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Exhaust Emission Reduction in SI Engine Using Catalytic Converter With Silicon Dioxide & Alumina With Silica as Catalysts

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ABSTRACT

Nowadays lots of vehicles are used for transporting purposes. These vehicles are emitting the exhaust gases. These gases are harmful to the human health. These gases contain some harmful gases such as CO, HC & NOX. These three gases are very dangerous to the environment. Currently catalytic converter using Platinum, Palladium, Rhodium as a catalysts are used to reduce these exhaust harmful gases in emissions. The aim of our main project is reducing these harmful gases experimentally using catalysts other than presently using in automobiles. In our project, we use silicon dioxide and alumina with silica as a catalyst in the catalytic converter. After analyzing the emission test using these catalysts as a catalyst in catalytic converter, the harmful gases are considerable reduced

Key words: silicon dioxide, alumina with silica, Catalytic converter

INTRODUCTION

Pollution may be defined as “an unwanted/undesirable foreign matter added to environment in other words, Pollution may be defined as “the excessive discharge or addition of undesirable substances or unwanted foreign matter into the environment, thereby adversely altering the natural air quality of the environment, and causing damage to human, plant and living things under the earth.

Air pollution may be defined as any atmospheric condition which is getting polluted. These substances include gases (sulphur oxides, nitrogen-oxides, carbon monoxide, hydrocarbons etc), particulate matter (smoke, dust, fumes, aerosols etc) and radioactive materials and may others.

Air is polluted by dust, cement, coal and some gases. An individual inhales about 16 kg of air in a day. If the air is polluted it causes many ill-effects on human beings.

Hence reduction of automobile emission under the new development of this project may contribute towards green environment and reduce the global warming.

1.1 Major Source of Pollution

- Primary pollution.

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- Secondary pollution.

Primary pollution contributes emission of harmful carbon monoxide (CO), unburned hydrocarbon (UHC), and oxides of nitrogen (NO_x) and particulate matter, where as secondary pollution contributes towards the green house effect.

CO formation: Carbon monoxide is formed due to incomplete combustion in combustion chamber.

HC formation: Unburned hydrocarbon is due to the evaporation of fuel from the fuel tank and also due to formation of unburned gases in the exhaust.

NOX / PM formation: oxides of nitrogen (NOx) and particulate matter is formed due to improper combustion and formation of NOx is mainly due to the availability of oxygen and presence of high combustion temperature.

S. No	TYPES OF SOURCES	FUEL	MAIN POLLUTANTS
1	Domestic heating, cooking	Wood, peat Biomass etc	pm, CO, NO_x
		Coal	pm, SO_x, CO, NO_x
		Coal, heavy oil	SO_x, NO_x
2	Industrial boilers, Power plants	Coal, heavy oil	pm, SO_x, NO_x
3	Manufacturing, industrial process		SO_x, Fluorides, Iron oxides
4	Transportation	Gasoline	CO, NO_x, Pb, HC, Oxidants, Ozone
		Diesel	pm, SO_x, NO_x, Odour

Table 1: Sources and pollutants

2.CATALYTIC CONVERTER

A catalytic converter is a device used to reduce the exhaust pollutant gases from an internal combustion engine. As these precious metal usage and honeycomb structure become costliest affair, now the automobile company / after treatment device manufacturer undergoing research on alternate source on substrate and catalyst materials.

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In this research, we develop a non-noble metal oxide based catalyst with high efficiency of catalytic activity performance as an alternative catalyst for carbon monoxide treatment emitted from vehicle emission.

The catalytic converter of the present invention is made by meticulous study on literature review and in depth study about usage of alumina and its composition on catalyst material in combination with chemical reaction to reduce the CO, HC, NOx.

Today the most successful exhaust gas treatment techniques used are as follows,

- EGR – Exhaust Gas Recirculation.
- Catalytic converter
- Thermal Reactor
- SCR – Selective catalyst Reaction
- DPF – Diesel Particulate filter

Out of these, our interest on this project experiment is Catalytic converter.

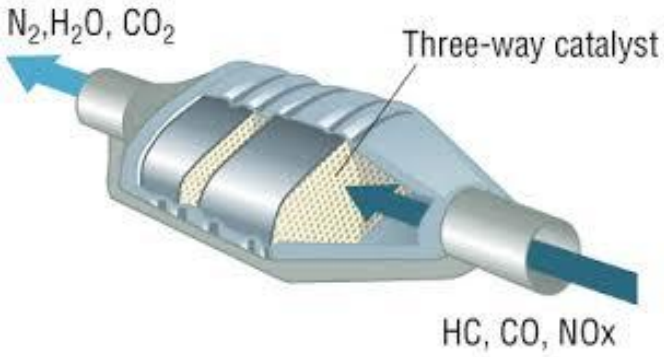

Fig.1. Cut Section of the Catalytic Converter

A catalytic converter is an after treatment device that reduce the exhaust pollutants from automobiles.

It has constructions as shown in the figure, it consists of honeycomb substrate, precious metal wash coat of Platinum, Palladium, Rhodium.

3.Project Objective and Methodology

3.1 Objective

The objective of the project is to do research on engine exhaust after treatment control by using alternate source of material like alumina for doing oxidising reaction in catalytic converter to make cost effective solution.

In the scope of the project two combination of wash coat technology is under experimental research.

- Silicon dioxide
- Alumina with silica

Based on the result best wash coat technology will be selected

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3.2 Methodology

In an existing catalytic converter the precious metals like platinum, palladium are normally used. To overcome from the cost and usage of precious metals, it was an effort to identify by project experiment results by using alternate source of material like silicon dioxide and alumina with silica

The silicon dioxide and alumina with silica is used as wash coat material. Wash coat assist in oxidation process to reduce the emission. The new trials will prove the concept of alternate material comparison over precious metals employed in recent trends, and will enhance the feasibility of cost effective solution.

4. Project Progress

4.1. Catalyst selection: Following catalyst were considered for experimental study, based on results best choice will be selected and recommended for use.

i) Silicon dioxide

ii) Alumina with silica

5. CONVERTER FABRICATION

5.1. Construction of catalytic converter: The exhaust gas after treatment device construction is having following phases

i)Drawing or layout preparation.
ii) Drawing consists of assembly drawing and detailed drawing of individual components.
iii) The selection of material.
iv) Fabrication of catalytic converter outer casing.
v) Preparation of other sub components like cone and flanges.

5.2.Drawing or layout preparation

The alumina catalysts are filled into the catalytic converter. The preparation of catalytic converter and its benchmarking observations are shown below,

The bench marking study shows following shapes,

i) Cylindrical

ii) Oval construction

Out of these, cylindrical shape is selected because it has following advantages.

i) Easy manufacturing feasibility,
ii) Uniform shape and structure formation,
iii) The manufacturing cost is less,

Purpose of cones fitment in the catalytic converter is to increase the gas velocity and to have uniform index and diffusion of pollutant to come in contact with alumina catalyst for better oxidation reaction. The connecting of coupling flanges is made for connecting the exhaust gas line with catalytic converter at suitable locations.

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The purpose of inner shell is to hold the alumina catalyst in the gas path. The outer cylindrical shell is an external construction to protect and hold the whole internal catalyst construction.

5.3. Preparation of sub components

List of sub components are as follows,

i) Inner shell
ii) Outer shell
iii) Cone
iv) Flanges
v) Support rings

5.3. Fabrication

Assembly of all sub components along with filled wash coat catalyst will make the all new alumina catalytic converter ready for testing.

The catalytic converter assembly is represented in the below figure. It has two inbuilt cones for uniform indexing of gas and better converter efficiency.

Fabrication assembly

6. Experiment and Results

Catalytic converter test on a SI engine:

The experimental engine is computerised single cylinder diesel engine. Before taking the catalytic converter efficiency, the base engine emission readings are acquired by using AVL 5gas analyser.

Before taking the emission test, a leak check has to be conducted in the digital gas analyzer. The leak check is conducted by closing the probe's nozzle manually. The purpose of leak check is to discharge the residual gases through the gas analyzer's exhaust tube. The components present in the exhaust gas such as hydrocarbon, NO_x in parts per million and carbon monoxide, carbon dioxide, oxygen in percentage volume will be displayed in the digital gas analyzer.

7.Base Results and discussion

The emission results on engine with 5 engine operating modes with different speed and load conditions were conducted.

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CONCLUSION

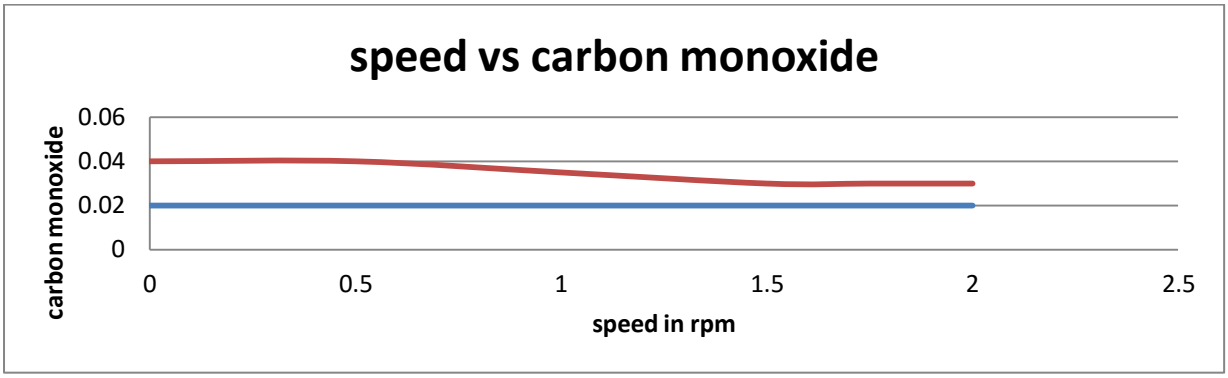
Due to increase in air pollution, the government agency started introducing the stringent emission norms to control the engine out emission from automobiles.

The stringent emission norms started a new drive on development of low or ultra low emission engines by using latest trend of technology like Multivalving, CRDI, Variable valve lift, VGT turbo charger, Camless valve gearing, hybrid or alternate source of fuels.

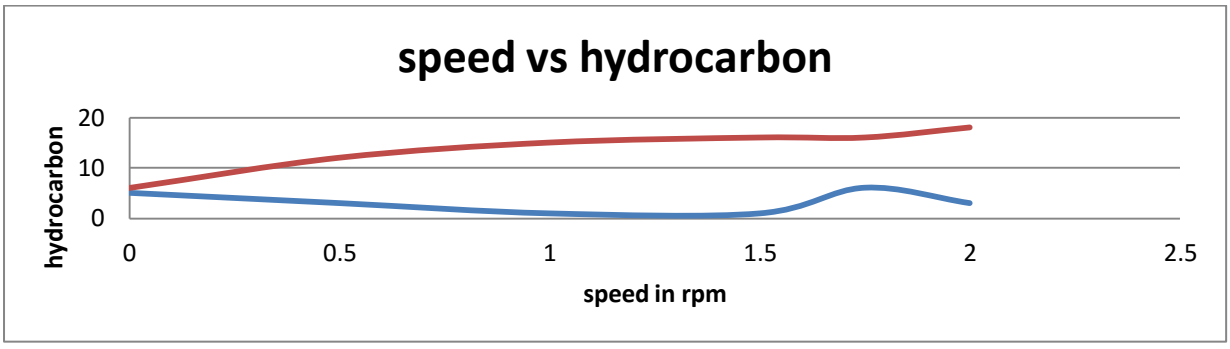
But the new development of engine can have this latest trend on engine technology, but what about the existing engines and its overhead infrastructure involved in making the assembly and production. Hence it was a great solution to use the exhaust after treatment devices to control the existing engine out emission and passing the required current emission norms and certifications.

The current catalytic converters are using the oxidation process by employing the precious coat metal like platinum and palladium. To overcome from cost and reducing the rare metal usage the project made the drive to develop an alternate source of oxidation catalyst for oxidation reaction and thus reduces the NOx and HC emissions. The substrate selected in this project is wash coat technology employed by using the silicon dioxide and alumina with silica. The catalytic converter is constructed with inner/outer shell construction supported with cones and flanges. The initial emission readings are conducted in the experimental engine. This catalytic converter reduces the harmful pollutant more efficiently and at a lower cost than the conventional catalytic converter.

Co-Graph



HC-Graph:



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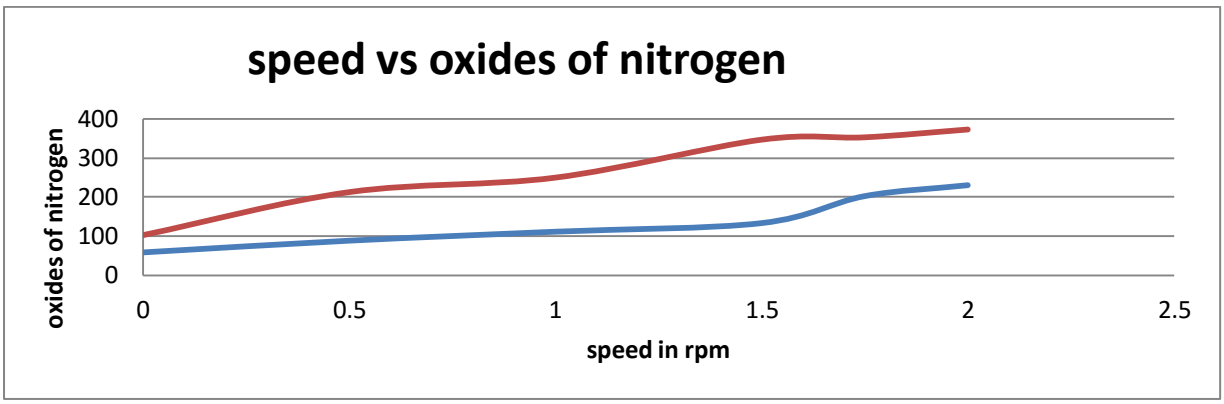
NOx-Graph:



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