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The effect of ethanol-gasoline blends on exhaust emissions and fuel consumption of a 125 cc four-stroke single cylinder engine

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Abstract: *In line with population growth, technological developments and the increase of vehicles, the need for fuel is increased. Therefore, many people try to find an alternative fuel such as ethanol as an alternative fuel. This study aims to determine the effect of a mixture of gasoline and 95% ethanol on exhaust gas emissions and fuel consumption. In this study, gasoline was blended with alcohol ranging from 10% to 40% by volume (E0, E10, E20, E30 and E40). Next, the exhaust gas emission levels were observed using an exhaust gas analyzer. The results show that the lowest CO emissions occur with E20 fuel at 0.88% or a 9.28% reduction in CO emission levels when compared to the highest CO emissions of 0.97% when using E0 fuel. The lowest hydrocarbon or HC emissions were 532.00 ppm or a 33.61% reduction in HC emission levels using E40 fuel when compared to the highest HC emissions of 801.33 ppm when using E0 fuel. Fuel consumption also decreases with the addition of ethanol to the fuel.*

Keywords: *Gasoline, ethanol, exhaust emission, fuel consumption.*

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I. INTRODUCTION

The number of motorized vehicles continues to increase in Indonesia, which ultimately has an impact on increasing levels of exhaust emissions produced. Exhaust gas emissions from vehicles are very dangerous for human life. Vehicles that use gasoline and diesel fuel will produce exhaust emissions (CO, HC, CO_2, SOx, Pb, and NOx). Apart from that, the use of fossil fuels in vehicles has an impact on reducing/depleting petroleum supplies (Brimasta and Sutjahjo, 2013).

Ethanol is a high octane fuel that can be used as an octane enhancer in gasoline (Sarjono and Putra, 2013). Ethanol contains oxygen so it improves fuel combustion with the positive effect of minimizing air pollution. The research of Winarno (2011) explained that the effect of adding ethanol to petrol is that apart from being able to improve the performance of petrol motorbikes for the better, adding ethanol to petrol is also able to reduce emissions from motorbikes (Putra et. al, 2020). The addition of ethanol is able to create more complete combustion by reducing carbon monoxide (CO) emissions and increasing carbon dioxide (CO_2) (Agrariksa et. al, 2013).

Moreover, the use of alternative fuels on petrol motorbikes, modification of several parts or systems used on motorbikes is very necessary to improve engine performance. Various methods have been used to create tools that can save fuel and can produce excellent exhaust emissions so that they do not pollute the surrounding air too much. One way is to treat the fuel before it enters the combustion chamber or before it undergoes the combustion process. The method that can be used is the application of a magnetic field (electromagnet) because this equipment uses a fairly simple coil (Suyatno, 2011).

II. EXPERIMENTAL PROCEDURE

Research methods are the steps taken by researchers to collect information or data to carry out analysis on the data that has been obtained. This research uses experimental methods and literature studies. The materials that are the object of research are gasoline, 95% ethanol with blend variations of 0%, 10%, 20%, 30% and 40% by volume. The parameters observed in this research are fuel consumption and exhaust emissions such as HC, CO, O_2, and CO_2. The testing equipment schematic is shown in Figure 1 below.

Figure 1. Testing equipment schematic. 1. Motorbike, 2. Exhaust gas analyzer, 3. Digital spring scala, 4. Fuel tank, 5. Fuel line

III. RESULTS AND DISCUSSIONS

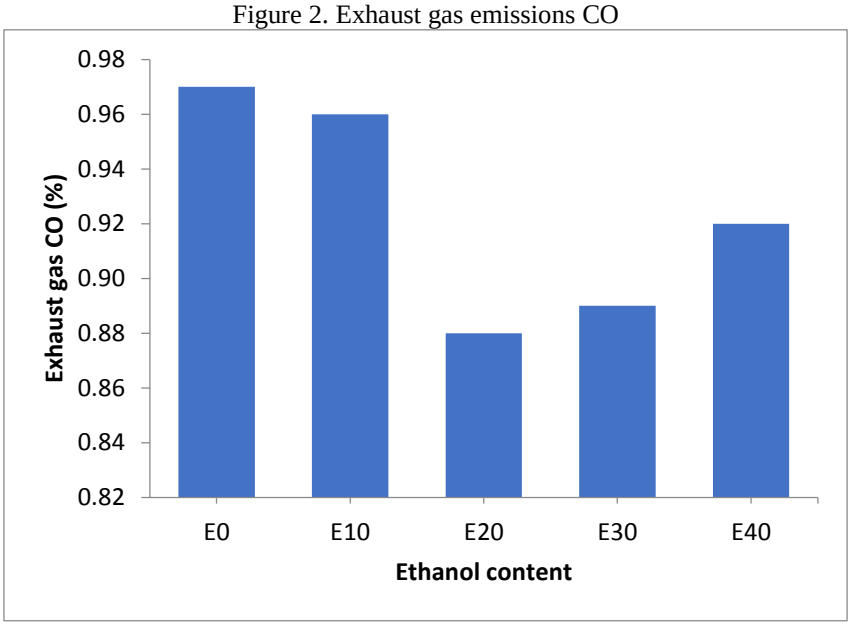
Data from research results will be analyzed using appropriate equations, presented in table form and plotted in a graph. Next, we analyzed the influence of the ethanol content parameters in gasoline fuel on exhaust emissions which were observed using a gas analyzer. Table 1 below is exhaust gas emission data.

Table 1 Exhaust gas emission data

Fuel blends	Exhaust emission			
	CO (%)	HC (ppm)	CO_2 (%)	O_2(%)
E0	0.97	801.33	15.20	1.64
E10	0.96	636.33	15.43	1.41
E20	0.88	673.33	15.50	1.51
E30	0.89	574.00	15.67	1.41
E40	0.92	532.00	15.50	1.21

In table 1 above, CO exhaust gas emission data varies depending on the ethano content in the gasoline fuel. The lowest CO emissions of 0.88 occurred in gasoline fuel with an ethanol content of 20%, while the highest CO levels were released from the combustion of fuel with an ethanol content of 0% or pure gasoline. Meanwhile, unburned hydrocarbon (HC) exhaust emissions tend to decrease with increasing ethanol levels in gasoline fuel.

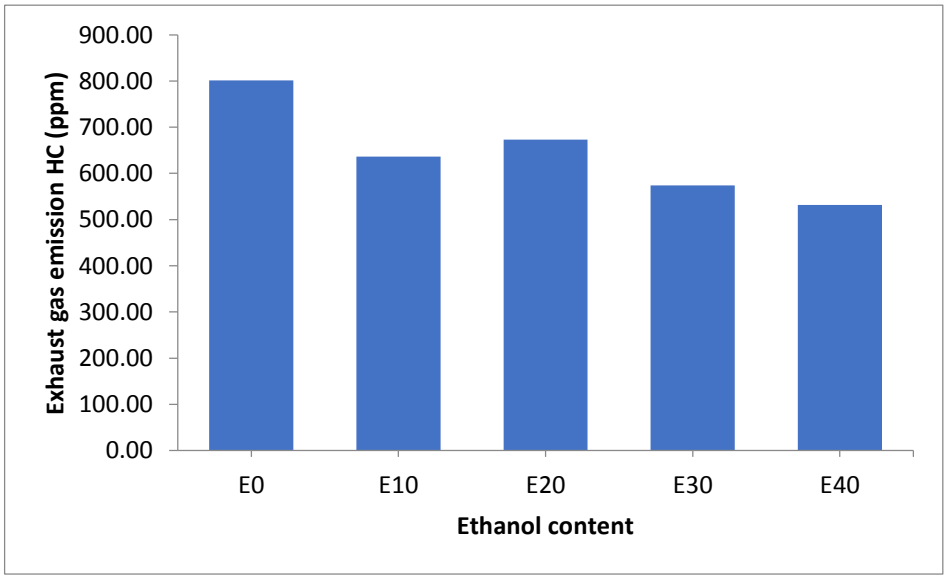
Figure 2. Exhaust gas emissions CO



In Figure 2 it can be seen that the lowest CO emissions in E30 fuel using magnets are 0.82% or a 15.46% reduction in CO emissions compared to the highest CO emissions of 0.97% when using E0 fuel. (gasoline). In research (Suhartoyo, 2021, Nugraha, 2022) explains that the oxygen contained in ethanol helps the combustion process occur more perfectly in the vehicle's combustion chamber so that CO levels in exhaust emissions become less. Ethanol contains oxygen, and when mixed with gasoline fuel, increases the oxygen levels in the fuel mixture. Higher oxygen levels allow for better and more complete combustion, reducing CO emissions.

Gasoline fuel mixed with ethanol can reduce carbon monoxide (CO) emissions in motor vehicles. However, if too much ethanol is used E30 and E40 tend to increase level of CO emission. Ethanol has different combustion characteristics than fossil fuels. If the ethanol mixture is too high, combustion may be less complete, producing more CO. This can reduce the quality of the fuel combustion process. Apart from that, it also allows the air and fuel ratio to become leaner or have excess air, emitting higher CO exhaust emissions.

Figure 3. Exhaust gas emissions HC

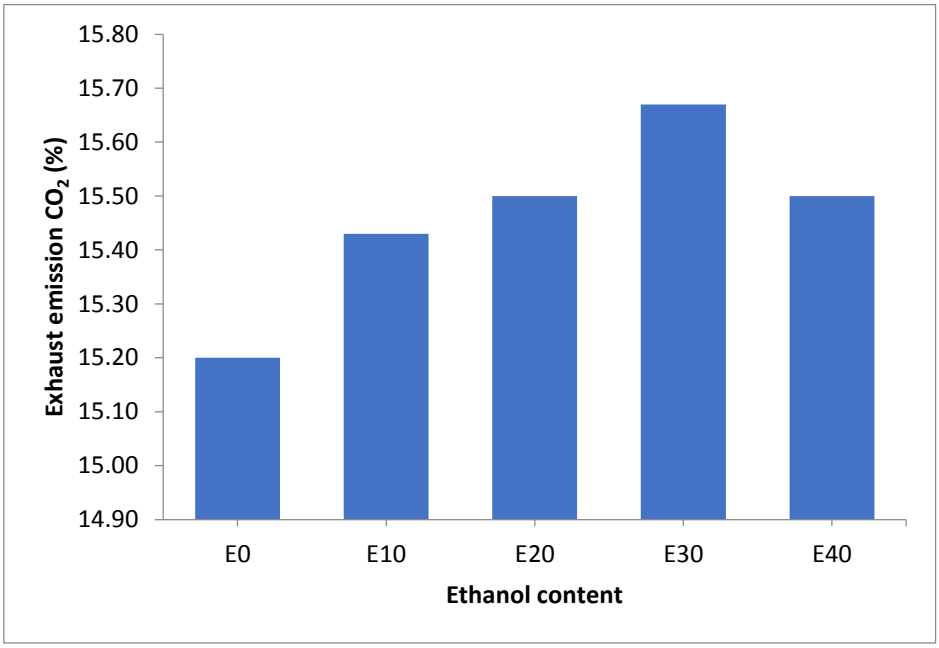


From Figure 3 it can be seen that the lowest Hydrocarbon or HC emissions are 446.33 ppm or a 44.30% reduction in HC emission levels using E30 fuel with the addition of magnets to the fuel line when compared to the highest HC emissions of 801.33 ppm in when using E0 fuel without adding a magnet to the fuel line. In research [9] explains his research that by adding ethanol to the fuel, oxygen is added so that combustion is more

complete and reduces HC gas emissions. With this process, combustion in the combustion chamber can take place more perfectly.

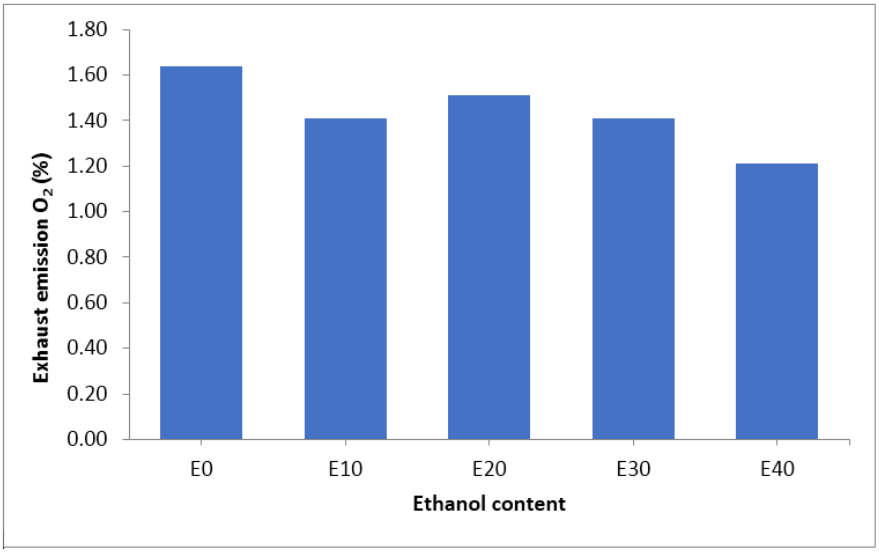
The addition of ethanol content in gasoline tends to reduce HC exhaust emissions. This is because ethanol contains oxygen, and when mixed with gasoline fuel, the oxygen level in the fuel mixture increases. Higher oxygen levels enable better and more complete combustion thereby reducing HC emissions.

Figure 4. Exhaust gas emissions CO_2



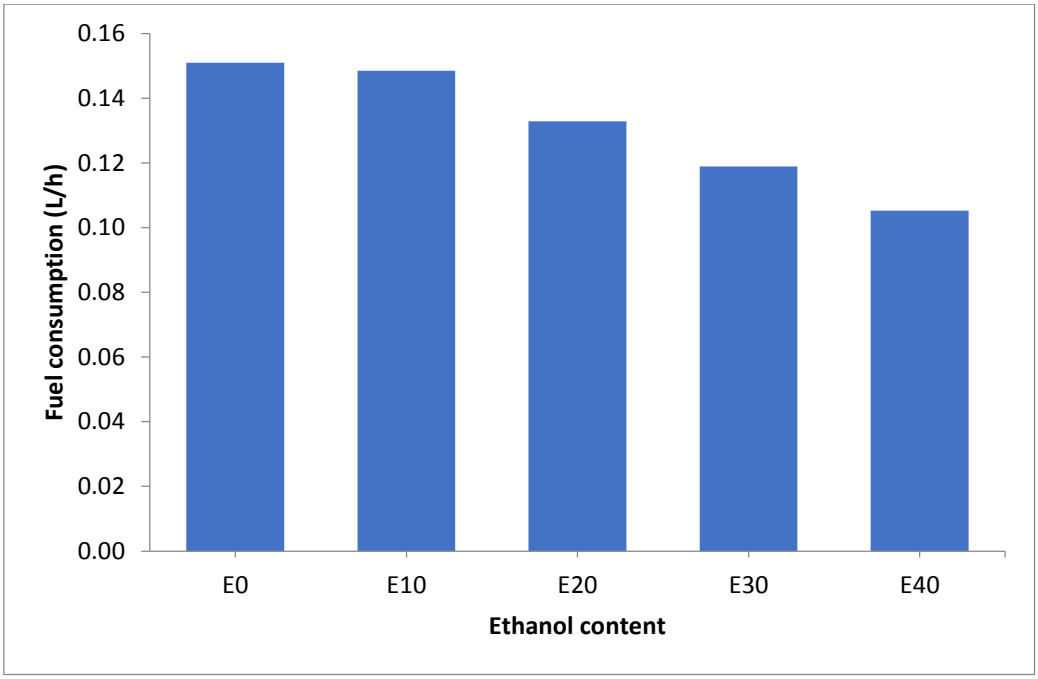
From Figure 4, the lowest CO_2 emissions were 15.20% or a 4.40% reduction in CO_2 emission levels using E0 fuel compared to the highest CO_2 emission levels of 15.90% when using E40 fuel with the addition of magnets to the fuel line. . The oxygen content in ethanol affects the amount of oxygen involved in the combustion process. This oxygen content will help the fuel burn more completely so that CO_2 exhaust gas tends to increase. In research (Nur and Pratirowi, 2022) explains that the CO_2 content in vehicle exhaust gas is formed due to complete combustion in the combustion chamber. The higher the CO2 content in the vehicle's exhaust gas, the more complete the combustion in the combustion chamber. The higher the CO_2 level, the lower the HC and CO content in the vehicle's exhaust gas, which means that the higher the CO_2, the less fuel is wasted because it burns completely in the vehicle's combustion chamber.

Figure 5. Exhaust gas emissions O_2



From Figure 5, the lowest O2 emission level is 1.18% or 28.04% reduction in O2 emission levels using E30 fuel with the addition of magnets to the fuel line when compared to the highest O2 emissions, namely 1.64% using E0 fuel without Adding a magnet to the fuel line. In research (Nugraheni, 2017) it is explained that the use of ethanol can reduce O2 because ethanol has the O2 element in it so that it helps combustion in the combustion chamber more completely. Research (Nugraha, 2022) explains that the addition of magnets can cause a decrease in O2 because magnets can weaken the attractive energy between hydrocarbon molecules, so that during the oxidation process the amount of oxygen captured by hydrocarbon molecules is more ideal.

Figure 6. Fuel consumption



From Figure 6, the lowest fuel consumption was 0.08 L/hour or a 48% reduction in fuel consumption when using E40 fuel with the addition of magnets to the fuel line when compared to the highest fuel consumption of 0.15 L/hour which occurred in use of E0 fuel without the addition of magnets. In research (Rifal, 2018) explained that ethanol has a greater oxygen content, namely 34.78%. This oxygen content causes the combustion that occurs in the combustion chamber to be perfect, so that even though the amount of fuel entering the combustion chamber is small, it will produce enough power to drive the motor mechanism. Research (Ilman, 2017) states that the addition of magnets has an effect on reducing fuel consumption because the magnetic field can cause the fuel to be affected or become more reactive, binding oxygen so that it burns more easily. This is because the size of the fuel molecular structure changes into smaller bonds due to magnetization. This smaller molecular size will directly result in an easier combustion process in the combustion chamber. In other words, the magnetization process in the fuel will make combustion more complete so that the engine consumes less fuel to produce the same power.

IV. CONCLUSION

Based on the results of the research that has been carried out, several conclusions can be drawn as follows. The lowest CO emissions occurred with E20 fuel at 0.88% or a 9.28% reduction in CO emission levels when compared to the highest CO emissions of 0.97% when using this material. burn E0. The lowest hydrocarbon or HC emissions were 532.00 ppm or a 33.61% reduction in HC emission levels using E40 fuel when compared to the highest HC emissions of 801.33 ppm when using E0 fuel. The lowest CO2 emissions were 15.20% on E0 fuel or a decrease of 3.00% when compared to the highest CO2 emission levels of 15.67% when using E30 fuel. The lowest O2 emissions were 1.21% or a 26.22% reduction in O2 emission levels using E40 fuel when compared to the highest O2 emissions, namely 1.64% using E0 fuel. The lowest fuel consumption was 0.11 L/hour or a 26.67% decrease in fuel consumption when using E40 fuel when compared to the highest fuel consumption of 0.15 L/hour which occurred when using E0 fuel.

Conflict of interest
There is no conflict to disclose.

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