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A Review on Second Generation Biodiesel Blending & their Future Perspectives

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ABSTRACT
In this paper we discussed second generation with biodiesel blends and reviewed the Characterization Tests and Performance Tests.
Second generation biodiesel (Pongamia, Jatropha, Karanja, Cottonseed, Mahua.....) could contribute to significant reductions in carbon dioxide emissions from transport because the bio feedstock used for their production is considered to be carbon neutral. This Paper inspect the life cycle sustainability of second generation biodiesel derived from different feed stocks and produced in different production systems, including integrated bio refineries. The regular use of fossil fuels is exhausting its reserve and produces harmful emission causing environmental issues. Hence, considerable attention has been given to alternative sources such as biodiesel. Biodiesel is mainly produces from conventionally grown edible oil plants thus leading to a competition of usage of food versus fuel. The increasing censure of the sustainability of first generation biodiesels (derived from edible oils) has raised awareness to the use of so-called second and third generation biodiesels. The second generation biodiesel includes non-edible vegetable oils, waste cooking oils as well as animal fats. These are considered as promising substitute for traditional edible food crops as they neither compete with food crops nor lead to land-clearing. This study introduces second generation biodiesel to be used as biodiesel feed stocks. Several aspects of these feed stocks are reviewed and discussed in this paper. This Paper includes Characterization and Performance Test of Biodiesel using Biodiesel Blends as per the required consideration. In this review paper we discussed about characterization test performance test with Biodiesel blends. The outcomes of the tests are discussed in this paper.

Keywords: Biodiesel, Cotton seed, Feed stocks, Jatropha, Karanja, Mahua, non-edible, Pongamia and Second Generation.

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I. INTRODUCTION

Biodiesel is a diesel fuel substitute obtained mainly by basic catalytic Trans esterification of oils and fats, and it is composed by fatty acid mono-alkyl esters that are produced from the reaction of low-acid-number vegetable oils with an alcohol in the presence of a basic catalyst. Biodiesel is currently produced by the base-catalyzed Trans methylation of triglycerides, producing fatty acids methyl esters (FAME). At the end of the reaction, the glycerol rich-phase is separated from the methyl ester layer by decantation. Methyl esters usually contain contaminant materials that are detrimental to the quality of the fuel, and must be eliminated from the product. Removal of glycerol and glycerides from biodiesel is an important step of the process because key aspects of the quality of the fuel strongly depend on the content of free and bound glycerol. Although it is slightly soluble in biodiesel, glycerol can be found dispersed as small droplets in biodiesel. The main advantages of biodiesel as compared to diesel fuel are eco-friendly, renewability, high flash point, non-toxicity and biodegradable [1]. Biodiesel have similar properties as petroleum diesel and lower emission, so it can be used in the transport sector as alternate solution to diesel fuel [2, 3]. Transesterification, pyrolysis and supercritical fluid method etc are the procedure for production of biodiesel [4]. From all of this method the most adoptive method of biodiesel production is trans esterification, which produce biodiesel and glycerol as the secondary product from the oil [5]. Due to the depletion of the world's petroleum reserves and the increasing environmental concerns, there is a great demand for alternative sources of petroleum-based fuel, including diesel and gasoline fuels. Biodiesel, a clean renewable fuel, has recently been considered as the best candidate for a diesel fuel substitution because it can be used in any compression ignition engine without the need for modification. The major disadvantage of using petroleum-based fuels is that, day by day, the fossil fuel reserves are decreasing. Another disadvantage is atmospheric pollution created by the use of petroleum diesel. Petroleum diesel combustion is a major source of greenhouse gas (GHG) [6,7]. Biodiesel is an environmentally friendly liquid biofuel similar to petro-diesel in terms of fuel quality and combustion characteristics. Increasing environmental concerns, fast depleting petroleum reserves and agriculture based economy are the driving forces to promote biodiesel as an alternative renewable fuel. Biodiesel, derived from vegetable oils and animal fats, is being used as engine fuel in USA and Europe to reduce air pollution and to reduce dependence on limited fossil fuel, localized to some specific regions. Because of the surplus availability of edible oils like soybean oil, sunflower oil and rapeseed oil, these countries are using edible oils as feed stocks for biodiesel production. On the other hand, the possibility of biodiesel production from edible oil resources in India is minor as the indigenous edible oil production is much less than the actual demand which is met by imports. India accounts for 9.3% of world's total oil seed production and is the fourth largest edible oil producer in the world and still about 46% of total edible oil is imported to meet the domestic requirements and as such the question of diverting edible oil resources for biodiesel production in India does not arise. The only possibility seems to be the non-edible oil resources like Jatropha curcas, pongamia, Mahua, sal, etc. which can be commercially grown on waste lands and the oil resources can be used for biodiesel production. Jatropha curcas has been identified as one of the important source for biodiesel production in India [8,9].

II. FEEDSTOCKS FOR BIODIESEL PRODUCTION

From the literature survey conducted, there are copious feed stocks reported for the production of biodiesel. The selection of feed stocks depends upon the availability and economic aspects of the concerned country. In countries like USA and Brazil, soybean oil is broadly used for biodiesel production whereas canola oil is main raw material in Canada. Meanwhile, Finland, UK Germany and Italy depend on rapeseed oil. Similarly, Asian countries like Malaysia, Indonesia with coastal belts have surplus palm and coconut oils which are utilized for biodiesel production. Also, Jatropha and Karanja have been reported to be potential feed stocks in the Indian peninsula. Among them, rapeseed oil, palm oil, castor oil and sun flower oil have been considered earlier for biodiesel production but their adverse effect on food crops have stalled their usage as feed stocks for biodiesel synthesis.

III. EDIBLE OIL (FIRST GENERATION)

In the advent of biodiesel era, widespread usage of edible oils is highly noticeable raw materials for biodiesel production. Hence the edible oils derived from feed stocks like soybean, mustard, rice, wheat, coconut, rapeseed, olive, palm, corn etc. are categorized as first generation feed stocks of biodiesel synthesis. Although the first generation feed stocks possess advantages like availability of crops and relatively simple conversion process, the major drawback of this feedstock is the threat of limitation in food supply which may lead to increase in food prices as the fuel is derived from food sources. On the whole, the controversial issue arises that is necessary to prefer one, or the other of food vs fuel alternatives. On the other hand high cost, a restricted region of cultivation and adaptability to climatic conditions also obstruct the utilization of first generation feed stocks. These setbacks restricted the users to move on to other resources for biodiesel production.

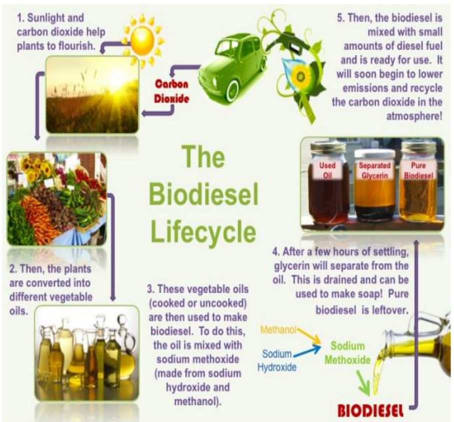

Fig. 1.1: Michelle Rodio, Biodiesel Lifecycle, Embry-Riddle Aeronautical University, 2012 [44]

IV. NON EDIBLE OIL (SECOND GENERATION)

As the results of the tremendous setbacks of first generation feed stocks, researchers started to use a meticulous variety of oils derived from non-edible crops. The fuel derived from these feed stocks are termed as second generation biofuels or advanced biofuels. These oils include Calophyllum inophyllum[10], Jatropha curcus, Mahua indica[11], Karanja, Neem, Rubber seed, Thevettia peruviana, Nagchampa etc. The major advantage of using non-edible is that there will be no necessity to saddle on food crops when compared to first generation oils. Adding to its advantage, the second generation feedstock can be grown on non-agricultural land or marginal land. Meanwhile, the problem arises when it comes to the yield of crops, where yield drops for major second generation crops like Jatropha, Cammelina, Rapeseed and oil palm when they are cultivated in marginal lands. So the farmers are forced to cultivate the second generation crops in agricultural lands which in turn affect the food production and economy of the society. To overcome the socioeconomic problems of second generation biofuels, the researchers focused on novel feedstocks which are economically viable in a productive manner and easily available to a larger extent.

V. OTHER SOURCES (THIRD GENERATION

Regardless of vegetable oils, some other sources like micro algae, waste frying oil, animal fat, fish oil, pyrolysis oil etc constitute third generation source of biofuel [12]. These viable sources of biofuel overcome the difficulties faced by previous generation feedstocks such as availability, economic feasibility, affecting food chain and adaptability to climatic conditions. Microalgae can be a potential feedstock for biodiesel production. Since several algal species have the ability to live in harsh conditions, it is best suited to local environments with low culturing cost. Another major advantage of micro algae is the lipid content i.e. the average lipid content of most species varies up to 70% but under certain enhanced conditions some species can yield up to 90% of dry weight [13]. Irrespective of an algal source, waste cooking oil proves a cost effective and very heterogeneous raw material for biodiesel production [14].

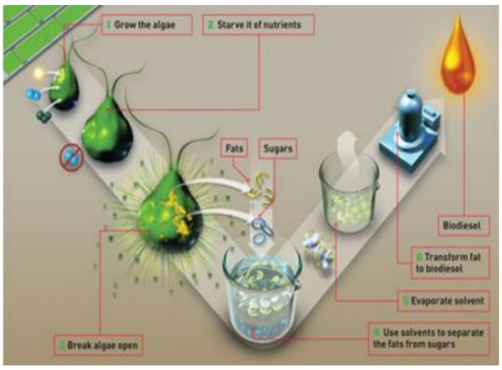

Fig. 1.2: Algae Biofuel Process, Concept Energy

VI. TRANS ESTERIFICATION

In Trans esterification process glycerol and esters are formed when triglyceride reacts with alcohol. Three fatty acids are connected to triglycerides (organic fats and oils) base and it has molecule of glycerin. Free fatty acids are formed by hydrolyzing triglycerides. After this these free fatty acids are reacts with alcohol and formed ester or biodiesel (methyl or ethyl fatty acid ester) and glycerol. Trans esterification is also known as alcoholysis, due to reaction of free fatty acid with alcohol. The end products of trans esterification process are separated, biodiesel settles on the top and due to high weight glycerol settles down.

The process of separation should be very fast to avoid reverse process. Usually in trans esterification process methanol and ethanol are used [15, 16]

VII. CHARACTERIZATION OF BIODIESEL

1. Calorific Value

Calorific value of a fuel is the thermal energy released per unit quantity of fuel when the fuel is burned completely and the products of combustion are cooled. Calorific value is obtained using Automatic Bomb Calorimeter, of make and model SE-1AC/ML, Test is done as per ASTM E870-82.

2. Viscosity

Viscosity is a measure of the internal fluid friction or resistance of oil to flow, which tends to oppose any dynamic change in the fluid motion. As the temperature increases its viscosity decreases and it is therefore able to flow more readily. Viscosity is calculated using HAAKE Falling Ball Viscometer.

3. Density

The density of a substance is the relationship between the mass of the substance and how, much space it takes up (volume).

4. Cloud Point and Pour Point

Cloud Point is the temperature below which waxes in diesel forms a cloudy appearance. And wax thickens the oil and clogs fuel filters and injectors in engines.

Pour Point is the minimum temperature at which a lubricant turns into semi solid and almost losses its flow characteristics.

5. Flash Point:

Flash point is the lowest temperature at which fuel produces enough vapor to cause ignition leading to flame generation. Biodiesel has a higher flash point than conventional diesel.

CHARACTERIZATION TEST RESULTS OF BIODIESEL

Table 1.1 shows the properties of the selected stocks of biodiesel we have chosen for study which will be studied based on the characterization test of the selected feedstock of biodiesel.

Table 1.1 Properties of Biodiesel based on characterization test

Biodiesel	Blends	Cloud Point (°C)	Pour Point (°C)	Viscosity at 40°C (cSt)	Flash Point (°C)	Density (kg/m³)
Cotton Seed	B5 B10 B20	-8.0 -9.0 -9.0	-30.0 -22.5 -15.0	2.64 2.88 3.02	125.0 140.0 173.0	860.0 882.0 900.0
Jatropha Seed	B5 B10 B20	6.2 6.6 6.9	3.15 3.20 3.30	3.80 4.25 4.36	80.3 89.7 99.0	832.6 836.2 839,2
Mahua Seed	B5 B10 B20	1.5 2.0 3.0	-7.5 -7.0 -5.0	2.35 2.40 2.70	57.5 64.0 76.0	826.5 829.0 835.0
Karanja	B5 B10 B20	6.9 7.3 7.7	3.2 3.3 3.4	2.77 4.30 5.20	80.3 84.7 86.2	844.7 843.0 850.0
Pongamia Seed	B5 B10 B20	5.4 6.2 7.9	2.0 2.4 2.7	3.07 3.29 3.73	52.0 55.0 57.0	811.0 818.7 821.0

VIII. BLENDING OF OIL WITH DIESEL

The blending of pure diesel with single & dual biodiesels is done in different proportion which is tested for fuel properties and performance. In Single biodiesel blends, diesel is blended with one biodiesel derived from only one seed oil. In dual biodiesel blending, two different biodiesels is blended in proportion with diesel fuel. The dual blending contains equal blending quantity of two different biodiesels [19].

The different blends with their proportions for characterization test are shown in the table 1.2

Table 1.2 Different blends with their properties for characterization test

Blends	Proportions
B5	5% Biodiesel + 95% Diesel
B10	10% Biodiesel + 90% Diesel
B20	20% Biodiesel + 80% Diesel

IX. PERFORMANCE TEST OF BIODIESEL

Properties of Biodiesel based on performance parameters:

1. Engine performance and emission parameters for Karanja biodiesel blends compared with diesel

(a) Engine load V/S BSFC

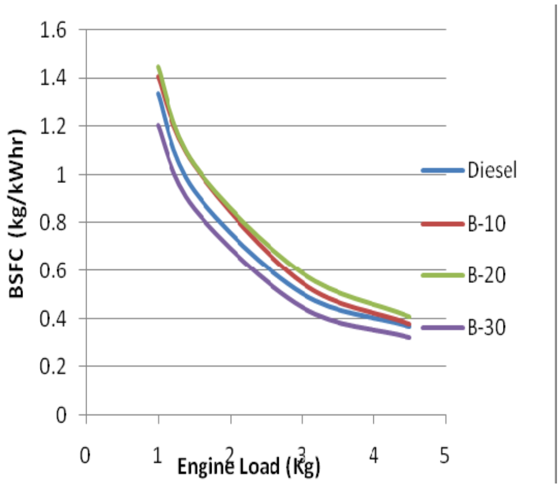

Fig.1.3: Variation of brake specific fuel consumption at different engine load condition [39]

From Fig. 1.3, it is been observed that the BSFC for B-10 blending is quite closer to that of diesel fuel. It is because when the load is higher, the cylinder wall temperature raises which results in the reduction of ignition delay leading to enhancement in combustion as well as reduction in fuel consumption. The lower BSFC is due to availability of oxygen in the biodiesel blend [39].

(b) Engine load V/S BTE

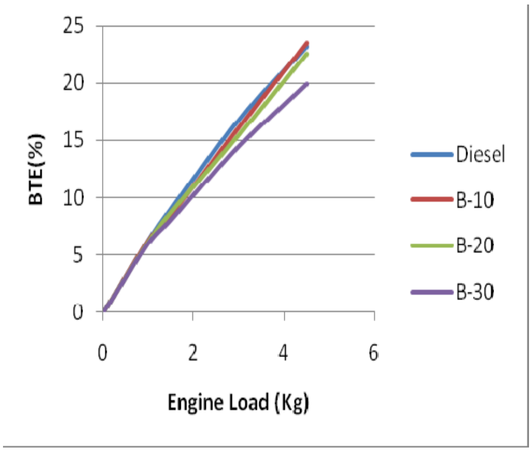

Fig.1.4: Variation of brake thermal efficiency at different engine load condition [39]

From Fig.1.4, it has been observed that BTE for B20 & B30 is somewhat comparable to diesel. With the rise in biodiesel proportion in the fuel blends, the brake thermal efficiency reduces because of lesser efficiency due to low calorific value, higher viscosity & higher density of the biodiesel of Karanja oil [39].

(c) Engine load V/S Volumetric Efficiency

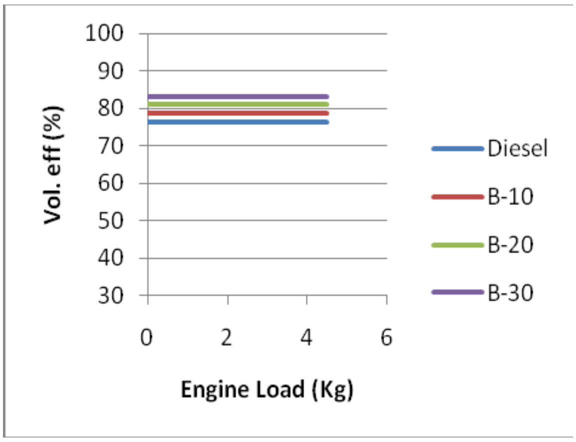

Fig.1.5: Variation of volumetric efficiency at different brake power [39]

From Fig.1.5, it can be seen that there is significant rise in volumetric efficiency with blend concentration. Volumetric efficiency is constant as the injection pressure of the engine is also constant. This is because of higher bulk modulus of Karanja biodiesel [39].

2. Engine performance and emission parameters for Pongamia biodiesel blends compared with diesel

(a) Brake power V/S Brake Thermal Efficiency

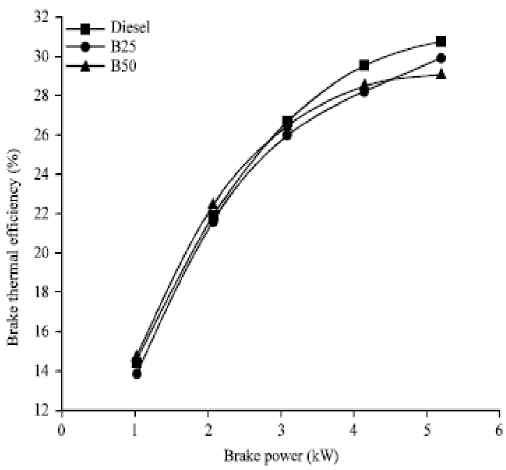

Fig.1.6: Comparison of Brake Thermal Efficiency with brake power [40]

From Fig.1.6, brake thermal efficiency increases with increase in load applied. It is because of the reduction in heat loss & due to increase in power developed with increase in load. Initially, the thermal efficiency is improved with increasing concentration of the biodiesel blend [40].

(b) Brake power V/S Specific fuel consumption

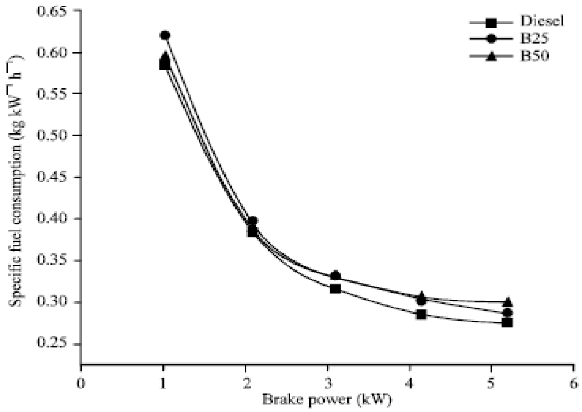

Fig.1.7: Comparison of Specific fuel consumption with Brake power [40]

From Fig.1.7, it is seen that all the blends other than B100 show better SFC. But the specific energy consumption of B50 is found to be lower than that of all other blends and the pure diesel. It may be because of better combustion & an increase in the energy content of the blends [40].

3. Engine performance and emission parameters for Mahua biodiesel blends compared with diesel

(a) Load V/S Brake Thermal Efficiency(BTE)

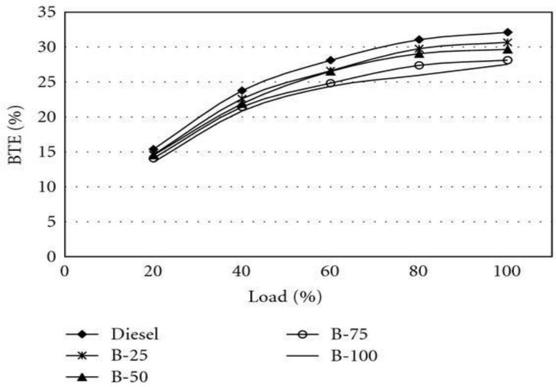

Fig.1.8: Comparison of BTE among diesel, Mahua biodiesel and blends [41]

From Fig.1.8, at any load condition, the brake thermal efficiency of all the blends of Mahua biodiesel and the neat Mahua biodiesel is lower than that of diesel. As the percentage of Mahua biodiesel in the blend increases, there is more reduction in brake thermal efficiency as compared to diesel operation. This may be due to the combined effect of higher viscosity, higher density and lower calorific value of Mahua biodiesel [41].

(b) Load V/S Brake specific fuel consumption(BSFC)

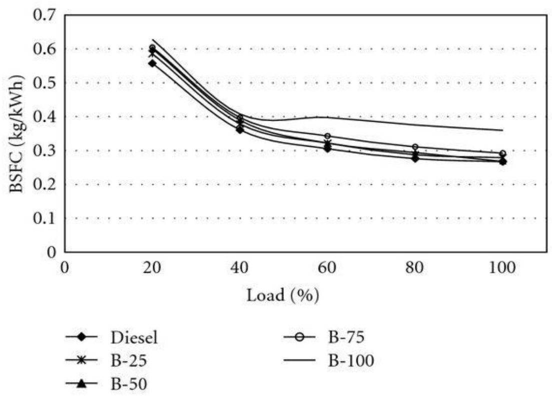

Fig.1.9: Comparison of BSFC among diesel, Mahua biodiesel and blends [41]

From Fig.1.9, it has been observed that the brake specific fuel consumption reduces more during lower loads than that for higher loads, when the load is inceased for all operations of diesel, Mahua biodiesel & their blends. The brake specific fuel consumption increases when the proportion in the blend of Mahua biodiesel is increased, but that increase in BSFC for B100 operation is very much greater than that of other blends & diesel operations at higher loads [41].

4. Engine performance and emission parameters for Jatropha biodiesel blends compared with diesel

(a) Torque V/S Engine Speed

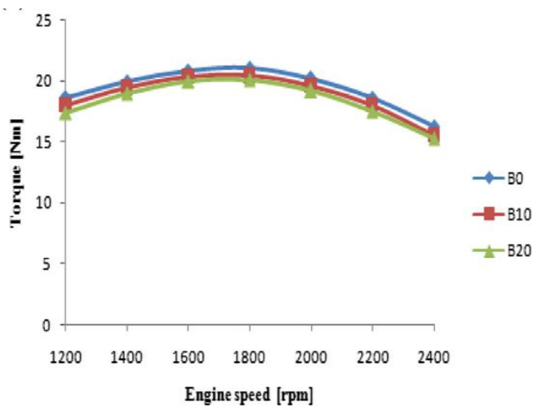

Fig.2.1: Torque-speed Characteristics [42]

From Fig.2.1, it is seen that the torque increases up to a maximum value and then falls down with further increase in speed. This is due to the mechanical friction loss and lower volumetric efficiency of the engine due to increasing speed. The engine torque is also reduced with blending of fuels due to higher viscosity and lower calorific value of the biodiesel [42].

(b) Brake power V/S Engine Speed

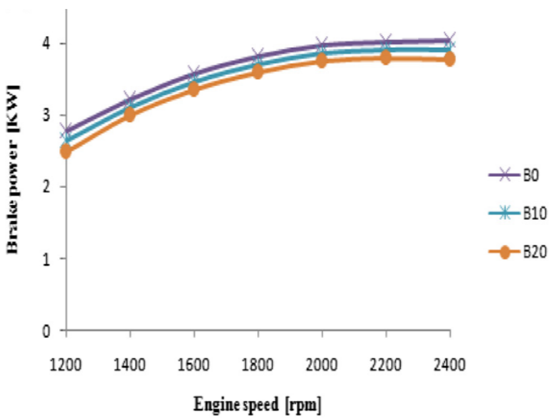

Fig.2.2: Brake power-speed characteristics [42]

From Fig.2.2, we can see that the brake power increases gradually with engine speed. The lower brake power of the biodiesels compared to diesel is due to their lower calorific values & higher viscosities & both of these have an effect on combustion. Also an uneven combustion characteristic of biodiesel fuel decreases the engine brake power [42].

(c) Brake specific fuel consumption (bsfc) V/S Engine speed

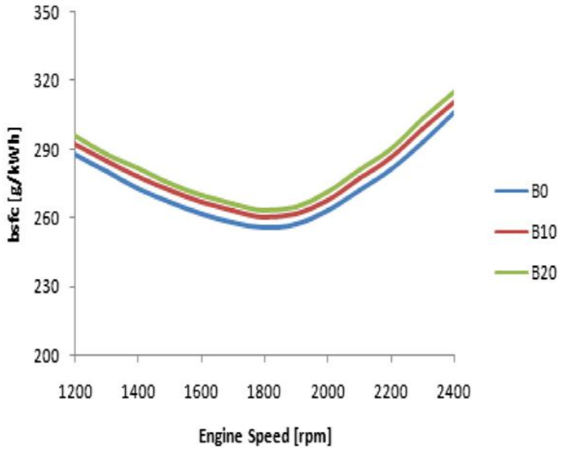

Fig.2.3: Variation of BSFC with respect to speed [42]

From Fig. 2.3, it is seen that the BSFC for blended biodiesel fuels is higher compared to diesel.

This is due to the combined effects of the relative fuel density, viscosity & heating value of the blends. So, to produce more power, more biodiesel fuel is required as biodiesel has lower caloric value compared to diesel [42].

5. Engine performance and emission parameters for Cottonseed biodiesel blends compared with diesel

(a) Brake thermal efficiency V/S Engine speed

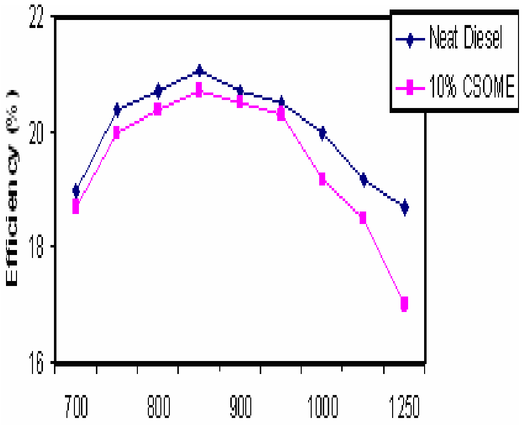

Fig.2.4: Effect of Engine speed on Brake thermal efficiency (Load=49N, CSOME-Cottonseed Oil methyl ester) [43]

From Fig.2.4, it can be seen that with the increase in engine speed up to 850 rpm, the brake thermal efficiency increases. This is because with the increase in speed, the output power of the engine increases. So, as power increases, the BTE increases as well. Moreover, the BTE decreases when the engine speed crosses above 850 rpm [43].

(b) Brake thermal efficiency V/S Torque

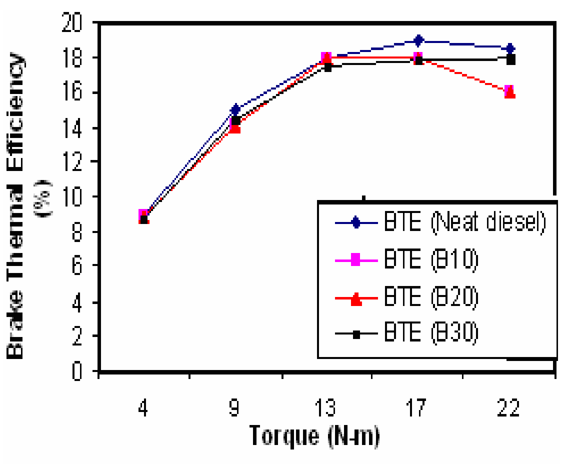

Fig.2.5: Effect of Engine Torque on Brake Thermal Efficiency (Engine speed 850rpm) [43]

Fig.2.5 shows that the brake thermal efficiency increases with the increase in engine torque & then reaches a maximum value & thereafter, the BTE decreases with the increase of engine toque. This reduction of BTE with biodiesel mixtures is due to poor spray characteristics, poor air-fuel mixture, higher viscosity, higher volatility & lower calorific value [43].

(c) Brake specific fuel consumption V/S Torque

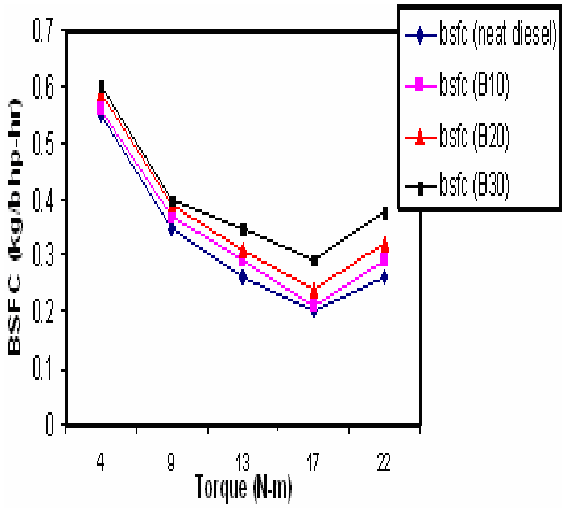

Fig.2.6: Effect of Engine Torque on Brake Specific Fuel Consumption (Engine speed 850rpm) [43]

Fig.2.6 shows that BSFC decreases with the increase in engine torque & reaches a minimum value and then increases again. Also, in case of biodiesel mixtures, the BSFC values were determined to be higher than those of neat biodiesel & thus more biodiesel mixtures are needed to maintain constant power output [43].

X. CONCLUSION

We have seen that Second generation biodiesels are very useful. We collected all the data's and we cannot conclude that without doing experiments with the biodiesels we have selected. In second generation biodiesel, all the biodiesel were having different ranges of properties and using them in different fields have shown us different results. Theoretically, it is difficult to conclude that the biodiesels we were using is less efficient or highly efficient. Different researchers have different data's about the biodiesel by doing several experiments with different methods.

Second generation biodiesels are used to increase the engine efficiencies and it has a wide future scope and in many vehicle it is used at a valuable range. It reduces the carbon dioxide emission.

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