

12. Use of Copper as a Converter Catalyst on Motorcycle Exhaust to Reduce HC (Hydrocarbon) Gas Emissions

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Submission date: 24-Oct-2022 11:08AM (UTC+0700)

Submission ID: 1933616443

File name: 12.Use_of_Copper_as_a_Converter_Catalyst_on_Motorcycle.pdf (382.68K)

Word count: 2599

Character count: 13075



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Use of Copper as a Converter Catalyst on Motorcycle Exhaust to Reduce HC (Hydrocarbon) Gas Emissions

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Abstract. The increasing number of vehicles especially in Surabaya means resulting in congestion in light traffic and there are a lot of gas such as CO, CO₂, SO_x, NO_x and HC which produced by motorcycles and other vehicles. It has a big impact for the living things health and needs a specific studies. Copper catalyst design is the most effective in reducing HC motor vehicle gas. The purpose of this study is using a copper catalyst design method that is varied with engine speed (rpm) 1000, 3000, 5000, 8000, type of fuel and using the number of skates 1, 3, 5. The best result of HC gas reduction from the design with skat 5 at rpm 8000 with premium used of 41,5 % from 171 ppm to 100 ppm. This best condition (8000 rpm, 5 skates) uses premium with 88 octane number, pertalite type fuel with 90 octane number, then use the pertamax with 92 octane number. The HC gas results are 6 ppm, 72 ppm and 42 ppm.

Keywords: Catalytic Converter, Hidocarbon Gas, Fuel.

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International Journal of Eco-Innovation in Science and Engineering Volume 01 No. 01

Received Date 10th April 2020

Accepted Date 11th May 2020

Published Date 15th May 2020

Online at <https://ijeise.upnjatim.ac.id/>

1. Introduction

Vehicles in the city of Surabaya, especially gasoline-based ones, produce the gas equivalent to 14 g / km and HC of 5.9 g / km which does not meet the quality standards of Minister of Environment Regulation no. 23 of 2012. One of the factors also relates to the type of fuel used, the type of fuel commonly used by people in Indonesia is a premium type fuel with octane 88, pertalite with 90 octane and then pertamax with 92 octanes. To avoid or reduce the concentration of motorized gas emissions requires a material that can potentially reduce the gas [1].

The size of the exhaust emissions of motorized vehicles is not only influenced by maintenance but also the actual condition of the vehicle, such as the age of the engine[2]. The service period is the service frequency within one year. Poor maintenance factors can accelerate wear and tear, block air flow and fuel, resulting in a decrease in engine work efficiency that can result in changes in the ratio of air mass and mass of fuel. As a result, the combustion process is less than perfect and the percentage of pollutants will change. Mileage is the number of kilometers that has been traversed by a motorized vehicle shown on the odometer. Mileage is usually associated with the age of the engine because the age of a machine that has long enough in general has high mileage numbers. This will have an impact on the amount of CO, HC, NO_x and CO₂ emissions produced [2].

This study provides innovation to reduce CO, HC, and NO_x emission gases are using a converter catalyst with a copper plate shaped like a spider's nest. The condition of the vehicle decreases every year due to frequent usage, the age of the vehicle and the lack of maintenance of the vehicle which causes an incomplete combustion process which causes gas emissions from the vehicle to increase CO gases. The parameter is called Air Fuel Ratio (AFR), which is the ratio of the amount of air to fuel in weight. The theoretical comparison value for the perfect combustion process or also called stoichiometric AFR for the otto motor is around 14.7. The fuel system must be able to produce an air ratio of the fuel needed to be cylinder in accordance with the engine operating conditions. For example, at cold start times, a mixture that is rich in fuel is needed.

In internal combustion engines, exhaust gas recirculation (EGR) is a nitrogen oxide (NO_x) emissions reduction technique used in petrol/gasoline and diesel engines. EGR works by re-circulating a portion of an engine's exhaust gas back to the engine cylinders. In a gasoline engine, this inert exhaust displaces the amount of combustible matter in the cylinder. In a diesel engine, the exhaust gas replaces

some of the excess oxygen in the pre-combustion mixture. Because NO_x forms primarily when a mixture of nitrogen and oxygen are subjected to high temperature, the lower combustion chamber temperatures caused by EGR reduces the amount of NO_x the combustion generates.

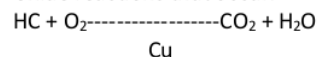
The exhaust gas, added to the fuel, oxygen, and combustion products, increases the specific heat capacity of the cylinder contents, which lowers the adiabatic flame temperature. In a typical automotive spark-ignited (SI) engine, 5 to 15 percentage of the exhaust gas is routed back to the intake as EGR. The maximum quantity is limited by the requirement of the mixture to sustain a contiguous flame front during the combustion event; excessive EGR in poorly set up applications can cause misfires and partial burns.

PCV is a way to control exhaust gases by means of an engine system that emits gas vapor from the engine room and flows this steam back to the cylinder for the combustion process. The most important part of this PCV system is the PCV valve. The function of the PCV valve is to control the amount of steam and gas entering the engine room into the intake manifold [3]. A catalyst is a substance that has a function to accelerate the reaction rate or accelerate the occurrence of a reaction [4]. But the catalyst does not undergo chemical changes permanently. The catalyst substance can be recovered at the end. Catalysts or catalysts are substances that are added to a reaction in order to increase the rate of the reaction. Catalysts sometimes get involved in reactions but do not experience permanent chemical changes. In other words, at the end of the reaction, the catalyst will be found again in the same form and amount as before the reaction. Catalysts can work by forming intermediate compounds or absorbing reacted substances. The function of the catalyst is to reduce activation energy. However, the catalyst does not change the energy between the product and its reactants. The catalyst added to a reaction decreases the reactant's reaction energy. The function of the catalyst is to increase the reaction rate (accelerate the reaction) by reducing the energy of activating a reaction and forming new reaction stages. With decreasing activation energy, at the same temperature, the reaction can take place faster.

Catalysts are substances that can increase the rate of reaction without experiencing permanent chemical changes. Catalysts can work to form intermediate compounds or adsorb the reacted substance. Catalysts are not only used in industrial needs, catalysts are also used in the automotive field to oxidize vehicle exhaust emissions. Oxidation is a

reaction of oxygen binding by a substance, the source of oxygen in an oxidation reaction is called an oxidizer. The most widely used oxidizer is air. The catalyst is used in the exhaust channel [5]. The monolithic converter uses ceramic material made in a honeycomb pattern to control the exhaust gas that comes out. These catalytic elements made of ceramics are coated or wrapped in stent iron [3]. This type of converter usually only can operate with hydrocarbons and carbon monoxide. Oxidation converter elements are usually encased in platinum [4]. Oxidation converts hydrocarbon and carbon monoxide compounds into water vapor and carbon dioxide by directing the vehicle's pollutant gas containing oxygen through the catalyst. This type of catalyst is almost similar to an oxidation converter, petrified catalyst reduction converter eliminates gas emissions of hydrocarbons and carbon monoxide and NOx. NOx emission gas is produced from combustion that occurs in the engine reaches a high temperature of more than 2500° F. Reduction is a chemical process where oxygen is taken from a compound, this process is the opposite of the oxidation process. NOx will be N2 because oxygen is present at NOx and there is a reduction process [4]. The double converter catalyst is a combination of an oxidation type converter and a reduction type converter in one container. Both types of converters are interconnected and oxidation and reduction reactions occur to reduce gas emissions from incomplete combustion [3].

Oxide reactions that occur:



2. Material and Method

The research method arranges in a sequence of steps as follows literature study, research preparation, sampling, data collection, analysis of the discussion, and conclusions.

2.1. Variables

Free variable :

- Engine rotation speed (rpm) : 1000, 3000, 5000, dan 8000.
- Number of skates used: 1,3, dan 5.
- Kinds of fuel: Premium, Peralite, Pertamina.

Fixed variable:

- Length of the exhaust 30 cm.
- Copper converter catalyst in the form of a spider's nest.
- Exhaust diameter 10 cm.
- Motorcycle Honda Supra X in 2000 with a 100 cc engine capacity.

2.2. Design of catalytic Converter

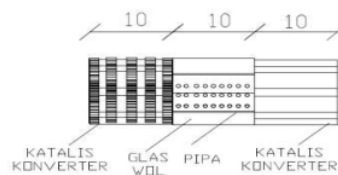


Fig. 1. Catalytic Converter arrangement

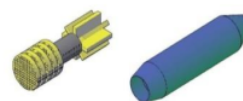


Fig. 2. Converter and Exhaust

3. Results and Discussion

3.1. Preparation

The study is began by analyzing gas emission samples from vehicles with 2000 manufacturing years which had a capacity of 100 cc of premium fuel with 88 octane. The parameters analyzed were the parameters listed in the quality standard of the Republic of Indonesia Minister of Environment Regulation number 5 year 2006.

3.2. The Effect of Profit-Type Copper Plate-Type Copper as Catalyst Converter and Engine Turn in Reducing HC Emission Gas by Using Premium Fuels

Table 1. Effect of Rpm Variation and Amount of skates on Reduction of Gas HC Concentration

skates	Gas Concentration of HC (ppm)			
	Rpm			
	1000	3000	5000	8000
0	185	180	174	171
1	171	165	155	141
3	161	150	126	113
5	122	119	100	100

The research results from testing pure copper reactors placed in the exhaust tube (exhaust) to reduce hydrocarbon emission gas (HC) by using standard exhaust control (exhaust) from the factory using a gas analyzer. The results of the gas emission allowance in the form of hydrocarbons (HC) can be

seen in table 4.1 with the effect of engine speed and the number of skates heads on the reactor.

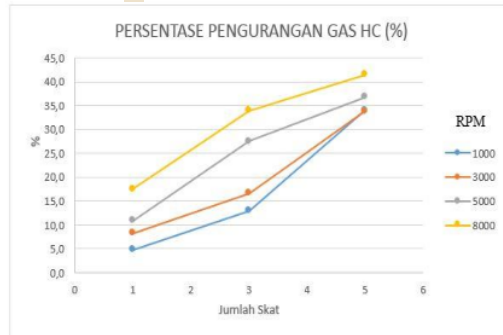


Fig. 3. Graph of the Relationship Between the Amount of skates and HC Gas Reduction Percentage in Each Variation of Rpm Using Premium Fuel.

In graph 4.1 can be seen the effect of engine rotation speed with the exposure time to HC gas removal (ppm) at 1000 rpm speed by using a skates which numbered 1 in getting a yield of 4.9% the value continues to decrease in increasing 3000-speed engine rotation speed. at the speed of the engine with a speed of 5000 and a speed of 8000 a significant decrease of 41.5% in the fifth screen due to the addition of temperature created by the rotation speed and supported by the number and area of contact area of the catalyst which causes a decrease in HC gas emissions direct contact with the catalyst and a chemical process that is a reduction in which hydrocarbon gas (HC) which will be damaged by hot copper atoms and the carbon gas emission into hydrogen and carbon gas then oxidation process wherein the hydrogen emission gas and carbon combine with oxygen (O₂) which is in the affixing tube gas (exhaust) becomes water vapor (H₂O) and carbon dioxide (CO₂) which results in a decrease in hydrocarbon emission gas. Besides the comparison of AFR (Air Fuel Ratio) the ratio of mixing fuel and oxygen affects the results of exhaust emissions. Because the combustion process is faster, engine temperature and engine conditions have the role of producing HC gas [6].

Hydrocarbon gas from the results of this study has been below the standard quality threshold set by the Ministry of Environment Republic of Indonesia Regulation No. 5 of 2006. It is known that hydrocarbon gas occurs due to incomplete combustion and fuel evaporation. Hydrocarbon gas compounds are raw gas and fuel which is broken down because the heat reaction turns into another HC group that comes out with the exhaust gas [7].

3.3. Effect of Fuel Type on HC Emission Reduction at Rpm 8000 ,5 skates

Table 2. Effect of Copper-Shaped Profit Nests - Profit on Fuel to reduce hydrocarbon gas

BBM	Premium	Pertalite	Pertamax
Parameter			
HC(ppm)	6	72	42

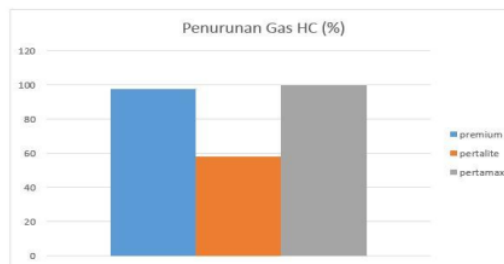


Fig. 4. Graph of the Relationship Between Types of Fuel and the Percentage of HC Gas Reduction in 8000 Rpm Engine Rounds and Total 5 Catalyst Converters.

From the results of the study, it was found that the efficiency of the spider-shaped converter catalyst made of copper to premium type gasoline which had an RON of 88 could be known that hydrocarbon gas produced a decrease of 97.6% and then used pertalite fuel which had RON of 90 known gases hydrocarbons increase by 40% because it is known that evaporation of fuel that is less complete and uses the material of the news type pertamax which has a RON of 92 can be known that the hydrocarbon gas is reduced by 42%. Factors affecting hydrocarbon gas are from additives in the fuel itself and can be reviewed also from the condition of the engine and the AFR (Air Fuel Ratio) ratio of mixing fuel and oxygen affects the results of exhaust emissions. Because the combustion process is faster, engine temperature and engine conditions have the role of producing HC gas [6].

4. Conclusions

1. The most efficient design in reducing HC gas is to use 5 skates at the engine rotation speed of 8000 rpm of motorized vehicles with premium fuel types.
2. The results of the reduction of gas HC from the design of copper catalyst with rpm 8000 for HC (ppm) 100, because of the higher rpm, the temperature in the storage of exhaust gas

(exhaust) increases, thus help the gas reduction process in the exhaust chamber (exhaust) which the catalyst efficiency works well.

3. It can be seen that the fuel type pertamax produces the best HC gas of 42 (ppm).

References

- [1] Gunawan H., dan Budi S.G. 2017. *Kajian Emisi Kendaraan di Persimpangan Surabaya Tengah dan Timur serta Potensi Pengaruh terhadap Kesehatan Lingkungan Setempat*. Jurnal Wilayah dan Lingkungan, Program Studi Teknik Sipil, Fakultas Teknik Sipil dan Perencanaan, Universitas Kristen Petra. Surabaya. Vol. 5, No.2, hal. 113 – 124.
- [2] Wanudyajati R. Sudarsono. Istirokathun T. 2013. *“Analisis Pengaruh Jarak Tempuh, Periode Servis Dan Umur Mesin Terhadap Konsentrasi CO, HC, NOx Dan CO₂ Pada Kendaraan Niaga (Studi Kasus : Motor Tossa)”* Jurnal Teknik, Universitas Diponegoro, Semarang.
- [3] Amin M. C., Rathod P. P, dan Goswani J. J. 2014 *“Copper based Catalytic Converter”* Engineering Research and Technology (IJERT). Vol. 1, No. 2, Hal 1-6.
- [4] Aryanto A., danRazif M. 2000. *“Study Penggunaan Tembaga (Cu) Sebagai Catalytic Converter Pada Knalpot Sepeda Motor Dua Tak Terhadap Gas Emisi Co”*. Jurnal Purifikasi, Jurusan Teknik Lingkungan, Fakultas Teknik Sipil dan Perencanaan, Institut Sepuluh November. Surabaya. Vol. 3, No. 3, Hal. 169-174.
- [5] Budiarto E. S. 2016. *“Analisis Penggunaan Katalis Tembaga Pada Knalpot Terhadap Emisi Gas Buang Sepeda Motor Honda Gl-Pro”*. Skripsi, Jurusan Teknik Mesin, Fakultas Teknik, Universitas Negeri Semarang. Semarang.
- [6] Fauzi M. 2012. *“Modifikasi Knalpot Dalam Upaya Penurunan Gas Karbon Monoksida Dalam Kendaraan Bermotor”*. Skripsi, Progdil Teknik Lingkungan, Fakultas Teknik Sipil dan Perencanaan Universitas Pembangunan Nasional “Veteran” Jawa Timur.
- [7] Ningrat K. W. A. A., Kusuma W. B. G. I., dan Adnyana B. W. I. 2016. *“Pengaruh Penggunaan Bahan Bakar Pertalite Terhadap Akselerasi Dan Emisi Gas Buang Pada Sepeda Motor Bertransmisi Otomatis”*. Jurnal Mekktek. Jurusan Teknik Mesin, Universitas Udayana. Bali. Vol. 2, No. 1, Hal 59 – 67.

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