TO INVESTIGATE THE WASTE-DERIVED ETHYLENE GLYCOL DIACETATE USING THE BLENDS OF KARANJA AND JATROPHA BIODIESELS

Dr.B.Tharmalingam
Assistant professor,Department Of Chemistry,AEC,Salem

Abstract

The purpose of this study was to introduce and test a new waste-derived oxygenated additive, ethylene glycol diacetate, on the performance and emission characteristics of a diesel engine running on diesel/biodiesel blends. The engine performance and exhaust emissions of a diesel engine were studied using Karanja and Jatropha blends with ethylene glycol diacetate additive in appropriate volume proportions (5 percent, 10%, and 15%). When compared to diesel, fuel characterisation data revealed that jatropha and karanja have a higher calorific value, a higher flash point, and a worse cold-flow plugging point. Ethylene glycol diacetate was added to these gasoline mixes at three different volumetric amounts, ranging from 1 to 3 percent.Under moderate engine load circumstances, the most appealing results were obtained when diesel fuel dosed with 3 vol percent ethylene glycol diacetate was combusted. In comparison to additive-free diesel fuel, this oxygenated fuel blend could result in significant reductions in nitrogen oxides and carbon dioxide emissions, but it could also result in an unfavourable rise in unburned hydrocarbon emissions. The purpose of adding DEE as an addition to KME-diesel blends is to improve the DEE blended biodiesel's combustion properties and emission pattern.This fuel combination produced carbon monoxide emissions that were comparable to that of straight diesel. Furthermore, the considerable reductions in nitrogen oxide and carbon dioxide emissions were achieved with only a 5% reduction in the engine's braking thermal efficiency. Finally, the discovered oxygenated additive could be utilised to reformulate diesel fuel in order to significantly reduce nitrogen oxide emissions.

Keywords: jatropha, karanja, ethylene glycol diacetate, biodiesel,

1. Introduction:

The environment is greatly polluted by emissions such as carbon monoxide (CO), CO2, NOx, SOx, unburnt or partially burnt hydrocarbons (HC) and particulate from transport vehicles. The chief contributors to urban air pollution and major source of greenhouse gases are fossil fuels, and they are considered to be the major cause of global warming. India imports petroleum products at an annual cost of approximately $50 billion in foreign exchange. In view of this high demand/cost of fossil fuels associated with higher emissions, it is necessary to find a suitable alternative to diesel oil.

Replacing just 5% of petroleum fuel by biofuel could enable India to save $2.5 billion per year in foreign exchange. Exhaustive literature work on the use of vegetable oils and their blends in diesel engine applications has been published by various researchers. Various non-edible oils, such as jatropha, honge, honne, rubber seed, mahua, hazelnut kernel, waste cooking and cotton seed oils, are investigated for their suitability to diesel engine fuels.The literature survey mainly suggests that work on the use of the combination of different biodiesels and their behaviour in diesel engines has not been explored in detail.

The combination of the two biodiesels was used in this study asnot much work has been reported in the literature. [1-5]Effect of injection pressures, injection timings and exhaust gas recirculation (EGR) on the performance of different vegetable oils in compression ignition (CI) engines has been reported by many investigators.[6-8] Changes in injection timings change the position of the piston and cylinder pressure and temperature at the injection. Retarded injection timings showed significant reduction in diesel. Cylinder pressures and temperatures gradually decrease when injection timings are retarded.

[9-13] Advanced injection timing by 48 before top dead centre (BTDC) with waste cooking oil in direct injection diesel engine resulted in better efficiency with reduced CO and higher NO emission. Retarding the injection timing by 48 BTDC with honge biodiesel has resulted in better efficiency with reduced HC, CO and smoke emissions. [14-18]Many researchers have also performed tests on CI engine with different vegetable oils at different injection pressures. Nevertheless, high NOx emissions, expensive feedstock, fuel stability and higher viscosity have limited its active usage. Carbon precipitates, cold-start complexity, higher BSFC, higher pour point, lower BTE are the additional limitation of BD. The usage of BD shall be improved by blending with additives with improved physicochemical properties.

[19-20] Higher alcohols (HA) and ignition enhancer (IE) shall be promising additives to improve the ignition properties of BD. HA and IE are loaded with improved properties such as higher cetane number, improved miscibility and higher calorific value. HA and IE are produced by the fermentation process of biomass and biowaste. The effective blending of HA and IE with BD/diesel blends results in a higher power and lower emissions than neat BD. [21]Among available additives, 1-Pentadecanol and DTBP are found to be appropriate candidate owing to their improved chemical and physical properties. Blending 1-Pentadecanol and DTBP to BD/D blends will reflect inferior emissions, enhanced combustion and improved performance. Cetane number, calorific value, lower pressures (vapor), flash point are the other positive properties of 1-Pentadecanol and DTBP. 1-Pentadecanol and DTBP provide the ignition quality and enhanced phase stability than other additives. The surplus oxygen available in DTBP and 1-Pentadecanol promotes the oxidation process and limits the emissions.[22]

[23] The biodiesels are prepared mainly for CI engines, that's why it is different from vegetable and waste oil. Biodiesel can be used separately as well as blended combination with petroleum-based fuels. The best option for biodiesel is non-edible oils. [24]The important, ample oil resources in India are Mahua oil, Jatropha oil, Neemoil, Pogamia oil

etc., The development of biodiesel provides benefits like pollution free environment, green shelter to waste lands, agricultural development, improvement in the economy.

India is improving its environment to become a major manufacturer of biodiesel, since biodiesel can be gained from non-edible oils like Mahua, Pongamia, linseed, neemJatropha, Castor, etc. [25]Among these oils, India is focusing on Pinnata, Pongamia and JatrophaCurcus, which can easily grow in waste and dry lands. The properties of the oil found in the Jatropha and Pongamia seed are about 30-40 percent. India contains 80 to 100 million hectares of waste and dry lands, that could be used for Jatropha and Pongamia farm. Moreover, India is also the large and unique manufacturer of Neem oils which comprises 30 percent oil needs.

[26]In the production of biodiesel, fatty acid resources like plant oils or animal fats are used. The usage of these kind of resources has given rise to some concerns because they are not only the alternative fuel sources but also the important food materials. It may increase the food crisis. So many of the researchers are focusing on waste cooking oils and non-edible oils as the feedstock for producing biodiesel, it includes oils like algae oil, grease oil and jatropha oil. The main problem for industrializing and commercializing the biodiesel is their production costs. By using waste cooking oil we can reduce the production cost up to 60-90% and we can also produce a greater quality diesel.

[27]Biodiesel's are substitute for diesel which can be extracted from vegetable oil, waste oils, and animal fats. The vegetable oils are edible as well as non-edible in nature. The vegetable oils are mainly gained from agriculture fields. The production of vegetable oil is lower than the demand, it is difficult to use it for biodiesel production. Even if we use it for fuel alternative, it may result in shortage for human consumption and it will affect the economy. So we can possibly use non-edible oils such as waste oil, animal fats, simuhua, Muhua oils which are also very economical. have experimented the fatty acids composition of 51 vegetables. They noticed that the fatty acid composition in vegetable oils like peanut oil, tobacco seed oil, palm oil, cotton seed oil, sesame oil, rice bran oil and linseed oil is different even in the plant of same species found in various locations of the world. Azam *et al*. presented the prospects and potential of methyl esters fatty acid on some of the non-traditional seed oils such as pongamia, pinnata which are used as major biodiesel in India. They noticed that 75 plant species have about 30% oil in their seed and kernel. presented that more than 300 different plant species, which generate oil-bearing seeds. So they are essential for non-edible vegetable oil source from different plants for the production of biodiesel as a substitute fuel for petroleum-based fuels.

Biodiesel is easily renewable and eco-friendly substitute fuel for diesel engines. That could be generated from consumable vegetable oils or edible oils, inconsumable vegetable or inedible. And also from animal fats and waste vegetable oils, through transesterification process. [28]Transesterification process is a chemical reaction where the animal fats and vegetable oils react to alcohol in the presence of a catalyst. The result of the three reactions is glycerin, the fatty acid alkyl ester, fatty acid alkyl which is called as biodiesel. Biodiesel is a fuel which is oxygenated. Biodiesel has over 10% to 15% oxygen weight. Being sulfur free is also an advantage in biodiesel production. These qualities take biodiesel to experience full combustion and lower the emission of harmful gas from the diesel engine. However, when compared to the fuel components of biodiesel as well as diesel fuel, the biodiesel has greater density, viscosity, flash point, pour point and cetane number than petroleum-based fuel. [29-30]Furthermore, the content of energy or net value calorific of biodiesel is over 12%, which is lower than that of petroleum fuels on the basis of mass. Biodiesel usage could decrease dependency of the world on petroleum fuels and it also has many environmental benefits. These environmental benefits are: It decreases the emissions of harmful gases like CO_2, PM, CO, Sox, VOCs, HC, subsequently. Many researchers have found that 100% biodiesel emanates less tailpipe emissions while comparing with the normal fuel; over 50% lower emission in PM, over 50% lower emission of CO and over 68% lower emission in HC. Moreover, since biodiesel is a sulfur-free fuel, it contains 99% lower SOx emission than the normal fuel.

2. Materials and Methods:

2.1.Preparation of Biodiesel

FFA (free fatty acid) is a major parameter for biodiesel.Around 8% of FFA was found from raw Karanja oil (KO) and Jatropha oil (JO). FFA content of raw oil is converted into methyl form by three-step transesterification technique. The initial reduction in FFA is carried out by acid-catalyst transesterification. It is then followed by alkali-catalyst transesterification and purification thereafter. Initially, the raw KO and a mixture of methanol and sulfuric acid are measured on the molar ratio of 16:1 and heat for 60 min to 65 °C. The obtained mixture is reheated by adding methanol at a molar ratio of 5:1. Subsequently, to obtain the methyl ester, 1.1% weight of catalyst (KOH) is included in the mixture and heated for 30 min to 60 °C. Later, methanol in the mixture is removed and purified by heating the mixture to its boiling point. After transesterification, 94% of yield was obtained from raw KO. The bubbling method was used to facilitate the biodiesel purification process. The fatty acid methyl ester profile of the biodiesel used is presented in Table 1.

2.2.Blends preparation

Biodiesel (KBD) and diesel each were blended exactly at 50% by volume and termed as KBD/D. The chosen additives were mixed at 10% volume with the equal blends of diesel and biodiesel. For instance, DTBP at 10% volume is mixed with the blend containing 45% of diesel and 45% of biodiesel and termed as "KBD/D/ DTBP." The raw KO and JO was first filtered for separation of impurities. Base catalyzed transesterification of the neat and filtered KO and JO was carried out in a 2 L capacity biodiesel reactor using KOH as base catalyst and methanol as reagent. 20% v/v methanol was used along with 10 gm of KOH for one single run of biodiesel production. Transesterification reactions were carried out at 60°C for a period of 1.5 h. After the reaction is over, the reaction products were permitted to settle down overnight. On the next day, glycerol was removed from the bottom layer and Karanja methyl ester (KME) and Jatropha methyl ester was collected to another container.Further, 1-Pentadecanol at 10% volume is mixed with the blend containing 45% of diesel and 45% of biodieseland termed as “KBD/D/1-DEC” by splash blending technique. Wider acceptance and the lower cost was the major cause of choosing splash blending. Upon investigation, all the samples were found stable and well mixed. The density of test fuels was calculated by employing digital densitymeter in line with ASTM D1298. The results of the fuel characterization are presented in Table 1.

Table 1. Test fuel properties

Fatty acid methyl ester	C14:0	C16:0	C18:0	C18:1	C18:2	C18:3
wt.%	0.78	33.54	4.42	40.3	18.33	1.27

2.3.Synthesis ofr Ethylene glycol diacetate

Acetic acid (purity > 99.85%), 2-ethylhexanol (purity > 99%), absolute ethanol (purity > 99.9%), toluene (purity > 99.9%), and Levitate were supplied by local chemical companies. Ethylene glycol diacetate was synthesized through esterifying waste-oriented ethylene glycol (purity > 99%) with acetic acid. The esterification process was carried out using two vertically assembled continuous fixed-bed tubular reactors (i.d.=3 cm, length=70 and 90 cm). Waste-oriented ethylene glycol and acetic acid were pre-mixed with a molar ratio of 1:5. A dosing pump (model DLX-MA/DA, ETATRON D. S. Co.) was used to introduce the pre-mixed reactants to the first reactor with a flow rate of 6.75 mL/min along with 30 g levitate catalyst. The temperature of the first reactor was adjusted at 90 °C. After leaving the first reactor, the mixture was fed to the second reactor in order to remove water from the reaction slurry through azeotropic distillation method. Toluene was used as entrainer for azeotropic water removal. Azeotropic distillation was performed at 84 °C. The collected samples contained unreacted acetic acid, toluene, ethylene glycol diacetate, and some by-products. In the next step, vacuum distillation was considered for separating the evolved ethylene glycol diacetate from the pre-distillated slurry. Air blowing method was used to accelerate the distillation rate.

2.4.Characteristics of Karanja and Jatropha biodiesels and their blends

In the present study, the karanja and jatropha vegetable oils were subsequently converted into their respective biodiesels, i.e. KB100 and JB100. The detailed transesterification procedure used in the stud.. These biodiesels were then blended with diesel at different proportions such as KB20, KB40, KB80 and JB20, JB40, JB80. Here, KB20 represents karanja biodiesel with 20% karanja and 80% diesel on volume basis, while JB20 represents jatropha biodiesel with 20% jatropha and 80% diesel on volume basis, respectively. Finally, both biodiesels were blended in different proportions namely KJB20, KJB40, KJB60 and KJB80. Here KJB20 represents karanja and jatropha biodiesels with 20% karanja and 80% jatropha on volume basis.

2.5.Transesterification of karanja and jatropha oils

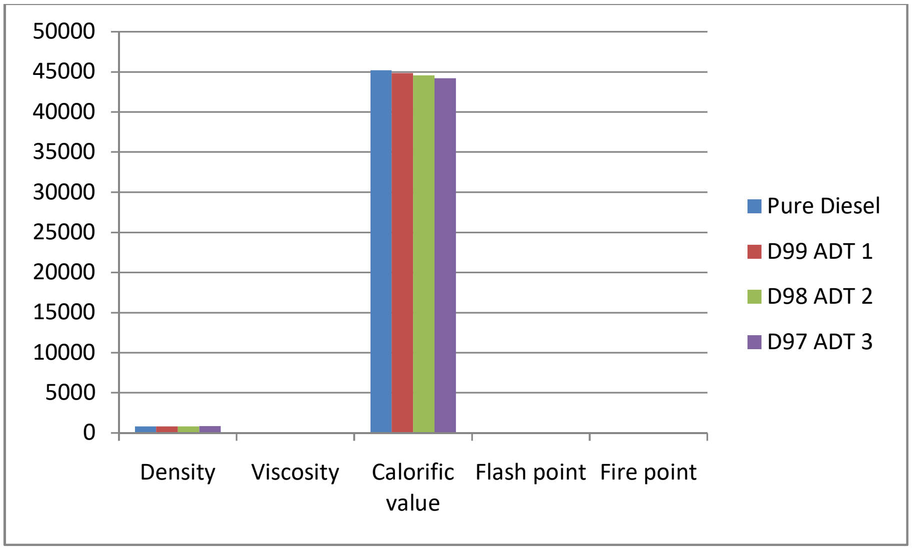
Karanja and jatropha oils were transesterified as theirviscosity is more than diesel. The factors affecting the transesterification process are temperature, reaction time, molar ratio and catalyst concentration. These were optimised for both the fuels during transesterification process. In the transesterification process, refined vegetable oil, methanol, sodium hydroxide (NaOH) and distilled water were used. This reactor was immersed in a constant temperature water bath. Both the water bath and reactor were equipped with thermometers to measure the temperature. The reactor has a magnetic stirrer and is used to achieve necessary agitation of the oil mixture. A constant speed of 300 rpm was maintained throughout the experiment. Initially, the reactor was filled with 1 l of vegetable oil (karanja or jatropha oil) and heated to 658C to remove the moisture. A catalytic solution of NaOH (1% by weight of oil) dissolved in the methanol (molar ratio of alcohol/oil is 1:5) was then added to the reactor.

3. RESULTS AND DISCUSSION

3.1.Density

In the synthesis of biodiesel from blended used vegetable oils, a heterogeneous acid catalyst called ethylene glycol diacetate is used. It determines that the high acid site density and blends of jatropha and karanja oil have a relationship with the high stability and catalytic activity. The results demonstrate that the density was extremely low, and the catalyst is non-toxic, renewable, inexpensive, user-friendly, and environmentally benign.

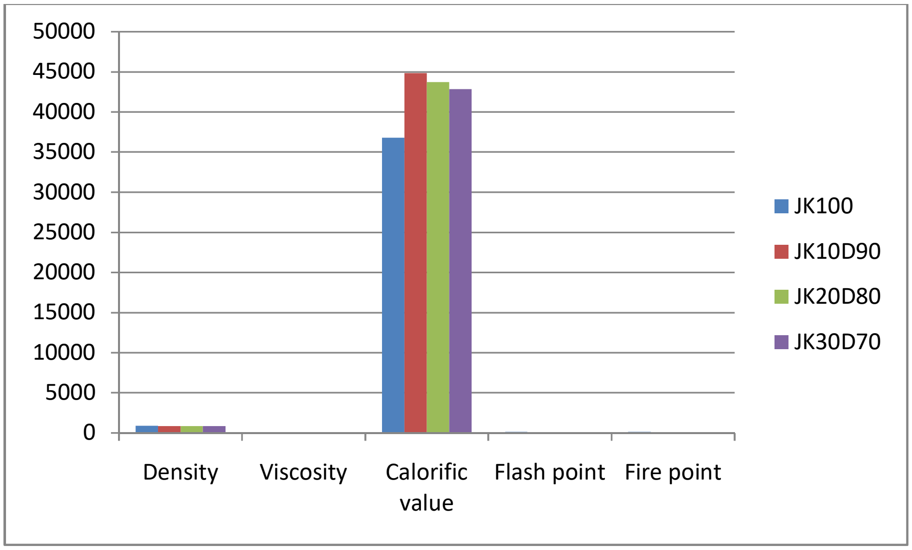
Component	Density	Viscosity	Calorific value	Flash point	Fire point
Pure Diesel	838	2.81	45217.6	56	64
D99 ADT 1	841.7	2.85	44817.2	53	60
D98 ADT 2	844.9	2.88	44557.2	50	56
D97 ADT 3	848.9	2.94	44185.2	47	53



3.2.Viscosity

In diesel engines, transesterification of jatropha and karanja oils using ethylene glycol diacetate has been found to be successful. The transesterification of jatropha and karanja oil reduces viscosity by enhancing the physical components. High water concentration can affect the saponification reaction, resulting in lower ester yields, hard glycerol and methyl ester separation, viscosity increase, and emulsion formation, all of which can pose problems in downstream purification and methyl ester recovery. It significantly reduces the viscosity of vegetable oil; we should warm it before injecting it into the burning chamber. The viscosity of the final product is identical to the viscosity of the diesel after preheating the vegetable oils over 550C before injection.

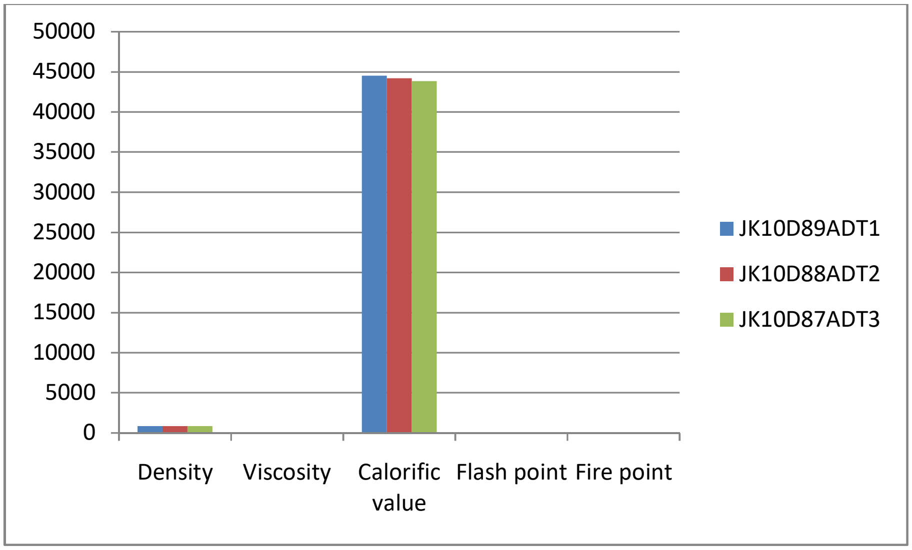
Component	Density	Viscosity	Calorific value	Flash point	Fire point
JK100	878.2	4.56	36824	123	134
JK10D90	846.6	2.97	44843	64.4	74.1
JK20D80	849.3	3.11	43729	65.2	75.3
JK30D70	852.3	3.3	42844	68.3	79.2



3.3.Calorific value

Because properties such as calorific value, density, and viscosity are extremely similar to diesel, Jatropha and Karanja oil (biodiesel) can be used to substitute diesel. The low calorific value of vegetable oil affects atomization and squirt production of gas, resulting in incomplete combustion, carbon authentication, injector harshness, and piston ring downhill. The software is given input values such as the density and calorific value of the blend.

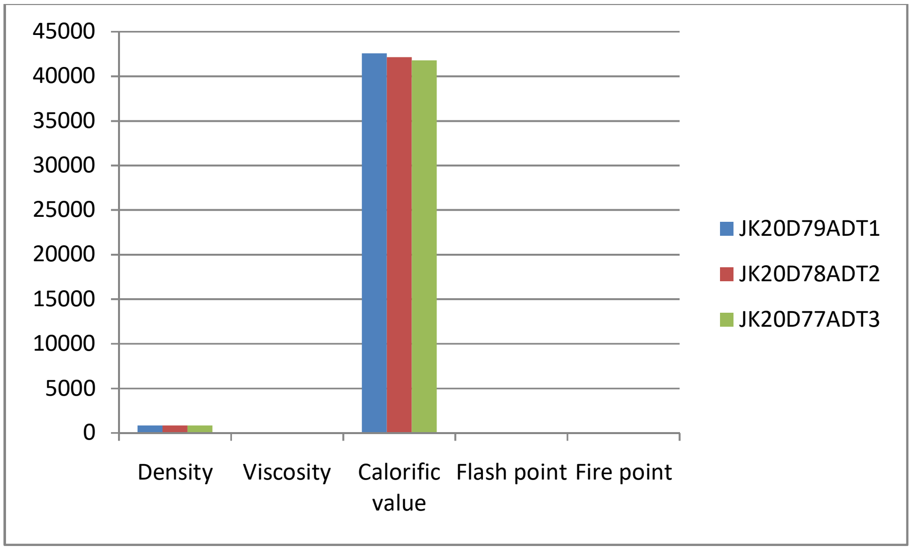
Component	Density	Viscosity	Calorific value	Flash point	Fire point
JK10D89ADT1	849.6	3.03	44515	62.4	72.2
JK10D88ADT2	853.8	3.08	44197	59.4	69.2
JK10D87ADT3	857.8	3.15	43869.7	56.3	65.2



3.4.Flash point

Biodiesel has a high flash point of 3000 degrees Fahrenheit, making it one of the safest alternative fuels. Jatropha and karanja oils have a flash point of more than 200 LC. It has been proved that using vegetable oils in diesel engines causes problems that are related to the fuel grade and type, as well as weather conditions. The main issues with these fuels include lubricating oil gelling, carbon deposits, fuel line blockage, ring sticking, and fouled piston heads.

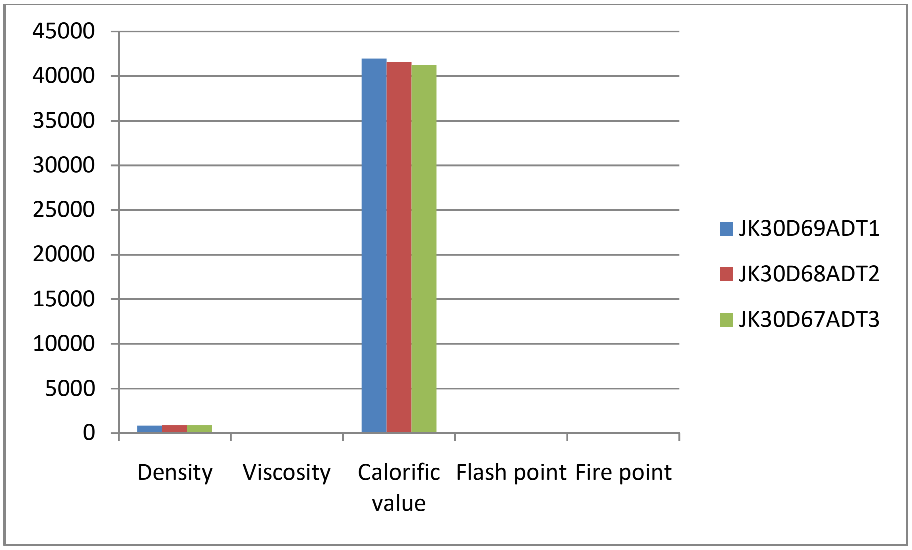
Component	**Density**	**Viscosity**	**Calorific value**	**Flash point**	**Fire point**
JK20D79ADT1	854.8	3.07	42573	66.4	76.3
JK20D78ADT2	857.9	3.14	42174	63.3	72.8
JK20D77ADT3	860.8	3.18	41791	59.4	68.6



3.5.Fire point

Waste cooking oil properties are checked in the thickness scope of 860.1g/cc at 81.3°C And its kinematic consistency is 4.07cSt and afterward it is again assess in a copper lamp fuel 1a an at 77.2°C. PMPC technique has streak point and fire point, research found in this manner the esteem is 189 °C in glimmer Point and 72.3 °C in flame point. Lotion content is 0.021 percent and the Acid esteem is in gram its esteem is 0.218 gram of oil/NaOH caloric esteem 866.5 cal/g, that research found.

Component	Density	Viscosity	Calorific value	Flash point	Fire point
JK30D69ADT1	860.1	3.24	41974	71.9	81.3
JK30D68ADT2	863	3.28	41644	68.9	77.2
JK30D67ADT3	866.5	3.36	41253	62.9	72.3



4. **Conclusion:**

The goal of this study was to see how waste-derived ethylene glycol diacetate, used as an oxygenated addition, affected the performance and emissions of a diesel engine running on diesel/biodiesel blends at varying engine loads. Increasing engine load significantly raised exhaust gas temperature, however substituting biodiesel for a portion of diesel decreased this parameter. The addition of an oxygenated ingredient to the gasoline mixes had no discernible effect on exhaust gas temperature. The following characteristics, such as density, viscosity, fire point and flash point, calorific value, acid value, and so on, have been tested, and the results are above the ASTM D6751 biodiesel standards limit. The ASTM D 6751 biodiesel standard was developed in the United States.

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