International Journal of GEOMATE, Oct., 2019 Vol.17, Issue 62, pp. 266 - 272
ISSN: 2186-2982 (P), 2186-2990 (O), Japan, DOI: https://doi.org/10.21660/2019.62.63134
Special Issue on Science, Engineering & Environment

PHYSICAL PROPERTIES ANALYSIS OF GASES EMISSION OF BLEND BIODIESEL BURNING PROCESS IN A FIRE TUBE BOILER

*Winny Andalia[1], Pramadhony[2], Susila Arita[3]

[1,2]Faculty of Engineering, University of Tridinanti Palembang, Indonesia
[3]Faculty of Engineering, University of Sriwijaya Palembang, Indonesia

*Corresponding Author, Received: 27 April 2019, Revised: 22 May 2019, Accepted: 10 June 2019

ABSTRACT: The use of biodiesel in boilers has great benefits because it reduces exhaust emissions. The purpose of this study is to test the quality of fossil diesel and biodiesel oil as fuel for fire Tube Boiler. The research is conducted by analyzing the concentration of exhaust gases (NOx, CO_2, SO_2) which is emitted by the Fire Tube Boiler. The combustion system in boiler tends to be simpler than compression ignition as is done with diesel engines. In this research, The authors are using a fire tube boiler, with a heat input rate of 60,000 kCal/hour and a pressure of 3 bar gauge. Biodiesel from crude palm oil (CPO), is blended with fossil diesel oil in various concentrations of 0, 5, 10, 15, 20 and 25% (B0, B5, B10, B15, B20 nd B25) and used as fuel for the boiler. This research is carried out experimentally by testing the exhaust gas emitted from the stack. The stack is expected to produce a low exhaust emission and environmentally friendly. The results show that the increase of biodiesel percentage in fossil fuel can reduce the concentration of some hazardous compound in exhaust gas emission. The lowest concentration of the hazardous compound has emitted the boiler which uses a blending of 25 % biodiesel and 75 % fossil diesel (B25) as its fuel. The lowest exhaust gas emissions are 4.142 ppm (NO_X); 12.50 ppm (SO_2) and 7.9% (CO_2).

Keywords: Biodiesel, CPO, Emission, Fire Tube Boiler, Physical Properties

1. INTRODUCTION

Air pollution has been increasing everywhere and has reached an increasingly worse condition. This pollution is emitted by some sectors such as industry, transportation, office and household activities. These activities contribute greatly to air quality degradation and cause some other negative impacts on the environment. Thus, the government of Indonesia has issued a government regulation No. 41 of 2009 which regulates the Air Pollution Control. As an important component, the ambient air quality should be maintained and improved in order to support the living things optimally. The increasing energy demand is causing some environments problem in Indonesia. One of the pollutions is coming from exhaust gas emission such as SO_2, CO and NO_X which is emitted by the combustion process in fossil diesel boiler. This exhaust gas emission is responsible for the degradation of ambient air quality. World Resource Institute stated that the ambient air quality in Indonesia is at level 14^{th} in the world, which expressed in the form of absolute emission. It indicates that the emission in Indonesia has given a negative impact on the atmosphere. The replacement of fuel type, from fossil-based oil to vegetable-based oil, is one of effort to prevent the degradation of air quality. In this research, the authors blend biodiesel with fossil diesel oil and use it as fuel in Fire Tube Boiler. The emission parameters (SO_2, CO_2, NOx) are analyzed by a gas analyzer. This research is focused to analyze the influence between biodiesel-fossil diesel oil composition and the quality of its emission. Based on some experiments, the flue gas emitted by diesel engine and diesel fuel boiler can be reduced by substituting its fuel from fossil diesel to biodiesel, particularly for the parameter of SO_2, PM, CO_2 and HC. In contrast, the substitution also increases the NO_X content in the flue gas [1]. By blending fuel of fossil diesel and biodiesel with various compositions, hopefully, we can find the best fuel composition which its emission is more friendly to the environment. This study is conducted by burning these fuel in a fire tube boiler and analyze the concentration of hazardous gas for each fuel composition.

2. LITERATURE REVIEW

2.1 Boiler

A boiler or steam cattle is the main component in a steam power plant system. This device is working by transferring the heat energy of flue gas, generated by the burning process, to feed water and transform the water into steam. The process is begun by transferring the Feed water into the drum. The water will adsorb the heat energy and alter its form from a liquid into vapor or steam. In order to increase the efficiency, steam will adsorb more heat energy and change from saturated vapor into superheated vapor. Finally, high pressure and

temperature of the steam is used to rotate the steam turbine.

2.2Fire Tube Boiler

In the operation of a fire tube boiler, the hight temperature of exhaust gas is flowing through tube bundle and transfers its heat energy to the feed water, located in the shell side, to become steam. Usually, a fire tube boiler is used to generate a low-medium pressure of steam. This boiler is competitive working competitively for a capacity of 12 000 kg/hour and a maximum pressure of 18 kgf/cm^2. In its operation, the heat energy is supplied by the burning process of various fuel types (gas, liquid or solid fuel). For practicality, usually, fire tube boiler is designed as a packaged boiler which can use various types of fuel [2].

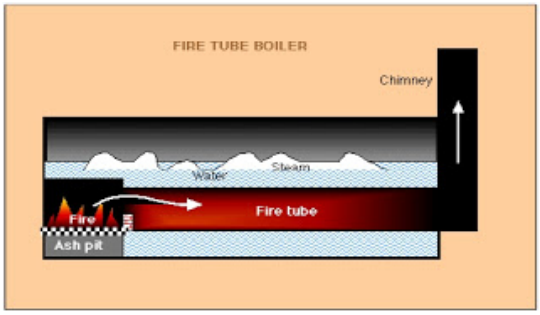

Fig.1 *Fire Tube Boiler*

Biodiesel is consisting of mono-alkyl ester and long-chain alkyl ester. As a renewable resource, biodiesel is made from vegetable oil or animal fat; biodiesel can be used as an alternative energy source for a diesel engine. Biodiesel has combustion properties which are similar to fossil diesel fuel and can substitute the fossil diesel fuel for many cases. Nevertheless, usually, biodiesel is used as a blending oil with fossil diesel oil which the mixing of these oils yields an ultra-low sulphur diesel fuel. [3]. Biodiesel is a simple chemical compound which contains six or seven different esters of fatty acid. This oil is defined as a methyl ester; its carbon chain length is ranging from 12 to 20. This oil can be produced from both of vegetable-based and animal-based oil. The composition and properties of biodiesel are determined by purity, length of the carbon chain, saturation level and structure of the fatty acid chain. [4]

The trans-esterification process is an efficient method to change a molecule of oil from bigger to smaller size. This process is reacting triglyceride with methanol and forms a single carbon chain. The length of the carbon chain is depending on the type of vegetable oil used in the reaction and usually has a similar length to diesel oil [5].

Table 1. Properties of Biodiesel

No	Parameter and unit	Threshold	Method	Other Method
1	Density at 40°C, Kg/m3	850--890	ASTM D 1298	ISO 3675
2	Kinematic Viscosity at 40°C, mm2/s (cSt)	2,3-6,0	ASTM D 445	ISO 3104
3	Cetane Number	Min. 51	ASTM D 613	ISO 5165
4	Flash point at 0° C	Min.100	ASTM D 93	ISO 2710
5	Cloud Point	Max.18	ASTM D 2500	
6	Pour Point	Max.18	ASTM D97	
7	Copper Strip Corrosion (3 hours,50 °C)	Max.3	ASTM D 130	ISO 2160
8	Carbon Residue, %			
	In original sample	Max.0,05	ASTM D 4530	ISO 10370
	In 10% distillation residue	Max.0,03		
9	Moisture and Cediment,%-vol.	Max.0,05	ASTM D 2709	-
10	Destilation Temperature 90%, °C	Max.360	ASTM D 1160	-
11	Sulfated Ash, %	Maks 0,02	ASTM D 874	ISO 3987
12	Sulphur, ppm	Maks.100	ASTM D 5453	Pren ISO 20884
13	Phospor, ppm	Maks.10	AOCS Ca 12-55	FBI-A05-03
14	Acid Number, mg-KOH/gr	Maks.0,8	AOCS Cd 3-63	FBI-A01-03
15	Free Glycerol, %	Maks.0,02	AOCSCa 14-56	FBI-A02-03
16	Glycerol Total, %	Maks.0,24	AOCS Ca14-56	FBI-A02-03
17	Alkyl Ester Content, %	Min.96,5	Counted *)	FBI-AO3-03
18	Iodine number,g-I2/100g	Maks.115	AOCS Cd1-25	FBI-AO4-03
19	Halphen Test	negatif	AOCS Cb 1-25	FBI-AO6-03

Source : (BSN,SNI -04-7182-2006)

Biodiesel has a yellowish color and similar viscosity to fossil-diesel oil. Therefore, biodiesel which is blended with fossil diesel oil can be used as a fuel for a diesel engine. Even this fuel can be used without any modification on the engine [6]. Table 1 shows the standard for biodiesel in Indonesia as regulated in *Standard Nasional Indonesia* (*SNI*). The advantages of using this fuel are the increasing of lubricity in fuel and the reduction of emission. Generally, biodiesel is produced by Trans-Esterification process. This process reacts one of several renewable resources such as vegetable oil, animal fats, or used cooking oil with alcohol. In addition, this reaction is also aid with a catalyst.

Fossil diesel fuel is a non-renewable resource. It needs an effort to reduce our dependency on fossil-diesel fuel. One effort is by replacing fossil diesel fuel with biodiesel. Nevertheless, the using of a 100 % biodiesel (B100) has some weaknesses; hence, blending biodiesel with fossil diesel fuel can be taken as a solution [7]. Blending is a process to combine two types of product to produce a new product which fulfills a specification. In Indonesia, we know a fuel of biodiesel or B5. At this moment, the highest of biodiesel percentage which blends with fossil-diesel oil is B20, it means 20 % of biodiesel is blended with 80 % of fossil diesel oil. In addition, we know other terms of biodiesel such as B5, B10, B15 and B25. The placement of the number behind B letter is presenting the percentage of biodiesel [8]. Cetane number shows the quality of diesel oil

when it has a low cetane number, it needs a higher temperature to be ignited and vice versa. Hence the high cetane number will reduce a detonation in the engine [9].

The emission is analyzed in order to evaluate the concentration of hazardous compounds in the exhaust gas. The parameters involve Carbon Monoxide (CO), Hydro Carbon (HC), particulate, Carbon dioxide (CO_2), and Nitrogen Oxide (NO_X). Research reveals that the hight percentage of biodiesel in fossil diesel fuel can reduce the emission for parameters of CO, HC, Particulate, and CO_2. In addition, the addition of biodiesel also contributes to increasing the power and torsion of the engine [10]. A blend of biodiesel and fossil diesel fuel also helps to control air pollution and reduce the pressure in the combustion chamber with no sacrifice its power and efficiency. Nevertheless, some research also reveals that the optimation and modification of engine should be conducted when the fossil diesel is replaced completely by biodiesel. [11]

3. MATERIALS AND METHOD

3.1 Materials

In this study the used blending biodiesel fuel B0, B10, B15, B20 and B25. The tool that I use to test the emissions that come out of the stack gas using gas analyzer IMR 14000.

3.2 Method

A fire tube cylindrical pilot plant boiler was used for investigating the effect of biodiesel blends on the emission of exhaust gas (NO_x, CO_2, and SO_2) during the combustion process. The boiler was operated in a pressure of 3 bars and heat capacity of 60 000 kcal/h. The detailed specification of the boiler was shown in Table 2. On burner set, the arrangement of air supply was at a fan damper scale of 3.5. The biodiesel flow rate of 5 liters/h was used in the test. Various blending composition of biodiesel in petroleum diesel (B5, B10, B15, B20, and B25) was tested in the boiler experimentally. The stack flue gas was monitored with portable gas analyzer IMR 1400.

Table 2. Specification of Fire Tube Boiler

TYPE	SB 60 MMT-Fire Tube
Pressure	4,5 Bar
Steam Capacity	60.000 k.cal/h
Temperature	150°C
Dimension	ID = 650mm, H=1425mm
Shell – Tube Plate	SS400-10 mm thick
Fire Tube	Seamless Boiler ST 35,8

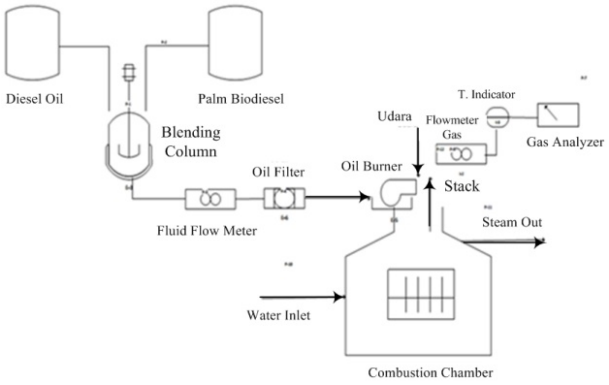

Fig. 2 Research System Series

4. RESULTS AND DISCUSSION

Table 3.Result of Fuel Properties Analysis

Fuel		Bxx	Viscosity (cst)	Moisture (ppm)	Heating Value (Cal/kg)	Cetane Number	Flash Point (°C)
Fossil fuel	Biodiesel						
100%	0%	B0	2,962	26,6	10737	47,4	83,1
95%	5 %	B5	2,997	10,4	10629	50,6	82,3
90%	10%	B10	3,072	7,4	10509	54,9	82,3
85%	15%	B15	3,118	4,5	10488,5	56,2	82,3
80%	20%	B20	3,164	2,6	10468	57,5	82,3
75%	25%	B25	3,118	1,5	10252	56,2	82

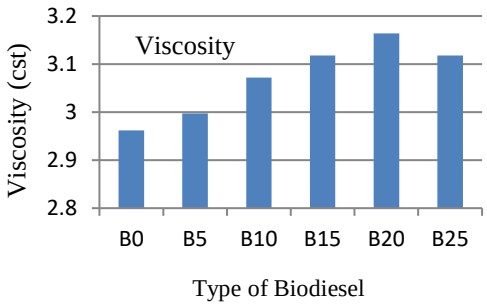

Fig. 3 The influence of Biodiesel Composition on its Viscosity

The results of fuel properties analysis is given in Table 3 and the influence of biodesel composition on its viscosity is shown in Fig.3. Based on the bar chart above, the viscosity is increased directly proportional to the increasing of biodiesel composition in the fuel (B0, B5, B15, B20, and B25). Moreover, the increasing viscosity causes a reduction in fuel atomization quality and then reduces the power of the engine. Finally, it gives an impact for reduction of engine thermal efficiency. In order to decrease biodiesel viscosity, there are some methods which can be taken such as blending biodiesel with ethanol or increasing its fuel temperature [12].

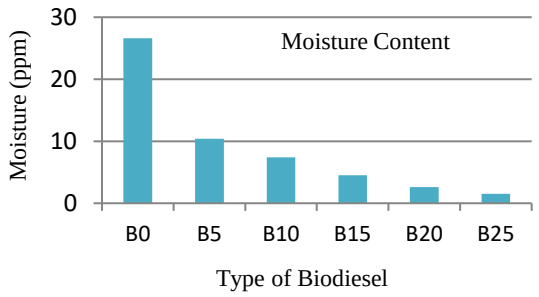

Fig. 4 The influence of Biodiesel Percentage to Moisture Content

The bar chart in Fig.4 shows a relation between biodiesel percentages to the moisture content in the fuel. When the biodiesel percentage is increased, the moisture content of a fuel is decreased. It affected by the moisture content in biodiesel is lower than in fossil diesel fuel. A pure fossil-diesel fuel has a moisture content of 26.6 ppm or 0.00266 %. The lowest moisture content is found in fuel with biodiesel percentage of 25 % (B25) which has a moisture content of 1,5 ppm. According to *Standard Nasional Indonesia* (*SNI*) 2006, the maximum moisture content of biodiesel is must not exceed 0.05 % or 5 ppm. Based on this moisture analysis, the biodiesel has fulfilled the requirement for moisture content parameter. The fuel which has lower moisture content is better than fuel which has higher moisture content. Moisture content in fuel is responsible for hydrolysis reaction which causes an increasing of free fatty acid in fuel [13]. Moreover moisture content in fuel also causes a heat drop in the burning process. Another negative impact from the high moisture content is corrosion because moisture in fuel could react with Sulphur and forms an acidic substance. In very low temperature, moisture could be frozen and clogs the fuel line.

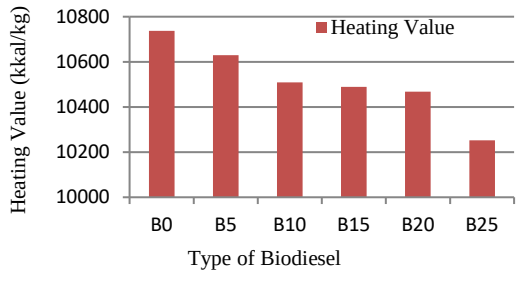

Fig. 5 The influence of Biodiesel Percentage to its Heating Value

The heating value (Fig.5) is decreased along with the increasing of biodiesel in the fuel (B0, B5, B10, B15, B20 and B25). The heating value is decreased because biodiesel has a lower heating value of 5 – 13 % than diesel fossil fuel. Thus it needs more fuel injected to the combustion chamber to reach an ideal stoichiometry and increases fuel consumption. When fuel temperature is increased, the need for fuel injected is increased. This statement is equal to Murni's statement who said that the increasing of flue consumption is caused by the increasing of fuel temperature. By increasing fuel temperature, the fuel can be burnt easily and the ignition delay is also reduced.[14]

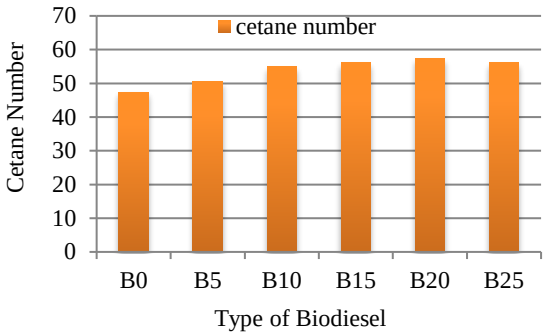

Fig. 6 The influence of Biodiesel Percentage to Cetane Number

Cetane number (Fig.6) is affected by biodiesel percentage contained in the fuel (B0, B5, B10, B15, B20 and B25). This value is increasing directly proportional to the increasing of biodiesel percentage. Moreover increasing cetane number value will give an advantage for the diesel engine performance by decreasing its ignition delay. The highest cetane number is found in B25 Biodiesel amounting of 57.5. According to Prihadana, the high cetane number indicates that the fuel could be ignited in a relatively low pressure, burnt easily in the engine combustion chamber and vice versa. [15]

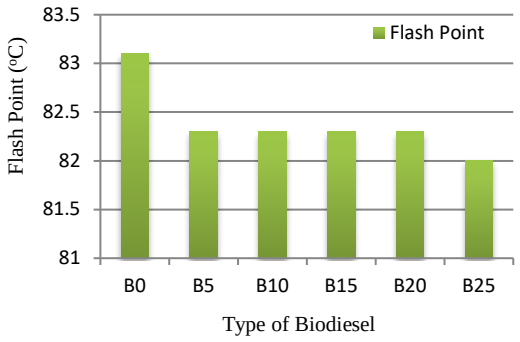

Fig. 7 The Influence of Biodiesel Percentage to Its Flash Point

As shown in Fig.7, the analysis of flash point is conducted by ASTM D-93 method at 60°C. In this analysis the authors are using two devices; they are Pensky-Martens Closed-Cup Test and ASTM thermometer. Based on the bar chart above, the

plash point temperature is ranging 80 - 83 °C and meets the requirement of SNI. Actually, the flash point does not affect the engine performance directly, but it relates to the safety of biodiesel storage. According to [16], biodiesel which has high flash point temperature can be stored at a higher temperature. Biodiesel which has lower flash point temperature is more dangerous because it can be ignited at a lower temperature.

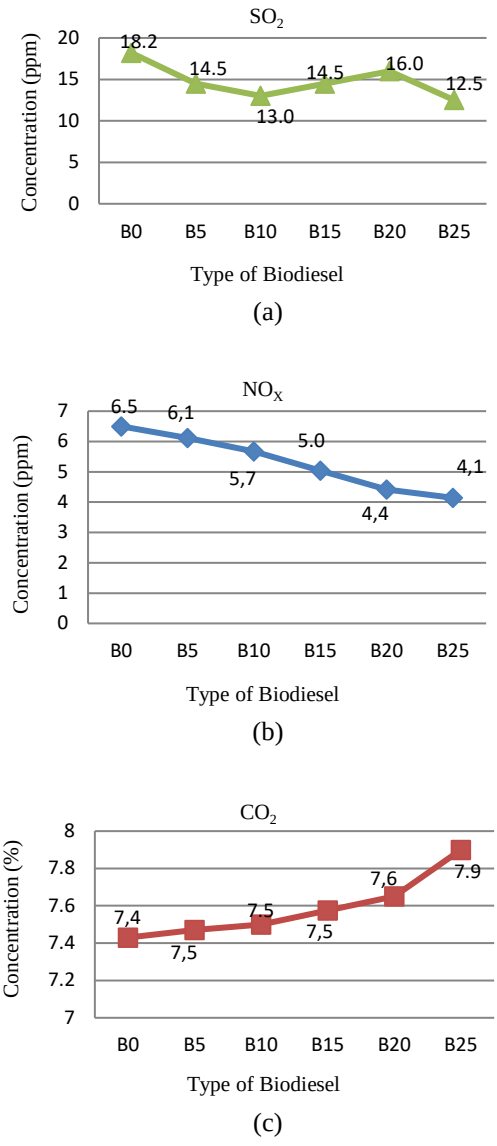

Fig. 8 Result of exhaust gas emission analysis (a) Sulfur Dioxide, (b) Nitrogen Oxide, (c) Carbon Dioxide

The Emission parameters, consist of sulphur dioxide (SO_2), nitrogen Oxide (NO_X) and carbon dioxide (CO_2), are analyzed with a digital gas analyzer (Fig.). The gas of Sulphur dioxide gas is formed by the reaction of Sulphur contained in fuel with oxygen in the air. Theoretically, the amount of Sulphur dioxide is twice to the amount of Sulphur which reacted with oxygen [17]. Generally, Sulphur compound can be found in fossil-based fuel while biofuel theoretically has no Sulphur content. More fossil-based fuel percentage in the fuel is causing the increasing of Sulphur dioxide content in the flue gas. This theory is accordance with the analysis result as shown in Figure 8 (a). The result shows that by increasing the biodiesel percentage is effectively reduced the emission of Sulphur dioxide in the flue gas. In addition, the emission of sulphur dioxide also can be reduced by replacing diesel fuel with Ultra-Low Sulphur Diesel (ULSD). The emission of sulphur dioxide can be dissolved easily with water and causing an acid rain which triggers negative impact on each component of ecosystems, building, road, bridge and other structures [18].

Nitrogen oxide is formed by the reaction of Nitrogen and Oxygen at high temperature. Both nitrogen and oxygen are the main constituent components of the air with a percentage of 75 % and 23 % respectively. Based on the analysis above, the heating value of biodiesel is lower about 5 – 13 % then fossil diesel oil. The lower heating value will decrease the temperature in combustion; as a result of the reaction amount between Nitrogen and Oxygen, which forms a nitrogen oxide, is also decreased. The analysis result of Nitrogen Oxide content of flue gas is shown in Figure 8 (b). It shows that by increasing the percentage of biodiesel, the temperature is decreased and as a result, nitrogen oxide content in flue gas is also reduced. According to A. Macor et al, the using of biodiesel could reduce the emission of nitrogen oxide even though it's not significant [19]. Similar to sulphur dioxide, nitrogen oxide is also dissolved easily with water and causing acid rain.

Carbon dioxide is not a hazardous compound for human and environment health. But it is the main contributor to climate change because the increasing of Carbon dioxide will cause the increasing of the earth's temperature. Carbon dioxide is the product of perfect combustion between atoms of carbon in fuel with oxygen in the air. It means the percentage of carbon dioxide is determined by the amount of carbon atom in the fuel. Based on the cetane number analysis, biodiesel has a higher cetane number value which shows the content of n-hexadecane in fuel. The analysis result of carbon dioxide content in flue gas is shown in Figure 8 (c). From the analysis result, the carbon dioxide content of flue gas emitted by diesel oil is higher than emitted by fossil-diesel oil. According to IPCC guidebook, CO_2 emission from a longer chain of hydro-carbon is higher than the shorter chain of hydro carbon [20].

5. CONCLUSIONS

Experimental research has been conducted to investigate the physical properties of biodiesel blending with diesel-fossil fuel (viscosity, moisture content, heating value, cetane number and flash point). The blending percentages of biodiesel which is added into diesel-fossil fuel are 0% (B0), 5% (B5), 10% (B10), 15% (B15), 20% (B20) and 25% (B25). Based on the investigation, the addition of biodiesel is causing some changes in its physical properties. The parameters of moisture content, heating value, and a flash point of fuel are decreased inversely proportional to the amount of biodiesel contained in the fuel. Meanwhile, the parameters of viscosity and cetane number is increased directly proportional to the increasing of biodiesel content. The properties changes are due to biodiesel have lower moisture content, heating value, and flash point compared to diesel-fossil fuel. Meanwhile, for other physical properties (viscosity and cetane number), biodiesel has a higher viscosity and cetane number compared to diesel-fossil fuel.

These variations of fuel composition are affecting the number of hazardous components in the flue gas. In order to investigate the composition of some hazardous compounds, the variation of fuel composition is used to generate steam in SB 60 MMT-Fire Tube Boiler. Based on the experimental result it's concluded that the substitution from fossil-diesel fuel to biodiesel fuel in fire tube boiler can reduce some parameters of emission. Since biodiesel has a lower heating value, the temperature of the combustion chamber could be decreased and reduce the formation of NO_X. Meanwhile, the reduction of SO_2 compound is affected by the Sulphur content in biodiesel is lower than Sulphur content in diesel-fossil fuel. For the last parameter, carbon dioxide percentage is increased due to the higher carbon content in biodiesel. Finally, The result shows that fuel which blends with 25 % of biodiesel (B25) is emitting the lowest emission compounds with the value of 4,142 ppm (NOx); 12,50 ppm (SO_2) and 7,9 % (CO_2).

6. ACKNOWLEDGMENTS

The authors would like to acknowledge supports from Directorate of Research and Community Service, Directorate General of Research and Development Strengthening Ministry of Research, Technology and Higher Education.

7. REFERENCES

[1] Bowman, C. T., (2011). Control of Combustion-Generated Nitrogen Oxide Emissions: Technology Driven by Regulation, Proc. Combustion Institute 24, pp. 859-878, 1992

[2] Raharjo W. D dan Karnowo.2008. Mesin Konversi Energi. Semarang : Universitas Semarang Press.

[3] Badan Standardisasi Nasional, B. (2006). SNI 04-7182-2006. Jakarta: Badan Standarisasi Nasional.

[4] Djamin, M., S.,Wirawan, S.S. (2010). Pengaruh Komposisi Biodiesel Terhadap Kinerja Mesin Dan Emisi Gas Buang. Jurnal Teknik Lingkungan 11 (3): 381-387.

[5] Komariah, L.N., Arita, S., Wirawan, S.S., Yazid, M., Novia. (2013). Emission factors of biodiesel combustion in the industrial boiler: A comparison to fossil fuel. Journal of Renewable and Sustainable Energy, 5, 052005.

[6] Habib, M. A., Elshafei, M., &Dajani, M. (2008). Influence of combustion parameters on NOx production in an industrial boiler. Computers and Fluids 37, 12-23.

[7] Komariah, L.N., Arita, S., Wirawan, S.S., Yazid, M., Novia.(2013). Effects of Palm Biodiesel Blends on Fuel Consumption in Fire Tube Boiler. Applied Mechanics and Materials Vol. 391 (2013) pp 93-97.

[8] Um, S., and S. W. Park. "Numerical Study on Combustion and Emission Characteristics of Homogeneous Charge Compression Ignition Engines Fueled with Biodiesel ." Energy Fuel, 2009: 24, 916-927.

[9] Setyadi, P., . S.C. Wibowo. Jurnal Konversi Energi dan Manufaktur UNJ, Edisi terbit II – Oktober 2015: 93–99.

[10] Wirawan, S. S., A. H. Tambunan, and M. Djamin. "The Effect of palm biodiesel fuel on performance and emission of the automotive diesel engine,"." Eng. Int. CIGR E-J., 2008: X, 1–13.

[11] Xue, J., Grift, T. E., & Hansen, A. C. (2011). Effect of biodiesel on engine performances and emissions.Renewable and Sustaianble Energy Reviews 15, 1098-1116.

[12] S.H. Park, S.H. Yoon, H.K. Suh and C.S. Lee. "Effect of the Temperature Variation on Properties of Biodiesel and Biodiesel-Ethanol Blends Fuels." Oil & Gas Science and Technology, 2008: 63, 737-745

[13] Yuan, W., Hansen, A. C., & Zhang, Q. (2003). Predicting The Physical Properties of Biodiesel for Combustion Modeling. American Society of Agricultural Engineers 46 (6), 1487-1493.

[14] Syamsidar, H. S. 2010. Pembuatan dan uji kualitas biodiesel dari minyak jelantah. Jurnal Tekno sains, volume 7 (2): 1-22.

[15] Murni. (2013). PengaruhTemperatur Solar Terhadap Performa Mesin Diesel Direck

Injection PutaranKonstan. Semarang: UniversitasDiponegoro.
[16] Prihandana, R., R. Hendrokodan M. Nuramin. 2006. Menghasilkan Biodiesel MurahMengatasiPolusidanKelangkaan BBM.PT. AgromediaPustaka. Jakarta.
[17] Sunita Bhargava and Sharad Bhargava. "Ecological consequences of The Acin Rain." IOSR Journal of Applied Chemistry, 2008: 63, 737-745
[18] European Envirionment Agency. 2013. EMEP/EEA Air Pollutant Emission Inventory Guidebook 2013.
[19] A.Macor, P. Pavanello. 2009. Performance and emissions in boiler for residential heating.Journal of Elsevier. Volume 34. Page 2025 - 2032.IPCC Guidelines for National Greenhouse Gas Inventories. 2006.
[20] A. Winny. 2019. "Analysis of Biodiesel Conversion on Raw Material Variation Using Statistical Process Control Method". Journal of Physic: Conference series, s 1167 (2019) 012037.