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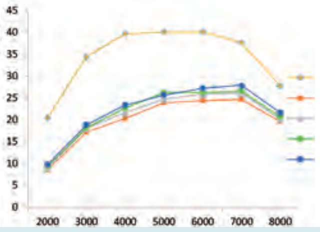
Septiembre - Octubre 2017

Suitable injection duration of pure ethanol fuel for motorcyle at a high compression ratio



Duración apropiada de la inyección de etanol puro para una motocicleta con una relación de compresión alta

Marthen Paloboran[1], **I Nyoman Sutantra**[2], **Bambang Sudarmanta**[3], **Renno FD Dharmawan**[4]

[1] Automotive Engineering Department. Universitas Negeri Makassar, Makassar 90242, South Sulawesi (Indonesia).
[2] Head of Automotive Laboratory. Sepuluh Nopember Institute of Technology, Surabaya 60111, East Java (Indonesia).
[3] Head of Fuel and Combustion Engineering Laboratory. Mechanical Engineering Department. Sepuluh Nopember Institute of Technology - Surabaya 60111, East Java (Indonesia).
[4] Undergraduate in Mechanical Engineering of Sepuluh Nopember Institute of Technology, Surabaya - 60111, East Java (Indonesia).

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RESUMEN

- El consumo de gasolina en el sector del transporte continúa aumentando junto con el aumento de población y civilización. Por otro lado, las reservas de combustibles fósiles continuaron disminuyendo en las últimas décadas. Por lo tanto, se necesita un nuevo tipo de combustible derivado de fuentes de energía renovables. Además los productos de combustión de los combustibles fósiles contribuyen a la contaminación del aire y al calentamiento global, por lo que el uso de los biocombustibles es una de las soluciones para superarla. El etanol tiene un impacto positivo en la reducción de las emisiones de gases de escape y el aumento del par y la potencia. Por esa razón, el etanol será un denominador común para reemplazar la gasolina en el futuro. Este estudio investigó el efecto del E100 sobre los resultados y las emisiones de la motocicleta indonesia. La investigación realizada mediante el mapeo de la duración de la inyección a una alta relación de compresión. Los resultados muestran un aumento del par, potencia y BMEP cuando aumenta la relación de compresión. Al mapear la duración de la inyección, todos los parámetros de rendimiento aumentaron gradualmente hasta la velocidad máxima. Además, la emisión de CO y HC disminuye significativamente por este método. Sin embargo, el SFC y la eficiencia térmica del etanol son inferiores a la gasolina, como consecuencia de que el valor de calentamiento del etanol es menor que el de la gasolina
- **Palabras clave:** Biocombustible, mezclas gasolina-etanol, alta concentración, duración de la inyección, mapeo.

ABSTRACT

The gasoline consumption in the transportation sector continues to increase along with the increase of population and civilization. On the other side, the fossil fuel reserves continue to decline in recent decades. Therefore, a new type of fuel derived from renewable energy sources is needed. Moreover, the combustion products of the fossil fuels contribute to air pollution and global warming, so the use of the bio fuels becomes one of the solutions to overcome it. Ethanol has a positive impact in reducing the exhaust carbon emissions and increasing the torque and power. By that reason, ethanol will be a nominator to replace the gasoline fuels in the future. This study investigated the effect of E100 on performances and emissions of Indonesian motorcycle. The research was conducted by mapping the injection duration at a high compression ratio. The results showed increased torque, power and BMEP when compression ratio increased. By mapping the injection duration, all the performances parameters increased gradually up to the maximum speed. Moreover, the CO and HC emission decreased significantly by this method. However, the SFC and thermal efficiency of ethanol were inferior to gasoline. It was because ethanol had lower heating value than that of gasoline.

Keywords: Biofuel, gasoline–ethanol blends, high concentration, injection duration, mapping.

1. INTRODUCTION

The combustion product of fossil fuels has caused the global warming that impacts on increased sea surface temperature. By about 73% of greenhouse gas (GHG) over the world is derived from the automotive activities. According to the data, the CO_2 emission is produced by more than 600 million vehicles of its daily operation. The gas emissions predicted will increase when the vehicles grow up to 2.5 billion in 2050 (Sergio and Otto Anderson, 2014; Mustafa Balat et al., 2008; S. Lopez et al., 2013).

Fossil fuel existence both as potential and proven reserves has decreased every year in all of regions. In March 2016, DEN has reported that 1.7 billion barrel of fossil fuels will be ready to serve the world energy consumption for 50-55 years. While the Indonesian fossil fuel by about 7.5 million barrel is estimated to be run out within 12–15 years. These are the estimates based on the assumption that there is no new discovery of oil wells anymore. The high production of CO_2 emissions in the transport sector caused by more than a half of the energy consumption is spent on this sector. As an illustration, the total use of fossil energy in Indonesia along 2014 amounted to 70.9 kiloliters, while 45.9 kiloliters used by car, truck and other automotive products (DEN, 2016).

Popularization of ethanol as a green fuel has been proven by many researchers, so the research in the bioethanol field continues to grow up until now. As an alternative energy, ethanol has been used by Nicholas Otto in 1897, previously Henry Ford has also used the fuels on the design T of Ford car since 1880 (Mustafa Balat et al., 2008; S. Lopez-Aparicio and C. Hak, 2013; Charles Wyman et al., 2004). As blend fuels with gasoline, however, the fuel has been used extensively since 1980s in Brazil. Even, the Brazil government has made a regulation that requires all gasoline be blended with at least 20 – 25% ethanol (Milnes R et al, 2010; Rubio E. Nicolas, 2006; Larry G. Anderson, 2015).

In Indonesia, the use of ethanol as an alternative energy is being re-echoed recently, due to the use of the fuel is only about 3% until now. Indonesian government has decided the necessity of use of bioethanol by 20% in all energy consumptions in 2025. Several infrastructures are being prepared to support the government's policies including the development of research on the use of bioethanol. Unfortunately, research on the use of bioethanol in Indonesia has never been conducted as advanced as the overseas. Whereas, Indonesia already has a bioethanol plant with a big scale production, even their products have been exported to neighboring countries i.e. Thailand, Philippines, and Vietnam etc.

This paper reports the effects of E100 fuel to the engine performance and emissions at a high compression ratio. As known, the calorific value of ethanol is lower than gasoline, so enlarging the hole of injector or increasing the injection duration of ethanol is a method to achieve an equal power to gasoline. Injection duration variation method is applied in this study to determine its effect on engine performance and emissions. The variations in injection duration start from 100% to 200% with an increment of 25% at all compression ratios and engine speeds. The specific of this study is the high compression ratio of 12-13 which has never been applied to a small capacity engine of 150cc. All the data is produced in this test will be compared with the engine performance when the engine runs with gasoline fuels.

2. LITERATURE REVIEW

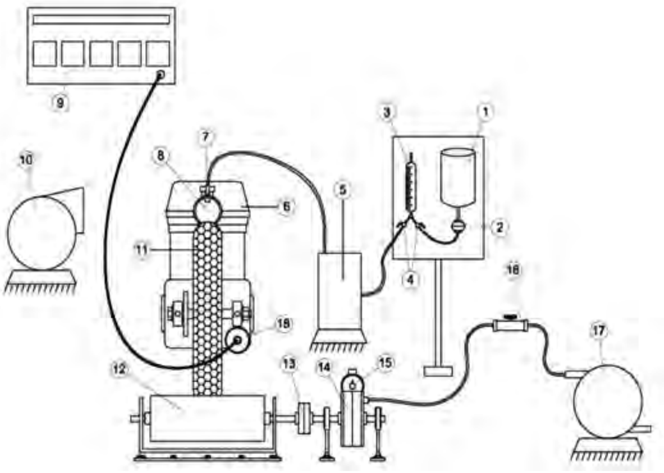
Research about the fuel blend of gasoline-ethanol up to 20% has been studied by many researchers successfully, where the engine does not need any adjustments at these kinds of composition (Marthen Paloboran, 2016). It is due to the fuel blend will act as an octane booster so that detonation problems can be reduced (Algariksa A. Fintas et al., 2013; Najafi G et al., 2015; B.M. Masum et al., 2015; Yang Hsi-Hsien et al., 2012; Murat Kapusuz et al., 2015; Yung-Chen Yao et al., 2013; Chan-Wei Wu et al., 2004).

The high oxygen content of ethanol is very useful to complete combustion process in decreasing hydrocarbon emissions (C. Ananda Srinivasan and C.G. Saravanan, 2010; Costa C. Rodrigo et al., 2010; Turkoz N. et al., 2014; Turner D. et al., 2011; Sudarmanta B. et al., 2016). The oxygen in ethanol is more effective to make the combustion process in a stoichiometric (Alan C. Hansen et al., 2005). The high of the latent heat of vaporization is another property of ethanol that confers a benefit when applied in spark engine. This property will give an impact in decrease of peak of cylinder temperature and give a cool effect on the combustion chamber. Then, the NO_x emissions will decrease and air flow rate into the combustion chamber increases. When the air flow rate increases, the density of mixture will be more solid, in turn, the volumetric efficiency will increase. The most popular of ethanol advantages is the high octane number when compared to gasoline. With a high octane number, ethanol can be run in the gasoline engine by improving the compression ratio in highest. The results, the power, torque, effective pressure and thermal efficiency can be increased. Furthermore, specific fuel consumption can be reduced by increasing the compression ratio (Costa C. Rodrigo et al., 2010; Balki MK and Sayin C, 2014; Farha Tabassum Anshari et al., 2013; Chan-Wei Wu et al., 2004).

Nowadays, many researchers study the effect of combustion gasoline-ethanol blend on the performance and emissions of engine at variations in the compression ratio, such as Rodrigo and Sudarmanta. Their studies found that the torque, power and BMEP increase if the compression ratio increases when the E22, E50 and E100 fuels are applied. However, the SFC of E22 is higher than E0 by about 0.09kg/HP-h, and the SFC will increase if the concentration of ethanol increases. It is caused by the calorific value of ethanol is lower than gasoline, so that the ethanol fuel consumption is wasteful by about 60-65% compared with gasoline (Chelik M. Bahattin, 2007; Jeuland N. et al., 2004; Dharmawan RFD, 2016).

The effect of M100, E100 and E0 fuels on the CO and HC emissions at variations in the compression ratio has been studied by Balki et al. The results show that the CO and HC emissions decrease if the compression ratio increases up to 9: 1 when M100 and E100 are burnt. However, the CO and HC emissions increase if the compression ratio is mounted on the 9.5: 1 for all of alcohol fuels. Different with Farha's study, the CO and HC emissions of E100 consistently decrease, even though the engine runs on the compression ratio of 10: 1. It is influenced by the spark timing, since the ignition timing will be advanced if the compression ratio increases. In the same thing, the ignition timing will advance if the concentration of ethanol increases. It is affected by the laminar flame speed and latent heat of vaporization of ethanol. With a high of laminar flame speed of ethanol, the combustion process of ethanol is being faster than that gasoline, so the ignition timing has to advance. Meanwhile, a high of latent heat of vaporization of ethanol will affect on a long time in ignition delay when the ignition timing is advanced. By a long time in ignition delay, the cylinder temperature decreases and volumetric efficiency increases (B. M. Masum et al., 2013; Marthen Paloboran et al., 2016).

The influence of the gasoline-ethanol blend fuels on the CO and HC emission at variations in engine load has also been investigated by Anshari et al. The results reveal that the CO and HC emissions will increase if the engine load increases. When the engine load increases, the flow rate of fuel also increases. At the same time, the mass flow rate of air is comparable with fuel in making a stoichiometric condition. Actually, the air flow rate come into the cylinder is insufficient restricted by the valve mechanism. Eventually, a part of hydrocarbons fuel is unburned and produces CO and HC emissions. Insufficient of air in the combustion chamber can be overcome by installing a turbocharger on engine (Marthen Paloboran et al., 2016; Elfasakhany Ashraf, 2015).



1. Fuel Tank
2. Filter fuel
3. Glass gauge
4. Valve
5. Fuel pump
6. Engine test
7. Injector
8. Throttle body
9. Gas analyzer
10. Blower
11. Back train
12. Roller
13. Clutch
14. Dynamometer
15. Torque gauge
16. Valve
17. Water pump
18. Exhaust manifold

Figure 1. Schematic diagram of experimental set-up

The low vapor pressure of ethanol is one of ethanol drawbacks in spark engine. A negative impact of these properties causing the engine is difficult to turned on in cold conditions. Therefore, an effort is required to make the fuel to be more volatile. Installing a heater on the injector nozzle is one of methods in increasing the fuel temperature. Raising the air temperature is another method by installing a heater on along a channel crossed by the air. However, using two fuel tanks ismore common to handle the problem, which the gasoline tank is used when cold starts and ethanol tank is used if engine temperature is hot (Chen RH et al., 2011; M. Clairotte et al., 2013; Mustafa Balat et al., 2008). The ethanol shortage that has not been seriously considered is the high solubility of ethanol in the water. Consequently, the engine material that made from metal is susceptible to corrosion (Jeuland N et al., 2004; Mustafa Balat et al., 2008).

3. EXPERIMENTAL TOOLS, MATERIAL AND METHODS

The engine test used in this experiment was 4 stroke engine, 1 cylinder and types of CB150R by Honda manufacturers. The compression ratio standard of engine was 11: 1, but it had been developed to 13: 1 to accommodate the use of ethanol.

Parameters	Standard
Engine type	4 Stroke, 4 Valve, 1 cylinder
Bore	63.5 mm
Stroke	47.2 mm
Displacement volume	149.48 cm^3
Compression ratio	11.0 : 1
Ignition system	Full transistorized
Maximum power	12.5kW(17 PS)/10000RPM
Maximum torque	13.1Nm(1,34kgf.m)/8000RPM
Intake valve opening	5° BTDC, lifting 1 mm
Intake valve closure	35° ABDC, lifting 1 mm
Exhaust valve opening	35° BBDC, lifting 1 mm
Exhaust valve closure	5° ATDC, lifting 1 mm
Valve Train	Chain, DOHC

Table 1: Engine specification

Compression ratio standard of engine was 11:1 which was developed up to 13:1 with applying a dome on cylinder head. While at the compression ratio of 12:1 and 12.5:1, a suitable gasket was applied on the engine. The detailed engine specifications are shown in Table 1.

The main condition in this test was a fully open throttle and speed engine varied from 2000 to 8000 rpm. Whereas the lambda value was noted according to natural conditions. The engine speed was controlled by a water brake dynamometer of DYNOmite type. In this experiment, the torque was measured directly by the torque gauge on the dynamometer. Thus, the power to be calculated indicated a brake horsepower (BHP) as an actually power delivered by engine. As known, the brake horsepower is usually measured by various devices, one of them is by water brake such as in this test (Paul W. Gill, 1959).

Some thermocouples were mounted to record the coolant oil temperature, cylinder block and cylinder head of engine. A STARGAS 898IND was placed on exhaust manifold to detect the CO and HC emissions. As additional information that CO_2 and NOx emissions sensor may not work properly, these emissions cannot be displayed in the discussion session. As known, however, the CO_2 and NOx emissions of pure ethanol fuels have no or less negative impact on the environment and ecosystem.

Type of gasoline used in this test has RON 92, in Indonesia it is called PERTAMAX. Whereas the ethanol has RON 110. The ethanol is produced by Energy Agro Nusantara (ENERO) Co. Ltd. Fuel consumption was noted when the engine had spent of fuel in every 25 mL. Whereas the mapping injection duration was performed to find the maximum torque at all of the compression ratios and engine speeds. Analysis of the performance and emission of engine was based on the best torque. The entire testing stages were controlled by an electronic control management by ECU SUM-IT.

4. RESULT AND DISCUSSION

Investigating the effect of injection duration on the performance and engine emissions at variations in engine speed and compression ratio is another objective of this study. Furthermore, some important results in this test are reported as below.

4.1. EFFECT OF THE E100 AND E0 ON THE PERFORMANCE OF ENGINE

Figure 2 shows the effect of E100 and E0 fuels on the BMEP at variations in the compression ratio and engine speed. The BMEP slightly increases when the engine speed increases. The maximum value is obtained by the BMEP when the engine runs with 7000 rpm at all compression ratios. If compared with gasoline, BMEP of ethanol increases by about 5, 8 and 9% at the compression ratio of 12, 12.5 and 13 respectively. In general, the BMEP is stated in the equation as follow (Heywood JB, 1988):

$$\mathrm{BMEP} = \frac{2\pi z T}{A \times L \times i}$$

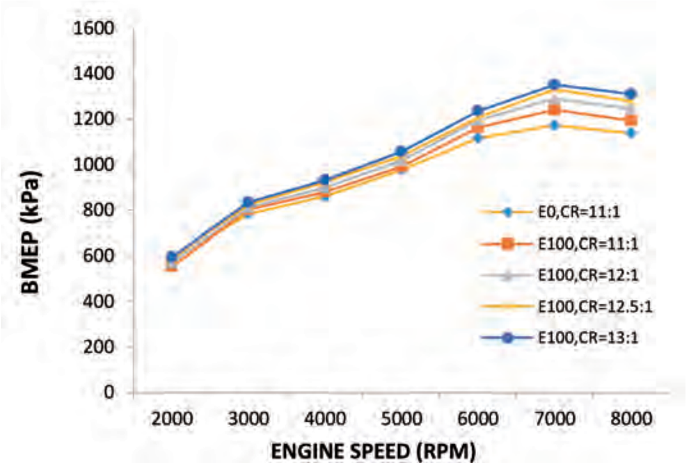


Figure 2: BMEP vs engine speed at variations in the compression ratio

Where T is torque, AxL is displacement volume (m^3), is a number of crank revolutions per power stroke (for a 4-stroke engine z=2) and is number of cylinder. The BMEP decreased in average by about 3.4% from the maximum values at all fuel and compression ratio. The decline is caused by many things, one of which is a cylinder pressure decrease when the expansion stroke is at a high speed.

Figure 3 shows the effect of E100 and E0 fuels on the power at the variation in the compression ratio and engine speed. The power of E100 is higher than E0 by about 2.1% in the same compression ratio. The power increases steadily by about 4.9%, 7.1% and 8.4% when the compression ratio increases of 12:1, 12.5:1 and 13:1 respectively. By the mapping injection duration strategy, the power increases continuously up to the maximum speed.

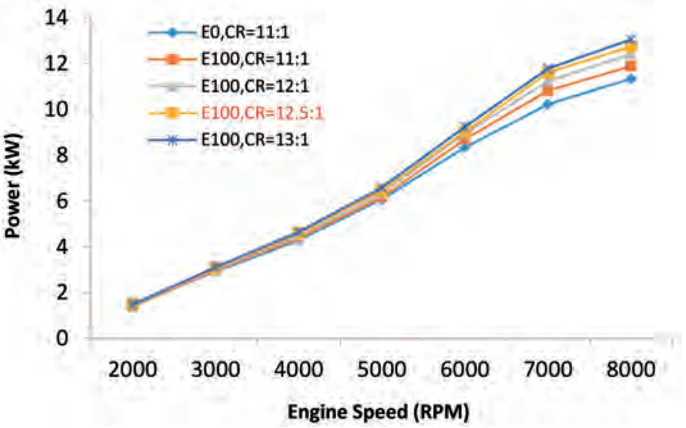


Figure 3: Power vs engine speed at variations in compression ratio

Overall, BMEP and power increase with increasing the compression ratio. The increase is contributed by the latent heat of vaporization and octane number of ethanol which is higher than gasoline. The latent HoV will be impact on increase of the density of charge. While, the octane number will be impact on the increase of cylinder pressure due to the combustion chamber has been narrowed. Mapping the injection volume is very helpful in increasing the pressure and power of engine. Since the mapping is conducted based on the maximum brake torque, thus, the injection of ethanol at each of engine speed and compression ratio will obtain the power maximum.

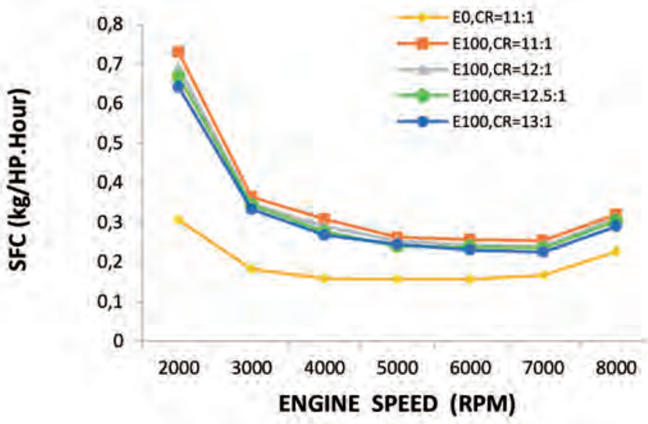


Figure 4: SFC vs engine speed at variable compression ratio

The effect of E100 and E0 fuels on the specific fuel consumption is given in Figure 4. The minimum SFC is obtained by the E0 at an engine speed of 6000 rpm, while the E100 at 7000 rpm at all of the compression ratios. The SFC of E100 is higher than E0 by 42.9% at the same compression ratio. However, the SFC can be lowered by a high compression ratio. The SFC of ethanol decreases gradually by about 2.9%, 4.6% and 6.5% at the compression ratio of 12:1, 12.5:1 and 13:1 respectively. In many studies, the SFC of E100 is higher about 60% than E0, because the heating value of ethanol is only 60% of the heating value of gasoline. In this test, however, the fuel consumption decreases by 17.1% with the method of mapping the injection duration.

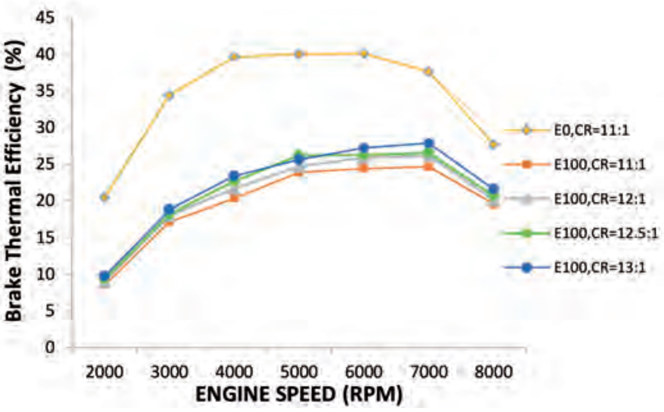


Figure 5: BTE vs engine speed at variable compression ratio

Figure 5 shows the influence of E100 and E0 on the brake thermal efficiency at variations in the compression ratio and engine speed. The BTE of gasoline reaches a peak value shortly at an engine speed of 4000 rpm. The BTE tends to be stable up to 7000 rpm, and eventually, the BTE decreases dramatically at a maximum engine speed. In contrast to gasoline, the BTE of ethanol rises gradually up to the engine speed of 7000 rpm. Furthermore, the BTU of ethanol decreases similarly with gasoline. The average of thermal efficiency of gasoline is about 34.3%, while the BTE of ethanol is around 19.8%, 20.8%, 21.4% and 22.0% at the compression ratio of 11, 12, 12.5 and 13 respectively. The BTE of ethanol is lower than that gasoline, because the calorific value of ethanol is lower than that gasoline. However, the BTE of ethanol can be increased by increasing the compression ratio and engine speed. In addition, a lot of frictional losses and heat loss during the engine work at 8000 rpm. By mapping the injection duration strategy, however, the increase of BTE of ethanol successfully is maintained at a high speed.

4.2. EFFECT OF THE E100 AND E0 ON EXHAUST EMISSION

Figure 6 illustrates the effect of E100 and E0 on carbon monoxide emission. The CO emission is obtained by ethanol fuels by about 26.7% lower than gasoline at the same compression ratio. These emissions decline in higher compression ratio. By increasing the compression ratio to 12, 12.5 and 13, the CO emissions decrease by around 38.8%, 50.3% and 63.7% respectively if compared with gasoline. Mapping the injection duration method has

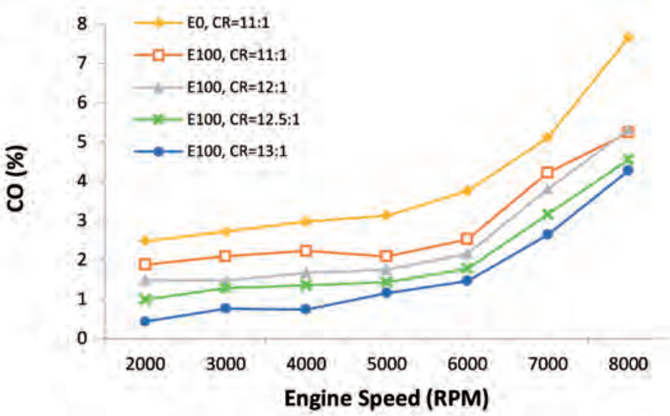


Figure 6: The CO emissions vs engine speed at variable compression ratio

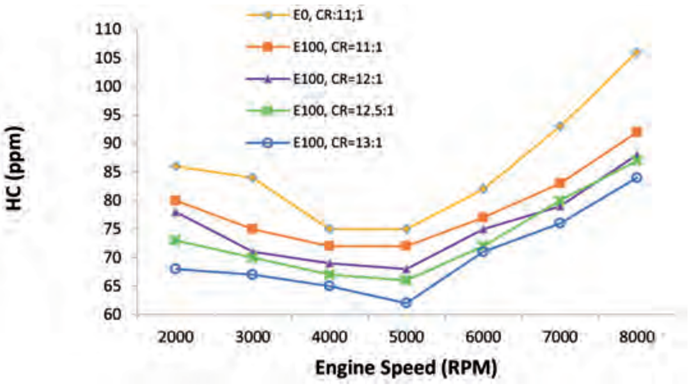


Figure 7: The HC emission vs engine speed at variable compression ratio

a significant impact on the CO emission which remains stable at 3000-6000 rpm. The high oxygen content of ethanol is a major contributor to the CO emissions of drops significantly. In addition, the high of octane number and laminar flame speed of ethanol causes the E100 burn completely than those E0.

Figure 7 shows the influence of E100 and E0 on the HC emissions at the variation of compression ratio and engine speed. The engine produces the HC emissions by about 86ppm with the gasoline fuel, but these emissions slightly decrease by 8.3% when E0 is replaced with the E100 at the same compression ratio. By increasing the compression ratio, the HC emissions gradually decrease when the engine runs with E100. In this test, the HC emissions of E100 decrease by about 12.1%, 14.3% and 18.0% at the compression ratio of 12, 12.5 and 13 respectively. The HC emission has been produced by the incomplete combustion in chamber. It is affected by a lot of things including the homogeneity of the charge, temperature of cylinder, the availability of air and the ignition timing.

CONCLUSION

The effect of E100 fuels on performances and emissions at high compression ratio with mapping the injection duration strategy has been investigated. All the results of E100 experiments will be compared with E0 fuels. These results have been summarized as follow:

- The temperature of fuel is not heated when engine runs with E100, but requires a great effort to start the engine. The air temperature on the summer in Indonesia, namely 31-33^{o}C, has influenced the ethanol, so the fuel does not need to be heated.
- Mapping the injection duration has been identified a maximum torque at any engine speed i.e. 200% on 2000-4000 rpm, 175% on 5000-6000 rpm and 150% on 7000-8000 rpm, respectively at the compression ratio of 12. The injection volume of ethanol becomes 200% on 2000-3000 rpm, 175% on 4000-6000 rpm and 150% on 7000-8000 rpm respectively at compression ratio of 12.5. Finally, 200% on 2000-3000 rpm, 175% on 4000-5000 rpm and 150% on 6000-8000 rpm when the engine runs with compression ratio of 13. Thus, the best performance of the engine is obtained when the injection duration is applied by 150-200%. In the engine speed of 2000-4000 requires maximum injection volume, because the caloric value of ethanol is lower. On the other hand, the low of engine temperature has caused the injection of ethanol increased to overcome the initial of engine load. By increasing the engine speed and compression ratio, the cylinder temperature will increase to resolve the low of vapor pressure of ethanol, in turn, the ethanol can be evaporated easily. According to the Celik's study, it necessitates 1.5-1.8 times more ethanol to obtain the equal energy output of gasoline.
- Thermal efficiency is given by the ratio between the output power and product of the fuel mass flow rate and the calorific value of fuel. An increase in compression ratio will affect on the increase in power, torque and thermal efficiency directly. According to this experiment, reductions in the fuel consumption are contributed by a high compression ratio. In the fact, reduction in fuel consumption will increase the thermal efficiency. At this point, the compression ratio becomes a key to improve the performances of the engine.
- As a mentioned above that an increase in compression ratio produced high pressure. But, if the pressure is too high will make the connecting rod of engine crooked. Thereby, increasing the compression ratio should consider the material strength of the engine
- Increasing the compression ratio has a risk to increases in HC and CO emissions. The ratio between combustion chamber's surface area and volume increased when the compression ratio is being improved. Increasing the compression ratio will lead to misfiring in the combustion chamber, in turn, the CO and HC emission was formed (M.B. Celik, 2007). Adjustment on ignition timing is a solutions to reduce CO and HC emissions when the compression ratio increased. The ignition timing should be advanced when engine runs with ethanol fuel. It caused by a low of vapour pressure and a high of latent heat of ethanol. The vapour pressure and latent heat of ethanol will have an optimum impact on combustion process if the ignition timing is advanced.
- Overall, mapping the injection duration strategy has been improved the performance and decreased the engine emissions significantly. An advance research of this work has been prepared to investigate the effect of E100 on performance and emission by varying the ignition timing. Theoretically, the results of this experiment can be optimized with applying the ignition timing strategy.

BIBLIOGRAPHY

[1] Alan C. Hansen, Qin Zhang, Peter W.L. Lyne. "Ethanol–diesel fuel blends – a review". Elsevier. Bio Resource Technology. June 2004. Vol. 96. P. 277–285. DOI: http://dx.doi.org/10.1016/j.biortech.2004.04.007

[2] Algariksa A. Fintas, Susilo B, Nugroho A. Wahyunanto."Uji Motor Bakar Bensin (On Chasis) Menggunakan Campuran Premium Ethanol". Jurnal Keteknikan Pertanian Tropis dan Biosistem, Universitas Brawijaya-Malang, Indonesia. October 2013. Vol. 1-3. P.194-203

[3] Farha Tabassuma Anshari, Verma Abhishek Prakash, Chaube Alok. "Effect on performance and emissions of SI engine using ethanol as blend fuel under varying compression ratio". International Journal of Engineering Research and Technology. December 2013. Vol. 2. P. 848-864

[4] Balki MK and Sayin C. "The effect of compression ratio on the performance, emissions and combustion of an SI (spark ignition) engine uelled with pure ethanol, methanol and unleaded gasoline". Elsevier. Energy. May 2014. Vol. 71. P. 194-201. DOI: http://dx.doi.org/10.1016/j.energy.2014.04.074

[5] B.M. Masum, H.H. Masjuki, M.A. Kalam, S.M. Palash, M. Habibullah. "Effect of alcohol-gasoline blends optimization on fuel properties, performance and emissions of a SI engine". Elsevier. Journal of Cleaner Production. August 2014. Vol. 86. P. 230-237. DOI: http://doi.org/10.1016/j.jclepro.2014.08.032

[6] C. Ananda Srinivasan and C.G. Saravanan. "Study of combustion characteristics of an SI engine fuelled with ethanol and oxygenated fuel additives. Journal of

Sustainable Energy & Environment. 2010. Vol. 1. P. 85-91

[7] Chan-Wei Wu, Rong-Horng Chen, Jen-Yung Pu, Ta-Hui Lin. "The influence of air–fuel ratio on engine performance and pollutant emission of an SI engine using ethanol–gasoline-blended fuels". Elsevier. Atmospheric Environment. January 2004. Vol. 38. P. 7093–7100. DOI: http://dx.doi.org/10.1016/j.atmosenv.2004.01.058

[8] Charles Wyman, Erick D., Adam Han, Brian H. "Ethanol as duel for recreational boats". The Thayer School of Engineering at Dartmouth College. March 2004. www.dartmouth.edu/~ethanolboat

[9] Chelik M. Bahattin. "Experimental determination of suitable ethanol–gasoline blend rate at high compression ratio for gasoline engine". Elsevier. Applied Thermal Engineering. November 2007. Vol. 28. P. 396-404. DOI: http://dx.doi.org/10.1016/j.applthermaleng.2007.10.028

[10] Chen RH, Chiang LB, Chen CN, Lin TH. "Cold-start emissions of an SI engine using ethanol-gasoline blended fuel". Elsevier, Applied Thermal Engineering. January 2011. Vol. 31. P. 1463-1467. DOI: http://dx.doi.org/10.1016/j.applthermaleng.2011.01.021

[11] Costa C. Rodrigo, Sodre R. Jose. "Compression ratio effects on an ethanol/gasoline fuelled engine performance". Elsevier. Applied Thermal Engineering. September 2010. Vol. 31. P. 278-283. DOI: http://dx.doi.org/10.1016/j.applthermaleng.2010.09.007

[12] Dewan Energi Nasional. Outlook Energi Indonesia 2015. Jakarta-Indonesia. March 2016. 145p. ISSN: 2503-1597

[13] Elfasakhany Ashraf. "Investigations on the effects of ethanol-methanol-gasoline blends in a spark-ignition engine: Performance and emissions analysis". Elsevier. Engineering Science and Technology, an International Journal. June 2015. Vol. 18. P. 713-719. DOI: http://dx.doi.org/10.1016/j.jestch.2015.05.003

[14] Jeuland N, Montagne X, Gautrat X . "Potentiality of ethanol as a fuel fo dedicated engine". Oil & Gas Science and Technology-Rev IFV. Institut Francais du Petrole, Francis. 2004. Vol. 59. P. 559-570

[15] M. Clairotte et al. "Effects of low temperature on the cold start gaseous emissions from light duty vehicles fuelled by ethanol-blended gasoline". Elsevier. Applied Energy. October 2012. Vol. 102. P. 44–54. DOI: http://dx.doi.org/10.1016/j.apenergy.2012.08.010

[16] Milnes R, Deller Laura, Hill N. "Ethanol internal combustion engines. Etsap, Energy Technology System Analysis Programme, United Kingdom, England. June 2010 – www.etsap.org

[17] Murat Kapusuz, Hakan Ozcan, Jehad Ahmad Yamin. "Research of performance on a spark ignition engine uelled by alcohol-gasoline blends using artificial neural networks". Elsevier. Applied Thermal Engineering. August 2015. Vol. 91. P. 525-534. DOI: http://dx.doi.org/10.1016/j.applthermaleng.2015.08.058

[18] Mustafa Balat, Havva Balat, Cahide Oz. "Progress in bioethanol processing". Elsevier. Progress in Energy and Combustion Science. January 2008. Vol. 34. P. 551-573. DOI: http://dx.doi.org/10.1016/j.pecs.2007.11.001

[19] Najafi G, Ghobadian B, Yusaf T, Ardebili S.M.S, Mamat R. "Optimazation of performance and exhaust emission parameter of a SI engine with gasoline-ethanol blended fuels using response surface methodology". Elsevier. Energy. July 2015. Vol. XXX. P. 1-15. DOI: http://dx.doi.org/10.1016/j.energy.2015.07.004

[20] Rubio E. Nicolas, "Brazilian government policies in the ethanol program". A Model for the Rest of the World, Thesis Master of Art, University of Florida, USA. 2006

[21] Sergio M, Otto Andersen. "A review of emission products from bioethanol and its blends with gasoline. Background for new guidelines for emission control". Elsevier. Fuel. October 2014. Vol. 140. P. 293-301. DOI: http://dx.doi.org/10.1016/j.fuel.2014.09.101

[22] S. Lopez-Aparicio, C. Hak. "Evaluation of the use of bioethanol fuelled buses based screening and on the road measurements". Elsevier. Science of the Total Environment. March 2013. Vol. 452-453. P. 40-49. DOI: http://dx.doi.org/10.1016/j.scitotenv.2013.02.046

[23] Sudarmanta B., Junipitoyo B., Putra Krisna A. B., Sutantra I. N. "Influence of the compression ratio and injection timing on sinjai engine performance with 50% bioethanol–gasoline blended fuel". ARPN Journal of Engineering and Applied Sciences. February 2016. Vol. 11. P. 2768-2774.

[24] Turkoz N, Erkus B, Karamangil MI, Surmen A, Arslanoglu N. "Experimental investigation of the effect of E85 on engine performance and emissions under variation ignition timings". Elsevier. Fuel. March 2013. Vol. 115. P. 826-832. DOI: http://dx.doi.org/10.1016/j.fuel.2013.03.009.

[25] Turner D., Xu H., Cracknell FR., Natarajan V., Chen X. "Combustion performance of bio-ethanol at variation blend ratios in a gasoline direct injection engine". Elsevier. Fuel. January 2011. Vol. 90. P. 1999-2006. DOI: http://dx.doi.org/10.1016/j.fuel.2010.12.025

[26] Yang Hsi-Hsien, Liu TC, Chang CF, Lee Eva. "Effects of ethanol-blended gasoline on emissions of regulated air pollutants and carbonyls from motorcycle". Elsevier. Applied Energy. August 2011. Vol. 89. P. 281-286. DOI: http://dx.doi.org/10.1016/j.apenergy.2011.07.035

[27] Yoon SH, Lee CS. "Effect of undiluted bioethanol on combustion and emissions reduction in a SI engine at various charge air condition". Elsevier. Fuel. February 2012. Vol. 97. P. 887-890. DOI: http://dx.doi.org/10.1016/j.fuel.2012.02.001

[28] Yung-Chen Yao, Jiun-Horng Tsai, I-Ting Wang. "Emissions of gaseous pollutant from motorcycle powered by ethanol–gasoline blend". Elsevier. Applied Energy. August 2012. Vol. 102. P. 93-100. DOI: http://dx.doi.org/10.1016/j.apenergy.2012.07.041

[29] Marthen Paloboran, I.N. Sutantra, Bambang Sudarmanta, "Performances and emissions characteristics of three main types composition of gasoline-ethanol blended in spark ignition engine", Praise Worthy Prize, International Review of Mechanical Engineering, November 2016, Vol. 10-7, p. 552-559, DOI: http://dx.doi.org/10.15866/ireme.v10i7.9968

[30] Larry G. Anderson, "Effects of using renewable fuels on vehicle emissions", Elsevier, Renewable and Sustainable Energy Reviews, March 2015, Vol. 47, p.162-172, DOI: http://dx.doi.org/ 10.1016/j.rser.2015.03.011

[31] Heywood John B. Internal Combustion Engine Fundamentals. USA: McGraw Hill Series, New York, 1988. 930p. ISBN: 0-07-028637-X

[32] B.M. Masumn, H.H.Masjuki, M.A.Kalam, I.M.Rizwanul Fattah, S.M. Palash, M.J.Abedin. "Effect of ethanol–gasoline blend on Nox emission in SI engine". Elsevier. Renewable and Sustainable Energy Reviews. April 2013. Vol. 24. Pp. 209–222. DOI: https://dx.doi.org/10.1016/j.rser.2013.03.046

[33] Paul W. Gill, James H. Smith, JR, Eugine J. Ziurys, "Fundamentals of internal combustion engines", OXFORD & IBH PUBLISHING CO. Calcutta, Bombay New Delhi, 557p.

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