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# Report on Design and Development of Catalytic Converter With Ammonia Injection to Reduce Exhaust Emissions

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## ABSTRACT

The automobiles play an important role in the transport system. With an increase in population and living standard, the transport vehicles as well as car population is increasing day by day. In addition to this there is steep increase in the number of four wheelers during the last two decades. All these are increasing exhaust pollution and particularly in metros as density of these vehicles in metros are very high. The main pollutants contributed by I.C. engines are CO, $NO_x$ unburned hydro-carbons (HC) and other particulate emissions. In addition to this, all fuel burning systems emit $CO_2$ in large quantities and this is more concerned with the Green House Effect which is going to decide the health of earth. Lot of efforts are made to reduce the air pollution from diesel engines and regulations for emission limits are also imposed in a few cities of India. An extensive analysis of energy usage and pollution shows that alternative power systems are still a long way behind the conventional ones. Further developments in diesel engine exhaust system i.e. catalytic converter will make difference in exhaust emissions. Catalytic converter is an exhaust after treatment, emission control device. In present assessment Non-noble materials use as catalyst in catalytic converter and ammonia injection system to reduce exhaust emissions. All exhaust emission measure with the help of emission analysis instrument i.e. AVL DIGAS 444

**Keywords:** CO, HC, NOx, Silver nitrate, Cerium oxide, Zirconium dioxide Ammonia, CI Engine, emissions.

## I. INTRODUCTION

Fuel is one of the major issues in the world yet. Because of the technological development and improvement in living standard of the people, the demand of the petroleum fuel is increased very rapidly. The increase in population of vehicles leads to largely reduction in fossil fuels and increasing environmental pollutions. 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), 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. In reality, the combustion is never complete, since the air-to-fuel mixture is not entirely homogenous. Thus, the fuel is not entirely burned; resulting in carbon monoxide (CO), hydrogen ($H_2$), and hydrocarbon (HC) emissions. This causes increasing exhaust pollution in the local environment. NOx emissions are having serious environmental concern because of their role in smog formation. NOx being more hazardous, the limit is set to 350 ppm in many countries, but the emission from diesel engines are generally up to 2500 ppm.

Catalytic converter is an exhaust after treatment, emission control device. It is intended to convert harmful combustion by-products from an engine cylinder into harmless products, by increasing the rate of reactions, with the use of catalytic reaction at comparatively lower temperature levels. Further to reduce more harmful combustion product NOx ammonia injection system use. A catalyst is an element or compound that promotes a chemical reaction without being affected by the reaction. The purpose of using catalytic converter and ammonia injection system in spark ignition and compression ignition engines is to convert the harmful combustion by-products into harmless products.

## II. METHODS AND MATERIALS

### Catalytic convertor

In this study, several stock solutions with different aqueous weight ratios will be used. Silver nitrate, Cerium oxide, Zirconium dioxide will be used as a metal oxide catalyst where Silver nitrate is used as the reducing agent and Cerium oxide acts as an oxygen buffer by storing excess oxygen under oxidizing (lean) conditions and releasing it in rich (reducing) conditions. Zirconium dioxide is used to enhance the thermal stability and strength of catalyst.

### Catalyst slurry preparation

The three catalysts according to their respective weight ratios were used for the slurry preparation. 15 gm of silver nitrate with 7.5 gm cerium oxide and 2.5 gm zirconium dioxide were added in 200 ml. distilled water to get slurry .The slurry was prepared using magnetic stirrer 9-10hrs at 1100 rpm-1300rpm.

### Material selection for substrate

The substrate material we are using is Brown fused alumina & stainless steel, not only because of its properties but also for its low cost.

### Substrate coating

The pellets were coated with the metal catalysts with dipping technique. In this process, spherical pellets were immersed into prepared catalyst slurry for 2 h duration. Pellets were removed from catalyst slurry and were kept at a room temperature for 1 h. Coated pellets were dried in an electric oven at 110°C for 4 h. Then the pellets were removed from oven for blowing off residual catalyst from alumina pellets surface. Further the coated pellets were then calcined in muffle furnace. Calcination process takes 6 h at a temperature of 500°C. After the calcinations process the coated pellets were arranged in perforated circular housing to form substrate.

### Arrangement of Pallets and Fabrication

The coated pallets were arranged in a stainless steel (Type 304) wire mesh in a cylindrical Shape and inserted in GI pipe of 1.5 diameter such way the Exhaust gas can make contact with pallets. This arrangement was then installed with the diesel engine setup.

### Ammonia injection system

Ammonia injection system spray ammonia into exhaust system in the presence of catalyst. This system need ammonia storage and fairly complex injection and control.

### Experimental setup

The different equipment's and setup which is required for experiment is shown in the figure 1,

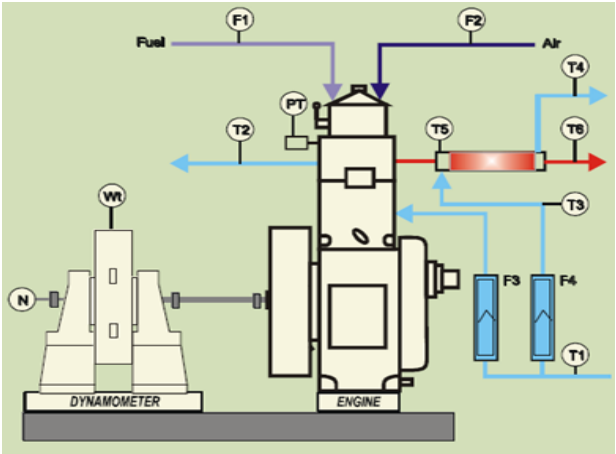


**Figure 1.** Experimental Setup

F1 fuel injector pressure sensor
F2Air flow measuring
PT peizo sensor N rpm pick up and TDC encoder
T1 Cooling water inlet temp to engine
T2 Cooling water outlet temp from engine
T3 Cooling water inlet temp to calorimeter
T4 Cooling water outlet temp from calorimeter
T5 Exhaust gas inlet temp to calorimeter.
T6 Exhaust gas outlet temp from calorimeter.

## III. EXPERIMENTATION

The experimentation is going to conduct in following steps

**Fuel characterization** – Diesel

**Exhaust setup –** Conventional converter & Develop Cat trap system

**Emission analysis** – The major engine exhaust gases namely CO, $CO_2$, $O_2$, $NO_x$, and unHC at the 90% loading condition for various Exhaust setups would be measured using AVL five gas analyzer.

## IV. CONCLUSION

The objectives of present work is to reduce the emissions mainly NOx which is more harmful than $CO_2$, also the HC,CO. A four stroke, single cylinder, 18 CR, water cooled diesel engine at 1500rpm, widely used in rural/agricultural applications in India, was selected for the present investigation of Cat Trap system consist of oxidizing agent namely $CeO_2$, reducing agent namely $AgNO_3$. These are used to convert the $NO_X$ into $N_2$ & $O_2$. Emission is tested on AVL analyser, which gives satisfactory result for CO, HC, NOx, $CO_2$. The experiments were carried out to test the diesel on the prepared experimental setup with necessary instrumentation to measure the engine emissions in the IC Engine Laboratory of the department. The required instruments have been incorporated in the experimental set up for this purpose. The engine emission measurements at 90% loading carried out for diesel.

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