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Biodiesel A Promising Renewable Alternative Fuel

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Abstract: **Demand of engine fuels is increasing tremendously, due to steep rise in the transportation activities. Fossil fuels are being used conventionally but their use results in high global warming, acid rain, ozone depletion and many other problems related to climatic changes and diseases. It is therefore required to find out the alternative fuels in to substitute fossil fuels, which shall be eco-friendly and also reduces import of fossil fuels.**

In this research paper we found that in order to meet the growing energy needs as a consequence of spiraling demand and diminishing supply, in today's world renewable energy and biomass sources mostly biofuels are receiving more attention. The demand for energy has been phenomenon due to the rapid development of certain growing economies, especially in developing countries. It can be concluded that biodiesel can be used as a promising renewable alternative fuel.

Keywords: **Alternative fuel, Biodiesel, Diesel engine, Pollution, Environments**

1. INTRODUCTION

In various western countries, edible vegetable oils have been used as an alternative fuel, in India; it will be very costlier affair to use edible oils as an alternative fuels in place of diesel. Mass production of Non-edible oils can be suitably planned in India, because of availability of large area of waste lands.

Energy is one of the most significant inputs for growth of all sectors including agricultural, industrial service and transport sectors. Energy has been at the centre stage of national & global economic development for several decades. The demand for energy, around the world is increasing exponentially, specifically the demand for petroleum-based energy. Petroleum derived fuels, actually, exceeds the demand of any other fuels or energy resources. The future energy availability is a serious global concern. Another, major global concern is environmental degradation or climate change such as global warming. Global warming is related with the greenhouse gases which are mostly emitted from the combustion of petroleum fuels. In order to control the emissions of greenhouse gases, Kyoto Protocol targets to reduce the greenhouse gas emission by a collective average of 5% below 1990 level of respective countries. The Intergovernmental Panel on Climate Change (IPCC) concludes in the Climate Change 2007 that, because of global warming effect the global surface temperatures are likely to increase by 1.1°C to 6.4°C between 1990 and 2100 [1].

2. INDIAN ENERGY SCENARIO

India had experienced robust growth for the past few years, and after an impressive 9.6 per cent gross domestic product (GDP) growth in 2006-07 the Indian economy is headed towards 8.7 per cent growth in the current fiscal [3]. The energy needs of India are also rising to cope up the growth rate Of the 156.1 million tonnes of crude oil that India consumed in 2007-08, it produced only 34.12 million tonnes [4]. Indian economy is mainly agriculture based and modern agriculture system is heavily dependent upon internal combustion engines for running farm machinery, irrigation pump sets, and other equipments. Indian growth is mainly based on energy, produced by "oil-burning" in IC engines. It is very difficult to find clear blue sky in Indian metropolis. Petroleum fuels are major contributor to ecological imbalance in India. As Indian economy is heavily based upon IC engines, it is not possible in any case to discard them and some other, easily available renewable fuels in India. These renewable fuels must be sought to lease new life to existing engines in order to curb the twin problems of fuel scarcity and air pollution. Various national emission standards have been set by the Government of India through which the fleets are facing greater pressures to switch to cleaner alternative fuels. The alternative fuels are desirable from the fact that they are the only fuels used with recent engine developments, which can meet the stringent EURO-IV emission norms, which are expected to be enforced in India from 2010. India being richer in flora and fauna can look forward to use fuels from bio origin as the suitable alternatives. The prominent bio fuels from Indian perspective are ethanol and biodiesel. India, the world's second most populous nation, has seen its population exploding from 300 million in 1947 to around 1.2 billion today. This rapidly growing population has placed a strain not only on India's infrastructure, but also on its environment. According to the World Health Organization, New Delhi is one of the top ten most polluted cities in the world. Two primary sources of air pollution in India are vehicular emissions and untreated industrial smoke. The number of

vehicles has registered a sharp increase more so, during the last decade. In Delhi alone, the vehicle number has crossed about 4.6 million. Today, the vehicular pollution contributes roughly 64 % of total air pollution in Delhi, followed closely by Mumbai at 52% and somewhat controlled figure of 30% for Kolkata. About 50% of the total petroleum products consumed in the country go into the transport sector mainly in the form of high-speed diesel and gasoline [5]. India's per capita energy use and carbon emissions, while lower than the world average, result in a substantial percentage of world energy use and carbon emissions, due to the country's large population and heavy reliance on fossil fuels. Increased use of renewable energy is one means of reducing carbon emissions.

3. ENERGY DEMAND AND SUPPLY

Energy Security is driven by the demand and supply behaviour. India ranks sixth in the world in terms of energy demand accounting for 3.64% of world commercial energy demand in 2007. Although India ranks fifth in total energy consumption in the world (404.4 MTOE (million tones of oil equivalent), this is only 17.12% of the energy consumed by the largest consumer, i.e. USA (2361.4 MTOE). In per capita terms, its consumption is only about 20% of the global average. Rapid Industrialization and Globalization have pushed the demand of energy to new heights. In the year 2011, India will have a total population of about 1.3 billion people of which 68% will be living in rural areas. Since diesel constitutes 37 % of total petroleum consumption mainly for transportation and other purposes, its demand is integrally related to economic growth and is seen as a growth inducing factor. Stress of the over-burdening population will augment the strain in terms of the volume of fuel required, but the picture of proven oil reserves distribution doesn't reflect the pleasant sight at all. The share with respect to the energy distribution of the remaining oil reserves across the world is shown in Figure 1.

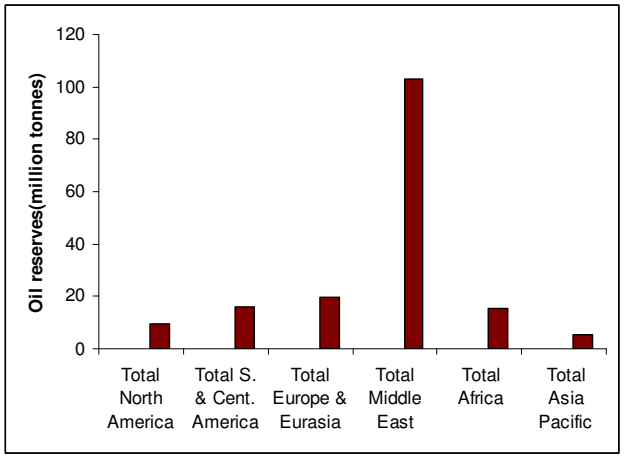

Figure 1: World Oil Reserves, 2008 [6]

As the prices of diesel are escalating and it creates more pollution, its alternative is required which shall be renewable, non-toxic and non-polluting. It is found that biodiesel is one of the most appropriate alternatives to diesel. The biodiesel is renewable, safe, non-toxic and non-polluting. Biodiesel is mainly fatty acid methyl ester and it is derived from triglycerides by transesterification. There are various processes of biodiesel production among which high level of conversion of triglycerides is obtained by transesterification using alkali as catalyst in short duration.

4. ALTERNATE FUELS

To solve dual problems of fossil fuel depletion and environmental degradation, the renewable fuels with lower environmental impact are necessary. Nowadays, many new fuels have been used and biomass derived fuels are among them. Some of the well known biomass derived fuels are ethanol for gasoline engines and bio-diesel for compression ignition engines. Biodiesel is a renewable and environmental friendly alternative fuel for diesel engine which is produced from variety of vegetable oils and animal fats by the trans-esterification process. Transesterification is a chemical reaction in which vegetable oils and animal fats are reacted with alcohol in the presence of a catalyst. The products of reaction are fatty acid alkyl ester and glycerine, and the fatty acid alkyl ester is known as biodiesel. Bio-diesel is an oxygenated fuel containing 10% to 11% oxygen by weight. Also it is a sulphur-free fuel.

These lead biodiesel to more complete combustion and less harmful exhaust emissions. However, biodiesel fuel has higher viscosity, density, pour point, flash point and cetane number than diesel fuel. Also the energy content or net calorific value of biodiesel is about 12% lower than that of diesel fuel on a mass basis. Using biodiesel can help in reducing the world's dependence on fossil fuels and also has significant environmental benefits. Using biodiesel instead of the conventional diesel fuel reduces exhaust emissions such as the overall life circle carbon dioxide (CO_2), particulate matter (PM), carbon monoxide (CO), sulphur oxides (SO_x), volatile organic compounds VOCs), and unburned hydrocarbons (UBHC). However, most of the biodiesels give 10% to 15% higher oxides of nitrogen (NO_x) when fuelling with 100% biodiesel [7]. Depending on the abundantly availability of feedstock in local region, the different feedstocks are tried for the biodiesel production.

In the United States, the primary sources for biodiesel production is soy bean oil, while EU nations prefer to utilize rapeseed oil, and in South East Asia regions, palm oil, coconut oil and Jatropha oil are used for biodiesel productions. Growing the production of biodiesel in many countries around the world has been accompanied by the development of standards to ensure high fuel quality. The biodiesel standards are ASTM D6751 in the United States and EN 14214 in EU

Nations. The properties of biodiesel are mainly determined by the structure of fatty acids alkyl esters which constitutes it, particularly, the combustion characteristics such as ignition quality, and the fuel properties such as density, viscosity, pour point and oxidation stability of biodiesel are mostly affected by the structure of fatty acids alkyl esters [8].

5. BIODIESEL ALTERNATIVE

Biodiesel is defined as the monoalkyl esters of fatty acids derived from vegetable oils or animal fats. It is known as Methyl ester chemically. Biodiesel can be produced when vegetable oil is chemically reacted with an alcohol in presence of catalyst such as Sodium Hydroxide or Potassium Hydroxide. Biodiesel can be produced from Methanol or Ethanol. When biodiesel is made from ethanol, it is called Ethyl Ester and when made from Methanol, it is called Methyl Esters. Due to large price differences, biodiesel is usually made from Methanol. The properties of biodiesel depend on the type of transesterification and the vegetable oil used.

Biodiesel is an organic, non-toxic and biodegradable fuel made from everyday renewable resources, like vegetable oils or animal fats. It can power your car's engine and help the environment at the same time. It doesn't contain any petroleum, so forget about escalating gas prices. Biodiesel cuts down on CO2 emissions; in fact, it's the only alternative fuel to have fully completed the health effects testing requirements of the US Clean Air Act. Biodiesel can be purchased at a growing number of fuelling stations around the world but you can also make it in your own backyard. Even if you don't like chemistry, you can brew your own. The vegetable oils cannot be used directly because of its high viscosity and it can be used after transesterification of oils to esters. [1]

Table 1: summary of proposed BIS (Bureau of Indian Standards) standards for biodiesel [9]

Standard / specification	Unit	Proposed BIS	Standard / specification	Unit	Proposed BIS
Density @ 15^{o}C	g/cm^{3}	0.87 – 0.90	Methanol	%mass	<=0.02
Viscosity @ 40^{o}C	mm^{2}/s	3.5 - 5.0	Ester content	%mass	>=96.5
Flash point	^{o}C	>=100	Diglyceride	%mass	<=0.2
Sulphur, max.	%mass	0.035	Triglyceride	%mass	<=0.2
CCR,100%distilation residual	%mass	0.05	Free glycerol	%mass	<=0.02
Sulphated ash,max,	%mass	0.02	Total glycerol	%mass	<=0.25
Water.max	mg/kg	500	Iodine no		<=115
Total contamination, max.	mg/kg	20	Phosphorus	ppm	<=10
Cetane no	-	>=51	Distillation, T 95%	^{o}C	<=360

Table 2: Properties of biodiesel from different oils

Vegetable oil methyl esters	Kinematic viscosity mm^{2}/s	Cetane no.	LHV MJ/kg	Cloud point (^{o}C)	Pour point (^{o}C)	Flash point ^{O}C	Density (kg/l)
Peanut	4.9	54	33.6	5	–	176	0.883
Soya bean	4.5	45	33.5	1	-7	178	0.885
Babassu	3.6	63	31.8	4	–	127	0.875
Palm	5.7	62	33.5	13	–	164	0.880
Sunflower	4.6	49	33.5	1	–	183	0.860
Tallow	–	–	–	12	9	96	–
Diesel	3.06	50	43.8	–	-16	76	0.855
20% Bid-d blend	3.2	51	43.2	–	-16		

Non-hydrogenated or partially hydrogenated oils will be the most common type of oils used in restaurants. Some will use completely hydrogenated oil that is solid at room temperature and should be avoided. Non-hydrogenated oil will have better cold flow properties, but will not store as well without adding stabilizers. Partially hydrogenated oil has a higher "cloud point" but will not oxidize as fast. The difference between non-hydrogenated and partially hydrogenated oil is small and both are treated the same when making biodiesel. Hydrogenation results in the conversion of liquid vegetable oils to solid or semi-solid fats. Complete hydrogenation converts unsaturated fatty acids to saturated ones. Changing the degree of saturation of the fat changes some important physical properties such as the melting point, which is why liquid oils become semi-solid. Since partially hydrogenated vegetable oils are cheaper than animal source fats and are available in a wide range of consistencies, and have other desirable characteristics (e.g., increased oxidative stability). Table 1 gives the summary of proposed BIS (Bureau of Indian Standards) standards for biodiesel.

Most restaurants tend to use partially hydrogenated oil due to cost and longer life of Non-hydrogenated or partially hydrogenated oils will be the most common type of oils used in restaurants. Some will use completely hydrogenated oil that is solid at room temperature and should be avoided. Non-hydrogenated oil will have better cold flow properties, but will not store as well without adding stabilizers. Partially hydrogenated oil has a higher "cloud point" but will not oxidize as fast. The difference between non-hydrogenated and partially hydrogenated oil is small and both are treated the same when making biodiesel. Hydrogenation results in the conversion of liquid vegetable oils to solid or semi-solid fats. Complete hydrogenation converts unsaturated fatty acids to saturated ones.

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6. CONCLUSIONS

In this work it is observed that the fuel properties of biodiesel need to be monitored when different feedstocks are used. If the fuel properties of biodiesel are compared to petroleum diesel fuel, it can be seen that biodiesel has higher viscosity, density, pour point, flash point and cetane number, near-zero aromatic compound, and no sulphur link make it more suitable than petro-diesel. Keeping the large wasteland available in India a concrete planning is needed to use the vegetable oil biodiesel as a supplement/ substitute for the petro-diesel.

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