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Short Review Paper

Analysis of a catalytic converter for pollution prevention from compression ignition engine based automobiles

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Abstract

Atmospheric pollution originating from Compression Ignition engine automobiles has emerged as a serious threat to one and all on this earth. Every year, the number of Compression Ignition engine automobiles is on the rise. So, there is an urgent need for combating the pollution from these vehicles. Two types of methods can be used for this purpose: One is based on pre-pollution control and the other is based on post pollution control using a device called catalytic converter. The present research paper is completely based on the detail analysis of a catalytic converter and its utility in controlling the pollution by effective reduction of the released exhaust emissions from automobiles. It paves the way the way for designing a suitable catalytic converter as per the given requirements which will effectively reduce the exhaust emissions level emitted to the atmosphere.

Keywords: Automobiles, Compression ignition, Catalytic converter, Pollution.

Introduction

The exhaust gases from vehicles working on Compression Ignition engines are emitted primarily due to the partial combustion of the engine fuel. These concentrations of the exhaust emissions from the vehicles working on Compression Ignition engines are dependent on multiple factors such as the working conditions of the engine, conditions of the combustion process, the composition of the fuel used and air-fuel ratio, changes in driving cycles and engine maintenance conditions. The malfunctioning of the engine devices, mainly the fuel injection system also leads to the increase in concentration of the main exhaust components[1].

The nano-materials based catalysts used in a catalytic converter was conventionally made from precious metals. Platinum is also identified as one of the most active catalysts, but it is not found suitable for various applications owing to its unwanted reactions and high cost. Palladium as well as Rhodium is also considered as important catalysts. Palladium is often employed as an oxidation catalyst. Manganese, iron and nickel have also been used, but each has its own limitations[2].

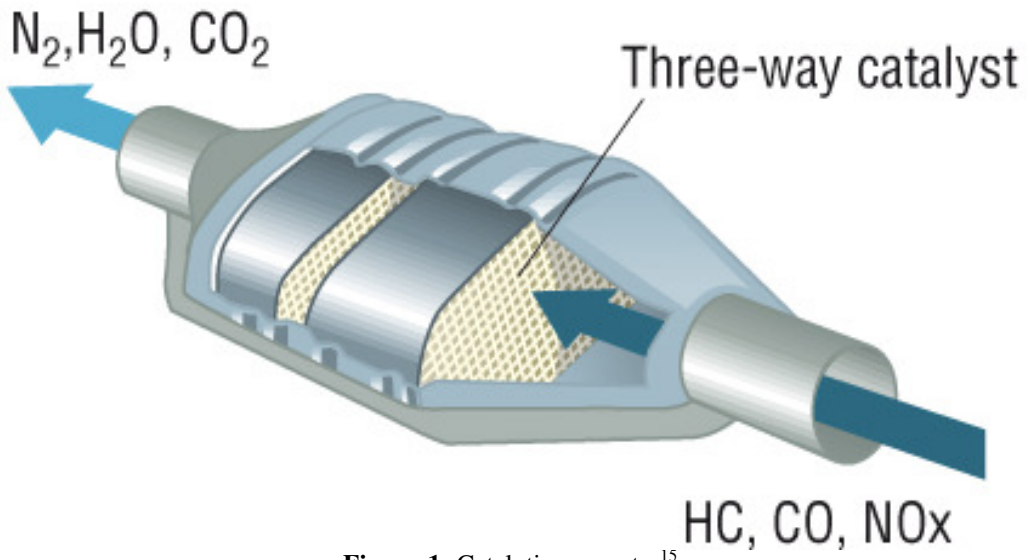

Figure-1: Catalytic converter[15].

Bulk gold is treated as inert and considered as an ineffective catalyst. But, if gold is in the form of micro particles with very small diameters it is very useful for various reactions that take place in chemical processing, environmental and automobiles pollution control. Out of the various important reactions that are catalyzed by gold particles supported on the transition metal oxides, oxidation of CO is of utmost importance[3].

Methodology

Thakur and Saikhedkar analyzed the pollution level of the exhaust emissions from the engine. They used copper for catalyst and the exhaust emissions level was found to be reduced significantly[4].

Thakur and Saikhedkar demonstrated emission parameters of an engine with a catalytic converter and without a catalytic converter by changing the loads and speeds. The emissions level was measured with a multi gas analyzer. They concluded that a catalytic converter can be very helpful in achieving a pollution free atmosphere[5].

A catalytic converter is the most effective solution for fighting the menace of air pollution from compression engine automobiles. Nano-particles have excellent properties required for reducing the concentration of harmful emissions on account their small dimensions. Different nano-particles have been experimented in the past for reducing pollution level from diesel engine automobiles. Iron oxide nano-particles have the potential to give excellent results due to their superior properties as compared to other catalysts[6,7].

Thakur and Saikhedkar conducted various experiments to reduce the harmful emissions like hydro carbons and carbon monoxide from vehicle exhaust emitted to the atmosphere. They performed experiments using copper as nano-particle catalyst coated on the surface of an improved design of a catalytic converter[8].

Thakur and Saikhedkar developed a mathematical model for predicting the behavior of the catalyst in reducing the exhaust gases concentration. The results of the developed mathematical model were validated using simulink and later compared with practical results[9,10].

A catalytic converter has generally two different types of catalysts which are known as reduction and an oxidation catalysts[11].

The main idea behind the designing the structure of a catalytic converter is to expose optimum surface area of the coated catalyst to the exhaust emissions. Exhaust emissions are made to pass through a catalyst. A strong catalytic action occurs at the surface of the catalytic converter and finally, the exhaust emissions concentration is minimized before entering the atmosphere[12,13].

Different catalysts were compared for utilizing in a catalytic converter for Compression Ignition Engine based automobiles. Out of the various catalysts analyzed, Iron oxide (Fe_2O_3) was found to give the best results to obtain a clean and green atmosphere[14].

Results and discussion

Air pollution level can be minimized by the effective use of catalytic converter. Catalytic converter provides a platform for interaction between the harmful exhaust gases and a catalyst. While designing a catalytic converter, the main focus is on creating a shape which will maximize the interaction of exhaust gases and the catalyst.

Conclusion

This paper highlights the scope of utilization of a device called catalytic converter in the area of automobile pollution prevention and control. Of all the catalysts used in pollution control, nano-particles based catalysts prove to be very effective due to their very small size and superior properties compared to other metal based catalysts.

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