

Design and Fabrication of Two-Wheeler Silencer Using Catalytic Converter

M. Ganesh*, A. Sriramavind, P. K. Saran Kumar

Department of Mechanical Engineering, IFET College of Engineering, Villupuram, Tamil Nadu, India

ABSTRACT

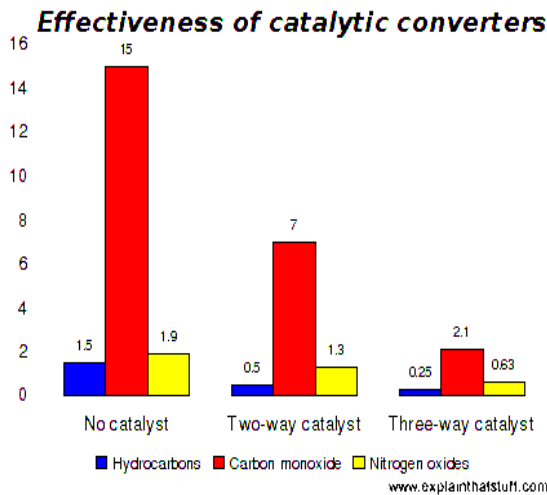
Air pollution is the biggest cause of environmental degradation in the world and it also cause health problems. The major source for these pollutions are industries & automobiles. In automobile pollutants can be reduced by using a catalytic converter the main aim of our project is fabricate the low cost catalytic converter for two wheeler. The emission contents namely NO_x and HC are 90% reduced. From the public health point of view the is most important is Air pollution , because every individual person breathes approximately 22000 times a day, inhaling about 15 to 22 Kg of air daily. Polluted air causes physical ill effects and undesirable aesthetic and physiological effects. The main pollutants are contributed by automobiles which include carbon monoxide (CO), unburned hydrocarbon (UBHC), oxides of nitrogen (NO_x) and Lead. So it is imperative that serious attempts should be made to conserve earth's environment from degradation

Keywords : Four Stroke Engine ,Oxides Of Nitrogen, Carbon Monoxide, Hydro Carbon, Silencer, Filter

I. INTRODUCTION

A catalytic converter is an exhaust emission control device that converts toxic gases and pollutants in exhaust gas from an internal combustion engine into less-toxic pollutants by catalysing a redox reaction (an oxidation and a reduction reaction). Catalytic converters are usually used with internal combustion engines fuelled by either gasoline or diesel—including lean-burn engines as well as kerosene heaters and stoves. The first widespread introduction of catalytic converters was in the United States automobile market. To comply with the U.S. Environmental Protection Agency's stricter regulation of exhaust emissions, most gasoline-powered vehicles starting with the 1975 year model must be equipped with catalytic converters. These "two-way" converters combine oxygen with carbon monoxide (CO) and unburned hydrocarbons (HC) to produce carbon dioxide (CO₂) and water (H₂O). In 1981, two-way catalytic converters were rendered

obsolete by "three-way" converters that also reduce oxides of nitrogen (NO_x) however, two-way converters are still used for lean-burn engines. This is because three-way-converters require either rich or stoichiometric combustion to successfully reduce NO_x. Although catalytic converters are most commonly applied to exhaust systems in automobiles , they are also used on electrical generators, forklifts, mining equipment, trucks, buses, locomotives, and motorcycles. They are also used on some wood stoves to control emissions. This is usually in response to government regulation, either through direct environmental regulation or through health and safety regulations.



II. OBJECTIVES

A huge amount of research and development activity has been devoted to control the pollution from these vehicles in recent years. In particular new and better technique for pollution control are emerging different pre-filter with three-way catalytic converter applied to a two wheeler. In the presented work, with the use of thin wall non glaze porous ceramic filter, copper porous mesh filter and aluminum porous mesh filter as carbon absorbing devices. It provides more time for oxidation of exhaust gases & is important for reducing harmful effect of leaded fuel with increase efficiency and life of catalytic converter in four stroke two wheeler that are designed to meet the special requirement of India and other developing countries.

III. CONSTRUCTION

The catalytic converter consists of following components:

a) The Core or Substrate:

The core is often a ceramic honeycomb in modern catalytic converters, but stainless steel foil honeycombs are used, too. The honey-comb surface increases the amount of surface area available to support the catalyst, and therefore is often called a "catalyst support".

b) The Wash coat:

A wash coat is used to make converters more efficient, often as a mixture of silica and alumina. The wash coat, when added to the core, forms a rough, irregular surface, which has a far greater surface area than the flat core surfaces do, which then gives the converter core a larger surface area, and therefore more places for active precious metal sites. The catalyst is added to the washcoat (in suspension) before being applied to the core.

c) The Catalyst

The catalyst itself is most often a precious metal. Platinum is the most active catalyst and is widely used. It is not suitable for all applications, because of unwanted additional reactions and cost. Palladium and rhodium are two other precious metals used. Platinum and rhodium are used as a reduction catalyst, while platinum and palladium are used as an oxidization catalyst.

IV. 4.TYPES

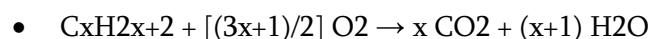
a. Two way catalytic converter:

A 2-way (or "oxidation", sometimes called an "oxi-cat") catalytic converter has two simultaneous tasks:

1.Oxidation of carbon monoxide to carbon dioxide:

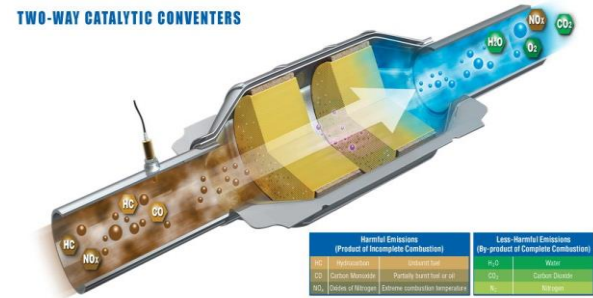


2.Oxidation of hydrocarbons (unburnt and partially burned fuel) to carbon dioxide and water:



This type of catalytic converter is widely used on diesel engines to reduce hydrocarbon and carbon monoxide emissions. They were also used on gasoline engines. Because of their inability to control oxides of nitrogen, they were superseded by three-way

converters.



b. Three way catalytic converter :

Three-way catalytic converters (TWC) have the additional advantage of controlling the emission of nitric oxide (NO) and nitrogen dioxide (NO₂) (both together abbreviated with NO_x and not to be confused with nitrous oxide (N₂O)), which are precursors to acid rain and smog. Since 1981, "three-way" (oxidation-reduction) catalytic converters have been used in vehicle emission control systems most of the countries have also adopted stringent vehicle emission regulations that in effect require three-way converters on gasoline-powered vehicles. The reduction and oxidation catalysts are typically contained in a common housing; however, in some instances, they may be housed separately. A three-way catalytic converter has three simultaneous tasks:

Reduction of nitrogen oxides to nitrogen (N₂)

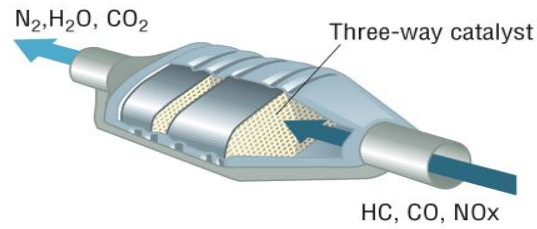
- $2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$
- $\text{hydrocarbon} + \text{NO} \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{N}_2$
- $2\text{H}_2 + 2\text{NO} \rightarrow 2\text{H}_2\text{O} + \text{N}_2$

Oxidation of carbon monoxide to carbon dioxide

- $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$

Oxidation of unburnt hydrocarbons (HC) to carbon dioxide and water, in addition to the above NO reaction

- $\text{hydrocarbon} + \text{O}_2 \rightarrow \text{H}_2\text{O} + \text{CO}_2$



V. ENVIRONMENTAL IMPACT

Catalytic converters have proven to be reliable and effective in reducing noxious tailpipe emissions. However, they also have some shortcomings in use, and also adverse environmental impacts in production. An engine equipped with a three-way catalyst must run at the stoichiometric point, which means more fuel is consumed than in a lean-burn engine. This means approximately 10% more CO₂ emissions from the vehicle. Catalytic converter production requires palladium or platinum; part of the world supply of these precious metals is produced near Norilsk, Russia, where the industry (among others) has caused Norilsk to be added to Time magazine's list of most-polluted places. Pieces of catalytic converters, and the extreme heat of the converters themselves, can cause wildfires, especially in dry areas.

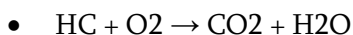
VI. LITRATURE SURVEY

A number of studies during the 60s reported evidence that seventy-five percent of carbon monoxide come from automobile. In all studies different techniques are used to control harmful pollution from vehicles. As per the all previous research and review papers, majority of them focused use of nano particle as catalyst, improved & latest design of nanosized catalytic converter, studies on ROL profile in catalytic converter and also modification and optimization of catalytic converter. In present studies, with the use of different pre-filter (poisoning control device) for catalytic converter in four stroke two wheeler. Some leaded fuel reduce the oxidation process by catalytic converter and so decreased the efficiency of it. Also to increase the retention period of exhaust gas in catalytic converter providing more time for its

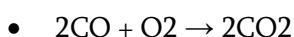
oxidation and to reduce poisoning effect of lead fuel on catalytic converter. The proposed method is very effective in the prevention of environmental pollution contributed from two wheelers.

VII. MECHANISM THROUGH THE CATALYTIC CONVERTER

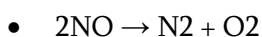
Catalytic converter is a device which is incorporated into the exhaust system of an automobile that reduces the amount of pollutants in the automobile's exhaust gases. A catalytic converter consists of an insulated chamber containing a porous bed, or substrate, coated with catalytic material through which hot exhaust gas must pass before being discharged into the air. The catalyst is one of a variety of metal oxides, usually platinum or palladium, which are heated by exhaust gas to about 500° C (900° F, 737 K). At this temperature unburned hydrocarbons and carbon monoxide are further oxidized, while oxides of nitrogen are chemically reduced in a second chamber with a different catalyst. Problems with catalysts involve their intolerance for leaded fuels (lead-free gasoline must be used otherwise the beads in the catalytic converter will become coated with lead and cease to function properly) and the need to prevent overheating. However because of the conversion of carbon monoxide to carbon dioxide it causes an increase in greenhouse gases and in the process of removing toxic gases to less non-toxic gases it causes an increase in the greenhouse effect.



This reaction is oxidization of the hydrocarbon.



This reaction is oxidization of Carbon monoxide.



This reaction is reduction of Nitrogen oxide. By using both a reducing and oxidizing catalytic converter, we can lower the activation energy for the HC, CO and NO so that they more quickly react to form less noxious products. The reactions that occur in the

catalytic converter are due to a catalyst. The catalyst is in a separate phase to the reactants is said to be heterogeneous, or contact catalyst. Contact catalysts are materials with the capability of adsorbing molecules of gases or liquids onto their surfaces.

STANDARD VALUE OF DIFFERENT EXHAUST COMPONENT

Exhaust component	Driving mode			
	Idling	Cruising	Accelerating	Decelerating
CO	5.2	0.8	5.2	4.2
HC	0.075	0.03	0.04	0.4
NO	0.003	0.15	0.3	0.006

VIII. CONVERSION BY CATALYTIC CONVERTER SUBSTRATES:

A substrate is a substance on which some other substance is absorbed or in which it is absorbed. (Catalytic conversion requires a precisely balanced air-to-fuel ratio, hence the need for oxygen sensors.) In dual-bed converter systems the exhaust gases are first reduced in order to eliminate the oxides of nitrogen; then they are oxidized with added air in order to eliminate carbon monoxide and unburned hydrocarbons. In more advanced threeway converters individual catalysts accomplish reduction of each species simultaneously. Catalysts are either platinum-group metals or base metals such as chromium, nickel, and copper. Platinum-group metals or noble metals are any of several metallic chemical elements that have outstanding resistance to oxidation, even at high temperatures; the grouping is not strictly defined but usually is considered to include rhenium, ruthenium, rhodium, palladium, silver, osmium, iridium, platinum, and gold. In base-metal catalysts the active surfaces are actually ceramic oxides of the metals. Because platinum metals are extremely expensive, they are deposited on ceramic catalyst supports as salts and then reduced to finely divided metal particles. For efficiency of conversion, extremely

large surface areas are required. These are accomplished by ingenious micro-structural engineering of the ceramic support structure. Two types of structure are made pellets and honeycomb monoliths. The pellets are porous beads approximately 3 millimetres (1/8 inch) in diameter. With a single pellet having up to 10 square millimetres of internal pore surface area, one litre of pellets can have up to 500,000 square metres of support surface. The pellet material is often alumina (aluminium oxide, Al₂O₃). High internal porosity is achieved by carefully burning off the organic additives and by incomplete sintering. Honeycomb monoliths have 1,000 to 2,000 longitudinal pores approximately one millimetre in size separated by thin walls. The material is commonly cordierite, a magnesium aluminosilicate (Mg₂Al₄Si₅O₁₈) known for its low thermal expansion. The extruded cordierite structure is coated with a wash of alumina, which in turn supports the platinum catalyst particles. The surface area of the monolith is typically in the range of one square meter; however, this figure must be multiplied many times because of the porosity of the alumina on the surface. Monolith supports are much more expensive than pellet supports, but they cause a smaller pressure drop in the exhaust system. Both types of catalyst support, because of their inherent friability, are susceptible to vibrational degradation. Containment of the supports is also difficult. A good seal must be achieved and maintained without imposing external stresses on the friable structure.

IX. DISCUSSIONS

All the experiments were accomplished in a condition which was not influenced by temperature, pressure, relative humidity, moisture or any other external factors of the environmental situation. At both the conditions the engine was made to run at an idle speed for about 15 minutes to make sure that the engine gets into a stable condition which is favourable for taking the measurements. The graphical representation shows us the reduction of

hydrocarbon content with the attachment of catalytic converter. The harmful contents like CO₂, CO, NO₂, NO have been reduced in quantity to a great extent with the presence of catalytic converter.

X. CONCLUSION

The presence of catalytic converter is must in an exhaust system as it reduces the pollutant content to a great extent except for sulphur di oxide the amount of which increases with the increase in speed even with the presence of catalytic converter. Although more study can be done with the latest designed catalytic converter along with other emission control devices. The graphical representation actually indicates the reduction of hydrocarbon and other harmful contents with the attachment of catalytic converter.

XI. REFERENCES

- [1]. V. Veeraragavan, "Fabrication and Testing of a Catalytic Converter", International Journal of Application or Innovation in Engineering & Management (IJAEM), Volume 2, Issue 11, November 2013 ISSN 2319 – 4847.
- [2]. J SojiAdeyinka, J U Okoli, YousuoDigineni, "Design and Fabrication of a catalytic reactor for treating automobile exhaust", Indian Journal of Chemical Technology, Vol. 11, July 2004, pp. 560-564.
- [3]. Rajesh B Biniwale, Moqtik A Bawase, M MDeshmukh, "Production of Automotive Catalytic Converter based on Non-noble Metal Catalyst technology: A feasible Option", Journal of Scientific & Industrial Research, Vol. 60, September 2001, pp 728-734.
- [4]. Narendrasinh R. Makwana, Prof. Chirag M. Amin, Prof. Shyam K. Dabhi, "Development and Performance Analysis of Nickel Based Catalytic Converter", International Journal of Advanced Engineering Technology E-ISSN 0976-3945.

- [5]. Prof. Bharat S Patel, MrKuldeep D Patel, “A Review paper on Catalytic Converter for Automotive Exhaust Emission”, International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.7 No.11 (2012).
- [6]. R Kumar,M Z Hasan , “A Non noble metal based catalytic converter for two-stroke, two wheeler applications.” Journal of Scienific& Industrial Research Vol.69,September 2005.
- [7]. Pascal Kiwitz, Christopher Onder, LinoGuzzella , “ Control- otiented modeling of a three-way catalytic converter with observation of the relative oxygen level profile”.Journal of Process ControlVolume 22, Issue 6, July 2012, Pages 984–994.
- [8]. Akira luiz jose Ricardo, “Evaluation of catalytic converter aging for vehicle operation with ethanol”, .” Journal of Scienific& Industrial Research Vol.36,oct. 2004.
- [9]. M VS Murali, “ Comparative studies on performance evaluation of a two stroke copper coted spark ignition engine with alcohols with catalytic converter. DOI: 10.1016/j.ces.2012.01.061.
- [10]. R.E. Hayes, “Hierarchical multi-scale model reduction in the simulation of catalytic converters” DOI: 10.1016/j.ces.2013.01.059.

Cite this article as :

M. Ganesh, A. Sriramavind, P. K. Saran Kumar, "Design and Fabrication of Two-Wheeler Silencer Using Catalytic Converter ", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 6 Issue 2, pp. 223-228, March-April 2019. Available at doi : <https://doi.org/10.32628/IJSRSET196247>
Journal URL : <http://ijsrset.com/IJSRSET196247>