Processing of Biodiesel and Comparison of Storage Parameters

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Abstract-*Diesel is considered as one of the major source of energy especially in transportation. But due its emission and toxic properties, it is becoming difficult for diesel to fit under the specified norms. Biodiesel overcomes major drawbacks of diesel without changing actual design of diesel engine and yet is eco-friendly in every aspect. Trans esterification is the most common method of processing Jatropha and Mix vegetable oil into biodiesel. Parameters such as flash point, fire point, oxidation stability, corrosiveness are considered for storage of biodiesel. These properties vary depending upon the type of biodiesel thus a common storage tank is to be designed for storing of different type of biodiesel.*

Keywords:-Biodiesel, Processing, Storage, Transesterifcation

I. INTRODUCTION

The world function in terms of many systems. The systems require energy to work. This energy has many forms and can be used for different application in the world. The world needs energy for survival, be it the thermal energy or heat energy produced by combustion of fuels. There are many types and forms of energy. Energy can neither be created nor be destroyed and remains constant. We use the energy in different forms to benefit the human world the energy is required in many walks of life. For example, the production of electricity which has become one of the basic needs of man. The heat energy is also converted into mechanical energy for transportation. The energy consumption is measured per year called as the world energy consumption. It involves all the energy harnessed in the world. Consumption has deep implications for humanity's social, economic, political globe. International energy agency (IEA), U.S energy information administration (EIA), and the European environment agency records and publishes energy data periodically. There is also growth in the use of oils and natural gas, followed by the hydro power and renewable energies like tidal energy solar energy. Thus energy is very important for the functioning of the world. A large portion of the energy consumed all over the world is used in transportation.

BIODIESEL

Rudolf diesel invented the diesel engine in the 1890's. From the beginning, this engine could run on a variety of fuels, including vegetable oil. In 1900, one of the new diesel engines featured at the Paris Exposition was powered by Peanut oil. However, because cheap petroleum fuels were easily available few people were interested in alternatives. As early as the 1930s there was interest in splitting the fatty acids from the glycerine in vegetable oils in order to create a thinner product similar to petroleum diesel. In 1937, G. Chavannes was granted a Belgian patent for an ethyl ester of palm oil. 1938, a passenger bus fuelled with palm oil ethyl ester plied the route between Brussels and Louvain. In 1970s, the petroleum oil embargo caused many countries to look to vegetable oil as a possible fuel. Scientists in Austria, the United States, South Africa and many other countries rediscovered that straight vegetable oil could be used to run diesel engines. However, eventually the poor quality of the fuel spray caused by the thickness of the vegetable oil caused damage the engines. Scientists then conducted experiments to convert vegetable oil into biodiesel. Biodiesel can be seen as one part of a larger plan to reduce air pollution, carbon emissions and dependence on fossil fuels. Energy crops can also be seen as an important source of income. Scientists are currently researching ways to produce biodiesel using new feedstock that are less limited by the availability of land. For example, some types of algae can produce oil. Energy crops could also be grown on land that is not suitable for food crops, such as soil is too salty or acidic, that has too many minerals or is too shallow, or that is in danger of eroding. In these cases, energy crops might help stabilize and restore land. Scientists are also experimenting with producing fuel from non-oilseed feedstock such as inexpensive, non-edible biomass that can be converted into a diesel replacement. While it is a fairly simple process to convert vegetable oil or animal fat into biodiesel, the conversion of cellulosic feedstock to fuel is more complicated and more expensive. To produce a hydrogen fuel, the biomass is first generally converted into a synthetic gas using high heat. Then the gas can be converted into a liquid diesel fuel for the usage.

100% biodiesel (B100) can be used as fuel or can be blended with diesel in different proportions. Its blends are decided according to the specifications of the engine as mentioned by the manufacturer. Biodiesel is highly reactive to rubber corks or hoses which tend to get dissolved in biodiesel. Biodiesel tends to break the residue of in fuel lines where diesel was used. Due to this fuel filter gets clogged due to particles. Thus it is suggested that regular replacement of fuel filters is necessary. Biodiesel is used as heating oil in various industries which consist of blend of biodiesel and petrol which is completely different from the diesel used in transportation. Blends of biodiesel when heated are equivalent to the petrol used alone for heating..

II. LITERATURE REVIEW

E. Christensen (et. al.) [1] studied longer-term storage stability of biodiesel and blends was studied in experiments simulating up to one year for 100% biodiesel (B100) and three years for blends. Aging was simulated by holding samples at 43 °C to after antioxidant treatment. Treating aged biodiesel was effective at restoring stability; however, antioxidant effectiveness was decreased relative to fresh biodiesel.

In a research conducted by Rodrigo A.A. Munoz (et. al.) [2], the behaviour of the antioxidant tert-butyl hydroquinone (TBHQ) was observed. The antioxidant increased the storage life of the biodiesel by increasing the oxidation stability.

The work conducted by Jose Ricardo Sodre (et. al.) [3] presents the physical–chemical properties of fuel blends of waste cooking oil biodiesel or castor oil biodiesel. The properties observed were fuel density, kinematic viscosity, cetaneindex, distillation temperatures, and sulfur content. Theresults were analyzed based on present specifications for biodiesel fuel in Brazil, Europe, and USA. Fueldensity and viscosity were increased with increasing biodiesel concentration, while fuel sulfur contentwas reduced.

A case study by Silvio Hamacher (et. al.) [4] was conducted on the optimization of biodiesel supply on small farmers. The article presents a planning of biodiesel supply from small farmers and taking into consideration the agricultural, logistical and social aspects of biodiesel.

R.K. Singh (et. al.) [5] researched the characterization of jatropha oil for biodiesel. Biodiesel was prepared from jatropha oil, first from esterification and then using Transesterification.

Antonio Gouviea De Souza (et. al.) [6] researched the influence of the synthesis processes on the properties of flow and oxidative stability of biodiesel from jatropha. Md. Hasan Ali (et. al.) [7] studied the properties of biodiesel obtained from neem oil. Neem oil contains more of the high 30-40 % oil. Oil contains mono alkyl esters produced using transesterification process.

Stuart Coles (et. al.) [8] studied the performance of biodiesel in motorsport and various transportation. Methyl esters from rapeseed, sunflower and soya bean alongside EN590 diesel fuel. Variations in output, torque and power were observed between fuels .

K. NanthaGopal (et. al.) [9] usedpongamia oil on a diesel engine using PME 20, PME 40. PME 60 and PME80. The results were compared with diesel. Parameters such as brake thermal efficiency brake specific fuel consumption carbon monoxide were compared.

José R. Zamian (et. al.) [10] studied the production of biodiesel from jupati. The study presents the characterization of biodiesel from jupati using an ethylic route methane sulfonic acid reaction catalyst.

R. P. Manorathna(et. al.) [11] presented paper different blends of bio-diesel and petro-diesel were tested in a conventional 2 cylinder Kubota tractor engine. Variations of speed versus torque, speed versus power and the environmental factors through emission levels were measured and presented.

C.G.Tsanaktsidis(et. al.) [12] studied how processed biodiesel affects the physical and chemical properties of their blends with diesel fuel. Parameters such as density, kinematic viscosity, humidity were investigated

III. PROCESSING OF BIODIESEL

The biodiesel is prepared from the jatropha seeds and waste vegetable oil which is obtained from the used vegetable oils for cooking. The biodiesel is prepared in two steps processes. The first process used for preparation of biodiesel is called esterification. The process is carried out in controlled temperatures. The oils obtained from the jatropha seeds has the acidity of about 19.88 mg KOH per gram. The waste vegetable has the acidity up to 35.36 mg KOH per gram. To prepare bio diesel from the jatropha oil the acidity is reduced to 0.5 mg KOH per gram. In this step the acidity of the jatropha oil is reduced to 5 mg KOH per gram and for the waste vegetable oil the acidity is reduced up to 22-20 mg

KOH per gram. This acidity of the oil is reduced by esterification of the oils. This process is as follows.

0.5 % of Sulphuric acid (H_2SO_4) and 13 percent of methyl alcohol is added with 1000 ml of jatropha or waste vegetable oil. The temperature of the oil is kept at 60 degree Celsius. This mixture is rotated with a speed of 600 rpm for 60 minutes. This process results in the formation of ester and acidity is reduced.

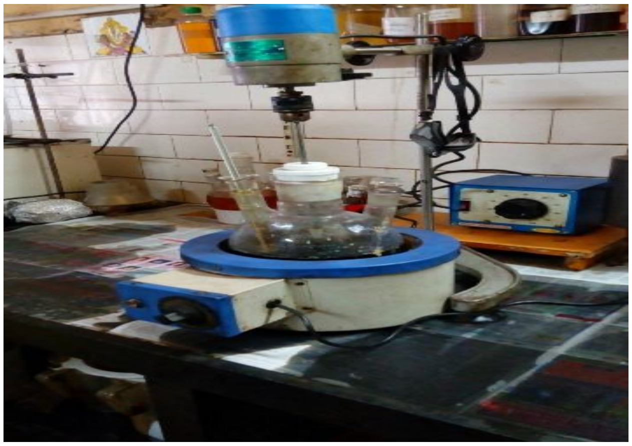

Figure.1 Apparatus for blend making

The acidity reduced so far is not useful for its usage as a fuel and hence the acidity is reduced again. This is carried out in the second step of the process. The process is called as Trans esterification In Trans esterification process, 0.5 percent of sodium hydro oxide and 10 percent of methyl alcohol is added with the esterified oil. The temperature of the mixture is kept as 60 degree Celsius and is rotated at the speed of 600 rpm for 60 minutes. Thus the esterified oil is converted into two parts by the process called as settling. The settling is carried out for 8-10 hours. The settling results in 80 percent of ester and 20 percent of oil. The oil is removed from the mixture as layer of oil is formed below the ester

Figure.2 Biodiesel phase separation

The ester is washed by hot distilled water (neutral pH) for 2 hours. Then distillation is carried out of the mixture for 3 hours to remove the moisture. Therefore biodiesel B100 is obtained Blends of the biodiesel and diesel are made and used for the various tests like emission analysis and also used in engines. The blends are made by mixing of the diesel and biodiesel as follows.

Figure.3 Distillation of biodiesel

For the blend B5% of quantity 100 ml, 950 ml of diesel is heated up to 40 degree Celsius in water bath and 50 ml of B100 biodiesel is added to the 950 ml diesel. This mixture is rotated at the speed of 300 rpm for 15 minutes. Settling process is carried out after mixing. A homogenous mixture is obtained after settling. If the blend contains moisture, a separate layer is formed and is separated out. The same process is carried out for other blends by changing the quantity of the biodiesel mixed with the diesel.

IV. STORAGE OF BIODIESEL

During Trans esterification of vegetable oil or animal fats, glycerol is obtained as the main by-product. Water and other metals can also be found during transportation and handling. Water can be corrosive to the engine and other parts. One of the major problems during storage of biodiesel is its oxidation instability. Biodiesel is more susceptible to oxidation as compared to petro-diesel. Oxidation processes are accelerated in the presence of water, heat, and oxygen. Biodiesel is hygroscopic, i.e. it attracts moisture. The water absorbed by the biodiesel can form a variety of organic acids, such as free fatty acids, and helps promote growth of micro-organisms. Free fatty acids may corrode metal parts in fuel lines. If oxidation stability, acid number and viscosity of biodiesel exceeds the limits given in the ASTM D6751, the biodiesel is rendered useless. The higher levels of unsaturated fatty acids, the more easily biodiesel will degrade. The unsaturated molecules in the Biodiesel can react with the oxygen and form peroxides that break down into acids, gums and sediments. The fuel in the tank can be separated from the atmospheric oxygen by providing a nitrogen blanket on the fuel. Some plants and animal fats naturally have antioxidants. Some biodiesel processes like bleaching, deodorizing animal fats can remove these anti-oxidants and lessen the stability of the biodiesel. Other processes can leave these antioxidants in the biodiesel. Antioxidants, whether natural or artificial, can be added to the biodiesel to increase the stability and hence the storage life.

Water is another major problem which can degrade biodiesel. Even if water is removed from the biodiesel during the manufacturing by the producer, water can still accumulate during transportation and handling. A research shows that biodiesel absorbed 1,000 to 1,700 ppm moisture at 4^o C to 35^o C, which was 15 to 20 times that of diesel. The best way to deal with this problem is to use the biodiesel immediately after manufacturing. A minimum flash point for diesel fuel is required for fire safety. B100's flash point is required to be at least 93ºC (200ºF) to ensure it is classified as non-hazardous under the National Fire Protection Association (NFPA) code. Cloud point is defined as the temperature at which the fuel starts to crystallize. Below theses temperatures the crystals might clog the filters and hoses. Cloud point is used to estimate the lowest working temperature of the fuel under cold conditions. The cloud point of B100 starts from -1^o C to 0^o C. The cloud point can go as high as 27^o C for highly saturated biodiesels. B100 can degrade or leak through hoses, gaskets, seals, elastomers and plastics if exposed for long periods of time. Some materials common with diesel can be used for biodiesel, but more research is required in this area. Materials like nitrile rubber compounds, polyvinyl, polypropylene are some of the materials which are susceptible to degradation by biodiesel. Moreover, oxidized biodiesel and its blends can accelerate the decomposition processes of the elastomers. Most tanks which store diesel can also store B100. Storage tank materials which are compatible with biodiesel are aluminium, stainless steel, fluorinated polyethylene, fluorinated polypropylene, Teflon and most fibreglass. Bronze, brass, copper, zinc accelerate the oxidation of biodiesel and create fuel insoluble and gels. Copper fittings and pipes, lead and zinc solders should be avoided. The affected parts change colour and should be replaced by aluminium and stainless steel fittings. Biodiesel can be used as a B20 or lower blend to minimize the adverse effects of biodiesel.

Table.1 Storage parameters of jatropha oil.

Sr. No.	Test description	Ref. Std. ASTM 6751	Reference		Diesel	Jatropha Biodiesel Blends			
			Units	Limit		B5%	B10%	B20%	B30%
1	Density	D1448	Gm/cc	0.8-0.9	0.830	0.833	0.835	0.839	0.841
2	Calorific value	D6751	MJ/Kg	34-45	42.5	-	-	41.70	-
3	Centane number	D613	-	41-55	49.00	-	-	49.47	-
4	Viscosity	D449	mm^2/sec	3--6	2.700	-	-	-	-
5	Moisture	D2709	%	0.05%	NA	NA -	NA	NA	NA
6	Flash point	D93	°C	-	64	74.000	80.000	88.00	92.00
7	Fire point	D93	°C	-	71	81.000	92.000	99.00	105.00
8	Ash content	D	%	-	0.05	NA	-	-	NA

V. CONCLUSION

The world is increasing its energy consumption day by day which is taking a toll on the fuel resources. Non-renewable resources are getting depleted very fast and we must find a resource which is renewable as well as energy rich. Biodiesel is one of the best alternatives to petro-diesel. Biodiesel has similar properties to diesel and can be used as a blend or in its pure form. More research must be conducted on biodiesel storage on processing. Storage parameters of biodiesel and diesel were compared. Most tanks used for diesel can also be used biodiesel storage.

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