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Fuel and boiling Point analysis in mixing between ethanol with bio-diesel and diesel fuel

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Abstract. Global warming can be caused by pollution in the environment. Pollution comes from combustion from fossil fuels. Therefore, it is important to study some renewable energies for alternative fuels other than fossil fuels. Blending between ethanol to biodiesel and diesel fuel is one practical solution that can be applied. This research was conducted by making a sample of the fuel to be tested with a mixture of ethanol - biodiesel formula (10%, 25% and 35%) and for a mixture of ethanol - diesel fuel (10%, 25% and 35%). The fuel properties were tested such as viscosity, density, boiling fuel, and cetane index. The results show that the addition of ethanol to biodiesel and diesel fuel can produce better fuel properties.
Keywords: Ethanol, Biodiesel, Diesel Fuel, Fuel properties, Blending

1. Introduction

Biodiesel is one of the renewable energy sources for substitute fossil fuels, the combination of mixing ethanol with diesel fuel is one of the solutions to have environmentally friendly fuel. In this research ethanol is blended to biodiesel and diesel fuel. Many researchers have blended diesel fuel with another liquid to have better fuel properties such as jathropa oil [1], carberra Manghas [2], palm oil [3] , soybean [4] karanja oil, kerosene and many other liquids. However biodiesel from edible oil would have some production problems with food production needs. Like bioethanol food grade, it needs a long process and high cost. The advantages are that biodiesel and bioethanol can reduce emission in combustion through the fuel properties. Therefore, it is important to study fuel properties from ethanol blends with biodiesel and diesel fuel. Fuel properties such as density, cetane number, viscosity and IBP (initiated boiling point) are compared with variant blending formula ethanol biodiesel and ethanol fuel diesel (15%v, 25%v and 35%v ethanol).

2. Methodology

1.1. Material method of biodiesel and diesel fuel blend with ethanol

The biodiesel and diesel fuel were purchased from gas stations for regular public transportation. Ethanol was purchased from a chemical store. The variant formula can be seen at Table.1.

Table 1. Mixed formula of biodiesel ethanol & fuel diesel ethanol

Nomenclature	Ethano %v	Biodiesel %v	Diesel fuel %v
EB10	10	90	
EB25	25	75	
EB35	35	65	
EPD10	10		90
EPD25	25		75
EPD35	35		65

EB10 is a mixture of ethanol with biodiesel with a content of 10% ethanol and 95% biodiesel, EPD10 is mixture of ethanol with fuel diesel with a content of 10% ethanol 95% fuel diesel and also applies for other nomenclature.

1.2. Fuel properties analysis

In this study fuel properties such as Cetane number, viscosity, density and IBP were analyzed [10]. Cetane number was determined under ASTM D4737-10 with standard cetane number min. 48 [5]. The kinematic viscosity (40^{o}) was determined under ASTM D445-19a with standard number viscosity 2.0 - 4.5. The density (15^{o}) was analyzed based on ASTM D1298-12b with standard number density 810-850. The distillation recovery basis was analyzed based on ASTM D86-17. The fuel parameters from all mixed formulas analyzed and compared each other.

Table 2. Fuel properties all variant

Nomenclature	Unit	EB10	EB25	EB35	EPD10	EPD25	EPD35	Method
Viscosity	cSt	2.598	2.534	2.601	2.318	2.331	2.226	ASTM D455-19a
Density	kg/m3	847.2	841.0	835.0	821.1	819.1	818.0	ASTM D1298-12b
Cetane index		37	36.2	35.2	40.4	39.2	38.7	ASTM D4737-10
IBP (95 %v)	^{o}C	367	360	360	325	320	326	ASTM D86-17

3. Result & discussion

3. 1 Fuel Analysis

3.1.1 Kinematic viscosity

Fuel injection performance is affected by the viscosity value. Viscosity is a measure of the resistance to flow of a liquid due to friction of the liquid against other materials in the injection process. High viscosity causes a larger droplet size of the fuel liquid so evaporation does not occur and complicates the process of spraying fuel in the cylinder. From Figure 1 shows the viscosity decreases when ethanol increases into the biodiesel and fuel diesel. So it can be indicated ethanol makes viscosity lower for biodiesel and fuel diesel [6][7] but all numbers are still in range standard ASTM D445-19a.

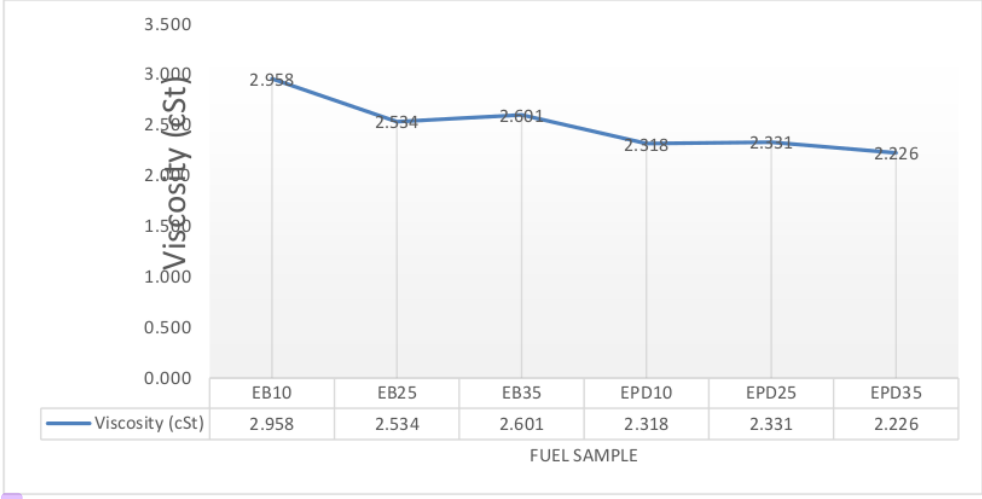

Figure 1. Viscosity in various blends.

3.1.2 Cetane number

The cetane number indicates the fuel's ability to self-ignition (autoignition), the cetane number is also an index which is commonly used for diesel motor fuel for indicates the degree of sensitivity to detonation. The higher the cetane number indicates that the fuel can ignites at a relatively low temperature, and vice versa if the number low cetane indicates the new fuel can be ignited at relatively high temperature. As Figure 2 shows, ethanol makes cetane numbers decrease [8]from EB10 to EB35 drop from 37 to 35.2. It happens to diesel fuel and biodiesel blend with ethanol. The cetane number below standar ASTM D4737-10 with min 48 [5].

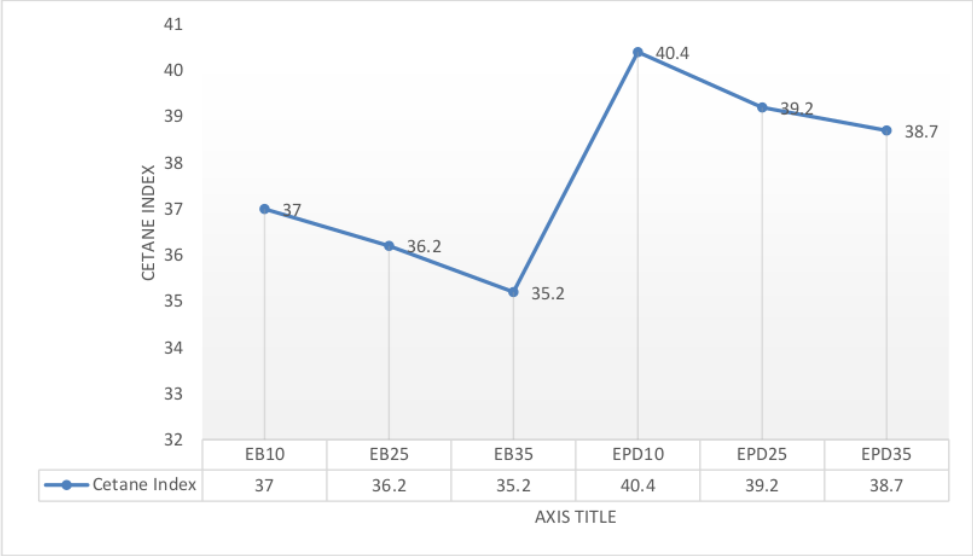

Figure 2. Cetane number in various blends.

3.1.3 Density

The air–fuel ratio and energy content within the combustion chamber are influenced by fuel density. So density it's important for combustion process. ITherefore, density is important for the combustion process. In general, density in biodiesel is slightly higher than diesel fuel, and increasing the ethanol blend level can decrease the density of the mixture [9].

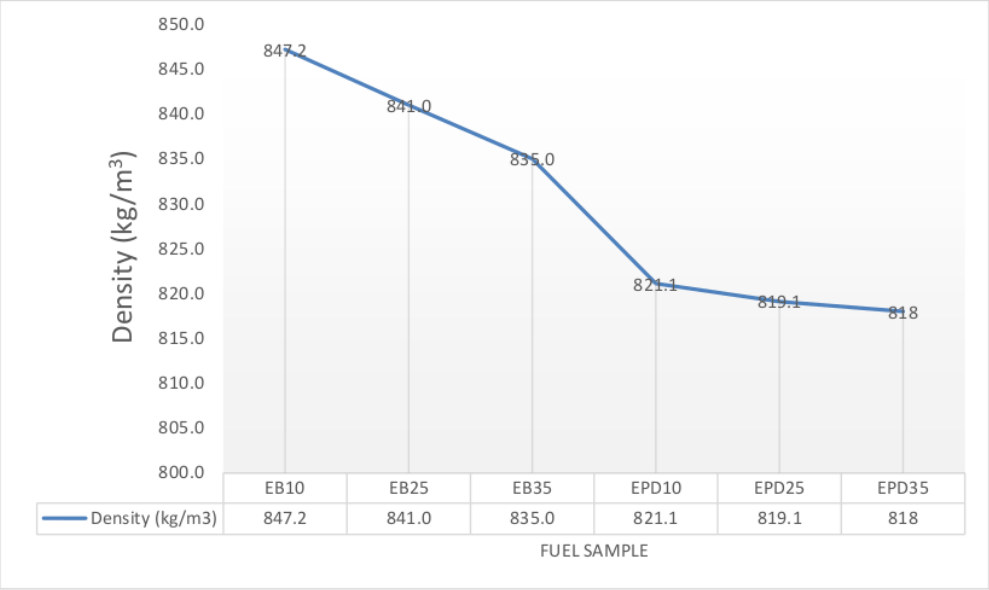

Figure 3. Density in various blends.

3.1.4 IBP (initial boiling point)

Initial boiling point of a fraction is typically lower than the true end point of the next lightest fraction (they overlap) because they are complex mixtures of different hydrocarbons [7]. Figure 4 shows boiling point measurement for several mixing variations. Boiling point decreases with the addition of ethanol. EB10 boiling point is at 367 °C, while EB25 down to 360 °C but EB35 have the same boiling point with EB25 of 360 °C. EPD10 boiling point is at 325 °C and EPD25 is down to 320 °C. but EPD35 boiling point increases to 326 °C. However boiling point decreases can be indicated that it is not needed high temperature to cause a burning fuel [6][8].

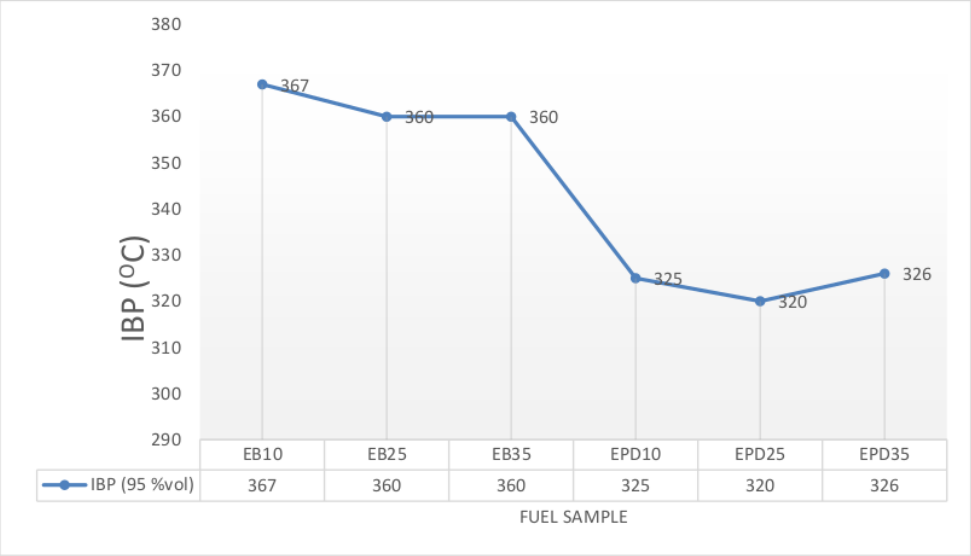

Figure 4. IBP (95 %v) in various blends.

4. Conclusion

1. Addition of ethanol can reduce dynamic viscosity, kinematic viscosity, density, boiling point, on diesel fuel.
2. The IBP of EB25 & EB 35 have the same value (360), but the IBP value for EPD25 & EPD35 has increase curve trendline.
3. The Viscosity of all sample are meet of ASTM D445-19a (2.0 - 4.5).
4. The cetane index for all sample are not meet of ASTM D4737-10 (Reapproved 2016) (min 48).
5. The density curve for all sample has reduce trendline as ethanol blended to biodiesel and diesel fuel, and the value of density for all sample meet standardization ASTM D1298-12b

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