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Comprehensive Review On Performance Combustion And Emission Of Diesel Engine Using Biofuel.

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Abstract: *For the past several years extensive efforts are being made to search for alternative fuels to overcome the dependence on fossil fuel and pollution. Direct injection diesel engines are more popular in the automotive sector than spark ignition (SI) engines due to its fuel lean operation. However, the use of fossil fuel is rising day by day and hence the major fuel source of petroleum-based fuel is depleting rapidly. Many countries depend mainly on imported fossil fuels due to lack of fuel reserves and it has the great impact on the economy. Several alternative fuels namely, hydrogen, oxygenated fuels like alcohol fuels, dimethyl ether and biodiesel fuels, etc., have been extensively analyzed. Recent studies show that biodiesel is one of the most promising alternative fuels for diesel engines because of its biodegradable, oxygenated and renewable characteristics. Hence, it is getting the attention of researchers all over the world. The blends of biodiesel with fossil diesel have many benefits like reduction in emissions, lower engine wear, lesser engine oil consumption and comparable thermal efficiency vis-a-vis diesel fuel. Therefore, this paper shows a comprehensive review of the, performance, combustion and emission characteristics of biodiesel fuels on diesel engines.*

I. Introduction

The resources of petroleum as fuel are decreasing day by day and increasing demand of fuels, as well as increasingpollution and strict emission regulations, placing a challenge to science and the technology. This concept has taken the attention to conserve and using the more oil reserves by conducting research on alternate fuels. Therefore, the research on biodiesel drawn from vegetable oils and animal fats lead to the study of an alternative to petroleum-based diesel fuels. Vegetable oils such as soybean, palm oil, cottonseed, sunflower, groundnut, castor oil etc. have been used and their performance reported by many researchers [1].

The consumption of diesel fuels in India was 28.30 million tones which were 43.2% of the consumption of petroleum fuels. This requirement was fulfilled by importing crude oil as well as petroleum fuels. The import bill on these items was 17,838 crores. The expected growth rate of diesel consumption of more than 14% per annum, decreasing crude oil reserves and limited refining capacity, India will be heavily dependent on imports of crude oil and petroleum fuels, due to that biodiesel is the best option for fossil fuel[2].

Due to the finite stock of fossil fuels and its negative impact on the environment, the International Energy Agency (IEA) predicted that the fossil fuel is available up to 2035 only. Many countries across the world now tend to move towards renewable sources energy like solar energy, wind energy, biofuel to ensure energy for the countries developments in which biodiesel is the best option [3]. It was a Belgian inventor in 1937 who first proposed using transesterification to convert vegetable oils into fatty acid alkyl esters and use them as a diesel fuel replacement. The transesterification reaction is the basis for the production of modern biodiesel [3].

From the view of preserving the global environment and to sustain from the large imports of crude oil and petroleum fuels from Gulf countries, alternate diesel fuel is the need of the time[2].

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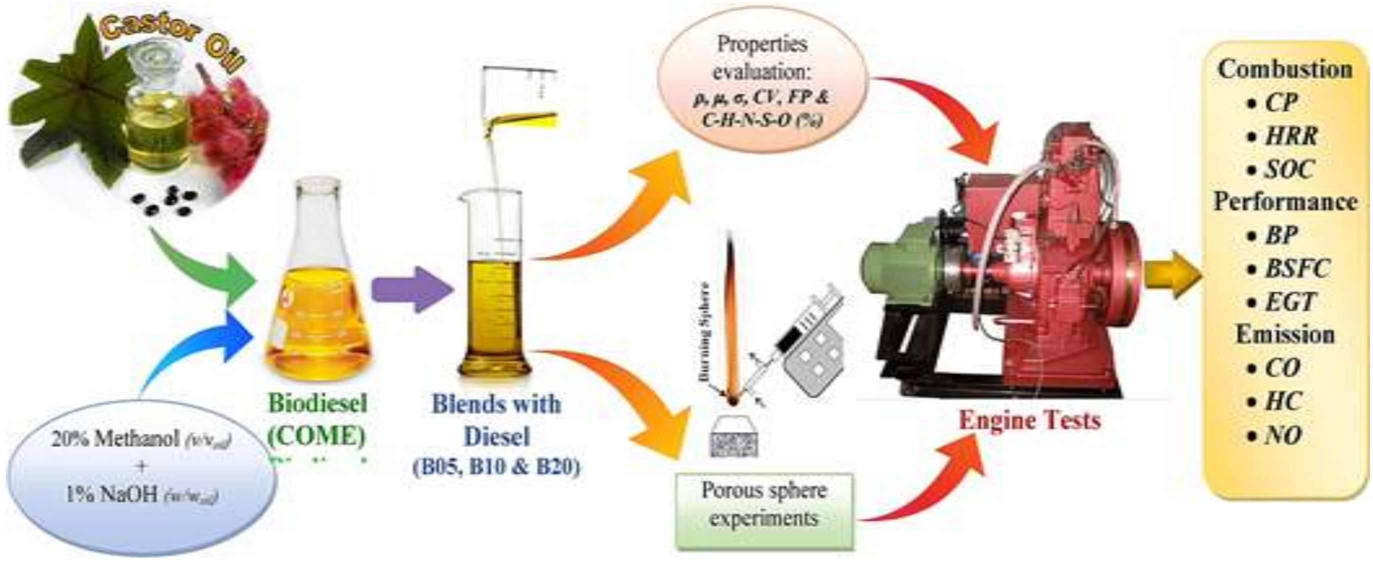

Fig. 1 – Process diagram

II. Fuels Used

1.Mahua

The Mahua trees are indigenous to India, grow even in drought-prone areas and are found abundantly in several parts of India. Seeds fallen are collected, and oil is extracted at village level expellers, few million tons of oil will be available for lighting lamps in a rural area. In some countries, Mahua oil is considered edible oil as it is used only for preparing ghee, but in our country, it is also considered as non-edible oil. Growing Mahua trees would also help in protecting the environment and benefit the farmers as well. It is the best substitute for kerosene. Since these are spread over a large area, the collection of seeds for Biodiesel manufacturer is not impracticable. A compact plantation can support a Biodiesel plant[4].

While preparing biodiesel oil is heated at 600 °C to 750 °C for an hour. Oil is mixed with potassium hydroxide (KOH) 0.7% of its volume and methanol 13% to 15% of its volume. After transesterification process biodiesel is yielding around 80% to 84% and the remaining is bi-product is glycerin. While separating biodiesel is washed, soaked, dried and finally distillate. While making an odd number of a blend of 1 liter. B09 with additive butanol, biodiesel is taken as 90 ml biodiesel with 5% butanol (50 ml) and rest of the diesel (860 ml). Biodiesel and butanol are heated up together at 400 °C. Diesel are separately heating at 400 °C. This solution is mixed together and kept settled for 2 hours. After that B09 blend is ready [5].

2.Castor Oil

Castor oil was converted into biodiesel through the alkaline transesterification reaction for which potassium hydroxide was used as a catalyst with methanol. Two percent of the potassium hydroxide catalyst was dissolved in methanol (30% by weight) and the mixture was added to the castor seed oil. Then the prepared mixture was stirred at 60 LC for 30 min. Thereafter the reactant material was poured into the transparent vessel and allowed for cooling at room temperature for 6–8 h. It was allowed to settle for separation of glycerol as a bottom layer.

The upper layer of biodiesel was put into another transparent vessel for washing with an equal amount of water. The biodiesel was heated up to 110 LC for 10 min to remove excess water. Then biodiesel was cooled down to room temperature before use, presenting a 94% yield.[6]

Transesterification, which is also called alcoholysis, is a process of substitution of the radical of an ester by the radical of one alcohol. Like hydrolysis, except for the fact of using an alcohol instead of water.
Important properties of transesterified oil were evaluated for comparison with the standard. These are given in Table 1. The presence of a bigger content of hydroxy acid in the castor oil is reflected in its colligative properties, such as high values viscosity and density. A density of the fuel was found using density bottle, Kinematic Viscosity of the oil was determined with the help of Redwood Viscometer No. 1 and flash point was obtained from electrically heated Pensky-Martens apparatus as per the standard test procedure of Bureau of Indian Standards (IS: 1448–1970). The gross calorific value of the castor oil, castor methyl ester, and diesel were determined with the help of Bomb Calorimeter (IS: 1359–1959) [6].

3.Cottonseed

By weight, cottonseed is 60% cotyledon, 32% coat and 8% embryonic root and shoot. These are 20% protein, 20% oil and 3.5% starch. The seeds are about 15% of the value of the crop. They are pressed to make oil and used as ruminant animal feed [5]

The cottonseed crop is a fast-growing plant and that grows even on drought and poor soils. Biodiesel also sustains at high temperature up to 44°C and at a low temperature of up to 4°C. Cotton was the third biggest crops grown worldwide as measured by acreage soybean which is 47%, occupying 75.4 million hectares; biotech maize (51 million hectares at 32%), biotech cotton(around 24.7 million hectares at 15%) and biotech canola (8.2 million hectares at 5%) [9]

4.Soyabean

The soybean in the US also called the soya bean in Europe (Glycine max) is a species of legume native to East Asia, widely grown for its edible bean which has numerous uses.

Soy vegetable oil is a product of processing the soybean crop. Soybeans produce significantly more protein per acre than most other uses of land. The oil is used in many industrial applications. The main producers of soy are the United States (36%), Brazil (36%), Argentina (18%), China (5%) and India (4%). The beans contain significant amounts of phytic acid, alpha-linolenic acid, and isoflavones.

The cost of food–grade soybean oil limits its use to cases of severe shortages of petroleum diesel fuel or emergency. Reducing the cost of the feedstock is necessary for biodiesel to be commercially viable. One way to reduce the cost of biodiesel is to use less expensive feedstocks. Waste oils and greases from restaurants and rendered animal fats are possible sources of lower cost feedstocks for biodiesel. When the free fatty acid level of these waste oils and fats is less than 15%, the product is known as "yellow grease"[7]

5.Palm Oil

Also known as Dende Oil is an edible vegetable oil derived from the Mesocarp (reddish pulp) of the fruit of the oil palms. Palm oil is naturally reddish in colour because of high beta-carotene content. It is not to be confused with palm kernel oil derived from the kernel of the same fruit, or coconut oil derived from the kernel of the coconut palm (Cocos nucifera). The differences are in colour (raw palm kernel oil lacks carotenoids and is not red) and in saturated fat content. Palm mesocarp oil is 41% saturated, while palm kernel oil and coconut oils are 81% and 86% saturated respectively.[4]

6.Rapeseed

The name derives from the Latin for turnip, rāpa or rāpum, and is first recorded in English at the end of the 14th century. Some botanists also include the closely related B. campestris within B. Napus. The production of biodiesel has been steadily increasing in USA to 15 million metric tons in 2010. Rapeseed oil is positioned to supply a good portion of the vegetable oils needed to produce that fuel. Every ton of rapeseed yields about 400 kg of oil. Rapeseed oil takes between 135 to 150 days to mature, with some varieties only taking 110 days [4]. The biodiesel is produced mainly from rapeseed with double improved varieties of seeds.

The composition of rapeseed oil must fulfill specific quality requirements that are included in the standard for methyl esters as fuels for diesel engines. Transesterification is the best way to obtain biodiesel because it is the well-known and cheap process which gives fewer problems for the engines than another method. In a standard process of producing biodiesel from rapeseed oil, there are following process steps i.e. esterification of rapeseed oil, separation of esterification products, methanol distillation and purification of the ester. The main stage of the process is based on the transesterification reaction of rapeseed oil with an alcohol. However, its use is the most effective while adding to the fossil fuels. Rapeseed oil is the main source of quality biodiesel which is important platform chemicals produced by the oleochemical industry. Transesterification of vegetable oil is a process by which triglycerides react with methanol in the presence of a catalyst to obtain futz acid methyl esters and glycerol[10]

Conclusion

Castor oil has more Cetane number than other oils. Hence Castor oil is preffered as a biofuel. Castor oil, like currently less expensive vegetable oils, can be used as feedstock in the production of biodiesel. Thus, the Castor oil is superior for cold winters, because of its exceptionally low cloud and pour points. A few properties, like extremely high viscosity and high water content, complicate the use of castor oil as a fuel for internal combustion engines.

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