Exhaust analysis of C.I engine by using zirconium dioxide coated Wire mesh catalytic converter - Review study

Krunal P. Shah[1] Dr. Pravin P. Rathod[2]
[1]P.G. Student, Mechanical Engineering Department
[2]Associate Professor, Mechanical Engineering Department
[1,2]Government Engineering College, Bhuj

Abstract-To study of different paper related to zirconium dioxide coating in catalytic converter and the wire mesh structure effect in the catalytic converter instead of honeycomb structure also find their effect on the performance of the I.C. engine. Catalytic converter with different catalyst for compression ignition engine to reduce pollute gases is chosen for present work. The emphasis is given on hydrocarbon (HC), carbon monoxide (CO) and oxides of nitrogen. The wire mesh is developed as catalyst .The wire mesh is coated with zirconium dioxide (ZrO_2). The catalyst materials are inexpensive in comparison with conventional catalysts (noble metals) such as palladium or platinum. Catalytic converter oxidizes harmful CO and HC emission to CO_2 and H_2O in the exhaust system and thus the emission is controlled.

I. INTRODUCTION

The most important chemical reaction in a petrol & diesel engine is the one that provides the energy to drive the vehicle is the combustion of fuel in air. In an 'ideal' system, combustion would be complete so that the only exhaust products would be carbon dioxide and steam. In practice, the complete oxidation of the fuel depends on a number of factors: first, there must be sufficient oxygen present; second, there must be adequate mixing of the petrol and air; and finally, there must be sufficient time for the mixture to react at high temperature before the gases are cooled. In internal combustion engines, the time available for combustion is limited by the engine's cycle to just a few milliseconds. There is incomplete combustion of
the fuel and this leads to emissions of the partial oxidation product, carbon monoxide (CO), and a wide range of volatile organic compounds (VOC), including hydrocarbons (HC), aromatics and oxygenated species. These emissions are particularly high during both idling and deceleration, when insufficient air is taken in for complete combustion to occur.

In internal combustion engines, the time available for combustion is limited by the engine's cycle to just a few Milli seconds. There is incomplete combustion of the fuel and this leads to emissions of the partial oxidation product, carbon monoxide (CO), oxides of nitrogen (NOx) and a wide range of volatile organic compounds (VOC), including hydrocarbons (HC), aromatics and oxygenated species. These emissions are particularly high during both idling and deceleration, when insufficient air is taken in for complete combustion to occur. Carbon monoxide is a product of a partial combustion of hydrocarbons in fuel. It is always present when there is a lack of oxygen during combustion and thus directly dependent on the applied engine air/fuel ratio. There are several paths that cause hydrocarbons in the exhaust. The most obvious is, as in the case of CO, a lack of oxygen when the air/fuel mixture is rich. The other reasons that can cause hydrocarbon emissions even with lean mixtures are crevices (piston top, threads around the spark plug), the quench layer (due to a lower temperature of the cylinders‟ walls), porous deposits, and absorption by oil. NOx is formed during combustion in the engine when oxygen reacts with nitrogen because of a high combustion temperature.

II. EFFECT ON EMISSION CHARACTERISTIC ON C.I. ENGINE USING CATALYST

P.V.Walke et al presents Catalytic converter with different catalyst for compression ignition engine to reduce pollute gases is chosen for present work. The emphasis is given on hydrocarbon (HC), carbon monoxide (CO) and oxides of nitrogen. The pellets are developed as catalyst The pellets are coated with copper oxide (CuO), cerium oxide (CrO_2) and zirconium dioxide (ZrO_2) . Pellets are held together in a circular housing at two ends of the converter shell. Cylindrical spacer was used in between circular housing containing pellets to vary the distance and to reduce back pressure on the engine. Experiments were carried out on computerized kirloskar single cylinder four stroke (10 B.H.P, 7.4 KW) diesel engine test rig with an eddy current dynamometer. The converter was tested with different catalyst.

Zirconium dioxide catalysts reduce HC Emission. All three catalysts (zirconium dioxide, cerium oxide and copper oxide) reduce CO emissions. The catalyst (zirconium dioxide + cerium oxide), reduce NOx emission Brake thermal efficiency decreases with. Catalytic converter.

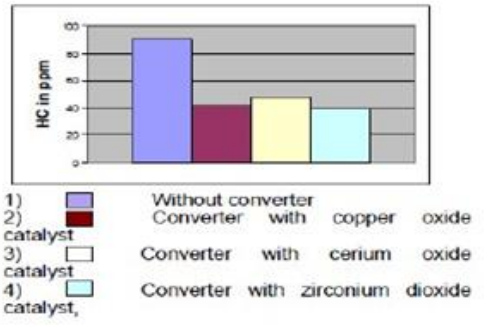

Fig.1. Comparison of HC emission (Constant RPM 1500)

However, this decrease is marginal and it can be accepted in view of benefits on environment and health of human being in particular.

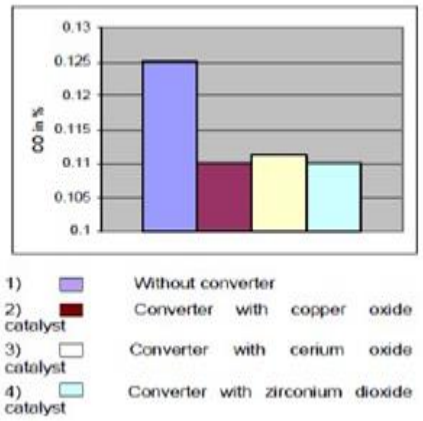

Fig.2. Comparison of CO emission (Constant RPM 1500)

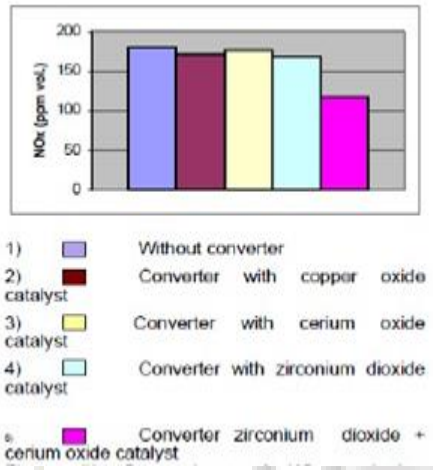

Fig.3. Comparison of NOx emission (Constant RPM 1500)

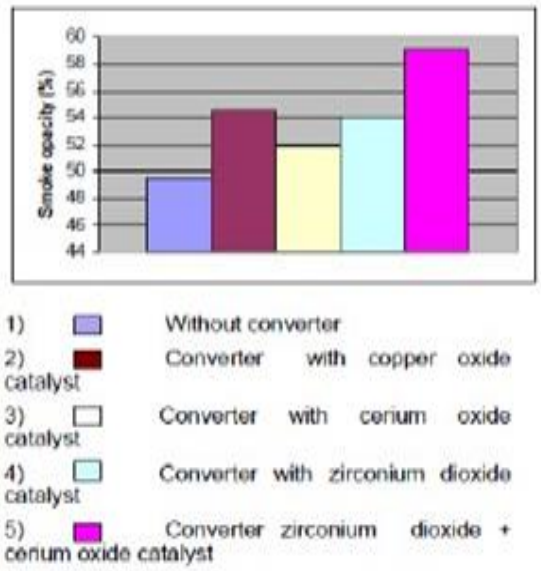

Fig.4. Comparison of Smoke opacity (Constant RPM 1500)

III. COPPER BASED CATALYTIC CONVERTER

Chirag Amin; Exhaust emissions of much concern are Hydrocarbon (HC), Carbon Monoxide (CO) and Nitrogen Oxide (NOx) from the automotive vehicles. Catalytic converter oxidizes harmful CO and HC emission toCO2 and H2O in the exhaust system and thus the emission is controlled. There are several types of problems associated with noble metal based catalytic converter. These factors Encourage for the possible application of non-noble metal based material such as copper as a catalyst, which may by proper improvements be able to show the desired activity and can also offer better durability characteristics due to its poison resistant nature. The present work is aimed at using copper as a catalyst for catalytic converter. Wire mesh copper catalytic converter is developed for a volume of 1.54 m3. The experiment is carried out on four stroke single cylinder CI engine.

Experimental results shows that, by using copper based catalytic converter, HC reduces by 38% and CO reduces by 33%. It is therefore concluded that development of copper based catalytic converter is feasible since it gave satisfactory results for given operating conditions and reduction of HC and CO emissions. Thus the copper based catalyst system can be the effective approach in place of expensive noble metal based catalytic converter. The expenditure for fabricating a single catalytic converter is ₹2000 to ₹2500 but on mass production this cost can be reduced to economic rang

IV. COST EFFECTIVE CATALYIC CONVERTER FOR DIESEL ENGINE

Walke P.V. et al presents cost effective catalytic converter (CAT) to be used for diesel engine. The CAT was developed based on catalyst materials consisting of combination of metal catalyst such Cerium Oxide (CeO_2),zirconium dioxide (ZrO_2), silver nitrate ($AgNO_3$) and copper nitrate ($Cu(NO_3)_2$) with pellets substrate.

These catalyst materials are inexpensive in comparison with convectional catalysts (noble metals) such as palladium or platinum. Cost effective catalyst combination and pellets type natural substrate were developed for catalytic converter for diesel engine. The catalyst combination (Cu/CeO_2 /ZrO_2 + (Ag/CeO_2 /ZrO_2) gives maximum back pressure (78 -290 mbar). The catalyst combination ($Cu/Ag/CeO_2$ /ZrO_2) gives minimum back pressure (46 -148 mbar).

Spherical pellets type substrate based catalytic converter has been successfully developed. The surface area of pellets type substrate is higher than ceramic substrate. The CAT with combination (Cu/CeO_2 /ZrO_2 catalyst) reduces HC, CO emissions with emission conversion efficiency of 65.6%, 70% respectively. The CAT with combination (Ag/CeO_2 /ZrO_2 catalyst) reduces NOx. Emission with emission conversion efficiency of 65%.

The CAT with combination ($Cu/Ag/CeO_2$ /ZrO_2 catalyst) reduces three major pollutants HC, CO and NOx with emission conversion efficiency of 62.29%, 64% and 59.7% respectively. The proposed CAT is inexpensive as Compared to existing system. Hence, ($Cu/Ag/CeO_2$ /ZrO_2) catalyst -based catalytic converter is effective for direct injection diesel engine

V. CONCLUSION

The summary of the present literature review is as follows:
Devices developed for after treatment of exhaust emissions includes thermal converters or reactors, traps or filters for

particulate matters and catalytic converters. The most effective after treatment for reducing engine emission is the catalytic converter found on most automobiles and other modern engines of medium or large size.
The surface contact area should be increase in the wire mesh structure and zirconium dioxide is cheap in the comparison of noble metal like platinum and palladium.
Converter oxidizes harmful CO and HC emission to CO2 and H2O in the exhaust system and thus the emission is controlled.

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