

Biofuels as an alternative to the Conventional Fuel in India – A review

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Abstract

The energy strategy of a nation aims at efficiency and security and to provide access which being environment friendly and achievement of an optimum mix of primary resources for energy generation. Increasing prices of petroleum fuel day to day is another major concern for developing country like India. The growing cost of fuels across the globe has triggered an interest in biofuels and other alternative sources of energy. Biodiesel is ethyl or methyl ester of fatty acid. Biodiesel is made from virgin or used vegetable oil (both edible and non-edible) and animal fats through transesterification. A review on the depletion of conventional fuels and possibilities for the biofuel is conducted in the present study.

INTRODUCTION

India is one of the fastest growing economies in the world. The Development Objectives concentrates on economic growth, uniformity and human wellbeing. Energy is critical input for social and economic development. The energy strategy of a nation aims at efficiency and security and to provide access which being environment friendly and achievement of an optimum mix of primary resources for energy generation. Fuels obtained from fossils will continue to play a dominant role in the energy scenario in our country in next forthcoming decades. However, conventional or fossil fuel resources are available in limited amount, non-replenish able and causing pollution. Hence, need to be utilized prudently. On the other side, renewable energy resources are indigenous, non-polluting and inexhaustible. India is endowed with plenty of renewable energy resources. Therefore, use of renewable energy resources should be encouraged in every possible way.

India's energy demand is primarily met through non-renewable sources such as coal, natural gas and oil. These will continue to play a dominant role in its energy scenario in the next few decades. The highest demand for energy comes from industry, followed by the transportation sector which consumed about 16.9% (36.5 m of oil equivalent) of the total energy (217 million tonnes). Within the transportation sector, the consumption of gasoline grew by 6.64% from 7.01 million tonnes in 2001-02 to 11.26 million tonnes in 2008-09 and that of high-speed diesel (HSD) by 4.1% from 36.55 million tonnes to 51.67 million tonnes (GOI 2009). This growth will only escalate over the next several years since India's vehicular population is expected to grow by 10-12% per annum [1]. Hence securing a long-term supply of energy sources and prioritizing development are critical for ensuring the country's future energy requirements are met. Currently, the country is looking for alternative energy options from biofuels to meet the transportation sector's demand. To promote the use of biofuels as an alternative energy source, the Government of India stipulated mandatory blending requirements of gasoline with biofuels, aided by policy incentives designed to facilitate optimal development and utilization of indigenous biomass

feed stocks for biofuel production.

India's energy security would remain vulnerable until alternative fuels to substitute/supplement Petro- based fuels are developed based on indigenously produced renewable feed stocks. In biofuels, the country has a ray of hope in providing energy security. Biofuels are environmental friendly in nature and their utilization would address global concerns about the containment of carbon emissions. The major cause of pollution is transportation sector. Use of biofuels, have therefore, become compelling in view of tightening automotive vehicle emission standards to curb air pollution.

The crude oil price has fluctuating in the world market and has increased significantly in past few years reaching a level of more than \$1186 per tonne. Such tremendous increment of crude oil prices is severely straining various economies world over, particularly those of the developing countries. Petro-based oil meets about 95% of the requirement for transportation fuels and still demand for it is steadily increasing day by day. According to the "biofuel policy", provisional statistics implied crude oil consumption in 2007-08 at about 156 million tonnes [2].

The domestic crude oil is able to fulfil only about 23% of the demand as shown in figure 1, while remaining demand is met from imported crude. Increasing prices of petroleum fuel day to day is really a major concern for developing country like India. According to the "statistical review of world energy june 2014" report we have only 0.3% share of total oil reserves in the world which is quite small amount as compared to our consumption. According to the report of "world energy and resources", India has produced only 1% share of total oil production of the World at the end of 2013. Hence there is need to search for alternative fuel, as petroleum resources are finite. According to the "Indian planning commission", oil demand will rise by about 1.6% from 324 million tonnes per year in year 2000 to 5184 million tonnes per year in 2030 in the world. Oil will remain the fuel of choice in road, sea and air transportation.

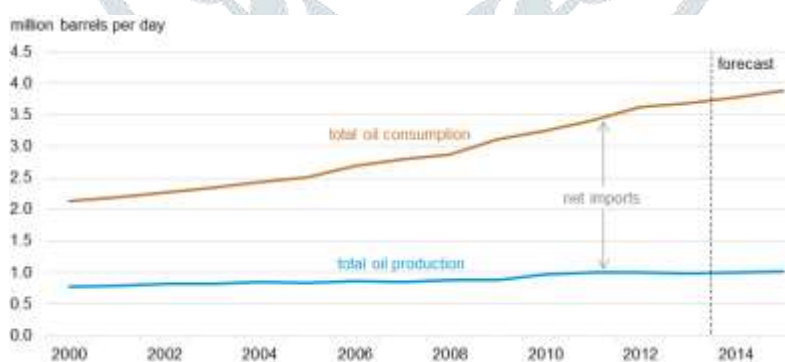


Figure 1: Indian petroleum and other liquids production and consumption, 2000-2015.

One of the major concerns is air pollution, of which one of the primary causes is transportation. About 100 000 premature adult deaths attributable to air pollution occur each year in the WHO European Region. Road traffic emissions account for a significant share of this burden. Some 40 million people in the 115 largest cities in the European Union (EU) are exposed to air exceeding WHO air quality guideline values for at least one pollutant. Children living in areas prone to heavy-duty vehicle traffic have twice the risk of respiratory problems as those

living near less congested streets. Transport is one of the fastest growing sources of fossil-fuel, CO₂ emissions, and largest contributor to climate change. In EU countries in 2004, transport accounts for approximately 35% of total energy consumption, resulting in a 20% net increase of greenhouse-gas emissions over the past decade, because of increase in transport volumes that outweighs improvements in vehicle efficiency. One of the solutions to this major problem is by utilizing alternative fuel such as biodiesel in automobiles. The reason behind using biodiesel is that it enhances the emission performance of diesel engines by reducing the harmful emissions causing diseases in humans. Various literatures depicted that using blends of biodiesel up to certain particular ratio will reduce harmful radiations like CO, NO_x and thereby preserving the atmosphere.

In recent years, biodiesel has become more attractive as an alternative fuel for diesel engines because of its environmental benefits and it is made from renewable resources. Biodiesel fuel production now exceeds 1.001 million tonnes per year in various countries, such as Belgium, France, Germany, Italy and the United States. (Krawczyk, 1996). The most important advantage of biodiesel is that they are renewable, widely available, biodegradable and non-toxic in nature.

BIOFUELS – ALTERNATE TO CONVENTIONAL FUELS

In an agricultural based country like India, the use of vegetable oil has to be identified and initiated in order to prevent environmental degradation and reduce dependence on imported fossil supplies by partially replacing them with renewable and domestic sources. Biofuels are derived from renewable bio-mass resources and, hence, provide advantage to promote sustainable development and to supplement conventional energy sources in meeting the rapidly increasing requirements for transportation fuels associated with high economic growth, and besides this, it is meeting the energy needs of India's vast rural population. Biofuels can satisfy these energy needs without polluting the environment along with cost effective manner while reducing dependence on import of fossil fuels and thereby providing a higher degree of National Energy Security.

The growth of biofuels around the globe is spurred largely by energy security and environmental concerns and a wide range of market mechanisms. Subsidies have been put in place to facilitate their growth. Some developing countries also view biofuels as a strong factor to stimulate rural development and create employment opportunities. The approach of Indians towards biofuels, is somewhat different to the current international approaches which could lead to conflict with food security. It only focuses on non-food feed stocks, so that they can be easily grown on degraded or wastelands that are not suited to agriculture. Thus, it can avoid the possibility of conflict with food security. In the context of international perspectives and National imperatives, it is the endeavor of "national policy of biofuels" to facilitate and bring about the optimal development and utilization of indigenous biomass feed stocks for production of biofuels.

Biodiesel is ethyl or methyl ester of fatty acid. Biodiesel is made from virgin or used vegetable oil (both edible and non-edible) and animal fats through transesterification. Just like petroleum diesel, biodiesel operates in compression ignition engine, which essentially require no modifications up to 20% blend and minor modifications for higher percentage blends. Biodiesel can be blended in any ratio with diesel fuel. It can be stored just like

diesel fuel and hence doesn't require separate infrastructure. Biodiesel used in conventional diesel engines result in substantial reduction of unburnt hydrocarbons, carbon monoxide and particulate matters. Biodiesel is considered as clean fuel, since it has no Sulphur, no aromatics and has about 10% built in oxygen, which helps it to burn fully. Its higher cetane number improves the combustion even when blended in diesel. According to the "biofuel policy" proposed by Indian Government, an indicative target of 20% blending of biofuels, both of biodiesel and bioethanol, by 2017 is proposed. The policy will bring about accelerated development and promotion of cultivation, production and use of biodiesel to increasingly substitute petrol and diesel for transport and can be used in stationary and other applications, while contributing to energy security, climate change mitigation, apart from creating new employment opportunities and leading to environmental sustainable development.

Biodiesel can be produced from a wide variety of plant oil, both edible and non-edible. Biodiesel in most of the developed countries are being produced from sunflower, palm, peanut and other feed stocks which are essentially edible in Indian context. Therefore, biodiesel can be produced from non-edible oils which can easily be grown in the waste lands of our country.



Figure 2: Schematic diagram of simple procedure developed for the production of biodiesel.

Biodiesel is the name given to clean burning alternative fuel produced from domestic renewable resources. The main commodity sources for biodiesel in India is non-edible oils obtained from plant species such as *Jatropha Curcas* (Ratanjyot), *Pongamia Pinnata* (Karanj), *Calophyllum inophyllum* (Nagchampa), *Hevca brasiliensis* (Rubber) etc. Therefore, in the developing countries like India, there is an essentiality to synthesize biodiesel from the non- edible oils which can be extensively grown in the waste lands of India [3]. According to the study it has been found that non-edible oils available in India are karanja, *Jatropha*, Rubber seed, Simarouba, Neem etc. During first half of the 20th century, emissions of exhaust gases from internal combustion engines are not recognized as problem, because of fewer automobiles, but count of automobiles grew along with world

population; the air pollution became an ever-increasing problem. This constrained the engine design during the 1980s and 1990s.

Due to arrival of newer technological, there is reduction in emissions by 90% since 1940s; they are still a major problem for the environment due to exponential increase of automobile population [4]. One of the major emissions produced by diesel engines is oxides of nitrogen (NO_x). In diesel engines, the combustion process forms oxides of nitrogen (NO_x) in which the nitric oxide (NO) is abundant; a small portion of the NO oxidizes into nitrogen dioxide (NO₂) at low temperatures in the presence of oxygen. The sum of NO and NO₂ is called NO_x. The formation of NO_x is dependent on the temperatures during the combustion, the amount of oxygen (O₂) and nitrogen (N₂) present in the charge and the time available for them to react with each other. NO_x are the precursor pollutants which can combine to form smog, which causes irritation in eyes and throat. Also, the oxygen carrying capability of blood reduces in brain and results in headaches and ultimately it causes respiratory problem in humans. One major solution for this is by using alternated or oxygenated fuel to increase the combustion. Certain edible oil such as cottonseed, palm, sunflower, and rapeseed can be used in diesel engine. For a longer life of the engines these oils can't be used straight ways, these oils are not cost effective to be used as an alternate fuel in diesel engine at present. Some of the non-edible oil such as mahua, castor, neem (*azadiracta indica*), rice bran linsed, karanja, zatropa tec can be used in diesel engine after some chemical treatment. Biodiesel has a higher cetane number than petroleum diesel, no aromatics and content upto 10% oxygen by weight. The characteristics of biodiesel reduced the emission of carbon monoxide (CO), hydrocarbon (HC), and particulate matter (PM) in the exhaust gas as compared with petroleum diesel [5]. However major disadvantage of vegetable oil is that it has higher viscosity than that of mineral diesel. Because of high viscosity and low volatility of vegetable oils, the brake thermal efficiency of this is inferior to those of diesel. This leads to problems of high smoke, more amount of HC and CO emissions. Due to some deficiencies, they are rarely used purely in unmodified diesel engines. They are generally used in form of blend with conventional diesel fuel with low percentages. On the other hand, disadvantages of biodiesel include the higher viscosity and pour point, as well as the lower calorific value and volatility. For all above reasons, it is generally not accepted that blends of standard diesel fuel with 10% or up to 20% biodiesels can be used in existing diesel engines without any modifications [6]. Consequently, in many cases the presence of a solvent additive in the biodiesel blend becomes necessary.

CONCLUSIONS

Biodiesel may not require an engine modification. Biodiesel can be blended with diesel so as to improve the efficiency of the engine without any hassles. Biodiesel is cheap. It is cost effective as it can be produced locally also. The growing cost of fuels across the globe has triggered an interest in biofuels and other alternative sources of energy. The reserves of fossil fuels like coal and petroleum products are reducing. It is the burning of these fossil fuels that are contributing to the greenhouse effect. Added to this, the energy security and climate change issues being debated in governments across countries make the use of biofuels an important alternative. Bio fuel has huge potential to stimulate rural development and to generate employment. Benefits to the environment as

well as energy security are key factors working in favor of bio fuels.

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