APPLICATION OF BIODIESEL IN TRANSPORTATION SECTOR

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Abstract— *Transportation accounts for more than 67 percent of the oil that is consumed in the world more than the production. Today India imports more than 54 percent of its oil supply, and it's estimated that this could increase to 75 percent by 2020.According to the U.S. Federal Highway Administration, the average vehicle on the road today emits more than 600 pounds of air pollution each year. These pollutants such as carbon monoxide, sulphur dioxide, nitrogen dioxide, and particulate matter contribute to smog and to many health problems. The average vehicle, through its combustion of fossil fuels, also emits greenhouse gases which surround the Earth's atmosphere like a clear thermal blanket, allowing the sun's warming rays in and trapping the heat close to the Earth's surface. This natural greenhouse effect keeps the average surface temperature at around 33˚C. However, the increased use of fossil fuels during the last century has created an enhanced greenhouse effect, known as global warming & transportation has played a large role in this increase. Hence one of the alternative fuels called biodiesel not only burn cleaner, produces lower emission In fact, in June of 2000 biodiesel became the only alternative fuel to complete tiers I & II of the health effects pertaining to the Clean Air Act .If this fuel is used in vehicles transportation the emissions can be reduced and hence less pollution in the environment can be expected and can have good humans health.*

Keywords— Biodiesel; Nitrogen dioxide; Carbon monoxide; Hydrocarbon.

1. INTRODUCTION

Biodiesel is a renewable, clean-burning diesel replacement that is reducing Indian dependence on foreign petroleum, creating jobs and improving the environment and human health. Made from a diverse mix of feed stocks including recycled cooking oil, soybean oil, and animal fats, it is the first and only EPA[12] (Environmental protection agency) designated Advanced Bio fuel in commercial-scale production. Meeting strict technical fuel quality and engine performance specifications, it can be used in existing diesel engines without modification and is covered by all major engine manufacturers' warranties, most often in blends of up to 5 percent or 20 percent biodiesel. Biodiesel is considered as one of the prime sources of non-conventional transportation fuels. Biodiesel is an alternative fuel for C I engine only. It is necessary to reduce the vehicles GHG(Green house gas) emissions by 7% around the world, the GHG[10] emissions from the transportation sector which account for 29% of the total GHG emissions, will continue to increase because the number of vehicle miles travelled will rise. Substantial reductions in world transportation GHG emissions per vehicle mile will travelled will be necessary to achieve the good environment. Using biodiesel to fuel motor vehicles helps reduce GHG emissions. The substitution of alternative fuel in road transportation sector should be achieved by 2020. The below figure is obtained from biodiesel.org.

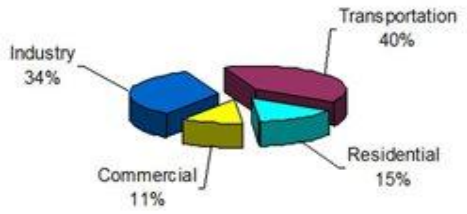


FIG.1 Some of the statistics related to energy consumption.

Hence from the above pie chart we can say that transportation sector consumes more energy than any other sectors.

2. RAW MATERIALS FOR BIODISEL PRODUCTION

2.1 Edible plant oils:

Biodiesel has been predominantly (more than 95 %) produced from edible vegetable oils all over the world, which are easily available on large scale from the agricultural industry. Currently, biodiesel is mainly prepared from rapeseed in Canada, soybean in US, sunflower in Europe and palm in Southeast Asia. Between 2005 and 2015[18], biodiesel use of edible oils is projected to account for more than a third of the expected growth in edible oil use , which means rise of biomass price, increase in water requirement and problem in water availability, and particularly, more land somewhere in the world will be converted into farmland, thereby releasing GHG emissions. Because of these disadvantages, researchers have sought other renewable resources for biodiesel production like non edible plant oils.

2.2 Non-edible plant oils:

Technologies are being developed to exploit cellulosic materials for the production of biodiesel such as leaves and stems of plants, biomass derived from waste, and also, oils seeds from non-edible plants. Non-edible biodie sel crops are expected to use lands that are largely unproductive and those that are located in poverty stricken are a sand in degraded forests. Moreover, non-edible oil plants are well adapted to arid, semi-arid conditions and require low fertility and moisture demand to grow. Added to this, non-edible oils are not suitable for human food due to the presence toxic components in the oils. For all these reasons, the use of non-edible oils as raw material is a promising way in biodiesel production. There are a large number of oil plants that produce non-edible oils. From a list of 75 plant species containing oil in their seeds or kernels, 26 species were reported by Azam etc as potential sources for biodiesel production. The important non edible oil plants are jatropha, karanja, tobacco, mahua, neem, rubber, sea mango, castor, cotton. Of these feedstocks, jatropha, moringa and castor oils are the most often used in biodiesel production. The non-edible oils plants are called to solve the problem of competition with food production. However, the problem of water requirement, water availability, and mainly, the quantity of GHG generated by the great rate of exploitable land could not be solved using this raw material. The table shown below consists of sources of biodiesel from various countries fallowed by the chart which consists source of oil for biodiesel production in percentage, both are obtained from biodiesel.org.

Table.1 Source of Biodiesel from various countries

S/N	Country	Sources of Biodiesel
1	USA	Soya Bean
2	Brazil	Soya Bean
3	Europe	Rape seed oil and Sunflower oil
4	Australia	Animal fat, Beef tallow and rapeseed
5	India	Jatropha
6	China	Guang pi
7	Indonesia	Palm oil
8	Canada	Vegetables oil
9	Ghana	Palm nut, Coconut oil

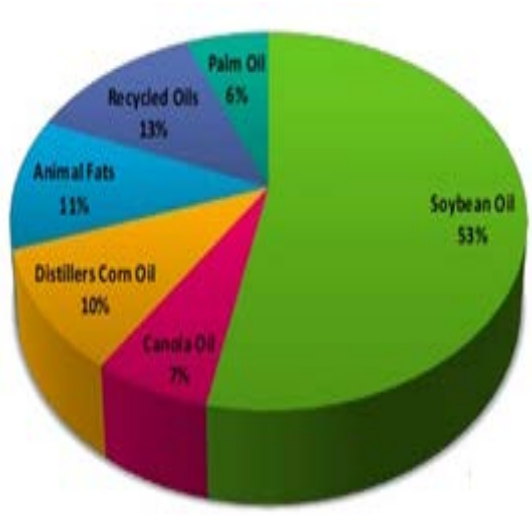


Fig.3 Various sources of biodiesel

Hence from the above pie chart we can say that soya bean oil is used more to produce biodiesel.

2.3 BIODIESEL PRODUCTION

- Pyrolysis
- Micro emulsification,
- Dilution
- Transesterification

PYROLYSIS:

Thermal decomposition of heavy molecules to simpler ones.

MICRO EMULSIFICATION:

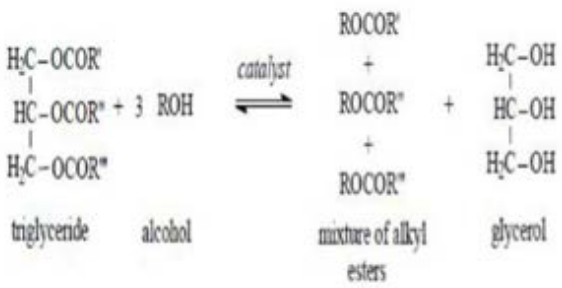
Emulsified with light organic compounds like ethyl alcohol.

DILUTION:

Diluted with a suitable light hydrocarbon or alcohols. Among these, transesterification is the commonly used commercial process to produce clean and environmental friendly fuel, called biodiesel.

2.3.1 TRANSESTERIFICATION

The vegetable oil/animal fat is first filtered, then processed with alkali to remove free fatty acids. It is then mixed with an alcohol (usually methanol but can also be ethanol) and a catalyst (typically sodium or potassium hydroxide) maintained at 600 c to 700 c for about two hours reacting to form fatty esters such as methyl ester or ethyl ester, and glycerol, which products are then separated and purified. Glycerol (used in pharmaceuticals and cosmetics) is produced as a co-product. The reaction is as fallows.



3. PROPERTIES & COMBUSTION OF BIODIESEL

- Biodiesel has high cetane number so the ignition properties of biodiesel are good.
- It has inbuilt oxygen which helps in formation of emissions like hydrogen to water, carbon monoxide to carbon dioxide, helps in complete combustion and hence reduction of smoke.
- It has almost no sulphur content and hence not harms the human health.
- The structure of biodiesel is simple.
- Biodiesel is independent which does not depend on petrol or diesel.
- Bio diesel in non flammable because it flashes at a very high temperature around 1720 c.
- It is non toxic.
- Biodiesel is renewable that is it can be produced by growing plants and than extracting oil from the seeds of the plants and then subjecting that to any one of the production methods.
- It is biodegradable and hence will not effect the environment.
- Biodiesel does not requires any engine modification.
- Biodiesel develops similar torque and power as that of the diesel.
- As the viscosity of biodiesel is almost twice that of diesel hence it has a lubricating property which helps in extending the engine life by avoiding friction between the engine parts.

The below table consists of various properties of biodiesel and diesel which are obtained from biodiesel.org

TABLE 2: PROPERTIES OF DIESEL AND BIODIESEL

Fuel Property	Diesel	Biodiesel	Units
Kinematic Viscosity	1.3-4.1	1.9-6.0	cSt
Specific Gravity	0.85	0.88	kgf
Density	850	898	Kg/m^3
Flash Point	60-80	130-170	°C
Cloud Point	-7 to 5	-3 to 12	°C
Pour Point	3.1	4.2	°C
Cetane No.	40 - 55	47 - 65	
Sulphur	29	0.005	Wt%
Carbon	0.1	0.0035	Wt%
Calorific Value	44.12	39.15	MJ/Kg

4. COMBUSTION

The combustion characteristics of the biodiesel and its blends can be analysed and compared by referring to cylinder pressure-crank angle diagram and heat release rate-crank angle diagram. To analyze the cylinder pressure, the pressure data of 100 cycles with a resolution of 1°CA was averaged and then used. The cylinder pressure variations for the different fuels, diesel, biodiesel and their blends, B25, B50, B75 and B100 when considered the peak cylinder pressures of the biodiesel and its blends are lower than that of the diesel due to higher brake specific fuel consumption of biodiesels. The occurrence of peak cylinder pressures of the biodiesels is little earlier than that of diesel. For B25 blend, peak pressure occurs at TDC and for other blends B50, B75 and B100 it occurs at 1° before TDC, while for diesel fuel it occurs at TDC. The oxygen content of the biodiesels increases fuel–air mixing rate in the cylinder compared to diesel, and this situation may cause to extend the combustion duration and enhance the combustion efficiency resulting in higher thermal efficiency.

Heat release calculations provide important information about the combustion process in a diesel engine. The comparison of heat release rate versus crank angle diagrams between different biodiesel blends and diesel when considered the starts of combustion (SOC) timing for biodiesels and blends are little earlier than diesel due to their earlier start of injection timings [16]. The SOC timing of the B25, B50, B75 and B100 was taken place at 16°CA before TDC, while the SOC timing in the case of diesel was occurring at 15°CA before TDC. This value shows that the SOC timing with the use of the biodiesels advanced more than 1°CA compared to diesel. The premixed combustion phase for all blends of biodiesels was found longer than that of diesel. This situation can be explained with the vaporization of biodiesel which is more slowly than diesel and contributes less premixed combustion. However, its oxygen content affects SOC timing.

5. PERFORMANCE CHARECTERISTICS, EMISSIONCHARECTERISTICS, ADVANTAGES&DISADVANTAGESOF BIODIESEL

5.1 PERFORMANCE CHARECTERISTIS

5.1.1 BRAKE SPECIFIC FUEL CONSUMPTION

BSFC is 15 % [4] more for Biodiesel obtained from waste cooking oil when compared to diesel because biodiesel has higher density, lower calorific value and has higher viscosity. The below figure is obtained from biodiesel.org.

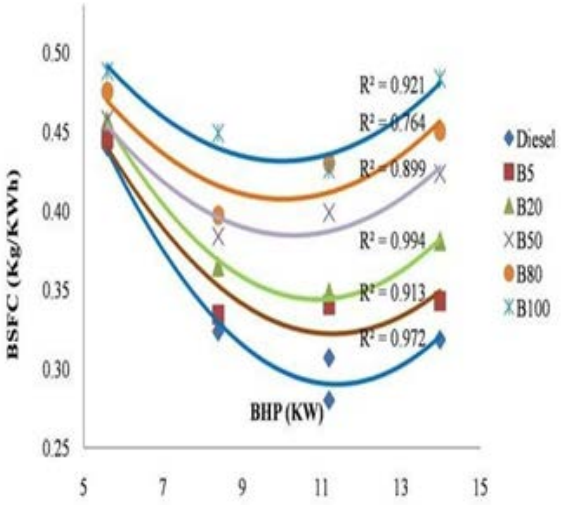


Fig.4 BSFC Vs BP

5.1.2 BRAKE THERMAL EFFICIENCY

Brake thermal efficiency is less for Biodiesel obtained from waste cooking oil when compared to diesel because the biodiesel is Attributed to higher viscosity, poor spray characteristics, poor air fuel mixing, lower volatility and lower calorific value of biodiesel. The below figure is obtained from biodiesel.org.

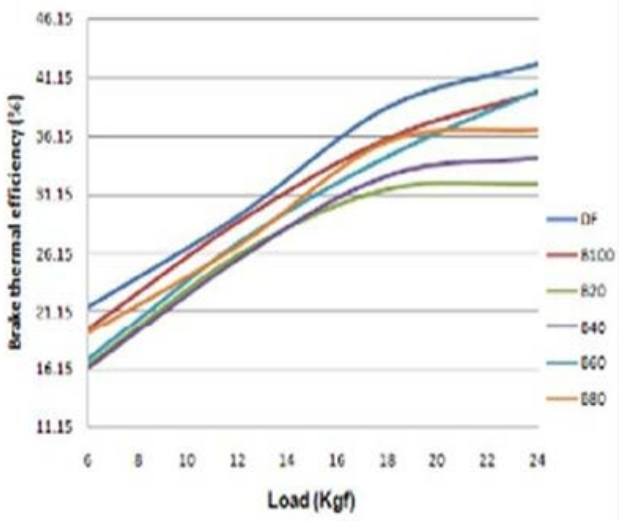


Fig.5 Brake thermal efficiency Vs load

5.1.3 ENGINE TORQUE & BRAKE POWER

Engine torque and brake power for biodiesel obtained from waste cooking oil is less when compard to diesel. The below figure is obtained from biodiesel.org.

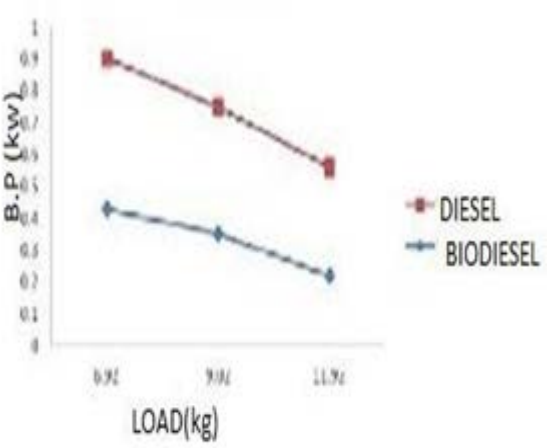


Fig.6 BP Vs Load

5.2 *EMISSION CHARECTERISTICS*

The biodiesel subjected to combustion emits hydrogen, carbon monoxide, nitrogen oxides smoke etc.

5.2.1 HYDROCARBON EMISSION

Biodiesel emits less hydrogencarbon when compared to diesel because biodiesel has inbuilt oxygen so that hydrogen combines with oxygen to form water which is not at all harmful. The below figure is obtained from biodiesel.org.

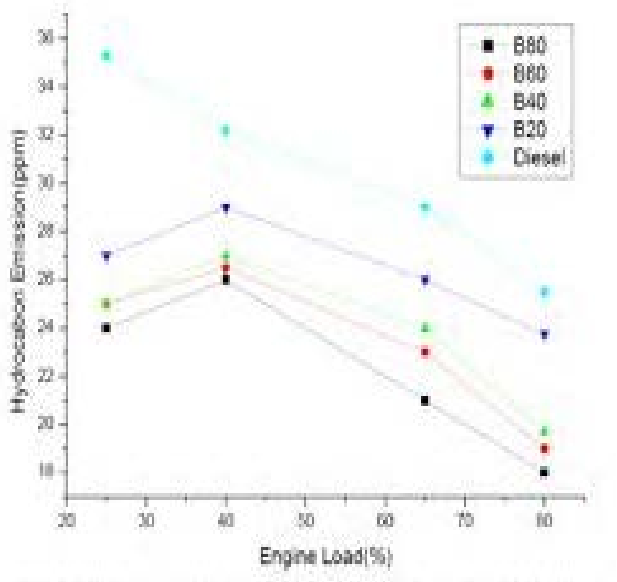


Fig.7 Hydrogen Vs Load

5.2.2 CARBON MONOXIDE EMISSION

Biodiesel emits less carbon monoxide when compared to diesel because biodiesel has inbuilt oxygen so that carbon monoxide combines with oxygen to form carbon dioxide which is less harmful than carbon monoxide. The below figure is obtained from biodiesel.org.

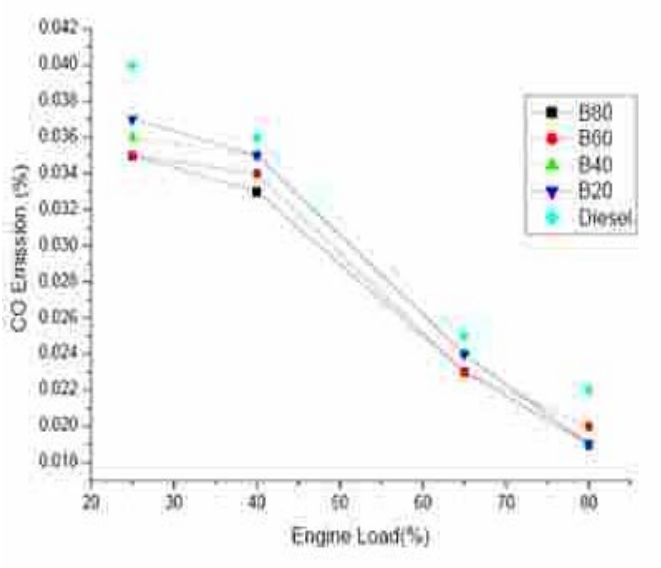


Fig.8 Carbon monoxide Vs Load

5.2.3 NITROGEN OXIDES EMISSION

Biodiesel emits more nitrogen oxides when compared to diesel because biodiesel has inbuilt oxygen and at higher temperatures (around 15000c to 18000c) the nitrogen combines with oxygen on its own and starts forming nitrogen oxides which is harmful. The below figure is obtained from biodiesel.org.

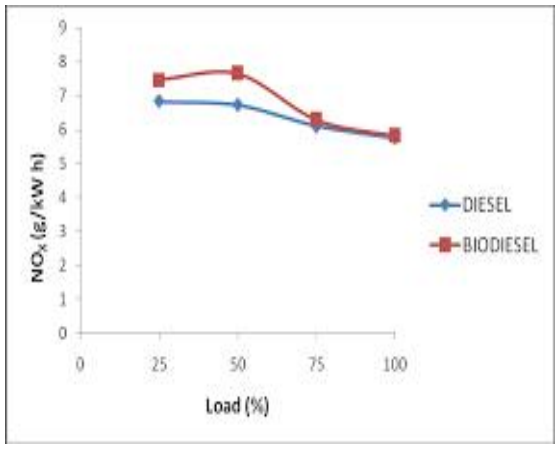


Fig.9 Nitrogen oxide Vs Load

5.2.4 SMOKE

Biodiesel emits less smoke when compared to diesel because biodiesel has less carbon value and more oxygen so complete combustion takes place, lower C/H ratio and absence of aromatic compounds as compared with diesel hence less emission of smoke. The below figure is obtained from biodiesel.org.

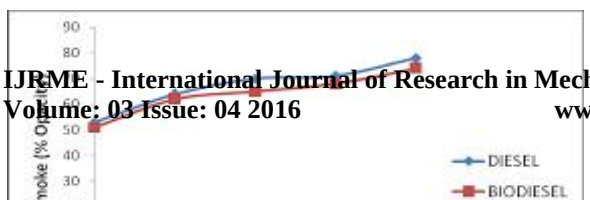


Fig.10 Smoke Vs Load

Hence the emission of biodiesel is very less when compared to other conventional fuels.

5.3 ADVANTAGES & DRAWBACKS OF BIODIESEL

- Cetane number of biodiesel is high and hence it can be used in diesel engines without any modifications.
- Emissions are overall greatly reduced with the use of biodiesel but the drawback of using biodiesel is that nitrogen oxide emissions can increase significantly. However, this can potentially be addressed through the use of fuel additives.
- The shelf life of biodiesel is shorter than petroleum based diesel.
- The viscosity of biodiesel is twice as that of diesel.
- Currently biodiesel fuel is not cost effective as is it significantly more expensive to produce than regular petroleum based diesel.
- Biodiesel includes a 10% reduction in power and fuel economy. While engine efficiency remains comparable regardless of fuel used, the higher heating value of biodiesel is responsible for the increased consumption.
- Biodiesel will also soften and break down some types of rubber compounds, including natural and butyl rubbers.

6. CONCLUSION

- The emissions (except NOx) are very less when compared to diesel and other conventional fuels hence biodiesel is proved to be the promising alternative energy source in the transportation sector (vehicles) from the point of emission reduction.
- Availability of biodiesel is very less,the biodiesel refuelling stations has to be increased because except US many countries has very less refuelling stations and government of all countries has to make the use of biodiesel as mandatory as it has got many good emission and performance characteristics than other conventional and other alternative fuels.
- To achieve a rapid scale-up in biodiesel production that can be sustained over the long term, governments must enact a coordinated set of policies that are consistent, long-term, and informed by broad stakeholder participation. Governments should promote biodiesel within the

context of a broader transformation to the transportation sector.

- Biodiesel alone will not solve all of the world's transportation-related energy problems. Development of these fuels must occur within the context of a transition to a more-efficient, less-polluting and more-diversified global transport sector. They must be part of a portfolio of options that includes dramatic improvements in vehicle fuel economy, investments in public transportation, better urban planning, and more creative means of moving around a village or across the globe. To achieve their full potential to provide security, environmental, and social benefits, biodiesel need to represent an increasing share of total transport fuel relative to oil. In combination with improved vehicle efficiency, smart growth, and other new fuel sources such as biogas and eventually even renewable hydrogen or electricity biodiesel can drive the world towards a far less .

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