A Study on the Characteristics of Biofuel Exhaust Gas Using Diesel Engine

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디젤엔진을 이용한 비이오연료 배기가스 특성에 관한 연구

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Abstract

Engine manufacturers are concerned about the particles created by diesel and spark-ignition engines because they affect engine performance and wear, as well as their environmental effect. Despite certain application issues, it is now widely regarded as one of the most promising alternative fuels for internal combustion engines. The purpose of this study is to conduct a full assessment of engine performance and NOx emissions using biodiesel derived from waste fry cooking oil and compare them to diesel. According to the findings, using biodiesel results in significant reductions in PM, HC, and CO emissions, as well as undetectable power loss, increased fuel consumption, and increased NOx emissions on conventional diesel engines with no or little modifications. However, many more studies on engine modifications, low-temperature engine performance, new instrumentation and measuring technique, and so on are recommended when utilizing biodiesel as a diesel alternative.

1. Introduction

Biodiesel is one of the most promising alternative fuels for dealing with these issues. It is renewable, biodegradable, non-toxic, and possesses properties similar to diesel fuel. It may be made from both vegetable oil and animal fats. Oils and fats are essentially triglycerides made up of three long-chain fatty acids. Because of their increased viscosity, these oils cannot be utilized as fuel. Transesterification is the process by which triglycerides are transformed into esters in order to lower viscosity. From one molecule of fat/oil, three smaller molecules of ester and one molecule of glycerin are formed. Glycerin is removed as a byproduct, and the esters are referred to as biodiesel [1].

It is challenging to maintain worldwide biodiesel standards as per ASTM and EU criteria due to the availability of various waste fry frying oils and biodiesel fuels from various sources. The physical and chemical properties of biodiesel oil influence combustion and fuel injection. Because biodiesel fuel has greater cetane values than diesel fuel, it reduces ignition delays. Biodiesel has a greater viscosity and boiling temperature, which impact atomization, evaporation, and spray of the fuel, resulting in a longer combustion period and slower burning. Taking these considerations into account, biodiesel research should focus on sustainable and inexhaustible sources, while also considering the influence on engine performance and combustion factors, as well as exhaust pollution.[2].

2. Emissions from Biodiesel

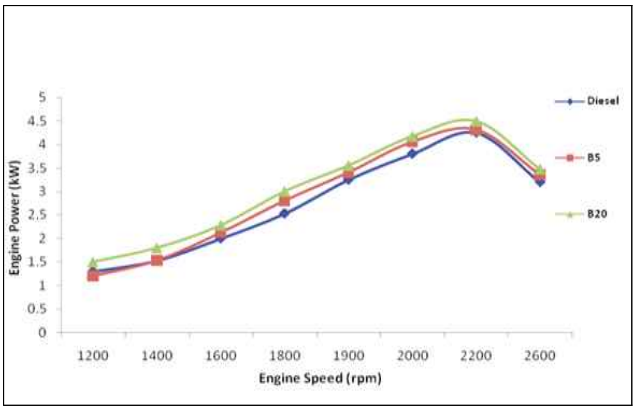
The high viscosity oil induced injector coking and polluted the lubricating oil, implying that the engine performance was lower while utilizing vegetable oil/diesel blend. The results of the testing using refined oil blends showed a significant improvement in performance. Unburned hydrocarbon emissions from the engine were found to be higher on all fuel blends than on diesel. The performance and emissions of several biodiesels reported by various authors were investigated in this study. When comparing all fuel blends to diesel, the emission of nitrogen oxides from the engine was found to be greater. Moreover, carbon monoxide, carbon dioxide, nitrogen oxides, sulphur oxides, and smoke are the principal emissions released by biodiesel [3].

3.Engine Performance

Engine performance with biodiesel and its mixes is influenced by air turbulence, air‐fuel mixture quality, fuel

injection pressure, ignition delay, fuel spray pattern, and fuel characteristics.

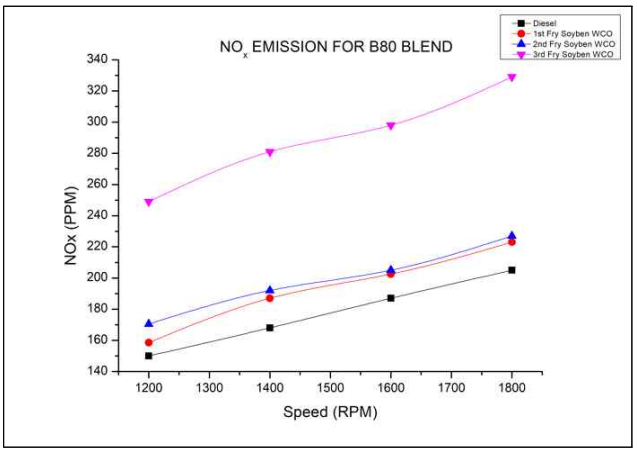
Figure 1 shows the engine power fluctuation as a function of engine speed at full load. The power grows with rising engine speed until it reaches a maximum value, as indicated in the graph, and then falls with increasing engine speed. At the same time, engine power is increasing in response to the addition of biodiesel to the blend. The power increases initially when the biodiesel content in the mix is increased, reaches a maximum value, and then drops as the biodiesel percentage is increased further. Despite the fact that adding biodiesel to diesel reduces its heating value, more power was produced in the tests.



[Fig. 1] Alteration of engine power in contrast to engine speed [4].

Figure 2 depicts NOx emissions as a function of speed, which ranges from 1200 to 1800 rpm. The NOx variation for diesel fuel was 150, 168, 187, and 205 ppm at engine speeds of 1200, 1400, 1600, and 1800 rpm, respectively. At 1200 rpm, B80 blend fuels 1FWCOB (fry waste cooking oil biodiesel), 2FWCOB, and 3FWCOB indicated 158.5, 170.5, and 249 ppm, respectively. At 1800 rpm, however, NOX levels rose to 223, 227, and 329 ppm for 1FWCOB, 2FWCOB, and 3FWCOB, respectively. Because of the high combustion temperature of biodiesel, biodiesel blends produced more NOx.

Because of the increased temperature of burning, oxygen and nitrogen atoms react quickly with each other. When the gasoline was changed from 1FWCOB to 3FWCOB, the NOx emissions rose. Due to the high density of the biodiesel fuel, the shorter ignition delay and greater volume of biodiesel undergoing premix combustion results in higher cylinder pressure and temperature. This leads in more fuel consumption for the same injection circumstances and more oxygen in the combustion chamber, resulting in NOx emissions.



[Fig. 2] Alteration of NOx emissions at different rpm. [2].

Another factor contributing to the increased NOx with increasing density (degree of unsaturation) tendency is that as the density of the biodiesel feedstock grows, so does its bulk modulus, resulting in advanced injection time. The creation of hydrocarbons during combustion, which results in the formation of NOx emissions, promotes the synthesis of fatty acids with double bond structure[2].

4.Conclusion

Because of the high combustion temperature of biodiesel, biodiesel blends emit more NOx. NOx emissions are lowest with 1FWCOB and rise with 3FWCOB. Smoke opacity in both mixes decreases with increasing speed and is lower than in pure diesel.

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