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Analysis Of Diesel Fuel, Biodiesel (B20 & B30) Utilizing In Excavator 313D (3054C Engine) To Greenhouse Gas At PT. Bukit Asam

Erwan Abjatar Simanjuntak, Abu Hasan, Muhammad Yerizam

Abstract: Global warming has become an important issue today, where this phenomenon is caused by an increase in the concentration of Greenhouse Gases (GHG), especially CO_2 in the atmosphere and has resulted in various adverse impacts on humans. In the world of Coal Mining today, such as PT. Bukit Asam, Tbk in its production operations uses a lot of heavy equipment that produces exhaust emissions, such as the excavator 313D. Exhaust emission analysis in this study uses a Digital Gas Analyzer. The results of this study indicate that the lowest emissions are obtained in the B30 biodiesel fuel variant and the highest engine power is found in the diesel fuel variant. For fuel consumption with diesel fuel variants, biodiesel B20 and B30 are the same.

Index Terms: biodiesel, exhaust emission, greenhouse gasses, engine, fuel, digital gas analyzer

1 INTRODUCTION

Global warming has become an important issue today, where this phenomenon is caused by an increase in the concentration of Greenhouse Gases (GHG), especially CO_2 in the atmosphere and has resulted in various adverse impacts on humans [1]. Various country, including Indonesia, pay great attention to the impact of global warming [1]. Energy use is the main factor causing greenhouse gas (GHG) emissions in the world. Utilization of alternative energy such as biofuels, hydrogen, natural gas and electricity can reduce greenhouse gas emissions [1]. In an effort to reduce dependence on fossil fuel sources and reduce greenhouse gas emissions, the government through Government Regulation (PP) No.79 of 2014 has set a national energy mix target where the role of new and renewable energy (EBT) is at least 23% in 2025 and 31 % by 2050 [2]. One form of renewable energy is biodiesel which is a fuel using vegetable oil as a mixture with diesel oil. Biodiesel is known as an environmentally friendly fuel because it is renewable and produces relatively cleaner exhaust emissions than conventional diesel fuel, namely diesel oil. In the world of Coal Mining today, in its production operations many use heavy equipment that uses petroleum as fuel. This has the potential to apply the use of new renewable energy fuels, namely biodiesel [3]. Several previous papers discussing biodiesel include in 2021, research from Riksa et al on the effect of diesel fuel, biodiesel B20 and biodiesel B30 at CAT 3406 engine on the greenhouse emissions in PT. Bukit Asam [3].

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Furthermore, there is a study on the performance test of diesel engines using biodiesel from wasted cooking oil by Aziz, I. (2010), Journal of Chemistry [4]. Research from Burhan et al (2019) on Achievement Analysis of One Cylinder Diesel Engine Using Virgin Coconut Oil Biodiesel [5]. Research from Basri, H., & Negeri Samarinda (2018) on the effect of mixing biodiesel fuel and dexlite on exhaust gas opacity and fuel consumption in internal combustion engines [6]. Yogyakarta City Land Transportation Sector, research from Puji Saksono and Pandu Prastiyo Utomo (2017) on the Analysis of the Effect of Engine Loading on Exhaust gas Emissions and Fuel Consumption Using Diesel Fuel and B10 Biodiesel on the Cummins QSK 45C Engine [8], as well as research from Wangi et al (2016) on the study of greenhouse gas emissions (CO_2, CH_4 and N_2O) due to vehicle activities (case studies of the mangkang terminal and penggaron terminal) [9]. Meanwhile research from Wirawan et al (2008) discusses the effect of palm biodiesel fuel on the performance and emission of the automotive diesel engine [10]. In this research paper, the research was conducted at PT. Bukit Asam Tbk which is one of the Indonesian State-Owned Companies that has used alternative energy fuel oil, namely biodiesel in mining operations. One of PTBA's mining operations that uses biodiesel fuel is the operation of the CAT excavator 313D heavy equipment which functions to load coal into dump trucks. This paper discusses the comparative analysis of emissions, fuel consumption and power generated from the use of diesel fuel, B20 biodiesel, and B30 biodiesel on the CAT 3054C engine as the main driver of the excavator 313D.

2 RESEARCH METHODOLOGY

This research was conducted experimentally. The research object used as a test material is excavator 313D (CAT 3054C engine) in Figure 1 using variants of diesel fuel, biodiesel B20 and biodiesel B30.

Figure 1. Excavator 313D

Table 1. Spesification of engine CAT 3054C [7]

Description	Spesification
Year	2017
Engine Model	3054C
Daya Bersih – ISO 14396	72 Kw
Daya Bersih – SAEJ1349/ISO 9249	67 kW
Diameter	105 mm
Step	127 mm
Silinder Capacity	4.41

Diesel fuel variants, biodiesel B20 and biodiesel B30 have fuel specifications shown in table 2.

Table 2. Spesification of Diesel and Biodiesel

Parameters	Unit	Diesel	B20	B30
Cetane Numbers	-	Min 48	Min 48	Min 48
Density	kg/m³	815 – 870	815 - 870	815 - 880
Viscosity	mm²/s	2.0 - 4.5	2.0 - 4.5	2.0 - 5
Flash Point	°C	Min 60	Min 52	Min 52
Fog Point	°C	Max 17	Max 18	Max 18
Pour Point	°C	Max 18	Max 18	Max 18
Water Content	max ppm	500	500	425
FAME Content	% m / m	0	20	30
Sulfur content	max mg/kg	Max 0.35	Max 0.35	Max 0.25
Total Acid Number	max mg KOH/g	0.6	0.6	0.6

The procedure of this research, preparation of heavy equipment CAT excavator 313D with engine drive CAT 3054C. The excavator is filled with a variety of diesel fuel, biodiesel B20 and biodiesel B30. The engine is turned on for a few minutes so that the engine working temperature is 88 ^{O}C - 98 ^{O}C. After the engine operating temperature is reached, position the excavator at engine speed at low idle rpm at 900 rpm. Next, position the excavator at engine speed at high idle rpm at 2000 rpm. After that, take the exhaust gas emission data generated at each low idle and high idle engine speed using a digital gas analyzer tool in figure 2. The specifications of the digital gas analyzer tool can be seen in table 3.

Figure 2. Digital Gas Analyzer

Table 3. Digital Gas Analyzer specification

Description	Specification
Merk	Bacharach Fyrite Intech
Model	0024 – 8512
Measurement	Ambient temperature range -5 to 45 °C Flue gas temperature range -20 to 650 °C Oxygen range 0 to 20.9 % Carbon monoxide range 0 to 2000 ppm Combution efficiency 0.1 to 100 %

Finally, record and analyze all exhaust gas emission data, engine rpm rotation and engine power with several tools and measuring tools which can be seen in table 4.

Table 4. Measuring instrument and tools

Digital analyzer type 0024 – 8512 (Made in Bacharach Ireland)	1 unit
Laptop	1 unit
Infrared Thermometer	1 unit
Caterpillar Electronic Technician (ET-Tool)	1 unit
Pressure gauge	1 unit
Fuel Truck	1 unit
Timer / Stopwatch	1 unit

3 Result and Discussion

The results of this study are to obtain exhaust gas emissions resulting from the operation of a excavator 313D heavy equipment (engine 3054C) which causes greenhouse gases with variants of diesel fuel, biodiesel B20 and biodiesel B30. The data taken is at engine speed of low idle rpm of 900 rpm and high idle rpm of 2000 rpm. The parameters measured in this study are CO, O_2, CO_2 and engine power from diesel fuel, B20 biodiesel and B30 biodiesel.

3.1 Ratio of O2 per Fuel Combustion

The working process of the diesel engine occurs because of the combustion process in the combustion chamber. One of the factors that determine the occurrence of the combustion process in the engine combustion chamber other than fuel is air/oxygen. The O_2 measured in this study is the O_2 remaining from the combustion in the diesel engine combustion chamber.

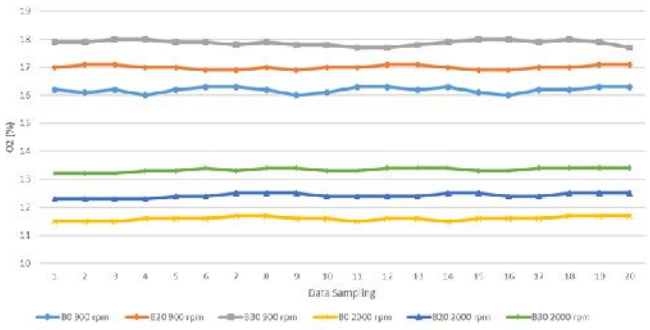

Figure 3. O_2 Gas comparison in Each Fuel Variant

From the results of the O_2 data shown in figure 3, the results obtained such as diesel fuel with low idle rpm engine speed (900 rpm) the lowest O_2 value is 16.1% and the highest is 16.3% with an average O_2 value of 16.2%, while with high idle rpm engine speed (2000 rpm) the lowest O_2 value is 11.5% and the highest is 11.7% with an average O_2 value of 11.6%.

For biodiesel fuel B20 with low idle rpm (900 rpm) the lowest O_2 value is 16.9% and the highest is 17.1% with an average O_2 value of 17%, while with high idle rpm engine speed (2000 rpm) the highest value is obtained. The lowest O_2 is 12.3% and the highest is 12.5% with an average O_2 value of 12.4%. For biodiesel fuel B30 with low idle rpm (900 rpm) the lowest O_2 value is 17.7% and the highest is 18% with an average O_2 value of 17.9%, while with high idle rpm engine speed (2000 rpm) the highest value is obtained. The lowest O_2 is 13.2% and the highest is 13.4% with an average O_2 value of 13.3%.

3.2 CO Ratio per Fuel Combustion

CO which is carbon monoxide which is one of the exhaust gas emission parameters produced by the combustion process in the CAT 3054C diesel engine.

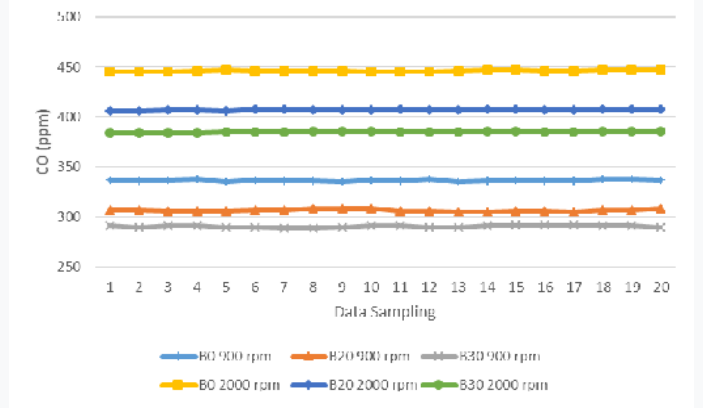

Figure 4. Comparison of CO gas in each fuel variant

From the results of the CO gas comparison data shown in figure 4 above, the results obtained such as diesel fuel with low idle rpm engine rotation (900 rpm) the lowest CO value is 335 ppm and the highest is 338 ppm with an average CO value of 337 ppm, while with high idle rpm engine speed (2000 rpm) the lowest CO value is 445 ppm and the highest is 447 ppm with an average CO value of 446 ppm. For biodiesel fuel B20 with low idle rpm engine speed (900 rpm) the lowest CO value is 305 ppm and the highest is 308 ppm with an average CO value of 307 ppm, while with high idle rpm engine speed (2000 rpm) the highest value is obtained. The lowest CO is 406 ppm and the highest is at 408 ppm with an average CO value of 407 ppm. For biodiesel fuel B30 with low idle rpm (900 rpm) the lowest CO value is 289 ppm and the highest is 292 ppm with an average CO value of 291 ppm, while at high idle rpm (2000 rpm) the highest value is obtained. The lowest CO is 384 ppm and the highest is at 386 ppm with an average CO value of 385 ppm. Based on the graph in figure 4, the CO value at 900 rpm engine speed is smaller than at 2000 rpm engine speed because the fuel supply at 900 rpm engine speed is smaller than at 2000 rpm engine speed.

3.2 Comparison of CO2 Gas per Fuel Combustion

CO_2 is one of the gases that are dangerous, especially against global warming today. CO_2 is one of the greenhouse gas emissions resulting from the fuel combustion process.

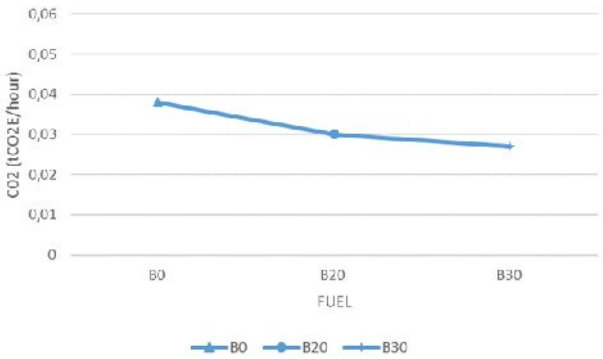

Figure 5. Comparison of CO_2 gas /hour in Each Fuel vVriant

From the results of the CO_2 data shown in figure 5 above, for diesel fuel it produces greater CO_2 than biodiesel B20 and biodiesel B30. Diesel fuel produces 0.038 tCO_{2e}/hour, B20 biodiesel fuel produces 0.03 tCO_{2e}/hour, and B30 biodiesel fuel produces 0.027 tCO_{2e}/hour.

3.4 Power Generated in Each Fuel

The power value is obtained from the fuel combustion process in the CAT 3054C engine. The value of the power generated depends on the type of fuel used. There is a difference between diesel fuel and biodiesel fuel, namely in the flash point, where the flash point of diesel fuel is higher than biodiesel because biodiesel has a mixture of vegetable raw materials. The power results obtained are shown in Figure 6. Engine power at low idle rpm (900 rpm) with diesel fuel is an average of 56 kW, biodiesel B20 is 55 kW, and biodiesel B30 is 54.3 kW. While the power results obtained at high idle rpm (2000 rpm) with diesel fuel are an average of 72 kW, biodiesel B20 is 70.8 kW and biodiesel B30 is 69.8 kW.

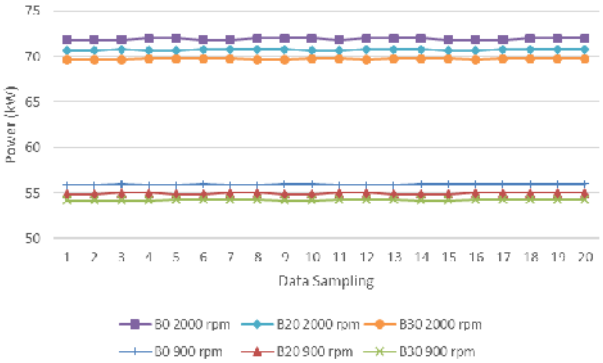

Figure 6. Comparison of engine power in each fuel variant

4 Conclusion

From the research that has been carried out with the title analysis of diesel fuel, biodiesel (B20 & B30) utilizing in excavator 313D (3054C engine) to greenhouse gases at PT. Bukit Asam, the following conclusions are obtained :

1. With diesel fuel variants, biodiesel B20 and B30 which produce exhaust gas emissions of CO content, the highest O_2 is found in diesel fuel and the lowest is biodiesel fuel B30.

2. With diesel fuel variants, biodiesel B20 and B30 which produce greenhouse gases, the highest CO_2 content is found in diesel fuel and the lowest is biodiesel fuel B30
3. The power generated from the use of diesel fuel variants, biodiesel B20 and B30 obtained the highest power on diesel fuel.

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