Experimental Study of Effects of Variation Use Fuel type On Exhaust Emissions With Loads 500,1050,2000 watt generator.

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Abstract. Electricity is the energy needed by the human subject. Planning Director of PT PLN (Persero) Nicke Widyawati say, until 2017 thiscapacity electricinstalled new nationally has 53 585 MW of electrical capacity. Our electrification ratio remained at 81.5%, or about 40 million people untapped power facilities. Research titled "Experimental Study of Effects of Variation Use Fuel Types Of Generators With Loads Small House." The purpose of this study is to be aware of differences in the effect of different fuels on performance and exhaust emissions generator. This study uses *research library* or library research, field work, and there is no single source of data is the primary source. The cornerstone of the theory used is Faraday, *otto cycle* and exhaust emissions. Based on data analysis, we concluded that among premium fuel, pertalite, and pertamax, fuel pertamax good fuel is used in the generator. Because there are several factors why fuel pertamax can be said to be better among the three of the fuel, both in the exhaust emissions, as well as in the time of usage. Keywords: Electricity; exhaust gas emissions; fuel; and generator.

1. Introduction

Electricity is the energy needed by the human subject. Electricity is also one of the vital energy and became the backbone of almost all economic activities and human activities. To meet the demand for electricity has many built power generation system in Indonesia. However, if the system's power is enough to meet all the electricity needs for the people in Indonesia? National Energy Board Member who is also a Professor of the University of Indonesia, Prof. Ir. Rinaldy Dalimi, M.Sc. Ph.D argued it did not oppose or antipathy to nuclear power plants, but several factors need to be considered in building nuclear power plants in Indonesia, among others, the energy potential of Indonesia, Indonesia's geographical conditions, the economics of nuclear power plants, the mastery of technology, national energy policy. Renewable energy is very varied. However, so far not been used optimally. The quantity of renewable energy in Indonesia is mapped as follows: Hydropower is expected: 75.67 gigawatts (GW); Geothermal: 28.00 GW; Biomass: 49.81 GW; Marine energy*(hydrokineticenergy):*240,00GW and the Sun (6-8 hours / day): 1200.00 GW. On the other hand there is also a potential for fossil energy, such as coal (104 billion tons) and gas (384.7 TSCF) which tends to current production is exported as a source of state revenue. In addition, Indonesia is also known as a producer of crude palm oil*(crudepalm oil /*CPO)in the world, where the CPO can be used as *biofuel.* The fact is that electricity generation capacity installed in Indonesia in 2013 was 47 128 MW. As of March 2014 the total installed capacity reached 47 788 MW with a map that 74 percent is supplied by PLN. Planning Director of PT PLN (Persero) NickeWidyawati say, until 2017's first capacity electricinstalled new nationally has 53 585 MW of electrical capacity. Our electrification ratio remained at 81.5%, or about 40 million people untapped power facilities. Not only in remote regions, major cities in Sumatra and Kalimantan, also often experience a power deficit. Therefore, to meet the electricity demand in Indonesia is still unmet demand for electricity has been diciptakanya generator is *portable.*Several typespower plants *of portable* of which we know the generator, inverter, diesel, and many more. Generator is a machine that converts the energy of motion (mechanical) into electrical energy (electrical) which serves to generate electricity so that it can be used for human purposes berrbagai. The energy that drives a generator itself the source manifold. In the example of wind power generators for their move because the wind turbines are spinning, as well as the hydroelectric plants that harness energy from water and other motion. The working principle is based ongenerator, *Faraday* ie when aConductor rotated in a magnetic field so that the cut lines of magnetic

force lines then at the end of the conductor will arise electric lines of force (EMF), which has units *ofvolts.*Based on the type of current used dibaga generator into two types, namely: Generator direct current (DC) and alternating current generator (AC). Fuel used on a generator that premium fuel, pertalite, pertamax and diesel fuel (diesel). The gasoline fuel has a value and quality of each level.

2. Research Methodology Testing Phase

2.1 Testing Emissions

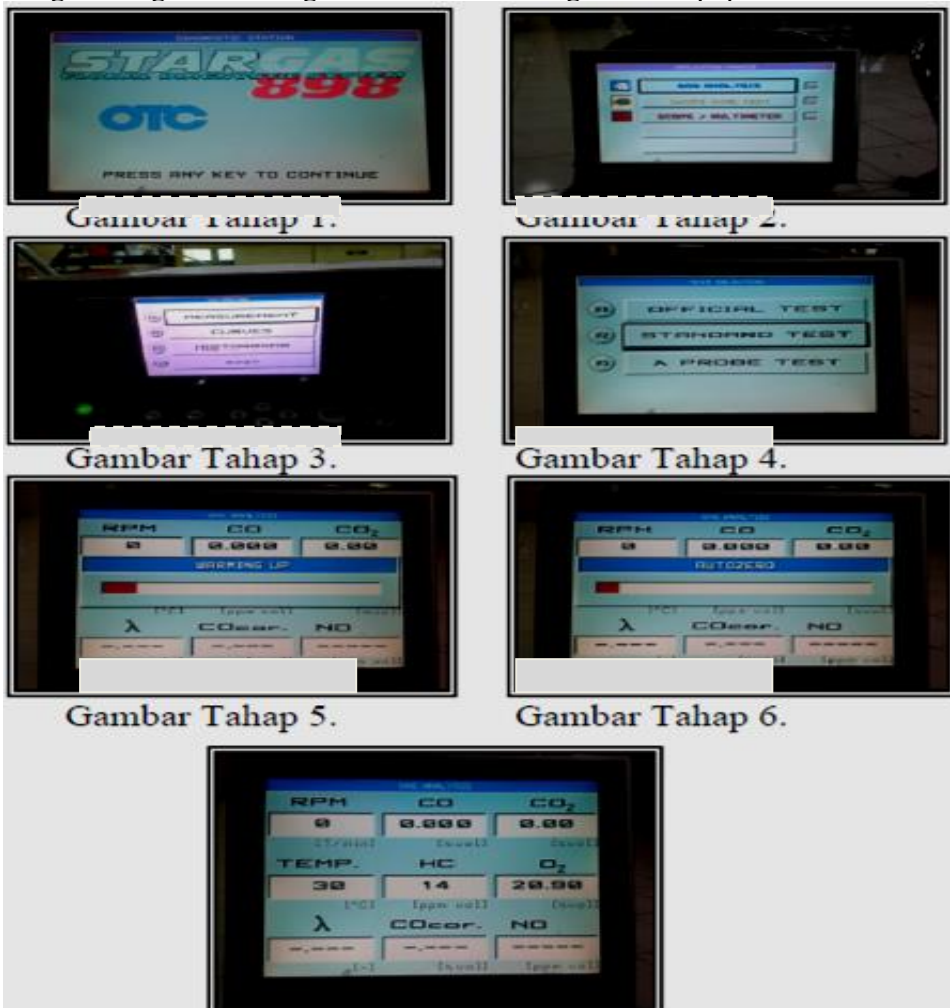1. Testing Gallery Installation of Exhaust Emissions InMotorcycle

Figure 1. Installation StargasRear 898.

Figure 2. Generator Exhaust Emission Testing Front with 898. Stargas tool Installation

2. Stages - Stages of Testing Emissions With Stargas Test Equipment 898

Figure 3. Phase 1-7

Materials and Equipment Materials:

Fuel premium (5 liters), fuel pertalite (5 liters), fuel pertamax (5 liters)

Equipment: Analyzer (Stargas898), generator an electric (electric generator), Tachometer,stopwatch,Multitester,ampermeter,tools, Cableconnectors, Load power (500 W, 1000 W, and 2000 W), measuringcup,funnel,Masks, bucket / basin

2.2 Process Testing

1.) Prepare the entire equipment and materials required.

2.) Turn on the engine analyzer test by pressing the on / off button that exists on the machine analyzer.

3.) Then exit the analyzer screen*"pressany key to*continue",pressbutton. (Figure 3.3)

4.) Then there is the option in the engine analyzer test menu, the*"Gas*analysis", "Smokeanalysis",and*"Scope/*multimeter".Select the*"Gasanalysis"*, press the enter key. (Figure3.4)

5.) When it hit the enter key, get out selection menu *"Measurement", "Curves", "Histogram",* and *"Exit".* Select the *"measurment"* and then press the enter key. (Figure 3.5)

6.) Then exit the menu selection*"Officialtest","StandardTest","aprobe*test".Select the*"officialtest"*and then press the enter key. (Figure 3.6)

7.) and then quit screen exhaust emissions test data in the form of data RPM, CO, CO_2,Temp, HC, O2, λ,$CO_{cast,}$NO. (Figure 3.9)

8.)Preparing the generator engine, generator and heat engines, because if the engine generator is not preheated, the temperature did not reach some degree, the combustion is not normal.

9.) After heating generator has been completed, turn off the generator engine. Then empty the contents in advance fuel in the fuel tube generator, and also empty the fuel is still contained in the generator engine carburetor.

10.) After the fuel tube and empty the generator carburetor, refill the fuel tube with fuel generator pertamax to contain as much as 1 liter.

11.) Connect the power load by using the connector cable to the generator with a load of 500 watts.

12.) Preparing stopwatch take into generator usage time.

13.) After generatorsudah connected to the power load, and a stopwatch is ready to use, enter the existing detection tools on the test engine analyzer in generator exhaust.

14.) Turn the engine generator, when the generator is on, immediately turn the stopwatch.

15.) When the engine analyzer test has been completed record, Press menupada engine analyzer test, exit the menu selection*"printout"*. Select the*"printout"*and then pressthe enter key. Then print the results of the test data on engine exhaust emissions analyzer exit.

16.) After the paper print out, press the*"esc"*and wait for the generator to death to measure time generator usage.

17.)Once the generator is shut down, turn off the stopwatch, the stopwatch shows the results of the data ongenerator-timedata the use of on fuel consumption of 1 liter.

18.) Perform this test again with a different power load dankemudian that in 1000 Watts 2000 Watts.

19.) After the power load 500.1000, and 2000 watts has been completed in the trial, did return with different fuels, namely fuel and premium pertalite by following the steps listed above.

3. Testing Data Analysis

3.1 Fuel pertamax

Rated speed 3000 rpm; The volume of fuel 1 Liter / load testing; Generator Model MX 4800DXE; Voltage 220 volts. Current 10.5 A; Frequency 50 Hz; Rated power COP 2,3 kW; Max AC output 2.5 kW The results of the data as follows:

Table 1 Fuel exhaust emissions pertamax

	500 watts	1050 watts	to 2000 watts
CO	0137 (%	0224 (%	0216 (%

	vol)	vol)	vol)
CO	0:32 (%	0:44 (%	0:46 (%
2	vol)	vol)	vol)
HC	6 (ppm	8 (ppm	11 (ppm
	vol)	vol)	vol)
O_2	20:21 (%	20:10 (%	20:13 (%
	vol)	vol)	vol)
Temp	67(^{o}C)	79($^\circ$C)	87($^\circ$C)
Time	02: 17: 27.8	01: 09: 05.5	00: 37: 47.3
	3	0	3

3.2 Fuel Pertalite

Rated speed 3000 rpm; The volume of fuel 1 Liter / load testing; Generator Model MX 4800DXE; Voltage 220 volts; Current 10.5 A; Frequency 50 Hz; Rated power COP 2,3 kW; Max AC output 2.5 kW The results of the data as follows:

Table 2 Fuel exhaust emissions pertalite.

	500 watts	**1050 watts**	**to 2000 watts**
CO	0213 (%	0301 (%	0352 (%
	vol)	vol)	vol)
CO	0:45 (%	0:58 (%	0.65 (%
2	vol)	vol)	vol)
HC	9 (ppm	11 (ppm	18 (ppm
	vol)	vol)	vol)
O_2	20:03 (%	19.89 (%	19.74 (%
	vol)	vol)	vol)
Temp	77(^{o}C)	82($^\circ$C)	89($^\circ$C)
Time	02: 00: 19.3	01: 00: 35.9	00: 30: 15.2
	2	2	6

3.3. premium fuel

Rated speed 3000 rpm; The volume of fuel 1 Liter / load testing; Generator Model MX 4800DXE; Voltage 220 volt Current 10.5 A; Frequency 50 Hz; Rated power COP 2,3 kW; Max AC output 2.5 kW The results of the data as follows:

Table 3. Exhaust emissions premium fuel.

|	**500 watts**	**1050 watts**	**to 2000 watts**
CO	0297 (%	0323 (%	0345 (%
	vol)	vol)	vol)
CO	0:47 (%	0:57 (%	0.65 (%
2	vol)	vol)	vol)
HC	10 (ppm	15 (ppm	14 (ppm
	vol)	vol)	vol)
O2	19.93 (%	19.81 (%	19.64 (%
	vol)	vol)	vol)
Temp	81(^{o}C)	86($^\circ$C)	94($^\circ$C)
Time	01: 32: 08.1	00: 47: 02.1	00: 23: 50.8
	3	4	2

3.4 Analysis of Emissions

Combustion is a chemical process that takes place rapidly between oxygen with flammable elements of the fuel at a certain pressure and temperature. Of course, the combustion process requires oxygen, and the oxygen is obtained from air. Hydrrcarbon bond (HC) on fuel will only react with oxygen during the combustion process, and produce water (H_2O) and carbon dioxide (CO_2), while nitrogen will come out as N_2. Unfortunately, on certain conditions to be imperfect combustion and it produces exhaust gases that are harmful to life, such as the formation of carbon monoxide (CO) and nitrogen oxides (NOx).

Value flue gas into emission quality standards are:

1. CO maximum 2.5%
2. HC <300 ppm
3. CO_2 should be greater than 12% and the theoretical maximum is 15.5%
4. $O_2 < 2\%$

Volumetric Analysis On The Perfect Fuel Combustion Premium / octane (C_8H18). Octane with the formula C_8H_{18} means that in 1 lb mole mole of fuel contained 8 and 9 mole Hydrogen Carbon.

Equations in molar units as follows:

$$C_8H_{18} + 15.2O_2 + 47.2N_2 \rightarrow 8CO_2 + 9H_2O + 47.2\ N_2$$
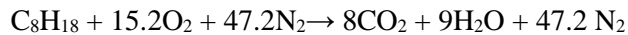
Table 4. Analysis VolumetricCombustion. Premium Fuel

	Total Mole	Mole / mole100/100%		Volume
CO_2	8	8 / 64.2 x 100	= 12,³	12.5
H_2O	9	9 / 64.2 x 100	= 14	14
N_2	47.2	47.2/ 64.2 x 100 = 73, ³		73.5
Total	64.2			

Volumetric Analysis On The Perfect Fuel Combustion Pertalite / octane (C_9H20). Octane formula C_9H_{20} means that in 1 lb mole of fuel contained 9 mole and 10 mole Hydrogen Carbon. Equations in molar units as follows:

$$C_9H_{20}\ O+ 17.02_2 + 52.92\ N_2 \rightarrow 9CO_2 + 10H_2O + 52.92\ N_2$$
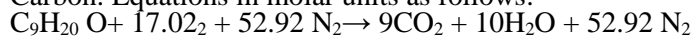
Table 5. Volumetric AnalysisCombustion. Pertalite Fuel

	Total Mole	Mole / mole100/100%	Volume
CO_2	9	9 / 71.92 x 100 = 12.5	12.5
H_2O	10	10 / 71.92 x 100 = 13.9	13.9
N_2	52.92	52.92 / 71.92 x 100 = 73.58	73.58
Total	71.92		

Volumetric Analysis On The Perfect Fuel Combustion PERTAMAX / octane ($C_{10}H24$). Octane with the formula $C_{10}H_{24}$ means that in 1 lb mole of fuel contained 10 mole and 12 mole Hydrogen Carbon.
Equations in molar units as follows:

$$C_{10}H_{24}\ O+ 19.4_2 + 60.48\ N_2 \rightarrow 10CO_2 + 12H_2O + 60.48\ N_2$$
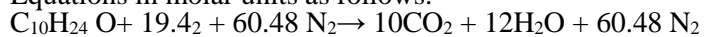
Table 6. Volumetric Analysis PERTAMAX Fuel Combustion.

	Total Mole	Mole / mole100/100%	Volume
CO_2	10	10 / 82.48 x 100 = 12.1	12.1
H_2O	12	12 / 82.48 x 100 = 13.9	14.5
N_2	60.48	60.48 / 82.48 x 100 =	73.3

	73.58
Total	82.48

3.5 Comparison of Carbon monoxide (CO) On Generator Using Load Variation Fuel and Power Layout.

Comparison of the levels of carbon monoxide (CO) at 2000 watts power between premium fuel, pertalite, and pertamax namely:

1. Premium fuel yield 0.345 vol% CO value.
2. Fuel pertalite generate value CO 0.352% vol.
3. Fuel pertamax generate value CO 0.216% vol.

From the test results, where the level of exhaust emission levels of carbon monoxide (CO), the highest fuel owned by pertalite which reached 0.352% vol. Based on the maximum level of CO levels for the quality of the machine, the level of carbon monoxide levels in the above three types of fuel still in the normal state (CO <2.5%). However, to reduce the level of carbon monoxide dangers of exhaust gas, it is advisable to use fuel pertamax, where the level of very low levels compared to the three existing fuels. CO emissions were higher, showing a condition where too rich AFR (lambda <1). Generally CO showed the efficiency of combustion in the combustion chamber. High emissions of CO due to his lack of oxygen to produce a complete and perfect combustion. Things that cause too rich AFR include: Idle speed is too low, the water filter is dirty, pelumnas machine is too dirty or heavily contaminated.

3.6 Comparison of Carbon Dioxide (CO_2)On Generator Using Load Variation Fuel and Power Layout.

Comparison of the levels of carbon dioxide (CO_2)at 2000 watts power between premium fuel, pertalite, and pertamax namely:

1. Premium fuel produces CO_2 value of 0.65% vol.
2. Pertalite fuels produce CO_2 value of 0.65% vol.
3. Pertamax fuels produce CO_2 value of 0.46% vol.

From the test results, where the level of exhaust emission levels of carbon dioxide (CO_2)is the highest-owned by a premium fuel and pertalite where it reached 0.65% vol. Based on the minimum level of concentration of CO_2 for the quality of the machine, the level of carbon dioxide levels in the above three types of fuel are not normal (CO_2<12%). The concentration of CO_2 directly indicating the status of the combustion process in the combustion chamber. The higher the better. When AFR is too thin and too rich, then the CO_2 emissions will drop drastically. When CO_2 is under 12%, then we should see other emissions that indicates whether the AFR terlalukaya or too thin. Keep in mind that the source of CO_2 is only the combustion chamber and CC, when CO_2 is too low but normal CO and HC indicates that the *exhaust pipe*leak. Based on test results and based on the theory that there can be seenlevel of CO_2 a goodis at the levellevels of CO_2 of premiumand pertalite, to the level of CO concentrations$_2$ pertamax too small.levels of CO_2 Premiumand pertalite better thanlevels of CO_2 pertamaxin the combustion process in the combustion chamber.

3.7 Comparison of Hydrocarbon (HC) On Generator Using Load Variation Fuel and Power Layout.

Comparison of the levels of hydrocarbons (HC) at power of 2000 watts of premium fuel, pertalite, and pertamax namely:

1. Premium fuel produces 14 ppm vol HC value.
2. Fuel pertalite generate value HC 18 ppm vol.
3. Fuel pertamax generate value HC 11 ppm vol.

From the test results, where the level of gas emission levels of hydrocarbons (HC), the highest fuel owned by pertalite which reaches 18 ppm vol. Based on the maximum levels of levels of HC for the quality of the machine, the level of hydrocarbon content in the above three types of fuel still in the normal state (HC <300ppm). However, to reduce the danger level of exhaust hydrocarbons, it is recommended to use fuel pertamax, where the level of very low levels compared to the three existing fuels. The smaller the HC content of its more perfect combustion process in the combustion chamber

or at least the remainder of the raw fuel (gas that does not burn after a failed ignition) is wasted during the combustion process.

3.8 Comparison of Oxygen (O$_2$)On Generator Using Load Variation Fuel and Power Layout.

Comparison of the levels of oxygen (O$_2$)at power of 2000 watts of premium fuel, pertalite, and pertamax namely:
1. Premium fuel generating value O$_2$ 19.64% vol.
2. Fuel pertalite generate value O$_2$ 19.74% vol.
3. Fuel pertamax generate value O$_2$ 20.13% vol.

The concentration of oxygen in the exhaust gas is inversely proportional to the concentration of CO$_2$.To obtain a perfect combustion process, the amount of oxygen into the combustion chamber should be sufficient for any hydrocarbon molecules. From the above test results, it can be seen that the highest oxygen content of fuel pertamax oxygen levels, whereas levels of O$_2$ reached 20.13% vol. LevelsO$_2$ low ofOlevel$_2$ fuelpremium reached 19.64% vol. On the results of the above data, the three fuel has a value of abnormal levels of oxygen (O$_{2>}$ 2%). Normally the concentration of oxygen in the exhaust gas is 1.2% or less. This indicates that all of the oxygen can be used up in the combustion process and this may mean that the value of AFR tends kaya.Dalam such conditions, the low concentrations of oxygen can mean the value of AFR is too lean but also may indicate some other things.

3. 9 Comparison Temperature Variations On Generator Using Fuel and Power Load Layout.

Comparison of temperature (T) at power of 2000 watts of premium fuel, pertalite, and pertamax namely:
1. Premium fuel produces a value of temperature 94°C
2. Fuel pertalite generate temperature values 89 $^{\circ}$C.
3. Pertamax produce fuel temperature values 87 $^{\circ}$C.

From the above test result, it can be seen premium fuels have the highest level of temperature reached 94°C, and the lowest temperature point is fuel pertamax is 87°C and is seen from the graph above, temperature the combustion chamber is greatly influenced by the power load, the higher the received power load, increasing the temperature in the combustion chamber.

3.10 Comparison of Time (time) On Generator Using Load Variation Fuel and Power Layout.

Comparison of time (t) at power of 500 watts of premium fuel, pertalite, and pertamax namely:
1. The time needed to spend a premium fuel volume is 01: 32: 08:13 (92 minute).
2. The time needed to spend pertalite fuel volume is 02: 00: 19:32 (120 minute).
3. The time required to spend pertamax fuel volume is 02: 17: 27.83 (137 minute).

Comparison of time (t) at 1050 watts of premium fuel, pertalite, and pertamax namely:
1. The time needed to spend a premium fuel volume is 00: 47: 02:14 (47 minute).
2. The time needed to spendfuel volume pertaliteis 01: 00: 35.92 (60th minute).
3. The time required to spend pertamax fuel volume is 01: 09: 05:50 (69 minute).

Comparison of time (t) at power of 2000 watts of premium fuel, pertalite, and pertamax namely:
1. The time needed to spend a premium fuel volume is 00: 23: 50.82 (24th minute).
2. The time needed to spend pertalite fuel volume is 00: 30: 15:26 (30 minute).
3. The time required to spend pertamax fuel volume is 00: 37: 47.33 (38th minute).

Can be seen the results of the above test data, pertamax fuel is a fuel that has the longest usage time. Premium fuels had the fastest time of use. If seen from the use of length of time of use, it is advisable to use fuel pertamax, duration of use is influenced by the RON value of each fuel. The fuel value of the third fuel pertamax presented above, is the highest value of RON RON 92, RON 90 fuel pertalite and RON premium fuel88.

4. Conclusion

1. The smaller the more perfect levels of CO gas combustion processes and more economical, this shows how fuel and air mix and burn. The higher levels of CO increasingly wasteful gasoline, it indicates a lack of air in the mixture.

2. The smaller the more perfect combustion HC levels, showed little fuel is wasted. The higher levels of the more residual HC raw fuel (gas that does not burn after a failed ignition) that is wasted in the process of burning, it indicates the amount of fuel wasted.
3. The higher levels of CO_2 more perfect combustion and the better acceleration. The lower levels of CO_2 indicates the crust blocked the machine is concentrated and must overhoul engine.
4. The higher levels ofO_2 exhaustindicates there is a problem either leaking or clogged, it indicates the amount of air in the mixture. The smaller the content of O_2 indicates the exhaust under normal circumstances.
5. From the results of data analysis showed that for the use of electric generators, emissions in the fuel pertamax, especially harmful exhaust emissions, the lowest exhaust emissions from pertalite or premium fuel.
6. Based on fuel usage time on a generator, fuel pertamax limits longest time compared with pertalite or premium fuel.

References

[1] 13 May 2015.*"Chasingthe target of 75,000 Installed MW* Capacity". http://www.presidenri. go.id/progr am-priority-2 / chase-kapasitas- targets mounted.20-75-000-megawatt.htmlJuly 2017.

[2] 2014.*"Benefitsof the Use of* fuel".http://www.sikerok.com/inilah-manfaat-pakai-bbm-jenis-ron-88-ron-90-dan-ron-92.3August 2017.

[3] Aditya, 26 September Pradana 2012http://eprints.undip.ac.id/41573/4/BAB_II_.pdf,2017.00.54 August 13.

[4] Alphonse.26September 2012. http://jdih.menlh.go.id/pdf/ind/IND-PUU-7- 2012-Candy% 20LH% 2010% 202 012% 20th%20baku%20mutu% 20emisi% 20kategori% 20L3.pdf .192017.01.45 August.

[5] ASUS. 27 Apir 2016. http://erepo.unud.ac.id/11923/3/c0b49958acb 10bcbee54280e7b75b157.pdf. 13 AUGUST 01.15.2017.

[6] Culp, Archie W., Jr.1989.*PrinciplesEnergy Conversion*.Jakarta: Erland.

[7] Dikysyahru.31 August 2012.*"Analysis* Generator", http://digilib.polban.ac.id/files/disk1/75/jbptp Polban-gdl-dikysyahru-3712-3-bab2--3.pdf.3 August 2017, http://repository.usu.ac.id/bitstream/handle/12 3456789/26240 / Chapter% 20II.pdf; JSESSIONID = D8D0E4752B7A375836B7924BCC4909C9? sequence = 4.2017.02.38 August 19.

[8]Insyaansori.2012.*"PowerElectricity*".http://insyaansori.blogspot.co.id/2013/09/pembangkit-tenaga-listrik.html.29July2017.

[9] Ir Kristianto, Philip.2014.*"MotorFuelTorak*".Yogyakarta: Andi.

[10]Mahargian, Hendra.17 December 2014,*"Thefact of Electrical Energy* Indonesia". http://whyzo.blogspot.co.id/2014/12 / fact-unique-electric-energy-indonesia.html.20 July 2017.

[11]Pertamina.21 March 2017*"ListPriceBBM*".http://www.pertamina.com/news-room/info-pertamina/pengumuman/daftar-harga-bbk-tmt-21-maret-2017/.3August2017.

[12] Pudjanarso, Astu & Nursuhud, Djati.2006.*Converting machineEnergy*.Yogyakarta: Andi

[13] Suryatmo, F.Febuari, 2014.*BasicsElectrical engineering*.Jakarta: PT Rineka Reserved. System.25 mei 2009.http: //www.gunadarma.ac.id/library/arti cles / graduate / industrial-technology / 2009 / Artikel_21402217.pdf. 2017.00.55 August 19.