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Effect of $MnFe_2O_4$ Nanoparticles to Reduce CO and HC Levels on Vehicle Exhaust Gas Emissions

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ABSTRACT

The air pollution particle emitted from transportation in Indonesia Bay 2015 consist of 70.50% CO; 18.34% HC; 8.89% NOx; 0.88% SOx; 1.33%. These gases are very harmful to humans. To reduce the toxic gas effect, special treatment is needed, one of them is by applying catalyst on exhaust system. $MnFe_2O_4$ has the potential to bind the CO and HC elements contained in the exhaust gas. This study aims to investigate the effect of $MnFe_2O_4$ addition on catalityc converter towards CO gas and HC emissions of motor vehicles. Therefore, the percentage of exhaust reduction with and without applying $MnFe_2O_4$ on varied engine rotation using fuel with RON of 88, 90, 92 and 98 can be revealed. The results describe that the highest reduction precentage of CO content by applying $MnFe_2O_4$ nanoparticles as a catalyst for premium, pertalite and pertamax fuel are 34.1% (effective at low and high rotation); 31.1% (effective at all rotations); and 3.9% (effective at low rotation). On the other hand, the highest reduction percentage of HC content on premium, pertalite, pertamax and pertamax turbo fuel are 79.3% (effective in high rotation); 71.4% (effective at high rotation); 53,6% (effective in high rotation); and 2.1% (only effective at low rotation).

Keywords: $MnFe_2O_4$ nanoparticles, vehicle exhaust, CO and HC levels

I. Introduction

The percentage of motorcycle vehicles in Indonesia by 2015 reaches 82% of the total vehicle [1]. According to [2], air pollution caused by motorcycle vehicles amounted to 70-80%, while industrial air pollution and others only 20-30% only. According to [3] the percentage of air pollution from transportation sources in Indonesia is 70.50% CO; 18.34% HC; 8.89% NOx; 0.88% SOx; 1.33% of the particles. These gases are very harmful to humans, in addition to negative impact on health, can also negatively impact the ecosystem or the environment in general. From this problem, it is necessary to reduce HC and CO on motorcycle vehicle exhaust emissions through catalytic converter (catalytic converter). Manganese ferrite ($MnFe_2O_4$) provides excellent performance as a catalyst or catalyst for many chemical reactions. Among the different ferrite spinel types, the Mn-Ferrite system ($MnFe_2O_4$) is one of the most versatile from the point of view of a large number of potential applications [4]. MnO that is applied as a catalyst to reduce exhaust emissions of motorcycle vehicles that react directly with the exhaust gases in the sewer, has a chemical reaction MnO2 + CO → MnO + CO2. This proves that $MnFe_2O_4$ has an MnO element as a catalyst that has the potential to reduce carbon monoxide (CO) emissions [5]. In the study of catalysts and ferrite metals for the reduction of hydrogen sulfur emissions from car exhaust. The Washcoat paste contained in% by weight of about 0.2-7% by weight of ferrite metal has the formula $MnFe_2O_4$, where M is Co, Ni, Cu, Zn, Mn, or Fe; about 20-50% by weight of alumina catalyst. This proves $MnFe_2O_4$ as a potential catalyst for reducing sulfur hydrogen gas emissions [6]. In a catalytic combustion study of methane on ferrite. High catalytic activity can be due to the simultaneous presence of manganese and iron, which can alter the oxidation rate: 2Fe (Mn) 3 ++ Olattice2-↔2Fe (Mn) 2 ++ ½O2 facilitates methane oxidation [7]. This proves $MnFe_2O_4$ as a catalyst that has the potential to reduce hydrocarbon gas (HC) emissions. From the TG results, the oxidation of nanocrystalline $MnFe_2O_4$ in the temperature range 500-620^{0}C [8]. Based on previous research, $MnFe_2O_4$ has the potential to reduce the concentration of HC and CO in the environment, but still not applied to motorcycle vehicles. Therefore a thesis is prepared on the application of catalysts as additives using $MnFe_2O_4$ nanoparticles on motorcycle vehicles, entitled "Effect of $MnFe_2O_4$

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Nanoparticles to Reduce CO and HC Levels on Motorcycle Vehicle Exhaust Emissions". It is hoped that with the application of Manganese ferrite nanoparticles ($MnFe_2O_4$) to motorcycle vehicle catalityc converter, it produces more environmentally friendly exhaust emissions.

II. Methodology

This research is an experimental type research involving independent variable, dependent variable and control variable. This research was tested on reactor using adsorbent and without adsorbent. Adsorbent used with $MnFe_2O_4$ particle nano powder sprayed on support. Support is used there are two kinds of alumina fiber and hole plate.

Alumina fiber serves as a buffer of $MnFe_2O_4$ particle nanopowder while hole plate serves as a buffer of fiber Alumina. The reactor tube is made of iron with a tube design located close to the engine exhoust hole in order to obtain the activation energy of the catalyst of sufficient temperature to speed up the oxidation reaction.

This study used a nanoparticle-sized $MnFe_2O_4$ compound (a solid particle size of 1 μm). The use of adsorbent in the form of $MnFe_2O_4$ as a substitute for this catalyst, aims to reduce exhaust emissions from the combustion chamber. The fuel used includes premium, pertalite, pertamax, and pertamax turbo which are already widespread in the community. Research object in this research is engine motorcycle 150 cc with injection system. This study was only conducted on Honda vehicles with Mega Pro type with the year of manufacture in 2013.

The tools used for testing include Gas analyzer brand tecnotest type infra red multi gas to measure the level of gas emitted from the combustion of the motorcycle. The working principle is the probe tip of the gas analyzer sensor inserted into the tip of the muffler (exhaust) at least 20 cm. The exhaust gas enters the Multi gas analyzer through the sensor probe channel. Tachometer to measure the rotational speed of an object, such as a measuring device in a motorcycle that measures per minute rotation (RPM) of the engine crankshaft in which the mechanical device rotates, which is usually indicated in RPM. In application, the tachometer has two cables. One cable is connected to a power source, and the other is connected to a coil cable.

The reactor tube for storing $MnFe_2O_4$ is inserted in Alumina Fiber folds as an adsorbent medium for CO and CH emissions. This tube is made of iron with a tube design located close to the engine exhoust hole in order to obtain the activation energy of the catalyst of sufficient temperature to speed up the oxidation reaction. For detail design shown in Figure 1.

This measurement method is done by measuring and taking directly measured data. The measured data is the amount of exhaust gas produced (CO and HC) and lamda (λ), then recorded in data analysis table with data retrieval procedure. First, install a fuel vessel on the carbulator hose. Second, fill the fuel specified on the vessel. Turn on all installed testing tools (Gas analyzer and Tachometer). Third, heating the motorcycle at the RPM is determined for 1 minute. Fourth, raise the motorcycle RPM by raising the gas pedal slowly until the next RPM is determined. Fifth, take steps 1 - 5 to maximal RPM on research (6000 RPM). Perform steps 1 - 6 on each specified fuel.

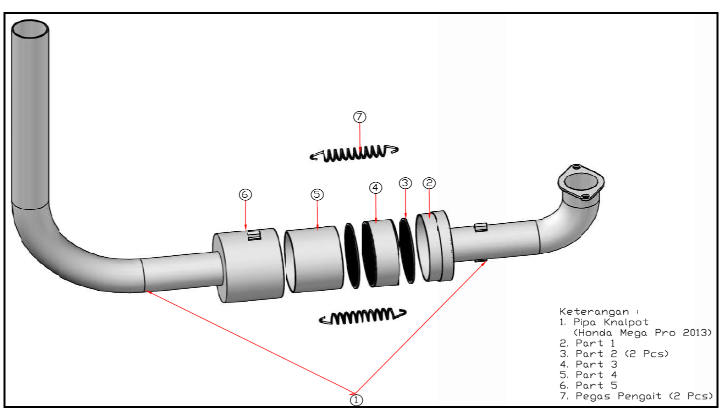


Fig. 1.Design of reactor tubes

Next performed data processing with several steps. First, make a line diagram with the function (Y) as the emission level of the exhaust (CO) and the function (X) as RPM in the experiment using $MnFe_2O_4$ nanoparticles and without $MnFe_2O_4$ (1 Graph per 1 type of fuel). Second, make the line diagram with the function (Y) as the exhaust gas emission level (HC) and the function (X) as RPM in the experiment using $MnFe_2O_4$ nanoparticles and without $MnFe_2O_4$ (1 Graph per 1 type of fuel). Third, make line diagram with function (Y) as Lamda (λ) and function (X) as RPM in experiment using $MnFe_2O_4$ nanoparticles and without $MnFe_2O_4$ (1 Graphs per 1 type of fuel). Fourth, make table percentage decrease of CO and HC level if using adsorbent $MnFe_2O_4$.

III. Results

A. Potential $MnFe_2O_4$ in reducing exhaust emissions (CO) of each fuel

Here is the data of CO content of each fuel presented in line diagram.

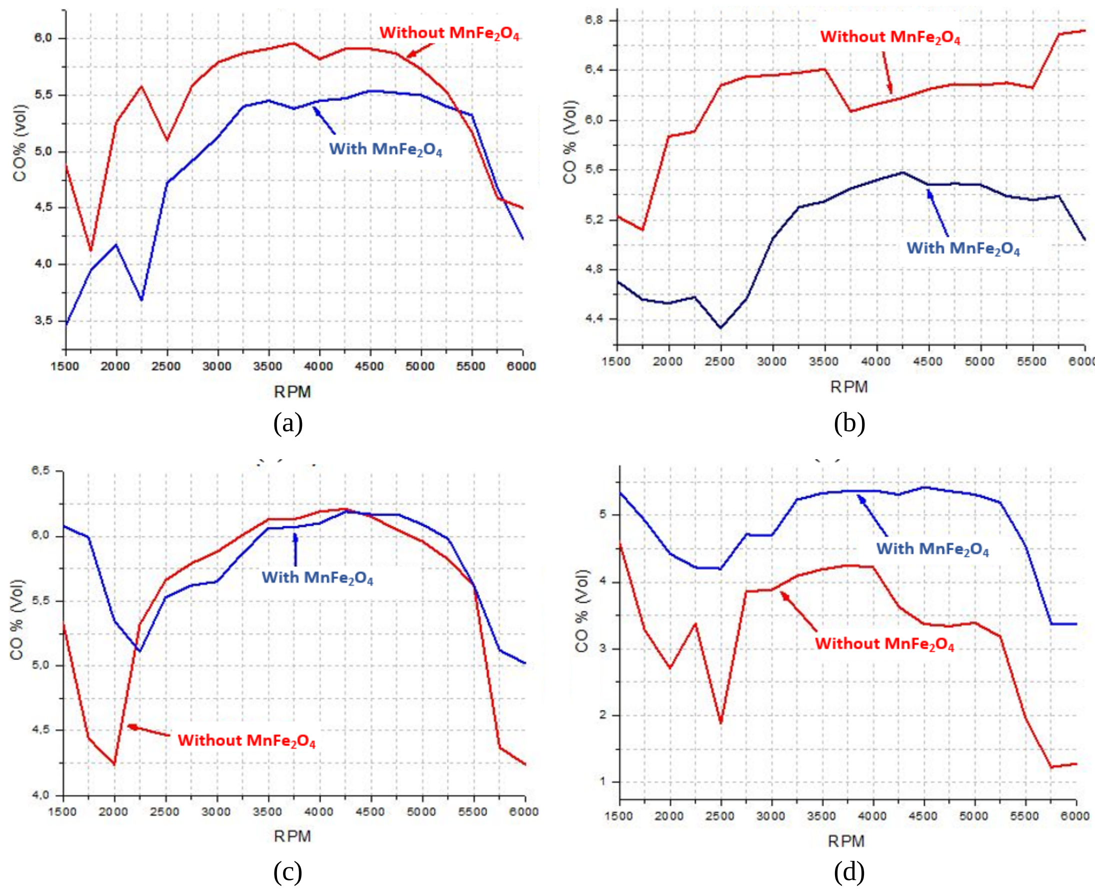
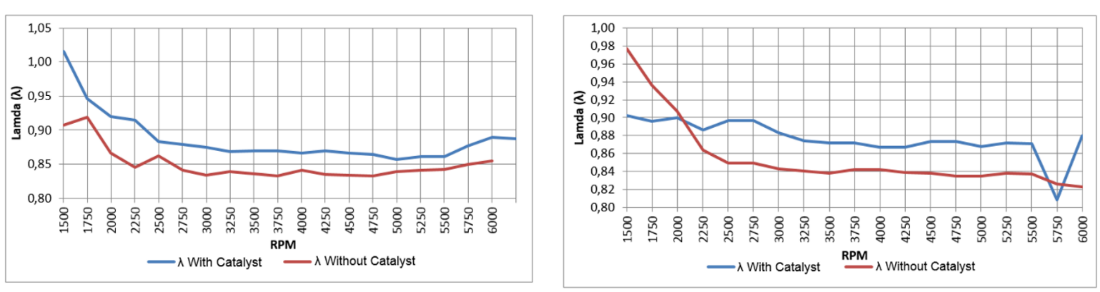
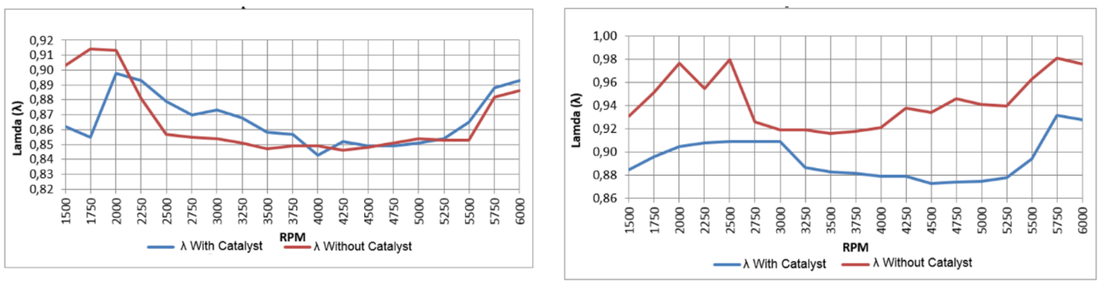


Fig. 2. Comparison graph of CO content without $MnFe_2O_4$ and with $MnFe_2O_4$ per fuel (a) Premium (b) Pertalite (c) Pertamax (d) Pertamax turbo



(a) (b)



(c) (d)

Fig. 3.Comparison graph of lamda (λ) without $MnFe_2O_4$ and with $MnFe_2O_4$ per fuel (a) Premium (b) Pertalite (c) Pertamax (d) Pertamax turbo

From the ratio diagram of CO content in Figure 2(a), it can be seen on engine rotation 1500 RPM to 5250 RPM, $MnFe_2O_4$ work lowers CO. While on the engine rotation 5500 RPM to 5750 RPM $MnFe_2O_4$ but multiply the CO. Then in the engine rotation 6000 RPM $MnFe_2O_4$ work again lowers CO. For the Lamda comparison diagram of Figure 3(a), it can be seen that from a rotation of 1500 RPM to 6000 RPM engine, the lamda with $MnFe_2O_4$ is more efficient or near zero than the lamda without $MnFe_2O_4$.

From the ratio diagram of CO content in Figure 2(b), it can be seen on engine rotation 1500 RPM to 6000 RPM $MnFe_2O_4$ entirely work lowers CO. For the lamda comparison diagram of Figure 3(b), it can be seen that from a machine rotation of 1500 RPM to 2000 RPM, lamda without $MnFe_2O_4$ is more efficient or near zero than lamda with $MnFe_2O_4$. While from engine rotation of 2250 RPM to 5500 RPM, lamda with $MnFe_2O_4$ is more efficient or near zero than lamda without $MnFe_2O_4$. On engine rotation of 5750 RPM lamda without $MnFe_2O_4$ is more efficient or near zero than lamda with $MnFe_2O_4$. At the end of a 6000 RPM engine rotation, the lamda without $MnFe_2O_4$ is again more efficient or near zero than the lamda without $MnFe_2O_4$.

From the comparison diagram of CO levels without $MnFe_2O_4$ and with $MnFe_2O_4$ in the first fuel of Figure 2(c), it can be seen on the rotation of the machine 1500 RPM to 2000 RPM $MnFe_2O_4$ does not work, but rather increases CO. While on the engine rotation of 2250 RPM to 4250 RPM $MnFe_2O_4$ work lowers CO. Then in the engine rotation 5500 RPM $MnFe_2O_4$ does not work lower CO levels and does not also increase CO levels. Then in the engine rotation 5750 RPM to 6000 RPM, $MnFe_2O_4$ re-multiply the CO content. For the lamda comparison diagram of Figure 3(c), it can be seen that from a machine rotation of 1500 RPM to 2000 RPM, lamda without $MnFe_2O_4$ is more efficient or near zero than lamda with $MnFe_2O_4$. Then in the engine rotation of 2250 RPM to 3750 RPM, lamda with $MnFe_2O_4$ is more efficient or near zero than lamda without $MnFe_2O_4$. Then in the engine rotation of 4000 RPM, the lamda without $MnFe_2O_4$ is more efficient or near zero than the lamda with $MnFe_2O_4$. Then in machine rotation 4250 RPM to 4500 RPM, lamda with MnFe2O4 returns more efficient or near zero than lamda without $MnFe_2O_4$. Then at machine rotation 4750 RPM to 5000 RPM, lamda without $MnFe_2O_4$ is more efficient or near zero than lamda with $MnFe_2O_4$. Then at machine rotation 5250 RPM to 6000 RPM, lamda with $MnFe_2O_4$ is more efficient or near zero than lamda without $MnFe_2O_4$.

From the ratio diagram of CO content in Figure 2(d), it can be seen on engine rotation of 1500 RPM to 6000 RPM $MnFe_2O_4$ entirely does not work lower CO levels. In this condition, lamda (λ) with $MnFe_2O_4$ has increased from 0.885 to 0.928. For the comparison diagram of lamda as shown in Figure 3(d), it can be seen that from a rotation of 1500 RPM to 6000 RPM engine, lamda without $MnFe_2O_4$ is more efficient or near zero than lamda with $MnFe_2O_4$.

B. Potential $MnFe_2O_4$ in reducing exhaust emissions (HC) of each fuel

Here is the data of HC content of each fuel presented in line diagram.

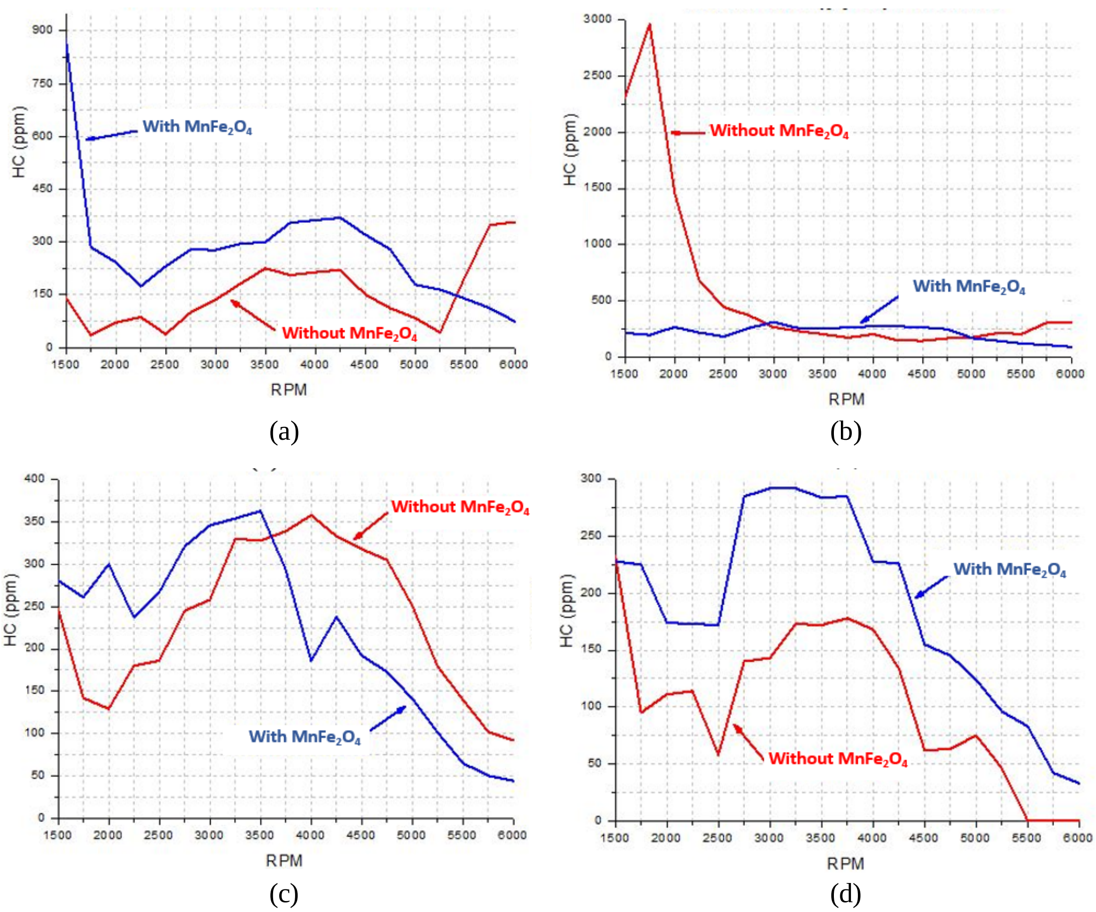


Fig. 4. Comparison graph of HC content without $MnFe_2O_4$ and with $MnFe_2O_4$ per fuel (a) Premium (b) Pertalite (c) Pertamax (d) Pertamax turbo

From the comparison diagram of HC concentration in Figure 4(a), it can be seen on a machine rotation of 1500 RPM to 5250 RPM $MnFe_2O_4$ does not work to lower HC levels, but adds HC levels. While on the engine rotation 5500 RPM to 6000 RPM $MnFe_2O_4$ work lowers HC levels.

From the comparison diagram of HC concentration in Figure 4(b), it can be seen on engine rotation of 1500 RPM to 2750 RPM $MnFe_2O_4$ is working to decrease HC content. While on the engine rotation of 3000 RPM to 4750 RPM $MnFe_2O_4$ does not work lower levels of HC, but multiply the level of HC. Then on the engine rotation 5000 RPM to 6000 RPM, $MnFe_2O_4$ back to work lowered HC levels.

From the comparison diagram of HC concentration in Figure 4(c), it can be seen on engine rotation 1500 RPM to 3500 RPM $MnFe_2O_4$ does not work to lower HC level, but increase HC. While on the engine rotation of 3750 RPM to 6000 RPM $MnFe_2O_4$ back to work lower levels of HC.

From the comparison diagram of HC concentration in Figure 4(d), it can be seen on the engine rotation of 1500 RPM, $MnFe_2O_4$ is working to decrease HC content. While on a machine rotation of 1750 RPM to 6000 RPM, $MnFe_2O_4$ does not work to lower HC levels, but multiplies HC levels.

IV. Discussion

Figure 5(b) shows that the extending of adsorption is the function of x. It shows that the value is directly proportional to the percentage decrease in CO or HC exhaust emissions. Or it could be said if the percentage decrease in CO or HC exhaust emissions higher, the higher the adsorption Ade

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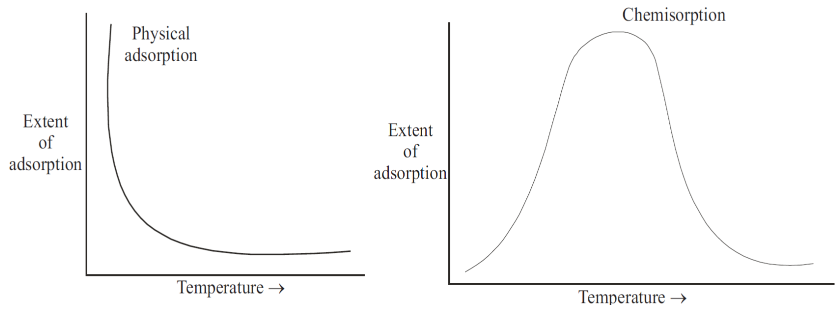
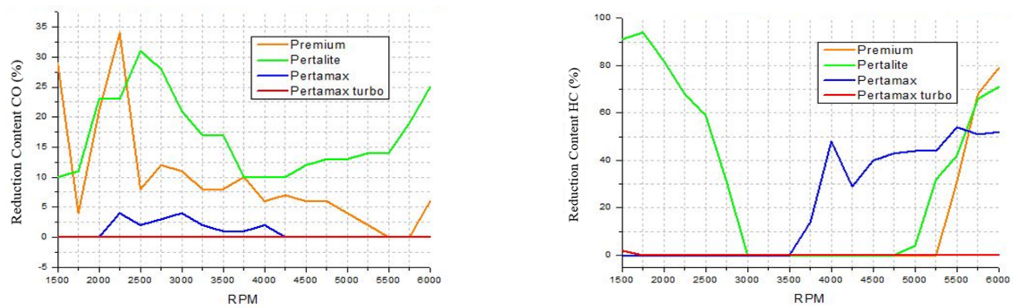


Fig. 5. Effects of temperature on (a) Physical adsorption (b) Chemisorption



(a) (b)

Fig. 6. Percentage of emission reduction per fuel (a) CO (b) HC content

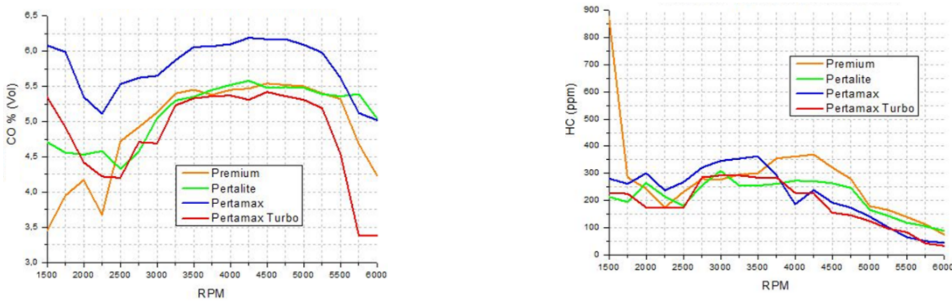
In Figure 5(b) it also shows that the temperature is as a function y. This shows that the value is directly proportional to the rotation of the engine, because if the engine rotation RPM the greater the exhaust temperature is also higher. If the graph in Figure 5(b) is related to the data analysis then we can see the potential of $MnFe_2O_4$ with the graph as follows:

The reaction rate of Figure 5(b) shows that after the adsorption rate of the chemisorption reaction reaches its peak point, then decreases, the adsorption content of the reaction will not rise again. When viewed from Figure 6(a), after the adsorption or percentage decrease in CO levels reaches the peak point, then decreases, the reaction rate on the peralite and premium fuel even increases again in the rotation of more than 5500. This indicates there are other factors that causing the reaction rate not to be the same as Figure 5(b).

When viewed from Figure 6(b) after the adsorption or percentage decrease in HC levels reaches the peak point, then decreases, the reaction rate at the premium fuel even increases again in the 5500 rotation upward, the pertalite in the 4500 rotation upwards and pertamax in the rotation 3500 and above. It shows there are other factors that cause the reaction rate is not the same as the Figure 5(b).

According to [9], factors affecting the gas adsorption rate on the solid surface are the adsorbent properties, the surface area of the adsorbent, the nature of the adsorbed gas, the temperature and the gas pressure. Of these factors, which can be taken parameters according to this research is from the nature of adsorbed gas, and gas pressure because we can connect with the characteristics of fuel and engine performance. Gas pressure is related to how much $MnFe_2O_4$ maximum ability to adsorp the HC and CO emissions emitted from combustion. The amount of exposure to HC and CO emissions depends on the complete combustion process. The more incomplete the combustion process, the more CO and HC levels are out.

To find out how much $MnFe_2O_4$'s maximum ability is required, a comparison of percentage graph decreases CO and HC levels per fuel with graphs of CO and HC levels per fuel. Here is a graph showing the difference in emissions of CO and HC levels per fuel :



(a) (b)

Fig. 7. Emissions levels per fuel (a) CO (b) HC content

From Figure 7(a) it is known that the average CO content is 4.914 (% vol), pertalite is 5,114 (% vol), pertamax is 5,778 (% vol), pertamax turbo is 4,826 (% vol). From Figure 7(a) it is known that the average percentage decrease in premium CO content is 10%, pertalite is 17%, pertamax is 1%, pertamax turbo is 0%. From these data we can conclude that the maximum ability of $MnFe_2O_4$ in lowering CO content is 17% with maximum CO exposure is 5,114 (% vol). Or we can conclude that, if exposure to CO levels above 5.114 (% vol), then the potential of $MnFe_2O_4$ decreases. From Figure 7(b) it is known that the average HC premium level is 279,737 (ppm), pertalite is 214,474 (ppm), pertamax is 221,737 (ppm), pertamax turbo is 186,421 (ppm). From Figure 7(b) it is known that the average percentage decrease in premium HC content is 9%, pertalite is 34%, pertamax is 22%, pertamax turbo is 0%. From these data we can conclude that the maximum ability of $MnFe_2O_4$ in lowering HC levels is 34% with maximum HC exposure is 214,474 (ppm). Or we can conclude that, if exposure to HC levels above 214,474 (ppm), then the potential of $MnFe_2O_4$ decreases.

Next is to prove that engine performance affects the amount of HC and CO each fuel. Parameters to determine the performance of machines that can be taken according to this research is Air Fuel Ratio (AFR), which is taken from the analysis of lamda value. The more the lamda value approaches one, the more perfect the combustion reaction of C_8H_{18} or $C_{10}H_{24}$ combustion by O_2. The more perfect the combustion process, the less CO and HC produced. If the lamda is less than 1, that means the flue gas is rich in fuel content. The more the value is less than 1, CO levels are also higher. If lamda is more than 1, that means the exhaust gas will be fuel. To find the actual AFR using the following comparison formula [10]

$$(\lambda \text{ actual})/(\lambda \text{ theory})=(\text{AFR actual})/(\text{AFR theory})$$

The ups and downs of the resulting HC levels are caused by the amount of fuel supply mixed with clean air. Poor mixtures result in greater HC concentration due to the slow burning process that occurs so that the fuel will come out before the fuel is completely burned. At low engine speed, the combustion chamber temperature is not high, and combustion is not perfect, due to insufficient amount of air to meet the ideal conditions of comparison to complete combustion, resulting in high HC levels. Then the increase of engine spin, the more the temperature of the combustion chamber, and the more complete combustion, with the approaching the ideal mix of fuel and air mixture, resulting in decreasing HC levels [11].

The higher the temperature of the walls of the combustion chamber, the more complete the combustion process with the air conditions used in combustion increasing, thus reaching the ideal conditions of complete combustion. The speed of the engine speed can decrease the HC content due to higher spark plug spark and make perfect combustion [12].

Here is the effect of machine performance on the potential of $MnFe_2O_4$ in reducing CO and HC levels in each fuel.

A. The effect of AFR on the potential of $MnFe_2O_4$ in reducing CO content of each fuel.

To find the value of AFR then equation (1) applied to the research results and obtained graphs as follows:

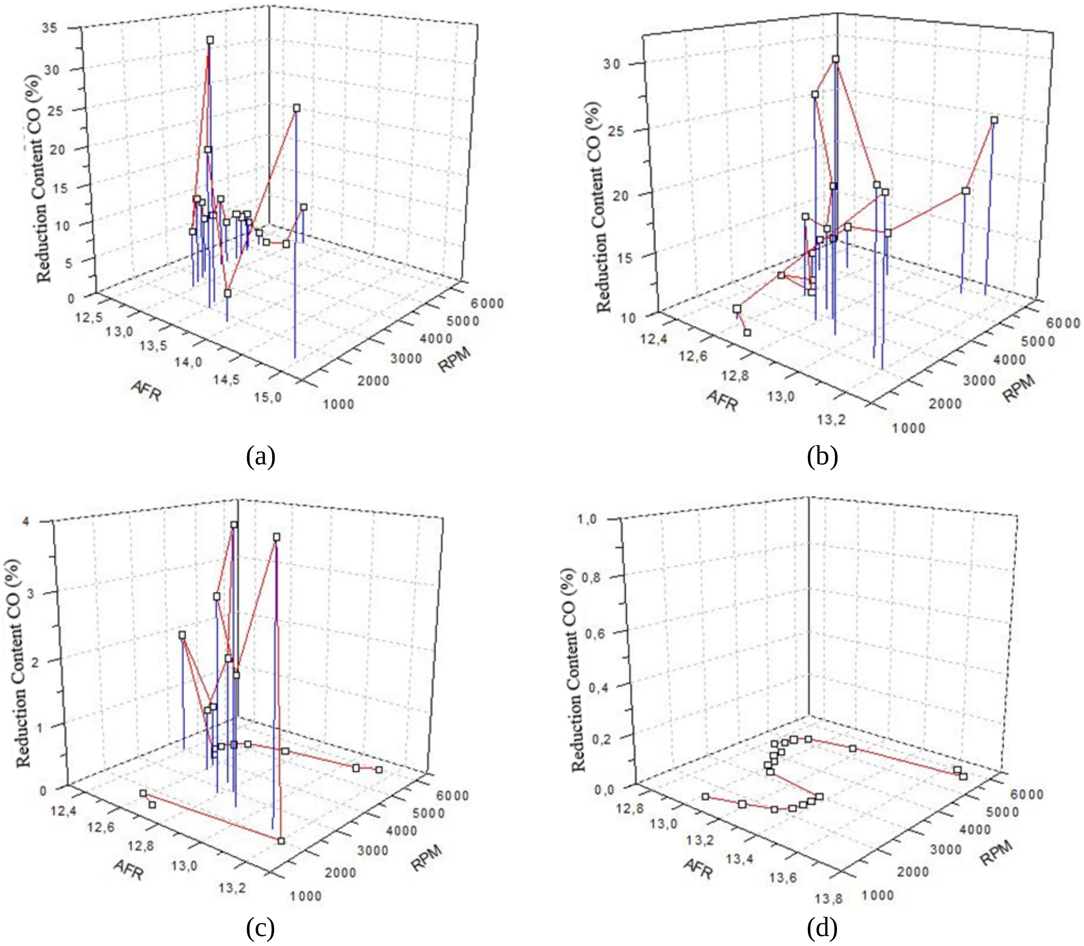


Fig. 8.Effect of AFR on decrease of CO content of each fuel (a) Premium (b) Pertalite (c) Pertamax (d) Pertamax turbo

From Figure 8(a) is known on the engine rotation of 1500 RPM to 5250 RPM $MnFe_2O_4$ potentially lowers CO levels with the highest AFR value of 14.395 and the lowest is 12,598. On a 5500 RPM engine rotation up to 5750 RPM, $MnFe_2O_4$ does not potentially lower CO levels. The AFR NRS which can not lower the CO level of 12,657 to 12,892, is still within AFR value difference which can decrease CO level 12,598 to 14,395. It shows that at an AFR of 12.598 to 14.935, 89% $MnFe_2O_4$ nanoparticles potentially lower CO levels and 11% do not potentially reduce CO levels.

From Figure 8(b) is known on the engine rotation of 1500 RPM to 6000 RPM $MnFe_2O_4$ potentially lowers CO levels with the highest AFR value of 13,259 and the lowest is 12,745. This suggests that in peralite fuel, $MnFe_2O_4$ nanoparticles potentially completely lower CO levels.

Figure 8(c) is known on the engine rotation of 2250 RPM to 4250 RPM $MnFe_2O_4$ potentially lowers CO levels with the highest AFR value of 13.127 and the lowest AFR value is 12.392. While on the engine rotation of 1500 RPM to 2000 RPM, 4500 RPM to 5250 RPM, and 5750 RPM to 6000 RPM, $MnFe_2O_4$ does not have the potential to reduce CO levels with the highest AFR value is 13,201 and the lowest value is 12,48. On a 5500 RPM $MnFe_2O_4$ engine rotation does not potentially reduce CO levels with an AFR value of 12,716. It shows that if the AFR value is less than 12.48 then $MnFe_2O_4$ has the potential to completely lower CO levels. If the AFR value is greater than 13.127 then $MnFe_2O_4$ does not have the potential to completely lower CO levels. If the AFR value is between 12.48 to 13.127 then $MnFe_2O_4$ has the potential of both 53% to decrease CO and 47% does not potentially reduce CO levels.

From Figure 8(d) known on a machine rotation of 1500 RPM to 6000 RPM, $MnFe_2O_4$ does not have the potential to reduce CO levels. This suggests that $MnFe_2O_4$ nanoparticles do not potentially completely lower CO levels with an AFR value between 12.833 to 13.7.

B. The effect of AFR on the potential of $MnFe_2O_4$ in reducing HC content of each fuel.

To Find the value of AFR then equation (1) applied to the research results and obtained graph as follows:

From Figure 9(a) is known on the 5500 RPM engine rotation to 6000 RPM $MnFe_2O_4$ potentially lowers HC content with the highest AFR value is 13,068 and the lowest value is 12,657. While on a machine rotation of 1500 RPM to 5500 RPM, $MnFe_2O_4$ does not have the potential to decrease HC content with the highest AFR value is 14,935 and the lowest AFR value is 12,598. This shows that if the AFR value is greater than 13,068 $MnFe_2O_4$ does not have the potential to completely lower the HC level. If the AFR value is between 12,657 to 13,068 then $MnFe_2O_4$ has the potential to both 20% decrease HC and 80% not potentially lower HC.

From Figure 9(b) known on moderate rotation (4250 RPM), $MnFe_2O_4$ does not potentially reduce HC levels by a very significant difference of 85.6%. With the application without $MnFe_2O_4$ its HC content is 146 ppm, whereas its application with $MnFe_2O_4$ HC level is 271 ppm. On the engine rotation of 1500 RPM to 2750 RPM and 5000 RPM to 6000 RPM $MnFe_2O_4$ potentially lowers HC levels with the highest AFR value of 13.259 and the lowest AFR value is 12.76. While on the engine rotation of 3000 RPM to 4750 RPM, $MnFe_2O_4$ does not have the potential to decrease the HC content with the highest AFR value is 12,98 and the lowest value is 12,745. It shows that if the AFR value is greater than 12.98 then $MnFe_2O_4$ has the potential to completely lower the HC level. if the AFR value is less than 12.76 then $MnFe_2O_4$ does not potentially completely lower the HC content. if the AFR value is between 12.76 to 12.98 then $MnFe_2O_4$ has the potential of both 38% to decrease HC and 62% does not potentially reduce HC levels.

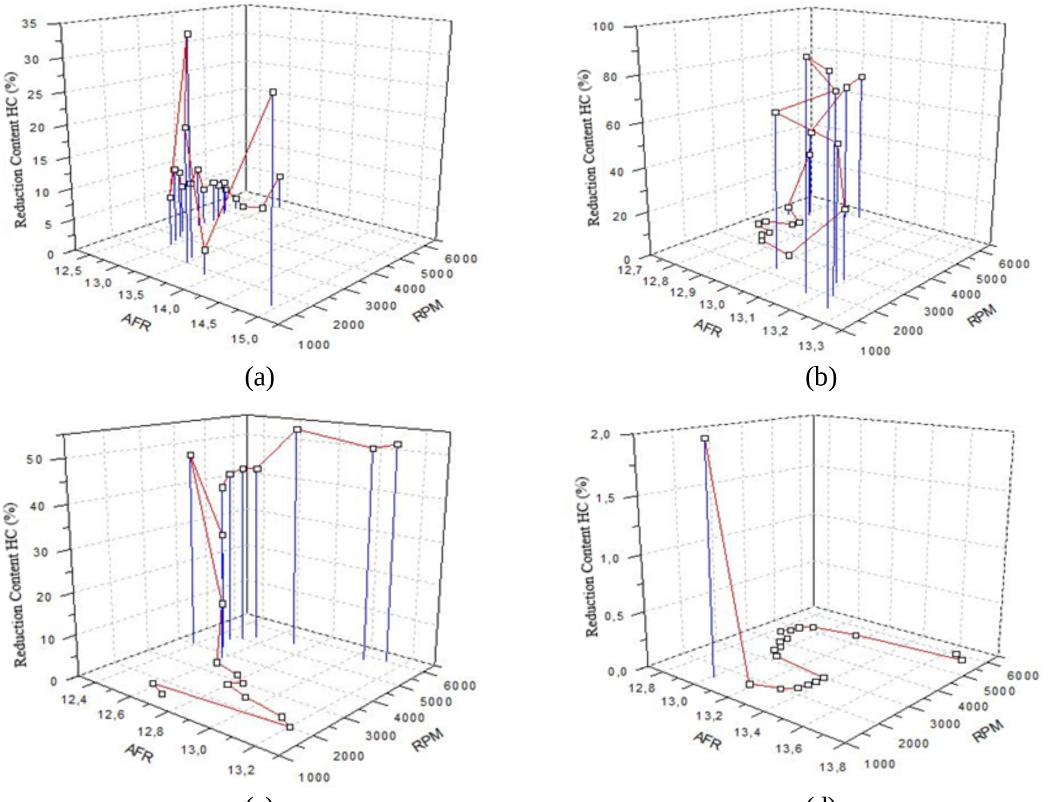


Fig. 9.Effect of AFR on decreasing of HC content of each fuel (a) Premium (b) Pertalite (c) Pertamax (d) Pertamax turbo

From Figure 9(c) known in low rotation (2000 RPM), $MnFe_2O_4$ does not have the potential to decrease HC content by a very significant difference of 132.6%. Under these conditions, the application without MnFe2O4 had a HC concentration of 129 ppm, whereas its application with $MnFe_2O_4$ was 300 ppm. In the engine rotation of 3750 RPM to 6000 RPM $MnFe_2O_4$ potentially lower HC levels with the highest AFR value is 13.127 and the lowest is 12.392. While on the engine rotation of 1500 RPM to 3500 RPM, $MnFe_2O_4$ does not have the potential to decrease the HC content with the highest AFR value is 13,201 and the lowest AFR value is 12,569. This shows that if the AFR value is less than 12.569 $MnFe_2O_4$ has the potential to completely decrease HC content. if the AFR value is greater than 13.127 then $MnFe_2O_4$ does not potentially completely lower the HC level. if the AFR value from 12,569 to 13,127 then $MnFe_2O_4$ has the potential of both 38% to reduce the HC level 62% does not potentially reduce HC levels.

From Figure 9(d) known on machine rotation 1500 RPM $MnFe_2O_4$ potentially decrease HC content with AFR value is 13,01. While the rotation of 1750 RPM to 6000 RPM $MnFe_2O_4$ does not have the potential to decrease the HC content with the highest AFR value is 13,7 and the lowest value is 12,965. AFR value that can decrease HC level is 13,01, still in difference of AFR value which can not decrease HC level that is 12,965 until 13,7. This suggests that 5% $MnFe_2O_4$ nanoparticles potentially decrease HC and 95% have no potential to reduce HC levels by AFR values from 12.833 to 13.7.

V. Conclusion

The application of $MnFe_2O_4$ to reduce CO exhaust emissions in Honda Mega Pro 2013 vehicles is effective on premium fuel (RON 88), in low rotation (1500 to 5250 RPM) and high rotation (6000 RPM) with the highest percentage decrease in CO content of 34.1 % on rotation 2250 RPM. For pertalite fuel (RON 90) is very effective from low rotation to high rotation (1500-6000 RPM) with the highest percentage decrease in CO content that is 31,1% at 2500 RPM rotation. For pertalite fuel (RON 92) is very effective at low rotation (2250-4250 RPM) with the highest percentage reduction of CO content is 3.9% at 3000 RPM rotation. However, for fuel pertamax turbo (RON 98) is not effective in all rotations.

The application of $MnFe_2O_4$ to reduce HC exhaust emissions on Honda Mega Pro 2013 vehicles is effective on premium fuel (RON 88) in high rotation (5500-6000 RPM) with the highest percentage of HC decline of 79.3% in 6000 RPM rotation. For pertalite fuel (RON 90) is effective in high rotation (5000-6000 RPM) with the highest percentage decrease of HC level that is 71,4% at 6000 RPM rotation. For Pertamax fuels (RON 92) is effective at high rotation (3750-6000 RPM) with the highest percentage decrease in HC content of 53.6% at 5500 RPM rotation. For Pertamax turbo fuel (RON 92) is only effective in low rotation (1500 RPM) with a percentage decrease in HC level of only 2.1%.

The high percentage decrease in CO and HC concentration of $MnFe_2O_4$ application was more effectively applied to fuel with low Research Octane Number values, namely premium and pertalite due to the nanoparticle characteristics of $MnFe_2O_4$ particles.

VI. References

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