Analysis of Water Content on Biodiesel Crude Palm Oil (CPO) and Biodiesel Virgin Coconut Oil (VCO) as Diesel Engine Fuels

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Abstract. This paper is based of policy to diversify energy from renewable energy, one of the types of renewable energy is biodiesel. The purpose of this paper is to explain the water content in biodiesel with palm oil added, and the water content in biodiesel with coconut oil added, and compare the water content of the two types of biodiesel. The type of research used is the research and development method, testing the water content of the biodiesel at the Sucofindo Padang Laboratory and the Pertamina Padang Laboratory. The results showed that the water content of biodiesel with palm oil had a lower water content compared to biodiesel with coconut oil. Referring to the provisions of the Indonesian National Standard (SNI 7182:2015) that the water content in biodiesel is 0.05% as the maximum limit, while referring to Gaikindo (Association of Indonesian Automotive Industries), the maximum water content in biodiesel is 0.020% to 0.025%, then biodiesel B5, B10, B15, and B20, with palm oil added, and biodiesel B5 and B10 with coconut oil added as fuel can be used for diesel engines.

1. Introduction
This paper is based on the background that Indonesia is one of the oil producing countries in the world, but until now it still imports fuel oil to meet the needs of fuel oil in the transportation and industrial sectors. In the long term, this fuel import will increasingly dominate the national energy supply if there is no government policy to diversify energy with renewable energy (Risnoyatiningsih, 2010)[1]. One type of renewable energy is biodiesel. As part of an economic policy package, the government will try to increase the share of biodiesel in the sale of biodiesel. Regulation of the Minister of Energy and Mineral Resources Number 12/2015, concerning the Third Amendment to the Regulation of the Minister of Energy and Mineral Resources Number 32/2008 concerning the Provision, Utilization and Trading of Biofuels as Other Fuels (Regulation ESDM 12/2015)[2]. In this regulation, what is revised is an increase in the minimum obligation target for the use of biodiesel (B100) as a mixture of fuel oil, from previously targeted to reach 20% in 2025, now targeted to 30% in 2025, now with the B30 program.

In general, biodiesel cannot be used directly as fuel for transportation, or it can be used directly, but engine modifications need to be made. The use of pure biodiesel (B100) has a negative impact on several things, such as: corrosion of the fuel injectors and tanks, softening of the rubber seals,
increased demand for pumping power, clogging of the fuel injectors and clogging of the fuel pipe/filter due to bacterial growth (Sidjabat et al., 2009). One way to overcome this problem is by blending biodiesel with diesel oil. [3]

Biodiesel is an innovative technology for this type of diesel fuel where it is expected to be able to meet national energy needs if the utilization and development continues to be carried out by the community in general and the government in particular. Biodiesel can be used as engine fuel whose combustion process uses a high compression system (diesel engine) with little or no modification. Biodiesel is not only from palm oil, but biodiesel is an additional or mixed fuel for fossil fuels, which are produced from raw materials derived from plants or known as biofuels in general, which are biofuels.

Virgin Coconut Oil is a process of processing and manufacturing coconut oil so that it produces products with low water content and free fatty acid content, clear color, smells good, and has a long shelf life. The advantages of Virgin Coconut Oil are that the raw material is easy to obtain with simple and less complicated processing, and minimal energy use because it does not use fuel so that the chemical content is maintained in the oil. The raw material for making Virgin Coconut Oil from coconut fruit is very abundant because Indonesia is a country with the most islands and an area where the coastline on each island is overgrown with coconut trees, it is possible that Virgin Coconut Oil will be able to continue to be developed with a large production scale and able to be utilized and managed properly for utilization as biodiesel fuel. In making virgin coconut oil biodiesel, there are several techniques, including: enzymatic technique, acidification technique, centrifugation technique, and fermentation technique.

The focus of this paper is to explain the water content of biodiesel in biodiesel with palm oil added and biodiesel with virgin coconut oil added, the water content in biodiesel that exceeds the safe limit, namely 0.05% (according to the Indonesian National Standard, SNI 7182:2015), can cause damage to diesel engine components and reduce the performance produced by the diesel engine.

1.1. Diesel Engine Fuels

Diesel Fuels is a clear brownish yellow distillate type fuel. Diesel oil is also known as Gas Oil, Automotive Diesel Oil, or High Speed Diesel. The use of diesel oil in general is for fuel in all types of diesel engines with high speed (above 1,000 RPM), it can also be used as fuel for direct combustion in small kitchens, where clean combustion is especially desired. The general requirement that diesel fuel must have is that it must be able to ignite and burn according to the conditions of the combustion chamber. Solar as a fuel has characteristics that are influenced by properties such as Cethane Number (CN), Cetana Index (CI), density, analin point, Flash Point, Viscosity, and sulfur content. As according to (Toyota, 2005).[4]

1.2. Biodiesel

Biodiesel is an alternative energy that can be used as a fuel like fossil fuels. Biodiesel is obtained from vegetable oil or animal oil so that it is renewable. Biodiesel is a non-fossil oil obtained from certain plants which has its own characteristics and characteristics, so it is necessary to develop it for use in vehicle engines. Biodiesel has similarities which are almost the same as the type of diesel fuel used by the community for vehicles in general in everyday life, as Syamsudin (2010: 1) states: "Biodiesel has properties that are very similar to petrodiesel or synthetic diesel oil, namely having combustion energy and higher cetane number (> 60) so that in addition to combustion more efficiently it also lubricates the engine pistons".[5].  

1.2.1 Biodiesel with a Crude Palm Oil (CPO)

In the development of biodiesel, the main raw material that is still used is oil derived from palm oil, palm oil, including food oil. In general, biodiesel cannot be used directly as fuel for transportation, or it can be used directly, but engine modifications need to be made. The use of pure biodiesel (B100) has a negative impact on several things, such as: corrosion of the fuel injectors and tanks, softening of
the rubber seals, increased demand for pumping power, clogging of the fuel injectors and clogging of the fuel pipe / filter due to bacterial growth (Sidjabat et al, 2009). One way to overcome this problem is by blending biodiesel with diesel oil.

1.2.2 Biodiesel with a Virgin Coconut Oil (VCO)
Virgin Coconut Oil is one of the processed coconut plant products that is liquid with a clear color and smells like coconut and has a long shelf life. Processing without going through the heating process. In contrast to copra coconut oil, which is made through a heating process so that the properties of the oil produced will be brownish yellow, smell odorless and easily rancid so that its shelf life is short. A. Hery and Budi (2005: 2).VCO (Virgin Coconut Oil) is the result of coconut oil which does not use chemicals at all and is pure processed coconut which is processed using pure water and squeezed so that it can produce oil from the coconut flesh which is commonly called VCO (Virgin Coconut Oil).

1.3. Water Content of Biodiesel
The water content contained in the biodiesel can affect the quality of the biodiesel. Based on the Indonesian national standard (SNI 7182: 2015), the maximum moisture content contained in biodiesel is 0.05%. If the water content contained in biodiesel is lower than the Indonesian national standard, namely 0.05%, it means that the quality of biodiesel is getting better. The moisture content is also a measure for the quality of biodiesel. High moisture content in biodiesel will cause a decrease in combustion heat, it is corrosive if it reacts with sulfur and will form acids, giving room for microbes to grow so that it can become an impurity for biodiesel. According to Freedman et al (1984) the free fatty acid content and water content of more than 0.5% and 0.3% in biodiesel can reduce the yield of the transesterification process. Because free fatty acids will react with an alkaline catalyst and will form soap, soap will cause a decrease in the yield formed, Soap will also make it difficult to wash biodiesel. Vegetable oils that have high levels of free fatty acids need to be processed twice to produce acyl esters according to biodiesel standards.

2. Methods
This type of research used in this research is a research and development method. According to Sugiyono (2012:297), research and development methods are research methods used to produce certain products. In order to produce certain products, research is used that is needs analysis and to test the effectiveness of the product so that it can function properly, research is needed to test the effectiveness of the product. So the use of the R&D method is in line with what is stated by the experts in accordance with the objectives of this study. The research was conducted at the Laboratory and Workshop of the Automotive Department, Engineering Faculty UNP, Sucofindo Laboratory Padang and Pertamina Laboratory Teluk Kabung Padang.

The stages in this research began with the procurement or purchase of FAME (Fatty Acid Methyl Ester) from palm oil obtained from several palm oil companies. Furthermore, the palm oil obtained is mixed with pure diesel oil, with a ratio of 95% diesel oil and 5% palm oil to produce biodiesel 5 or B5. To produce biodiesel 10 or B10, mix 90% diesel oil and 10% palm oil, to produce biodiesel 15 or B15, mix 85% diesel oil and 15% palm oil, to produce biodiesel 20 or B20, mix 80% diesel oil and oil. palm oil 20%, to produce biodiesel 30 or B30, mix diesel oil 70% and palm oil 30%, to produce biodiesel 40 or B40, mix diesel oil 60% and palm oil 40%, and to produce biodiesel 50 or B50, mix the oil. diesel fuel 50% and palm oil 50%. The same is done in making biodiesel with virgin coconut oil as an added ingredient. After making virgin coconut oil, then mixing diesel oil with virgin coconut oil is carried out to produce biodiesel B5, B10, B15, and B20. After the biodiesel is formed, the water content is testing in the Sucofindo laboratory Padang and the Pertamina Laboratory Teluk Kabung Padang.
3. Results and Discussion
The results of water content testing in biodiesel CPO at the Sucofindo Laboratory Padang, are as in table 1.

Table 1. Water content in Biodiesel CPO result testing at Sucofindo Laboratory Padang

| No | Biodiesel | Water content (mg/kg) | Water content (% wt) | Limit (SNI 7182:2015) (mg/kg) / (% wt) | Methods |
|----|-----------|-----------------------|----------------------|----------------------------------------|---------|
| 1  | B 5       | 85                    | 0,0085               | 500 / 0,05                             | ASTM D6304 |
| 2  | B 10      | 111                   | 0,0111               | 500 / 0,05                             | ASTM D6304 |
| 3  | B 15      | 139                   | 0,0139               | 500 / 0,05                             | ASTM D6304 |
| 4  | B 20      | 172                   | 0,0172               | 500 / 0,05                             | ASTM D6304 |
| 5  | B 30      | 296                   | 0,0296               | 500 / 0,05                             | ASTM D6304 |
| 6  | B 40      | 416                   | 0,0416               | 500 / 0,05                             | ASTM D6304 |
| 7  | B 50      | 560                   | 0,0560               | 500 / 0,05                             | ASTM D6304 |
| 8  | B 100     | 1300                  | 0,1300               | 500 / 0,05                             | ASTM D6304 |

The results of water content testing in biodiesel VCO at the Pertamina Laboratory Padang, are as in table 2.

Table 2. Water content in Biodiesel VCO result testing at Pertamina Laboratory Padang

| No | Biodiesel | Water content (mg/kg) | Water content (% wt) | Limit (SNI 7182:2015) (mg/kg) / (% wt) | Methods |
|----|-----------|-----------------------|----------------------|----------------------------------------|---------|
| 1  | B 5       | 119                   | 0,0119               | 500 / 0,05                             | ASTM D6304 |
| 2  | B 10      | 155                   | 0,0155               | 500 / 0,05                             | ASTM D6304 |
| 3  | B 15      | 254                   | 0,0254               | 500 / 0,05                             | ASTM D6304 |
| 4  | B 20      | 268                   | 0,0268               | 500 / 0,05                             | ASTM D6304 |

The comparasion of water content testing in biodiesel CPO and biodiesel VCO, are as in table 3 below:

Table 3. Comparasion Water content in Biodiesel PCO with Biodiesel VCO

| No | Biodiesel | Water Content (% wt) | Limit (SNI 7182:2015) (mg/kg) / (% wt) |
|----|-----------|----------------------|----------------------------------------|---------|
| 1  | B 5       | 0,0085               | 0,0119                                 | 0,05    |
| 2  | B 10      | 0,0111               | 0,0155                                 | 0,05    |
| 3  | B 15      | 0,0139               | 0,0254                                 | 0,05    |
| 4  | B 20      | 0,0172               | 0,0268                                 | 0,05    |
3.1. Analysis biodiesel with Crude Palm Oil as Diesel Engine Fuels

Furthermore, from the data from table 1 is then made a graph of the relationship between water content and types of biodiesel CPO to obtain a graph like figure 1.

Referring to Figure 1 above, it can be concluded that the greater the percentage of palm oil content in biodiesel, the greater the value of the water content. When the palm oil content is only 5% in biodiesel B5, then the water content is only 0.0085%. If the percentage of palm oil content is increased by 50% at B50, then the water content becomes 0.0560%. If we use fuel from palm oil with a percentage of 100% is such as biodiesel B100, then the water content will be 0.1300%. According to Gaikindo (Association of Indonesian Automotive Industries), the maximum water content in biodiesel is 0.020% to 0.025%. Meanwhile, referring to the Indonesian National Standard (SNI 7182:2015), the maximum water content contained in biodiesel is 0.05%. If the water content contained in biodiesel is lower than the Indonesian National Standard, namely 0.05%, it means that the quality of biodiesel is getting better, the water content in bisolar is also a measure for the quality of biodiesel.

3.2. Analysis biodiesel with Virgin Coconut Oil as Diesel Engine Fuels

Furthermore, from the data from table 2 is then made a graph of the relationship between water content and types of biodiesel VCO to obtain a graph like figure 2.
Referring to Figure 2 above, it can be concluded that the greater the percentage of virgin coconut oil content in biodiesel, the greater the value of the water content. When the virgin coconut oil content is only 5% in biodiesel B5, then the water content is only 0.0119%. If the percentage of virgin coconut oil content is increased by 10% at B10, then the water content becomes 0.0155%. If the percentage of virgin coconut oil content is increased by 15% at B15, then the water content becomes 0.0254%. And if the percentage of virgin coconut oil content is increased by 20% at B20, then the water content becomes 0.0268%. According to Gaikindo (Association of Indonesian Automotive Industries), the maximum water content in biodiesel is 0.020% to 0.025%. Meanwhile, referring to the Indonesian National Standard (SNI 7182:2015), the maximum water content contained in biodiesel is 0.05%.

3.3. Comparison water content Biodiesel CPO and Biodiesel VCO

Furthermore, from the data from table 3 is then made a graph of the comparison water content biodiesel CPO and biodiesel VCO to obtain a graph like figure 3.

![Figure 3. Graph of comparison water content in biodiesel CPO with biodiesel VCO](image)

Based on Figure 3 above, it can be explained that the water content contained in biodiesel with added of crude palm oil and biodiesel with virgin coconut oil has a different water content. For biodiesel B5, the water content in biodiesel CPO was 0.0085% and the water content in biodiesel VCO was 0.0119%. For biodiesel B10, the water content in biodiesel CPO is 0.0111% and the water content in biodiesel VCO is 0.0155%. For biodiesel B15, the water content in biodiesel CPO is 0.0139% and the water content in biodiesel VCO is 0.0254%. For biodiesel B20, the water content in biodiesel of CPO is 0.0172% and the water content in biodiesel VCO is 0.0268%.

4. Conclusion

Base on the above discussion, it can concluded that the water content of biodiesel with crude palm oil (CPO) added had a lower water content compared to biodiesel with virgin coconut oil (VCO) added. Referring to the provisions of the Indonesian National Standard (SNI 7182:2015) that the water content in biodiesel is 0.05% as the maximum limit, while referring to Gaikindo (Association of Indonesian Automotive Industries), the maximum water content in biodiesel is 0.020% to 0.025%, then biodiesel B5, B10, B15, and B20, with crude palm oil added, and biodiesel B5 and B10 with virgin coconut oil added as fuel can be used for diesel engines.

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