# Analysis of the Effect of Using B30 Fuel on the Performance of the DEUTZ BV 8M 628 Engine in Unit 5 of the Diesel Power Plant Selayar

Firman Firman[1*], Herman Nawir[1], Nur Hamzah[1], Muhammad Anshar[1], Muhammad Ruswandi Djalal[1], Steven Bestry[1]

[1]Department of Mechanical Engineering, State Polytechnic of Ujung Pandang, Makassar 90245, Indonesia
Corresponding Author's email: firman@poliupg.ac.id

**Abstract.** The Diesel Power Plant (DPP) utilizes energy from fuel, converting it into mechanical energy and then into electrical energy. Over time, changes in fuel types have been necessary to meet the electricity production needs of DPPs. As fossil fuels become increasingly scarce, alternative fuels such as biodiesel are being adopted. However, the use of biodiesel can have several effects on the engine. This research aims to determine the impact of using biodiesel 30 (B30) fuel on diesel engines. Specifically, it involves comparing the effects of B30 and high-speed diesel (HSD) fuels on the Deutz BV 8M 628 engine at DPP Selayar. The data used in this research were obtained from secondary sources provided by Selayar DPP, as well as from fuel specifications issued by PT. Pertamina. This data was gathered through a literature review and supplemented by information obtained from interviews with the DPP Selayar agency. Based on the research results, it is evident that using B30 fuel increases specific fuel consumption (SFC) while enhancing thermal efficiency compared to HSD fuel. Additionally, there is an increase in the use of fuel filters with B30 fuel. The highest SFC recorded with B30 fuel was 0.2895 L/kWh. Conversely, the thermal efficiency improved with B30 fuel, reaching a maximum of 70.9%.

**Keywords:** B30 Fuel, Diesel Power Plant, High-Speed Diesel (HSD), Specific Fuel Consumption (SFC), Thermal Efficiency.

## 1 INTRODUCTION

The use of electrical energy in Indonesia has a significant impact on people's lives. As technological advancements and human activities continue to increase the demand for electrical energy [1, 2], there is a growing need for reliable sources of electricity generation to meet these needs [3, 4]. In Indonesia, there are several types of power plants, including diesel, hydro, steam, and gas. Most of these power plants still rely on fossil fuels to generate rotational energy, which then drives the generators to produce electrical energy [5, 6].

In Indonesia, diesel power plants (DPP) play a crucial role. In large cities, these plants often operate during peak load times, while in smaller towns or cities without other power plants, they typically serve as the primary source of electrical energy. DPPs are relatively easy to operate and have sufficient power to supply electrical energy [7].


M. A. Muflikhun et al. (eds.), *Proceedings of the 10th International Conference on Science and Technology (ICST 2024)*, Advances in Engineering Research 268,
https://doi.org/10.2991/978-94-6463-772-4_30

Additionally, some diesel engines are housed in containers, often referred to as containerized diesel engines, which allows for easy relocation to different cities as needed.

At PT. Perusahaan Listrik Negara (PLN) Main Sulawesi Generation and Distribution Unit Tello Control, the diesel power plant service unit (ULPLTD) Selayar operates as a key source of electricity for the Selayar District. The ULPLTD Selayar serves as the main generator and operates continuously, 24 hours a day. The operation of the generator significantly impacts the availability of electrical energy for development, household, and business needs in Selayar Regency. The power generation capacity of the DPP Selayar is 10.42 MW.

One of the units at UPLTD Selayar is the Deutz BV 8M 628 engine, which has a capacity of 900 kW and has been in operation since 1986. Initially, UPLTD Selayar used High-Speed Diesel (HSD) fuel but has since switched to Biosolar 30. This change was made in accordance with the Minister of Energy and Mineral Resources Regulation No. 12 of 2015, which mandates that, starting January 2020, the electricity generation sector use Biosolar 30 (B30), a blend of 30% biodiesel and 70% diesel fuel.

HSD is a type of diesel fuel used in diesel engines, produced from petroleum processing [8]. Crude oil is separated into its fractions through the distillation process to produce a diesel fraction with a boiling point between 250°C and 300°C. This fuel is commonly used in all types of diesel engines that operate at high RPM (above 1,000 RPM). [9]. B30 fuel is a type of high-speed diesel engine fuel [10]. It consists of a blend of 30% vegetable oil and 70% diesel fuel [11].

Biodiesel is an effective alternative to petroleum due to its biodegradability, environmental friendliness, local production, and its ability to reduce fossil fuel use [12, 13]. Research [14] found that a 15% methyl ester blend effectively separated the phases in a diesel-alcohol mixture, resulting in reduced CO and soot emissions. The objectives of the B30 fuel use program are to: reduce greenhouse gas emissions; stabilize CPO prices; increase added value through the downstream palm oil industry; reduce fuel consumption and imports; enhance energy security and independence; and achieve a 23% contribution of renewable energy to the total energymix.

Buchari and Prasetyo [15] analyzes the use of HSDand B30 fuels on fuel consumption and exhaust gasemissions in a 1.4 MW DPP diesel engine. However, itdoes not address the calculation of thermal efficiency orthe impact of using B30 fuel. A diesel engine generatesmechanical energy through combustion in thecombustion chamber. This process occurs whenatomized fuel and compressed air mix in the chamber,creating very high temperatures and pressures, whichleads to detonation [16, 17].

As fossil fuels become increasingly scarce,alternative fuels like biodiesel are being adopted to meetthe electricity production needs of DPP. However, theuse of these alternative fuels can impact engineperformance. This research aims to evaluate the effectsof B30 fuel on diesel engines. Specifically, it involves acomparative analysis of B30 and HSD fuels on theDeutz BV 8M 628 engine at DPP Selayar.

# 2 RESEARCH AND METHODS

## 2.1 Research Location and Time

This research was conducted at PT. PLN ULPLTD Selayar in South Sulawesi Province. The data used include operating records for the Deutz BV 8M Unit 5 engine at DPP Selayar, covering the periods from August to September 2018 and June 2020.

## 2.2 Data analysis technique

The data collected at PT. PLN ULPLTD Selayar were analyzed to obtain values based on parameters used to evaluate DPP performance. The methods for analyzing data based on these parameters are as follows:

1. Prepare the necessary data, including kWh production, the amount of fuel used during operation, and the temperature of the inlet and exhaust gases at DPP Selayar.
2. Calculate SFC.
3. Calculate thermal efficiency.

## 2.3 Diesel Engine Performance Measurement Methods

The primary data obtained was then used to analyze the performance of the DPP Selayar. The method used to measure the performance parameters of the diesel engine is as follows :

1. Calculating SFC with Equation (1)

$$SFC = \frac{m_f}{p} \tag{1}$$

With:
SFC = Specific fuel consumption (L/kW )
$m_f$ = fuel consumption (Lh)
P = engine power (kWh)

2. Calculate thermal efficiency using Equation (2)

$$\eta_{sg} = 1 - \frac{total\ losses}{HHF(Fuel\ cost)} - 100\% \tag{2}$$

The thermal losses are as follows:

1. Disadvantages of dry gas (DGL)

$$DGL = w_g c_p (T_{g\ out} - T_{g\ in}) \tag{3}$$

$$w_g = \left[\left(\frac{A}{F}\right) + 1 - R - M - 9H2\right] \tag{4}$$

2. Wetness loss (ML)

$$ML = \left(M + 9H_2\right)\left(h_s - h_w\right) \tag{5}$$

*If Tg out > 300C

$(h_s - h_w) = 2442 + 2.093T_{gout} - 4.187T_{gin}$

*If Tg out < 300C

$(h_s - h_w) = 2492.6 + 1.926T_{gout} - 4.187T_{gin}$

3. Losses due to combustion wetness (MCAL)

$$MCAL = \left(\frac{A}{F}\right) wc_{p.g}(T_{g\ out} - T_{g\ in}) \quad (6)$$

$$\omega = \frac{0{,}622\Phi P_{sat}}{P_{atm} - \Phi P_{sat}} \quad (7)$$

4. Disadvantages of incomplete combustion (ICL)

$$ICL = \frac{\%CO}{\%CO + \%CO_2}\left(\frac{28.01}{12.01}\right) C_b (HHV)_{co} \quad (1)$$

5. Disadvantages of unburned carbon (UCL)

$$UCL = C_r\,(HHV)_c = 32.778C_r \quad (2)$$

6. Losses due to radiation are incalculable (RL)

$$RL = (HHV)_{fuel\ cost}\,(Radiation\ Loss\ Factors) \quad (3)$$

With :

$\eta_{sg}$ = Combustion chamber efficiency (%)
$w_g$ = kg dry flue gas/ kg fuel
$R, M, H_2$ = Mass fraction of flue gas, wetness and hydrogen
$hs$ = Enthalpy of superheated steam at Tg out and pressure 1lb/in2 abs
$hw$ = Enthalpy of water at inlet gas temperature Tg in, kJ/kg
$c_p$ = Specific heat of smoke gas = 1.0048 kJ/kg C
HHV = High heating value (kJ/kg)
LHV = HHV – 3240 kJ/kg
$A_{ult}$ = Ash content

# 3 RESULTS AND DISCUSSIONS

## 3.1 Comparison graph of Specific Fuel Consumption (SFC) HSD with B30 against load

Figure 1 illustrates that the SFC of B30 is higher than that of HSD. The highest SFC value is for B30 fuel, at 0.2895 L/kW, while the lowest SFC value is for HSD fuel, at 0.2680 L/kW. This difference is attributed to the calorific value of the fuels; HSD has a higher calorific value than B30, which results in a lower SFC. SFC measures the amount of fuel required to produce electrical energy, so a lower SFC indicates more efficient diesel engine performance.

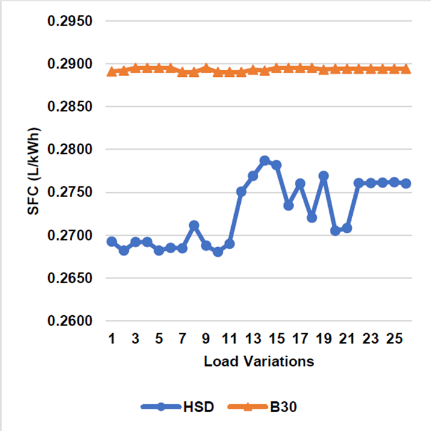


**Fig. 1.** Comparison Chart of SFC HSD with B30 Against Load.

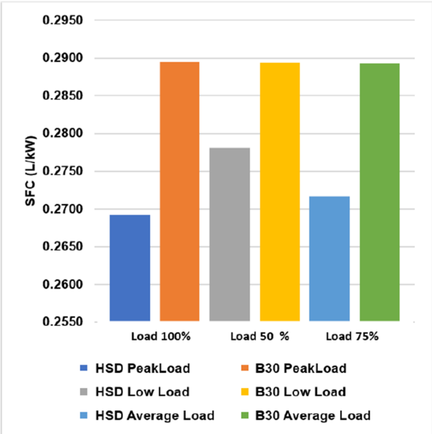


**Fig. 2.** Comparison Chart of SFC HSD and B30 on Loading Variations

### 3.2 Comparison graph of SFC HSD and B30 with varying loading, namely peak load, low load and average load

Figure 2 compares the SFC across different load variations. It shows that SFC is higher at low loads compared to peak loads. At peak load, the SFC for HSD fuel is 0.2692 L/kW, while for B30 fuel it is 0.2895 L/kW, representing a 7.5% increase for B30. At low loads, the SFC for HSD fuel is 0.2781 L/kW, and for B30 fuel it is 0.2894 L/kW, showing a 4.1% increase for B30. At average load, the SFC for HSD fuel is 0.2717 L/kW, and for B30 fuel it is 0.2893 L/kW, indicating a 6.5% increase for B30.

### 3.3 Comparison graph of thermal efficiency of HSD with B30 against load

Figure 3 illustrates the fluctuations in thermal efficiency for HSD and B30 fuels due to hourly load changes. The highest thermal efficiency is observed with B30 fuel at 70.9%, while the lowest is with HSD fuel at 66.3%. Thermal efficiency is influenced by losses that occur during combustion in the diesel engine's combustion chamber. Higher exhaust gas temperatures indicate greater energy loss, which results in lower thermal efficiency.

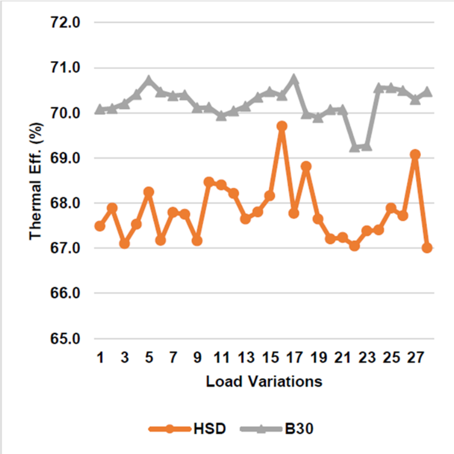


**Fig. 3.** Comparison Chart of HSD and B30 Thermal Efficiency Against Load.

### 3.4 Comparison graph of HSD and B30 thermal efficiency with varying loads, namely peak load, low load and average load

Figure 4 compares thermal efficiency across different load variations. It shows that with HSD fuel, the highest efficiency occurs at average load, whereas with B30 fuel, the highest efficiency is observed at low load. At peak load, the thermal efficiency for HSD fuel is 60.2%, compared to 70.1% for B30 fuel, representing a 4.3% increase in efficiency for B30. At low loads, the thermal efficiency for HSD fuel is 67.2%, while for B30 fuel it is 70.6%, indicating a 5.1% increase for B30. At average load, the thermal efficiency for HSD fuel is 67.8%, and for B30 fuel, it is 70.2%, showing a 3.5% increase for B30.

The use of B30 fuel affects not only engine performance and fuel consumption in electricity generation but also impacts various components of the diesel engine, particularly the fuel filter. These effects are attributed to the presence of sludge in the B30 fuel.

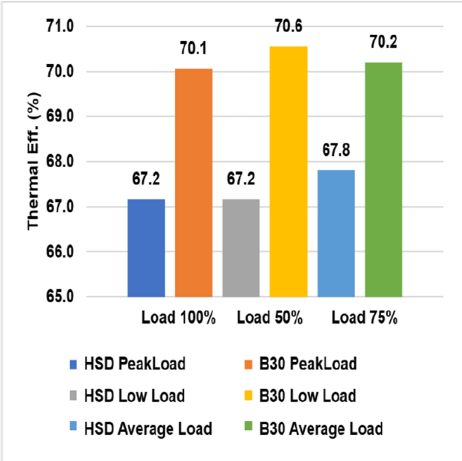


**Fig. 4.** Comparison graph of the thermal efficiency of HSD with B30 against load variations

To address this issue, DPP Selayar has implemented the following solution:

- Use of Backwash Filter
  The backwash filter system is used to filter fuel from the upright tank to the daily tank. It operates by trapping sludge in the filter. As sludge accumulates, the pressure on the pump increases. When the pressure exceeds a preset threshold, the compressor automatically cleans the filter by blowing air through it, which expels the sludge into a drain tank.
- ROT maintenance is carried out more quickly
  The ROT filter is installed after the backwash filter to further purify the fuel. ROT cleaning is performed manually or by replacing the filter when it becomes sufficiently dirty. Prior to the use of B30 fuel, ROT cleaning was conducted every three months. However, with the introduction of B30 fuel, the frequency of ROT cleaning has increased to once a month to prevent sludge from entering the daily tank.
- *Implementation of the FIFO (First In First Out) method*
  The FIFO method is used to prevent the fatty acids in B30 fuel from becoming a breeding ground for microbes, which can lead to sludge formation if the fuel is stored for too long. Additionally, fatty acids can oxidize over time, potentially causing rust in the tank.
  The use of fuel filters with B30 fuel in diesel engines significantly differs from their use with HSD fuel due to the presence of sludge in B30. This sludge is caused by the high fatty acid and water content in B30 fuel. To manage this issue, DPP Selayar performs a fuel changeover in the upright storage tank every two weeks and conducts sludge cleaning in the daily tanks every two months.

# 4 CONCLUSION

Regarding the effect of using B30 fuel on the performance of the Deutz BV 8M 628 engine, Specific Fuel Consumption (SFC) increased with B30 fuel. The lowest SFC observed was with HSD fuel at 0.2680 L/kWh, while the highest SFC was with B30 fuel at 0.2895 L/kWh. Conversely, thermal efficiency improved with B30 fuel, with the lowest efficiency recorded for HSD fuel at 66.3% and the highest for B30 fuel at 70.9%.

The use of B30 fuel affects the fuel filter more significantly compared to HSD fuel. To mitigate these effects and ensure smooth engine operation, several measures are implemented: the addition of a backwash filter, more frequent ROT maintenance, and the use of the FIFO method. Additionally, fuel filters need to be replaced more frequently when using B30 fuel compared to HSD fuel.

**Notation List**

| Parameters | Notation |
|---|---|
| $SFC$ | Specific fuel consumption (L/kW ) |
| $m_F$ | Fuel consumption (Lh) |
| $P$ | engine power (kWh) |
| $\eta_{sg}$ | Combustion chamber efficiency (%) |
| $w_g$ | kg dry flue gas/ kg fuel |
| $R, M, H_2$ | Mass fraction of flue gas, wetness and hydrogen |
| $hs$ | Enthalpy of superheated steam at Tg out and pressure 1lb/in2 abs |
| $hw$ | Enthalpy of water at inlet gas temperature Tg in, kJ/kg |
| $c_p$ | Specific heat of smoke gas = 1.0048 kJ/kg C |
| Tg in,out | Inlet and outlet air temperature C |
| HHV | High heating value (kJ/kg) |
| $A_{ult}$ | Ash content |

## References


1. Jamal, J. and M.R. Djalal, *Effect of Outlet at the Bottom of the Drying Chamber on the Performance of Natural Convection Solar Dryers.* Przeglad Elektrotechniczny, 2023. **2023**(11).
2. 2. Suwasti, S., Y. Klistafani, and M.R. Djalal, *Application of Water Tube Filling Pump in Hybrid System of Solar Energy and PLN.* Przegląd Elektrotechniczny, 2024. **7**.
3. 3. HAMZAH, N., et al., *Thermodynamic Modelling of Waste to Energy Power Plant: A Case Study in Makassar City, Indonesia.* Przeglad Elektrotechniczny, 2024. **2024**(2).
4. Sonong, S., et al., *Utilizing PVSyst for planning a hybrid system rooftop solar power plant at Makassar Eye Hospital.* SINERGI, 2024. **28**: p. 513.
5. Hartono, D., et al., *Comparing the impacts of fossil and renewable energy investments in Indonesia: A simple general equilibrium analysis.* Heliyon, 2020. **6**(6).

6. Yudha, S.W., B. Tjahjono, and P. Longhurst, *Sustainable transition from fossil fuel to geothermal energy: A multi-level perspective approach.* Energies, 2022. **15**(19): p. 7435.
7. Kabeyi, M.J.B. and O.A. Olanrewaju, *Sustainable energy transition for renewable and low carbon grid electricity generation and supply.* Frontiers in Energy research, 2022. **9**: p. 1032.
8. Likhanov, V. and O. Lopatin. *Research of high- speed diesel engines of small dimension on biofuel*. in *Journal of Physics: Conference Series*. 2019. IOP Publishing.
9. Aguk, Z., I. Adhi, and R. Karomur, *The Effect of Blend Fuel Waste Plastic and Waste Cooking Oil on Diesel Engine Performance based on Simulation.* International Journal of Marine Engineering Innovation and Research, 2020. **5**(3).
10. Ali, O.M. *Evaluation of diesel engine performance with high blended diesel-biodiesel fuel from waste cooking oil*. in *IOP Conference Series: Materials Science and Engineering*. 2019. IOP Publishing.
11. Hartono, Z.A. and B. Cahyono, *Effect of Biodiesel B30 on Deposit Forming and Wear Metal of Diesel Engine Components. International Journal of Marine Engineering Innovation and Research, 2020. **5**(1).*
12. Brahma, S., et al., *Biodiesel production from mixed oils: A sustainable approach towards industrial biofuel production.* Chemical Engineering Journal Advances, 2022. **10**: p. 100284.
13. Seaf Elnasr, T.A., et al., *Sustainable biodiesel production from waste olive oil: Utilizing olive pulp-derived catalysts for environmental and economic benefits.* Sustainable Chemistry and Pharmacy, 2024. **37**: p. 101426.
14. Akash, P., B. Amiya, and B. Kushal, *Effect of Diesel Engine Fuelled with Biofuel Blends.* International Journal of Trend in Scientific Research and Development (IJTSRD), 2018. **2**(6).
15. Buchari, A. and A.N. Prasetyo, *Analisis Pemakaian Bahan Bakar High Speed Diesel Dan Biodiesel (B30) Terhadap Konsumsi Bahan Bakar Dan Emisi Gas Buang Mesin Diesel PLTD 1.4 MW.* Presisi, 2017. **18**(2).
16. Breeze, P., *Chapter 5 - Diesel Engines*, in *Piston Engine-Based Power Plants*, P. Breeze, Editor. 2018, Academic Press. p. 47-57.
17. Tan, Y.H., M.O. Abdullah, and C. Nolasco- Hipolito, *The potential of waste cooking oil-based biodiesel using heterogeneous catalyst derived from various calcined eggshells coupled with an emulsification technique: A review on the emission reduction and engine performance.* Renewable and Sustainable Energy Reviews, 2015. **47**: p. 589-603.