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Exhaust Emission Analysis on Motorcycle with Fuel and Gasoline Mixture of H_2O Electrolysis

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ABSTRACT

In this study, researchers used a type of motor 4 stroke 125 cc Suzuki Shogun brands with the year of manufacture 2010. Data collection exhaust emission test performed when the motor before and after wear electrolytes with various mixtures of electrolyte. Data were taken by the engine rotation changes from 1,000 RPM to 4,000 RPM. The highest yield for CO occurred at 4000 RPM with an electrolyte mixture of distilled water and 1 ½ tablespoons of KOH with a value of 1.04%. While the lowest CO occurred at 3,200 RPM when the motor was not used electrolysis with a value of 0.07%. For HC was highest at 1,000 RPM when the motor was not used electrolysis the value of 382 ppm. While the lowest occurred in HC 4,000 RPM with a mixture of distilled water and KOH electrolyte ½ tablespoons of as much as 20.33%. The highest value of CO_2 was in the second electrolyte mixture, 8.2%. It was the first mixture between KOH electrolyte and distilled water. In the other hand, the lowest value of CO_2 value was around 4.1%. It happened for the second time mixture while the motor electrolysis only distilled water and electrolytes itself.

Keywords: *electrolysis, exhaust emissions, motorcycle*

1. INTRODUCTION

Air pollution in Indonesia in recent years was increasingly worrying, especially in Jakarta(Baum et al., 2015). As the capital city, Jakarta was a city that has a very high pollution problem both for the household sector, industry, and transportation. Based on the results of studies conducted by JICA and BAPEDAL year 1997, it was known that a motor vehicle was a contributor to emissions of CO and SO_2 largest in Jakarta. The air pollute reported to 599 180 and 411 140 tonnes / year, much smaller than the utility / household, industrial (Izzati, 2016a, b; Izzati et al., 2016a; Izzati et al., 2016b; Izzati et al., 2016c)and solid waste(Goembira et al., 2014).

For a four-wheeled vehicle ownership, based on the study conducted by JICA and BAPPENAS, it was known that the average car ownership per 100 inhabitants was 20.7 and the average car ownership per home ownership was 1.2, equal and even surpass developed countries (Dharmowijoyo et al., 2014; Putra et al., 2016). Also explained that, there are 28.8% of the population who do not use motor vehicles and 78.2% using a motor vehicle, with the composition, 52.7% use the bus, 30.8% use private cars, 14.2% use the bike, and only 2.0% are using the train fire.

Based on the Indonesian Motorcycle Industry Association (AISI), the motorcycle in the last four years has increased very significantly. In 2014 only motorcycle production was 7,926,104 units. With increasing motorcycle, hence the need for fuel oil was only increasing. The more fuel used, the more pollution produced(Amalia et al., 2013; Both et al., 2013; Prayudyanto et al., 2013), especially because of the limitation of open space to provide the green area(Izzati and Poerwanti, 2014).

The modification automotive sector recently experiencing rapid growth and diversification, almost all systems in automotive technology, both motorcycles and cars to experience a touch of modification(Razali et al., 2015). Modification of the automotive sector which do aim to get better performance from a system of automotive work, carried out with a standard working system, or component specification changes by giving an additional component(Cavallo and Pinto, 2014).

One of the new technologies had developed the Hydrogen Electrolyzer as a reused source system(El Shenawy et al., 2012; Gahleitner, 2013; Ono, 2016). Hydrogen Electrolyzer is form of plastic tube components therein contains two stainless steel rods filled with distilled water was added electrolyte then connected to a motorcycle battery to convert water into H_2 and O_2 gas. These gases will be used as reused energy source in a combustion engine.

Electrolytes material in the new technology was H_2O and KOH. Due to its existence readily available and cheap, many researchers try to modify the fuel system by adding an H_2O gas formed by H_2O and KOH electrolysis. This technology is important in order to reduce emissions in vehicles.

2. METHODS

2.1 Materials

The study was conducted in Auto Works Great Hall Training-Serang, (BBLKI -Attack), and motorcycles that will used in the study was a motorcycle -type 4 -step Brand Suzuki Shogun 125 CC with the year of manufacture 2010.

2.2 Instrumentation

The test was divided into two, among others, the first test was to ensure that electrolyzer. The electrolyte was working well and the second was where the Exhaust Emissions testing in this test will be directly measured by a tool called Gas Analyzer.

2.3 Electrolyzer Test

This test was done to identify that the electrolyzer was working well. In addition to the testing process the electrolyzer was once again testing exhaust emissions from the electrolysis occurring(Ng et al., 2015; Summers et al., 2013; Xie et al., 2015). As for some of the data that will be taken include:

1) Before taking electrolyzer,
2) After taking electrolyzer with electrolyte capacity I = 500 ml of pure distilled,
3) After wearing electrolyzer with a capacity of 500 ml Electrolyte II = + ½ tablespoon distilled KOH.
4) After wearing electrolyzer with a capacity of electrolytes III = 500 ml distilled + 1 tablespoon KOH.
5) After wearing electrolyzer with a capacity of electrolytes III = 500 ml distilled + 1 ½ tablespoon KOH.

This testing was done with the parameters of rotation (RPM) of the motor by a combination of changes to the 1000 RPM up to 4000 RPM.

2.4 Procedures

The procedures in this test included:

1) Making the electrical circuit
2) Making a mixture of electrolytes with terms consistent with the data to be retrieved
3) Turning on the motor and setting the RPM motor with provisions of the data to be retrieved

2.5 Emissions test

Emissions testing used a tool called Automotive Emission Analyzer(Martínez et al., 2014; Park and Lee, 2013; Park et al., 2013). The procedures to be followed in testing the Exhaust Emissions were:

1) Heating up the vehicles that will be tested emissions.
2) Setting emission test tool to calibrate (zero calibration) and discharge tube (Purging).
3) When you are ready (Stand by) insert the probe into the motorcycle exhaust.
4) Motorcycles given engine rotation variation from high to low round.
5) Press Meas / enter to start the measurement.
6) Pressing Hold for reading.
7) After the readings can be the result, press esc.
8) Remove the probe from the exhaust of the motorcycle and
9) Press Purging for emptying tube

3. RESULT AND DISCUSSION

The results of performance tests on the motorcycle, Suzuki Shogun 125 CC 2010, were showed in Table 1. The data obtained by utilizing the electrical system resulting from spull motors and variations of the spin machine.

Table 1. Data on average test results without using electrolyzer

NO	RPM	TIME (s)	CO (%)	HC (PPM)	CO_2 (%)
1	1,000	120	0.08	382.00	4.10
2	1,300	240	0.09	248.00	4.10
3	1,600	360	0.09	119.00	4.60
4	2,000	480	0.09	58.67	5.20
5	2,400	600	0.08	22.67	6.30
6	3,200	720	0.07	25.67	7.30
7	3,600	840	0.10	24.67	7.20
8	4,000	960	0.24	23.33	7.70

The motorcycle performance without electrolyzer showed the increasing for the rotation of the engine and the emissions level of CO and CO_2 levels. In the other hand, the HC emission level was wane.

The second test was varying RPM using electrolyzer with electrolyte. The data obtained in accordance with Table 2.

Equally when the motorcycle was not using the electrolyzer, with increasing spin machine then CO and CO_2 also increased while the HC on the wane. In the third experiment tested by varying RPM using electrolyzer with KOH electrolyte mixture of distilled water and ½ tablespoon. The data obtained in accordance with Table 3. The third experiment showed the increasing spin machine as well as the CO and CO_2 emissions while the HC on the wane.

Table 2. Data electrolyzer test using distilled water with electrolytes itself

NO	RPM	TIME (s)	I (Ampere)	CO (%)	HC (PPM)	CO_2 (%)
1	1,000	120	0.36	0.08	141.67	6.93
2	1,300	240	0.42	0.08	137.67	7.03
3	1,600	360	0.5	0.09	65.00	7.53
4	2,000	480	0.52	0.12	46.67	7.73
5	2,400	600	0.76	0.10	34.33	8.07
6	3,200	720	1.1	0.25	45.00	8.50
7	3,600	840	1.3	0.39	40.33	8.30
8	4,000	960	1.4	0.55	32.67	7.20

Table 3. Data test of using electrolyzer with a mixture of distilled water and KOH electrolyte Spoon ½ Spot

NO	RPM	TIME (s)	I (Ampere)	CO (%)	HC (PPM)	CO_2 (%)
1	1,000	120	1.86	0.10	108.67	6.60
2	1,300	240	1.91	0.11	55.67	6.73
3	1,600	360	1.96	0.15	36.33	7.20
4	2,000	480	2.06	0.19	30.33	8.10
5	2,400	600	2.17	0.22	31.00	7.50
6	3,200	720	2.35	0.56	29.33	7.90
7	3,600	840	2.39	0.70	26.00	7.70
8	4,000	960	2.42	0.77	20.33	8.00

In the fourth experiment tested by varying RPM using electrolyzer with distilled water and KOH electrolyte mix in 1 tablespoon. The result in this experiment was showed in Table 4. It performed by the reference when the motorcycle was not using electrolyzer. It was obtained the increasing of engine rotation and the CO as well as CO_2 emissions. In the other hand, the HC keep on the wane.

Table 4. Data test of using electrolyzer and a mixture of distilled water and KOH electrolyte 1 Dinnespoon

NO	RPM	TIME (s)	I (Ampere)	CO (%)	HC (PPM)	CO_2 (%)
1	1,000	120	4.3	0.083	195.33	6.93
2	1,300	240	5.2	0.090	120.00	7.30
3	1,600	360	5.9	0.110	65.67	8.00
4	2,000	480	6.3	0.233	44.00	7.80
5	2,400	600	6.4	0.243	26.67	7.30
6	3,200	720	6.6	0.550	34.67	8.00
7	3,600	840	6.65	0.433	25.33	8.43
8	4,000	960	6.8	0.860	23.00	7.90

In the last experiment, the examination with varying RPM using electrolyzer and the mixture of KOH electrolyte as well as distilled water, 1.5 tablespoon. The data obtained in accordance with Table 5. It showed the increasing the engine rotation and the levels of CO and CO_2 emissions, while the level of emissions for HC was wane.

Table 5. Data test of using electrolyzer with a mixture of distilled water and KOH electrolyte 1.5 tablespoon

NO	RPM	TIME (s)	I (Ampere)	CO (%)	HC (PPM)	CO_2 (%)
1	1,000	120	2.14	0.10	149.67	7.1
2	1,300	240	2.38	0.10	94.33	7.1
3	1,600	360	2.53	0.14	53.67	8.2
4	2,000	480	2.79	0.25	29.67	8.1
5	2,400	600	2.84	0.30	21.00	8
6	3,200	720	2.83	0.98	49.33	7.3
7	3,600	840	2.8	0.93	36.67	7.2
8	4,000	960	2.82	1.04	35.00	7

Data Analysis Exhaust Emission Test

Based on the generated data from exhaust emissions testing above, the research analyzes was shown into a graph below, Figure 1.

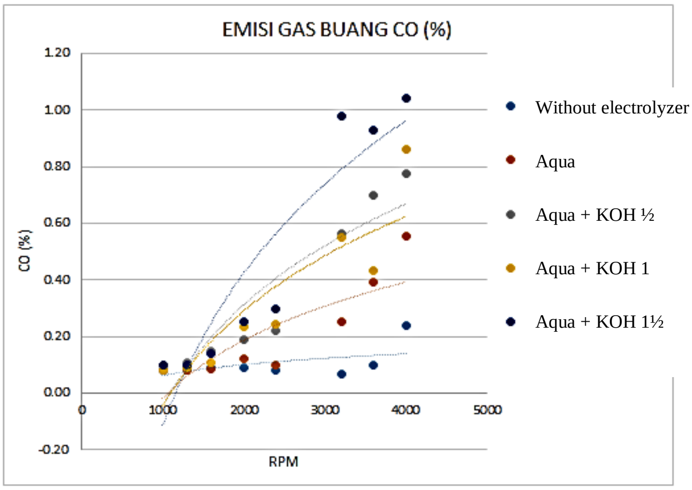

Fig. 1. Exhaust Emissions Analysis for Carbon monoxide (CO)

Figure 1 showed that the exhaust emission analysis aimed at gauging the exhaust gas in the form of Carbon Monoxide (CO). The rose of the engine rotation and the levels of CO emissions was increasing too. The addition of electrolyzer on motorcycles impacts the exhaust emission levels for CO. It was not better rather than without using the electrolyzer because the exhaust emission level was still increasing.

The highest levels of CO occurred at engine speed of 4,000 RPM with a mixture of distilled water and electrolyte 1 ½ tablespoons of KOH with a value of 1.04%. For the lowest level of CO occurred at the value of 0.24%. The CO emission level was the best for when the engine turns 3,200 RPM. It happened when the engine did not use electrolyzer. The results of motorcycle with electrolyzer and with distilled water plus KOH electrolyte as much 1 ½ tablespoons showed that the emission level of CO was 0.07%, while the highest levels for 3,200 RPM rotation was 0.98%.

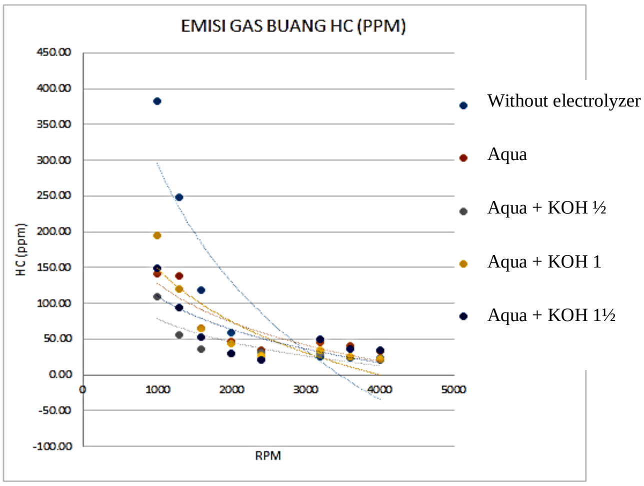

Fig. 2. Exhaust Emissions Analysis for Hydro Carbon (HC)

Oppositely, the emission level on Carbon Monoxide (CO), for Hydro Carbon (HC) have change in the higher engine speed, the exhaust emissions of HC decreases. It showed in Figure 2. The average changed in exhaust emissions for HC was better when the motorcycle with electrolyzer. The exhaust emission level of HC was highest when the engine turns 1,000 RPM with a value of 382 ppm. It happened with the motorcycle without using electrolyzer, while the levels of the lowest emissions at the same RPM.

The HC emission levels have the lowest value at the engine speed of 4,000 RPM with a mixture of distilled water and KOH ½ tablespoon of 20.33 ppm. It had the highest levels of exhaust emissions at the same engine speed, 35 ppm, when the motorcycle using electrolyzer with a mixture of distilled water and 1 ½ tablespoons KOH.

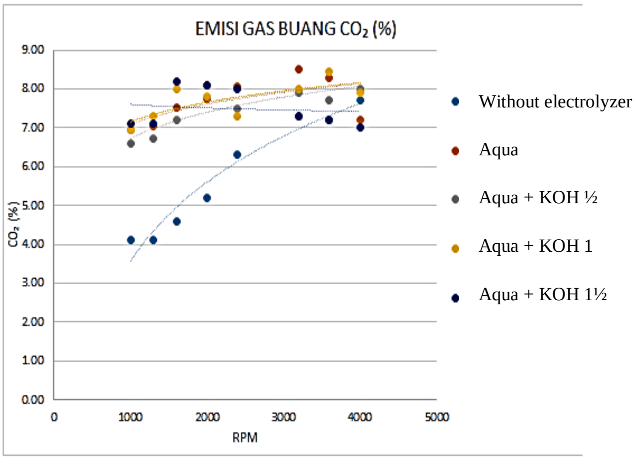

Fig. 3. Exhaust Emissions Analysis for Carbon Dioxide (CO_2)

In Figure3, it showed the exhaust emissions of CO_2 higher. The opposite trend of the exhaust emission was very clear between HC and CO_2, as showed in Figure 2 and Figure 3.

The CO_2 emission levels had a lowest was at 1,000 RPM at the motorcycle engine without electrolyzer , 4.1%. Otherwise, in the same round obtained the highest CO_2 level was 7.1% when the motorcycle using electrolyzer, with a mixture of distilled water and 1 ½ tablespoon KOH.

In the other hand, the HC exhaust emission levels had a highest generated at the engine speed of 3,200 RPM when the motorcycle using electrolyzer. It filled with distilled water only. At the same engine speed low emission levels occurred when the motorcycle using electrolyzer, with a mixture of distilled water and 1 ½ tablespoons.

4. CONCLUSION

The use of research analysis Electrolyzer against Exhaust Emissions of CO and HC at 4 Step Brands Motorcycles Suzuki Shogun 125 CC Year 2010 in this research had some conclusions as below:

1. Based on some mixture of electrolytes in the study, the KOH electrolytes only work to reduce emissions of HC.
2. The exhaust emission levels of CO and no effect of CO_2, even exceeding the levels of gas emission was the main reference for the motorcycle without electrolyzer.
3. The impact of the use of electrolyzer was increasing the value of CO emission if a round of engine rotation of motorcycles was increasing while the HC emission levels lower.
4. The exhaust emissions of CO was lowest when the motorcycle without electrolyzer with the average value was 0.11%. As for the exhaust emissions of CO highest when the motorcycle using electrolyzer with distilled electrolyte and an additional 1 ½ tablespoon KOH ..
5. The exhaust emissions of HC was the highest for the motorcycle without electrolyzer and the rotation of 382 ppm. The HC exhaust emissions had a low level when the motorcycle using electrolyzer and KOH electrolyte distilled water and ½ tablespoon with 20,33 ppm.
6. The values of the above emission levels are still below the government regulations standard of exhaust emission.

5. REFERENCES

Amalia, M., Resosudarmo, B.P., Bennett, J., 2013. The Consequences of Urban Air Pollution for Child Health: What does Self Reporting Data in the Jakarta Metropolitan Area Reveal?

Baum, G., Januar, H.I., Ferse, S.C., Kunzmann, A., 2015. Local and regional impacts of pollution on coral reefs along the Thousand Islands north of the megacity Jakarta, Indonesia. PloS one 10, e0138271.

Both, A.F., Westerdahl, D., Fruin, S., Haryanto, B., Marshall, J.D., 2013. Exposure to carbon monoxide, fine particle mass, and ultrafine particle number in Jakarta, Indonesia: Effect of commute mode. Science of the Total Environment 443, 965-972.

Cavallo, V., Pinto, M., 2014. Visual factors affecting motorcycle conspicuity: Effects of car daytime running lights and motorcycle headlight design. In: Increasing Motorcycle Conspicuity: Design and Assessment of Interventions to Enhance Rider Safety. Visual factors affecting motorcycle conspicuity: Effects of car daytime running lights and motorcycle headlight design. In: Increasing Motorcycle Conspicuity: Design and Assessment of Interventions to Enhance Rider Safety, 12p.

Dharmowijoyo, D.B., Susilo, Y.O., Karlström, A., 2014. Day-to-day interpersonal and intrapersonal variability of individuals' activity spaces in a developing country. Environment and Planning B: Planning and Design 41, 1063-1076.

El Shenawy, E., El-Ghetany, H., Ahmad, G., 2012. Annual Performance of a Photovoltaic Hydrogen Electrolyzer System in Egypt. Journal of Applied Sciences Research 8, 4417-4427.

Gahleitner, G., 2013. Hydrogen from renewable electricity: An international review of power-to-gas pilot plants for stationary applications. International Journal of Hydrogen Energy 38, 2039-2061.

Goembira, F., Surianti, I., Ihsan, T., 2014. Prediksi Tingkat Emisi Gas Karbon Dioksida (Co2) Dari Kegiatan Transportasi Akibat Beroperasinya Rumah Sakit Pendidikan Di Kampus Universitas Andalas Limau Manis. Jurnal Dampak 11.

Izzati, T., 2016a. An Initial Study Of The Air Pollution Through Rainwater In An Industrial Area Of Bekasi. World Chemical Engineering Journal 1.

Izzati, T., 2016b. An Initial Study Of The Air Pollution Through Rainwater In An Industrial Area Of Cikarang, West Java, Indonesia (A Case Study). Science International 28.

Izzati, T., Poerwanti, Y., 2014. Enhancing The Productivity And Multifunctionality Of Open Space Using Simple Techniques In Green Buildings. Science International 26, 689-690.

Izzati, T., Suprihatiningsih, W., Kristovorus, M., Andrean, A.G., 2016a. An Initial Study Of Laundry Industrial Effects To The Water Pollution In East Jakarta. IOSR Journal of Environmental Science, Toxicology and Food Technology 10, 35-37.

Izzati, T., Suprihatiningsih, W., Satuti, W., Febrian, F.S., Rahayu, M.N., Jenario, J.R., 2016b. An Initial Study Of Industrial Area's Effects For The Air Pollution Through Rainwater In East Jakarta. IOSR Journal of Mechanical and Civil Engineering 13, 159-162.

Izzati, T., Wuryandari, N.E.R., Ayudia, S., syafei, F., Triyadi, F., 2016c. An Initial Study Of Laundry Industrial Effects To The Water Pollution In Bekasi. IOSR Journal of Business and Management 18, 109-111.

Martínez, J.D., Rodríguez-Fernández, J., Sánchez-Valdepeñas, J., Murillo, R., García, T., 2014. Performance and emissions of an automotive diesel engine using a tire pyrolysis liquid blend. Fuel 115, 490-499.

Ng, J.W.D., Hellstern, T.R., Kibsgaard, J., Hinckley, A.C., Benck, J.D., Jaramillo, T.F., 2015. Polymer Electrolyte Membrane Electrolyzers Utilizing Non-precious Mo-based Hydrogen Evolution Catalysts. ChemSusChem 8, 3512-3519.

Ono, K., 2016. Energetically Self-Sustaining Electric Power Generation System Based on the Combined Cycle of Electrostatic Induction Hydrogen Electrolyzer and Fuel Cell. Electrical Engineering in Japan 195, 10-23.

Park, S.H., Lee, C.S., 2013. Combustion performance and emission reduction characteristics of automotive DME engine system. Progress in Energy and Combustion Science 39, 147-168.

Park, S.H., Youn, I.M., Lim, Y., Lee, C.S., 2013. Influence of the mixture of gasoline and diesel fuels on droplet atomization, combustion, and exhaust emission characteristics in a compression ignition engine. Fuel processing technology 106, 392-401.

Prayudyanto, N., Tamin, Z., Driejang, R., Umami, D., 2013. Will Jakarta road pricing reduce fuel consumption and emission, Proceedings of the Eastern Asia Society for Transportation Studies.

Putra, T.H., Woltjer, J., Tan, W.G.Z., 2016. Metropolitan Governance and Institutional Design: Transportation in the Jakarta Metropolitan Region, Decentralization and Governance in Indonesia. Springer, pp. 171-200.

Razali, H.H., Sopian, K., Mat, S., Ibrahim, S., 2015. Modification of motorcycle with hydrogen mixture and effect on emission. ARPN Journal of Engineering and Applied Sciences 10, 7719-7722.

Summers, W.A., Colon-Mercado, H., Weidner, J., 2013. Electrolyzer Component Development for the HyS Thermochemical Cycle. 2013 Annual Merit Review Proc; Hydrogen Prodn and Delivery.

Xie, Y., Xiao, J., Liu, D., Liu, J., Yang, C., 2015. Electrolysis of Carbon Dioxide in a Solid Oxide Electrolyzer with Silver-Gadolinium-Doped Ceria Cathode. Journal of The Electrochemical Society 162, F397-F402.