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Performance of Single Cylinder Diesel Engine Uses Bio-Diesel

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ABSTARCT:

In recent years, much research has been carried to find suitable alternative fuel to petroleum products. In the present investigation experimental work has been carried out to analyze the performance and emissions characteristics of a single cylinder compression ignition DI engine fuelled with the blends of mineral diesel and biodiesel at the different injection pressures. The optimal value of the injection pressure was observed as 200 bar in the range of 180 to 220 bar. The performance parameters evaluated were brake thermal efficiency, break specific fuel consumption and the emissions measured were carbon monoxide (CO), carbon dioxide (CO2), hydrocarbon (HC), and oxides of nitrogen (NOx). The results of experimental investigation with biodiesel blends with diesel are compared with that of diesel. The results indicated that the CO emissions are slightly less, HC emissions were also observed to be less for B10 and B20, and NOx emissions decreased by 39 % for B10 and 28 % for B20 compared with B100. The brake thermal efficiency of the engine decreased around 6% for all blends in comparison with diesel, and the break specific fuel consumption was slightly more for B10 and B20.

INTRODUCTION:

In 1911, Rudolf Diesel presented the world with the compression ignition engine, which at that time did not have a specific fuel. Diesel claimed that the engine could be fed by vegetable oils which could help the agricultural development in countries using this engine. Biodiesels are derived from vegetable oils or animal fats, more specifically the alkyl esters from these. The esters from vegetable oils are considered to be superior since they have a higher energetic yield and essentially no engine modifications are necessary for their use. Biodiesels have been traced back to the mid-1800s, where transesterification was used to make soap and the alkyl esters (biodiesels) were just considered byproducts. Early feedstocks were corn, peanut, hemp oils, and tallow. In 1973, the OPEC nations cut down their oil exports to the West, resulting in the oil crisis of the 1970s. Prices of oil increased dramatically and people started to look into renewable sources of energy. Many of the federal renewable energy programs were initiated during the 1970s including the National Renewable Energy Laboratory. Once prices began to fall in 1979, tax incentives and other support for the renewable energy industry ended thanks to shortsighted policies. The initial steps taken toward a renewable energy initiative were abandoned. In recent years, oil prices have been rising rapidly again and there is a major concern for the long term availability of fossil fuels. This and the growing concern for our environment have created a much larger market for renewable resources. The idea of using vegetable oils instead of fossil diesel fuels has resurfaced as a way to minimize the net carbon footprint left by emissions from compression ignition (CI) engines. Straight vegetable oils (SVOs) have their fair share of problems in unmodified CI engines. These problems include: cold-weather starting; plugging and gumming of filters lines, and injectors; engine knocking; coking of injectors on piston and head of engine; carbon deposits on piston and head of engine; excessive engine wear; and deterioration of engine lubricating oil. Vegetable oils decrease power output and thermal efficiency while leaving carbon deposits inside the cylinder. Most of these problems with vegetable oil are due to high viscosity, low cetane number, low flash point. For the past decade, there has been increased interest in using biodiesels instead of fossil diesel in CI engines. The use of biodiesel was not economically feasible until recently due to rise in prices of fossil fuels. There is a significant amount of research being conducted to lower the cost of producing biodiesel as well as to increase its performance in CI engines. Biodiesels have a higher viscosity and specific gravity than fossil diesel, which affects fuel consumption, injection timing, and spray pattern. Since the cetane number, a measure of combustion quality, for biodiesels is higher when compared with fossil diesel (No. 2 fuel oil), a shorter ignition delay will result which will require an advance of combustion timing. Canakci and Van Gerpen showed that B100 (100% soy biodiesel) had a higher brake specific fuel consumption (BSFC) when compared to fossil diesel. This reflects its lower heating value (about 12% lower than diesel).

BIODIESELS

A brief overview of the production of biodiesels and the use of various components used is given here. There are many methods that can be used to make biodiesels with multiple combinations of catalysts, neutralizers, and feed stocks. After reviewing the general and most popular methods, the ones used to create our test samples will be explained in greater detail.

Overview

Organic Chemistry

The major components of vegetable oils are triglycerides. Triglycerides are esters of glycerol with long-chain acids (fatty acids). The composition of vegetable oils varies with the plant source. The fatty acid profile describes the specific nature of fatty acids occurring in fats and oils. The chemical and physical properties of fats and oils and the esters derived from them vary with the fatty acid profile. Transesterification is the process where an alcohol and an ester react to form a different alcohol and a different ester. For biodiesel, an ethyl ester reacts with methanol to form a methyl ester and ethanol. These ethyl esters react with methanol to form biodiesel and glycerol. As mentioned above, the purpose of transesterification is to reduce the viscosity of the oil so that it has properties closer to that of regular diesel used in CI engines. Methanol is the preferred alcohol for obtaining biodiesel because it has the lowest cost and it is readily available. However, for the reaction to occur in a reasonable time, a catalyst must be added to the mixture of the vegetable oil and methanol to accelerate the speed of a reaction.

Feedstock

Feedstocks for production of biodiesels are vegetable oils (soybean, canola, palm, and rapeseed), animal fats (beef, tallow, lard, poultry fat, fish oils) or recycled grease (mix of the above two). All of the above feedstocks contain triglycerides, free fatty acids (FFAs) and other contaminants. The proportions vary in level depending on the feedstock and these variables affect the chemical reactions needed to transform the primary raw materials (feedstock and alcohol) to create the biodiesels. Commercially available vegetable oils are made up of a small percentage of FFAs, but crude vegetable oil may contain more FFAs and phospholipids, which are removed in two processes: refining and degumming, respectively. The technology required depends on whether the vegetable oils are refined, degummed, or crude. Animal fats and recycled grease have high levels (up to 15% concentration) of FFAs. The FFA content affects the process and yield associated with the final product, and thus these feedstocks (greater that 1% concentration) must be pretreated before the reaction can begin. Other contaminants also affect the feedstock preparation necessary before it can be used in the reaction.

Alcohol

In order to form the biodiesel, a primary alcohol is coupled with the feedstock to form the esters. The most common alcohol is methanol but ethanol, isopropanol and butyl (derived from butane) can also be used. The key quality parameter associated with the process of transesterification is the water content. If the water content is high, it results in low yields, high levels of soap, and leftover FFAs/triglycerides. Therefore, it is important to use stronger alcohols, since the weaker ones are hygroscopic (absorb water from the air). Some alcohols also require higher operating temperatures, longer mixing times, and lower mixing speeds which result in higher operation costs and lower throughput. The decision of which alcohol to use with each process is determined by cost, amount needed, and ease of recycling. Quality requirements on fuel and water content in ethanol make methanol the most popular choice among alcohols. Conventionally, methanol is not renewable since it is normally generated from either natural gas or coal gas and steam however methanol can now be produced from renewable biomass materials (like wood, and black liquor from pulp and paper mills).

CONCLUSION:

In conclusion, biofuels can be used in current compression ignition engines quite effectively. Some biodiesel fuels may even be more effective under certain diesel applications. Engine performance characteristics with biodiesels are similar to those with fossil diesel which makes biodiesel fuels an alternative to help overcome the current energy and environmental crises.

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