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The Effect of a Mixture of Bioethanol with Octane 92 Fuel on Gasoline Engine Vibration

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***Abstract*— Along with technological developments, the system in vehicle engines is also experiencing developments, with the technology embedded in vehicle engines it is hoped that vehicles can become more efficient, powerful, produce low emissions, even vibration and sound produced is very small. This also needs to be supported by using the right fuel. Bioethanol is an alternative fuel made from vegetable and can produce complete combustion. The data collection method is by recording the proportion of the bioethanol mixture with 92 octane fuel and changes in engine speed, when vibrations occur, the LCD vibration meter will display the vibration value. Engine speed starts from 1500 to 8500rpm with a change of 1000rpm each rotation. From the tests carried out, at engine speed of 1500 to 2500 rpm the 5% mixture is a good mixture because the vibration value is lower than before mixing. Then for engine speed of 3500 to 8500 rpm a 10% mixture is a good mixture because the vibration value is lower than before mixing and lower than other mixtures.**

Keywords—Bioethanol, Combustion, Gasoline Engine, Vibration.

I. INTRODUCTION

Along with the development of technology, the system in the vehicle engine is also experiencing development, with the technology embedded in the vehicle engine which is expected to make the vehicle more efficient, powerful, the emissions produced are low, even the vibrations and sound produced are very small. This must be balanced with the use of fuel according to the needs of the engine, so that the resulting combustion is perfect. There are several ways to improve fuel quality, namely by adding special additives that can increase the octane number or by utilizing natural ingredients such as bioethanol.

Bioethanol is a fuel that produces a complete combustion process resulting in small vibrations. Combustion occurs due to a chemical reaction between fuel and air which can cause heat and light in the form of glow or fire [11]. The combustion process in a gasoline engine can occur when the mixture of fuel and air in the combustion chamber is ignited by a spark from the spark plug [9]. There are two types of combustion, perfect combustion and imperfect combustion:

1. Perfect combustion

Perfect combustion is a combustion reaction between a mixture of fuel and air with the reactants assumed to be completely burned which produces exhaust gas products CO_2, N_2, and H_2O. its chemical formula is:

Combustion with 92 octane fuel

$$C_8H_{18}+12{,}5(O_2+3{,}76N_2)\text{-}$$
$$8CO_2+47{,}16N_2+9H_2O+\text{energy} \quad (1)$$

Combustion with bioethanol

$$C_2H_5OH+3(O_2+3{,}76N_2)\text{–}$$
$$2CO_2+3H_2O+11{,}13N_2+\text{energy} \quad (2)$$

2. Imperfect combustion

Imperfect combustion is imperfect combustion of reactants between fuel and air so that exhaust gases are produced, in the form of CO, CO_2, H_2O, O_2, N_2 and HC. In the imperfect combustion process there are two conditions, namely the condition of excess air, with the chemical formula

Combustion with 92 octane fuel

$$C_8H_{18}+20(O_2+3{,}79N_2)\text{-}$$
$$8CO_2+9H_2O+71{,}45N_2+7{,}5NO_2+\text{energy} \quad (3)$$

Combustion with bioethanol

$$C_2H_5OH+4(O_2+3{,}76N_2)$$
$$2CO_2+3H_2O+15{,}04N_2+7{,}52NO_2+\text{energy} \quad (4)$$

And the condition of lack of air, with its chemical formula

Combustion with 92 octane fuel

$$C_8H_{18}+10{,}5(O_2+3{,}76N_2)\text{-}$$
$$4CO_2+4CO+9H_2O+39{,}48N_2+\text{energy} \quad (5)$$

Combustion with bioethanol

$$C_2H_5OH+2(O_2+3{,}76N_2)\text{–}$$
$$2CO_2+3H_2O+7{,}52N_2+\text{energy} \quad (6)$$

Bioethanol is a fuel derived from plants. This fuel has properties that resemble the fuels currently circulating, besides that bioethanol is an alternative energy source that is environmentally friendly because it is made from materials that are readily available in nature. Bioethanol is a fuel made from fermented plant parts containing carbohydrates with the help of microorganisms [5].

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Octane 92 fuel is a fuel for motor vehicles with an octane number of 92. This fuel is used for vehicles with an engine compression ratio of 10:1 to 11:1. Following are the specifications for 92 octane fuel:

TABLE 1.
92 OCTANE FUEL SPECIFICATIONS

Characteristic	Unit, min/max	Specification
Ethanol Content	%-v, min	99.5 (before denaturation) 94.0 (after denaturation)
Methanol Content	mg/L, max	300
Water Content	%-v, max	1
Denaturation Content	%-v, min %-v, max	2 5
Copper Content (Cu)	mg/kg, max	0.1
Acidity as CH3COOH	mg/L, max	30
Looks	-	Clear and bright, no deposits and dirt
Chloride ion levels (Cl)	mg/L, max	40
Sulfur Content (S)	mg/L, max	50
Gum Level, washed	mg/100 ml, max	5,0
pHe	-	6.5-9.0

TABLE 2.
BIOETHANOL SPECIFICATION

Characteristic	Unit	Limitation Min	Limitation Max
Research Octane Number	RON	92.0	-
Oxidation Stability	Minute	480	-
Sulfur Content	% m/m	-	0.05
Lead Content (Pb)	g/l	-	0.013
Phosphorus Content	mg/l	-	-
Metal Content (Mn, Fe, etc)	mg/l	-	-
Silicon Content	mg/kg	-	-
Oxygen Content	% m/m	-	2.7
Aromatic Content	% v/v	-	50.0
Benzene content	% v/v	-	5.0
Distillation:			
10% Vol Evaporation	°C	-	70
50% Vol Evaporation			
90% Vol	°C	77	110
Final Evaporation Boiling Point			
Residue	°C	130	180
	°C	-	215
	% vol	-	2.0
Sediment	mg/l	-	1
Steam Pressure	kPa	45	60
Density	kg/m3	715	770

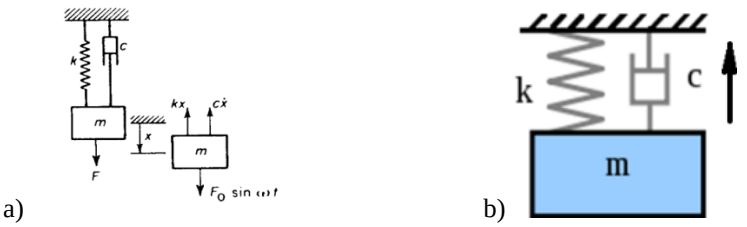

Figure 1. Forced vibration (a) and free vibration (b)

Mixing bioethanol with 92 octane fuel also affects sound and vibration. One of the errors in the operation of the machine that results in damage is the frequent occurrence of abnormal sounds or vibrations that occur in the machine [10]. Vibration on a machine under normal conditions is different from a machine under abnormal conditions. Vibration is a movement back and forth with a certain time interval. Vibration refers to the repetitive motion of objects and the forces associated with those movements [4].

Vibration is divided into two, namely forced vibration and free vibration. Forced vibration is a phenomenon of alternating motion that gets external interference or occurs due to external stimulation, when the stimulus oscillates, the system is forced to oscillate at the frequency of the stimulus [1].

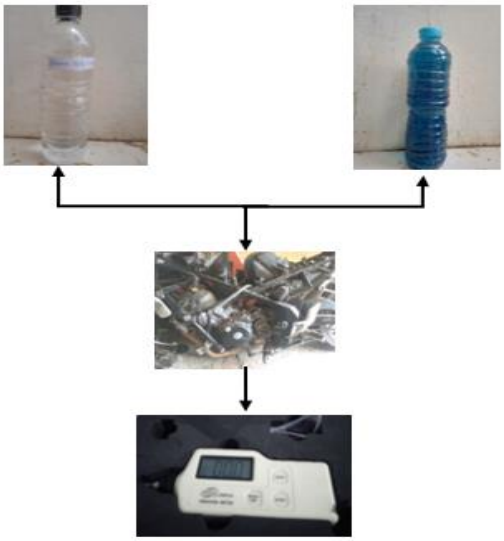

Figure 2. Study method

TABLE 3.
VIBRATION VALUE

RPM	Vibration Value (mm/s)			
	0%	5%	10%	15%
1500	5,6	4,0	4,7	4,5
2500	3,3	2,7	2,9	3,0
3500	5,3	4,9	4,3	4,7
4500	10,9	10,2	8,9	11,2
5500	15,9	15,6	14,9	16,2
6500	17,3	15,1	14,5	17,9
7500	22,7	22,2	20,8	24,7
8500	45,2	41,6	40,2	53,6

Free vibration is the vibration that occurs when a mechanical system is actuated by an initial force on the system itself and is allowed to oscillate freely [2]. Free vibration then creates a natural frequency because it can be dynamic and mass distribution so as to produce a force that causes vibration [8].

According to [3] by title “Pengaruh Jenis Bahan Bakar Gasoline terhadap Prestasi, Pembakaran, Getaran, Kebisingan, dan Emisi Gas Buang pada Mesin Type TV-1” states that the effective performance of the three types of fuel (octane 88, octane 90, and octane 92) is generally constant and the lowest SFC is fuel with an octane number of 92. In addition, the combustion performance of 92 octane fuel also tends to be stable, but vibration and noise higher. Meanwhile CO and HC emissions from the three types of fuel tend to be constant. According to [6] by title ”Analisa Getaran Mesin Sepeda Motor Berkapasitas 125cc 4 Langkah terhadap Campuran Bahan Bakar Premium dengna Minyak Turpentin (Pinus)” with a mixture of turpentine oil composition of 5%, 10% and 15% at engine speed of 1000rpm, 2000rpm and 3000rpm. The results of the study show that the greater the turpentine oil mixture, the greater the vibration on the engine, the torque generated by the engine is lower, the temperature in the combustion chamber increases significantly and the exhaust emission results are higher. According to [7] by title “Pengaruh Campuran Bioetanol Singkong dengan Premium terhadap Emisi Gas Buang Motor Bensin 4 Langkah 1 Silinder” By adding bioethanol to premium fuel for exhaust emissions, the lowest CO is produced in the E20 mixture with a content of 0.82% vol at 2000 rpm engine speed. For the lowest HC content produced in the E20 mixture with levels of 75.3 ppm at 6000 rpm engine speed.

To determine the vibration value resulting from mixing bioethanol with fuel, it is necessary to do study. Therefore the study raised this topic entitled "The Effect of Bioethanol Mixture with Octane 92 Fuel on Gasoline Engine Vibration"

II. Method

Figure 2 shows the concept of testing to be carried out to obtain vibration values from mixing bioethanol with gasoline In carrying out this study, bioethanol is needed which will be mixed with 92 octane fuel. The bioethanol used contains 96% ethanol content. Then for testing, bioethanol will be mixed with 92 octane fuel with a ratio of 0%, 5%, 10% and 15% bioethanol. For data collection, a mixture of bioethanol and 92 octane fuel will be tested with engine speed of 1500 to 8500rpm with an increase range of 1000rpm. The tool used is a vibration meter or vibration meter. Any change in rpm,

and mix percentage will be recorded for the vibration value.

III. Results and Discussion

From the results of vibration testing on a gasoline engine whose fuel has been mixed with bioethanol in a ratio of 0%, 5%, 10%, and 15%, the vibration values obtained for each engine rotation and for each mixture are as Table 3.

At 1500 rpm engine speed for the lowest vibration, which is in a 5% mixture with a value of 4.0 mm/s, then for the highest rotation, it is in a mixture of 0% or pure 92 octane fuel with a vibration value of 5.6 mm/s. At 2500 rpm engine speed the lowest vibration value is at 5% mixture with a value of 2.7 mm/s, and the highest vibration value is at 3.3 mm/s at 0% mixture. At 3500 rpm the lowest vibration is at 10% mixture with a vibration value of 4.3 mm/s, then for the highest vibration at 5.3 mm/s at 0% mixture. At 4500 rpm the lowest vibration is in the 10% mixture with a vibration value of 8.9 mm/s, then the highest vibration is in the 15% mixture with a vibration value of 11.2 mm/s. at 5500 rpm the lowest vibration is in the 10% mixture, which is 14.9 mm/s, then the highest vibration is in the 15% mixture with a vibration value of 16.2 mm/s. at 6500 rpm the lowest vibration is in the 10% mixture with a vibration value of 14.5 mm/s, then the highest vibration is in the 15% mixture with a vibration value of 17.9 mm/s. At 7500 rpm the lowest vibration is in the 10% mixture with a vibration value of 20.8 mm/s, then the highest vibration is in the 15% mixture with a vibration value of 24.7 mm/s. at 8500 rpm the lowest vibration is in a 10% mixture with a vibration value of 40.2%, and for the highest vibration there is a 15% mixture with a vibration value of 53.6 mm/s.

From the graphic images that have been obtained, it shows that the higher the engine speed (rpm), the greater the vibration produced, but the difference is the proportion of the bioethanol mixture with 92 octane fuel using platinum spark plugs. The lowest vibration is at 1500 rpm with a 5% bioethanol mixture and the highest vibration is at 15% mixture at 8500 rpm. This shows that the addition of bioethanol to 92 octane fuel with a certain proportion and using platinum spark plugs will not produce the same vibration value every time this can be influenced by spark plugs as a trigger for an explosion in the combustion chamber and from the explosion it will produce vibrations in the combustion chamber machine.

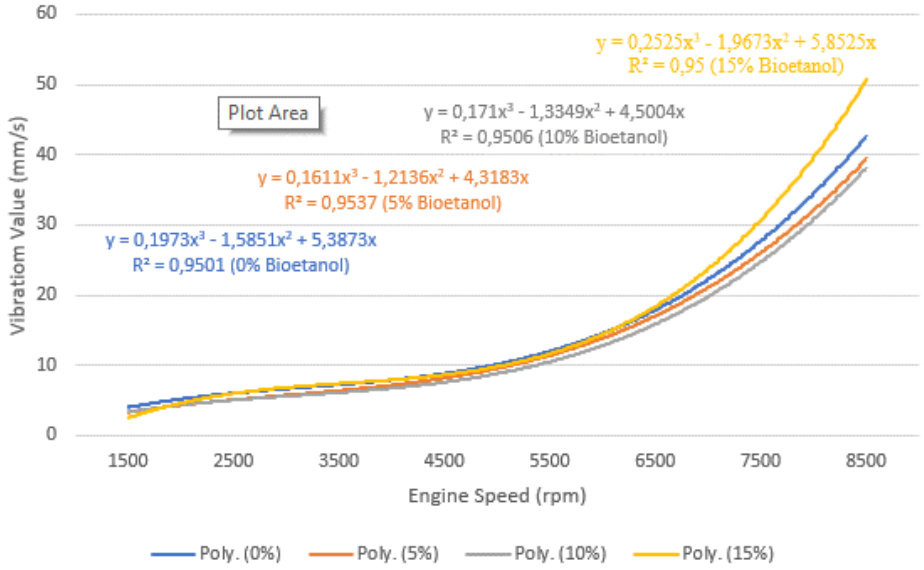

Figure 3. Vibration chart

IV. Conclusion

The addition of bioethanol to the fuel can affect engine vibration because fuel can determine the explosion that occurs in the combustion chamber, if the mixture does not match the engine's requirements this can result in higher engine vibrations than before mixing, but if the mixture is in accordance with the engine's requirements this can produce lower engine vibration than the vibration generated before the addition of bioethanol. From the tests carried out, at engine speed of 1500 to 2500 rpm the 5% mixture is a good mixture because the vibration value is lower than before mixing. Then for engine speed of 3500 to 8500 rpm a 10% mixture is a good mixture because the vibration value is lower than before mixing and lower than other mixtures.

REFERENCES

[1] Ali, A, I., & Hatidin. M., "Perancangan Pemanfaatan Energi Peredaman Getaran Paksa Akibat Eksitasi Massa Tak Balance Menjadi Energi Listrik", Bandung, Indonesia: Departmant of Mechanical Engineering, National Institute of Technology, 2017.

[2] Chandra Manubulu, C., Hendrikus, R., & Ndouk, F. "Getaran Bebas pada Struktur MDOF Bangunan Penahan Geser", Jurnal Teknik Sipil, 1(1), 2020.

[3] Erwin, A., Putra, E., & Aziz, N. "Pengaruh Jenis Bahan Bakar Gasoline terhadap Prestasi, Pembakaran, Getaran, Kebisingan, dan Emisi Gas Buang pada Mesin Type TV-1". *xx*, *No. y*(2). https://doi.org/10.33772/djitm.v%vi%i.19886, 2020.

[4] Hidayat, R., & Wilis, G. R. "Analisis Getaran pada Kompresor Mesin Pendingin dengan Variasi Putaran (RPM)" (Vol. 15, Issue 2), 2017.

[5] Samawa, J., Mufarida, N. A., & Bahri, M. H. "Pengaruh Variasi Campuran Bioetanol dan Pertamax terhadap Performa Motor Sport 4 Langkah 150 cc Injeksi". *J-Proteksion*, *6*(2), 35–40. https://doi.org/10.32528/jp.v6i2.6091, 2022.

[6] Mahardika, O., Ariyansah, R., & Gamayel, A., "Analisa Getaran Mesin Sepeda Motor Berkapasitas 125 CC 4 Langkah terhadap Campuran Bahan Bakar Premium dengan Minyak Turpentin (PINUS)", *Jurnal Ilmiah Program Studi Magister Teknik Mesin* (Vol. 11, Issue 1), 2019.

[7] Pradana, B. A., "Pengaruh Campuran Bioetanol Singkong dengan Premium terhadap Emisi Gas Buang Motor Bensin 4 Langkah 1 Silinder", Malang. Politeknik Negeri Malang, 2020.

[8] Rusianto, T., Getaran Mekanis. Yogyakarta. Akprind Press, 2021.

[9] W. A. Yuniarto, Santoso, Nurhadi., "Motor Bakar 1", Malang. Politeknik Negeri Malang, 2019.

[10] Eka Risano, Ay., Wardono, H., & Poniton Sihombing, G. R. "Pengaruh variasi campuran bahan bakar pertamax dan bioetanol 99,9% terhadap torsi mesin bensin 4 langkah Tecquipment TD201", *Jurnal Teknik Mesin UM Metro*, *2021*.

[11] Nanlohy, H. Y. "*Studi komparasi pengaruh waktu pengapian terhadap performa SI engine berbahan bakar bensin-bioetanol"*. Vol.*7*(2), 118–125, 2021.