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HYDROCARBON POLLUTANT EMITTED FROM A DIESEL ENGINE FUELED WITH BIODIESEL AND DIESEL FUEL NO.2

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ABSTRACT

In this study, effects of biodiesel in fuel mixture (biodiesel and diesel fuel No.2) on hydrocarbon (HC) pollutant that emitted from a 4 cylinder water cooled diesel engine were studied. The data were collected by the standard experiments on a direct-injection diesel engine. Results showed that by the use of biodiesel, HC emissions decreases 30 to 85% than net diesel fuel No.2 Also results indicated that by increasing rpm of the engine emission of HC decreases continuously. On other hand HC emissions are higher at low engine loads.

Keywords: Biodiesel, Diesel, Engine, Hydrocarbon emission.

1. INTRODUCTION

Increasing global concern due to air pollution caused by internal combustion engines has generated much interest in the environmental friendly diesel fuels. In the last two decades, the researchers and manufacturers have provided major reductions in the exhaust emission levels of the diesel engines. However, increasing number of diesel vehicles will probably bring the same air pollution problem again in the next years. These forecasts have triggered various research studies in many countries to replace petroleum based diesel fuel (PBDF) with oxygenated fuels such as biodiesel, ethanol etc. Nowadays, some diesel engine manufacturers allow using neat biodiesel or its blends instead of PBDF. The guarantees only apply to biodiesel that fulfills the ASTM D 6751-03 for USA and EN 14214 for European Union.

Biofuels such as alcohols and biodiesel have been proposed as alternatives for diesel engines [1-3]. In particular, biodiesel has received wide attention as a replacement for diesel fuel because it is biodegradable, nontoxic and can significantly reduce toxic emissions and overall life cycle emission of CO_2 from the engine when burned as a fuel [4, 5]. Although the fuel properties of biodiesel show some variations when different feedstocks are used, it has higher cetane number, near-zero aromatic, and free sulphur compared to conventional diesel fuels.

Biodiesel can form blends with petroleum diesel fuel at any ratio and thus have the potential to partially, or even totally, replace diesel fuel in diesel engines.

There has been a lot of study on the regulated emission characteristics of diesel engines with biodiesel/diesel blends. For HC emissions of diesel engines, many studies have shown HC emissions of biodiesel fuels are lower than pure diesel fuel. Compared to petroleum diesel fuel, many studies found over a 50% mean reduction in HC emissions when using pure biodiesel [6, 7]. However, a few studies have shown that there are either increases or no significant differences in the HC emissions of diesel engines using biodiesel instead of diesel [8]. Puhan, et al. [9] reported that the HC emissions reduced average around 63% for biodiesel compared with diesel. Sahoo, et al. [10] compared the biodiesels from jatropha, karanja and polanga and their blends compared with diesel on a 3-cylinder WC tractor engine during 8 mode cycle tests, and reported that HC emissions for the pure biodiesels reduced by 20.73%, 20.64% and 6.75%, respectively. Several researches [11, 12] showed that there was no significant difference between biodiesel and diesel. And an amazing trend, which the THC emissions increased for biodiesel, was found in several literatures [8, 13, 14]. Effect of engine load on HC emissions for biodiesel was studied primarily, but there are inconsistent conclusions. Some authors [15, 16] showed experimentally the increase in HC emissions with load increase. Lertsathapornsuka, et al. [17] also reached the same conclusion, and the explanation given was due to high fuel consumption in high load. However, Tat, et al. [18] and Tan, et al. [19] found that the HC for biodiesel reduce as load increases. Also Canakci, et al. [20] reported that the decrease in HC emissions with engine speed increase due to higher injection pressure and better atomization ratio.

The paper's primary contribution is to study the effects of biodiesel percentage in fuel mixture (biodiesel and diesel fuel No.2) as fuel parameter and engine speed and engine load as engine operation parameters on changes in hydrocarbon emissions of a diesel engine. In addition, using diagrams, the interaction effects of process parameters on the parameters are analyzed and discussed.

2. MATERIALS AND METHODS

2.1. Biodiesel Preparation and Fuel Properties

Biodiesel from waste cooking oil from sunflower oil is a more economical source of the fuel, so biodiesel was produced from this source in the present investigation. In the present research, biodiesel was produced by transesterification process biofuels laboratories. The important properties of biodiesel and No. 2 diesel are shown in Table 1.

Table-1. Properties of diesel and biodiesel fuels used for present investigation

Property	Method	Units	Biodiesel	Diesel
Flash point	ASTM-D92	°C	150	61
Pour point	ASTM-D97	°C	-5	0
Cloud point	ASTM-D2500	°C	-1	3
Kinematical viscosity, 40°C	ASTM-D445	mm^2/s	4.3	4.15
Density	---------	Kg/m^3	875	830

2.2. Test Engine Experimental Setup and Procedure

The engine tests were carried out on a 4-cylinder, four-stroke, turbocharged, water cooled and naturally aspirated DI diesel engine. The engine speed was measured by a digital tachometer with a resolution of 1 rpm. The engine was allowed to run for a few times until the exhaust gas temperature, the cooling water temperature, the lubricating oil temperature, have attained steady-state values and then the data were recorded. The major specifications of the engine under the test are shown in Table 2.

Table-2. Specifications of the test engine.

Engine type	Diesel OM314
Cylinder number	4
Stroke(mm)	128
Bore(mm)	97
Compression ratio	16:1
Power (hp/rpm)	110/2800
Torque (Nm/rpm)	340/1800
Cooling system	Water cooled

3. ANALYSIS AND RESULTS

3.1. HC Emissions

The hydrocarbon (HC) emitted by diesel engines is a complex mixtures of unburned and partially burned hydrocarbon fuel components partitioned in the gaseous and liquid phases. The amount of HC in the exhaust gases depends on the engine's operating conditions, fuel properties, fuel-spray characteristics, and the interaction between fuel spray and air in the combustion chamber. The predicted HC amounts for different fuel blends and engine speeds are also shown in Figures 1 to 4. For the fuel blends, the HC amount in the exhaust was decreased with increasing the amount of biodiesel in the fuel blend. As can be understood from the percentages, the HC emission level decreased with the proportion of biodiesel in the blend. Probably, the main reason for the higher HC emissions for diesel fuel No.2 is the insufficient oxygen in the combustion region. On the other hand, the higher oxygen content of biodiesel in combustion region provided more complete combustion. This means that biodiesel in the fuel mixture increases the cetane number and oxygen content of the blend; that causes higher combustion efficiency and reduces the level of HC emission [20]. The main reason for reduced HC emissions at high engine speeds is the increased atomization. At the same time, high engine speeds cause the increased inlet air flow speed or turbulence. This enhances the effect of atomization of the fuel in the cylinder, makes the mixture more homogeneous, and reduces HC emission [20].

Fig-1. Effect of Percentage of biodiesel in fuel mixture and engine speed on brake torque at 25% engine load.

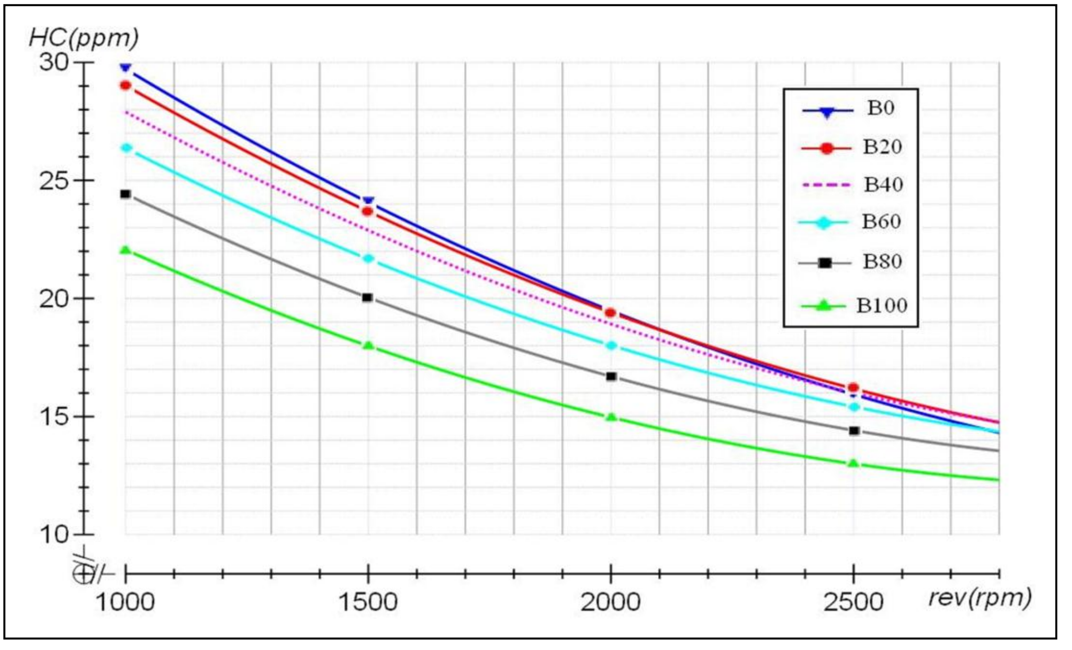


Fig-2. Effect of Percentage of biodiesel in fuel mixture and engine speed on brake torque at 50% engine load.

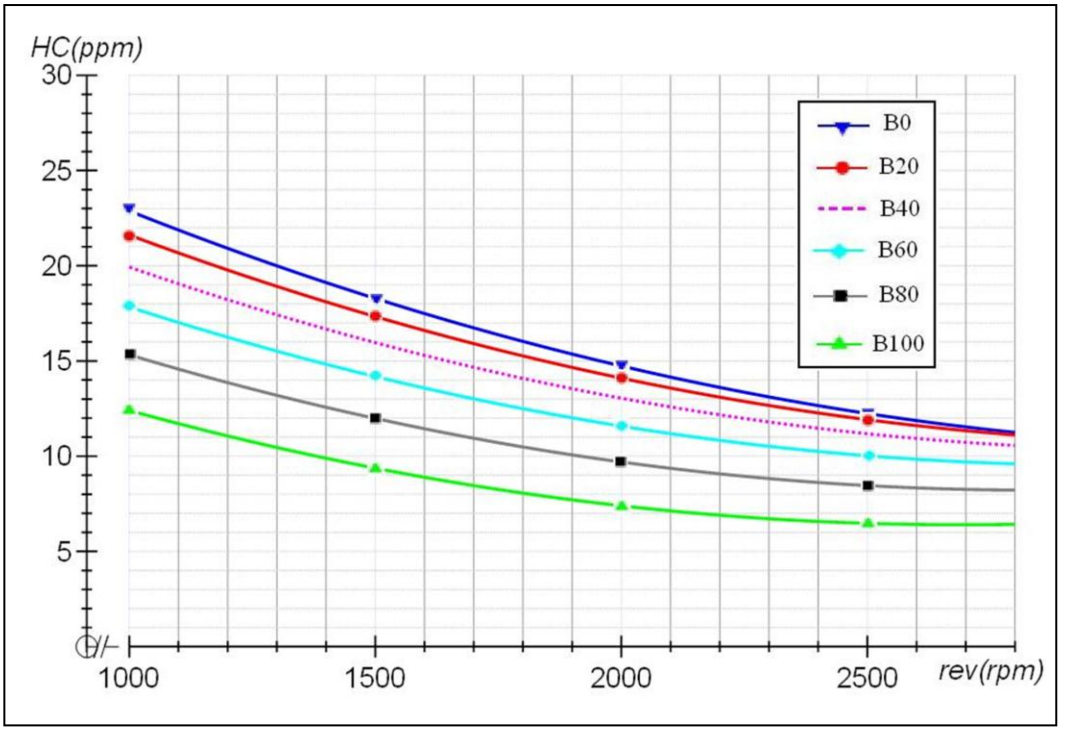


Fig-3. Effect of Percentage of biodiesel in fuel mixture and engine speed on brake torque at 75% engine load.

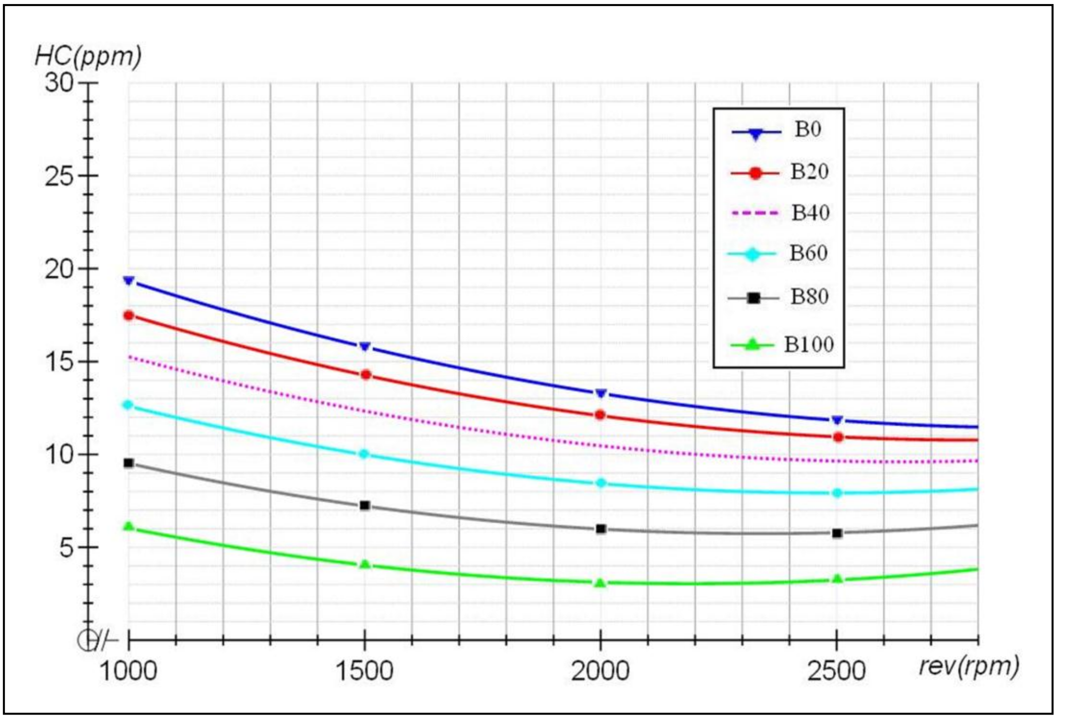
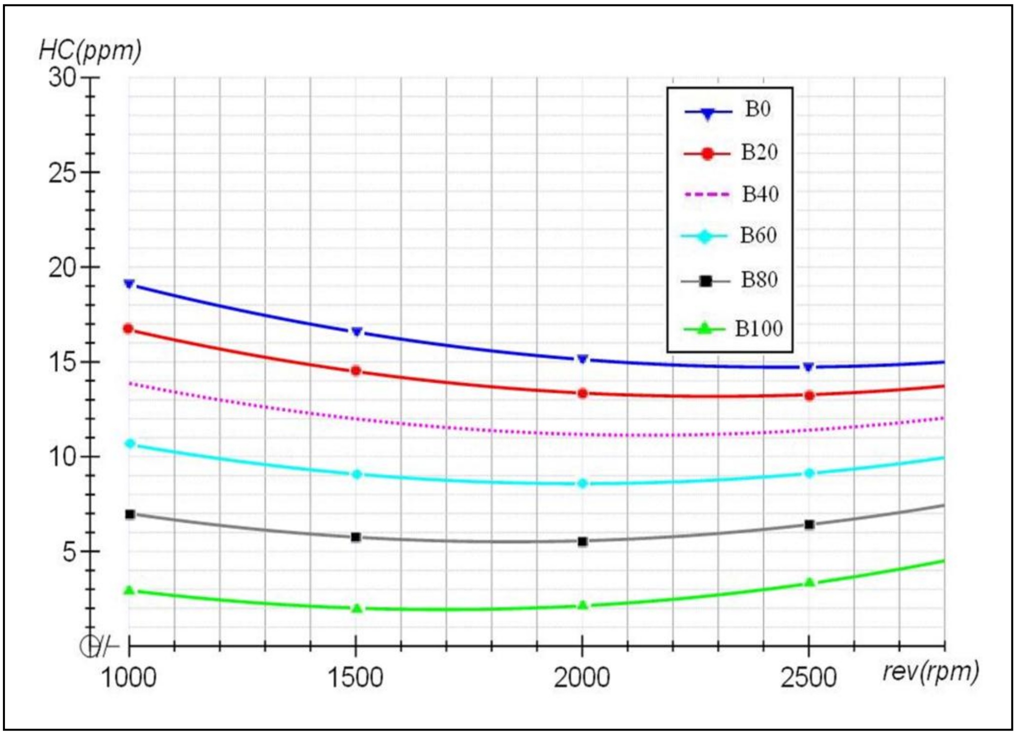


Fig-4. Effect of Percentage of biodiesel in fuel mixture and engine speed on brake torque at full engine load.



4. CONCLUSIONS

1- The HC emissions decrease 30 to 85% with the increase of biodiesel in the blends than HC emissions of net diesel No.2 fuel.

2- On the emissions, in general, HC emissions are higher at low engine loads.

3- These results are similar to those found in the literature and support that waste cooking oil methyl esters have similar properties with diesel fuel.

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