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Effect of an Electromagnetic Fuel-Saving Device on Motorcycles Using Blended fuel of Pertalite-bioethanol

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Abstrak.

Meningkatnya permintaan untuk efisiensi bahan bakar dan keberlanjutan lingkungan telah menyebabkan eksplorasi campuran bahan bakar alternatif dan teknologi hemat bahan bakar yang inovatif. Studi ini menyelidiki efek perangkat penghemat bahan bakar elektromagnetik pada kinerja sepeda motor menggunakan campuran bahan bakar Pertalite-Bioetanol pada komposisi yang berbeda (P100, P90, P80, dan P70). Kinerja mesin dievaluasi berdasarkan Torsi Maksimum, Daya Kuda Rem (BHP), dan Konsumsi Bahan Bakar Spesifik (SFC) menggunakan uji dinamometer sasis. Hasilnya menunjukkan bahwa penggunaan perangkat penghemat bahan bakar elektromagnetik secara signifikan meningkatkan kinerja sepeda motor. Torsi tertinggi tercatat pada P80, mencapai 13,52 Nm dengan perangkat, dibandingkan dengan 12,7 Nm tanpa perangkat. Demikian pula, BHP pada P80 meningkat dari 7,45 HP (tanpa perangkat) menjadi 9,89 HP (dengan perangkat), yang menunjukkan peningkatan efisiensi pembakaran. Selain itu, SFC lebih rendah saat menggunakan perangkat, dengan konsumsi bahan bakar terendah diamati pada P80 (0,025 kg/HP·h dengan perangkat), dibandingkan dengan 0,029 kg/HP·h tanpanya. Temuan ini menunjukkan bahwa campuran bioetanol 20% (P80) memberikan keseimbangan daya, torsi, dan efisiensi bahan bakar yang optimal, terutama bila dikombinasikan dengan pengolahan bahan bakar elektromagnetik. Namun, pada konsentrasi bioetanol yang lebih tinggi (P70), kinerja sedikit menurun, kemungkinan karena kandungan energi etanol yang lebih rendah dibandingkan dengan bensin. Peningkatan efisiensi dengan perangkat elektromagnetik dikaitkan dengan peningkatan dispersi molekul hidrokarbon, yang mengarah pada pembakaran yang lebih baik. Perangkat penghemat bahan bakar elektromagnetik secara efektif meningkatkan kinerja mesin dan efisiensi bahan bakar, terutama bila dipasangkan dengan campuran bioetanol 20%. Studi ini memberikan wawasan berharga tentang potensi pengolahan bahan bakar alternatif dalam meningkatkan efisiensi pembakaran dan keberlanjutan. Penelitian di masa depan dapat difokuskan pada daya tahan jangka panjang, analisis emisi, dan pengoptimalan lebih lanjut dari campuran bahan bakar bioetanol untuk meningkatkan kinerja mesin.

Kata kunci: Perangkat penghemat bahan bakar elektromagnetik, Campuran Pertalite-Bioetanol, Performa sepeda motor, Efisiensi bahan bakar.

Abstract.

The increasing demand for fuel efficiency and environmental sustainability has led to the exploration of alternative fuel blends and innovative fuel-saving technologies. This study investigates the effect of an electromagnetic fuel-saving device on the performance of a motorcycle using a Pertalite-Bioethanol fuel blend at different compositions (P100, P90, P80, and P70). The engine's performance was evaluated based on Maximum Torque, Brake Horse Power (BHP), and Specific Fuel Consumption (SFC) using a chassis dynamometer test. The results show that the use of the electromagnetic fuel-saving device significantly improves motorcycle performance. The highest torque was recorded at P80, reaching 13.52 Nm with the device, compared to 12.7 Nm without the device. Similarly, BHP at P80 increased from 7.45 HP (without device) to 9.89 HP (with device), indicating enhanced combustion efficiency. Additionally, SFC was lower when using the device, with the lowest fuel consumption observed at P80 (0.025 kg/HP·h with the device), compared to 0.029 kg/HP·h without it. These findings suggest that a 20% bioethanol blend (P80) provides an optimal balance of power, torque, and fuel efficiency, particularly when combined with electromagnetic fuel treatment. However, at higher bioethanol concentrations (P70), performance slightly declined, likely due to the lower energy content of ethanol compared to gasoline. The improvement in efficiency with the electromagnetic device is attributed to the enhanced dispersion of hydrocarbon molecules, leading to better combustion. The electromagnetic fuel-saving device effectively enhances engine performance and fuel efficiency, particularly when paired with a 20% bioethanol blend. This study provides valuable insights into the potential of alternative fuel treatments in improving combustion efficiency and sustainability. Future research could focus on long-term durability, emissions analysis, and further optimization of bioethanol fuel blends for improved engine performance.

Keywords: *Electromagnetic fuel-saving device, Pertalite-Bioethanol blend, Motorcycle performance, Fuel efficiency.*

Introduction

The global push for energy efficiency and environmental sustainability has intensified research into alternative fuels and fuel-saving technologies. One promising method involves the use of electromagnetic-based fuel-saving devices, which are designed to improve fuel combustion by influencing the molecular structure of the fuel [1]. These devices have been explored as a potential solution to enhance engine performance and fuel economy, particularly when used with alternative fuel blends [2].

Pertalite, a widely used gasoline type in Indonesia, could be blended with bioethanol as part of efforts to reduce fossil fuel dependency and lower emissions. While bioethanol offers benefits such as improved octane rating and reduced carbon footprint, its combustion characteristics can be further optimized through innovative techniques [3]. The application of an electromagnetic field to fuel before combustion is hypothesized to enhance fuel atomization, leading to better combustion efficiency and improved engine performance [4].

This study investigates the effect of an electromagnetic fuel-saving device on a Pertalite-bioethanol fuel blend when used in a motorcycle engine. The research focuses on key performance parameters, including Brake Horse Power (BHP), Specific Fuel Consumption (SFC), and torque. BHP represents the engine's effective power output, while SFC indicates fuel efficiency by measuring fuel consumption per unit of power produced. Torque, on the other hand, is a crucial indicator of the engine's rotational force, directly affecting acceleration and overall performance [5].

By analyzing these parameters, this study aims to determine whether electromagnetic treatment can enhance engine performance and fuel economy [6]. The findings are expected to provide valuable insights into the feasibility of integrating electromagnetic fuel-saving technology in small-scale internal combustion engines, contributing to the development of more efficient and sustainable transportation solutions.

Theory

The application of an electromagnetic field to fuel is based on the principle that hydrocarbon molecules, which naturally exist in clustered formations due to intermolecular forces, can be dispersed into smaller clusters when exposed to a magnetic field [7]. As shown in the fig. 1, untreated fuel consists of larger hydrocarbon clusters, which may result in incomplete combustion due to limited surface area for oxidation [8]. When the fuel passes through an electromagnetic-based fuel saver, the applied magnetic field disrupts the intermolecular attractions, breaking down these large clusters into smaller and more uniform molecular structures [9]. This increased dispersion enhances the fuel's atomization during injection, leading to a more efficient mixing with air and promoting a more complete and uniform combustion process [10]. Consequently, this improved combustion efficiency can lead to better fuel economy and increased power output.

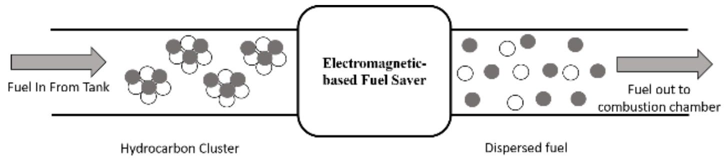

Figure 1: Schematic figure of de-cluster process of fuel molecules due to magnetic exposure.

The blending of Pertalite with bioethanol is based on the principle that bioethanol, an oxygenated fuel, improves combustion efficiency by enhancing the air-fuel mixing process and promoting a more complete burn [11]. Bioethanol has a higher octane rating than Pertalite, which helps reduce engine knocking and allows for higher compression ratios, potentially increasing engine power output [12]. Additionally, the presence of oxygen in bioethanol contributes to a more efficient combustion process, leading to reduced carbon monoxide (CO) and hydrocarbon (HC) emissions. However, bioethanol has a lower energy density compared to gasoline, which may slightly increase fuel consumption depending on the blend ratio [13]. In motorcycle engines, the use of a Pertalite-bioethanol blend can result in improved brake horsepower (BHP) and torque due to better combustion characteristics, but the specific fuel consumption (SFC) may vary depending on factors such as engine tuning and operating conditions [14].

The relationship between torque, brake horsepower (BHP), and specific fuel consumption (SFC) is fundamental in understanding engine performance and efficiency. Torque represents the rotational force generated by the engine's crankshaft, which directly influences acceleration and load-carrying capacity as shown in eq. 1.

$$\tau = F \,.\, s \tag{1}$$

BHP, on the other hand, is a measure of the engine's effective power output, calculated as the product of torque and rotational speed (RPM) divided by a constant as shown in eq. 2. As engine speed increases, BHP typically rises until it reaches an optimal point before declining due to mechanical and thermal limitations.

$$BHP = \frac{2\pi \,.\, n \,.\, \tau}{746} \tag{2}$$

Specific fuel consumption (SFC) indicates the fuel efficiency of the engine by measuring the amount of fuel required to produce one unit of power (BHP) over time as shown in eq. 3. A lower SFC signifies higher efficiency, meaning the engine can generate more power while consuming less fuel. The interplay between these parameters is crucial in optimizing engine performance, where an ideal balance between torque, power output, and fuel consumption ensures maximum efficiency and sustainability.

$$\boldsymbol{SFC = \frac{mfuel}{BHP}} \tag{3}$$

Method

The study involves evaluating the performance of a motorcycle using a chassis dynamometer (dyno test) to measure key engine parameters. The experiment is conducted by running the motorcycle on the dynamometer under controlled conditions while using a fuel blend of Pertalite and bioethanol. The fuel is first passed through an electromagnetic-based fuel-saving device as shown in Figure 2 before entering the combustion chamber [15]. This setup allows for the assessment of the device's impact on engine performance by measuring brake horsepower (BHP), torque, and specific fuel consumption (SFC). Data collection is performed at various fuel blend of Pertalite and bioethanol to analyze performance trends and fuel efficiency improvements. The results obtained from the dynamometer test are then compared to baseline measurements taken without the electromagnetic device to determine its effectiveness in enhancing combustion efficiency and overall engine performance.

Figure 2: Electromagnetic-based fuel-saving device.

A. Electromagnetic-based fuel-saving device specification

Fig. 2 shown an electromagnetic-based fuel-saving device with the specification shown in Table 1, which consists of a cylindrical core wrapped with a conductive coil. The device operates by generating a magnetic field when an electric current flows through the coil, as indicated by the positive and negative terminals. As fuel passes through the device, the applied electromagnetic field interacts with hydrocarbon molecules, breaking down large molecular clusters into smaller, more uniform structures.

Table 1. Specification of Electromagnetic-based fuel-saving Device

Parameters	**Value**	**Unit**
Galvanum Pipe Length	100	mm
Galvanum Pipe Diameter	35	mm
Galvanum Pipe Thick	1	mm
Copper Wire Diameter	0.15	mm
Number of coils	5000	

B. Pertalite-bioethanol fuel blend variations

This study will be conducted using various fuel blend variations of Pertalite and bioethanol as shown in Table 2 to analyze their impact on engine performance. Different mixing ratios will be tested to observe changes in key parameters such as brake horsepower (BHP), torque, and specific fuel consumption (SFC). By varying the bioethanol content in the fuel blend, the study aims to determine the optimal composition that enhances combustion efficiency while maintaining engine performance. The experimental data will provide insights into how bioethanol influences fuel efficiency and power output when used in combination with Pertalite, contributing to the development of more sustainable and efficient fuel alternatives.

Table 2. Fuel Blend Variations

Fuel Variant	**Pertalite Composition (%)**	**Bioethanol Composition (%)**	**Density (g/mL)**
P100	100	0	0.729
P90	90	10	0.7295
P80	80	20	0.7394
P70	70	30	0.7673

Results and Discussion

This section presents and analyzes the findings obtained from the experimental study on the effects of an electromagnetic-based fuel-saving device on a motorcycle engine using various Pertalite-bioethanol fuel blends. The results include measurements of brake horsepower (BHP), torque, and specific fuel consumption (SFC) using different fuel variations usage on motorcycle.

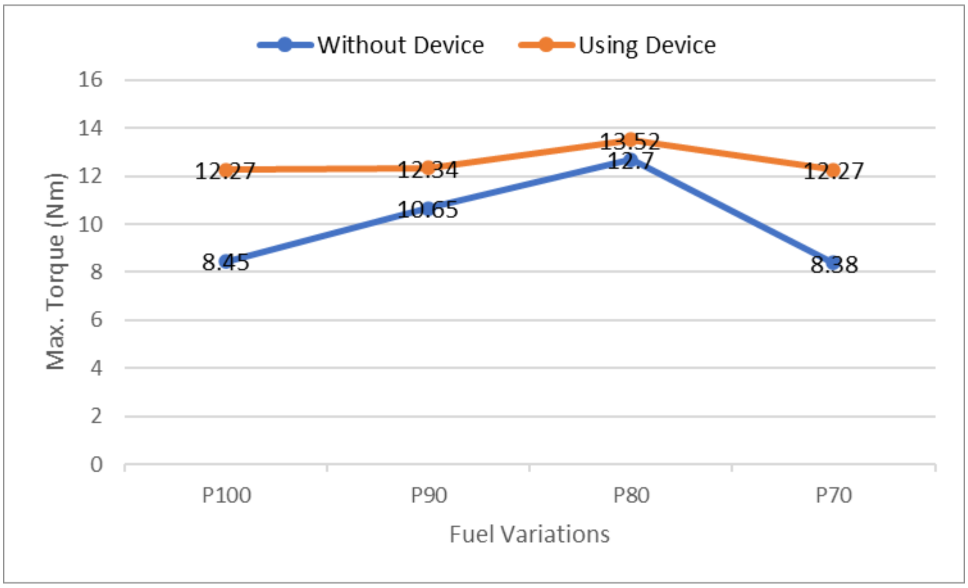

Figure 3: Maximum torque value.

Fig. 3 illustrates the maximum torque (Nm) of a motorcycle for different fuel blend variations, comparing conditions with and without the electromagnetic fuel-saving device. The results indicate that the torque generally increases as the bioethanol content rises from P100 to P80, reaching its peak at P80, before decreasing at P70. This suggests that a bioethanol concentration of 20% provides the best combustion characteristics.

Across all fuel variations, the use of the electromagnetic fuel-saving device consistently enhances torque output. At P100 (pure Pertalite), the maximum torque increases from 8.45 Nm (without the device) to 12.27 Nm (with the device). Similarly, at P90 (90% Pertalite, 10% Bioethanol), the torque improves from 10.65 Nm to 12.34 Nm. The highest recorded torque occurs at P80 (80% Pertalite, 20% Bioethanol), where it rises from 12.7 Nm to 13.52 Nm when using the device. However, at P70 (70% Pertalite, 30% Bioethanol), a decline in torque is observed, dropping to 8.38 Nm without the device and 12.27 Nm with the device, indicating that excessive bioethanol content may negatively impact performance.

These findings suggest that the optimal fuel blend for maximizing torque is P80 (80% Pertalite, 20% Bioethanol), especially when using the electromagnetic device. The increase in torque with the device indicates improved fuel atomization and combustion efficiency. Additionally, the decline at P70 highlights the potential limitations of higher bioethanol concentrations due to its lower energy density.

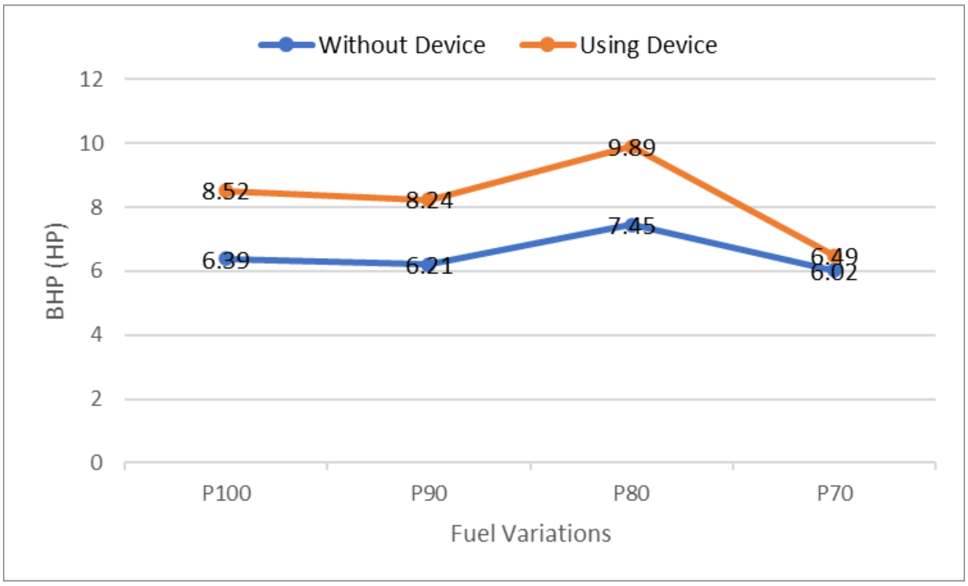

Figure 4: Maximum BHP value.

Fig. 4 displays the Brake Horse Power (BHP) of a motorcycle under different fuel blend variations, comparing conditions with and without the electromagnetic fuel-saving device. Similar to the torque trend, the BHP generally increases as the bioethanol content rises from P100 to P80, reaching its peak at P80, before decreasing at P70. This suggests that a bioethanol concentration of 20% optimally enhances engine power output.

Across all fuel variations, the use of the electromagnetic fuel-saving device significantly improves BHP performance. At P100 (pure Pertalite), the BHP increases from 6.39 HP (without device) to 8.52 HP (with device). A similar trend is observed at P90 (90% Pertalite, 10% Bioethanol), where BHP rises from 6.21 HP to 8.24 HP. The highest recorded BHP occurs at P80 (80% Pertalite, 20% Bioethanol), reaching 7.45 HP without the device and 9.89 HP with the device. However, at P70 (70% Pertalite, 30% Bioethanol), a decline in BHP is observed, dropping to 6.02 HP without the device and 6.49 HP with the device, indicating that excessive bioethanol content may reduce the engine's power output due to its lower energy density.

These results reinforce the finding that the optimal fuel blend for maximizing power output is P80 (80% Pertalite, 20% Bioethanol), especially when using the electromagnetic device. The increase in BHP with the device suggests improved fuel atomization and combustion efficiency, leading to more effective power generation. The reduction in BHP at P70 highlights the limitations of higher bioethanol concentrations, which may result in incomplete combustion and reduced energy content.

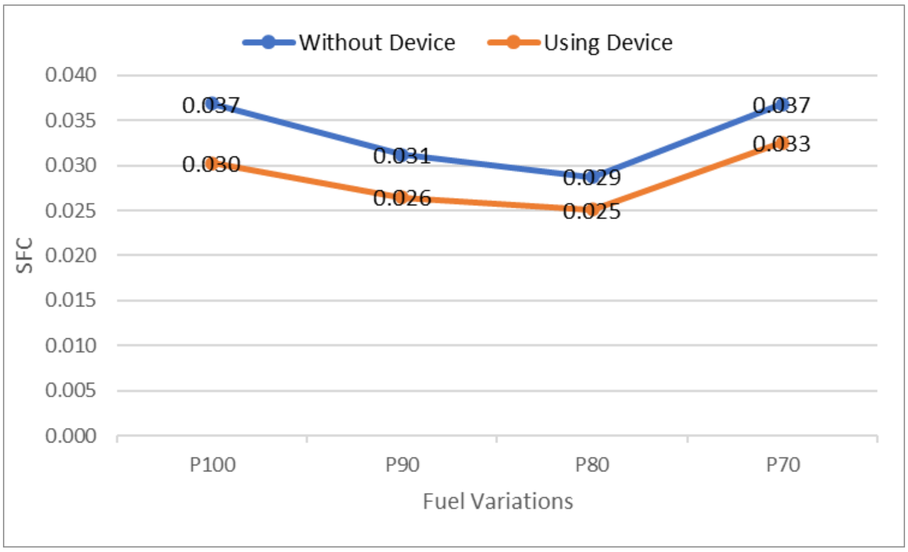

Figure 5: SFC value.

Figure 5 illustrates the Specific Fuel Consumption (SFC) of a motorcycle for different fuel blend variations, comparing conditions with and without the electromagnetic fuel-saving device. SFC represents the fuel efficiency of the engine, with lower values indicating better fuel economy. The results show that SFC generally decreases from P100 to P80, reaching its lowest value at P80, before increasing again at P70. This suggests that a bioethanol concentration of 20% (P80) provides the best fuel efficiency.

Across all fuel variations, the electromagnetic fuel-saving device reduces SFC, indicating improved combustion efficiency. At P100 (pure Pertalite), SFC decreases from 0.037 kg/HP·h (without device) to 0.030 kg/HP·h (with device). Similarly, at P90 (90% Pertalite, 10% Bioethanol), SFC drops from 0.031 kg/HP·h to 0.026 kg/HP·h. The lowest SFC occurs at P80 (80% Pertalite, 20% Bioethanol), where it reaches 0.029 kg/HP·h without the device and 0.025 kg/HP·h with the device, confirming enhanced fuel utilization at this blend ratio. However, at P70 (70% Pertalite, 30% Bioethanol), an increase in SFC is observed, rising to 0.037 kg/HP·h without the device and 0.033 kg/HP·h with the device, indicating reduced efficiency due to the lower energy content of bioethanol.

These findings further support that the optimal fuel blend for maximizing fuel efficiency is P80, especially when combined with the electromagnetic device. The consistent reduction in SFC across all variations when using the device suggests enhanced fuel atomization and better combustion characteristics, leading to more effective energy conversion. The increase in SFC at P70 indicates that excessive bioethanol content may negatively impact fuel efficiency, likely due to its lower calorific value.

Conclusions

This study analyzed the impact of an electromagnetic fuel-saving device on the performance of a motorcycle using different fuel blends of Pertalite and Bioethanol (P100, P90, P80, and P70). The parameters measured included Maximum Torque, Brake Horse Power (BHP), and Specific Fuel Consumption (SFC). The results indicate that bioethanol blending up to 20% (P80) improves engine performance and efficiency, particularly when used in combination with the fuel-saving device.

For Maximum Torque, the use of the electromagnetic device led to a consistent increase across all fuel variations. The peak torque was recorded at P80, with 13.52 Nm using the device, compared to 12.7 Nm without the device. This suggests that a 20% bioethanol blend enhances combustion efficiency, allowing for better power transmission. However, torque decreased at P70, indicating that excessive bioethanol content negatively affects performance.

Similarly, BHP results showed an overall improvement with the device. The highest power output was observed at P80, where BHP increased from 7.45 HP (without device) to 9.89 HP (with device).

This reinforces the idea that a 20% bioethanol blend optimally balances energy content and combustion properties. The decline at P70 suggests that higher ethanol concentrations may reduce the effective energy output due to the lower calorific value of ethanol compared to gasoline.

Regarding SFC, the study found that fuel consumption was lower when using the electromagnetic device, demonstrating improved fuel efficiency. The lowest SFC was recorded at P80, where values dropped to 0.025 kg/HP·h with the device compared to 0.029 kg/HP·h without the device. This suggests that 20% bioethanol, combined with electromagnetic treatment, enhances fuel atomization and combustion, leading to better efficiency. However, at P70, SFC increased, indicating that higher bioethanol content requires more fuel to produce the same power, reducing overall efficiency.

Overall, the findings confirm that a 20% bioethanol blend (P80) provides the best balance of torque, power, and fuel efficiency. Additionally, the use of an electromagnetic fuel-saving device consistently improves engine performance across all variations, likely due to its ability to enhance fuel molecule dispersion and combustion efficiency. However, when the bioethanol content exceeds 20%, performance and efficiency begin to decline, suggesting a limitation in bioethanol usage without engine modifications.

Thus, this study concludes that the optimal fuel blend for performance improvement in a standard motorcycle engine is P80, particularly when combined with electromagnetic fuel treatment. Future research could explore long-term effects, durability, and potential enhancements to further optimize bioethanol utilization in internal combustion engines.

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