using sodium hydroxide as catalyst.

Here hexane solvent is added which reduced the reaction time and operational temperature and which improved the efficiency of conversion to biodiesel. The obtained biodiesel properties are close to petro-diesel and can be as a alternative to diesel.

R. El-Araby , Ashraf Amin , A.K. El Morsi , *et al.*,[2] Here palm oil methyl esters are blended with diesel fuel , the blends were characterized as an alternative fuels for diesel engines. Density, kinematic viscosity, and flash point were estimated according to ASTM as key fuel properties. Plam oil biodiesel is blended with diesel. The results showed that the fuel properties of the blends were very close to that of diesel till 30% unless other characteristics are within the limits.

Dilip Kumar Bora , L M Das , M K Gajendra Babu , *et al.*,[3] Here study presents application of biodiesel produced from the mixture of polanga oil (Calophyllum inophyllum), karanja oil (Pongamia pinnata) and jatropha oil (Jatropha curcas) in CI engines and compares biodiesel performance and emissions characteristics with petro diesel. Biodiesel derived from mixture of pongamia, karanja and jatropha oils has been found to meet ASTM D-6751 specifications.

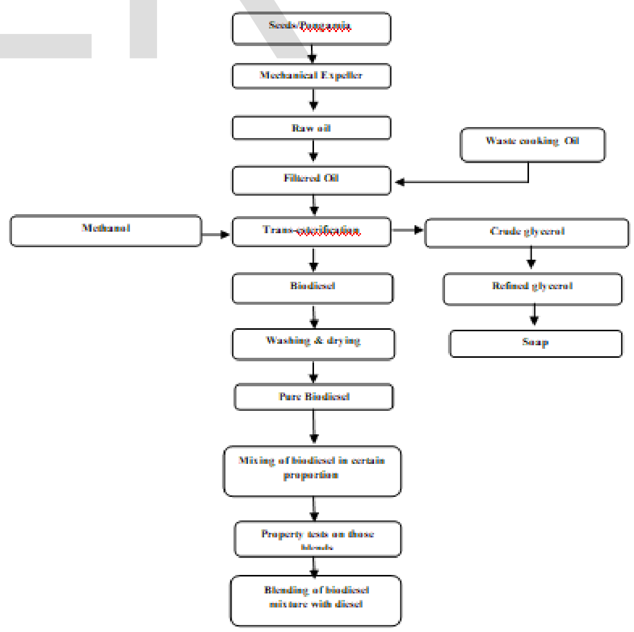
Ejike k. Okoye, Charles P. C. Edeh , *et al.*,[4] Here Biodiesel produced from waste cooking oil using controlled reactor plant. This analysis showed that the biodiesel we produced using waste cooking oil (used vegetable oil) met with international standards such as ASDM D 6751-07b. So this biodiesel can be competitive alternative to the highly priced petroleum diesel.

3. OBJECTIVES

The main objectives of the present work are,

- Collection of seeds from the tree and waste cooking oil from hotel.
- Extraction of oil from the seeds using mechanical expeller.
- Conversion of oil into Biodiesel by transesterification process.
- Mixing of two biodiesel obtained from Pongamia and waste cooking oil in percentage 50%P+50%V, 75%P+25%V and 25%P+75%V.
- Blending of the biodiesel mixture with diesel in proportion 10%, 20% and 30% by volume.
- Property test on different blends.
- Comparing the individual blend result with diesel

4. METHODOLOGY



Process involved

4.1 OIL EXTRACTION:

A) Pongamia oil.

Fig:4 Pongamia seeds.

The dried pods are stuck with hammers and sticks to open them after which the seeds are removed out. The pods are kept in water for 2-3 hours, then followed by drying at high temperature 100-105℃ for 30 minutes. The moisture content in seeds is 10%. The oil is extracted using mechanical expeller. It is found that yield of seed using mechanical expeller is around 24%. The oil from the mechanical expeller is filtered and is collected in glass reagent container which it gets filtered by remaining in container around 10-12 hours. The pure oil is separated which gets settled on upper and impurities deposited at bottom of the container.

B) Waste cooking oil.

Fig.5 Waste cooking oil.

Waste cooking oil refers to the used vegetable oil obtained from cooking food. Repeated frying for preparation of food makes the edible vegetable oil no longer suitable for consumption due to high free fatty acid (FFA) content.Waste oil has many disposal problems like water and soil pollution, human health concern and disturbance to the aquatic ecosystem so rather than disposing it and harming the environment, it can be used as an effective and cost efficient feedstock for Biodiesel production as it is readily available.

4.2 Production of biodiesel.

Transesterification process successfully converts vegetable oil to biodiesel (Methyl ester). The objective of transesterification is to reduce the viscosity of raw oil with alcohol (methanol) reacting with triglycerides of vegetable oil (fatty acids) in the presence of catalyst (NaOH OR KOH). In transesterification , the FFA of vegetable oil converts or reduce to mono-glycerides. The final product obtained is pure biodiesel with glycerine as a co-product.

4.3 Determining the free fatty acids contents

$$\text{FFA content} = \frac{28.2 * Normally\ of\ NaOH * Titration\ valve}{Weight\ of\ oil}$$

Transesterification process of Pongamia and Waste cooking oil.

A) Pongamia oil.: Here one liter of pongamia raw oil is taken in 3-neck beaker. The oil in 3-neck beaker heated to 60℃ using magnetic stirrer. Burette is filed with a solution in which 0.5gm of NaOH is dissolved in distilled water. 10gm of oil is taken from beaker, warm heated with additional two drops of Phynaptheline indicator. It is titrated until pale pink appears in solution. If difference in burette reading falls above 4 in FFA, its double process as free fatty acid is more in pongamia. The 0.25ml of Sulphuric acid and 150ml methanol is poured into beaker. It is heated for another two hours and poured into separation flask which is kept for one day. The glycerine and unreactants are separated. Again it is titrated for knowing FFA value. The calculated FFA falls below 4, hence it is continued with adding 150ml of methanol and calculate the amount of NaOH is added and heated for another two hours. The heated oil is then poured to separation flask which is kept for a day settling of glycerine and unreactants which is later separated by washing with water. Later it is heated to 120℃ for evaporation of water to form pure biodiesel and allowed it to cool.

Fig.6 Washing of biodiesel.

B) Waste cooking oil.

Here one liter of waste cooking oil is taken in a three neck beaker. The oil is in three neck beaker heated to 60℃ using magnetic stirrer. Burette is filled with a solution in which 0.5gm of NaOH is dissolved in distilled water. 10gm of oil is taken from beaker, warm heated with additional two drops of Phynaptheline indicator. It is titrated until pale pink appears in solution. If difference in burette reading falls below 4 in FFA, its single process otherwise it is considered as double process. Here the FFA value is 1.7. Hence it is a single process in which process is directly followed with adding 300ml methanol with dissolving calculated amount of NaOH. It is heated for another two hours. The heated oil is then poured to separation flask, which is kept for a day for settling of glycerine and unreactants which is later separated by washing with water. Later it is heated to 120℃ to separate water from biodiesel and allowed it to cool.

4.4 Preparation of blends.

A Biodiesel produced is blended with petro diesel to decrease the viscosity. An equal part of biodiesel and petro diesel taken and poured into stirrer vessel and stirred continuously for 20min for better diffusion of molecules. The well stirred blended biodiesel is stored in a bottle and kept it couple of hours before usage.

Initially both biodiesel mixtures are produced. Pongamia pinnata (P) and waste cooking oil (V) biodiesel mixtures are prepared in proportion 50%P+50%V, 75%P+25%V and 25%V+75%P.

50%P+50%V	P250ml+V250ml
75%P+25%V	P375ml+V125ml
25%P+75%V	P125ml+V375ml

Table 1 Biodiesel proportions.

Fig.7 Biodiesel mixture.

Blends are prepared in the percentage 10%(B10), 20%(B20) and 30%(B30).

BLENDS OF P50+V50

B10(P50+V50)	50ml(P50+V50)+450ml(Diesel)
B20(P50+V50)	100ml(P50+V50)+400ml(Diesel)
B30(P50+V50)	150ml(P50+V50)+350mll(Diesel)

Table.2 Blends of P50+V50.

Fig.8 Blends of P50+V50(B10,B20,B30).

BLENDS OF P75+V25

B10(P75+V25)	50ml(P75+V25)+450ml(Diesel)
B20(P75+V25)	100ml(P75+V25)+400ml(Diesel)
B30(P75+V25)	150ml(P75+V25)+350mll(Diesel)

Table.3 Blends of P75+V25.

Fig.9 Blends of P75+V25(B10,B20,B30).

BLENDS OF P25+V75

B10(P25+V75)	50ml(P25+V75)+450ml(Diesel)
B20(P25+V75)	100ml(P25+V75)+400ml(Diesel)
B30(P25+V75)	150ml(P25+V75)+350mll(Diesel)

Table.4 Blends of P25+V75.

Fig.9 Blends of P25+V75(B10,B20,B30).

Property test.

Kinematic viscosity: Here the viscosity of biodiesel is measured using viscometer placed in water bath. The biodiesel is filled into viscometer up to the mark on viscometer and water is heated using coil. Here viscosity is measured at temperature at 40°C.

Density: The density of biodiesel is measured using Hydrometer. The biodiesel is filled in a measuring flow jar up to the mark. The hydrometer is placed into the jar which floats. The floating of hydrometer stops and value of the density is noted where mucus of biodiesel coincide with scales of the hydrometer.

Calorific value: Here bomb calorimeter is used to determine the calorific value of the fuel. The oil of 1gm is placed in the cup with bomb calorimeter pressure 20 atm. The coil is wired around the cup. A thread is tied to coil and other end of thread is dipped into cup containing biodiesel. With ignition, spark is ignited and the heat is released after combustion of fuel which is absorbed by surrounding water. The difference in initial and final temperature gives the calorific value of the fuel.

Flash & Fire point: These properties are determined using Pensky marten apparatus. The copper cup vessel is filled with biodiesel and placed upon the heating device. Using a flame placing near cup, a temperature where flash point and fire point is observed is noted.

5. EXPERIMENTAL SETUP

5.1 PROPERTY TEST APPARATUS.

VISCOMETER

Kinematic viscosity

Kinematic viscosity is a fluid running over a surface offers resistance from one layer of fluid to another under the influence of gravity. This physical property is most important for the fuel influence performance and efficiency of engine. Viscosity affects the flow properties of the fuel which has the impact on the size of the droplets of the fuel performing during fuel injection. A fluid with higher viscosity forms the larger droplets leading to incomplete combustion of the fuel and pollutants become more. Here the viscosity is determined at temperature at 40°C using viscometer.

Kinematic viscosity in centistokes= Number of seconds*standard factor of bulb viscometer(0.0092)

Fig.10 Viscometer.

HYDROMETER

Density of biodiesel or any other fluids are measured using Hydrometer. It is measured in terms of relative density of fluids that is ratio of density of fluid to be measured to density of water. It contains mercury at the bottom of meter to make it flow upright. The hydrometer placed float easily in a measuring flask. The lower mucus of liquid touches the steam of hydrometer correlates to specific gravity to the contained scale inside it.

Fig.11Hydrometer

BOMB CALORIMETER

Bomb calorimeter is a device used to determine the heating value or calorific value of the liquid fuels. A oil of one gm is placed in the cup with pressure of 20 atm. The heat released after combustion of fuel is absorbed by surrounding water. The difference in initial and final temperature gives the calorie of the fuel.

Fig.12 Bomb Calorimeter.

PENSKY MARTEN APPARATUS

Flash Point: while heating a liquid fuel, it gives sufficient combustible vapour at certain temperature forming a mixture with air which gets ignited by contact with a hot surface, spark, or flame and at temperature where it is observed is called flash point.

Fire Point: with continue in heating after flash point, a temperature at which the vapour of that fuel will continue to burn for at least for 5-6 sec with a spark or flame. This test is conducted using Pensky Marten apparatus.

Fig.13 Pensky Marten apparatus.

6. RESULTS AND DISCUSSION

6.1 PROPERTIES OF BIODIESEL AND BLENDS.

Fuel Property	Viscosity	Density	Calorific value	Flash point	Fire point
Units	Cst	Kg/m^3	KJ/Kg	°C	°C
Diesel	3.28	825	44800	45	48
P100	4.76	835	27940	175	186
V100	4.27	870	32774	157	168

Table 5 Properties of Pongamia(P100) and Waste cooking oil(V100).

The graphs plotted below represents the variation of property values with respective biodiesel

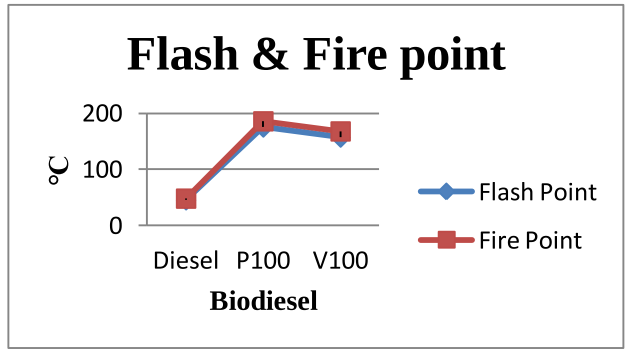


Fig.14 Flash & Fire point of biodiesel.

Fig 14 shows the flash and fire point of diesel, Pongamia and waste cooking oil biodiesel. Here flash and fire point of diesel occurs at lower temperature as diesel have higher calorific value and for biodiesels of pongamia and waste cooking oil flash and fire point occurs with higher temperature due to lower calorific value.

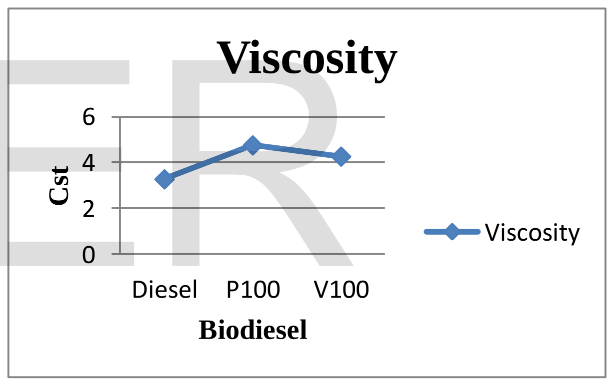


Fig.15 Viscosity of biodiesel.

Fig 15 shows the viscosity of diesel, pongamia and waste cooking oil biodiesel. Here the diesel have lesser viscosity and both biodiesels have higher viscosity. It is due to the higher density in both biodiesel.

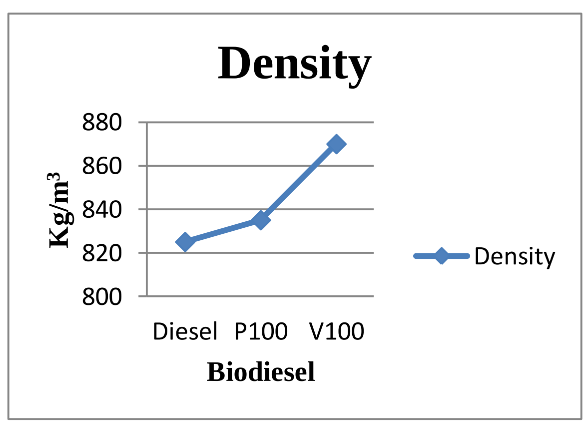


Fig.16 Density of biodiesel.

Fig 16 shows density of the diesel is lower as compare to pongamia and waste cooking oil biodiesel.

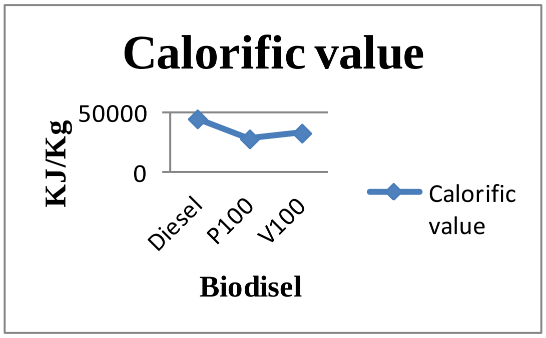


Fig.17 Calorific values of biodiesel.

Fig 17 shows that Diesel has a highest calorific values as compare pongamia and waste cooking oil biodiesel. Here Waste cooking oil biodiesel shows slightly higher calorific value than pongamia biodiesel.

Fuel Property	Viscosity	Density	Calorific value	Flash point	Fire point
Units	Cst	Kg/m^3	KJ/Kg	℃	℃
Diesel	3.28	825	44800	45	48
P50+V50	5.07	880	37422	165	179
P75+V25	5.014	875	39729	159	168
P25+V75	4.44	885	22715	163	175

Table 6 Biodiesel Mixtures properties.

The graphs plotted below represents the variation of property values with respective biodiesel mixtures.

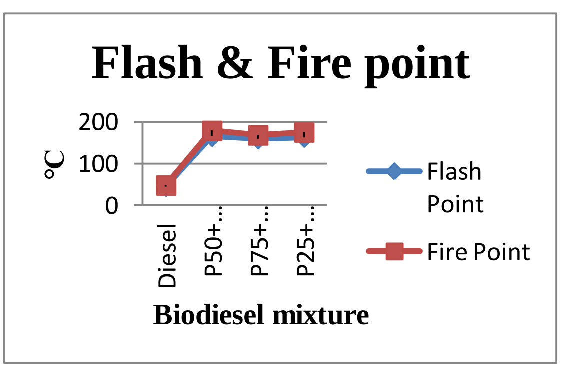


Fig.18 Flash & Fire point of biodiesel mixtures.

Fig 18 shows the flash and fire point of diesel is lower as compare to all the biodiesel mixtures present. Among three biodiesel mixtures P75+V25 shows slightly lower than P50+V50 and P25+V75.

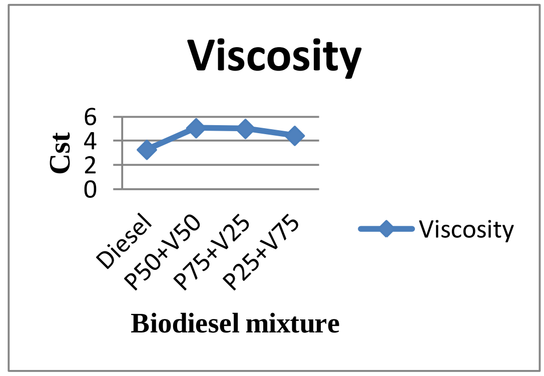


Fig.19 Viscosity of Biodiesel mixtures.

Fig 19 shows the variation of viscosity for different biodiesel mixtures. Diesel has the lowest viscosity and P50+V50 biodiesel mixture has highest viscosity among all the biodiesel mixtu

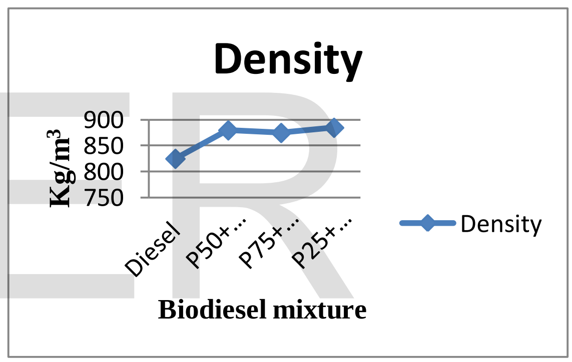


Fig.20 Density of biodiesel mixtures.

Fig 20 shows the density variation of biodiesel mixtures it shows that the biodiesel mixtures have higher density as compare to diesel. Among all the three biodiesel mixtures P75+V25 has lower density.

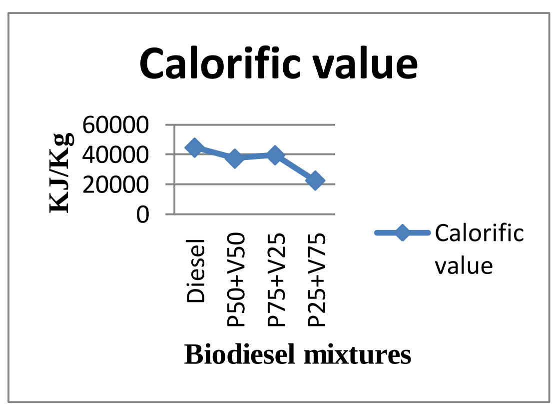


Fig.21 Calorific value of biodiesel mixtures.

Fig 21 shows the variation of calorific value of biodiesel mixtures with diesel. Here diesel has the highest calorific value and in biodiesel mixtures the P75+V25 has the highest calorific value as compare to P50+V50 and P25+V75.

Fuel Property	Viscosity	Density	Calorific value	Flash point	Fire point
Units	Cst	Kg/m^3	KJ/Kg	°C	°C
Diesel	3.28	825	44800	45	48
B10	3.24	825	37422	65	71
B20	3.29	826	31541	67	75
B30	3.43	830	32765	71	78

Table.7 Properties of P50+V50 Blends.

The graphs plotted represents the variation of property values with respective blends of P50+V50.

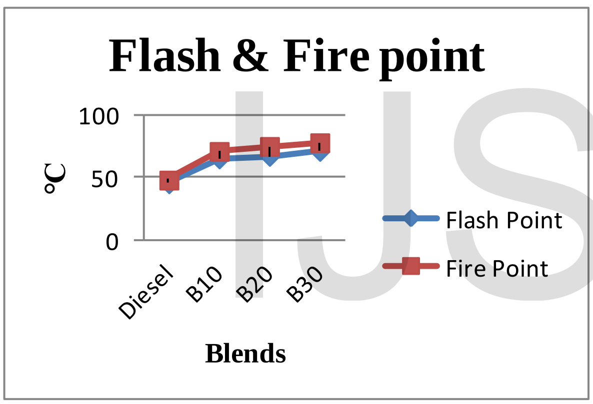


Fig.22 Flash & Fire point of P50+V50 blends.

Fig 22 shows the flash and fire point of diesel and blends of P50+V50. Diesel has the lowest flash and fire point among all the blends of P50+V50. Here B10, B20 and B30 blends shows higher flash and fire point than diesel. Among three blends B10 shows the lower flash and fie point.

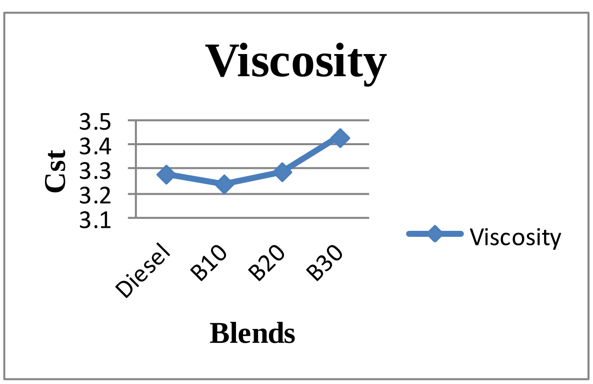


Fig.22 Viscosity of P50+V50 blends.

Fig22 shows that B10(P50+V50) has lowest viscosity. As the percentage of P50+V50 increases viscosity also increases.

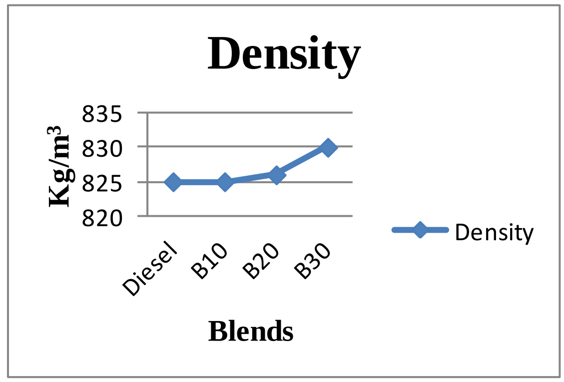


Fig.23 Density of P50+V50 blends

Fig 23 shows that diesel and B10(P50+V50) has no difference in the density but as the percentage of the biodiesel mixture increases the density also increases and B30(P50+V50) has the highest density among all the blends.

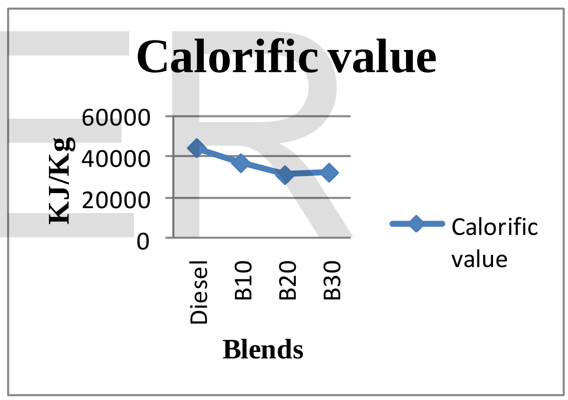


Fig.24 Calorific values of P50+V50 blends

Fig 24 shows the variation of calorific value with respect to the blends. Here B10 of P50+V50 shows the higher calorific value than B20 and B30.

Fuel Property	Viscosity	Density	Calorific value	Flash point	Fire point
Units	Cst	Kg/m^3	KJ/Kg	°C	°C
Diesel	3.28	825	44800	45	48
B10	3.43	825	31072	75	86
B20	3.56	830	37991	76	88
B30	3.9	840	35743	79	91

Table.8 Properties of P75+V25 Blends

The graphs plotted below represents the variation of property values with respective blends of P75+V25.

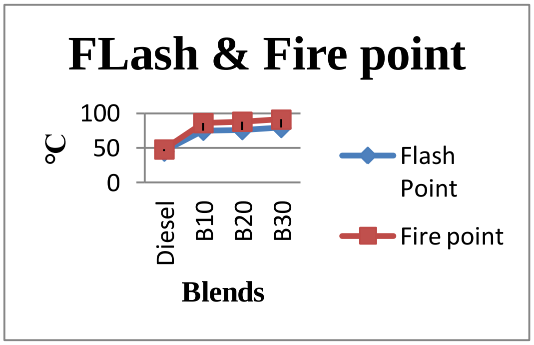


Fig.25 Flash & Fire point of P75+V25 blends

Fig 25shows that flash and fire point of P75+V25 blends increased as the percentage of biodiesel mixture increases. B10 has the lower flash & fire point compare to B20 & B30.

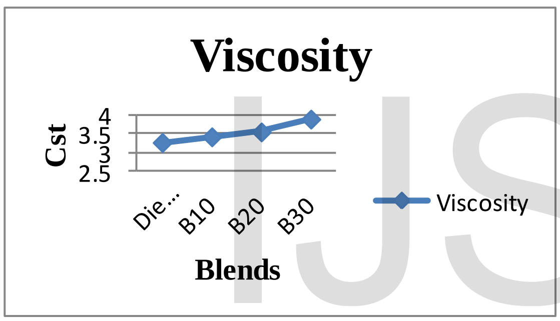


Fig.26 Viscosity of P75+V25 blends

Fig 26 shows the variation of viscosity with respect to blends. As the percentage of biodiesel mixture increases viscosity also increases gradually. B10 has the lower viscosity compare to B20 & B30.

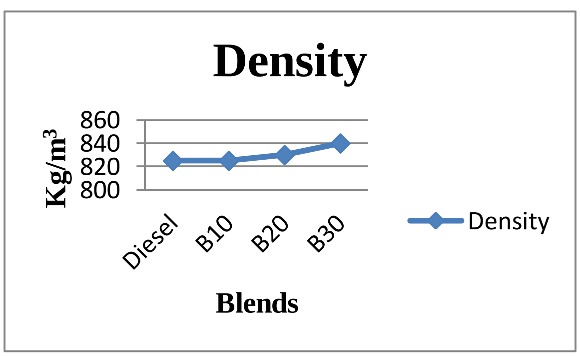


Fig.27 Density of P75+V25 blends

Fig 27 shows the variation of density with respect blends. Here diesel and B10(P75+V25) has almost similar density expect that for B20 and B30 density is increased.

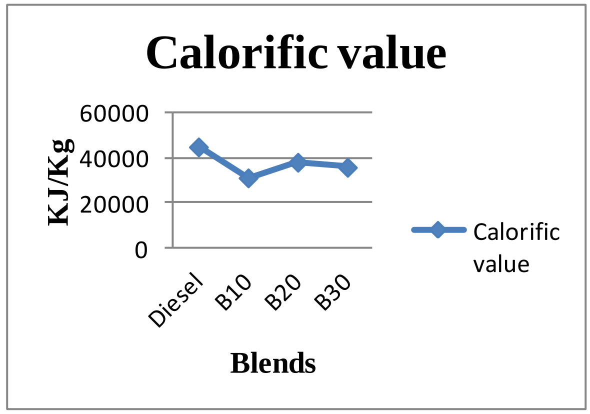


Fig.28 Calorific value of P75+V25 blends

Fig 28 shows the variation of calorific value with respect to the blends of P75+V25. Among the three blends B20 has the highest calorific value as compare to B10 & B20

Fuel Property	Viscosity	Density	Calorific value	Flash point	Fire point
Units	Cst	Kg/m^3	KJ/Kg	°C	°C
Diesel	3.28	825	44800	45	48
B10	3.312	830	31376	70	81
B20	3.34	835	38320	74	87
B30	3.75	846	32774	85	90

Table.9 Properties of P25+V75 Blends

The graphs plotted below represents the variation of property values with respective blends of P25+V75.

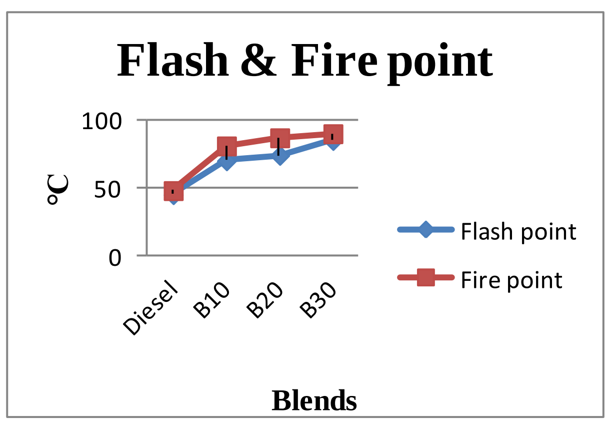


Fig.29 Flash & Fire point of P25+V75 blends.

Fig 29 shows that flash and fire point of P25+V75 blends increased as the percentage of biodiesel mixture increases. B10 has the lower flash & fire point compare to B20 & B30.

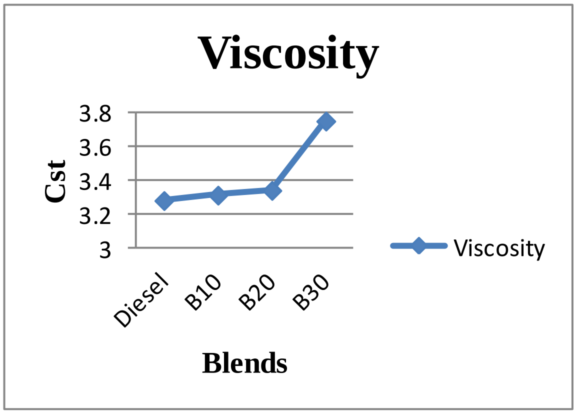


Fig.30 Viscosity of P25+V75 blends.

Fig 30 shows the variation of viscosity with respect to blends. As the percentage of biodiesel mixture increases viscosity also increases gradually. B10 has the lower viscosity compare to B20 & B30.

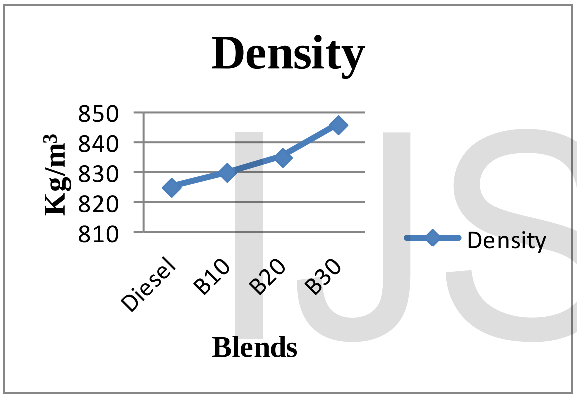


Fig.31 Density of P25+V75 blends.

Fig 31 shows the variation of density with respect blends B10, B20 & B30. Here B10 has the lower density as compare to B20 & B30.

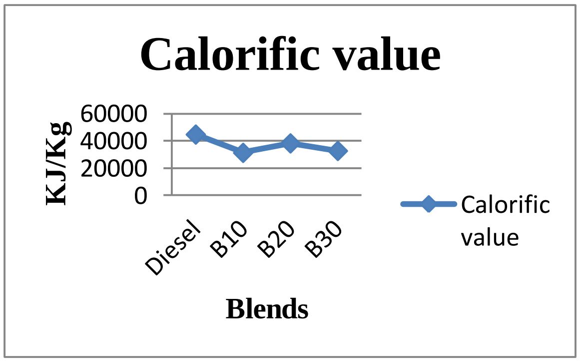


Fig.32 Calorific value of P25+V75 blends.

Fig 32 shows the calorific value of blends of P25+V75. For blend B20 has the highest calorific value as compare to B10 & B30.

7. CONCLUSION

A study on properties on biodiesel mixtures and blends of biodiesel is studied and compared to diesel fuel. The results are summarized as follows,

1) Kinematic viscosity: From the entire graphs, among all the blends, it has been observed that B10, B20 of P50+V50 and P25+V75 are closer to the viscosity of diesel. B10(P50+V50) viscosity is similar to that of diesel.
2) Density: From the entire graphs, it has been observed that the density of B10, B20 of (P50+V50) and B10 of (P75+V25) are closer to that of diesel. B10 of (P75+V25) and B10 of (P50+V50) shows similar density to that of diesel.
3) Flash & Fire point: From the entire graphs, among all the blends Flash and fire point of the blend B10(P50+V50) is closer that of diesel.
4) Calorific value: From the entire graphs, among all the blends calorific value of the blend B20(P25+V75) is nearer to the diesel.

8. REFERENCES

1) Mulimani, H., Hebbal, O. D., Navindgi, M. C *"Extraction of Biodiesel from Vegetable Oils and Their Comparisons, International Journal of Advanced Scientific Research and Technology"*
2) Gashaw, A., and Lakachew, A. *"Production of biodiesel from non edible oil and its Properties"*
3) Dilip Kumar Bora, L M Das and M K Gajendra Babu *"Performance of a mixed biodiesel fueled diesel engine"*
4) R. El-Araby, Ashraf Amin *"Study on the characteristics of plam –oil biodiesel blend"*