



## Bio-diesel production and its engine characteristics—An expatriate view

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### ABSTRACT

Nowadays, the awareness about the environment rose among general civic to search for an alternative fuel that could burn with not as much of the pollution. In general, all the vegetable oils are cleaner forms of energy, renewable, and sustainable. So they could be used as an alternative fuel especially in C.I. engines. This review depicts the different methods of bio-diesel production such as transesterification, radio frequency (RF), two-step catalytic process, etc. Subsequently, performance and emissions are two distinct factors that decide the use of fuels in engines; a brief discussion is made on the performance and emission characteristics of various bio-diesel sources like edible oil, inedible orange oil, animal tallow, turpentine oil, waste plastic oil, etc. This paper extends to distinguish exhaust gas recirculation (EGR) from other available methods for NO<sub>x</sub> reduction, and finally a comparative evaluation has been made on thermal barrier coated engines with conventional diesel engines.

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## 1. Introduction

Petroleum-based fuels are used in almost all sectors of transportation. As the demand of these fuels increases, the price of the fuel also keeps on increasing which has become a great setback for the nation's economy. It is becoming increasingly important to develop sustainable solutions to our energy needs. As fossil fuels are depleting at a faster rate and global warming more heavily affects our lives, the urgency of finding a solution to these problems is more obvious. Energy is considered a critical reason for economic growth, social development, and human welfare. Since their exploration, the fossil fuels continued as the major conventional energy source. With the trend of modernization and industrialization, the world energy demand is also growing at a faster rate. To cope up the increasing energy demand, the majority of the developing countries import crude oil. This puts extra burden on their home economy [1].

The alternative to diesel fuel must be technically feasible, economically competitive, environmentally acceptable, and readily available. Many of these requisites are satisfied by vegetable oils or in general by triglycerides. The problems with directly using vegetable oils are lubrication oil contamination, carbon buildup, etc. Based on the economic aspect, the present market price of vegetable oil is higher than that of diesel. The barriers and interruptions to the bio-diesel production are the availability and wide-spread usage of fossil fuel almost in all places. On the other hand, as a result of developments in oil extraction techniques and agricultural methods, it is expected that in the future the cost of vegetable oils will be getting reduced. In spite of everything, it is possible in certain localities to purchase a number of inedible oils at fairly low prices. Due to the wide variations in soil, climate conditions, and rival uses of agricultural lands, several countries have to think through different vegetable oils as the potential fuels. Each country has to carefully contemplate the type and extent of land for raising such plants [2–4].

Several methods such as preheating, blending, micro-emulsion, pyrolysis (Thermal cracking), and transesterification exist for modifying vegetable oils usable in engines. Among those the most significant is the transesterification method [5]. In C.I. engines the use of bio-diesel reduces CO, HC, PM (Particulate Matter), and smoke, where  $\text{NO}_x$  increases in most of the cases. The most effective and low-cost technique to reduce  $\text{NO}_x$  was found to be exhaust gas recirculation (EGR) [6]. Conjointly, the advent of thermal barrier coated (TBC) engines enhanced the performance and emissions when compared to uncoated engines [7]. Based on the above particulars, an endeavor has been made to review renewable bio-diesel technologies across the globe, green field ventures along with the latest innovation, and also to present a clear picture about the current trends in bio-diesel technologies.

## 2. Historical background

The steps towards alternative fuels were on the go from the invention of the diesel engine by Rudolf Diesel in 1885 onwards. In 1912, he stated, "The use of vegetable oils for engine fuels may seem insignificant today. But such oils may in the course of time become as important as petroleum and the coal-tar products of present time" [6–8]. Since the global energy crisis in 1970s substantial attention has been focused on the development of alternate fuels [9]. On the other hand, the oil Gulf crisis in 1973 triggered numerous studies on natural oil and fats all over the world, but the search for alternative fuel has been identified only on 2nd August 1990 [10]. Many researchers and scientists had tried out different types of fuels namely compressed natural gas (CNG), liquefied petroleum gas (LPG), hydrogen, and alcohols. The vegetable oils and alcohols (methanol and ethanol) are favorable renewable liquid fuels. Alcohols are not suitable for diesel engines due to their low cetane number. The poor volatility and low octane number make vegetable oils unsuitable for spark ignition (petrol) engines. One possible solution to this problem is the use of bio-diesel. Straight vegetable oil (SVO) and bio-diesel (which are esters of SVO) are the two fuels which can be used as sole fuel or as mixture along with diesel fuel. Banapurmath et al. [11], Palanisamy and Manoharan [12], Rushang et al. [13], Sharma and Singh [14], Srinivas and Rathanasamy [15], Venkatachalam and Chitra [16], and Hamed et al. [17] reported that the following advantages are noted with bio-diesel:

- Bio-diesel is non-toxic and degrades four times faster than diesel.
- Its oxygen content improves the bio-degradation process.
- Pure bio-diesel degrades 85–88% in water.
- Blending of bio-diesel with diesel fuel increases engine efficiency.
- Bio-diesel has a lower vapour pressure and higher flash point than its petroleum counterpart, making it safer to handle and store.
- Oxygen content of bio-diesel improves the combustion process and decreases its oxidation potential.
- The uses of bio-diesel can extend the life of diesel engine because it has more lubricating property than petroleum diesel fuel.
- Provides a domestic, renewable, and potentially inexhaustible source of energy with energy content close to diesel fuel.
- Bio-diesel obtained from crops produces favorable effects on the environment, such as decrease in acid rain and in the greenhouse effect caused by pollution.
- Bio-diesel is termed as a "carbon neutral" as bio-diesel yielding plants absorbs more carbon dioxide from the atmosphere

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