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A REVIEW ON CONTROLLING AUTOMOBILE EXHAUST EMISSIONS

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Abstract – *The purpose of this paper is to present the possible solutions available to reduce the emission of incomplete combustion products and also the greenhouse gases emitted as a result of catalytic process. The unburned fuels have negative effects on the quality of the air. The best way to control these unburned fuel products is the usage of Catalytic Converter. CO_2 is developed as an end product of the catalyst reaction. Though the emission of incomplete combustion products is reduced by the usage of a converter, the emission of CO_2 doesn't change. It is a major greenhouse gas. This review paper also tells the working of a catalytic converter and how CO_2 is a major global warming causing agent.*

Keywords Automobile exhausts, Emission, Catalytic converter, Exhaust gases, Carbon dioxide

1. INTRODUCTION

Automobile and its innovations have been supportive to mankind. But the pollution caused by them has made the environment unclean and unsafe for the people to survive. Introduction to catalytic converter resulted in less impact on environment. The major incomplete combustion products are oxides of nitrogen, hydrocarbons and carbon monoxide. If a converter converts only the carbon monoxide to CO_2 and hydrocarbons as steam (oxidation) with help of Platinum, it is called a two way catalytic converter. If along with oxidation process reduction of nitrogen oxides to nitrogen also takes place with addition of Rhodium in the membrane, it is called a three way catalytic converter. The reactions are:

- $2CO + O_2 \longrightarrow 2CO_2$
- $C_xH_{2x+2} + [(3x+1)/2]O_2 \longrightarrow xCO_2 + (x+1)H_20$
- $2NO_x \longrightarrow xO_2 + N_2$

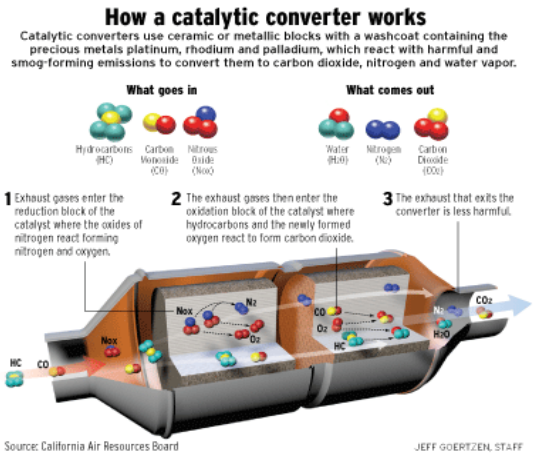


Fig -1 Typical Three-way catalytic converter

Apart from these outputs unwanted reactions may lead to formation of hydrogen sulphide and ammonia. Their formation can be limited by modifications to the washcoat.

2. CARBON DIOXIDE – A GREENHOUSE GAS

More than any other global warming drivers, CO_2 has contributed quite a lot to the climatic changes in recent times. Deforestation has been a major term for the later to take place. The Intergovernmental Panel on Climate Change (IPCC) calculated the Radiative forcing (RF) of each heat trapping particles. Positive and negative RF's were obtained in the result. CO_2 was found to have the highest positive RF. CO_2 remains in the atmosphere much longer than any other major heat trapping gases as a result of the activities taking place on the land by human. CO_2 takes a century's time period to leave the atmosphere. But also daily activities make sure that 20% of the CO_2 remains for approximately 800 years from now. This makes the planet not survivable for the forthcoming generations.

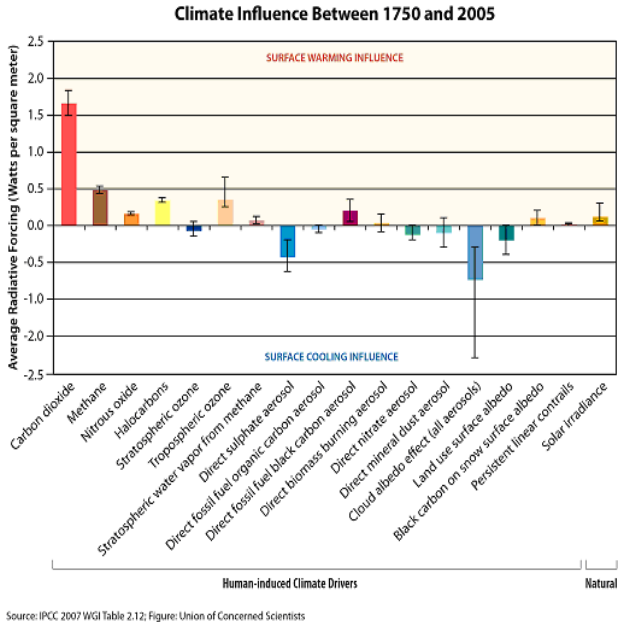


Fig -2 CO_2 with highest positive RF

3. LITERATURE SURVEY:

This paper will discuss three different methods that can be implemented In order to avoid the global warming.

3.1EMISSION CONTROL BY CHANGING THE COMPOSITION OF THE CONVERTER

Most of the modern three way catalytic converters use noble metals such as platinum, palladium and Rhodium. The noble metals are more efficient oxidizing and reducing agents. The problem with the noble metals are they are volatile in nature and they do not withstand high temperatures of 773K-11273K. So non noble metallic oxides are preferred. R M Bagus Irawar et al. [1] conducted experiments by designing manganese coated copper catalytic converter to reduce CO emissions. They preferred manganese and copper rather noble metals because these compounds are readily available and cost efficient. The experiments yielded the results as the number of catalyst cells were increased the amount of carbon monoxide emission decreased drastically.

K. Donadel et al. [2] conducted their experiments by keeping Natural amorphous Silica Fibers (NASF) and $Ni(NO_3)$ solution for wet route and NiO for dry route. The NASF were obtained from a spongillite ore in cylindrical form. The result of passage of flue gases through both the routes was observed. A higher conversion efficiency was observed in the side of dry route. Fibrous ceramic with Ni deposited on the fiber surfaces could be used to purify gases released due to diesel combustion.

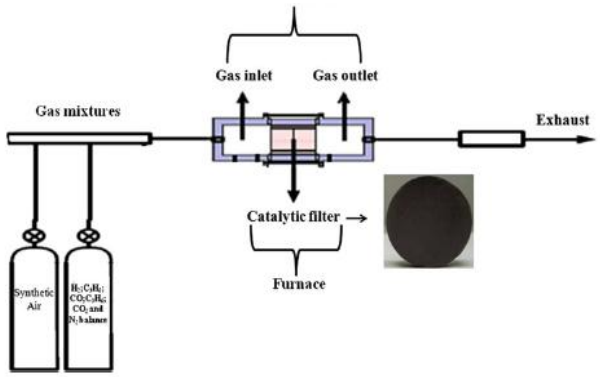


Fig -3 Schematic drawing of the experimental setup used to evaluate the Catalytic efficiency

Zeolite is another non-noble material preferable. Zeolite is hydrated alumina silicate, crystalline formed in nature or can be synthesized. AlO_4 and SiO_4 are bonded together in such a way that they constitute cavities, channels and cages thus enabling adsorption and catalysis process. Randip K Das et al. [3] used zeolite based converter to conduct emission test on a 4stroke petrol engine. The overall conversion efficiencies were 55.8% and 57.4% for NO_x and CO respectively. It was observed that catalyst works efficiently in elevated temperatures also. M A Kalam et al. [4] presented a design of the catalytic convertor for natural gas fuelled engine. Titanium dioxide and Cobalt

oxide with mesh substrate was chosen as catalytic materials. The conversion efficiencies at the end of the experiment were 93%, 89% and 82% for NO_x, CO and HC respectively.

Ramesh B. Poola [5] experimented catalytic combustion with various catalysts such as Nickel, Copper, and Chromium. These were electroplated on to the walls of combustion chamber, top of the piston and cylinder head. Among the different experiments carried out copper was more efficient. It revealed low emission of hydrocarbons and carbon monoxide.

3.2EMISSION CONTROL BY MEANS OF AUTOMOBILE CHARACTERISTICS

Due to hike up in prices of petrol and diesel, natural gas fuelled engines will become popular by 2040. Fen Zeng et al. [6] [7] kept this in mind and presented the characteristics of catalytic converter for natural gas fuelled Engine. Ceria of structural properties is added which acts as a rapid oxygen storage and release. The experiment was conducted in two stages. Fuel rich feed yielded insufficient or less amount of CO conversion. This is because of insufficient oxygen for oxidation of carbon monoxide. On other hand the conversion of NO was very high. When the experiment was conducted with lean fuel, oxidation of CO was high but the conversion rate of NO was very slow. Stoichiometric air-fuel ratio exhibited high emission removal efficiency. Speed of the vehicle will also determine the amount of exhaust emissions. J Q Hansen et al. [8] checked the driving patterns of petrol passenger cars with corresponding emissions.

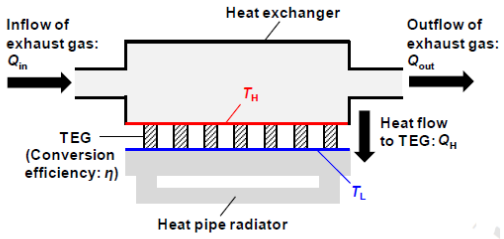
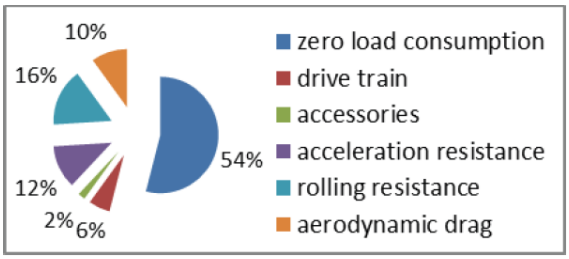


Fig -4 Thermo electric generator

Thermoelectric generators (TEG) is shown in fig: 4. These generators are devices which convert the waste heat into electrical energy. These work well within the temperatures of 573K. However due to economic reasons TEG market has not yet been developed. Yusuke kishita et al. [9] experiment by attaching the TEG to passenger cars. After the experiment it was concluded that TEG need improvements. It had low conversion efficiency. Higher conversion efficiency was required to achieve carbon neutrality.

Emission of the automobile increases with heavy parts. Considering the light weight automobile San Wenlong et al. [10] discussed the lightweight materials such as aluminium and magnesium suitable for automobile components. Fuel consumption by different parts can be identified in the fig: 5.

Fig -5 Fuel consumption of various automobile parts



3.3CARBONDIOXIDE CAPTURE TECHNOLOGY

Carbon dioxide as a flue gas is a heat trapping gas and a global warming causing agent. Carbon dioxide may be captured from exhausts, stored and converted to other forms and can be used for other purposes. Patricia Luis et al. [11] worked on membrane based technology for capturing and storing CO_2. The membrane technology may be any of the following types:

I. Non dispersive absorption using porous membranes.
II. Gas permeation.
III. Supported liquid membranes.

The limitation of membrane technology is the cost. Membranes are less stable. Frequent performance evaluation is required for their working.

Carbon di oxide capture is also dissolving it in water and making it carbonic acid, and use it for industrial purposes. Sergio E. Wang et al. [12] worked on small molecule catalyst for CO_2 capture. Carbon di oxide doesn't react with water in slow condition. Hence biological catalysts help in accelerating the carbon dioxide to form carbonic acid.

Carbonic acid has variety of industrial purposes. Recent innovation in carbon di oxide capture technology was made by Nandi de Luna [13]. The author after the research concluded that nickel metal along with pyridylcarboxylate exposed to higher temperature and pressure makes the metal deform into a honeycomb structured metal similar to that of a platinum in a catalytic converter. This metal at greater pressures of 2 bar or more absorbs CO_2 more efficiently.

4. CONCLUSION

CO_2 is an inert gas and it is an environmental concern since it is a major greenhouse gas. Varied technologies have been developed over the recent years to reduce the emissions and capture of CO_2. All the techniques have their own limitations. However there are not many techniques to remove CO_2 from large CO_2 sources. However Nandi de Luna [13] work is consider efficient to some extent.

But still future research should focus on fast absorption of CO_2. Fast kinetics may be achieved using unique structural designs such as Nano layer sorbents and use of effective high stability catalysts.

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