



A comprehensive review of bio-diesel as alternative fuel for compression ignition engines



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ABSTRACT

In the wake of oil crisis, the world is looking for the alternative source of energy where bio-diesel came into play as an attractive renewable alternative fuel. However, it was realized that extensive utilization of bio-fuel would tax the food chain and could lead to food shortages. So, the use of a blend of bi-fuel with conventional fuel was suggested to balance its usage which still could provide beneficial green house effect. In the hot and cold climate bio-diesel cannot conveniently replace fossil fuel but in the controlled environment with modified combustion equipment, bio-diesel can be used as an alternate fuel. Having lower heating value, bio-diesel is consumed more in comparison to the fossil diesel fuel. Bio-diesel also generates more NO_x emission, which is an adverse environmental pollutant. The raw material source of bio-diesel limits food growing ground which is ultimately becoming a great concern. A dilemma of using bio-diesel as an alternative for mineral fuel has raised a concern about environment, engine performance and involved costs these have to be investigated in depth to provide a recommendation.

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Contents

1. Introduction	411
2. Bio-diesel	411
2.1. Biofuel properties	414
2.2. Biodiesel production costs	414
2.3. Biodiesel effect on engine	415
2.3.1. Engine power	415
2.3.2. Economy performance	416
2.4. Emissions of bio-diesel	417
2.4.1. Impact of engine emissions on environment and human health	417
2.4.2. Factors affecting engine emission	417
2.4.3. Particulate matter (PM)	417
2.4.4. NO _x	418
2.4.5. CO	418
2.4.6. HC	418
2.4.7. CO ₂	418
3. Impact of bio-diesel as an alternative fuel	419
3.1. Food price evolution	419
3.2. The freezing impact on bio-fuel production	419

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3.3. The elimination impacts on bio-fuel production	420
4. Summary	420
Acknowledgements	421
References	421

1. Introduction

Oil crisis in 1970 had influenced many countries to consider alternative fuels for replacement of fossil fuel. The National Alcohol Program (PROALCOOL) in Brazil was accomplished by implementing product stimulation, distribution and also by use of ethanol fuel from sugar cane [1]. To aid this program, the car manufacturing industry designed the specific engines for ethanol fuel. In 1986, this program established a landmark, when ethanol-fuelled automobiles reached 96% of the market shares in Brazil. In 1989, the interest to ethanol vehicles and flexible-fuel were lost due to enhancement of ethanol fuel cost, which ultimately failed to provide advantages to the consumers [1,2].

Brazil in 1990 experienced increase of vehicle import due to the lower import tax. The modern production strategy encouraged the local automotive enterprise to involve in continuous improvement and produce new products. Government encouragement for manufacturing small engines powered by cheap fuel turned Brazil into the one of major automobile manufacturers. Recently, continuous analysis in global arena has developed the flexible fuel engines that might run with any concentration of gasoline and ethanol blend. Automobiles, which can run with the variable fuel engines, attract many customers due to the possible ways to make a choice from gasoline and ethanol in accordance to the price and availability [1,3].

Bio-fuel is actually known as a renewable energy, which is produced from alternative renewable energy materials. Other bio-based renewable fuels systems have various ecological drawbacks. Biomass from agricultural resources is comparatively land intensive, and runs the risk of water resources pollution from pesticides and fertilizers which are normally needed to add to the land to enhance plant growth. Many scientists have observed this conundrum and also have tried to investigate bio-ethanol programs to explain their sustainability in the environment. With sufficient efforts researchers have discovered bio-fuels which could provide sustainable objective for environmental transportation. A number of articles were dedicated to ethanol alone and outlined typical undesirable environmental issues [4,5]. Alternative reviews on bio-fuels of many types and noted many favorable aspects for ethanol along with caution regarding many potential adverse environmental impacts [6] are highlighted. Different studies were conducted in the United States particularly on corn-to-ethanol route and finally inferred that the environmental sustainability is a great concern [5,7–9].

However, the question of problem of sustainability is quite complex, which encompasses environmental and human health along with societal issues. The attempts to provide solution a widen perspective is needed to prevent changing issues from one to different spot [10]. Many researchers have mentioned that these systems of liquid bio-fuel production, both projected and current could be sustainable if it is eco-friendly in nature [5].

The most prevalent bio-fuels, like biodiesel from vegetable seeds and ethanol from wheat, corn sugar beet, are produced from food plants, which require the rich agricultural land for growth [11–13]. Currently critical issues are dealing with the impact on global food supply. Fuel vs. Food could become a problem with the danger of diverting crops farmland for producing liquid bio-fuels, which will be detrimental to the world food supply. There are differences in opinion concerning how important this could be, what the impact is, what it inflicting and what need

to be done to alleviate this concern. Recently, the increase in world oil prices generated a serious concern towards improvement of the global bio-fuels production. Some products like sugarcane, vegetable oil and corn are going to be used either as feed, food, or even create bio-fuels. Vegetable oils can be a renewable supply to replenishable source of fuel having energy content near to the diesel fuel. In addition, intensive usage of vegetable oils could potentially result in important adverse issues like food shortage in developing countries. Forest resource, knowledge of agriculture science and appropriate technology could be prescribed as a solution for issues of world food resources [11,14,15].

Energy costs influence clients decision and behavior and have significant impact on economic development. The taxes on energy costs are needed to be definitely recognized from prices, contract markets, spot markets etc. Biomass fuel is one of the main exploited global renewable energy sources. Developing low cost and efficient methods for the process of biomass into liquid bio-fuels conversion is crucial for minimizing reliance on petroleum sources, increasing the employment of neutralizing carbon techniques, and improving rural profits [16,17]. Recently, grain-based vegetable-oil and their product ethanol are notably used as biodiesels which generate problems for the use of grains in the food chain [11].

The goal is always to supply cheap biomass to a stream which is accustomed to selection of chemicals, fuels and alternative materials which might be cost competitive to the regular products. The definition of liquid bio-fuel is noted as biomass-to-liquid fuel. BTLF can supply completely different renewable sources alternative to petroleum; on the other hand, it still incorporates a low quantity of petroleum in the blend. The main distinction between petroleum and bio-fuel feedstocks is the content of oxygen [18,19].

Biodiesel means any kind of equivalent between diesel and bio-fuel that typically derived from animal fats or seed oils [20–22]. Specifically, it can be employed as the fuel for some engines, or mixed with petroleum in diesel engines with no or few modifications. Biodiesel has developed a wide range of applications due to its environmental advantages [23,24]. The biodiesel price is usually the main obstacle for it commercial usage. The used cooking oils could be a raw material where nonstop transesterification method and recovery of the best quality of glycerol as a biodiesel by-product could be a primary choices to reduce the cost of biodiesel [11,13,25,26].

The biomass thermochemical conversion processes are globally endothermic, and the required heat is supplied by solar energy [11,27]. However, if additional energy is provided from other renewable resources like wind, then the additional biomass carbon could to be changed to the liquid fuel [28,29]. Solar energy can possibly supply a few percentages of the thermal energy of bio-fuel plants. A test of direct focused radiation in biomass reactors has introduced many challenges. Solar radiation energy can be stored and utilized for the temperature levels required in processing of biomass. An operating fluid might transfer heat for processing of bio-fuel if needed. However, by adding energy from wind and solar sources, the energy requirement for bio-mss processing could be retarded [27,30,31].

2. Bio-diesel

Bio-fuel or bio-diesel is usually identified as ester-based fuels produced from animal fats or from vegetable oils by using an

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