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Tim Penyunting:

Ketua : Akhmad Aminuddin Bama
Anggota : H. Melki
Hasanudin
Isnaini
Yulia Resti
Maeriska Verawaty
Mardiyanto

Fakultas Matematika dan Ilmu Pengetahuan Alam
Universitas Sriwijaya
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The Effect of n-Butanol Addittion on Research Octane Number and Water Content of Gasohol

PRA DIAN MARIADI[1)] AND IAN KURNIAWAN[2)]

[1,2)]Lecture of Technology Medic Laboratory Of STIKes Perdhaki Charitas Palembang, [2)]Post Graduate Student of Ph.D Environmental Science Of Sriwijaya University; Email 1): pradian_dian@yahoo.co.id, 2): iankurniawan019@gmail.com

Abstract: It has been conducted the research about the effects of butanol addition on thel characteristics of gasohol. The aims of this study are to determine the stability of ethanol and n-butanol in gasoline, to know the characteristics of gasohol and after the addition of butanol and compare the characteristics of gasohol and after the addition of butanol. Mixture of of butanol on gasohol were characterized by using ASTM method. The parameters measured are water content (ASTM D-1995), Research Octane Number (RON) (ASTM D-2699), Reid Vapor Pressure (RVP) (ASTM D-323) and Copper Strip Corrosion test (ASTM D-130). The result of this research shows that n-butanol 99,9% and ethanol 99,9% are miscible in gasoline. The characterization result shows that the addition of butanol will decrease water content, reid vapor pressure, research octane number (RON), G-80%/E-10%/B-10% mixture is the best characteristic of gasohol with ron 93. The result of all the parameters and characterization meets the ASTM standard of gasoline.

Keyword: gasoline, gasohol, ethanol, n-butanol

1 INTRODUCTION

In the recent years, the trend of energy consumption has been increasing continuously. Alcohol, especially ethanol, is the new challenge candidate in alternative fuel because it can be produced from many source of biomass and used as the renewable energy. In addition, the raw materials for ethanol production, cassava and sugarcane, are also the main economic vegetation. Although the lower heating value of alcohols is lower than that of gasoline, alcohols release a little more heat than gasoline under the same equivalence ratio. Moreover, a high octane number will allow an increase in high compression ratio; thus, an engine fueled with ethanol will have higher power output and better thermal efficiency than gasoline [1].

Ethanol was firstly suggested as an automotive fuel in USA in the 1930s, but widely used only after 1970. Nowadays, ethanol is used as fuel, mainly in Brazil or as a gasoline additive for octane enhancement and better combustion, mainly in USA and Canada. As gasoline price increases and pollutant emissions restrictions become more stringent, ethanol could be given more attention as a renewable fuel or gasoline additive. Although ethanol addition into fuel may contribute to a reduction in hydrocarbon and carbon monoxide emissions, higher ethanol and acetaldehyde emissions could be emitted [2].

Gasohol is a mixture of one part ethanol (commonly known as grain alcohol" or beverage alcohol) and nine parts unleaded gasoline. The ethanol can be produced from several types of plant material using technology that is currently available and in most cases gasohol can be substituted for gasoline with only minor changes in mileage and performance.

The use of ethanol fuel in country will decrease the dependent on gasoline and crude oil supply from other country and simultaneously control the global gasoline price. Therefore, ethanol fuel will simulate country to change the agriculture trend to plant more sugarcane to produce ethanol. In teh other words, the easiest way to produce ethanol is by fermentation of sugar. The Use of ethanol fuel will decrease the green house gases such as hydrocarbon (HC), carbon monoxide (CO) and nitrogen oxide (NOx). This poisonous gas reduces in gasohol usage because the increase in octane number in the blend increase oxyen contain in fules leads to better emission. Using gasohol as fuel in natural-aspirated engine cause increases in fuel economy due to some gasohol properties [3].

Fuel additives are very important because many of these additives can be added to fuel in order to improve its efficiency and its performance. One of the most important additives to improve fuel performance is oxygenates (oxygen containing organic compounds). Several oxygenates have been used as fuel additives, such as methanol, ethanol, buthanol, Iso propyl alcohol and methyl tertiary butyl ether (MTBE). The 20% ethanol fuel blend gives the best result of the engine performance and exhaust emissions [4].

Although ethanol has higher octane rating and cleaner emissions than gasoline, but ethanol has low heating value. Heating value of ethanol is lower than the gasoline, it will have impact on engine power and the power of ethanol-fueled engine will be lower than its gasoline-engine vehicles. Therefore, it is necessary to add the compound which has higher heating value than ethanol to increase the heating value of ethanol-gasoline mixtures [5].

n-butanol overcomes three deficiencies of ethanol. N-butanol has a higher energy content, n-butanol-gasoline blends do not separate the presence of water and it can be blended with gasoline in any percentage. Moreover, both n-butanol and ethanol can be fermented from some feedstock which include the sugar and starch crops and lignocellulosic fermentation from wood and crops residues [6].

Table 1.properties of gasoline, ethanol and n-butanol [7,8,9]

Properties	Gasoline	Ethanol	n-butanol
Sp. Gravity, 60/60 F	0.720-0.775	0.794	0.814
Heating value (MJ/kg)	32,2-32,9	21,1-21,7	26,9-27
RON	88	129	96
MON	85	102	78
Oxygen (% w/w)	2.7	34.7	21,6
Water solubility	< 0.01	100	9.1

n-butanol is a viable alternative to ethanol and offers several benefit over ethanol. Ethanol is fully miscible in water and thus cannot be transported using existing fuel supply pipelines whereas n-butanol is less corrosive than ethanol and less prone to water contamination, allowing it to be transported using existing fuel supply pipelines. Moreover, n-butanol has heating value of 27MJ/kg compared 21.7 MJ/kg for ethanol wihich is much closer to 32.9 MJ/kg of gasoline. This combined with the higher stoichiometric air-fuel ratio, allow higher blending levels n-butanol in gasoline than ethanol without changing regulations, engine control system and distribution networks. In addition, n-butanol has a lower latent heat of vaporization than ethanol which can reduce issues with fuel atomization and combustion during cold start conditions typical of alcohol.

2 MATERIALS AND METHOD

In doing research of the testing ethanol and n-butanol on gasoline fuels, this would require a study design concept that can include all stages of the process to be done to achieve the purposes of research. The equipment of this research are glass equipment, shyringe and the bottle. Each gasoline from pump station were mixed to get representatif of sample for blending with etanol n-butanol. All of sample kept in a bottle 1000 ml. Splashing the etanol-n-butanol from the bottom of the bottle and shake well. (see figure 1) The blending ratio of ethanol-n-butanol on gasoline follow table 1 below. Blending was done with 1000 rpm as long 10 minutes.After splash each sample was kept motionless in a laboratory at room temperature (30°C) under atmospheric pressure.

Table 1. Ratio of fuel stability

No	Gasoline (%)	Ethanol (%)	N-butanol (%)	Kode
1	90	10	0	G-90/E-10/B-0
2	90	5	5	G-90/E-5/B-5
3	90	0	10	G-90/E-0/B-10
4	85	15	0	G-85/E-15/B-0
5	85	10	5	G-85/E-10/B-5

6	85	5	10	G-85/E-5/B-10
7	85	0	15	G-90/E-0/B-15
8	80	15	5	G-80/E-15/B-5
9	80	10	10	G-80/E-10/B-10
10	80	5	15	G-80/E-5/B-15

Stability Observation

Blending of n-butanol-ethanol on gasohol observed for three days at room temperature under atmospheric pressure. The observation include the haze, bubble or layer in mixture. Each sample observed in covered bottle to reduce evaporation of sample.

Characterization of gasoline, ethanol-n-butanol blending with Gasoline.

Testing the characteristic of the fuel gasoline, then blending ethanol-buthanol blends with gasoline that consist of water content ASTM D-1995, octane number ASTM D-2699, Reid vapor Pressure (RVP) (ASTM D-323) and Copper Strip Corrosion Test (ASTM-130).

3 RESULTS AND DISCUSSIONS

Stability test

Good quality of gasoline should be stable almost at any storage condition. Such storage should be in an airtight container to prevent oxidation and water mixing. Solubility and stability tests has been performed in ethanol-n-butanol in gasoline by looking at blending ethanol-n-butanol with gasoline, through visual observation (see haze, bubble and layer of mixture) until 3 days. Solubility observations conducted until the addition 20 % alcohol (ethanol-n-butanol) because the use gasohol fuel engine without modification, the maximum percentage of blending alcohol in gasoline is as much as 20% [4].

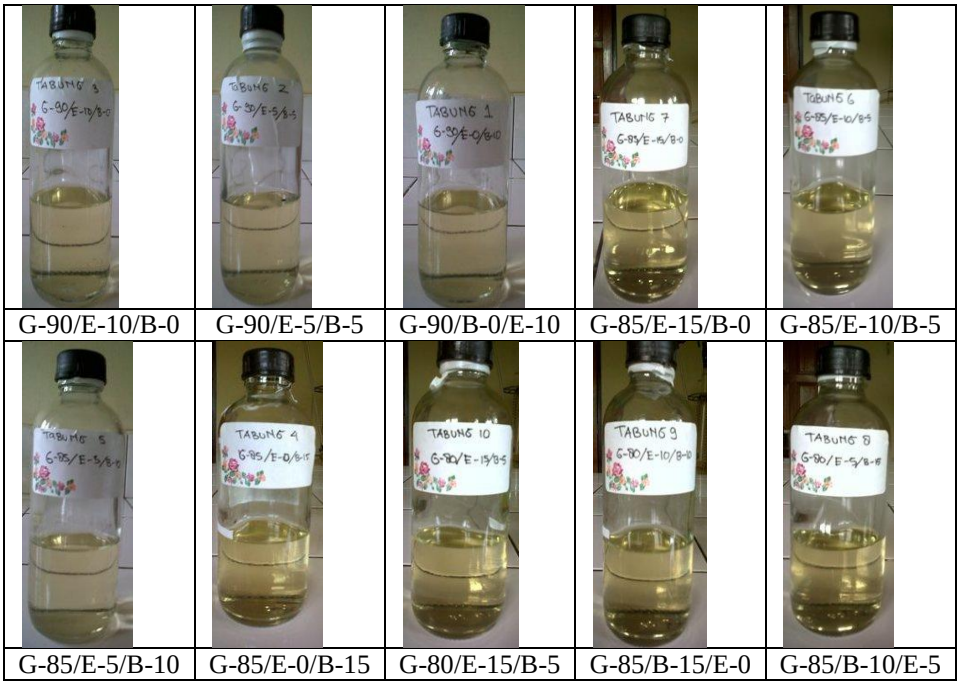


Figure 1. n-butanol-etanol in gasoline after three days blending.

From the observation of mixture of ethanol-n-butanol in gasoline create one phase mixture because using ethanol and n-butanol 99,5% [10]. After 3 days observation, etanol-n-butanol on gasoline create one phase solutions. Judging from VSEPR theory, Ethanol may partially miscible in gasoline because of the van der Waals bonding between ethanol and gasoline molecules by dipole force induction.

Ethanol is a polar molecule will induce the gasoline molecules that are non-polar so that the gas will be formed dipole molecules and molecules involved in an interaction between ethanol and gasoline.

The Effect of n-butanol Addition on Water Content of Gasohol

Measurement of water content aims to find out how much water is contained in the gasoline with ethanol-n-butanol. The presence of water can cause a decrease in the quality of a fuel because it can make heating value decrease, and requires a certain amount of heat for evaporation, disturb the combustion process and increase the volume of waste gas. Results of water content analysis for ethanol-n-butanol in gasoline presented in Figure 2.

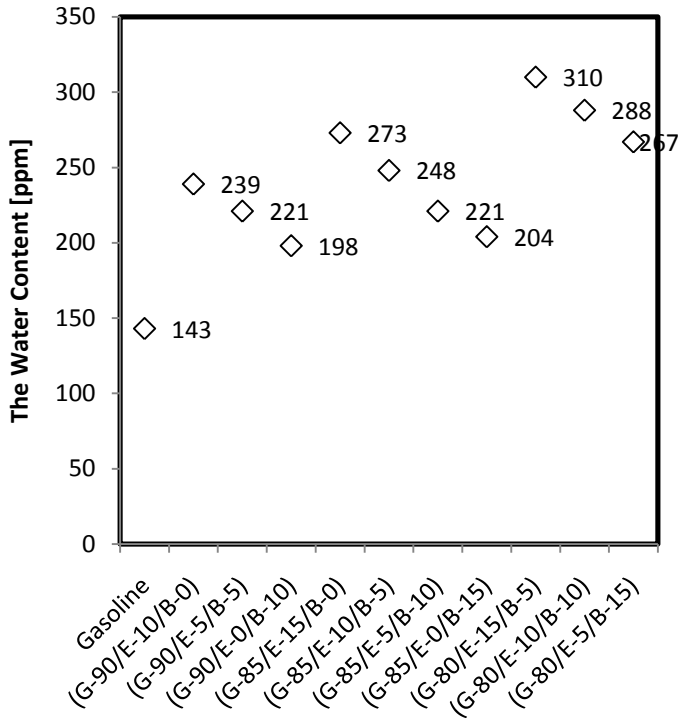


Figure 2. The effect of n-butanol addition on Water Content of gasohol

Based on figure , the water content decrease with the addition of n-butanol for each mixture. The decerasing of water content cause the hygroscopic properties of n-butanol lower than ethanol. Lower water content can reduce corrosion in the combustion chamber. Within increasing of percentage of butanol added to gasohol, the hygroscopic nature mixture decrease so that water content in the mixture decrease

The Effect of n-butanol addition on Research Octane Number (RON) of Gasohol

Measurement Research Octane Number (RON) aims to find out how big a knock that can produced from the combustion of a fuel. The knock in engine due to incomplete combustion, which caused by not precise comparison of fuel vapor and air that is not balanced. This will cause not all the fuel burned in the engine. Unburned fuel result in uneven heat and caused the engine crust. Incomplete combustion will cause high pressure and heat, resulting in loss of power, fuel wastage and damage the engine. The quality motor gasoline by the knock from combustion can be seen in the octane number. The occurrence of a knock in engine due to the fuel not meets octane number requirement. The greater the octane number of the knock produced fewer. The measurement results of Research Octane Number (RON) for ethanol-n-butanol in gasoline can be seen in 3.

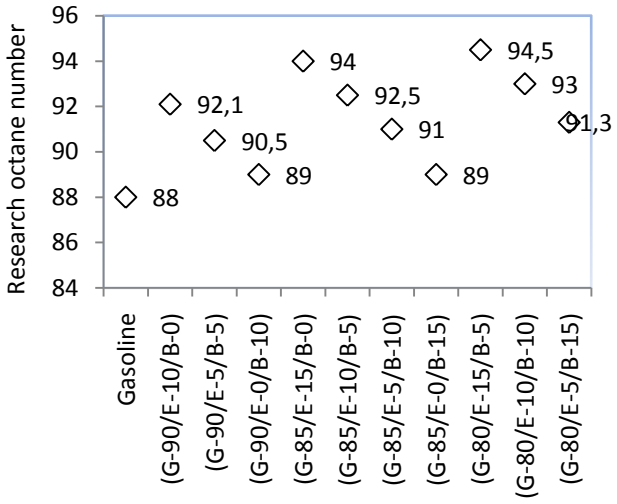


Figure 3. The effect of n-butanol addition on Research Octane Number of gasohol

Figure 7 show that with higher percentage of Ethanol were added to the gasoline, octane value is increases. This is because the Ethanol is an oxygenate compound that has an octane number greater than gasoline, so that with the increasing number of ethanol were added to the gasohol, the RON of the mixture will also increase. ethanol has internal oxygen in the structure of compounds, so that the ethanol is able to provide oxygen in the combustion process. Therefore, combustion occur perfectly and knock effect can be reduced. It is can be indicated from the RON value of the mixture.

The Effect of n-butanol Addition on The Reid Vapor Pressure (RVP) of Gasohol

Measurement Reid Vapor Pressure method aims to measure the volatility of gasoline or fuel. The nature of evaporation has an important influence in the operation of the machine. The excessive volatility result in what known as "vapor lock" where combustion fails to occur, because the liquid fuel has changed to gasoes fuel in the fuel lines, rendering the fuel pump, ineffective and straving the angine fuel. Conversely do not be so easily evaporate, causing vapor lock and the formation of ice grains in the carburetor, whereas if its spread is difficult to evaporate will cause imbalance in the cylinder, the engine difficult to start up. This will cause carbon deposits and lubricating oil causes dilution. Figure 4 shows the relationship between the compositions of the mixture with a value of RVP.

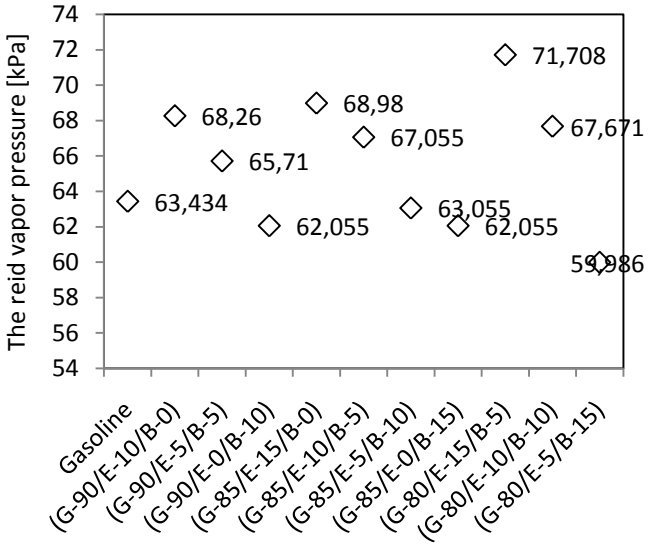


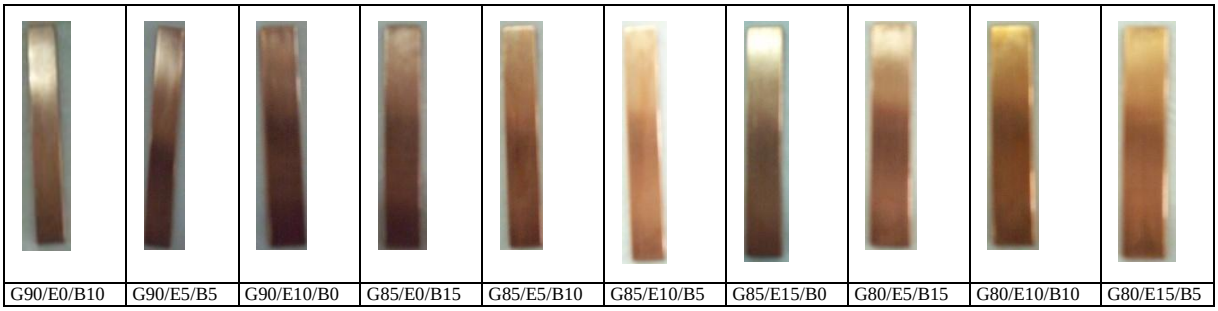
Figure 4. The effect of n-butanol addition on Reid Vapor Pressure of gasohol

From the graph above shows that an decrease in RVP after the n-butanol but increase after addition ethanol. n-butanol has lower vapor pressure than ethanol. Decrease RVP showed that the vapor pressure of the mixture decreased. Reid vapor pressure data for G-80/E-15/B-5 was over the limit the reid vapor pressure standart of gasoline. That is the nature of the evaporation of this mixture will reduce. This is to be expected from this study because one of the problems in the blending of ethanol is increasing pressure after the addition of ethanol vapor mixture, the increase in vapor pressure can cause the fuel to evaporate too easily result can lead to vapor lock and the formation of grains of ice in the carburetor. With the decrease of vapor pressure from the fuel is expected that the results of this study can be obtained by a state where the fuel mixture with air that is ideal to ensure complete combustion in the combustion chamber. In addition, this vapor pressure drop can reduce evaporative emissions of smog-forming hydrocarbons from gasoline.

The Effect of n-butanol addition on The Copper Strip Corrosion Test of Gasohol

The copper strip corrosion test covers the detection of the corrosiveness of the fuel on copper. This test is base on the effect of the test sample on the polished copper strip. The polished copper strip immersed in a specific volume of the sample being tested, and heated under conditions of temperatures of 122 ° F as long 3 hours. At the end of heating period, the copper strip removed and washed. The color and tarnish levels are assessed against the corrosion standards According to ASTM D-130. Figure 6. shows copper strip corrosion test results of tests to determine grade level of gasoline corrosiveness each mixture of ethanol-n-butanol in gasoline.

Figure 5. Copper Strip Corrosion Standard



G90/E0/B10	G90/E5/B5	G90/E10/B0	G85/E0/B15	G85/E5/B10	G85/E10/B5	G85/E15/B0	G80/E5/B15	G80/E10/B10	G80/E15/B5

Figure. 6 Copper Strip Corrosion of Ethanol-n-butanol in gasoline

From the picture 6, shows that the Copper strip Corrosion test results showed that copper strip of gasoline, each mixture give the same color (Sligh Tarnish) and they are in class Ia. This indicates that all the copper strip of ethanol-n-butanol in gasoline almost same as a freshly polished strip which showed that low levels of corrosiveness

4 CONCLUSIONS

Accroding to the result and discussion of this study, the conclusion can be summerized as follow :

1. Each mixture of butanol on gasohol create no separation phase, haze and bubble.
2. The result of all the parameters and characterization of ethanol-n-butanol in gasoline meets the ASTM standard of gasoline.
3. The addition of n-butanol on gasohol will reduce water content, research octane number, and reid vapor pressure of gasohol
4. G-80/E-10/B-10 mixture is the best characteristic of gasohol with RON 93 and meet the standart of gasoline.

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