The Role of Hydrogen Bonds Of The Azeotropic Hydrous Ethanol Fuel Composition To The Exhaust Emissions

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Abstract. In this study observed the role of hydrogen bonding to the composition of exhaust emissions which is produced hydrous ethanol fuel (95.5% v). Testing is done by using single cylinder four stroke motor engine. The composition of exhaust gas emissions is tested using exhaust gas analyzer on lean and stoichiometry mixer. The exhaust emissions produced by anhydrous ethanol were also tested. The composition of emissions produced by that two fuels is compared. The results showed CO emissions levels produced by hydrous ethanol are slightly higher than anhydrous ethanol in stoichiometric mixtures. But the composition of CO hydrous ethanol emissions is lower in the lean mix. If lean the mixer the different in the composition of emissions is increasing. On hydrous ethanol emission CO2 content little bit lower on the stoichiometric mixer and higher on the lean mixture. Exhaust emissions of ethanol fuel also produce O2. O2 hydrous ethanol emissions is higher than anhydrous ethanol fuel.

1. Introduction
The depletion of petroleum reserves and the tightness of emissions standards in recent years has encouraged the use of alternative renewable fuels for use on gasolin engines. Ethanol has been studied intensively and is considered a potential alternative fuel burner used in gasoline engines [1],[2],[3],[4]. Researchers have been researching performance and emissions gasoline engine fueled by mixture of ethanol and gasoline. The various comparative mixtures their applications in flex-fuel vehicles.

According to the results of the study [2],[3], the addition of ethanol increases oxygen into the mixture, improving combustion efficiency and reducing hydrocarbons (HC) and carbon monoxide (CO) emissions. Gasoline and ethanol can blend perfectly because of the short molecular structure and contain polar fractions of OH radicals and non-polar fractions on CH radicals, and leads to more complete combustion [5]. However, due to the stronger hydrophilicity of ethanol, the fuel mixture is readily mixed with water in the air, resulting in higher mix stability and higher costs in storage and transport. In addition, anhydrous ethanol production has high energy consumption, especially in the dehydration process. Currently hydrous ethanol is promoted to additives on gasoline fuel to save energy consumption in dehydration steps. Blending of gasoline with hydrous ethanol is becoming more popular due to energy conservation and reduction of harmful emission.

[6] doing hydrous ethanol testing on a 1000cc engine. The fuel used is ethanol with water content of 4.46% v. Ethanol (CH3CH2OH) is more reactive than hydrocarbon fuels such as gasoline. Because the molecular structure of alcohol shows the polar fraction due to the hydroxyl radical and the non-polar fraction in the carbon chain results in why ethanol can dissolve in both types of gasoline (non
polar) and water (polar) liquids. Due to short carbon chains, the polar ethanol fraction properties overcome the non polar properties. The formation of hydrogen bonds in ethanol molecules results in higher boiling temperatures compared to gasoline. Ethanol is less toxic than other methanol-alcohols used as fuel. Simple molecular structure of ethanol makes it very suitable for gasoline motors. A high octane number indicates a match against a higher compression ratio. The use of hydrous ethanol reduces CO and HC emissions but increases CO2 and NOx levels. [4],[6],[7]

[8] tested the use of ethanol hydrous as fuel on homogeneous compression-balancing machine (HCCI). The tested fuel is ethanol with a fraction composition of 100% - 70% with a 5% interval or a water content of 0% v-30% v. The purpose of this study is to determine the ability of HCCI engine equipped with exhaust heat recovery. By using ethanol fuel, the results showed that: 1). High output power, noise and low nitrogen oxide emissions occur with high pressure pressure, equivalent to high ratios, and delayed burning time. 2). HCCI engines can use ethanol fuel up to 20% v water as long as the operating conditions of fuel evaporation can be maintained. 3). The use of hydrous ethanol can eliminate the major energy needs for the drying process. 4). The use of hydrocarbon ethanol tends to accelerate the duration of combustion so that burning needs to be delayed

[9] conduct research on hydrous ethanol. According to [9] hydrous ethanol is ethanol with a composition of 95.1-96% v. The objective of the research was to know the effect of addition of hydrous ethanol (95.7% v) on reference fuel that is mixture of 25% v anhydrous ethanol with 75% v gasoline (E25). Hydrous ethanol is an azeotrope with evaporative temperature of 78.1 °C with a water content of 4.4% v and can not be further purified by distillation method. The same thing is also said by [10],[11]. It also becomes a record of H100 that has a higher capability in all other operating conditions. In general, CO emissions are reduced by the addition of hydrocarbon ethanol, which results from oxygen levels of ethanol that follow the oxidation reaction to CO2. With the addition of hydrous ethanol the tendency of NOx emission reduction occurs at rpm 1500 and 2250. At high speed (4500 rpm), NOx increases. This is the next researcher's note to take a look at the hydrous ethanol mixture between H0 and H50 to better understand energy efficiency, CO2 and NOx emissions.

[12] tested the stability of the mixture between gasoline-ethanol and water. He was Tested at three different temperatures (2°C; 10°C and 20°C), three moisture content, three gasoline compositions and three additives. Mixed 60:40 petrol-ethanol plus 10% hydrous ethanol (E40h), used as a stationary automotive fuel engine. Measurement of exhaust emissions (NOx, NO, HC, CO2, CO, O2), Power, fuel consumption and other parameters were observed and compared with gasoline (E0) and ethanol fuel 60:40 (E40). Toyota VV Ti 997 cc gasoline engine without catalytic converter, used over and over against all three types of fuel without modification. The results show an impressive reduction of NOx emissions against ethanol blends and other changes are less significant to emissions yields. Also the fuel consumption of mass fractions was significantly higher for ethanol mixtures and ethanol anhydrous because of low ethanol heating values.

[13] research results found the use of hydrous bioethanol in lean mixture better than the use of anhydrous bioethanol. The %HC produced by hydrous bioethanol is less than anhydrous bioethanol. The use of hydrous bioethanol causes faster burning mass fractions and lower combustion temperatures when compared with anhydrous bioethanol in lean mixtures.

In this study tested the composition of exhaust emissions produced by hydrous ethanol fuel at azeotropic composition with emissions of gas produced by anhydrous ethanol fuel.

2. Experiment set-up and Prosedur
Anhydrous ethanol used was absolute ethanol for analysis from Merck, then diluted in analytical laboratory to hydrous ethanol (95.5% v). Emission composition testing is done by experimental research, which is testing the composition of emissions produced by anhydrous and hydrous ethanol. The testing of CO, CO2 and O2 emission composition using Automotive Emission Analyzer emission test apparatus, CG 450 model. The experimental set-up see in fig. 1
3. Results and Discussion

3.1 CO Emission
In AFR 9.2 or lamda (λ) = 1.0 (stoichiometric condition) CO content for ethanol fuel 95.5% v is 7.46% v while for ethanol fuel 99.7% v is 7.32% v. The higher CO composition in hydrous ethanol caused replacement of main jet with a larger size so the fuel does not evaporate completely due to conventional modified channel changes. The hydrogen bonding of hydrous ethanol causes a strong bond between the fuel molecules so that the evaporation temperature becomes higher. Due to higher temperature evaporation is the fuel that enters into the combustion chamber is not an ion but droplet-shaped that causes fuel hard to burn.

In the burning process the outer portion of the hydrous ethanol molecule burns first, while the water molecule that serves as the center of the molecule does not fully react to produce CO emissions. The core of the fuel is H2O not burning perfect so that the manifold exit is still O2 emission. Low fuel temperature into the combustion chamber causes the fuel has not decomposed into a radical resulting in less than perfect combustion so that the remaining O2 gas.

On the lean mixer AFR>10 or (λ)> 1.0 CO content for ethanol fuel 95.5% v lower than CO content of anhydrous ethanol fuel, the results of this study are in accordance with [8]. This is due to the large volume of air in the combustion process so that CO emissions change into CO2. Fig 2.

Figure 2. CO emission composition

Figure 3 shows the composition of CO emissions produced by hydrous ethanol 95.5% v in the lean mixture. The results of the current study showed similar trends with the results of the previous study [13]. The results of the current study showed in higher CO emissions than the previous study [13]. This is due to the non-standard use of the main jet on the carburetor resulting an incomplete atomization process which yield to an incomplete combustion as well.
Figure 3. Comparison CO emission composition

3.2 CO₂ Emission
Figure 4 shows the CO₂ composition for hydrous ethanol in the stoichiometric composition was 8.3% v while for anhydrous ethanol was 8.9% v. The composition of CO₂ is less due to incomplete combustion as a result of fuel coming into the combustion chamber is still droplet-shaped. Low combustion temperatures as a result of water content in fuels that have a heating value are higher than anhydrous ethanol fuels. Another thing that causes less combustion is the replacement of main jet carburetor with main jet modification, to increase the volume of flow. That implies in the lack of perfect process of atomization.

The leaner the air-fuel mixture is, the higher the hydrous ethanol fuel CO₂ emissions. This is due to the abundance of air so that the fuel gets enough air so that there is more complete combustion.

Figure 4. CO₂ emission composition

3.3 O₂ Emission
The presence of O₂ in the combustion process results as an indication of the presence of more air in the combustion process. In the combustion process of ethanol fuel there is emission of O₂. On the other hand also occurs where CO should be between CO and O₂ to form CO₂. This signifies the burning process so rapidly that there is no time between O₂ and CO to react to be CO₂ form. In this case it is required to adjust the timing ignition process of the fuel. Fig 5.
The presence of O₂ emissions indicates that hydrous ethanol fuel with a centralized molecule, with water as the center of the molecule has not burned out in the combustion process. Fuel that has a circular structure burned on the outside only. But water as the core of the fuel just breaks down into H₂ and O₂ and has not burned yet. This unburned H₂ and O₂ will increase HC and O₂ emissions. To solve this need to be modified main jet so that fuel into the combustion chamber is already a radical so easily to burn.

Figure 5. O₂ emission composition

4. Conclusion
Hydrous ethanol produces exhaust emissions on stoichiometric mixture (AFR) 9.2 is 7.46 (%) for CO, 255.75 ppm for HC, 8.32 (%) for CO2 and 7.1 (%) for O2. While in the lean mixture at 10.2 consecutive AFR for CO, HC, CO2 and O2 were 5.21; 220.8; 9.64; And 7.6.

While for the fuel of hydrous ethanol produce emission of exhaust gas in the stoichiometric mixture (AFR) 9.2 was 7.32 (%) for CO, 105 ppm for HC, 8.9 (%) for CO2 and 6.58 (%) for O2. Whereas in lean mixture at AFR 10.2 for CO, HC, CO2 and O2 respectively 5.27; 92.2; 9.3; And 7.23.

Overall, in this study, the incomplete combustion of hydrous ethanol fuel use in stoichiometric mixture was due to the replacement of larger diameter main jet (done with modification) to obtain a larger fuel intake to obtain stoichiometric mixtures, But the result of the atomization with the modified main jet was not good this is due to the shape of the channel is not in the form of nozzles.

5. References
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