VANOS
JOURNAL OF MECHANICAL ENGINEERING EDUCATION
http://jurnal.untirta.ac.id/index.php/vanos
ISSN 2528-2611, e-ISSN 2528-2700
Vol.3, No.1, July 2018, Page.1-11.

THE EXHAUST GAS EMISSION TEST ON HONDA BRIO SATYA WITH VARIATION OF FUEL AND ROTATION ENGINE

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Received: 23 June 2018; Accepted: 30 June 2018; Published: 31 July 2018.

DOI: 10.30870/vanos.v3i1.3605

ABSTRACT

The purpose of this research are: 1) Knowing the exhaust gas emission test result from Honda Brio Satya with variation of fuel 2) Knowing the type of fuel that produces the lowest exhaust gas emission value. This research is using experimental method. This research was conducted in the automotive workshop of SMKN Udanawu Blitar Regency. Test media is a Honda Brio Satya type E 2017. The emission test used QROTEC QRO 402 gas analyzer. The results show that: 1) There is influence of fuel type to vehicle exhaust emissions, both at idle and intermediate rotation; 2) The average of CO gas emissions at idle rotation with fuel of each premium, pertalite and pertamax are 0.026%, 0.023% and 0.003%. The average of HC gas emission at idle rotation in each fuel type are 87 ppm, 86.3 ppm and 30 ppm. Thus, pertamax fuel produces the lowest level of exhaust emissions. The third fuel type still meets the threshold of motor vehicle emissions threshold in accordance with PERMEN LH No. 5 of 2010 so it is worthy to be used as an environmentally friendly learning media.

Keywords: Emission Test, Exhaust Gas, Fuel, engine rotation

INTRODUCTION

The automotive industry continues to grow rapidly, not least in Indonesia. Gaikindo (2017) reported that throughout 2016, the sum of vehicle production reached 1,177,797 units and sales during of it's year reached 1,062,729 units. Production and sales increased compared to 2015 with production of 1,098,780 units and sales reached 1,013,291 units.

The data is in line with the BPS data. BPS (2017) released from vehicle data in 1987-2013 where every year the number of vehicles ranging from passenger cars, buses, trucks, and motorcycles tends to increase. For example, in 2013 there was an addition of 9.7 million units, in 2012 increased 8.7 million units and in 2011 increased 8.6 million units.

The development of automotive industry still leaves three major issues, and this issues are a global issues. Kumara (General Secretary of Gaikindo) in Kompas.com (2017) stated that there are three major issues as a global challenge to be able to follow the trend of global industry. Ranging from energy and environmental issue, security technology, and free trade issue.

Energy and environmental issue like Corporate Average Fuel Economy (CAFE) and Carbon Tax. Security technologies such as seatbelt and airbags and free trade issue such as car density. Especially for energy and environmental issue, the government continues to strive global standards (CAFE and Carbon Tax) through the EURO standard (European Emission Standard). Indonesia currently still impose EURO 2 standards, whereas global standards are already above EURO 4.

The meaning of EURO is emissions. Wikipedia.org (2017) on its website announces that the EURO 2 standard for the type of passenger vehicle with gasoline fuel (gasoline), CO should not exceed of 2.2 g/km. EURO 4, EURO 5 and EURO 6 maximum CO not exceed of 1 g / km.

Fulfillment of EURO 2 standard and preparation towards EURO 4 should be the concern of every automotive industry including stakeholders who are involved in this scholarship. Air pollution caused by industrial development including the automotive industry is increasing very sharply. Arifin & Sukoco (2009: 31) states that some air pollution (70%) is caused by transportation activities. This problem becomes a global problem, where everyone is feeling the consequences. The existence of air pollution can damage air function.

Amruthraj, Nataraj & Poojary (2012) states that incomplete combustion has produced a waste gas that can degrade environmental quality. Prakash, Habib, Kumar, Sharma & Haider (2017) stated that vehicles on the road have had a significant influence in influencing the changing regional and global climate issues and human health.

Zakaria (2013) states that based on data from 2011-2012, from 22 major cities implementing the exhaust emissions test, 15 cities have increased concentrations of carbon monoxide gas (CO). There are only 7 cities that have decreased the concentration of CO gas, they are Tangerang, Semarang, Yogyakarta, Denpasar, Palembang, Surakarta and Malang. As a result of this case study in Jakarta, there are 57.8% of Jakarta residents suffering illness and medical costs for this problem reached 38.5 trillion.

Absolute experimental efforts must be done continuously by utilizing a number of variables that can be examined. Selection of variations of vehicle must be careful. Not only focus in economic or artistic, but also must prioritize for elements of human health and environmental hygiene.

The use of fuel affects vehicle exhaust emissions. This is accordance with the findings of Ningrat et al. (2016) which states that the use of Pertalite fuel on automatic transmit motor is more environmentally friendly than using premium fuel. The use of pertalite can reduce HC and CO gas.

The findings are in accordance with Yahya's findings (2015). There is a significant influence from the variation of fuel on CO and HC emissions in SUZUKI SPIN CW 125 motorcycles 2008. Pertalite fuel produces CO gas = 2.59% and HC gas = 452.16 ppm. While with pertamax yield CO gas= 2.14%, and HC gas 380.42 ppm.

The effect of fuel variation on exhaust gas emission level has also been stated by Sarjono & Sugiyarta (2014) that at rpm 8770 (premium, pertamax plus and super R95 extra shell) produce power of 20.7 HP, 21.6 HP and 24.4 HP. At 8189 rpm, torque of 17.61 kg.m, 14.36 kg.m, and 20.37 kg.m. respectively. The highest value of HC gas emissions (4020 ppm) is generated when using premium fuel, but with premium also CO emissions at the lowest level of 0.76%.

The three findings are also in line with the results of a study by Prawoto (2011) which states that in vehicles operating within the city, the exhaust emissions (CO and HC) using pertamax plus fuel are better than using Liquid Gas Vehicle (LGV) . Conversely, for out-of-town conditions, fewer CO2 emissions are generated when using LGV fuel instead of using pertamax fuel.

The fuel factor is not one of the causes affecting the exhaust emission levels of a vehicle, because combustion involves not only fuel but also air and ignition factors. The findings from Usman & Usman (2017) for example state that the test of carbon monochide (CO) carbon content with electronic stabilizers gives their respective values for standard plugs 0.11%, platinum 0.10% spark plug and 0.10% iridium spark plug. Without using an electronic stabilizer, carbon mono-oxide (CO) is produced with standard spark plugs of 0.15%, platinum plugs 0.12% and 0.12% iridium spark plugs.

Based on the existing literature review, the objectives of this research are: 1) To know the effect of the variation of fuel on the exhaust emission from Honda Brio Satya; 2) Knowing the type of fuel that produces the lowest exhaust gas.

THEORETICAL BASIS

Gasoline Engine

Gasoline engine is a type of motor fuel by using gasoline as a fuel source. Daryanto (2013: 1) states that motor fuel is a prime mover that converts fuel chemistry into heat (calor) power by combustion. The heat is then transformed into mechanical power. The combustion process occurs inside the combustion chamber so that this type of motor is also known as internal combustion engine or I.C Engine.

The burning process occurs when a machine meets several criteria. Daryanto (2013: 66) states that combustion can occur when there is fuel, air and fire (heat). These three conditions do not guarantee the complete combustion so that it is necessary to set the ratio of the amount of fuel and air with a certain ratio and also other factors namely the maximum (heat) flame.

Based on the cycle work, the motor is divided into 2 parts, there are motor 2 stroke and 4 stroke. Daryanto (2013: 12) states that the 2-stroke motor is a motor that requires 2 times the piston step (one rotation of the crankshaft) to produce one work, while the motor 4-stroke is a motor that requires 4 times the piston step (2 times the spin axis crank) to produce a one-time effort. The steps of the piston are known by the steps of intake, compression, combustion and exhaust.

At the intake step, the introduction of new gas into the cylinder through the suction valve. In the compression step, the pressure and temperature of the gas is increased by the compression of the gas by reducing the space. Position of inlet and exhaust valve closes. At the step of the combustion, the combustion pressure pushes the piston down and the position of the valve closes. At the exhaust step there is expenditure of used gas from the cylinder, through the exhaust valve. (Daryanto, 2013: 20).

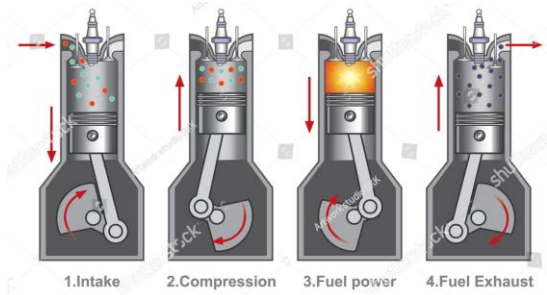


Figure 1. Motorized Burning Cycle
Sources: image.shutterstock.com

Exhaust emissions

Daryanto (2013: 20) states that in the exhaust step occurs the exhaust gas discharges from the cylinder through the exhaust valve. Arifin & Sukoco (2009: 34) states that the combustion gases consist mostly of non-toxic gases such as N_2 (nitrogen), CO_2 (carbon dioxide) and H_2O (water vapor). The other half is a toxic gas

such as NOx, HC and CO. Popular in the exhaust gases are toxic gases. On the gasoline engine the amount of exhaust emissions coincides with the large amount of the mixture of air and fuel, because the entry into the cylinder is a mixture between air and fuel.

Denton (2006: 120) describes the negative effects of toxic gases from combustion. CO gas mixed with blood hemoglobin will inhibit the flow of oxygen in the blood and potentially the occurrence of poisoning in the blood. HC gas potentially damages the human respiratory system (throat) when inhaled and is a carcinogenic gas. NOx gas has the potential to disrupt the respiratory system, and when mixed with nitric acid can damage the tracheal and lung tract.

The causes of toxic gas combustion results are very varied. CO gas is caused by insufficient oxygen (air) in combustion resulting in incomplete combustion. Chien, Martin & Rankin (2016) stated that the oxidation reaction of an incomplete hydrocarbon fuel would produce a CO gas. While, HC gas caused among others because around the walls of the combustion chamber is low temperatures that are not capable of burning, missfire and the over lap intake valve (both valves are equally open). NOx gas arises if the combustion temperature exceeds 2000 ° C.

Vehicle exhaust emission limits must follow government regulations. Based on PERMEN LH no 5 2010, motor vehicle for category M which is driven by motor burning fuel burning fuel over the value of CO threshold value of 1.5% and HC of 200 ppm.

Fuel

Combustion process occurs with the availability of fuel. Daryanto (2013: 14) states that based on the type of fuel, there are vehicles that are fueled liquid and some are gas-fueled. Liquid fuels include gasoline, diesel and kerosene. Gas fuel includes methane, prophan (LPG) and soil gas (LNG).

Gasoline-fueled vehicles currently have many alternative options. The fuel selection must necessarily follow the technical specifications of the engine manufacturer, although the final choice remains at the consideration of the economic factor of the vehicle owner. The gasoline variants in general are marketed in Indonesia include premium, Pertalite and pertamax.

Arifin & Sukoco (2009: 106) states that the premium is a type of fuel with a yellowish colour. Premium is generally used for gasoline motor fuels such as cars, motorcycles and outboard motors. This fuel is often also referred to as gasoline or petrol. Technical specifications have octane number (RON) 88.

Pertalite is a new variant of gasoline issued by Pertamina since mid-2015 ago. Pertalite is produced by adding additives in the process of processing at the oil refinery.

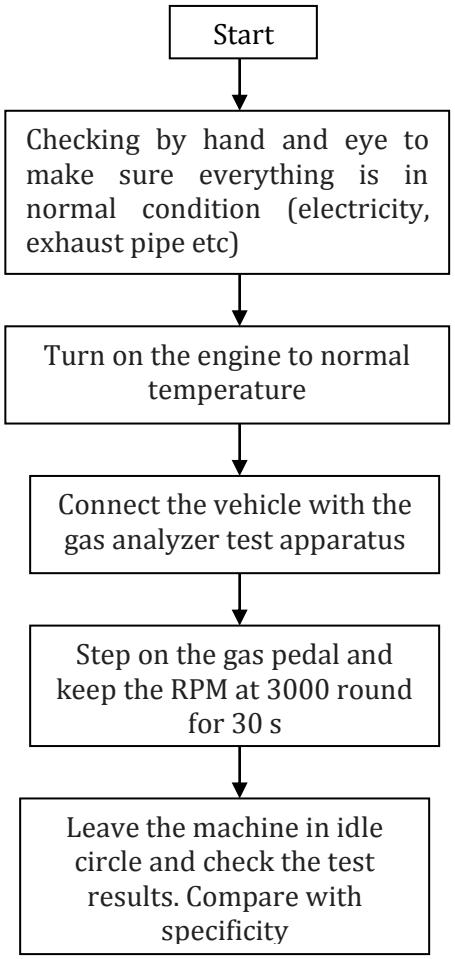
Pertalite has a quality above the premium that is with octane number (RON) 90.

Pertamax is unleaded gasoline with a state-of-the-art additives additive that can clean the intake valve port fuel injectors and combustion chamber from carbon. Pertamax is commonly used in vehicles with high compression. Technically, the octane number (RON) of pertamax is 92.

Figure 2. Pertalite, Premium and Pertamax
Sources: Mansar (2015)

Revolution Per Minutes (RPM)

The engine rotation is identical to the term RPM (Revolutions Per Minutes). RPM is the number of revolutions in a minute. Denton (2013: 122) states that vehicle exhaust emission checking procedures are carried out during engine conditions in idle or spin lap times. The idle rotation is the engine speed when the accelerator is not stepped on or when the trottle valve closes fully. Here are the exhaust gas emission checking procedures.



Flowchart 1. Chart of Emission Test Procedures
Sources: Denton (2006: 122)

The rotation of an idle or stationary machine of several vehicles is at 750 rpm. In general, the vehicle recommends the engine rotation between 2000-3000 rpm when running normally.

RESEARCH METHOD

This research is a kind of quantitative research. According to Sugiyono (2013: 34), quantitative methods are used when we want to know the effect of certain treatment. For this purpose the correct method is the experimental method.

The experiments planned in this research were to use variations of fuel (premium, pertalite and pertamax) and engine rotation difference (idle and normal rotation) on exhaust emissions. Fuel variation and engine rotation as well as independent variables and exhaust emissions as dependent variables.

This research was conducted in automotive workshop of SMKN Udanawu Blitar Regency. Technique of collecting data that is by measurement of exhaust emission from vehicle of Honda Brio Satya Type E year 2017 by using test instrument gas analyzer QROTEC QRO 402. The data collected, analyzed by using descriptive statistical analysis.

Figure 3. Technique of Exhaust Emission Testing
Sources: Wraiter (2017)

RESULT AND ANALYSIS

Based on the experiments that have been done, following data emissions from gas emissions Honda Brio Satya Type E 2017 by using premium fuel in a few rounds of the engine.

Table 1. Emission test results with Premium at idle rotation (750 rpm)

No	CO (%)	NOx (ppm)	HC (ppm)
TEST 1	0.03	0	87
TEST 2	0.02	0	85
TEST 3	0.03	0	89
Average	0.026	0	87

Table 2. Emission test results with Premium at intermediate rotation (2000 rpm)

No	CO (%)	NOx (ppm)	HC (ppm)
TEST 1	0.81	0	591
TEST 2	0.84	0	583
TEST 3	0.79	0	594
Average	0.81	0	589

The result of emission test with premium fuel at idle cycle (750 rpm) showed that CO gas concentration in three trials resulted in average 0.026%. NOx gas concentration average 0 ppm and HC gas average 87 ppm.

Based on the data and PERMEN LH No. 5 of 2010, the Honda Brio Satya type E 2017 with premium fuel still meets the emission threshold category where for production vehicles above 2008 at the time of maximum idle rotation testing of CO 1.5% and HC 200 ppm.

The following data of exhaust emissions of Honda Brio Satya Type E 2017 by using fuel pertalite in several engine revolutions.

Table 3. Table emission test results with Pertalite at idle rotation (750 Rpm)

No	CO (%)	NOx (ppm)	HC (ppm)
TEST 1	0.01	0	84
TEST 2	0.03	0	87
TEST 3	0.03	0	88
Average	0.023	0	86.3

Table 4. Emission test results with Pertalite at intermediate rotation (2000 rpm)

No	CO (%)	NOx (ppm)	HC (ppm)
TEST 1	0.72	0	571
TEST 2	0.74	0	583
TEST 3	0.67	0	580
Average	0.71	0	578

The result of emission test with Pertalite fuel at idle cycle (750 rpm) showed that CO gas concentration in three trials resulted in average 0.023%. NOx gas concentration average 0 ppm and HC gas average 578 ppm.

Based on the data and PERMEN LH No. 5 of 2010, the Honda Brio Satya type E 2017 with premium fuel still meets the emission threshold category where for production vehicles above 2007 at the time of maximum idle rotation testing of CO 1.5% and HC 200 ppm.

The following data of exhaust emissions of Honda Brio Satya Type E 2017 by using pertamax fuel in several engine rotations.

Table 5. Emission test results with Pertamax at idle rotation (750 rpm)

No	CO (%)	NOx (ppm)	HC (ppm)
TEST 1	0.00	0	27
TEST 2	0.01	0	33
TEST 3	0.00	0	30
Average	0.003	0	30

Table 6. Emission test results with Pertamax at intermediate rotation (2000 rpm)

No	CO (%)	NOx (ppm)	HC (ppm)
TEST 1	0.45	0	501
TEST 2	0.43	0	507
TEST 3	0.45	0	499
Average	0.44	0	502.3

The result of emission test with fuel pertamax at idle rotation (750 rpm) showed that CO gas concentration in three trials resulted in average 0.003%. NOx gas content average 0 ppm and 30 ppm of HC gas.

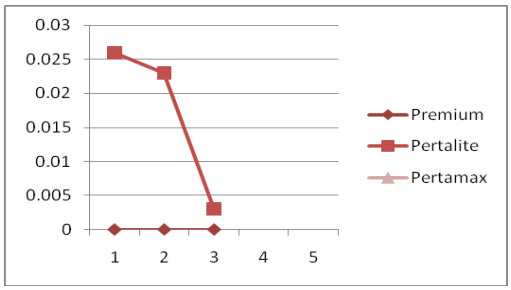
Based on the data and PERMEN LH No. 5 of 2010, the Honda Brio Satya type E 2017 with premium fuel still meets the emission threshold category where for the production vehicle above 2007 at the time of maximum idle rotation testing of CO 1.5% and HC 200 ppm.

The three types of fuel in the idle rotation test are still included in the threshold of exhaust emissions based on PERMEN LH No. 5 of 2010. The best value is obtained when the experiment uses Pertamax fuel with the average CO value of 0.003%, NOx of 0 ppm and HC level equal to 30 ppm.

In the intermediate round (2000 rpm), the best value is also obtained when using pertamax fuel with an average CO content of 0.44% and HC 502.3 ppm. CO concentration during mid-round is still within the threshold limit of 1.5% but for the HC level exceeds the threshold of 200 ppm. High levels of HC is possible because of the occurrence of missfire and the over lap intake valve (both valves are equally open).

There is a comparison chart of CO gas emission levels in idle rotation with variation of three types of fuel.

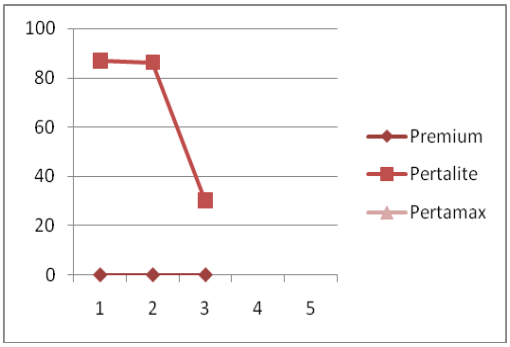
Chart 1. CO Gas Level at idle



Based on the chart, then CO emission levels when using premium fuel and Pertalite is almost the same (0.026, 0.023). While at the same time using pertamax CO gas emission level 0.003. This is possible because Pertamax fuel has RON 92 and Honda Brio Satya type E 2017 is recommended to use fuel with RON 92 (pertamax).

There is the chart of HC gas emission levels on idle rotation with variation of three types of fuel.

Chart 2. HC Gas Level at idle



Based on the chart, the level of HC gas emissions when using premium fuel and Pertalite is almost the same (87; 86.3). While at the time of using pertamax 30 cm of HC gas emission level. At the time of idle and medium rotation did not find NOx gas emissions due to the occurrence of NOx gas ie burning temperature exceeding 2000° C does not occur.

CONCLUSION

Based on the results and discussion, it can be concluded as follows.

1. The influence of the use of fuel to vehicle exhaust emissions. Both on idle and intermediate rotations.
2. The average of CO gas emissions in idle rotation with fuel of each premium, pertalite and pertamax is 0.026%, 0.023% and 0.003%. The average of HC gas emission at idle rotation in each fuel is 87 ppm, 86.3 ppm and 30 ppm. Thus, pertamax fuel produces the lowest levels of exhaust emissions.

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