Experimental Test of the Effect Wet Ethanol on Decreasing Emissions Exhaust in EFI Gasoline Engine with EGR System

by Nazaruddin Sinaga

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1. Introduction

The growth in the number of vehicles is increasing. More fuel consumption. The air pollution produced is higher. The fuel consumption of a motorized vehicle is affected by the acceleration process. Low octane value reduces the acceleration of motor vehicles. Fuels containing low octane values increase fuel consumption. The octane number is obtained by comparing the n-heptane and iso-octane content on a fuel. The higher the octane value of the fuel, the better the performance produced by the engine [1[. Wet ethanol is a derivative of alcohol. Wet ethanol has a fairly high octane value that can be used as a mixture of fuel in motorized vehicles. The heating effect on Hot EGR raises the combustion temperature and air-fuel mixture, thereby reducing HC and CO emissions [2].

Wet ethanol has a higher octane value than premium, which is 109. Experiments carried out by blend premium fuel (octane value 88) and wet ethanol with composition WE0, WE5, WE10 and

WE15 on a 4 cylinder gasoline engine 1781 cc EFI showed improved engine performance and increasingly good exhaust emissions [3]. Reduced emissions are affected by oxygen levels on wet ethanol. Adding oxygen to the fuel can improve the combustion process for the better [4]. The addition of methanol and ethanol to fuel can be used on gasoline engines and facilitate the initial ignition of the engine when cold. The resulting CO and HC emissions decreased [5].

In this study, wet ethanol was used as a mixture of premium fuel. The mixing is expected to improve engine performance and reduce exhaust emissions. Emissions include measurement of levels of (Carbon Monoxide) CO, (Hydrocarbon) HC, (Carbon Dioxide) CO_2, and (Exhaust Gas Temperature) EGT. This research was conducted in consideration of whether or not the emissions produced using the mixture were better.

2. Research Methods

The fuels used in this study are the gasoline engine, castor oil, and wet ethanol. Premium fuel is produced by PT. Pertamina, Tbk. Wet ethanol was obtained from the Indrasari chemical shop, Semarang. The percentage of castor oil volume is 10% while the percentage of wet ethanol volume tested is 5%, 10% and 15% of premium fuel amount, respectively called P100WE0, P95WE5, P90WE5, P85WE15. Mixing fuel is prepared before the start of the experiment to ensure that the mixture is homogeneous. A stirrer was used when mixing the fuel.

Table 1. Fuel properties

Properties	Wet-Ethanol	Premium
Octane Number	109	88.8
Water Content (%v)	>5.0	0.003
Viscosity	1.623	0.22
Density Temperature15°C(kg/m^3)	0.8974	744
Number Value (MJ/kg)	21.73	42.69
Flash Point (°C)	24	7.22
Laten Heat (KJ/Kg)	1139	328.91

Table 2. Machine specifications

Engine Toyota Kijang 7K	
Engine Type	Gasoline engine
Production	Toyota
Number of Cylinders	4 Straight
Engine Capacity	1781 cc
Valve	(SOHC) 8 valve
Maximum Power	94 hp - 5000 rpm
Maximum Torque	155 Nm – 3200 rpm
Fuel System	EFI

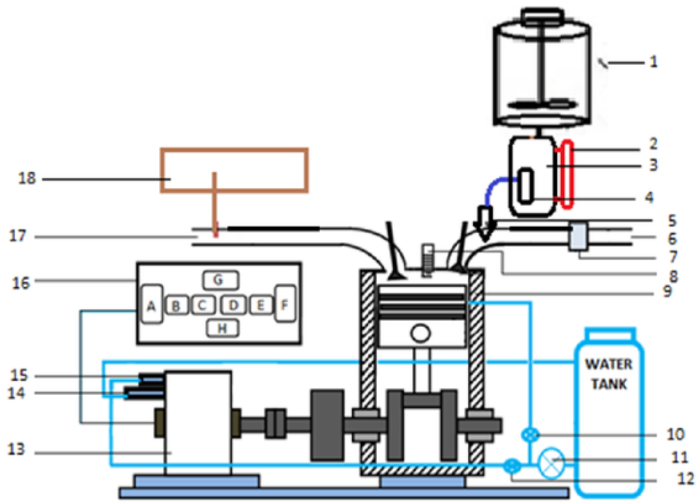

Figure 1. Experimental set-up

The experiment was carried out by using a 4K 7K Toyota Kijang gasoline engine with 4 cylinders with a capacity of 1781 cc and 2500, 3000, 3500 and 4000 rpm engine speed variants. Measuring the flow rate of fuel using a stopwatch by determining the volume of fuel that runs out on each test. Mixing fuel is done using a mixer (1). In the tank, there is a burette (2). Fuels that have been homogeneously mixed are then channeled to the tank (3) and fuel pump (4). A burette is used to determine the volume of fuel used. When the gasoline engine is working, loading is carried out with a constant load measured using a water brake type DYNOmite Land and Sea dynamometer (13). This is done to measure torque and engine power. All measurement data is informed by the display panel (16). At the intake manifold channel and the exhaust manifold are installed thermocouple to measure air temperature. At the exhaust manifold, a Gas Analyzer 898 (18) is installed. to measure exhaust gas HC, CO, CO2, and O2.

3. Result and Discusion

3.1. Test results of Brake Spesific Fuel Consumption (BSFC)

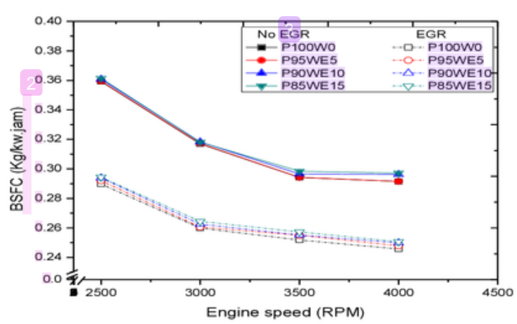

Figure 2. Graph of the effect of wet ethanol on Brake Specific Fuel Consumption (BSFC)

Figure 2 shows the results of BSFC testing with variations in engine speed and fuel blends with EGR and without EGR. Effect of variations in engine speed and fuel mixture with EGR and without EGR on BSFC. The test results show a decrease in fuel consumption along with increasing engine speed and variations in the use of fuel mixtures. The use of EGR shows that fuel consumption is lower than without EGR. BSFC reduction with the use of wet ethanol due to more oxygen content increases the combustion efficiency [6]. BSFC declined as the engine load increased. Wet ethanol mixture BSFC is higher in some engine operating conditions, due to lower heating value than gasoline. Low calorific value on wet ethanol because it contains 50% oxygen in the fuel so it does not contribute to further heat during combustion in the cylinder [4]. BSFC rises as the percentage of wet ethanol rises. The low energy content of the wet ethanol-gasoline mixture causes an increase in BSFC [7]. The value of heat and oxygen atoms in a higher mixture of wet ethanol-gasoline causes an increase in fuel consumption [8]. With energy content and heat value of ethanol/methanol which is lower than gasoline causes an increase in fuel consumption compared to using gasoline [9]. BSFC is lower on low load operating machines with EGR than machines without EGR [10]. BSFC methanol vapor and methanol gas are lower than gasoline, this is due to increased fuel heating value when the fuel is heated with exhaust heat before being injected into the intake manifold so as to increase thermal efficiency, make BMEP rise and lower BSFC compared to gasoline [11]. Whereas according to the use of EGR can reduce BSFC and (nitrogen oxide) NOx emissions [12]. The increase in BSFC without the largest EGR at WE15 is 3.36% at 0.38 kg/kW. Hour, while the decrease in BSFC with the largest EGR at WE5 is 17.61% at 0.30 kg/kW. Hour.

3.2. The test result in hydrocarbon (HC)

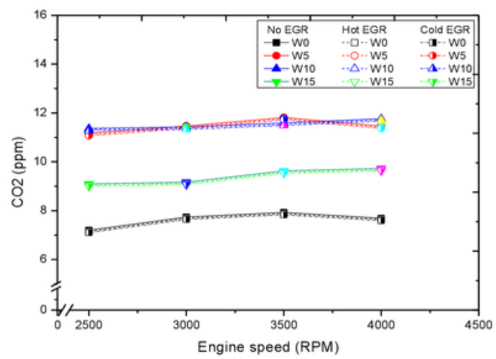

Figure 3. Graph of wet ethanol effect on hydrocarbon (HC)

Figure 3 shows that HC emissions formed from combustion results decrease in each mixture. The use of Cold EGR with P100 HC fuel formed reaches 79 ppm at 4000 rpm engine speed. The most decrease in the P85WE15 mixture reached 34 ppm at 4000 rpm engine speed. The decline reached 56.96%. Decreasing HC occurs due to increased oxygen levels in the combustion reaction. Wet ethanol contains oxygen compounds. When wet ethanol is mixed with the premium, there is an increase in oxygen content in the combustion chamber. Increased oxygen levels trigger the reaction of hydrogen with oxygen more than hydrogen with carbon [13].

3.3. The test result in carbon dioxide (CO2)

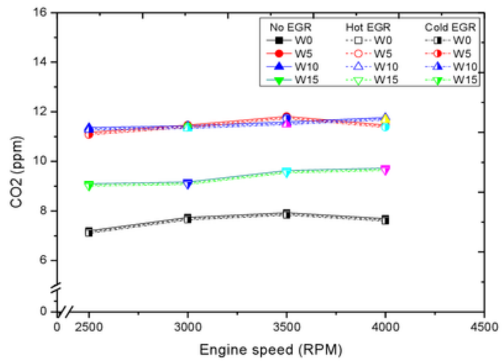

Figure 4. Graph of wet ethanol effect on carbon dioxide (CO2)

Figure 4 CO2 content produced by the P85WE15 mixture reaches 1.1% at 2500 rpm engine speed. At 4000 rpm engine speed, there was a decrease in CO2 levels in the P85WE15 mixture which produced CO2 levels of 1.02%. Increased O2 levels and CO2 levels are influenced by oxygen compounds in alcohol derivatives. The addition of wet ethanol increases combustion efficiency. Combustion efficiency increases Brake Thermal Efficiency (BTE) and CO2 emissions. CO emission levels decrease [14]. Alcohol fuel causes increased CO2 emissions. The ratio of oxygen in alcohol produces combustion efficiency and causes higher CO2 emissions [15]. Wet ethanol has a higher speed of fire spread compared to gasoline, and can increase octane in gasoline and reduce CO and HC emissions [3]. Wet ethanol contains oxygen so that when experiencing the combustion process there is an increase in O2 and CO2 levels in the remaining combustion results [16].

3.4. The test result in carbon monoxide (CO)

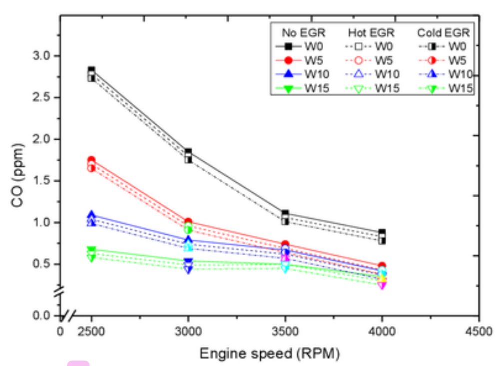

Figure 5. Graph of wet ethanol effect on carbon monoxide (CO)

Figure 5 The highest decrease in CO content occurred in the P85WE15 mixture with Cold EGR. The CO P85WE15 level reaches 10% at 4000 rpm engine speed. The decrease is influenced by the combustion process and the oxygen content on wet ethanol [17]. The addition of wet ethanol to gasoline can reduce CO emissions because the higher oxygen content contributes to the formation of CO2 and NOx. In addition, there is a decrease in CO emissions when using wet ethanol instead of gasoline [18]. Other research also shows that a mixture of ethanol-gasoline (E5 and E10) and methanol-gasoline (M5 and M10) fuels used in Honda Civic 1.4i cars can reduce vehicle exhaust emissions in the form of HC and CO significantly at vehicle speeds of 80 km/hours [4].

3.5. The Test Result in Exhaust Gas Temperature (EGT)

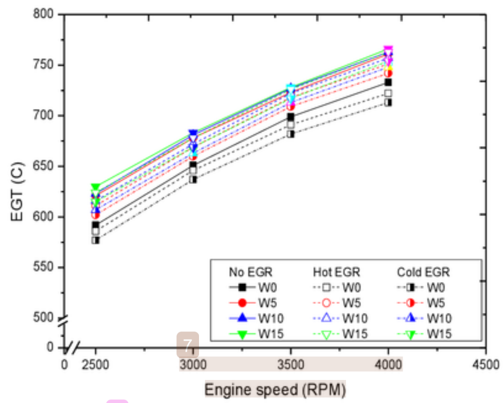

Figure 6. Graph of wet ethanol effect on *Exhaust Gas Temperature (EGT)*

Figure 6 presents a graph of the results of testing the exhaust gas temperature (EGT). In general, the use of gasoline engine, premium, and wet ethanol blends fuels shows an increase in exhaust gas temperature. The highest increase in exhaust gas temperature occurred in the P85WE15 mixture which reached 2.86%. The P85WE15 mixture produces a flue gas temperature of 754 °C at 4000 rpm engine speed. Premium produces an exhaust gas temperature of 733 °C at 4000 rpm engine speed. Increasing the exhaust gas temperature which is affected by latent heat on wet ethanol is higher than the premium. Wet ethanol has a higher combustion speed than premium. Oxygen levels on wet ethanol affect the heat generated in the combustion process. This causes the combustion of the fuel in the cylinder to be more perfect [5].

4. Consclusion

The following are the main conclusions obtained from research on engine performance and exhaust emissions from the EFI gasoline engine with premium and wet ethanol mixed fuels:

1. The use of EGR shows that fuel consumption is lower than without EGR.
2. The emission of exhaust gas produced in the testing machine decreases. It can be seen from the decreasing levels of emission of CO and HC contained in the residual gas from combustion.
3. Oxygen levels in wet ethanol reduce the levels of HC and CO formed and increase the levels of O2 and CO2.

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