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The Effect of Fatty Acid Composition on the Combustion Characteristics of Biodiesel

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1. Introduction

Biodiesel is an alternative fuel for diesel engines that can be manufactured from vegetable oil, used cooking oil and animal fat. Biodiesel offers many advantages such as it is renewable, energy efficient, nontoxic and biodegradable, and it take cleaner diesel combustion and can reduce global warming gas emission from the diesel engines. Specifically, the combustion of biodiesel does not add the net CO_2 to the atmosphere.

In this study, the objective is to clarify the effect of fatty acid composition on the combustion characteri -stics of biodiesel. Additionally, the fuel properties and the exhaust gas emissions of biodiesel and the development of a correlation program between fatty acid compositions and exhaust emissions were also carried out.

2. Test Fuel

Test fuels used in the experiments are five kinds of fatty acid methyl ester(FAME) type vegetable oil biodiesels (coconut oil methyl ester, palm oil methyl ester, palm kernel oil methyl ester, rapeseed oil methyl ester and soybean oil methyl ester), five kinds of common and higher purity FAMEs (methyl laurate, methyl myristate, methyl palmitate, methyl stearate and methyl oleate), and three kinds of unsaturated FAMEs (high oleate safflower oil methyl ester, high linoleate safflower oil methyl ester and linseed oil methyl ester).

3. Experimental Apparatus and Procedure

A single cylinder DI diesel engine was used for the experiments. It is a naturally aspirated, water-cooled, four stroke diesel engine. The standard fuel injection system recommended by the engine manufacturer was used for both FAME fuels and the gas oil.

The experiments were started with the engine warmed up as the standard condition. The engine speed was fixed at 2000 rpm and the loads were applied from 0% to 25, 50, 75, 100% using an electronic dynamometer. At 100% load condition the brake mean effective pressure (BMEP) of the test engine was 0.67 MPa. For combustion character measurements, the cylinder pressure and the needle lift of the fuel injector were recorded with a digital scope recorder at all load conditions.

The exhaust gases were taken from the exhaust system of the test engine and measured following standard procedure. From the exhaust gases, the CO emission was measured by a non-dispersive infrared detector, the HC emission was measured by a flame ionization detector, the NOx emission was measured by a chemiluminescent detector, and the smoke emission was measured by a light transmitting type smoke meter.

4. Results and Discussions

The results of all experiments, it can be said that more saturated FAMEs biodiesel such as coconut oil methyl ester improves the combustion characteristics and reduces the exhaust emissions. Furthermore, the smaller carbon number saturated FAMEs especially methyl laurate has suitable diesel fuel properties, good diesel combustion characteristics and less exhaust emissions. From these engine experiment results a correlation program between FAMEs compositions and the exhaust emissions was developed in this study. By applying this program, basic estimation on exhaust emission (HC, CO, NOx and smoke) of methyl ester type biodiesel is possible.

5. Conclusion

This study give valuable knowledge on the combustion characteristics, fuel properties and exhaust emissions of five kinds of methyl ester type vegetable oils biodiesels, five kinds of pure fatty acid methyl esters (FAMEs) and three kinds of unsaturated FAMEs.

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