

Recent Trends in Catalytic Converter for Automobile: A Review Approach

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Abstract: Automobile Emission is the major contributor to the air pollution .A technology is needed to control auto exhaust pollution problem so as to meet the emission standards set up by government legislation and the upcoming more stringent norms. The catalytic converter is successfully utilized to control air pollution from vehicle emissions. Catalytic Converter are manufactured based on platinum, palladium and rhodium catalyst but they are very much costly and rarely available. Recent work in catalytic converter are, instead of using these material non-noble material are also used as a catalyst, which are easily available, operated at lower temperature, cheap, and act as a catalyst. Copper, nickel and zinc are some option to use as non-noble material and other material are also used as non-noble metal catalyst.

Key Words: Air pollution; Catalytic Converter; Emission Standard; Non-noble Material; Noble metal; Automobile; Technology.

Introduction:

The Automobiles are a necessary requirement, they have made living easy and convenient, they have also made human life more complicated in case of toxic emissions and an increased risk of accidents. Due to non-perfect combustion control in the combustion chamber, the exhaust contains significant amounts of pollutants which need to be transformed into harmless compounds^[3]. These pollutants have negative impact on air quality as well as on human health and on environment. Numbers of Different alternative technologies like improvement in engine design, fuel pre-treatment, use of alternative fuels, fuel additives, exhaust after-treatment etc. are being considered to reduce the emission levels of engine. Among all the types of technologies developed so far, use of catalytic converters is the best way to control automotive exhaust emissions. The failure of catalytic converter may be due to following factors like, Converter meltdown, high cost, Carbon deposit, Catalyst fracture, Poisoning. Other different disadvantage of noble metal based catalytic converter indicate the other possible way of making catalytic converter which are on the base of factor like easily available and lower cost. Recent research work in the field of catalytic converter is making the catalytic converter with non-noble metal catalyst.

Past research work:

Biniwale *et al.*^[8] This paper represent the feasible option in the catalytic converter, production of automotive catalytic converter based on non-noble metal catalyst technology. National Environmental Engineering Research Institute (NEERI) has developed a catalytic converter based on non-noble metal catalyst considering the present and future standard of emission. Catalyst used in this type is a peroxide type. It is low cost catalytic converter manufacturing technique.

Amin Chirag, Chavda Kalpesh and Gadhia Utsav^[1] This paper represent the Exhaust analysis of four stroke single cylinder diesel engine using copper based catalytic converter. They developed the copper metal based catalytic converter with the same chamber and casing system of catalytic converter used for automobile. The converter volume used is 1.54 m³. The experiment is carried out on four stroke single cylinder CI engine. The optimum values of exhaust emissions found at full load are HC (126 ppm), CO (0.03 %). By using copper based catalytic converter it is found that HC is reduced by 33 % and CO by 66 % at full load.

Narendra Makwana, Chirag Amin, Shyam Dabhi^[4] This paper represents the development and performance analysis of nickel based catalytic converter. Several types of problem and higher cost of noble metals encourage for the possible application of nickel based catalytic converter. Four cylinder four stroke diesel engine are coupled with electrical dynamometer are used for data collection. By using Nickle based catalytic converter HC reduced by 40% and CO reduced by 35%.

Walke P.V, Deshpande N.V and Mahalle A^[7] They work on to the Emission Characteristics Of A Compression Ignition Engine Using Different Catalyst. The catalytic converter was designed and developed with different

catalyst for compression ignition engine to reduce pollution are tested. The pellets are coated with copper oxide (CuO), cerium oxide (CrO₂) and zirconium dioxide (ZrO₂). Experiments were carried out on computerized Kirloskar single cylinder four stroke diesel engine test rig with an eddy current dynamometer. The converter was tested with different catalyst. There is considerable reduction in HC, CO and NO_x.

Catalytic converter:

It has now been over 25 years since the introduction of the catalytic converter to reduce emissions from the internal combustion engine^[4]. The catalytic converter looks like a small muffler and is mounted in the exhaust system between the exhaust manifold and the actual muffler. There are millions of cars on the road and each one is a source of air pollution. Especially in large cities, the amount of pollution that all the cars produce together can create big problems.

To solve those problems, cities, states and the federal government create clean-air laws that restrict the amount of pollution that cars can produce. Over the years, automakers have made many refinements to car engines and fuel systems to keep up with these laws. One of these changes came about in 1975 with an interesting device called a **catalytic converter**. The job of the catalytic converter is to convert harmful pollutants into less harmful emissions before they ever leave the car's exhaust system.

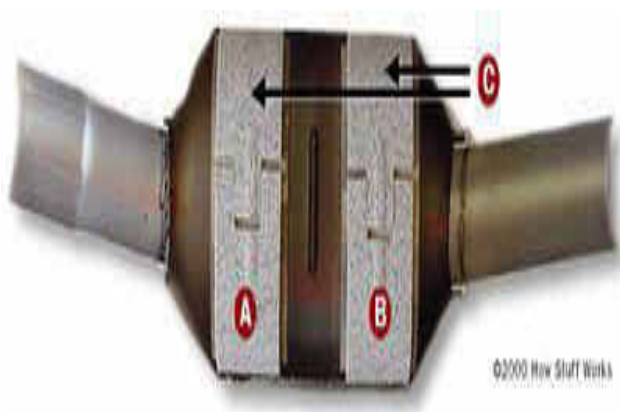


Fig.1 Catalytic converter^[2]

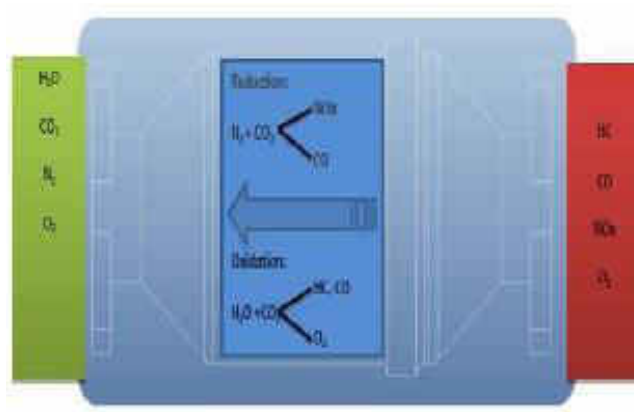


Fig.2 Chemical Reaction Inside Catalytic Converter^[6]

The converter has no moving parts and forms a chamber for catalyst material in the exhaust systems through which the engine exhaust passes. When the exhaust gases flow through the catalyst material, the pollutants are converted into harmless by products of combustion. The reduction catalyst is the first stage of the catalytic converter. It uses platinum and rhodium to help reduce the NO_x emissions. When an NO or NO₂ molecule contacts the catalyst, the catalyst rips the nitrogen atom out of the molecule and holds on to it, freeing the oxygen in the form of O₂. The nitrogen atoms bond with other nitrogen atoms that are also stuck to the catalyst, forming N₂. For example:



The *oxidation catalyst* is the second stage of the catalytic converter. It reduces the unburned hydrocarbons and carbon monoxide by burning (oxidizing) them over a platinum and palladium catalyst. This catalyst aids the reaction of the CO and hydrocarbons with the remaining oxygen in the exhaust gas. For example:



Non-noble metal based catalytic converter:

Non noble metal based catalytic converter are considering the present and future solution for the emission control^[4]. The non noble metal based converters can also be fitted to old, on-road vehicles, which shares major part of total vehicle emissions, and thus a large market is readily available. Financial analysis reveals that the technology is cost effective and has wide commercial application.

Why Catalytic Converter Based On Non-Noble Material:

Generally catalytic converter uses platinum group of metals like Pt, Pd and Rh^[8]. There are several types of problems associated with noble metal based catalytic converter^[5].

- Noble materials are rarely available into earth crust and exhausted one day.
- The cost of extraction of noble material from the earth crust is high and hence causes overall increase the cost of the catalytic converter.
- The operating temperature of the catalytic converter made of noble material is very high compare to the non-noble material.

Different Non-noble metal based catalyst is Copper, Nickel and Zink and other used.

Catalyst and Substrate Preparation:

Subpart of the catalyst and substrate preparation are shown in below^[1].

(1)Material Selection for Catalyst:

Choose one material which is act as catalyst for pollution control like Copper, Nickel, Zink or other.

(2)Material Selection for Substrate:

The substrate material is stainless steel, as it is widely used in the automotive exhaust system not only due to its advantages in mechanical and physical properties but also low-cost. The stainless steel wire mesh was cut to a circular shape prior to catalyst coating.

(3)Treatment for Wire Meshes Substrate:

The stainless steel wire mesh pieces were coated with metal catalyst before arranged onto a straight bar. Following procedure is carried out for Nickel coating on substrate:

- Cleaning of wire mesh with 10% HCL for 1 hr.

-Activation of wire mesh with solution of sulphuric acid of concentration of 20%.

-Electro plating with selected catalyst.

Conclusion:

The vehicle population and problem of pollution are increased day by day. The government stipulations and the emission standards are being made and are going to be more stringent in the coming days. As a combined effect of this the present vehicle on-road and new vehicles would require to adopt the exhaust emission control measures. The catalytic converter is successfully applied for after-treatment of vehicular exhaust to reduce pollution. The demand of catalytic converter is increasing with vehicle population and is expected to increase manifold if retrofit for in use vehicles are considered. The advantages of non-noble metal based catalytic converter are simple manufacturing process, easily available, cheaper raw material and indigenous plant and machinery. The vehicle specific design and retrofit possibilities ensure large market potential for this catalytic converter in India.

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