Honda Tiger 2000 Bike Engine Modification Test against Exhaust Emissions and Fuel Consumption

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Abstract
This study aims to determine the effect of modification of the Honda Tiger 2000 on exhaust emissions of CO and HC. The method used is to modify the carburettor venturi piston and replace the rocker arm with a roller rocker arm. The exhaust emission test used a gas analyzer type SUKYOUNG SY-GA 401. The object of the study was a Honda Tiger 2000 motorcycle. The results showed that modification of the Honda Tiger 2000 motorcycle at idle, 1000 rpm, 1500 rpm, and 2000 rpm increased CO emissions but reduced HC emissions. Based on comparing the motorcycle emission threshold values for manufacture ≤ 2010, namely CO emissions exceeding 5.5% and HC emissions less than 2400 ppm. Pertamax Turbo fuel consumption is more efficient than Pertalite with a distance ratio of 45 km requiring 1L Pertamax Turbo and 1.4L Petalite.

Keywords: Modifications, Honda tiger 2000, Exhaust emissions, Fuel consumption

Abstrak
Penelitian ini bertujuan untuk mengetahui pengaruh modifikasi Honda Tiger 2000 terhadap emisi gas buang CO dan HC. Metode yang digunakan adalah memodifikasi venturi karburator, piston, dan mengganti rocker arm menjadi roller rocker arm. Uji emisi menggunakan gas analyzer tipe SUKYOUNG SY-GA 401. Objek penelitian adalah sepeda motor Honda Tiger 2000. Hasil penelitian menunjukkan bahwa modifikasi sepeda motor Honda Tiger 2000 pada putaran idle, 1000 rpm, 1500 rpm dan 2000 rpm meningkatkan emisi CO namun menurunkan emisi HC. Berdasarkan perbandingan nilai ambang batas emisi sepeda motor tahun pembuatan ≤ 2010 yaitu emisi CO melibih 5.5 % dan emisi HC kurang dari 2400 ppm. Konsumsi bahan bakar Pertamax Turbo lebih irit digunakan dari pada Pertalite dengan perbandingan jarak 45 km membuat hubung 1L Pertamax Turbo dan 1.4L Petalite.

Kata-kata kunci: Modifikasi, Honda tiger 2000, Emisi gas buang, Konsumsi bahan bakar

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1. Introduction

Chemical compounds of gas emissions in motor vehicle exhaust include hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO2), and lead (Pb) [1]. The amount of chemical compounds in motor vehicle exhaust emissions depends on driving conditions, engine type, fuel emission control devices, and vehicle technology [2]. Motorcycle vehicles are one of the emitters of exhaust gases, thus causing air pollution [3].

In Indonesia, old or classic motorcycles are still high due to the limited number, model, and relatively high price [4]. Old motorcycles will increase exhaust emissions because the engine components wear a lot, and many dirt sticks to the air filter [5]. One of the old motorcycles in Indonesia that is still in use is the Honda Tiger 2000. Older motorcycle users can improve the quality of exhaust emissions by updating technology, fuel, and engine maintenance [6]. Modification of Honda Tiger 2000 technology is expected to enhance the quality of exhaust emissions produced. The exhaust emission standards for the old type 4 stroke motorcycle in manufacture 2010 are CO 5.5% and HC 2400 ppm [7].

Modifications to the Honda Tiger 2000 motorcycle technology include the carburettor, piston, and rocker arm. Changing the carburettor on the Jupiter Z motorcycle by replacing the smaller main jet can reduce the CO content by 1.31%, and the HC does not decrease [8]. Modifying the flat and dome pistons of Jupiter Z motorcycles at 2000 RPM experienced a 5% reduction in CO exhaust emissions and 0.047 ppm HC [9]. However, in modifying the rocker arm into a roller rocker arm on a 5D9 motorcycle, CO and HC exhaust emissions have increased [10].

Based on this background, modifications to the carburettor, piston, and rocker arm were applied to the Honda Tiger 2000B to reduce exhaust emissions and fuel consumption. Exhaust emissions were measured using a gas analyzer with rpm variations, and fuel consumption was measured using a measuring cup with variations in distance travelled. Furthermore, the measurement results are compared with the regulation standards for motorcycle exhaust emissions in the year of manufacture 2010. Fuel consumption is compared between using Pertamax Turbo and Pertalite fuels to find out which power is more efficient.
2. Method

The specifications of the 2000 year Honda Tiger motorcycle are presented in Table 1.

**Table 1.** Specifications Honda Tiger 2000

| Component Name             | Specification       |
|----------------------------|---------------------|
| Length x WIDTH X HEIGHT    | 2029 x 747 x 1124 mm |
| Machine Type               | 4 Langkah, OHC, 1 Silinder |
| Power                      | 11,5 HP             |
| Cylinder Volume            | 196,9 cc            |
| Compression Comparison     | 9,0: 1              |
| Maximum Power              | 17,0 PS / 8.500 RPM |
| Maximum Torque             | 1,60 kgf.m / 7000 RPM |
| Operating Pattern          | Gigi 1-N-2-3-4-5-6  |
| Ignition System            | CDI-DC, Magneto     |
| Step Diameter              | 63,5 – 62,2 mm      |
| Cooler                     | Udara               |

Modification of the Honda Tiger 2000 motorcycle carburettor has been done by changing the diameter of the carburettor venture. Changes in the size of the venture carburettor of a Honda Tiger 2000 motorcycle are presented in Table 2.

**Table 2.** Changes in Carburetor Venture Size for Honda Tiger 2000

| Before | After |
|--------|-------|
| 28 mm  | 30 mm |

Table 2. shows that the venture carburettor is enlarged by 2 mm from the standard size. The change in the size of the venture carburettor of a Honda Tiger 2000 motorcycle is shown in Figure 1.

**Figure 1.** Enlarged Honda Tiger 2000 Carburetor Venture

After making changes to the venture carburettor, then replace. The piston is replaced with a size larger than the factory standard. The piston sizes are presented in Table 3.
**Table 3.** Changes in Piston Diameter Size Honda Tiger 2000

| Before | After |
|--------|-------|
| 64 mm  | 70 mm |

The standard rocker arm is replaced with a roller rocker arm. Change the standard rocker arm to a roller rocker arm by modifying the camshaft. The camshaft surface is welded using argon, then the base circle, ramp, flank, and cam lift are changed. The camshaft and roller rocker arm changes affect the in and ex valve clearances of Honda Tiger 2000 motorcycles. Changes in the in and ex valve clearances are presented in **Table 4.**

**Table 4.** Valve Gap Honda Tiger 2000

| Component Name | Before | After |
|----------------|--------|-------|
| Katup In     | 0,10 mm | 0,20  |
| Katup Ex     | 0,10 mm | 0,20  |

After making modifications to the carburettor, piston, and rocker arm, exhaust emissions were measured. Exhaust emissions were measured using a gas analyzer type SUKYOU NG SY-GA 401. Measurements were made to determine the levels of HC and CO. The data obtained will be compared with the regulation standards for motorcycle exhaust emissions in manufacture 2010. Furthermore, fuel consumption is measured at a maximum distance of 45 km. Fuel consumption measurement is carried out with variations in length, namely: 15 km, 25 km, 35 km, and 45 km. Fuel consumption is measured using a measuring cup.

3. **Result and Discussion**

The modifications applied to the Honda Tiger 2000 motorcycle, then tested for exhaust emissions. The emission test results using a gas analyzer obtained data on the amount of CO and HC. CO and HC emission test data are presented in **Figure 2** and **Figure 3.**

3.1 **CO Emission Test**

CO emissions are gases that arise due to incomplete combustion due to a mixture of air and fuel that is too rich, and the temperature is low around the cylinder wall [11]. CO Emissions Test on a Honda Tiger 2000 motorcycle is presented in **Figure 2.**
In Figure 2 it is known that at idle rotation CO = 4.01%, 1000 rpm = 4.67%, 1500 rpm = 5.26%, and 2000 rpm = 5.42%. Based on the data in Figure 2, it can be concluded that the higher the engine speed, the higher the CO emission. CO emissions increase because there is a tendency that the higher the engine speed, the greater the CO emissions produced [12]. Based on the results of emission tests on motorcycles in manufacture 2010, it can be seen that CO emissions exceed the specified threshold value. The comparison table of allowable threshold values is presented in Table 5.

Table 5. Comparison of CO Threshold Values

| Category                          | Parameter CO % | Test Result          | Description           |
|-----------------------------------|----------------|----------------------|-----------------------|
| 4 Stroke Motorcycle Year of Manufacture ≤ 2010 | 5.5            | CO idle rotation = 4.01% |
|                                   |                | 1000 rpm = 4.67%     | Exceeding             |
|                                   |                | 1500 rpm = 5.26%     | Threshold Value       |
|                                   |                | 2000 rpm = 5.42%     |                       |

3.2 HC Emission Test

HC emissions arise because the fuel is not burned and comes out with the rest of the combustion [13] [14]. The HC emission test on a Honda Tiger 2000 motorcycle is presented in Figure 3.
In Figure 3 it is known that at idle speed HC = 1300 ppm, 1000 rpm = 1103 ppm, 1500 rpm = 856 ppm, and 2000 rpm = 725 ppm. Based on the data in Figure 3, it can be concluded that the higher the engine speed, the lower the HC emission. HC emission decreases because there is a tendency that as the engine speed increases, the resulting HC emission decreases [15]. Based on the results of emission tests on motorcycles in the year of manufacture 2010, it can be seen that HC emissions are less than the specified threshold value. The comparison table of allowable threshold values is presented in Table 6.

| Category                        | Parameter HC ppm | Test Result          | Description        |
|---------------------------------|------------------|----------------------|--------------------|
| 4 Stroke Motorcycle Year of Manufacture ≤ 2010 | 2400             | HC idle = 1300 ppm   | Less Than Threshold Value |
|                                 |                  | 1000 rpm = 1103 ppm  |                    |
|                                 |                  | 1500 rpm = 856 ppm   |                    |
|                                 |                  | 2000 rpm = 725 ppm   |                    |

3.3 Fuel Consumption Test

Modification of Honda Tiger 2000 motorcycle affects fuel consumption (kh/L). The fuel used is Pertamax Turbo and Petalite. Pertamax Turbo is used in research because powers that have high octane values are resistant to high temperatures [16]. The effect of the modification is presented in Figure 4.

![Figure 4. Average Fuel Consumption](image)

In Figure 4, it is known that the Pertamax Turbo fuel consumption required at a distance of 15 km = 0.34 L, a distance of 25 km = 0.57 L, a distance of 35 km = 0.75 L, and a distance of 45 km = 1 L. required at a distance of 15 km = 0.42 L, a distance of 25 km = 0.66 L, a distance of 35 km = 0.97 L, and a distance of 45 km = 1.4 L.
km = 0.97 L, and a distance of 45 km = 1.4 L. Based on the data in Figure 4, it can be concluded that the fuel consumption of Pertamax Turbo is lower than the Pertalite used for the Honda Tiger 2000 motorcycle modification.

4. Conclusion

Based on data analysis on CO and HC emission tests, it can be concluded:

a. Honda Tiger 2000 motorcycle modification affects the amount of CO emissions. CO emissions increase at engine idle speed, 1000 rpm, 1500 rpm, and 2000 rpm.

b. Honda Tiger 2000 motorcycle modification affects the amount of HC emissions. HC emissions decrease at engine idle speed, 1000 rpm, 1500 rpm, and 2000 rpm.

c. Comparison of modifications of Honda Tiger 2000 motorcycles on the threshold value of motorcycles in the year of manufacture 2010, namely CO emissions are exceeding 5.5% and HC emissions less than 2400 ppm at engine idle speed, 1000 rpm, 1500 rpm, and 2000 rpm.

d. The fuel consumption of the Honda Tiger 2000 motorcycle modification is more efficient using Pertamax Turbo when compared to Petalite. A distance of 45 km requires fuel Pertamax Turbo 1L and Pertalite 1.4L.

References

[1] M. Ferdnian, “Analisis Uji Emisi Gas Buang Kendaraan Bermotor dan Dampaknya Terhadap Lingkungan di Kota Balikpapan (Kal-Tim),” Transmisi, vol. XII, pp. 15–24, 2016.

[2] S. H. Mulyanto, “PENGARUH DIAMETER MUFFLER TERHADAP EMISI KARBON MONOKSIDA (CO) PADA MOTOR BENSIN,” Politek. Negeri Balikpapan SNITT, pp. 374–377, 2018.

[3] D. Kusumawardani, M. Navastara, D. Perencanaan, and F. Teknik, “Analisis Besaran Emisi Gas CO2 Kendaraan Bermotor Pada Kawasan Industri SIER Surabaya,” J. Tek. ITS, vol. 6, no. 2, pp. 399–402, 2017.

[4] “Motor Klasik, Makin Tua Makin Dicinta - Carmudi Indonesia,” carmudi.co.id. https://www.carmudi.co.id/journal/motor-klasik-makin-tua-makin-dicinta/ (accessed Mar. 24, 2021).

[5] T. Lupita, Cyndia, Putri; Sudarno; Istirokhatun, “ANALISIS PENGARUH UMUR MESIN, PERIODE SERVIS DAN JARAK TEMPUH TERHADAP KONSENTRASI EMISI CO, NOX, HC DAN CO2 PADA SEPEDA MOTOR TIPE SPORT (STUDI KASUS : MOTOR YAMAHA VIXION),” Tek. Lingkung. Univ. Diponegora, 2013.

[6] F. Radityasani, Muhammad, “Motor Tua Tak Perlu Khawatir Jika Ikut Uji Emisi,” otomotif.kompas.com, 2021. https://otomotif.kompas.com/read/2017/10/23/124200615/motor-tua-tak-perlu-khayawatir-ikui-ikut-emi (accessed Mar. 26, 2021).

[7] A. Muhamamd, PEMODELAN EMISI GAS BUANG SEPEDA MOTOR, 2nd ed. Bandung:
[8] Febriansyah, “PENGARUH PENGGANTIAN MAIN JET PADA KARBURATOR TERHADAP KONSUMSI BAHAN BAKAR DAN EMISI GAS BUANG PADA SEPEDA MOTOR YAMAHA JUPITER Z,” J. Tek. Otomotif Univ. Negeri Padang, vol. 1, no. 2, pp. 1–8, 2014.

[9] W. Wardana, Galih, “Analisis Pengaruh Model Piston Terhadap Emisi Gas Buang Pada Motor Bensin Empat Langkah,” Univ. Nusant. PGRI Kediri Simki-Techsain, vol. 2, no. 7, pp. 1–12, 2018.

[10] B. Wilantara, “Uji Cam Modifikasi dan Rocker Arm dengan Roller pada Yamaha SD9,” Automot. Exp., vol. 2, no. 1, pp. 28–33, 2019.

[11] I. M. Mara, I. M. Nuarsa, I. B. Alit, and I. M. A. Sayoga, “Analisis emisi gas buang kendaraan berbahan bakar etanol,” Din. Tek. Mesin, vol. 9, no. 1, pp. 45–57, 2019, doi: 10.29303/dtm.v0i0.258.

[12] V. S. Bachtiar, “Kajian hubungan antara variasi kecepatan kendaraan dengan emisi yang dikeluarkan pada kendaraan bermotor roda empat,” J. Tek. Lingkung., no. 2, pp. 1–18, 2005.

[13] R. Lapisa, T. Sugiarito, and A. G. Halim, “Efek Geometri pada Katalis dalam Penurunan Level Emisi Gas Buang Kendaraan,” J. Pendidik. Teknol. dan Kejuru., vol. 2, no. 1, pp. 1–8, 2019.

[14] I. M. Adi Sayoga, “Pengaruh Masa Pakai Dan Tingkat Transmisi Terhadap Kadar Emisi Gas Buang Sepeda Motor Honda Astrea Grand,” Din. Tek. Mesin, vol. 1, no. 1, pp. 1–6, 2011, doi: 10.29303/d.v1i1.123.

[15] D. Fernandez, “Pengaruh Putaran Mesin Terhadap Emisi Gas Buang Hidrokarbon (Hc) Dan Karbon Monoksida (Co),” J. Sainstek UNP, vol. 12, no. 1, pp. 81–44, 2009.

[16] I. W. B. Ariawan, I. G. W. Kusuma, and I. B. Adnyana, “PENGARUH PENGGUNAAN BAHAN BAKAR PERTALITE TERHADAP UNJUK KERJA DAYA, TORSI DAN KONSUMSI BAHAN BAKAR PADA SEPEDA MOTOR BERTRANSMISI OTOMATIS,” J. METTEK, vol. 2, no. 1, pp. 51–58, 2016.