

# A Study on the Effect of Blended Biofuel in Terms of the Performance And Emission of Diesel Engines

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## 디젤 엔진을 이용한 바이오혼합연료의 연소성능 및 배기가스 특성 연구

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### Abstract

The internal combustion engine plays a vital role in transportation, industry, and shipping. However, diesel as one of the main fuels for internal combustion engines, caused many environmental and human health problems. In order to solve the problems, more researchers have been committed to the research of alternative fuels. Biodiesel is a renewable, sustainable alternative fuel, and its characteristics are similar to traditional diesel. It can be mixed with pure diesel. It has been found that a mix with pure diesel in a certain ratio can effectively reduce the negative effects caused by its characteristics, improve the combustion performance, and reduce the NOx and PM emissions. This article mainly reviews the effects of the mixture of biodiesel and diesel on diesel engine combustion characteristics and exhaust emissions.

## 1. Introduction

According to the statistics of the transportation sector, the average fuel consumption of diesel oil increases at the rate of 1.1% every year, resulting in the rapid reduction of existing crude oil fuel. With the development of society and the enhancement of environmental protection awareness, people have higher and higher requirements for fuel, so to find an alternative fuel is an important goal. Biodiesel is one of the alternative fuels with wide application prospects, it is non-toxic, biodegradable, and can be extracted from renewable plants or animal fats, food waste, and non-edible plants. Biodiesel can be used for replacing some diesel in the engine to reduce diesel consumption, reduce the generation of exhaust emission and protect the environment. Biodiesel has similar characteristics to traditional diesel, and can be used directly in existing engines without any modifications. When low concentration of biodiesel was used in the engine, it was found that the emissions of HC, CO, and smoke were lower than diesel, and the engine characteristics were better [1]. Therefore, a through review of biodiesel-diesel blends performance is made here to analyze the effect of biodiesel on engine performance and

exhaust emissions.

## 2. Combustion characteristics and exhaust gas emissions

### 2.1 Brake thermal efficiency

The braking thermal efficiency (BTE) is the value obtained by dividing the braking output by the heat energy supplied by the fuel. It is an important index to determine the engine performance. In Fig.1, it can be found that the BTE of biodiesel-diesel mixed fuel was lower than that of diesel, and that the BTE decreased with an increase of biodiesel proportion, because biodiesel has higher kinematic viscosity and lower calorific value, which will lead to poor atomization and more fuel consumption.

For biodiesel-diesel mixed fuel, the BTE is related to the oxygen content, density, kinematic viscosity, calorific value and specific fuel consumption of biodiesel fuel. The oxygen content of biodiesel is higher than that of diesel, and oxygen is released during combustion, resulting in complete combustion in the cylinder, and increases BTE. Conversely, biodiesel has higher

viscosity and density, causes poor atomization, increases the BSFC, affects combustion of blends, reduces combustion efficiency.

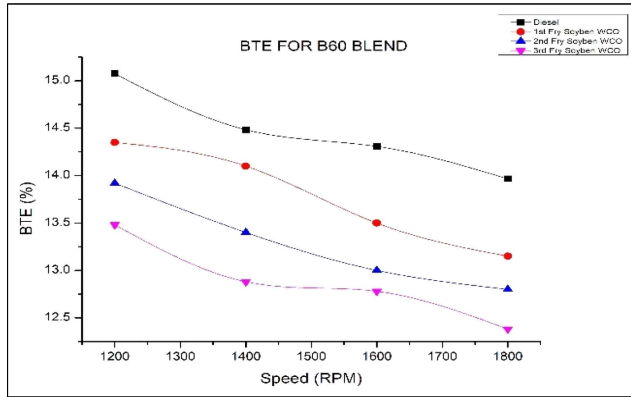


Fig.1 Variation of BTE at different blends [2].

### 2.2 CO emission

Carbon monoxide (CO) in exhaust emission is the result of incomplete combustion of fuel. In other words, the more incomplete the combustion, the more CO emissions will be produced. Figure 2 shows the effect of biodiesel ratio on CO emissions. As the proportion of biodiesel in biodiesel/diesel blends increased, CO emission decreased. First, biodiesel is an oxygenated fuel, which can release more oxygen when the engine burns, promote combustion and reduce CO emissions; Second, biodiesel has a high cetane number, which can shorten ignition delay, increase cylinder temperature, more fuel is fully burned, and it reduces CO emissions.

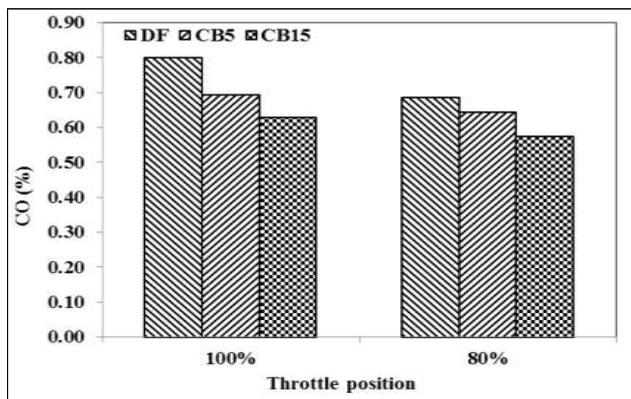


Fig.2 CO emission with different blends [3].

### 2.3 NOx emission

NOx emissions are related to oxygen content and combustion temperature. Excess oxygen reacts with nitrogen to produce NOx. Figure 3 shows the effect of biodiesel-diesel mixed fuel on NOx emissions and found that NOx emissions were closely related to the oxygen content in the combustion process and the temperature

in the cylinder. The low heat transfer and oxygen-rich biodiesel promoted the cylinder combustion, increased the exhaust gas temperature, and caused a large amount of NOx generation.

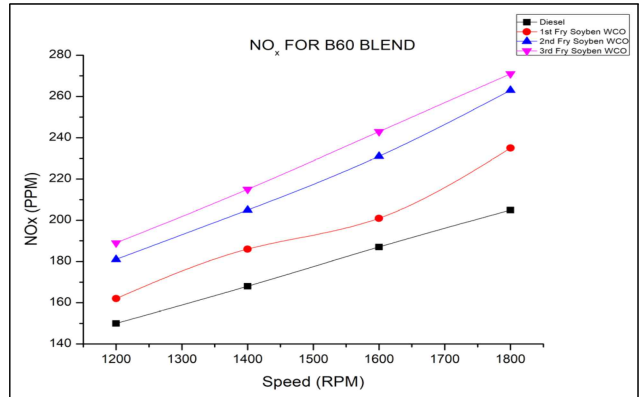


Fig.3 NOx emission with different blends [2].

### 3. Conclusions

The use of biodiesel can reduce the demand for crude oil materials, effectively reduce its consumption. The use of biodiesel can reduce emissions and reduce environmental damage.

1. Biodiesel can be used in existing engines without any modifications, reduce the cost of engine modification. In diesel engines, biodiesel-diesel mixed fuel can improve engine performance and significantly reduce emissions.
2. Compared with diesel, biodiesel has a lower calorific value and higher flash point, density, viscosity and cetane number. It has similar characteristics to traditional diesel. The high viscosity of biodiesel will increase the BSFC, cause a long reaction cycle and reduce the BTE. However, when the mixing ratio of biodiesel and diesel is low, biodiesel contains a large number of oxygen atoms, so it can promote combustion. Moreover, the emission of CO is reduced, and the emission of NOx is increased.

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