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Experiment Analysis an effect Ethanol/Gasoline Blend at Port Injection Gasoline Engine

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ABSTRACT---- ***Currently fuel ethanol are environmental friendly and easy to use. To determine the effect of gasoline/ethanol blend on the gasoline engine, in this research done used engine dyno test. Research done on several ethanol/gasoline blends are from gasoline, ethanol 10% to 20%. Addition of ethanol will produce less power compared with gasoline fuel for low speed operation, but at high speed, Used E10 and E20 will Increase engine power. An engine using ethanol blend fuel has higher fuel consumption, E10 fuel consumption average increase is 12%, and E20 fuel consumption increase is 14%. Increasing the ethanol content further in fuels will reduce the emissions productions.***

Keywords--- port injection gasoline engine, engine performance, ethanol/gasoline blend.

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1. INTRODUCTION

Current issue of global warming and energy crisis becomes a major problem in the automotive world. Growing number of vehicles available, the rate of fuel consumption rate will increase. Some researchers have done many tests on several types of fuel more environmentally friendly and renewable. Ethanol as an ingredient in a lot of concern as a fuel substitute for gasoline. Ethanol as fuel has chemical properties similar to gasoline. With almost the same properties will facilitate the use of ethanol as fuel. Ethanol has a lower calorific value compared with gasoline. Addition of 10% ethanol will only affect a little on power and fuel consumption.

Due to the high evaporation heat, high octane number and high flammability temperature, ethyl alcohol has positive influence on the engine performance and increases the compression ratio. The low reid evaporation pressure enable to storage and transportation safely. Since the oxygen contain has positive effect on environment. In spite of its positive effect when used in gasoline engine as alternative fuel, it is necessary to make some modification on the engine. The fuel system requires more fuel. The vehicle takes less distance with alcohol fuel than gasoline. Because of the first cold starting problem of the pure ethanol, the blend called E85 has a widespread usage as alternative fuel. This fuel consists of 15 vol% unleaded gasoline and 85 vol% ethanol. However, the other blend consisting of 90% gasoline and 10% ethanol called as gasohol. In addition, the flame of the alcohol is colorless in the natural burning processes and this is another advantage of alcohols [3,5].

Ethanol has advantages to prove its attraction. Table 1 shows the properties of ethanol and gasoline. It can be used as an additive or an alternative fuel for gasoline engines. With the addition of ethanol into gasoline, the fuel economy and thermal efficiency are improved and because of the high octane number, engines are allowed to operate under a higher compression ratio. Compared with gasoline, the lower boiling point, faster flame propagation speed, high oxygen content (50 wt%) and simple chemical structure of methanol all help to reduce the CO and Hydrocarbon (HC) emissions, Hu *et al*. (2007). But NOx emissions do not always decrease; Liu e*t al*. (2007) observed an increase by 5-10%. However, the addition of methanol may cause a slight power loss, a cold start problem in deep cold conditions and the risk of a vapor block in hot weather. Power loss can be solved by prolonging the injection pulse width or by enlarging the injector's flow flux; the cold start and vapor block problems can be settled by providing particular methanol/gasoline blend fuels for summer and winter. Other disadvantages such as toxicity, separation from gasoline, erosion on plastic and rubber and so on can be solved by strictly sealing the fuel supply system, adding additives in fuel blends and changing to anticorrosion parts, respectively.

Jia *et al*. (2005) influence of ethanol-gasoline blended fuel on emission characteristics from a four-stroke motorcycle engine. The results indicate that CO and HC emissions in the engine exhaust are lower with the operation of E10 as compared to the use of unleaded gasoline, whereas the effect of ethanol on NOx emission is not significant. Furthermore, species of both unburned hydrocarbons and their ramifications were analyzed by the combination of Gas Chromatography/Mass Spectrometry (GC/MS) and Gas Chromatography/Flame Ionization Detection (GC/FID)

Al-Hasan, M., 2007, Study focuses on measurement of the engine exhaust emission and fuel consumption during engine warm-up period. In this study show that as the ambient temperature increases the concentration of both hydrocarbon and carbon monoxide and fuel consumption decreases while the carbon dioxide increases. Also, the time required for the engine to fully warm-up is shortened.

In previous studies, the research octane number (RON) of the gasoline has been changed due to the addition of ethanol. The more ethanol added, the higher the RON; e.g., the RON values are 95, 98, 101, 102, and 105 for non-oxygenated unleaded gasoline, gasoline with 10, 20, 30% v/v ethanol blends, and pure ethanol, respectively, Hsieh et al., (2002). Thus, the results previously obtained may not accurately represent the commercial gasoline in which the typical RON value ranges from 92 to 98. Octane number is also an impartment parameter for vehicle combustion. Al-Farayedhi. (2002). showed decreases in CO and HC emissions along with but higher NOx emission with increasing octane number of the fuel. The combustion duration becomes prolonged as octane number increases; longer combustion duration may result in low thermal efficiency and increased fuel consumption, Shen et al., (2008). Moreover, gasoline with a high octane number is suitable for vehicles with a high compression ratio. The compression ratios of motorcycles (8–10:1) are less than those for gasoline cars (9–12:1). High-ethanol content gasoline (>15% v/v) may not be suitable for motorcycles due to its high octane number, Chen, (2005).

In this study, to investigate the effects of the ethanol/gasoline properties on Spark Ignition (SI) engine emission at warm-up process, especially unburned-Hydrocarbon emission, three typical methanol/gasoline blends of E0, E10, E20 and E30 were tested. An emission in the exhaust gas is measured by a portable gas analyzer Kane OIML CLAS 1 (N0356). The working principle of the tool is based absorbstivitas wave infrared radiation from the gas detection. Gas analyzer can detect CO2, CO, HC and Air fuel ratio.

Table. 1 Some properties of gasoline and ethanol

	Gasoline	Ethanol
Chemical formula	C4-C12	C2H5OH
Molecular Weight	100-105	46
Oxygen (Mass%)	0-4	34.7
Net lower heating value (MJ/kg)	43.5	27
Latent heat (KJ/L	223.2	725.4
Stoichiometric air/fuel ratio	14.6	9
Vapor pressure at 23.5°C (kPa)	60-90	17
MON	82-92	92
RON	91-100	111

2. METHODOLOGY AND PROCEDURE

Research will be done at with 4G92 port-injection four-cylinder gasoline engine, for specification listed in tables 1 and for engine is shown in figure 1. Experiment was conducted in the laboratory of faculty of Mechanical Engineering, University Malaysia Pahang. To get the data engine power and fuel consumption, engine couple with eddy current dynamometer. Fuel consumption can be measured using calibrated burette and stopwatch. Two different fuel samples were experimentally investigated during this study. Unleaded gasoline was obtained from PETRONAS petrol station. Ethanol, with a purity of 99%, was used in preparing the blends. The unleaded gasoline was blended with ethanol to get test blends ranging from 0%, 10% and 20% ethanol. The fuel blends were prepared just before starting the experiment to ensure that the fuel mixture is homogenous and to prevent the reaction of ethanol with water vapor. Which in the run in with 2,000 rpm up to 5,000 rpm with the increase of 500. Experiment is done with the use of wide open throttle.

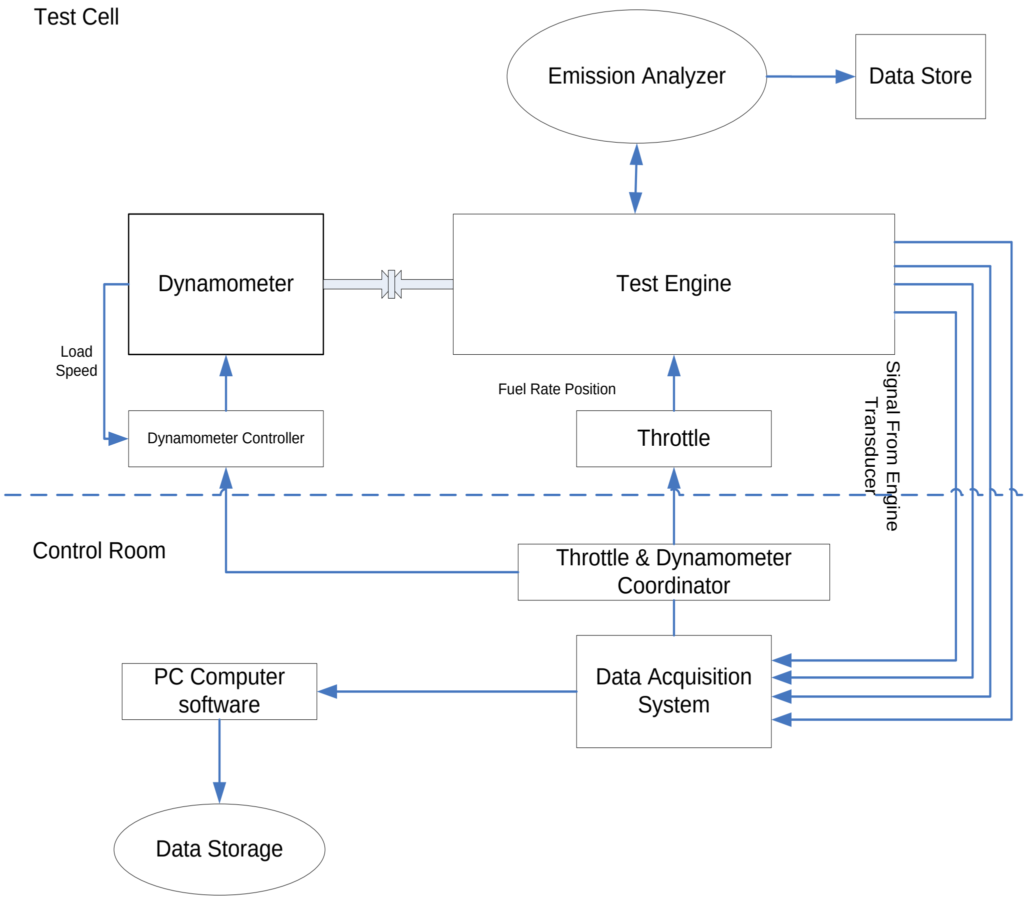

Fig 1. Layout view of experimental data acquisition system

Table 2. Engine specification

Engine Parameter	Value
Bore (mm)	81.0
Stroke (mm)	77.5
Displacement (cm3)	1.597
Number of cylinder	4
Connecting rod length (mm)	118.1
Max. intake valve open (mm)	7.095
Max. exh. valve open (mm)	7.095
Intake valve open	140
Close	580
Exhaust valve open	520
Close	160

Experiment procedure

The test engine is equipped with an electronically controlled fuel injection system, 1,600 cc, 4 valves per cylinder and the maximum absorbing power of the dynamometer is 100 Kw. The test engine keeps constant operating condition during the experiment.

Some special facilities of laboratory were set up for the test because environmental conditions could affect a long term experiment. In order to make stable experimental surrounding, ventilation facilities, blower system for engine air cooling, a large external fuel tank, a closed loop cooling system for an engine dynamometer, and constant temperature system for a dynamometer cell are equipped as additional apparatuses.

the engine was started and allowed to warm up for a period of 20-30min. engine test were performed at 2,000, 2,500, 3,000, 3,500, 4,000,4,500, and 5,000rpm engine speed at wide open throttle. The lowest desired speed is maintained by the load adjustment. The required engine load was obtained through the dynamometer control.

Before running the engine to a nee fuel blend, it was allowed to run for sufficient time to consume the remaining fuel from the previous experiment.

For each experiment, three runs were performed to obtain an average value of the experimental data. the variable that were continuously measured include engine rational speed (rpm), torque, time required to consume 100cm3 of fuel blend (s), air – fuel ratio, CO, CO2, and HC emission. The fuel consumption is esteemed by measuring the fuel consumed per unit time and the calculated values of the density for different fuel blends through Equation. (1) and (2):

$$\dot{m}_f = \frac{3.6 Q_f \rho_b}{t} \qquad (1)$$

$$\rho_b = \sum \rho_i v_i \qquad (2)$$

The brake power is calculated by measuring the engine speed and the engine torque and is given by Eq. 3. The specific fuel consumption is defined as the ratio of fuel consumption to the brake power, as shown in Equation 4.

$$B_P = \frac{NT}{9549.29} \qquad (3)$$

$$BSFC = \frac{\dot{m}_f}{B_p} \qquad (4)$$

3. RESULT AND DISCUSSIONS

Ethanol effect on engine performance

Experiment conducted on four-cylinder gasoline engine with port injection engine using gasoline fuel, ethanol 10% and 20% ethanol. As shown in figure 4. Power generated by ethanol fuel will be reduced, either with E10 or with E20. Addition of 10% ethanol in gasoline will have almost the same performance with gasoline fuel, but for E20 will experience a huge decrease in power. At 2,000 rpm, with E10 fuel will decrease the power at 3.5%, while for E20 will reduce 3.6% of power. Decrease the power generated by the gasoline blend is caused by the low heating value.

The use of ethanol as fuel will result in better performance if the engine operates at high speed. This is apparent in Figure 3, where by using E10 and E20 fuel above 3,000 rpm will generate higher power in comparison to gasoline fuel. Increasing power in this case caused flame speed. Flame speed affects the combustion process. Ethanols as fuel have higher flame speed than gasoline. Fuel with a high flame speed effects will be feel in the 3,000 rpm upwards. Usage on the use of daily where the engine will rotate fewer than 3,000 rpm, fuel usage with high speed flame less can be perceived. At 6,000 rpm, each spark plug fires 50 times per second, that's a lot of combustion processes happening in a very short time in the same combustion chamber. By using fuel that has a high flame speed; combustion process will be more perfect. With a more complete combustion process, engine power will be increased and reduced unburned hydrocarbons. This can be viewed at power engines and engine emissions using fuel ethanol 10% and 20% at low rpm compared with the high rpm.

In addition to affecting the power generated, the addition of ethanol in gasoline fuel will affect fuel consumption. At 2,000 rpm addition of ethanol would increase fuel consumption by 0.053% for E 10 and 10% for E20. E10 has a different character with the E20 or gasoline. By E10, at low rpm, fuel consumption is almost the same with gasoline fuel, but with increasing engine speed, fuel consumption will be almost the same as E20 fuel. Increased fuel consumption caused by the addition of ethanol, many in result by decreasing the heating value of the bladder in the fuel.

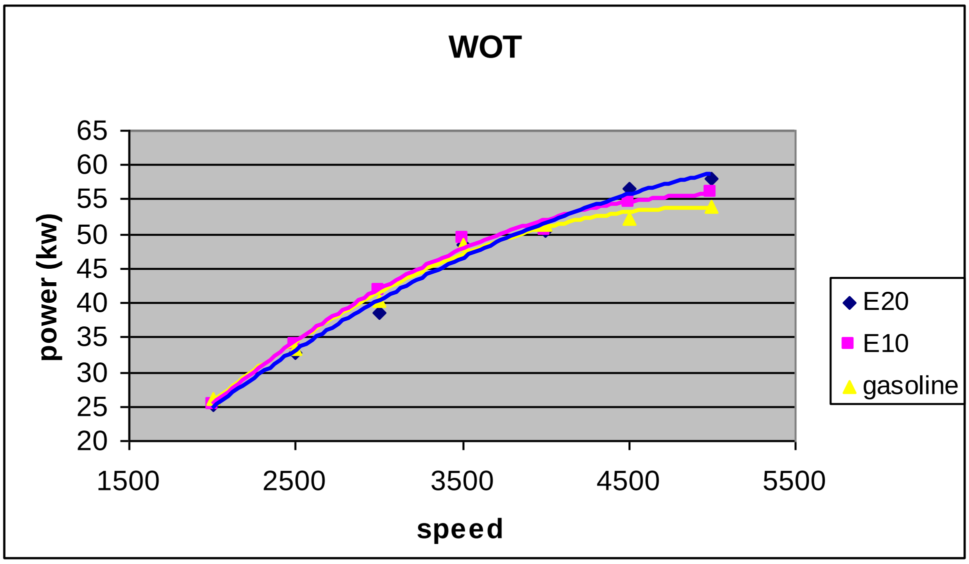

Fig. 2. Effect of ethanol addition to engine power at different engine speed

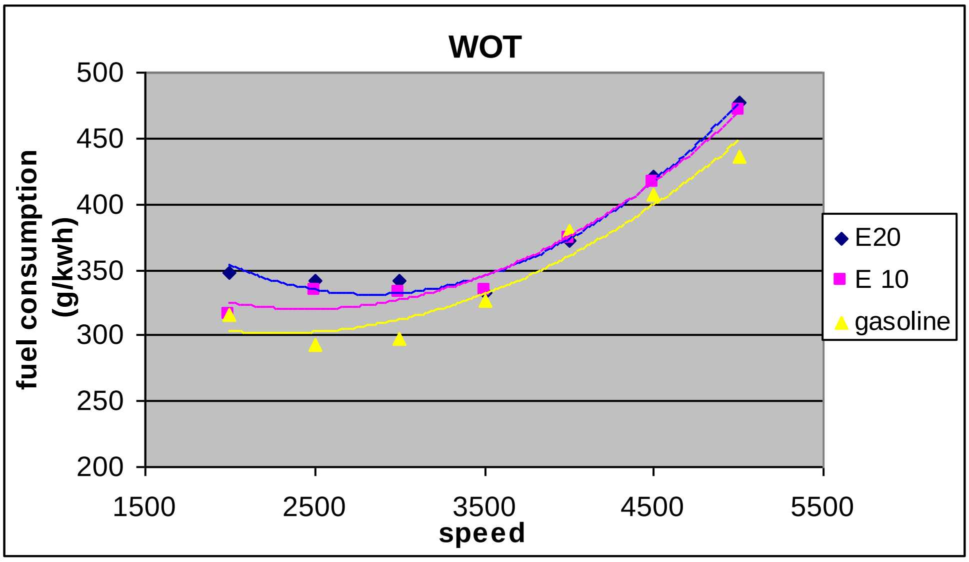

Fig. 3. Effect of ethanol to fuel consumption at different engine speed

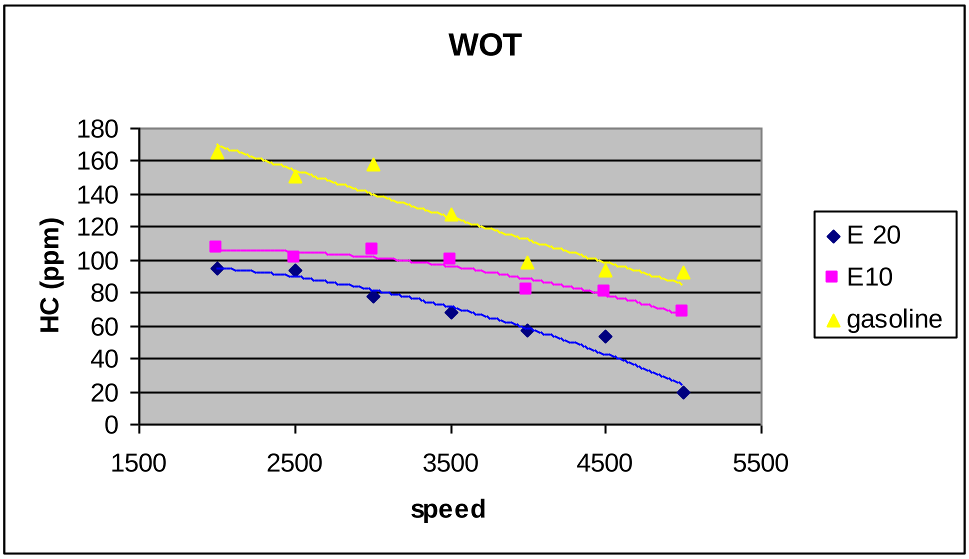

Fig. 4 effect of ethanol at un-burn hydrocarbon

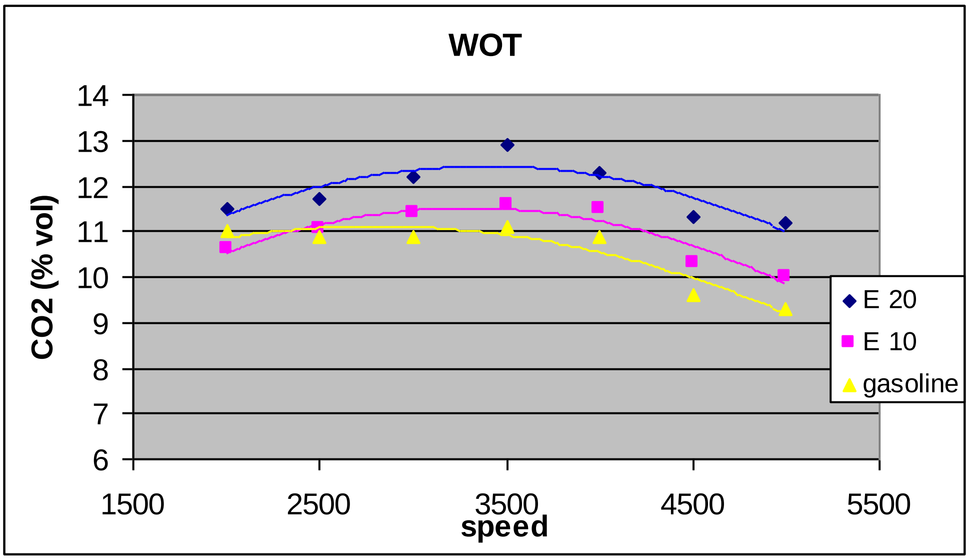

Fig 5. CO2 emission using ethanol

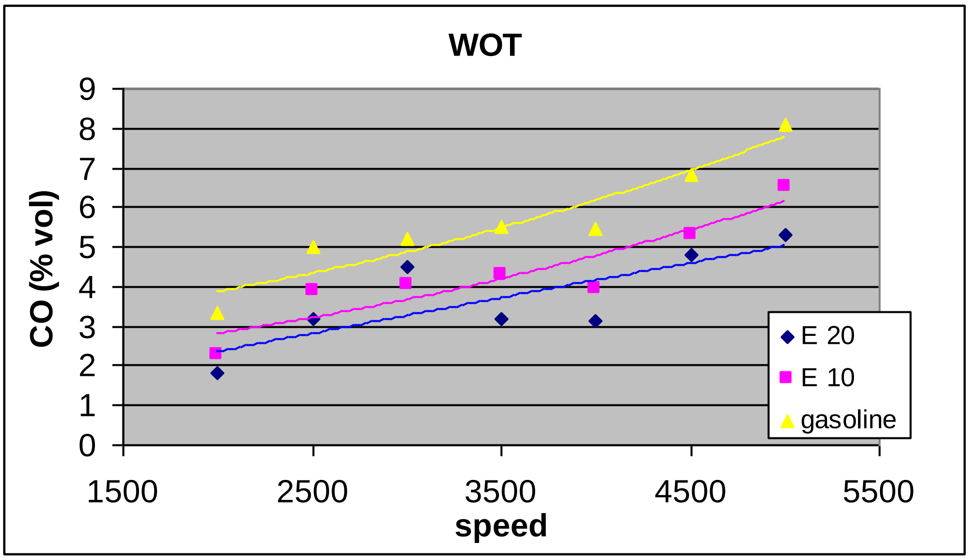

Fig 6. CO emission at athanol fuel

Effect of Ethanol on Emissions

In this experiment measuring the emission such as (HC, CO, and CO_2). In HC measurements gasoline fuel has the greatest value, to be precise 180 ppm at 2,000 rpm, and 93 ppm at 5,000 rpm. Produced of HC will be decrease with increasing rpm. Ethanol addition in fuel has a very good effect on the emissions produced. Using E10 fuel for the engine will produce 105 ppm HC at 2,000 rpm, and 65 ppm in the 5,000 rpm. For E20 fuel has a smaller HC compared with E10, which is 98 ppm at 2,000 rpm and 25 ppm at 5,000 rpm.

In figure 5, using E10 at low speed has almost the same unburned hydrocarbon with E20 fuel, but at high speed unburned hydrocarbon generated by the E10 is almost the same with gasoline fuel. Addition of ethanol in fuel to produce combustion temperature becomes lower. Lower combustion temperature, the HC that produced would decrease.

Besides reducing the combustion temperature, the addition of ethanol causes the fuel contains oxygen. Oxygen content in the fuel will improve the combustion process when the engine operates at high speed, this can be seen in Figure 3 and 5. Where with the addition of ethanol in fuel will result in higher power and lower emissions. Addition of ethanol will have a great influence on engine operating at high speed.

Ethanol addition also affects the resulting CO_2 emissions. E10 and E20 will produce higher CO_2 than gasoline. These results are in accordance with the results of research Tolga at.al. Where is the CO_2 produced by the larger E20 compared with E10. In addition to increasing CO_2 is produced, the addition of ethanol in fuel will reduce CO emissions. Using E10 will produce CO at 6% in the 2000 rpm, while the E20 has a lower CO emission than E10. Increase in CO_2 and decrease in CO from combustion products showed a more perfect combustion. Haywood says that perfect combustion process will produce CO_2, H_2O and energy. So with the increase of CO_2 produced by the addition of ethanol in the fuel showed a more perfect combustion process compared with gasoline fuel.

4. CONCLUSION

Addition of ethanol will produce less power compared with gasoline fuel for low speed operation, but at high speed, Used E10 and E20 will Increase engine power. An engine using ethanol blend fuel has higher fuel consumption, E10 fuel consumption average increase is 12%, and E20 fuel consumption increase is 14%. Increasing the ethanol content further in fuels will reduce the emissions productions.

Performance in relation to the torque, E10 in the case Half Open Throttle at 2000 rpm reduces the engine torque by 3.8 %, at 4000 rpm the engine torque is reduce 1.6%. E10 in the case of Wide Open Throttle at 2000 rpm reduce the engine torque by 3.4%, and at 4000 rpm reduces the torque by 1.2%. In the case of E20 at Half Open Throttle and rpm 2000 the engine torque reduces by 5.8%, and at 4000 rpm increases by 2.7%. Ethanol blend as fuel will have better performance when the engine works at high engine speed or full load.

5. REFERENCES

1. Alasfour FN. NOx emission from a spark ignition engine using 30% iso-butanol–gasoline blend: Part 2—ignition timing. Appl Thermal Eng 1998;18(8):609–18.
2. Cherry, M. catalytic-compression timed ignition, US patent 5 109 817, December 18, 1990
3. F. Scha¨fer, R.v. Basshuysen, Reduced Emissions and Fuel Consumption in Automobile Engines, Springer-Verlag Wien and Society of Automotive Engineers, Inc., Altenburg, 1995.
4. Hu¨seyin Serdar Yu¨cesu. Effect of ethanol–gasoline blends on engine performance and exhaust emissions in different compression ratios. Appl. Thermal engineering. 2006
5. J. W. Hodgson, et. Al., Improving the cold start performance of ethanol fueled engine using a rich combustor device,. SAE technical paper 981359, 1998.
6. L.M. Das, Y.V.R. Reddy, Evaluation of alternative fuels for internal combustion engine, in: First Trabzon International Energy and Environment Symposium, July 29–31, 1996, pp. 951–958
7. MohÕd Abu-Qudais. Engine performance using vaporizing carburetor. Energy conversion and management 2000
8. M. Bahattin Celik. Experimental determination of suitable ethanol–gasoline blend rate at high compression ratio for gasoline engine. Appl. Thermal engineering. 2007
9. N. D. Brinkman. Effect of compression ratio on exhaust emissions and performance of a methanol fueled single-cylinder engine. SAE paper 7707791.
10. Tolga Topgu¨l. The effects of ethanol–unleaded gasoline blends and ignition timing on engine performance and exhaust emissions. Renewable energy.2006
11. R.a. Amaral and J.R. Sodre. Influence of engine operational parameters on aldehyde emissions from an ethanol fueled vehicle. Proceedings of the brazilian congress on thermal science, porto alegre, RS, brazil. 2000.
12. Kim s, dale be. Environmental aspects of ethanol derived from non-tiled corn grain: nonrenewable energy consumption and greenhouse gas. Biomass bioenergy 2005;28:475-89.
13. DA. Caffrey PJ, rao v. envestigation into the vehicular exhaust emission of high percentage ethanol blades. SAE paper no. 950777.
14. Taylor AB, mocan DP, bell AJ, hodgson NG, myburgh IS, botha JJ. Gasoline/alcohol blends:exhaust emission, performance and burn-rate in multi-valve production engine, SAE paper no.961988,1996.
15. Stump F, Knapp K, Racy W. influence of ethanol blended fuels on the emissions from three pre-1995 light-duty passenger vehicles. J air waste manage assoc 1996;46:1149-61.