

## ANALYSIS OF THE EFFECT OF ADDITIVE MIXTURES IN B35 FUEL ON FUEL CHARACTERISTICS AND CONSUMPTION AND EXHAUST GAS EMISSIONS

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### **Abstract**

B35 biodiesel fuel is more environmentally friendly than diesel fuel, but it has disadvantages as it can produce deposits and increase water content that can damage the engine. STP Diesel Fuel Treatment and GP Gold Complete Diesel Treatment additives are used as B35 mixtures with varying amounts of different mixtures, from 1% to 3%. Fuel characteristics, such as viscosity and sulfur content, are still up to standard except for water content. Adding additives also lowers fuel consumption and reduces the opacity of exhaust emissions. However, some fuel-additive variations led to small increases in emissions, although they still met government standard limits. This study concluded that using additives in B35 can improve fuel efficiency and quality and reduce the impact of exhaust emissions.

**Keywords:** Additives, B35, Exhaust emissions, Fuel characteristics, Fuel consumption.

### **INTRODUCTION**

Along with the increasing consumption of domestic diesel fuel (HSD) with an average rate of use reaching 5% per year and production of only 75% of total needs, HSD fuel reserves are decreasing from year to year. One of the government's efforts to reduce HSD fuel consumption is to find new energy sources or use renewable fuels. Biodiesel is one of the new and renewable energy types of biofuels (BBN) that can replace HSD type fuels (Ali & Nugroho, 2017). The use and development of biofuels in reducing fuel use in Indonesia has been supported by the Law on the Regulation of the Minister of Energy and Mineral Resources Number 12 of 2015 concerning the procurement, utilization and trading system of biofuels. In this regulation, the government sets a minimum obligation for the use of biofuels (biodiesel, bioethanol, and pure vegetable oil) for the Public Service Obligation (PSO) sector, such as micro-enterprises, fisheries businesses, agricultural businesses, transportation, public services, non-PSO transportation, industrial and commercial power plants until 2025. The implementation of the use of biofuels has been set by the government since 2015 with a biodiesel substitution of 15% (B15), 20% in 2016 (B20), 30% in 2020 (B30), and is targeted to increase to 35% or B35 in 2023 (Syahbana *et al.*, 2022).

The use of biodiesel as a fuel has the advantage of being more environmentally friendly. This is proven by the use of biodiesel can reduce carbon monoxide and carbon dioxide emissions. The nature of the emissions produced by biodiesel tends to be more easily decomposed, is not more toxic than diesel, has a better cetane number, the smoke produced tends not to be black and has a lower sulfur content (Syahbana *et al.*, 2022).

However, behind the advantages there are problems that arise due to the use of biodiesel, including reduced filter life caused by clogging, the potential for deposits to form in the engine, and

the hygroscopic nature of biodiesel is also prone to causing an increase in water content in the fuel which can cause damage to the engine. One solution that can be done to maintain and improve the quality of biodiesel fuel is to add additives (Syahbana *et al.*, 2022).

The addition of additives to fuel has advantages including increasing better combustion efficiency, improving vehicle performance and reducing pollutants, protecting the engine from corrosion, oxidation and scale deposition, helping to maintain stability during storage (Endyani & Putra, 2011).

The lack of use of additives in fuel can increase production costs, dependence on certain additives can be a problem if the additive is not available it may be difficult to meet the expected fuel quality standards, unwanted side effects on both the engine and the environment. For example, if using additives carelessly it can damage engine components or increase emissions of other pollutants, additions to fuel require testing and regulatory approval before they can be used widely. Based on the problems above, a study is needed on the addition of additives to biodiesel fuel, especially on fuel characteristics, fuel consumption and emissions produced. Therefore, an analysis of the effect of the mixture of additives in B35 fuel on the characteristics and fuel consumption and exhaust emissions is considered necessary.

## LITERATURE REVIEW

Fossil fuels are the main source of energy and foreign exchange for the country. However, Indonesia's oil reserves are limited and will experience a crisis if exploited on a large scale. Meanwhile, human needs for energy are increasing. For this reason, an alternative fuel is needed that has renewable and environmentally friendly properties.

Additives are used to provide increased basic properties and high octane numbers can improve engine performance. The presence of additives will improve the combustion process which will reduce CO, CO<sub>2</sub>, HC levels, increase oxygen consumption (O<sub>2</sub>) and will eliminate NO<sub>x</sub> compounds.

## RESEARCH METHOD

This study uses an experimental method through primary data collection and testing to determine the effect of variations in the percentage of B35 fuel mixture and additives on the resulting characteristics, fuel consumption, and exhaust emissions. This study was conducted at the Heavy Equipment Engineering Workshop, Balikpapan State Polytechnic, JL. Soekarno-Hatta Km8 in March-July 2023.

The equipment used in this study is as follows:

1. **ISUZU Engine Trainer:** The machine used in this study is the ISUZU Engine Trainer.
2. **Gas analyzer:** Exhaust Gas Test Machine Specification Table

| Uraian                        | Keterangan                              |
|-------------------------------|-----------------------------------------|
| Power                         | 270 V 50-60 Hz                          |
| Battery                       | 16 V (5A Fuse)                          |
| Max consumption               | 70 W                                    |
| Printer                       | Thermal bi-color (black/red 2A, column) |
| Serial Ports                  | COM1, COM2, RS232, RS485                |
| Video Plug VGA                | PAL or NSTC                             |
| Parameter ambient temperature | -40 - +60 °Celsius                      |
| Ambient pressure              | 750 - 1060 hPa                          |
| Ambient relative humidity     | 0 % - 100 %                             |
| Refresh rate                  | 20 times per second                     |
| Flow rate                     | 10 liters per minute                    |
| Working temperature           | +5 - 40 °Celsius                        |
| Feature                       | Clock, date and time print              |
| Size                          | 400 x 180 x 450                         |
| Weigh                         | 8,6 kgs                                 |

3. **Tachometer:** A tachometer is a handheld measuring instrument used to measure the speed of rotating objects such as engine operations.
4. **Measuring cup:** The measuring cup is used to mix biodiesel fuel with additives and then to measure the amount of variation in the fuel mixture before being put into the tank for testing.
5. **Ohaus digital balance:** Used to weigh the materials to be used
6. **Stopwatch:** Used to calculate the operating time of the diesel engine for fuel consumption testing.

## Materials

Some of the materials used in this study are as follows:

### a. Additives

Additives are used to improve certain basic properties that they have, the method of use of which is directly inserted into the fuel according to the specified ratio.

- STP diesel fuel treatment

STP diesel fuel treatment is an additive containing cetane improver that aims to help improve combustion, reduce emissions, save fuel, prevent rust and corrosion, and eliminate water content in the fuel system and lines. One 236 ml bottle of STP can be mixed with 40-60 liters of biosolar.

- GP Gold Complete Diesel Treatment

GP Gold Complete Diesel Treatment is made from a mixed formula of additives such as dispersants, demulsifiers, detergency, corrosion inhibitors, anti-foaming, and several other additives. This additive aims to reduce sulfur content, maintain the purity of diesel from the water mixture, clean the engine from carbon deposits, prevent corrosion, and prevent sedimentation/gum. One 250 ml bottle of GP Gold can be mixed with 50-60 liters of biodiesel.

### b. Fuel

The fuel used in this test is B35 fuel

Variations in the mixture of B35 biodiesel with additives are carried out by giving codes to the materials used, to determine the differences in additives and their percentages as follows: B35: is pure STP biodiesel fuel, GP GOLD: is a type of additive 1%, 2%, 3%: Percentage of additives mixed with fuel.

Table of Variations in Fuel Mixtures with Additives

| No | Code Variasi Campuran | Biosolar        | Aditif         |
|----|-----------------------|-----------------|----------------|
| 1  | B35                   | 100 % = 1000 ml | 0 % = 0 ml     |
| 2  | B35 STP 1%            | 100 % = 1000 ml | 1 % = 4,72 ml  |
| 3  | B35 STP 2%            | 100 % = 1000 ml | 2 % = 9,44 ml  |
| 4  | B35 STP 3%            | 100 % = 1000 ml | 3 % = 14,16 ml |
| 5  | B35 GP GOLD 1%        | 100 % = 1000 ml | 1 % = 4,54 ml  |
| 6  | B35 GP GOLD 2%        | 100 % = 1000 ml | 2 % = 9,08 ml  |
| 7  | B35 GP GOLD 3%        | 100 % = 1000 ml | 3 % = 13,62 ml |

## RESULTS AND DISCUSSION

From the results of the study, the author is interested in knowing the characteristics of mixing B35 fuel with additives, using the parameters of viscosity, density, cetane index, sulfur content, carbon residue, water content, fatty acid methyl ester (fame) and testing the comparison of the use of pure B35 fuel and a mixture of additives between STP Diesel Fuel Treatment and GP Gold Diesel Fuel Treatment on the ISUZU 2500CC engine stand, and seeing the major influence on exhaust gas opacity whether the comparison is better or not. In this study, the author carried out several processes to obtain the data needed in the research process to test the effect of the comparison of variations in the percentage of B35 fuel mixture with additives on its characteristics, the variations of the B35 mixture, B35 STP 1% = 4.72 ml, B35 STP 2% = 9.44 ml, B35 STP 3% = 14.16 ml and B35 GP 1% = 4.54 ml, B35 GP 2% = 9.08 ml, B35 GP 3% = 13.62 ml The test was conducted 1 time. Each test was conducted 3 times on the engine stand with rpm 1000, 2000 and 3000.

## CONCLUSION

Based on the results of the experimental test of the effect of the mixture of additives on B35 fuel on the characteristics and consumption of fuel and exhaust emissions, the conclusions obtained are as follows:

1. It is known that the results of mixing B35 fuel with additives from the characteristic tests carried out in the petrolab services laboratory obtained the following results:
  - a) Viscosity decreased in all variations of STP and GP GOLD percentages but were still within the standard.
  - b) Density decreased in STP variations of 1% and 3% but did not change in the 2% variation, GP GOLD decreased in the 1% percentage variation but in the 2% and 3% percentage variations experienced the same increase and were within the standard.
  - c) Cetane index STP decreased in variations of 1% and 2% but increased in the 3% percentage, GP GOLD decreased which was still within the standard.
  - d) Sulfur content STP at 1% and 3% variations experienced the same decrease while at 3% it increased, GP GOLD experienced a decrease in each percentage and was within the standard.
  - e) Residue carbon STP 1% experienced an increase while at 2% and 3% percentage variations did not experience a change, GP GOLD from each percentage variation experienced an increase and was within the standard.
  - f) Water content STP 1% experienced an increase while at 2% and 3% it decreased, GP GOLD experienced an increase in each percentage variation not according to the standard.

- g) FAME content STP experienced an increase in the percentage variation of 1% while at 2% and 3% it decreased, GP GOLD experienced an increase in each percentage variation so that only the FAME parameter in the GP GOLD percentage variation was not standard.

2. The fuel consumption of B35 fuel mixture with STP and GP GOLD additives is lower compared to pure B35 fuel, the use of STP additives at percentage variations of 1%, 2% and 3% experienced an increase in fuel consumption while at percentage variations of 3% with rpm 2000 the fuel consumption was lower, for the use of GP GOLD additives at percentage variations of 1%, 2% and 3% experienced a decrease in fuel consumption while at percentage variations of 3% with rpm 1000 fuel consumption experienced a slight increase.

3. The opacity of exhaust emissions of B35 fuel mixtures with STP and GP GOLD additives is lower compared to pure B35 fuel with the use of STP additives at a percentage variation of 1% having the lowest opacity, while at percentage variations of 2% and 3% there is a slight increase in opacity from each percentage, for the use of GP GOLD additives at percentage variations of 1%, 2% there is an increase in exhaust emission opacity while at percentage variations of 3% with exhaust emission opacity there is a decrease but at rpm 3000 there is a slight increase. The results obtained are that the average smoke concentration value is still below the threshold of the Regulation of the Minister of Environment number 05 of 2006

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