Emission Analysis of a Single Cylinder Di Engine Running on Biodiesel Blend as Fuel

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Abstract: Biodiesel production is undergoing rapid technological reforms in industries and academia. This has become more obvious and relevant since the recent increase in the petroleum prices and the growing awareness relating to the environmental consequences of the fuel overdependency. In this paper, various technological methods to produce biodiesel being used in industries and academia are reviewed. Catalytic transesterification, the most common method in the production of biofuel, is emphasized in the review. The two most common types of catalysts; homogeneous liquids and heterogeneous solids, are discussed at length in the paper. Two types of processes; batch and continuous processes, are also presented. Although batch production of biodiesel is favored over continuous process in many laboratory and larger scale efforts, the latter is expected to gain wider acceptance in the near future, considering its added advantages associated with higher production capacity and lower operating costs to ensure long term supply of biodiesel.

Key words: Biodiesel • Transesterification • Biodiesel

INTRODUCTION

Biofuels are fuels derived from biomass. Biomass is organic matte taken from o produced by plants and animals. It comprises mainly wood, agricultural crops and products, aquatic plants, forestry products, wastes and residues and animal wastes. In its most general meaning, biofuels are all types of solid, gaseous and liquid fuels that can be derived from biomass. Examples of solid biofuels include wood, charcoal and bagasse. Wood and charcoal are widely used as fuel for domestic purposes such as cooking in the rural areas of most developing countries. Waste bagasse, the fibrous material produced from sugar cane processing, is extensively used for steam and electrical power generation in raw sugar mills. Examples of gaseous biofuels include methane gas and producer gas. Methane gas is produced from the anaerobic fermentation of animal wastes, wastewater treatment sludge and municipal wastes in landfills. On the other hand, producer gas can be made from the pyrolysis or gasification of wood and agricultural wastes. Examples of liquid biofuels include methanol, ethanol, plant oils and the methyl esters produced from these oils commonly referred to as biodiesel [1].

The focus of this book is on liquid biofuels that are used primarily as transport fuel. In particular, it covers biofuels from plant oils. However, this chapter will briefly discuss the production of ethanol from sugar crops, starchy crops and cellulosic biomass in order to provide a more complete overview of the two major types of biofuels that are commercially available, namely, ethanol and biodiesel [2].

The second group of feedstock is sugar and starchy crops. These are plants such as sugar cane and sugar beets that can store through photosynthesis the energy from the sun by converting it into simple sugars. In a similar fashion, there are plants such as corn, cassava and sweet potato that store the energy as complex sugars or starches. Although the name sugar is most often used to refer to sucrose or table sugar, in general, sugars are water-soluble carbohydrates that have relatively low molecular weight and usually characterized with having a sweet taste. Carbohydrates, on the other hand, are a group of organic compounds that include sugars, starches, cellulosics and gums [3]. They provide a major source of energy in the diet of humans and animals. These compounds are produced through photosynthesis by plants and contain only molecules of carbon, hydrogen and oxygen, usually in the ratio 1:2:1.
Experimental Setup
Preparation Of Ethanol: The process of making bio-diesel from vegetable oil is called transesterification. This involves making the vegetable oil to react with methyl alcohol in the presence of catalyst to produce bio-diesel. In this process, vegetable oil, methyl alcohol and catalyst are taken in a tank. This mixture was heated and stirred for 1 hour time. Then it is allowed to cool without stirring. Two layers are formed. The bottom layer consists of glycerol and top layer is of ester [4].

\[ C_{19}H_{36}O_8 = 2 \text{CH}_2\text{CH}_2\text{OH} + 2 \text{CO}_2 \]

Ester is separated from the glycerol. The esters are the basis for bio-diesel fuel. During the transesterification process, the glycerin component of Vegetable oil is replaced with alcohol. The bio-diesel thus obtained is tested for its properties. Transesterification is the process of exchanging the alkoxy group of an ester compound by another alcohol. These reactions are often catalyzed by the addition of an acid or base.

Transesterification alcohol + ester - different alcohol + different ester Acid can catalyze the reaction by donating a proton to the carbonyl group, thus making it more reactive, while bases can catalyze the reaction by removing a proton the alcohol thus making it more reactive. Transesterification process is performed in biodiesel.

Engine Specification:
Make: KIRLOSKAR OIL ENGINE LTD.
Model: SV 1
Max Power: 5hp
Speed: 1500 Rpm
No Of Cylinder: 1
Bore: 80 Mm
Stroke Length: 110 Mm
Staring: Cranking
Compression Ratio: 17.5:1
Lubrication Oil: SAE40
Injection Timing: 28°bTDC
Method Of Cooling: Water Cooled

RESULTS AND DISCUSSION

This section of report examines the differences between bio-diesel and conventional diesel, with respect to emissions of hazardous airborne toxins [8]. The scope of the emissions impact analysis of this report covers five types of emissions: NO (nitrogen oxide), PM (particulate matter), HC (hydrocarbons), CO (carbon monoxide) and CO\textsubscript{2}. While CO\textsubscript{2} is not a hazardous air toxin, it is considered a greenhouse gas emission causing global warming and, in some cases, may be capable of generating emission credits.

Hydro Carbon (HC):

The agency of toxic substances and disease registry reports that hydrocarbons (HC) “enter the air mostly as releases from volcanoes, forest fires, burning coal and automobile exhaust”. A 1999 EPA study estimates that on-road vehicle sources were responsible for 29 percent of the total emission of HC. Mobile sources release two types of regulated HC measured as speciated hydrocarbons and a subset of known or suspected carcinogenic compounds titled polycyclic aromatic hydrocarbons (PAH). A presentation given to the national Bio-diesel board entitled “Bio-diesel” tier 1 health effects” presented a correlation between the emission rate of C\textsubscript{1} to C\textsubscript{12} and the potential reduction of Ozone and also stated that HC are a carcinogen. The department of health and human services reiterated this health concern. Specifying that some PAHs are known to cause cancer. There was significant decrease in HC for each blend of etherified gingelly oil than conventional diesel [9].

Carbon Mono Oxide (CO):
Carbon monoxide (CO) is produced from incomplete combustion whenever any carbon fuel, such as gas, oil, kerosene, wood or charcoal is burned. Unlike many gases, CO has no order, colour or taste and it does not cause skin irritation. According to the centers control and prevention, red blood at quicker
rate then oxygen. If cells can attack themselves to CO at quicker rate than oxygen. If there is a large quantity of CO in the air, red blood cell may replace oxygen with CO, leading to possible tissue damage, carbon monoxide poisoning or death. As CO levels increase and remain above 70 parts per million (PPM), symptoms may become more noticeable (headache, fatigue, nausea). As CO levels increase above 150 to 200 ppm, disorientation, unconsciousness and death are possible. Emission of CO decrease with increase in percentage of esterified Biodiesel with diesel [10].

**Carbon Di Oxide (CO₂):** Carbon dioxide is a naturally occurring gas that is linked to global warming. It is also released in to the atmosphere by human activity, such as when solid waste, fossil fuels (oil, natural gas and coal) and wood products are burned. Carbon dioxide by itself is not considered to be a toxin. However, any impacts on global climate could cause health problems. Biodiesel burning involves no net additions to atmospheric carbon [11].

CO₂ emission is higher for B60 when compound to diesel and other blends. The comparison of different emission of diesel and esterified Biodiesel blends are charted below [12].

**CONCLUSION**

- Production of esterified gingelly oil is done successfully.
- There is a significant improvement in the calorific value with the reduction in viscosity than raw gingelly oil.
- Cetane number of esterified Biodiesel has also improved after esterification Process. A blend of esterified gingelly oil was tested successfully in a single cylinder Unmodified diesel engine. Test runs were also made with diesel order to make Comparative assessments. Tabulations and calculations were done. Graphs were plotted for various efficiencies and emission parameters.
- B40 blends higher Brake thermal efficiency than diesel and other blends.
- In the case of indicated thermal efficiency. Diesel has higher efficiency than all other blends.
- Blends of esterified Biodiesel have better performance in mechanical efficiency than conventional diesel. B60 has higher efficiency than others.
- There is only slight variation in BSFC for both diesel and biodiesel blends. Basic is more or less equal for al the blends except b40 which is slightly higher than others.
- NOx emission increase with increase in percentage biodiesel blends. B60 has higher emission than B10, B20, B40 and diesel
- HC decreases with increases in load in all fuels but lower emission for higher blends of esterified Biodiesel.
- The emission of carbon dioxide is high in blends of esterified Biodiesel than Diesel. B60 has higher CO₂ emission.
- There is no significant difference between diesel and blends of esterified SSO for carbon monoxide. CO emission nr diesel is slightly higher than blends. The methyl esters of SSO and its blends can be used as a engine fuel and emission can be reduced by using suitable catalytic converter [13-16].

In this project the gingelly oil is taken us bio-diesel and the esterification process to reduced the viscosity of the gingelly oil is done. Then the performance test and emission test on diesel engine is also carried out. The performance of the three blended of 10%, 20%, 30% bio-diesel is compared with diesel performance. From this the 20% of bio-diesel is similar to the diesel fuel. So we can conclude 20% blended fuel is best one, then the other blended fuel.

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