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Use of Copper as A Converter Catalyst on Motorcycle Exhaust to Reduce Hydrocarbon (Hc) Emissions

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ABSTRACT

The number of vehicles especially in Surabaya, the increasing number of transportation means resulting in congestion in light traffic and a lot of gas CO, CO2, SOx, NOx and HC produced in wheeled motorcycles. Has a very real influence on the health of living things, so special studies are needed. Copper catalyst design is the most effective in reducing HC motor vehicle gas. The purpose of this study is to use a copper catalyst design method that is varied with engine speed (rpm) 1000, 3000, 5000, 8000, type of fuel, and uses the number of skates 1, 3, 5. The result From the best condition at 8000rpm and 5 skates result of HC gas reduction from premium fuel and the design with skat 5 and at rpm 8000 octane values 88 can reduce HC (96,7%), then the use of pertalite type fuel with 90 octane values, using 5 skat catalyst converters and engine speed at 8000 rpm the HC gas results are (40%), use the first petrol pertamax with 92 octane values, use 5 skates and engine speed at 8000 rpm get HC gas results of (42%).

Keywords: Catalytic coverter, hidrocarbon, fuel

Introduction

Vehicles in the city of Surabaya, especially gasoline-based ones, produce 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 of fuel with octane 88, pertalite with octane 90, and then pertamax with 92 octanes. Avoiding or reducing the concentration of motorized gas emissions requires a material that can potentially reduce the gas (Gunawan & Budi, 2017).

According to Wanudyajati et al. (2013), 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. The service period is the service frequency within one year. Poor maintenance factors can accelerate wear and tear, and block airflow 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 have been traversed by a motorized vehicle shown on the odometer. Mileage is usually associated with the age of the engine because in general, the age of a machine that has long enough has high mileage numbers. This will have an impact on the amount of CO, HC, NOx, and CO2 emissions produced (Wanudyajati, 2013).

This study provides innovation to reduce CO, HC, and NOx emission gases 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

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which causes an incomplete combustion process that causes gas emissions from the vehicle to increase CO gases.

Vehicle emission control

Air Fuel Ratio (AFR)

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 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 a cylinder by the engine operating conditions. For example, at cold start times, a mixture that is rich in fuel is needed. In the condition that the engine is still cold automatically the fuel that evaporates is only partially so that additional fuel is needed to obtain the mixture that is ready to be burned in the cylinder.

Exhaust Gas Recirculation (EGR)

In internal combustion engines, exhaust gas recirculation (EGR) is a nitrogen oxide (NOx) 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 NOx forms primarily when a mixture of nitrogen and oxygen is subjected to high temperature, the lower combustion chamber temperatures caused by EGR reduces the amount of NOx 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 percent 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.

Positive Crankcase Ventilation (PCV)

PCV is one way to control exhaust gases using 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 (Amin et al., 2012).

Catalytic

According to Aryanto and Razif (2000), a catalyst is a substance that has a function to accelerate the reaction rate or accelerate the occurrence of a reaction. However, the catalyst does not undergo chemical changes permanently. So that the catalyst substance can be recovered at the end. Catalysts or catalysts are substances that are added to a reaction 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.

Catalytic converter

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 (Budiarto, 2016).

Kinds of catalytic converter

Monolithic converter

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 stenical iron (Amin et al, 2012).

Oxidation type

According to Aryanto and Razif (2000), this type of converter usually can only operate with hydrocarbons and carbon monoxide. Oxidation converter elements are usually encased in platinum. 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.

Reduction type

This type of catalyst is almost similar to an oxidation converter, a petrified catalyst reduction converter eliminates gas emissions of hydrocarbons and carbon monoxide and NOx. NOx emission gas produced from combustion that occurs in the engine reaches a high temperature of more than 2500o F. Reduction is a chemical process where oxygen is taken from a compound, this process is the opposite of the oxidation process. Just as NOx will be N2 because oxygen is present at NOx there is a reduction process (Aryanto & Razif, 2000).

Dual bed converter

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 (Amin et al, 2012).
Oxide reactions that occur:

$2CO + O_2 \xrightarrow{CU} 2CO_2$ -----> Oxidation reaction (2.1)

(Amin et al, 2012)

Material and Methods

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

Variable

Free variable:

a. Engine rotation speed (rpm): 1000, 3000, 5000, dan 8000.
b. Number of skates used: 1,3, dan 5.
c. Kinds of fuel: Premium, Pertalite, Pertamax.

Fixed variable:

a. Length of the exhaust 30 cm.
b. Copper converter catalyst in the form of a spider's nest.

c. Exhaust diameter 10 cm.
d. Motorcycle Honda Supra X in 2000 with a 100 cc engine capacity.

Design of the catalyst converter as follows:

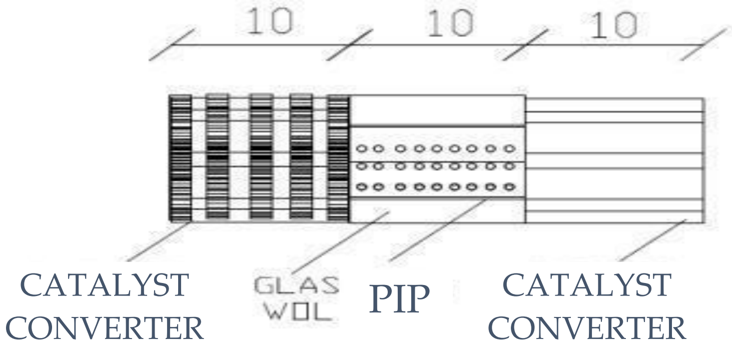

Figure 1. Arrangement of catalyst converter

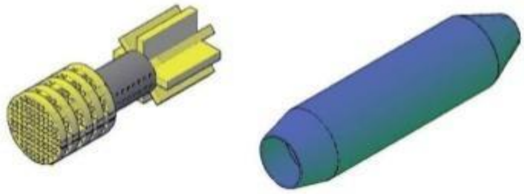

Figure 2. Catalyst converter and exhaust

Results and Discussion

Preparation

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

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 3 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
	Gas Concentration of HC (ppm)			
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 skatesheads on the reactor.

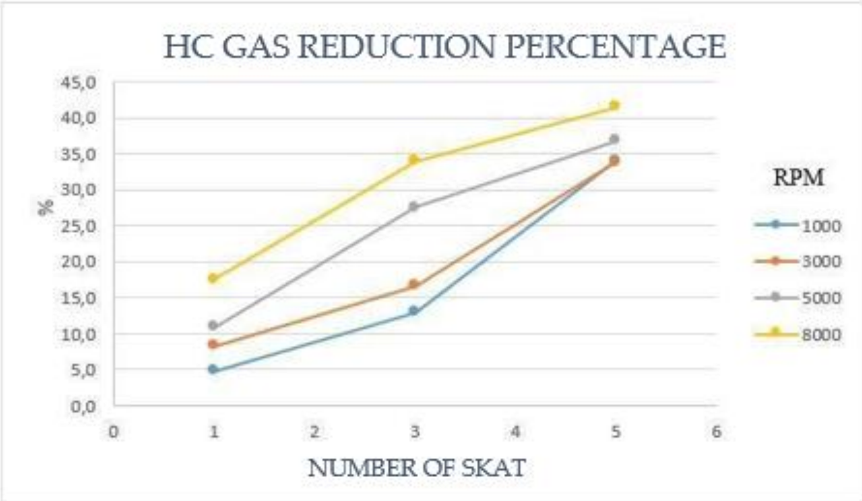

Figure. 3 Graph of the relationship between the number of skates and HC gas reduction percentage in each variation of RPM using premium fuel

In figure 4 shows the effect of engine rotation speed with the exposure time to HC gas removal (ppm) at 1000 rpm speed by using 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 the 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 (O_2) which is in the affixing tube gan gas (exhaust) becomes water vapor (H_2O) and carbon dioxide (CO_2) 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 (Fauzi, 2012). 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 divided into two, the first is raw gas and fuel which is broken down because the heat reaction turns into another HC group that comes out with the exhaust gas (Ningrat et al., 2016).

Effect of fuel type on HC emission reduction at Rpm 8000

Table 2. Effect of Copper-Shaped Profit Nests - Profit on Fuel to Reduce Hydrocarbon Gas.

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

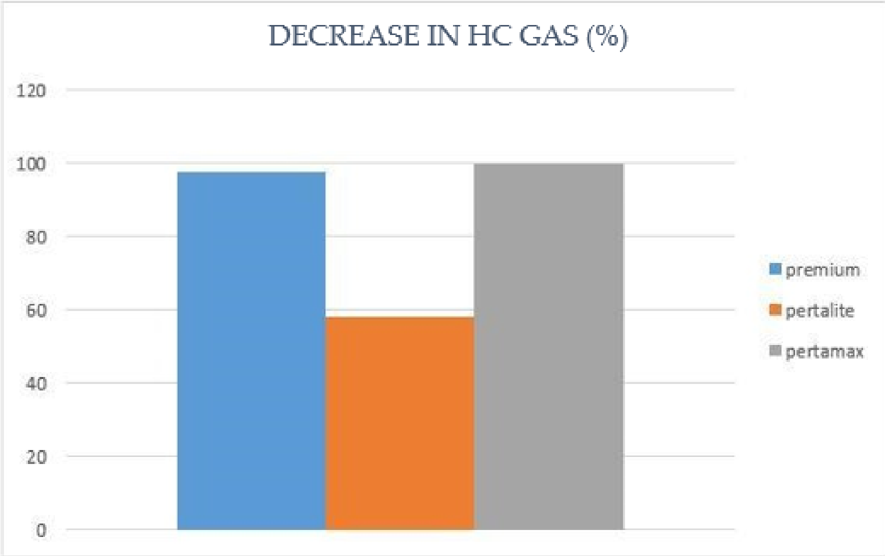

Figure 4. Graph of the Relationship Between Types of Fuel and the Percentage of HC Gas Reduction in 8000 Rpm Engine Rounds and Total 5 Catalyst Converters

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 a 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 hydro carbon 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 (Fauzi, 2012).

Conclusion

1. In this study the most efficient design in reducing HC gas is to use 5 skates and at the engine rotation speed of 8000 rpm of motorized vehicles with premium fuel types.
2. In this study the results of the reduction of gas HC from the design of copper catalyst with rpm 8000 for HC (ppm) 100, because the higher the rpm, the temperature in the storage of exhaust gas (exhaust) increases, thus helping the gas reduction process in the exhaust chamber (exhaust) the better the catalyst efficiency works.
3. In this study it can be seen that the fuel type pertamax produces the best HC gas of 42 (ppm).

Suggestion

1. In the research of catalyst design using 5 bulkheads capable of reducing gas it is suggested that further research can examine other exhaust emissions such as CO_2 and NO_2.
2. It is recommended that further research add a sound level meter (dB) to the research variable.
3. It is recommended that further research examine the age/saturation point of the catalyst.
4. It is recommended that further research uses a larger compression and cc motor so that the HC gas content is known.
5. It is recommended to use a good standard of motor compression.

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