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Optimum Design of Manganese-Coated Copper Catalytic Converter to Reduce Carbon Monoxide Emissions on Gasoline Motor

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Abstract

One of the engineering technologies that can be used to reduce air pollution is the use of catalytic converter mounted on vehicle gas exhaust duct. Unfortunately, these tools are very expensive in the market and not all motor vehicles use these technologis, because the catalyst was made from exoensive metals and rarely available in the market, such as: Palladium, Platinum and Rhodium. Besides, the catalyst is susceptible to premium fuel with low levels of lead (Pb) which results in the damage of the function of the catalyst due to blockage in the honeycomb Catalytic Converter. Therefore research needs to be done in the laboratory to test the other substrate materials as a catalyst, to study the ability of the catalyst in a catalytic converter to reduce exhaust emissions of Carbon Monoxide. This research will also study the performance capabilities and assess the effectiveness of Manganese-coated Copper catalysts which are designed in such a way to obtain the appropriate shape and type of Catalytic Converter catalyst and suitable for premium fuel motor vehicles. The result showed that (1) Catalytic Converter design and modification of catalytic materials can be an alternative to overcome the high air pollution problem from the transportation sector, esspecially particular Carbon Monoxide exhaust emissions from gasoline motors. (2) The use of Manganese-Coated Copper as a catalyst in the catalytic converter was significantly able to increase the reduction of Carbon Monoxide exhaust emissions. (3) The increase of catalyst cells amount decreased the concentration of Carbon Monoxide exhaust emissions. (4) Optimum Design of Model 2 Catalytic Converter was able to reduce exhaust emissions of Carbon Monoxide.

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Keywords: catalytic converter, copper catalyst, manganese, exhaust emissions, carbon monoxide

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1. Introduction

The use of catalytic converter to reduce emission from vehicle exhaust has been recently. Mostly the cataytic converter used for motor vehicles (on the market) is in a type of pellet and monolithic catalysts and the materials made from nobel metals, such as palladium (Pd), Platinum (Pt) and Rhodium (Rh) [1]. Those metals have a high specific activity, a large degree of volatility, easily oxidized and easily broken at temperature of 500-900 ^{o}C, which result in reducing activity of the catalyst. Besides these metals have a low availability and quite expensive [2]

The installation of the catalytic converter on exhaust channel with catalysts of Pd, Pt and Rh with alumina, silica and ceramic buffer, are quite expensive in facrication, difficult to find and less suitable used in Indonesia, because most of fuel still contains high Pb. However, this type of catalytic converter can convert exhaust emissions (CO, HC and NOx) with quite high conversion (80-90 %) [3]. These information lead us to search new alternative for new materials and lower price. For this alternative, the transition metal oxides are the promising options to oxidize CO emission such as CuO, NiO and Cr_2O_3. The materials known as oxidation catalyst are Platinum, Plutonium, Nickel, Manganese, Chromium and other metals oxides forms, while some metals are known as a reduction catalyst, i.e. iron, copper, nickel alloys and these materials oxides [4]. Besides, some metals known to be effective as an oxidized and reduction catalyst materials, ranging from large to small are Pt, Pd, Ru > Mn, Cu >> Ni > Fe > Cr > Zn and oxides of these metals [5]. Thoese types of catalytic converter can reduce exhaust emissions (CO, HC, NOx) between 16 % to 80 % [6]. The other alternatives are modification of the exhaust duct in motor vehicle[7]. Therefore, how is the ability of an catalytic converter to reduce exhaust emissions need to be conducted.

This study aims to design or to create a tool to reduce exhaust emissions of motor vehicles often called as catalytic converter in variation of Manganese-Coated Copper Catalyst. This tool is particularly to reduce exhaust emissions of carbon monoxide and to find optimum design.

2. Methodology

This research is based on the ideas and stages that are systematically arranged. The initial phase of the research is conducted by library research to deepen the fobject to be researched, both the problems of air pollution and emission control technologies, especially in the design of Catalytic Converter. This library research on the previous research is used as the basis in comparing the results of the research with the previous research, so the originality of the research is maintained and there is no duplication of the research.

2.1. Research Material

The research material consists of two main parts: the inside and outside construction of Catalytic Converter. The inside construction consists of a substrate and washcoat material made of copper metal as the catalyst, whereas the outer form of the catalyst (Chasing) is made of Stainless Steel and support / sustainer. [8]

The inside substrate material is made of Manganese-Coated Copper with the size of 160 mm x 100 mm in oval shaped adjusted with the shape of chasing and half of the area is given 2 mm holes with 3 mm space between holes.

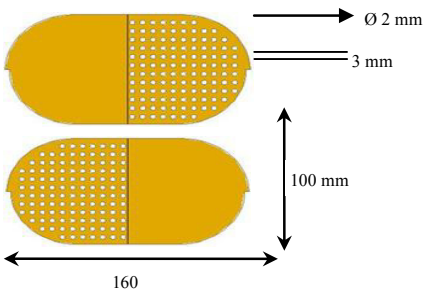

Fig. 1. Catalyst Dimension