Use Of Biodiesel B35 In Direct Injection Diesel Engine With Load Variation

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Abstract. Crude Palm Oil (CPO) is one of the raw materials for making biodiesel and until 2022 B30 biodiesel has been used which is marketed by Pertamina but B30 biodiesel is not popular because it is not yet trusted by consumers. In 2023 the CPO content in biodiesel will be increased to 35% (B35), therefore it is necessary to do a lot of testing on diesel engines, especially conventional engines with direct injection systems to determine engine performance so that it can provide information for the public to want to use biodiesel fuel. The aim of this research is to obtain the performance of a diesel engine with a direct injection system when using B35 biodiesel fuel with load variations. The method used is to use B35 biodiesel at loads of 30 32.5 kgf, 35 kgf, 40 kgf, 45 kgf. The engine is tested at 3500 rpm and will be compared with pure diesel and B30 by analyzing engine power, fuel consumption, thermal efficiency and Co and HC exhaust emissions. The research results show that using B35 biodiesel at light loads has almost the same performance compared to pure diesel and B30, if the load is increased higher then the power produced is lower than using pure diesel. Spesifik Fuel consumption is relatively balanced and only differs by less than 3% per hour of use. The best performance of B35 is in exhaust emissions where the use of B15 reduces Co by more than 5% and HC decreases by more than 52%.

Keywords: B35, Biodiesel, Direct Injection, Performance.

1 Introduction

Environment friendly renewable energy continues to be developed because fossil energy reserves are running low and there are efforts to reduce exhaust emissions so as not to damage the environment. Environmentally friendly energy is primarily directed as energy to drive motorized vehicles because the majority of fossil energy users are motorized vehicles or means of transportation. Therefore, it is necessary to look for renewable and environmentally friendly energy that is suitable for motorized vehicles. Currently there are two types of environmentally friendly energy that are being developed as vehicle energy, namely electrical energy and biodiesel energy, however both of these energies are still closely related to fossil energy, namely electrical energy is obtained from generators which mostly still use fossil energy such as coal, while biodiesel still mixed with diesel. A lot of research has been carried out with fuel from

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plants or what is called biodiesel, but because the fuel requirements for diesel engines are difficult to fulfill, some of the biodiesel products produced, despite complex processing, also need to be mixed with diesel so that they approach the fuel requirements, namely low viscosity and high calorific value. .

No research on Pertamina's biodiesel product for B35 has been published yet because it will only be released at the end of 2022 and will be used in 2023, however, for B30 biodiesel, many studies have found that using B30 when compared with pure diesel, the performance of large capacity engines up to 1 MW decreases 3 .7% if using B30 at 50% load while the exhaust emissions are not much different [1]. For engines with a smaller capacity of 2 HP, the performance of engines using B30 is around 15% lower and exhaust emissions also decrease by 10% [2]. In order for the decrease in performance to be minimal, other treatments are needed when the biodiesel fuel has not been injected into the engine, such as adding a fuel heater to reduce the viscosity which results in a decrease in performance of only 2% [3].

The fuel to be used in a diesel engine must meet certain requirements such as viscosity, flash point and specific gravity that are suitable for compression ignition, and in particular the cetane number must be appropriate to prevent knocking. So the important thing in making fuel is trying to meet these requirements so that diesel engine performance remains optimal [4]

Biodiesel is one option as a fuel that can reduce fuel consumption because the characteristics of biodiesel are almost the same as pure diesel, especially if mixed with pure diesel or similar in a certain percentage, where up to now the biodiesel mixture in fuel is still around 30%. although power has decreased slightly and fuel consumption has increased, the reduction in exhaust emissions is very significant [5]. The use of biodiesel with a significant percentage, besides being able to reduce exhaust emissions, can also increase the country's foreign exchange because it is a domestic product, thereby reducing exports [6]. Overall, using B30 biodiesel for fuel consumption can save fuel and engine power is still within the required standards and exhaust emissions can be reduced [7]. For use in large capacity engines or power plants, fuel consumption is close to that of pure diesel and does not significantly reduce gas emissions because generator engines generally operate at high loads and low rpm, but for long use it can cause residual deposits in the fuel pump. [8]

Crude Palm Oil (CPO) is a palm oil product which is generally made into cooking oil and is one of the most superior local products for export. The use of CPO as biodiesel is significant, but it still has to be mixed with diesel at a certain percentage to make it suitable for use as diesel engine fuel. Until 2022, 30% CPO biodiesel will still be used and 70% diesel, this mixture is named B30. The research results show that the use of B30 in diesel engines can make engine power almost the same as the power produced with pure diesel fuel, and very significantly reduces exhaust emissions [9].

One of the problems that often makes biodiesel undesirable is the high viscosity so that the fuel atomization is less than perfect, therefore one method used to reduce viscosity is to heat the fuel before it is injected into the combustion chamber, so that the ignition is better [10]. The use of heating plugs and incandescent light bulbs in the fuel line to heat the fuel can improve diesel engine performance [11]

2 Material and Method

Please The fuel used is Pertamina Dex, Biodiesel B30 and Biodiesel B35, which are Pertamina products. Material characteristics are measured with the tools found in laboratory of the mechanical engineering department, namely calorific value, viscosity and density. The diesel engine used for testing is a Nissan brand of four cylinders and four stroke direct injection. The loads given are 30 kg, 32 kg, 35 kg, 37 kg and 40 kg. The performance measured is Power, Thermal Efficiency, Spesifik Fuel Consumption, CO and HC exhaust emissions and compare it with pure dexlite and B30 biodiesel. Testing was carried out at a fixed rotation of 3500 rpm

Table I. Physical Properties Of Material Fuel

Fuel Material	**Heating Value (Calori/gram)**	**Viskosity (cSt) 40°c**	**Density (gram/ml)**
Pertamina Dex	11245	2,0	0.85
B30	10450	3,7	0.87
B35	10245,8	4,0	0.88

Table 1 above shows the characteristic values of the fuel to be used, tested on the same test equipment.

3 Result and Discussion

3.1 Result

1. Effecctive Power. Effecctive power can be seen in Figure1 shows that the use of B35 at low loads produces almost the same power as pure dexlite but when the load is increased the power produced by B35 tends to decrease

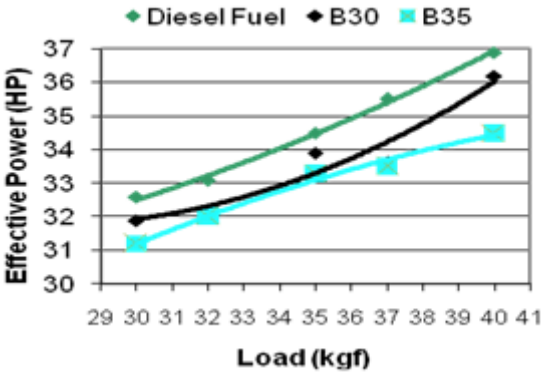

Fig. 1. Effecctive Power

2. Thermal Effeciency. Figure 2 shows that the thermal efficiency produced by using biodiesel B 35 is slightly lower when compared to using pure dexlite and B30. This is related to the energy that can be utilized by the engine to produce power which is greatly influenced by viscosity and calorific value where B 35 has a higher viscosity

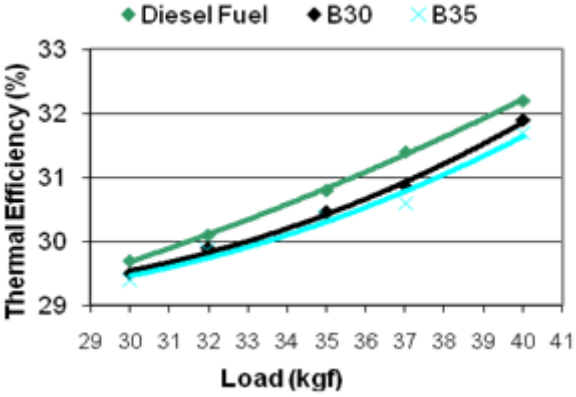

Fig. 2. Thermal Efficiency

3. Specifict Fuel Consumption. It can be seen in Figure 3 that specific fuel consumption increases as the applied load increases, the use of biodiesel B35 uses more fuel compared to pure dexlite and B30. This is related to the flow of fuel needed by the engine to work. is greatly influenced by the heating value because the heating value of B35 is lower

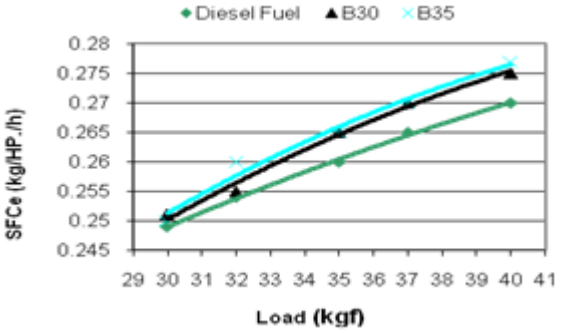

Fig.3. Specifict Fuel Consumption

4. Exshaust Emmission CO. In Figure 4 we can see that if the load is increased, the CO percentage will increase because the amount of fuel used will increase to produce the same rotation and power, but the use of B35 biodiesel shows a decrease in Co of up to 45%, this is because some of the dexlite fuel has been replaced with biodiesel so that CO emissions have decreased

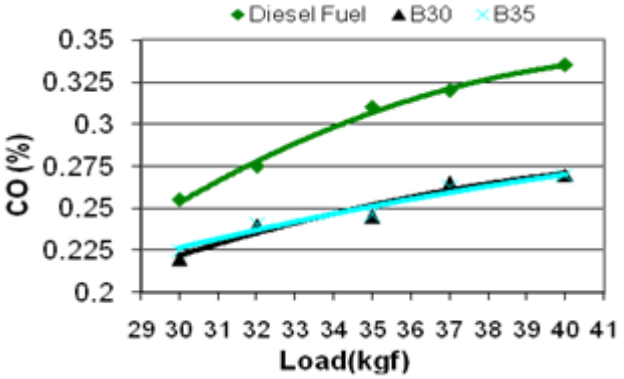

Fig. 4. Exhaust Emission CO

5. Exhaust Emission HC. It can be seen in Figure 5 that if the engine load is increased, the hydrocarbon exhaust gas will increase, but the use of Biodiesel B35 can reduce HC by 50% because the use of B35 reduces the amount of hydrocarbon fuel so that gas emissions are greatly reduced.

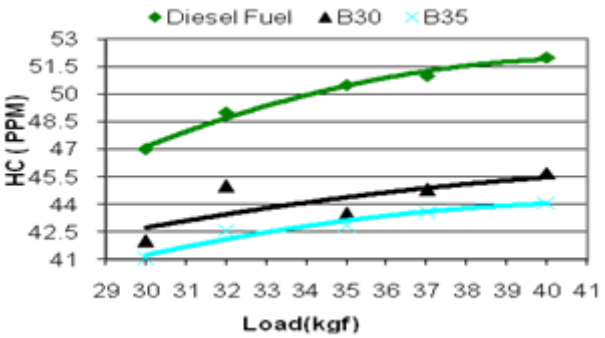

Fig. 5. Exhaust Emission HC

3.2 Discussion

The results of research through fuel testing on conventional engines with direct injection show that the power produced is almost the same as using pure dexlite, so there is no power loss if using B35 biodiesel.

Thermal efficiency has produced a percentage that tends to be the same as biodiesel B30 and is close to pure dexlite usage. Likewise, the specific fuel consumption is almost the same as using B 30 and pure dexlite. at low and medium loads the engine performance is close to pure dexlite, deficiencies in the use of B35 can occur at higher loads. This is due to the higher viscosity and lower heating value.

For exhaust gas emissions, using B35 biodiesel is very good because it can reduce CO by 45% and HC by 50%, this happens because B35 biodiesel partly contains vegetable ingredients that do not contain hydrocarbons.

4 Conclusion

1. Using biodiesel B35 produces the same power as pure dexlite and B30 at low and medium loads but the power will decrease at high loads
2. uel consumption when using B35 will be higher at maximum load
3. Using biodiesel B35 can reduce CO exhaust emissions by 15% and Hc by 25%
4. Based on the research results above, it is recommended to use B35 biodiesel in conventional diesel engines with a direct injection system and increase the percentage of CPO in marketed biodiesel.

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