



The Effect of Using a Voltage Stabilizer on The Performance of a Four-Stroke Motorcycle

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ABSTRACT

This study evaluates the effect of a voltage stabilizer on the performance of a Yamaha MX King four-stroke motorcycle. The investigation focused on engine power, engine torque, and fuel pressure in the electronic fuel injection system. An experimental method was applied by comparing the standard condition without a voltage stabilizer with five stabilizer output-voltage settings: 13.5 V, 14.0 V, 14.5 V, 15.0 V, and 15.5 V. Each condition was tested three times using a chassis dynamometer at Pekajaman Dyno Test Workshop, Yogyakarta, while fuel pressure was measured using a fuel pressure tester. The results show that the effect of the voltage stabilizer was more evident at higher output voltages. The 15.5 V setting produced the highest average power of 34.97 HP and a maximum power of 35.1 HP at 11,500 rpm, representing a 0.6 HP increase compared with the standard maximum power. The same setting also produced the highest average torque of 24.20 Nm and a maximum torque of 24.3 Nm at 8,750 rpm, or 0.1 Nm higher than the standard maximum torque. Fuel pressure increased from 2.4 bar in the standard condition to 2.5 bar at 15.0 V and 2.6 bar at 15.5 V. These findings indicate that a voltage stabilizer can improve power, torque, and fuel pressure at high voltage settings, although further durability and safety validation is needed before application above the manufacturer's normal electrical range.

1. Introduction

Motorcycles are the dominant mode of transportation in Indonesia because they have relatively low operating costs, are easy to use, and are well-suited for people's daily mobility needs. Data from the Central Statistics Agency and the Indonesian National Police's Traffic Corps indicate that the number of two-wheeled vehicles continues to rise and has become one of the largest components of national road traffic [1], [2]. This situation underscores the need for applied research aimed at maintaining the performance, efficiency, and reliability of motorcycles, which are widely used by the public.

In four-stroke motorcycles, power generation occurs through the intake, compression, power, and exhaust cycles. Engine performance is influenced by combustion quality, fuel supply stability, and ignition system stability [3]–[5]. In motorcycles equipped with electronic fuel injection (EFI)

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systems, electrical voltage stability becomes increasingly critical because the electronic control unit (ECU), injectors, fuel pump, sensors, and ignition system require a consistent electrical supply to function according to their design specifications [6].

In daily use, modifications to a motorcycle's electrical system are common; for example, replacing standard headlights with higher-wattage ones to improve visibility. Replacing the headlight from the standard 35 W specification to 80 W can significantly increase the electrical load. Under certain conditions, the battery voltage may drop when the lights are turned on, causing the ignition system and EFI to lose a stable power supply. This voltage drop has the potential to reduce combustion quality, engine power, and fuel efficiency [7], [8].

Table 1. Comparison of motor power with and without a light load

No.	With a lamp load (HP)	Without a lamp load (HP)
1	34.3	34.8
2	34.5	34.7
3	32.6	34.6
4	33.9	34.4
5	34.4	34.4
Average	33.9	34.6

The preliminary test results in Table 1 show that the use of a lighting load caused the average power to drop from 34.6 HP to 33.9 HP. These findings indicate that the addition of electrical loads needs to be evaluated, as it can affect the stability of the power supply and engine output. One device widely used to address voltage fluctuations is a voltage stabilizer, an additional component designed to help maintain stable battery voltage and power supply to the vehicle's systems.

Several studies have shown that changes to the engine support systems—including the electrical system, fuel system, and transmission components—can affect power, torque, fuel consumption, and exhaust emissions [8]–[11]. However, quantitative studies on the effect of variations in the voltage stabilizer's output voltage on power, torque, and fuel pressure in EFI motorcycles remain limited. Therefore, this study aims to analyze the effect of using a voltage stabilizer on the performance of a four-stroke motorcycle, specifically regarding power, torque, and fuel pressure.

2. Method

This study employed an experimental method by comparing the performance of a motorcycle without a voltage stabilizer to that of a motorcycle equipped with a voltage stabilizer set to various output voltages. The subject of the study was a Yamaha MX King motorcycle with a four-stroke engine and an EFI system. Testing was conducted at the Pekajaman Dyno Test Workshop in Yogyakarta from May to June 2025.

The independent variable in this study was the variation in the voltage stabilizer's output voltage, namely the standard condition without a stabilizer, 13.5 V, 14.0 V, 14.5 V, 15.0 V, and 15.5 V. The dependent variables included engine power (HP), engine torque (Nm), and fuel pressure (bar). The primary equipment used was a chassis dynamometer to measure power and torque, a fuel pressure tester to measure fuel pressure, and a voltage stabilizer with adjustable output voltage settings.

The testing procedure began with an inspection of the vehicle's condition, engine warm-up, and initial condition calibration before each test. Each voltage variation was tested three times to obtain maximum power and torque data. Measurements were taken across the engine speed range from low to maximum RPM. Fuel pressure was measured in the fuel line using a fuel pressure tester after the stabilizer's output voltage was set according to the test variation.

The data were analyzed descriptively using mean values, standard deviations, and maximum values. Comparisons were made between standard conditions and each voltage variation to identify trends in changes in power, torque, and fuel pressure. Since this study did not employ inferential statistical tests, the terms “increase” or “decrease” in the discussion are interpreted as trends based on the experimental data obtained.

3. Results and Discussion

3.1. Power

Table 2 shows that the average power under standard conditions without a voltage stabilizer is 34.23 HP, with a maximum power of 34.5 HP. At voltages of 13.5 V and 14.0 V, the changes in power do not yet show a strong upward trend, as the average values are relatively close to those under standard conditions. A more pronounced increase is observed at 14.5 V, 15.0 V, and 15.5 V. A voltage of 15.5 V produces the highest average power, namely 34.97 HP, as well as the highest maximum power of 35.1 HP at 11,500 rpm.

Table 2. Engine power test results for each voltage variation

Output voltage (V)	Test 1 (HP)	Test 2 (HP)	Test 3 (HP)	Average (HP)	SD	Maximum (HP)
Standard	34.3	34.5	33.9	34.23	0.31	34.5
13.5	34.4	34.3	34.3	34.33	0.06	34.4
14.0	34.3	34.3	34.1	34.23	0.12	34.3
14.5	34.5	34.5	34.4	34.47	0.06	34.5
15.0	34.6	34.6	34.6	34.6	0	34.6
15.5	34.8	35	35.1	34.97	0.15	35.1

Compared to standard conditions, the maximum power at 15.5 V increased by 0.6 HP, or about 1.74%. In terms of average values, the increase from 34.23 HP to 34.97 HP is equivalent to about 2.16%. This increase indicates that a more stable and higher voltage supply can support the operation of the ignition and EFI systems, allowing for more consistent combustion. However, the power gain achieved is relatively small, so it should be interpreted with caution and should not be immediately considered a statistically significant improvement.

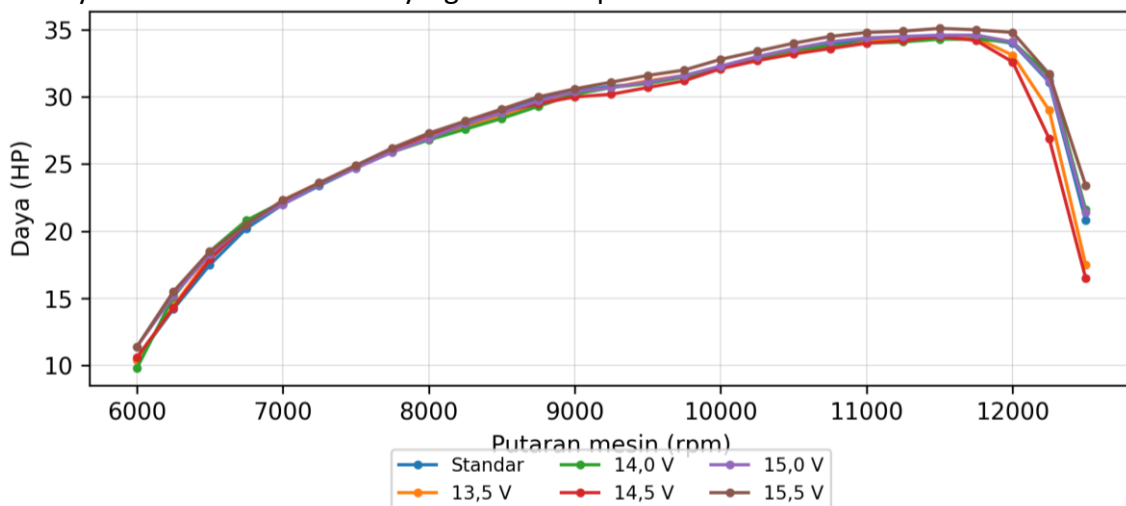


Fig. 1. Power versus engine speed for each voltage variation

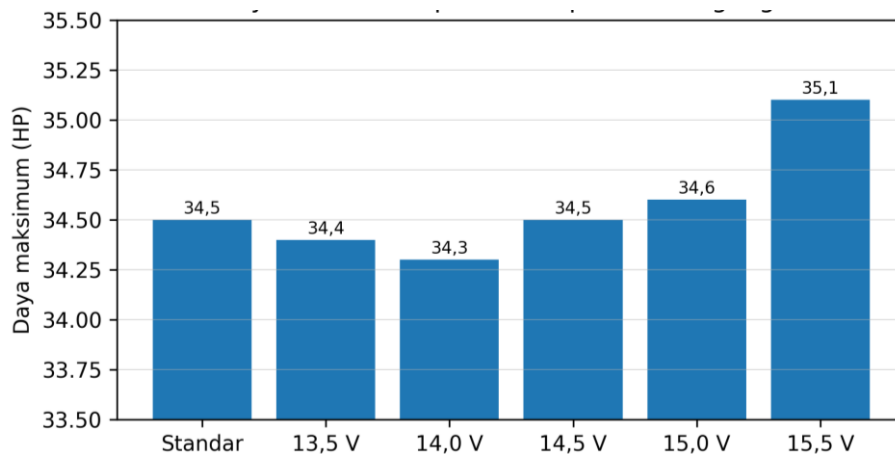


Fig. 2. Maximum power at each voltage level

3.2. Torque

Table 3 shows that the average torque under standard conditions is 23.97 Nm, with a maximum torque of 24.2 Nm. At a voltage of 13.5 V, the average torque decreases to 23.83 Nm, while at 14.0 V, the value returns to a level close to that under standard conditions. An increase in torque begins to be observed at 14.5 V and 15.0 V, then reaches its peak at 15.5 V with an average torque of 24.20 Nm and a maximum torque of 24.3 Nm at 8,750 rpm.

Table 3. Engine torque test results for each voltage variation

Output voltage (V)	Test 1 (Nm)	Test 2 (Nm)	Test 3 (Nm)	Average (Nm)	SD	Maximum (Nm)
Standard	24	24.2	23.7	23.97	0.25	24.2
13.5	23.9	23.8	23.8	23.83	0.06	23.9
14.0	24	23.9	23.9	23.93	0.06	24
14.5	24	24.1	23.9	24	0.1	24.1
15.0	24	24	24.1	24.03	0.06	24.1
15.5	24.1	24.2	24.3	24.2	0.1	24.3

The increase in maximum torque at 15.5 V compared to standard conditions is 0.1 Nm, or about 0.41%, while the average increase is about 1.0%. This pattern indicates that the voltage stabilizer's effect on torque tends to be smaller than its effect on power. These results are consistent with the characteristics of motorcycle engines, namely that changes to the engine's auxiliary systems can alter torque and power response, but the magnitude of these changes remains influenced by the engine's mechanical condition, the fuel system, the ignition system, and the test load [10], [11].

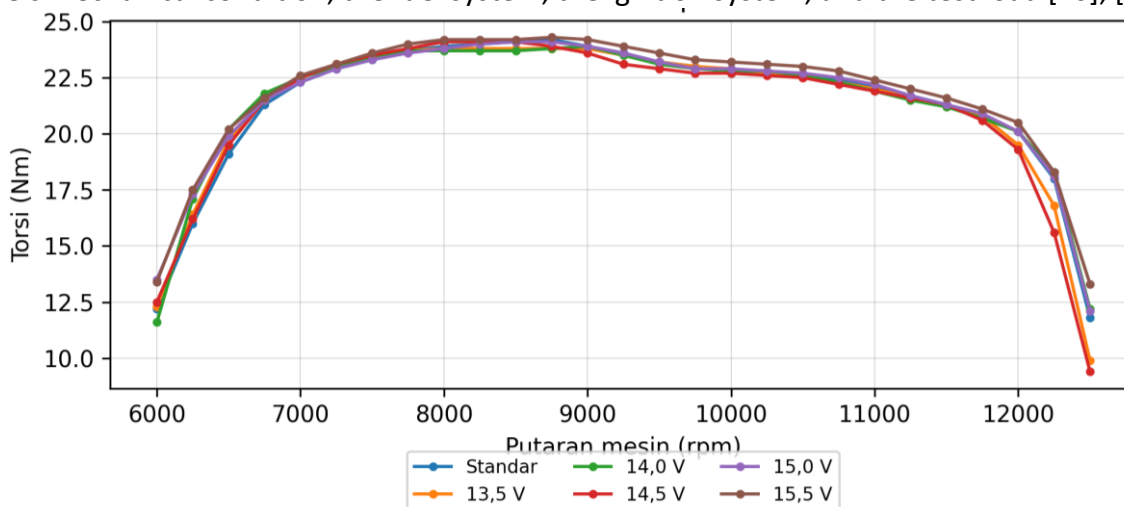


Fig. 3. Torque versus engine speed for each voltage variation

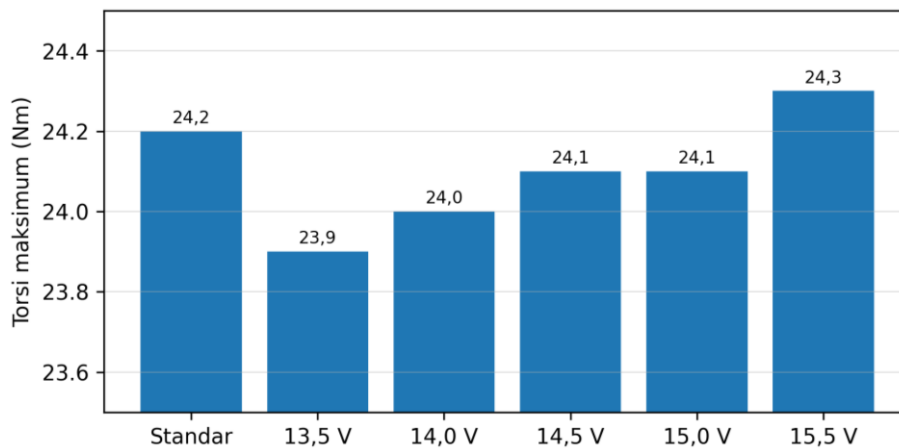


Fig. 4. Maximum torque for each stress variation

3.3. Fuel Pressure

Table 4 shows that the fuel pressure under standard conditions is 2.4 bar. At voltages of 13.5 V and 14.0 V, the fuel pressure drops to 2.3 bar and 2.35 bar, respectively. The pressure returns to the standard value at 14.5 V, then increases to 2.5 bar at 15.0 V and 2.6 bar at 15.5 V. Thus, a significant increase in fuel pressure is only clearly visible in the 15.0–15.5 V voltage range.

Table 4. Fuel pressure for each voltage variation

Output voltage (V)	Fuel pressure (bar)
Standard	2.4
13.5	2.3
14.0	2.35
14.5	2.4
15.0	2.5
15.5	2.6

The rise in fuel pressure from 2.4 bar to 2.6 bar corresponds to an increase of approximately 8.33%. Technically, an increase in the voltage supplied to the fuel pump can enhance the pump's ability to maintain pressure in the fuel line. However, an excessively high pressure increase requires further evaluation, as it may affect injector spray characteristics, fuel consumption, and the safety of EFI components. Therefore, the results at 15.5 V can be considered the optimal variation within the scope of this test, but cannot yet be directly recommended as a daily operating voltage without durability testing and verification of the electrical system's safety limits.

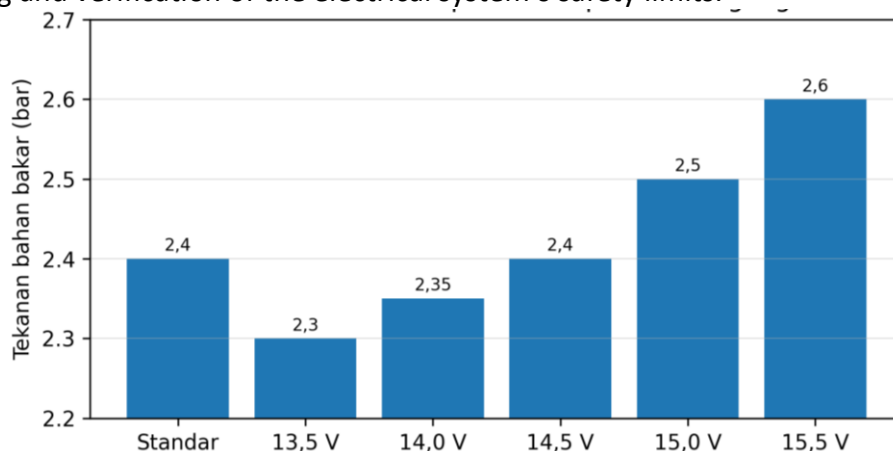


Fig. 5. Fuel pressure for each voltage variation

3.4. Practical Implications

In practical terms, the results of this study show that installing a voltage stabilizer does not always result in improved performance across all voltage variations. Increases in power, torque, and fuel pressure are only clearly evident at voltages of 15.0 V and 15.5 V. Therefore, the use of a voltage stabilizer must take into account the characteristics of the vehicle's electrical system, the condition of the battery, the alternator's capacity, and the specifications of the EFI components to avoid placing an excessive load on the vehicle's system.

For daily use, excessively high voltages cannot be recommended based solely on a temporary performance increase on the dynamometer. Parameters such as voltage stability when the headlights are on, component temperatures, battery life, fuel pump performance, fuel consumption, and exhaust emissions must be thoroughly evaluated. Thus, the selection of a voltage stabilizer setting should aim for a balance between performance gains, component safety, and long-term reliability.

4. Conclusions

Based on the test results, the use of a voltage stabilizer showed a tendency toward improved performance in the Yamaha MX King motorcycle, particularly at high output voltages. In terms of power, standard conditions produced an average power of 34.23 HP and a maximum power of 34.5 HP, while a voltage of 15.5 V produced an average power of 34.97 HP and a maximum power of 35.1 HP. For torque parameters, standard conditions produced an average torque of 23.97 Nm and a maximum torque of 24.2 Nm, while a voltage of 15.5 V produced an average torque of 24.20 Nm and a maximum torque of 24.3 Nm. Regarding fuel pressure, voltages of 15.0 V and 15.5 V increased the pressure to 2.5 bar and 2.6 bar, respectively, compared to the standard condition of 2.4 bar. Thus, the 15.5 V condition represents the optimal scenario within the scope of this study. However, the application of such high voltage requires further evaluation regarding the electrical system's safety limits, battery durability, fuel consumption, emissions, and the reliability of EFI components. Future research is recommended to include measurements of the air-fuel ratio (AFR), exhaust emissions, actual battery current and voltage, engine temperature, and long-term durability testing. Testing should also be conducted on multiple vehicle units and various types of voltage stabilizers to ensure more representative results.

Conflict of interest

The authors declare no conflict of interest.

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