**ABSTRACT**

**TOPIC :- BIODIESEL IN DIESEL ENGINES:A CRITICAL ASSESSMENT**

**Biodiesel** refers to a vegetable oil- or animal fat-based [diesel fuel](http://en.wikipedia.org/wiki/Diesel_fuel) consisting of long-chain [alkyl](http://en.wikipedia.org/wiki/Alkyl) ([methyl](http://en.wikipedia.org/wiki/Methyl), [propyl](http://en.wikipedia.org/wiki/Propyl) or [ethyl](http://en.wikipedia.org/wiki/Ethyl_group)) [esters](http://en.wikipedia.org/wiki/Ester). Biodiesel is typically made by chemically reacting [lipids](http://en.wikipedia.org/wiki/Lipids) (e.g., [vegetable oil](http://en.wikipedia.org/wiki/Vegetable_oil), animal fat) with an [alcohol](http://en.wikipedia.org/wiki/Alcohol). Biodiesel production is a modern and technological area for researchers due to constant increase in the prices of petroleum diesel and environmental advantages.

The use of fatty acids methyl esters either in mixtures with fossil diesel or in pure state in diesel engines is correlated to a series of technical problems which are to be taken into account in order to not spoil the important environmental and social advantages that this kind of bio-combustibles reports. Throughout this work, the most critical aspects of biodiesel use as well as their immediate consequences are introduced. In general, this work tries to be a guide, which allows identifying the most sensible areas within the engine, as well as the suitable means and solutions for the correct use of biodiesel in compression ignition engines (diesel engines).

# CONTENTS

1. Introduction
2. Historical Background
3. Manufacturing Process
4. Technical Specifications
5. Use In Diesel Engines
6. Biodiesel in Other Countries and India
7. Advantages and Limitations
8. References

**INTRODUCTION**

Biodiesel is a clean-burning diesel fuel additive produced from soybean and other vegetable oils instead of petroleum. Biodiesel is produced from vegetable oils by converting the triglyceride oils to methyl (or ethyl) esters with a process known as trans-esterification.

Biodiesel is used in compression ignition (diesel) engines to enhance engine combustion performance, improve engine lubrication, and reduce air and water pollution caused by the exhaust. Biodiesel blends operate in diesel engines, from light to heavy-duty, just like petroleum diesel fuel. No engine conversions are required at all, unless an engine has old fuel lines. It is a renewable domestically produced liquid fuel that can help reduce the countries dependence on foreign oil imports.

**HISTORICAL BACKGROUND**

[Trans-esterification](http://en.wikipedia.org/wiki/Transesterification) of vegetable oil was conducted as early as 1853 by scientists E. Duffy and J. Patrick, many years before the first [diesel engine](http://en.wikipedia.org/wiki/Diesel_engine) became functional. [Rudolf Diesel](http://en.wikipedia.org/wiki/Rudolf_Diesel)'s prime model, a single 10 ft (3 m) iron cylinder with a flywheel at its base, ran on its own power for the first time in [Augsburg](http://en.wikipedia.org/wiki/Augsburg), [Germany](http://en.wikipedia.org/wiki/Germany), on 10 August 1893 running on nothing but [peanut oil](http://en.wikipedia.org/wiki/Peanut_oil). In remembrance of this event, 10 August has been declared "[International Biodiesel Day](http://en.wikipedia.org/w/index.php?title=International_Biodiesel_Day&action=edit&redlink=1)".

It is often reported that Diesel designed his engine to run on peanut oil, but this is not the case. Diesel stated in his published papers, "at the Paris Exhibition in 1900 ([*Exposition Universelle*](http://en.wikipedia.org/wiki/Exposition_Universelle_%281900%29)) there was shown by the Otto Company a small Diesel engine, which, at the request of the [French](http://en.wikipedia.org/wiki/France) government ran on [arachide](http://en.wikipedia.org/wiki/Arachide) (earth-nut or pea-nut) oil, and worked so smoothly that only a few people were aware of it. The engine was constructed for using mineral oil, and was then worked on vegetable oil without any alterations being made. The French Government at that time thought of testing the applicability to power production of the Arachide, or earth-nut, which grows in considerable quantities in their [African](http://en.wikipedia.org/wiki/Africa) colonies, and can easily be cultivated there." Diesel himself later conducted related tests and appeared supportive of the idea. In a 1912 speech Diesel said, "The use of vegetable oils for engine fuels may seem insignificant today but such oils may become, in the course of time, as important as petroleum and the [coal-tar](http://en.wikipedia.org/wiki/Coal-tar) products of the present time."

Interest in vegetable oils as fuels for internal combustion engines was reported in several countries during the 1920s and 1930s and later during [World War II](http://en.wikipedia.org/wiki/World_War_II). [Belgium](http://en.wikipedia.org/wiki/Belgium), France, [Italy](http://en.wikipedia.org/wiki/Italy), the [United Kingdom](http://en.wikipedia.org/wiki/United_Kingdom), [Portugal](http://en.wikipedia.org/wiki/Portugal), Germany, [Brazil](http://en.wikipedia.org/wiki/Brazil), [Argentina](http://en.wikipedia.org/wiki/Argentina), [Japan](http://en.wikipedia.org/wiki/Japan) and [China](http://en.wikipedia.org/wiki/China) were reported to have tested and used vegetable oils as diesel fuels during this time.

Some operational problems were reported due to the high viscosity of vegetable oils compared to petroleum diesel fuel, which results in poor atomization of the fuel in the fuel spray and often leads to deposits and coking of the injectors, combustion chamber and valves. Attempts to overcome these problems included heating of the vegetable oil, blending it with petroleum-derived diesel fuel or ethanol, pyrolysis and cracking of the oils.

In 1977, Brazilian scientist Expedito Parente invented and submitted for patent, the first industrial process for the production of biodiesel. This process is classified as biodiesel by international norms, conferring a "standardized identity and quality. No other proposed bio-fuel has been validated by the motor industry."

**MANUFACTURING PROCESS**

A lot of research work has been carried out to use vegetable oil both in its neat form and modified form. Studies have shown that the usage of vegetable oils in neat form is possible but not preferable. The high viscosity of vegetable oils and the low volatility affect the atomization and spray pattern of fuel, leading to incomplete combustion and severe carbon deposits, injector choking and piston ring sticking. The methods used to reduce the viscosity are

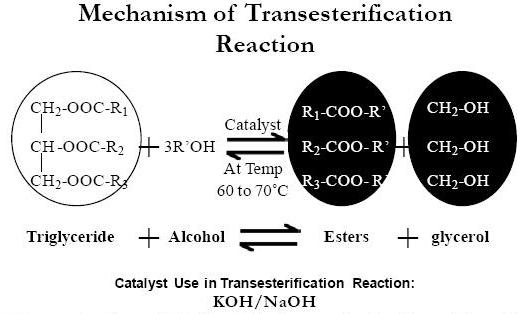
\* Blending with diesel

\* Emulsification

\* Pyrolysis

\* Transesterification

Among these, the trans-esterification is the commonly used commercial process to produce clean and environmental friendly fuel. However, this adds extra cost of processing because of the trans-esterification reaction involving chemical and process heat inputs. Trans-esterification involves reaction of the triglycerides of Jatropha oil with methyl alcohol in the presence of a catalyst Sodium Hydroxide (NaOH) to produce glycerol and fatty acid ester.



The production of biodiesel by trans-esterification of the oil generally occurs using the following steps:

1. **Mixing of alcohol and catalyst.** For this process, a specified amount of alcohol (e.g. methanol) and Sodium Hydroxide (NaOH) is mixed in a round bottom flask.

2. **Reaction.** The alcohol-catalyst mix is then charged into a closed reaction vessel and Jatropha oil is added. Excess alcohol is normally used to ensure total conversion of the fat or oil to its esters.

3. **Separation of glycerin and biodiesel.** Once the reaction is complete, two major products exist: glycerin and biodiesel. The quantity of produced glycerin varies according to the oil used, the process used, the amount of excess alcohol used. Both the glycerin and biodiesel products have a substantial amount of the excess alcohol that was used in the reaction. The reacted mixture is sometimes neutralized at this step if needed.

4. **Alcohol Removal.**

5. **Glycerin Neutralization.** The glycerin by-product contains unused catalyst and soaps that are neutralized with an acid and sent to storage as crude glycerin. In some cases, the salt formed during this phase is recovered for use as fertilizer. In most cases the salt is left in the glycerin.

6. **Methyl Ester Wash.** The most important aspects of biodiesel production to ensure trouble free operation in diesel engines are complete reaction, removal of glycerin, removal of catalyst, removal of alcohol and absence of free fatty acids.

A by-product of the trans-esterification process is the production of [glycerol](http://en.wikipedia.org/wiki/Glycerol). For every 1 tonne of biodiesel that is manufactured, 100 kg of glycerol are produced. Originally, there was a valuable market for the glycerol, which assisted the economics of the process as a whole. However, with the increase in global biodiesel production, the market price for this crude glycerol (containing 20% water and catalyst residues) has crashed. Research is being conducted globally to use this glycerol as a chemical building block. One initiative in the UK is The Glycerol Challenge.

A variety of oils can be used to produce biodiesel. These include:

* Virgin oil feedstock: rapeseed and [soybean oils](http://en.wikipedia.org/wiki/Soybean_oil) are most commonly used, soybean oil alone accounting for about ninety percent of all fuel stocks in the US. It also can be obtained from [field pennycress](http://en.wikipedia.org/wiki/Thlaspi_arvense), [*Jatropha*](http://en.wikipedia.org/wiki/Jatropha) *Curcas*, Karanja and other crops such as [mustard](http://en.wikipedia.org/wiki/Mustard_plant), [flax](http://en.wikipedia.org/wiki/Flax), [sunflower](http://en.wikipedia.org/wiki/Sunflower), [palm oil](http://en.wikipedia.org/wiki/Palm_oil), [coconut](http://en.wikipedia.org/wiki/Coconut), [hemp](http://en.wikipedia.org/wiki/Hemp);
* [Waste Vegetable Oil](http://en.wikipedia.org/wiki/Waste_vegetable_oil) (WVO);
* Animal [fats](http://en.wikipedia.org/wiki/Fat) including [tallow](http://en.wikipedia.org/wiki/Tallow), [lard](http://en.wikipedia.org/wiki/Lard), [yellow grease](http://en.wikipedia.org/wiki/Yellow_grease), chicken fat, and the by-products of the production of [Omega-3 fatty acids](http://en.wikipedia.org/wiki/Omega-3_fatty_acids) from fish oil.
* [Algae](http://en.wikipedia.org/wiki/Algae_fuel), which [can be grown](http://en.wikipedia.org/wiki/Algaculture) using waste materials such as sewage and without displacing land currently used for food production.
* Oil from [halophytes](http://en.wikipedia.org/wiki/Halophyte) such as [*Salicornia Bigelovii*](http://en.wikipedia.org/wiki/Salicornia#Industrial_use_.28contemporary.29), which can be grown using saltwater in coastal areas where conventional crops cannot be grown, with yields equal to the yields of soybeans and other oilseeds grown using freshwater irrigation.

**TECHNICAL SPECIFICATIONS**

**The Biodiesel Standard (ASTM D 6751)**

All engines are designed and manufactured for a fuel that has certain characteristics. In the US, the industry organization that defines the consensus on fuels is the American Society for Testing and Materials (ASTM). In the case of diesel fuel (and biodiesel), the responsibility for setting standards lies within ASTM Committee D02 on Petroleum Products and Lubricants. In order to assure that the standards are rigorous and robust, ASTM committee D02 is comprised of fuel producers, engine equipment manufacturers, and third party interests (users, government agencies, consultants). An ASTM standard is not easily achieved. Some standards can take over 10 years to gain agreement and be issued by ASTM. This rigorous, time-consuming process is why ASTM standards are recognized and adopted by others worldwide.

* ASTM fuel standards are the minimum accepted values for properties of the fuel to provide adequate customer satisfaction and/or protection. For diesel fuel, the ASTM standard is ASTM D 975. All engine and fuel injection manufacturers design their engines around ASTM D 975. In cooperative discussions with the engine community early in the biodiesel industry's development, engine manufacturers strongly encouraged the biodiesel industry to develop an ASTM standard for biodiesel fuel which would allow them to provide their customers with a more definitive judgment on how the fuel would affect engine and fuel system operations compared to ASTM D 975 fuel for which an engine was designed.
* In June of 1994, a task force was formed within ASTM Subcommittee E on Burner, Diesel, Non-Aviation Gas Turbine, and Marine Fuels of ASTM Committee D02, with the expressed objective of developing an ASTM standard for biodiesel. The biodiesel standard, ASTM PS 121-99, was approved by Subcommittee E, and subsequently issued by ASTM in June of 1999. In December of 2001, ASTM approved the full standard for biodiesel, with the new designation of D-6751 (succeeds PS 121-99). This standard covers pure biodiesel (B100), for blending with petro-diesel in levels up to 20% by volume. Higher levels of biodiesel are allowed on a case-by-case basis after discussion with the individual engine company, since most of the experience in the US thus far has been with B20 blends.
* The approval of this biodiesel standard, and the technical reviews necessary to secure its approval, has provided both the engine community and customers with the information needed to assure trouble free operation with biodiesel blends.

**EN 14214** is a European Standard that describes the requirements and test methods for FAME - the most common type of biodiesel. This European Standard exists in three official versions - English, French, German. The current version of the standard was published in November 2008 and supersedes EN 14214:2003. Differences exist between the national versions of the EN 14214 standard. These differences relate to cold weather requirements and are detailed in the national annex of each standard. The ASTM and EN standards both recommend very similar methods for the GC based analyses.

Blends are designated as "B" followed by a number indicating the percentage biodiesel. For example: B100 is pure biodiesel. B99 is 99% biodiesel, 1% petro-diesel. B20 is 20% biodiesel and 80% fossil diesel.

**USE IN DIESEL ENGINES**

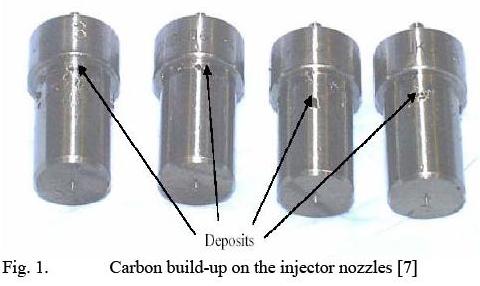
Additives are abundantly manufactured and mixed with IC engine fuels to meet the proper performance of fuel in engine. Additives act like catalyst so that they aid combustion, control emission, control fuel quality during distribution and storage and reduce refiners operating cost.

The performance of diesel engine using diesel additive and methyl-ester of Jatropha oil as the fuel was evaluated for its performance and exhaust emissions. The fuel properties of biodiesel such as kinematic viscosity, calorific value, flash point, carbon residue and specific gravity were found. Results indicated that B25 have closer performance to diesel and B100 had lower brake thermal efficiency mainly due to its high viscosity compared to diesel. The brake thermal efficiency for biodiesel and its blends was found to be slightly higher than that of diesel fuel at tested load conditions and there was no difference between the biodiesel and its blended fuels efficiencies. Its diesel blends showed reasonable efficiencies, lower smoke, CO2 and CO. Multi-DM-32 additives with methyl ester of Jatropha offer fuel conservation as well as reduce pollution.

**Problem of fuelling with biodiesel and suggested solutions**

The engine resistance and the consequent overcoming of the durability test are two of the major issues that must be considered within the power sector of production and consumption of biodiesel, in relation to assuring and guaranteeing the suitable use of this carburant (methyl ester of vegetal oils) in compression ignition engines. Among the most important items that would be necessary to correct in order to achieve a good operation with such bio-carburants, several researchers recommend the elimination of the subsequent list of compounds, which might affect both resistance and durability of the engine: monoglycerides, unreacted di- and triglycerides, unreacted free fatty acids, and uneliminated methanol and glycerol, as well as absorbed water. P. Gateau add to the list the following group of potentially harmful substances for the engine, namely, salts, phospholipids and strong acids from catalytic origin.

Triglycerides and diglycerids are greases from vegetal or animal origin, which have not completed the trans-esterification process, and that when being dissolved in biodiesel, their presence supposes an extra difficulty in relation to the combustion process. Due to their nature as fats, their behavior is analogous to which some vegetable bio-oils experience when being used as fuels for diesel engines: the soot deposit formation (coke) on the injectors, certain components of the piston (rings) and in the interchange ports (inlet and outlet valves). The rest of the elements mentioned by Graboski, namely, monoglycerides, fatty acids, glycerol, methanol and water, present the disadvantage of corroding and wearing out metallic bearings and other mechanical pieces that are in permanent movement and contact. On the other hand, it is also possible to emphasize and stress some of the less favorable properties associated to biodiesel use. Among most decisive ones are the elevated boiling point and the high viscosity of methyl esters, what negatively affect combustion process in low load conditions, thus entailing two immediate consequences. The portion of biodiesel that has not completed the combustion process is forced past the rings of the cylinder until reaching the crankcase, where it dissolves with the lubricating oil thus diminishing its viscosity (followed by a thickening, presence of soot and a decrease of the antioxidants concentration) and, in general, the lubricant properties of lube oil. This *problem could be avoided* at least partially adapting both the angles and the diameter of the injector orifices. The presence of organic rests in the lubricating oil causes anomalous changes in some of its major characteristics, as for example an increase in the acidity derived from the organic degradation of biodiesel. As a negative element regarding this dissolution process it can be emphasized the fact that the elevated boiling point of biodiesel, mixed with the lubricating oil, does not facilitate its own evaporation with the heating produced by the engine; which, in affirmative case, would make possible the elimination of the residual biodiesel through an easier and simpler way. This dilution process of lubricating oil in biodiesel takes place in general as a consequence not of the known phenomenon of blow-by, but by the normal drag process of certain fractions of biodiesel that are carried out by the pistons rings. It is normal to register important viscosity losses on lube oil after relatively few running hours whether the engine or the diesel- biodiesel mixture does not perfectly fit to the suitable parameters. Biodiesel derived from very unsaturated oils or raw materials (sunflower, olive oil, soybean) tends to give greater degrees of dissolution in lubricating oil because its boiling point is higher than that of methyl esters elaborated from saturated fats (palm, animals fats, coconut). Justification to this phenomenon exactly lies in the greater calorific energy, which is required to break multiple bonds in comparison to the simple ones from saturated fats. In synthesis, palm oil biodiesel burns better than another one synthesized from soybean or sunflower oil, what will subsequently generate a lower dissolution rate on the lubricating oil. Therefore, a partial solution to this problem is suggested to be the addition of biodiesel with a small percentage of methyl ester highly saturated, which would improve the combustion eradicating or diminishing the problem. In his report on biodiesel from *sativa camelina* A. Fröhlich talked about the accumulation of important amounts of methyl esters in the lubricating oil, reaching levels up to 16% at the end of 8,000 km tests. Simultaneously, the viscosity of lubricating oil submitted to the mentioned kilometric tests underwent reductions of 30% due to ester dilution in lube oil. The unburned biodiesel fraction not mixed with the lubricating oil in engine crankcase is deposited on the air box cover, on the injectors (Figure 1), rings and valves, as well as on the top of the cylinder shirts. Finally it undergoes a process of carbonization of undesirable consequences. These deposits happen generally at average load (at full load combustion becomes more homogenous and perfect) when the low fuel volatility causes it not to burn and therefore to be



deposited on the surfaces suffering a formation process of coke and soot. Soot deposits are the result of the imperfect fuel combustion (due to the high boiling point), but also sometimes has their origin in drying and later carbonization of remains of lubricating oil. Deposition of residual material on the surfaces of mechanical pieces also adopts a second type of structure formed by lacquers (lacquering); defined these ones as hard, dry deposits, generally gleaming and insoluble in oil, and that in addition they are not easily eliminated with water. On the other hand, as a solution to this topic, biodiesel distillation remarkably reduces the tendency of deposits formation, by eliminating the less volatile fractions from biodiesel. As a conclusion, it is observed that at full load biodiesel generally has a more perfect combustion, which directly implies a lower dilution rate of methyl esters into the lubricating oil as well as a decrease in the deposit formation.

On the other hand, it is very well known that low temperature behavior and the outstanding oxidative and storage instability are among the two most important technical difficulties in relation to biodiesel use. The latter property generates the fuel oxidation producing degradations such as hydro peroxides or carboxylic acids, which generate rubbers, conferring on the bio-combustible a plastic and viscous behavior. A possible solution to improve biodiesel low temperature behavior and at the same time to diminish its boiling and flash point would consist in the addition of certain alcohol (methanol, ethanol) in a variable percentage according to the technical and environmental specifications in which engine operation is pretended to be assessed. The immediate result is an improvement in the above mentioned problems of lube oil dilution and deposits formation; although certain power loss would also be registered as an important and negative consequence, always proportional to the amount of added alcohol.



**BIODIESEL IN OTHER COUNTRIES AND INDIA**

**International Laws and regulation**

Several countries have active Biodiesel programmes. Such countries also have given legislative support and have drawn up national polices on biodiesel development. Wide variety of motives for action taken can observe like

* Increase of energy supply security
* Reduction of dependence on fossil energy forms
* Reduction of harmful locally acting emissions.
* Protection of soil by biodegradable products
* Reduction of health hazard by using non-toxic products.

Since the passage of the [Energy Policy Act of 2005](http://en.wikipedia.org/wiki/Energy_Policy_Act_of_2005), biodiesel use has been increasing in the United States. In the UK, the [Renewable Transport Fuel Obligation](http://en.wikipedia.org/wiki/Renewable_Transport_Fuel_Obligation) obliges suppliers to include 5% renewable fuel in all transport fuel sold in the UK by 2010. For road diesel, this effectively means 5% biodiesel. In 2007, McDonalds of UK announced that it would start producing biodiesel from the waste oil byproduct of its restaurants. This fuel would be used to run its fleet.

Throughout the 1990s, plants were opened in many European countries, including the [Czech Republic](http://en.wikipedia.org/wiki/Czech_Republic), Germany and [Sweden](http://en.wikipedia.org/wiki/Sweden). France launched local production of biodiesel fuel (referred to as *diester*) from rapeseed oil, which is mixed into regular diesel fuel at a level of 5%, and into the diesel fuel used by some captive fleets (e.g. [public transportation](http://en.wikipedia.org/wiki/Public_transportation)) at a level of 30%. [Renault](http://en.wikipedia.org/wiki/Renault), [Peugeot](http://en.wikipedia.org/wiki/Peugeot) and other manufacturers have certified truck engines for use with up to that level of partial biodiesel; experiments with 50% biodiesel are underway. During the same period, nations in other parts of the world also saw local production of biodiesel starting up: by 1998, the Austrian Biofuels Institute had identified 21 countries with commercial biodiesel projects. 100% Biodiesel is now available at many normal service stations across Europe.

In September 2005 [Minnesota](http://en.wikipedia.org/wiki/Minnesota) became the first U.S. state to mandate that all diesel fuel sold in the state contain part biodiesel, requiring a content of at least 2% biodiesel. In 2008, [ASTM](http://en.wikipedia.org/wiki/ASTM) published new Biodiesel Blend Specifications Standards.

**INDIA**

Biodiesel Technologies:

Headquartered in Kolkata India, Biodiesel Technologies was conceived in 2002 in response to the serious environmental and health hazards arising out of the various polluting emissions casing our environment. Biodiesel Technologies was conceived by a group of Technologists with a comprehensive professional experience with multinational companies under the able stewardship of Mr. Amitabha Sinha who is the M.D & Chief of Technology of the company. Mr. Amitabha Sinha proposed a journey for the present society at large from the present polluted and harmful environment back to the green and pure environment as it was ages before. He thought of developing an alternative source of energy that can reduce pollution levels in our country, organic in nature. Soon, his thoughts were materialised into action when the idea of manufacturing Biodiesel Processing Plants crystallized. The feedstock used was organic in character which produced Biodiesel as per the ASTM, EN and BIS Standards. This marked the beginning of our organization. Since the operation of the first Biodiesel processing Plant in Hyderabad, Biodiesel Technologies has built a strong reputation as a leading pioneer in the manufacturing, fabricating and assembling Biodiesel Processing Plants.

[**The National Mission on Jatropha  Biodiesel**](http://www.jatrophaworld.org/)

In April 2003, the committee on development of BIO-FUEL, under the auspices of the Planning Commission of India, presented its report that recommends a major multi-dimensional programme to replace 20% of India’s diesel consumption. The National Planning Commission has integrated the Ministries of Petroleum, Rural Development, Poverty Alleviation and the Environmental Ministry and others.

**Biodiesel Scenario In India**

As India is deficient in edible oils, non-edible oil is the main choice for producing biodiesel. According to Indian government policy and Indian technology effects, some development works have been carried out with regards to the production of transesterified non edible oil and its use in biodiesel by units such as Indian Institute of Science, Bangalore, Tamilnadu Agriculture University Coimbatore and Kumaraguru College of Technology in association with Pan horti consultants, Coimbatore. Generally a blend of 5% to 20% is used in India (B5 to B20). Indian Oil Corporation has taken up Research and development work to establish the parameters of the production of tranesterified Jatropha Vegetable oil and use of bio diesel in its R&D center at Faridabad. Research is carried out in Kumaraguru College of Technology for marginally altering the engine parameters to suit the Indian Jatropha seeds and to minimize the cost of transesterification.

**ADVANTAGES AND CURRENT RESEARCH**

**1.Emissions Reduction**

Since Biodiesel is made entirely from vegetable oil, it does not contain any sulphur, aromatic hydrocarbons, metals or crude oil residues. The absence of sulphur means a reduction in the formation of acid rain by sulphate emissions which generate sulphuric acid in our atmosphere. The reduced sulphur in the blend will also decrease the levels of corrosive sulphuric acid accumulating in the engine crankcase oil over time.

The lack of toxic and carcinogenic aromatics (benzene, toluene and xylene) in Biodiesel means the fuel mixture combustion gases will have reduced impact on human health and the environment.

**2.Smoke and Soot Reductions**

Smoke (particulate material) and soot (unburned fuel and carbon residues) are of increasing concern to urban air quality problems that are causing a wide range of adverse health effects for their citizens, especially in terms of respiratory impairment and related illnesses. The lack of heavy petroleum oil residues in the vegetable oil esters that are normally found in diesel fuel means that a diesel engine operating with Biodiesel will have less smoke, and less soot produced from unburned fuel. Further, since the Biodiesel contains oxygen, there is an increased efficiency of combustion even for the petroleum fraction of the blend. The improved combustion efficiency lowers particulate material and unburned fuel emissions

**3.Positive Energy Balance for Solar Energy in Biodiesel**

Although it takes fossil energy to produce and transport biofuel, Biodiesel has a very favorable energy balance, especially relative to energy-negative ethanol from corn.

**4.Better Engine Performance and Efficiency**

**5.Better Lubricating Properties**

**6.Better Fuel Consumption Efficiencies**

Biodiesels are mono-alkyl esters containing approximately 10% oxygen by weight. The oxygen improves the efficiency of combustion.

**7. Environmental Effects**

The surge of interest in biodiesels has highlighted a number of [environmental effects](http://en.wikipedia.org/wiki/List_of_environmental_issues) associated with its use. These potentially include reductions in [greenhouse gas](http://en.wikipedia.org/wiki/Greenhouse_gas) emissions, [deforestation](http://en.wikipedia.org/wiki/Deforestation), [pollution](http://en.wikipedia.org/wiki/Pollution) and the rate of [biodegradation](http://en.wikipedia.org/wiki/Biodegradation).

**Current Research**

There is ongoing research into finding more suitable crops and improving oil yield. Scientists are researching three major sources to produce biodiesel since the current yields are consuming vast amounts of land and fresh water. They are algal sources, fungal sources and biodiesel from coffee grounds. These do not entail a decrease in food production and fresh water. General urban waste is also being researched upon.

**CONCLUSION**

As a substitute for fast depleting fossil fuel, Biodiesel had come to stay. In future, it should also serve to reduce and maintain the price of automobile fuel. The under exploited and unexploited vegetable oils are good sources of bio-fuel. Our country is endowed with many such plants. Research is being carried out now to convert vegetable oils into biodiesel through biotechnological processes using biodiesel. With a concentrated and coordinated effort, wide use of bio diesel in our country is going to be a reality in the days to come.

Diesel forms nearly 40% of the energy consumed in the form of hydrocarbon fuels, and its demand is estimated at 40 million tons. The national demand for fuel in India is six times that of other countries. So, biodiesel can open up new advents in fuel consumption and meets the ever-rising demands of fuel in the country.

India has vast stretches of degraded land, mostly in areas with adverse agro- climatic conditions, where species of Jatropha, Mahua etc can be grown easily. Even 30 million hectares planted for bio-diesel can completely replace the current use of bio-fuels. The production of Bio fuels will also boost the rural economy which will bring more enthusiasm in more than one billion lives in the area.

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