Jurnal E-KOMTEK (Elektro-Komputer-Teknik)
Vol. 5, No. 1 (2021) pp. 123-132
https://jurnal.politeknik-kebumen.ac.id/index.php/E-KOMTEK
p-ISSN : 2580-3719 e-ISSN : 2622-3066

The Effect of Installing Modified Copper in Muffler to Reduce CO Levels in Vehicle Exhaust

Arif Setyo Nugroho
Department of Mechanical Engineering, Sekolah Tinggi Teknologi Warga Surakarta, Indonesia, 57552

arifsn@sttw.ac.id

https://doi.org/10.37339/e-komtek.v5i1.545

Published by Politeknik Dharma Patria Kebumen

Artikel Info
Submitted:
15-04-2021
Revised:
10-06-2021
Accepted:
11-06-2021
Online first :
30-06-2021

Abstract

This study aims to determine the effectiveness of modified copper to reduce carbon monoxide (CO) levels. Copper in the form of a plate shaped like a honeycomb and altered with activated carbon (SiO) and ZSM-5. The test uses a four-stroke 125 CC two-wheeled motor vehicle, fuel using Petalite, gasohol E5, gasohol E10, gasohol E15. The test carried out is the emission test of the effect of fuel variations and modified copper. The use of petalite fuel, variations of honeycomb copper + activated carbon (SiO-C) + ZSM-5 is more effective because it can reduce CO levels the most, which is 3.66% CO at 9000 rpm engine speed. For E5 fuel, the use of a honeycomb-shaped copper exhaust + Titan dioxide (TiO2) + Activated carbon (SiO-C) + ZSM-5 reduces CO levels by 3.42% CO at 9000 rpm engine speed. On the other hand, E10 fuel reduces CO levels by 1.35% CO when using exhaust with honeycomb copper+ TiO2 + SiO-C +ZSM-5.
Keywords: *Carbon monoxide, Copper, Fuel, Emission*

Abstrak

Penelitian ini bertujuan untuk mengetahui efektivitas tembaga termodifikasi dalam menurunkan kadar karbon monoksida (CO). Tembaga berupa pelat berbentuk seperti sarang lebah dan diubah dengan karbon aktif (SiO) dan ZSM-5. Pengujian menggunakan kendaraan bermotor roda dua empat tak 125 CC, bahan bakar menggunakan Petalite, gasohol E5, gasohol E10, gasohol E15. Pengujian yang dilakukan adalah uji emisi pengaruh penggunaan variasi bahan bakar dan modifikasi tembaga. Penggunaan bahan bakar petalite, variasi honeycomb copper + karbon aktif (SiO-C) + ZSM-5 lebih efektif karena mampu menurunkan kadar CO paling banyak, yaitu 3,66% CO pada putaran mesin 9000 rpm. Untuk bahan bakar E5, penggunaan knalpot tembaga berbentuk sarang lebah + Titan dioksida (TiO2) + Karbon aktif (SiO-C) + ZSM-5 mengurangi kadar CO sebesar 3,42% CO pada putaran mesin 9000 rpm. Di sisi lain, bahan bakar E10 mengurangi kadar CO sebesar 1,35% CO saat menggunakan knalpot dengan honeycomb copper+ TiO2 + SiO-C +ZSM-5.
***Kata-kata kunci**: Karbon monoksida, Tembaga, Bahan bakar, Emisi*

1. Introduction

Pollution makes the initially clean air and fresh turns into dirty and harmful to health. The cause of polluted air is industrial smoke, and the increasing number of motorized vehicles, where the conditions of these vehicles are following emission standards and some are not according to emission standards. The amount of air pollution caused by vehicle exhaust gases contributes the most significant pollution to air pollution, meaning that vehicle exhaust gases significantly increase air pollution. These ancient vehicles do not meet emission standards **[1]**.

The content of toxic exhaust emissions, one of which is CO, can endanger human health. The most significant cause of the increased range of poisonous exhaust emissions is the incomplete combustion of fuel in the cylinder **[2]**. With technological advances, technology is created that is useful for human life. The technology developed serves to reduce the amount of vehicle exhaust emissions, namely catalytic converters. Catalyst converters made from palladium, platinum, and rhodium are already on the market but at relatively high prices. In addition, the use of premium fuels with high levels of lead is risky for the catalyst material, so that it can interfere with the function of the catalyst **[3].**

Some vehicles are old when the emission test gets high CO levels, so this research was carried out to reduce CO exhaust emissions in cars with more affordable prices and materials easily obtained to be installed on all motorized vehicles.

One of the materials that can reduce the CO content is copper. Copper can reduce CO levels in vehicle exhaust emissions through an oxidation reaction process. On the other hand, much copper is used in electronics or electricity and in the industrial world, such as batteries, electrodes, sulfur collectors, crafts which can then become copper waste from the malfunctioning of these objects due to damage. Copper waste has not been utilized optimally. One of the copper processing to reduce CO levels in the exhaust is selecting readily available materials.

In addition, the use of copper to reduce levels of CO exhaust emissions. SiO-C from biomass waste treatment can be used as a copper modification material for more effective functions [4]. SiO-C is an adsorbent that can absorb CO gas, so the adsorbent in copper can help absorb CO. Properties of the fuel variations shown in **Table 1.**

Table 1. Properties fuel variations

Fuel	Viscosity (mm^2/s)	Density (kg/m^3)	Calorific Value (kJ/kg)
Pertalit (E0)	0,49	706	44931
Pertalite + 5% ethanol mixed volume (E5)	0,50	712	43155
Pertalite + 10% ethanol mixed volume (E10)	0,50	716	39489
Pertalite + ethanol 15% mixed volume (E15)	0,51	719	37729
Reference	ASTM D 445-97	ASTM D-1298	ASTM D-240

2. Method

The combustion engine used is a four-stroke 125 CC two-wheeled motor with a modified exhaust to install modified copper. Motor data are shown in **Table 2.**

Table 2. Machine specifications

Engine type	: SOHC, two-valve air cooling
Fuel system	: Carburetor
Diameter x stroke	: 52.4 mm x 57.9 mm
Compression Ratio	: 9 x 1
Step volume	: 124.9 CC
Transmission Gear	: 4 Step

The fuel used is Petalite, gasohol E5, E10, E15 [6]. First, determine whether the installation of modified copper in the exhaust interferes with the exhaust gas velocity or not. The exhaust gas velocity was measured using the Krisbow KW06-562 anemometer.

Exhaust emission testing using a gas analyzer Qrotech (QRO 401). Exhaust gas testing determines the effect of using ethanol fuel and modified copper on reducing CO levels in vehicle exhaust gases. Measurement of vehicle exhaust velocity using Krisbow brand anemometer. The variation of petalite fuel and a mixture of Petalite with ethanol (E5, E10, E15) is the research variation. The test was carried out with the vehicle not running, only varying the vehicle rpm. Variations of engine rpm 1300 rpm, 3000 rpm, 5000 rpm, 7000 rpm, 9000 rpm. Modified copper mount near muffler neck.

Figure 1. Modified muffler

Figure 1 is a modified muffler where copper is installed. The muffler used in the test is standard. The damper is fitted with unmodified honeycomb copper, honeycomb-shaped copper with modified SiO-C +ZSM-5, and modified honeycomb copper TiO2 + SiO-C + ZSM-5 catalyst.

Figure 2. Copper formed into an unmodified honeycomb

Figure 3. Honeycomb-shaped copper with modified SiO + ZSM-5 Catalyst

Figure 4. Modified honeycomb copper TiO2 +SiO-C + ZSM-5 Catalyst.

Figure 2 is the copper used for testing in the form of a honeycomb 90 mm long and 38 mm in diameter unmodified. **Figure 3** is a honeycomb-shaped copper 90 mm long and 38 mm in diameter modified SiO-C + ZSM-5 catalyst. **Figure 4** is a honeycomb-shaped copper 90 mm long, and 38 mm in diameter changed TiO2 +SiO - C+ catalyst ZSM-5. The research flow chart can be seen in **Figure 5.**

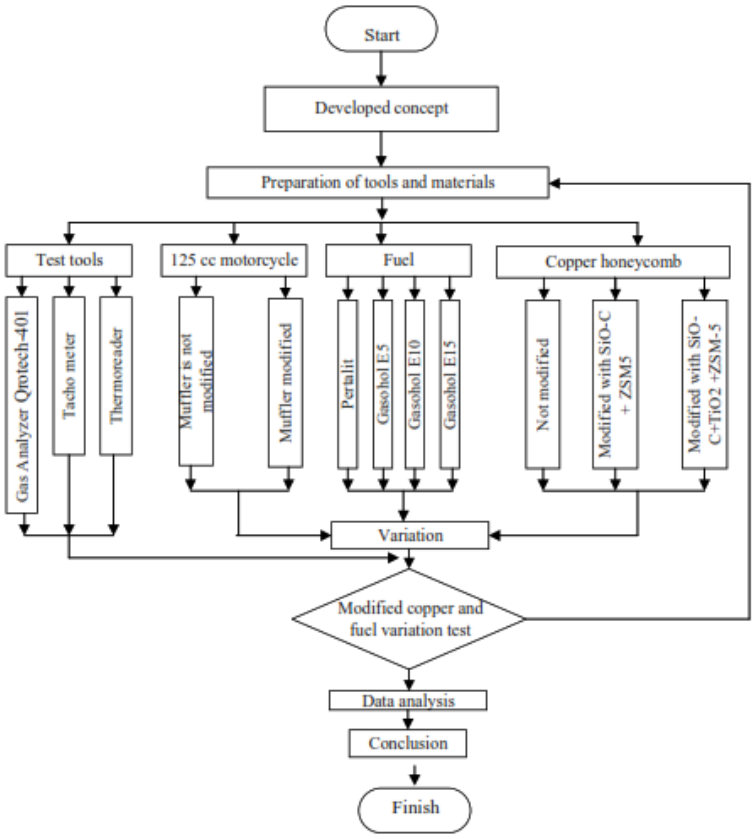

Figure 5. Research flow chart

3. Results and Discussion

In testing the exhaust gas rate when using a standard muffler without honeycomb copper, the exhaust gas velocity is 5.39 m/s at 1300 rpm engine speed. Meanwhile, when using a damper with honeycomb copper, the exhaust gas speed becomes 5.29 m/s at 1300 rpm engine speed. The exhaust gas velocity test explained that the installation of copper in the muffler did not hinder the exhaust gas velocity. The results of the exhaust emission testing of vehicles with standard muffler variations, muffler with ordinary honeycomb copper, mufflers with modified honeycomb copper SiO-C +ZSM-5, and mufflers with modified honeycomb copper + TiO2 + SiO-C +ZSM-5 is as **Figure 6.**

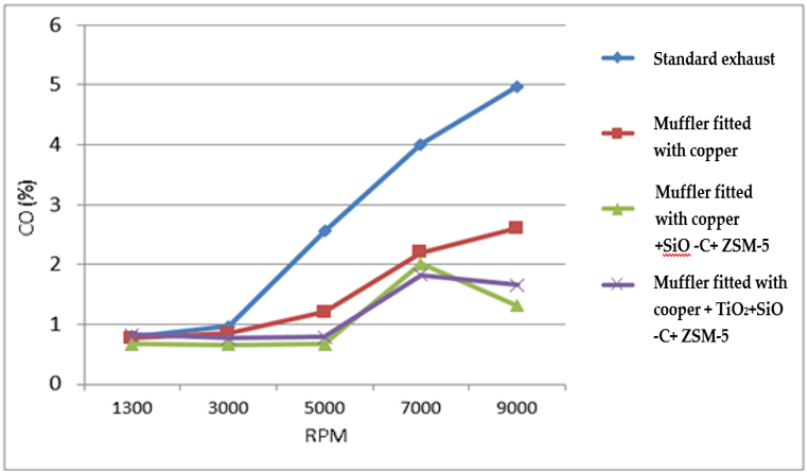

Figure 6. Graph of CO content produced from vehicle rpm variations

As shown in **Figure 6**, the test results show the results of using standard muffler and modified muffler plus modified copper for CO gas with petalite fuel. In the standard muffler, the CO gas content increases with increasing engine speed, and the highest CO gas content is 4.97% in the standard muffler at 9000 rpm engine speed. The most considerable CO gas reduction value in petalite fuel is 3.66%. The CO value is 4.97% when using a standard muffler and becomes 1.31% when using a damper with SiO-C +ZSM-5 at 9000 rpm rotation. It can be interpreted that using copper modified with SiO and ZSM-5 can help reduce CO gas levels because it is an adsorbent. The use of activated charcoal in SiO is also effective in reducing exhaust emissions **[4] [5] [6]**. So that the reduced CO gas content is greater than the use of ordinary honeycomb copper without modification **[7] [8]. Figure 7** shows the results of CO gas reduction when using copper reducer in E5 fuel. Using a standard muffler, the more the engine speed increases, the higher the CO gas level that comes out. The highest CO gas content when using E5 fuel is in the standard muffler with an engine speed of 9000 rpm, which is 4.79%.

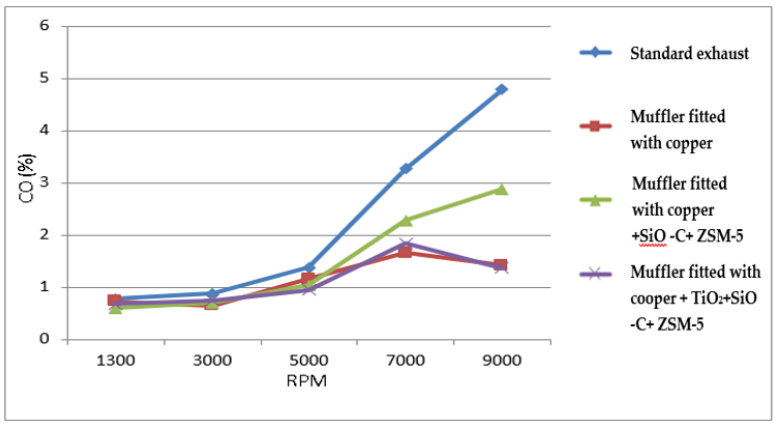

Figure 7. Graph of CO content produced from vehicle rpm variations using gasohol E5 fuel

CO gas levels can be reduced in all rpm variations and copper variations when using a copper-added muffler. In comparison, the most significant reduction value is 3.42% in the use of a honeycomb-shaped copper muffler + TiO2 + SiO-C + ZSM-5 at 9000 rpm engine speed, where when using a standard muffler CO gas content is 4.79% to 1,37% when using muffler with honeycomb copper + TiO2 + SiO-C +ZSM-5. When the engine speed increases and the exhaust gas temperature increases, it can help honeycomb copper reduce CO gas better. Moreover, the use of TiO2 + SiO-C + ZSM-5 can reduce CO levels more **[9]. Figure 8** shows the results of using standard muffler and muffler with copper adsorption on CO gas levels in E10 fuel. The lowest level of CO gas is the use of damper with honeycomb copper + TiO2 + SiO-C + ZSM-5 and standard muffler with 1300 rpm engine speed which is both 0.62%, while the highest CO gas content is on the use of a stock muffler of 2.39% with 9000 rpm.

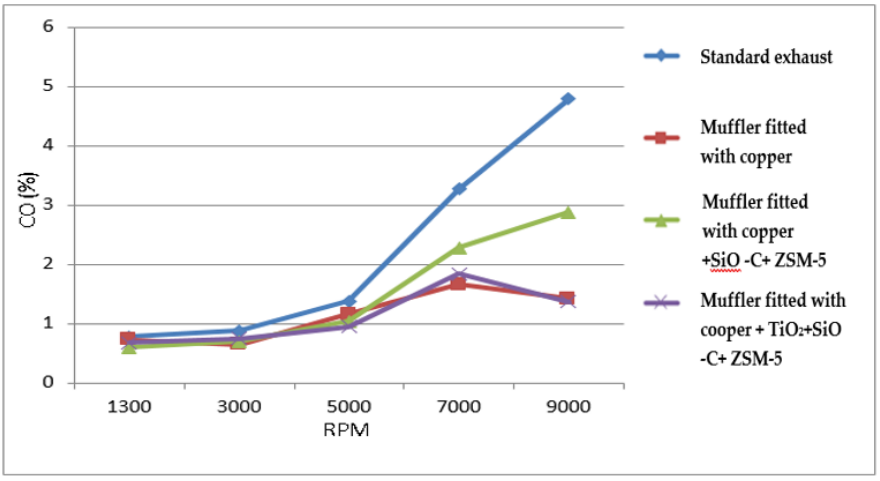

Figure 8. Graph of CO content produced from vehicle rpm variations using gasohol fuel E10

The use of a honeycomb copper muffler + TiO2 + SiO-C + ZSM-5 with an engine speed of 9000 rpm can reduce the value of CO gas at the most, which is 1.35%, wherefrom the standard muffler is 2.39% to 1.04% when using muffler with modified copper with TiO2 + SiO-C +ZSM-5.

Figure 9 shows the results of using copper adsorbent on E15 fuel. The minor CO gas content uses a standard muffler with an engine speed of 5000 rpm and exhaust with ordinary honeycomb copper at 3000 rpm, which is both 0.06%.

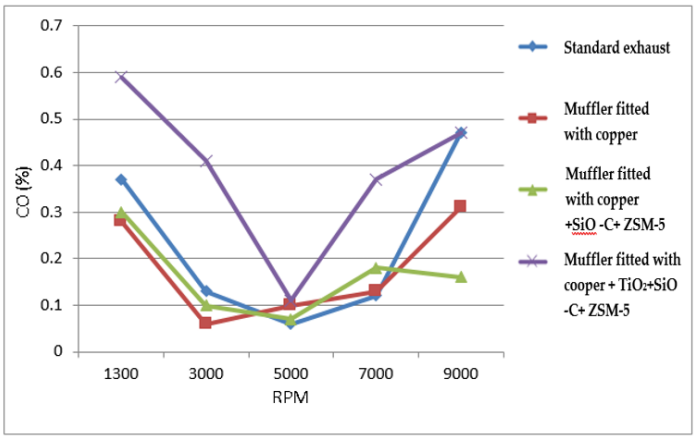

Figure 9. Graph of CO content produced from vehicle rpm variations using gasohol E15 fuel

The reduction in CO levels only occurs when using a muffler with ordinary honeycomb copper and a muffler with honeycomb copper+ SiO-C +ZSM-5 at engine speeds of 1300 rpm, 3000 rpm, 9000 rpm. The muffler with honeycomb-shaped copper + TiO2 + SiO-C + ZSM-5 cannot reduce CO levels in exhaust gases. From these data, it can be seen that in the use of E15 fuel, the installation of copper adsorbent is not practical because the higher the ethanol content results in the combustion in the cylinder being complete, so the value of CO levels is getting smaller. The copper adsorption cannot reduce CO levels significantly **[10].**

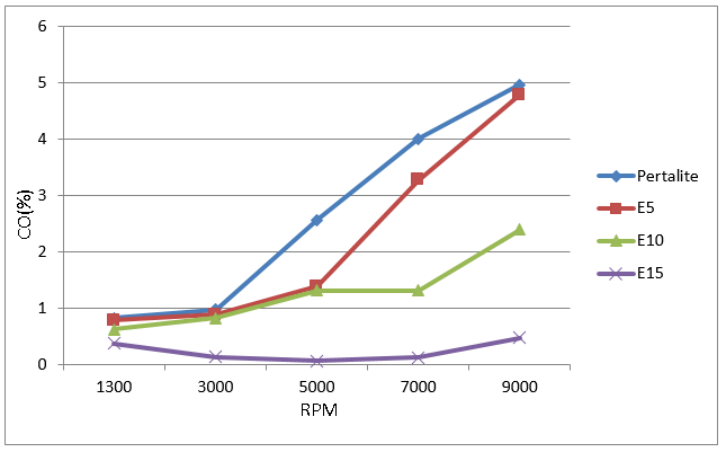

Figure 10. Graph of CO content produced from the variation of vehicle RPM using the standard muffler of the fuel used is Petalite, E5, E10, E15

Figure 10 shows the results of reducing CO gas levels using a mixture of E5, E10, E15 fuel with the standard muffler. From these data, petalite fuel at 9000 rpm produces the highest CO content of 4.97%. Moreover, the use of E15 fuel or a mixture of 85% volume petalite + 15% ethanol volume has a minor CO gas content of 0.06% at 5000 rpm engine speed. The increasing levels of

ethanol in the fuel mixture make the CO gas levels less, which happens because ethanol has a higher octane value than Petalite, which is 108 [11], makes combustion occur faster and combustion is complete than it can reduce gas levels. CO in exhaust emissions. In addition, the oxygen content in ethanol can also reduce CO gas [12]. Exhaust gas speed testing when using a standard muffler without honeycomb copper obtained exhaust gas speed of 5.39 m/s at 1300 rpm engine speed, 9.60 m/s at 3000 rpm engine speed, 12.86 m/s at engine speed 5000 rpm, 16.87 m/s at 7000 rpm engine speed, 21.23 m/s at 9000 rpm engine speed.

Meanwhile, when using a muffler with honeycomb copper, the exhaust gas rate is 5.19 m/s at 1300 rpm engine speed, 8.98 m/s at 3000 rpm engine speed, 12.93 m/s at 5000 rpm engine speed, 18.23 m/s at 7000 rpm engine speed, and 20.26 m/s at 9000 rpm engine speed. The engine speed is 1300 rpm using honeycomb copper in muffler the exhaust gas speed drops by 0.2 m/s, at 3000 rpm engine speed using honeycomb copper in the muffler the exhaust gas speed drops by 0.62 m/s, at the engine speed 5000 rpm by using honeycomb copper in muffler the exhaust gas speed increases by 0.07 m/s, at 7000 rpm by using honeycomb copper in muffler the exhaust gas speed increases by 1.36 m/s. At 9000 engine speed rpm using honeycomb copper in the muffler, the exhaust gas velocity decreased by 0.97 m/s.

4. Conclusions

Testing with petalite fuel and using variations of honeycomb copper + SiO-C + ZSM-5 installed in the muffler is more effective because it can reduce CO levels at most, which is 3.66% CO 9000 rpm rotation. On the other hand, tests using E5 fuel and honeycomb-shaped copper + TiO2 + SiO-C + ZSM-5, installed in the muffler, are more effective because they reduce CO levels more, namely 3.42% CO at 9000 rpm engine speed.

Tests using E10 fuel, the most significant reduction in CO levels is 1.35% CO when using a muffler fitted with honeycomb copper + TiO2 + SiO-C + ZSM-5. Using a damper with honeycomb copper + TiO2 + SiO-C + ZSM-5 at 9000 rpm engine speed can reduce the value of CO gas at most, which is 1.35%, from 2.39% to 1.04% when using muffler fitted modified copper TiO2 + SiO-C + ZSM-5. The installation of copper or changed copper in a damper is very effective at absorbing CO when using Petalite, E5, and E10 fuels but not practical when using E15 energy because the more ethanol in the fuel mixture, the more complete the combustion and the less CO produced in the exhaust gases.

References

[1] D. S. Ismiyati, Devi Marlita, "Pencemaran Udara Akibat Emisi Gas Buang Kendaraan Bermotor.pdf," J. Manaj. Transp. Logistik (JIM TransLog), vol. 01, no. 03, pp. 241–248, 2014.

[2] Lelawati, "Pengujian Emisi Gas Buang Sepeda Motor Dengan Bahan Bakar Premium," Maj. Tek. Simes, vol. 11, no. 1, pp. 1–5, 2017.

[3] A. H. P. Arif Setyo Nugroho, "KATALIS GRANULE CU-SiO 2 -C GUNA MEREDUKSI GAS BUANG CO PADA KENDARAAN BERBAHAN BAKAR GASOLIN DAN ETHANOL," in Prosiding SNATIF, 2018, pp. 507–510.

[4] D. Maryanto, S. A. Mulasari, and D. Suryani, "Penurunan Kadar Emisi Gas Buang Karbon Monoksida (CO) Dengan Penambahan Arang Aktif," KES MAS, vol. 3, no. 3, pp. 198–205, 1978.

[5] T. Arif Setyo Nugroho, Y Yulianto Kristiawan, "Reduction of CO and HC Emision on ZSM -5 Catalyst Supported o Activated Carbon in Motorcycle Fueled Gasolin-Ethanol Blends," Medwell Journals, vol. 11, no. 6, pp. 1196–1200, 2016.

[6] G. Setyono and D. Khusna, "Pengaruh Variasi Penambahan Bahan Bakar Pertalite dengan Ethanol terhadap Performa Mesin SI (Spark Ignition) Fi -125cc 4 Langkah 1 Silinder," J. Saintek, vol. 14, no. 2, pp. 69–73, 2017.

[7] A. S. Nugroho, "TRAKSI: Majalah Ilmiah Teknik Mesin," Traksi, vol. 20, no. 1, pp. 59–71, 2020.

[8] A. H. Listiyono, Bambang Irawan, "Optimalisasi Composite Absorber Pada Muffler Untuk Menurunkan Kadar Emisi Gas Buang Motor Bensin," J. Energi dan Teknol. Manufaktur, vol. 02, no. 01, pp. 13–22, 2019.

[9] D. R. Setiyono and D. Widjanarko, "Penggunaan Serbuk TiO 2 dan Karbon Aktif Sebagai Campuran Bahan Catalytic Converter Keramik untuk Mengurangi Polutan Berbahaya pada Kendaraan Bermesin Bensin Use of TiO 2 Powder and Activated Carbon as Catalytic Ceramic Filling Material to Reduce Hazardou," vol. 13, no. 2, pp. 165–173, 2018.

[10] A. Mokhtar, "Catalityc converter jenis katalis plat tembaga berbentuk sarang lebah untuk mengurangi emisi kendaraan bermotor," J. Gamma, vol. 10, no. 1, pp. 104–108, 2014.

[11] Yos Nofendri, "Pengaruh Penambahan Aditif Pada Bensin Ron 88 dan Ron 92 Terhadap Prestasi Mesin" Jurnal Konversi Energi dan Manufaktur UNJ, vol. 1, no. 1, pp. 33–39, 2018.

[12] A. S. N. Stefanus Unjanto, Martinus Heru Palmiyanto, Thoharudin, "Emisi CO DAN NOX Pada Gas Buang Kendaraan Menggunakan Katalis Tembaga Berporitermodifikasi.pdf." pp. 117–124, 2015.