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# Experimental investigation on Urea injection with selective catalytic convertor in two stroke petrol engine

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**ABSTRACT:- Catalytic Convertor is used to reduces the Vehicular emissions that contains, Oxides of Nitrogen(NOX), Carbon Monoxide (CO), Hydrocarbon (HC),Particulate matter(PM), Sulphur dioxide(SO2) and other products of combustion. There arevarious types of Catalytic Convertors are Three Way, SCR (Selective Catalytic Convertor), Lean NOx Catalyst. Among these technologies, urea selective catalytic reduction is one of the most promising systems which have been proved of being able to reduce more than90% of NOx emissions. The Obtained result shows, SCR setup reduces NOx highly, carbon monoxide and unburned hydrocarbon by using urea injection and compressor setup.**

## I. INTRODUCTION

The various literature presented would be discussed under the following broad areas of interest that is, selective catalytic reduction system using urea injection and studies on NOx control methods.Asad Naeem Shah et al in their research it is envisaged that the future emission levels for diesel engines will no longer be met merely by engine tuning. The controlling of NOx and particulate matter (PM) from diesel engines has always been a challenge for researchers due to ever tighter emission legislations. Reduction of NOX and PM from diesel engine. M. Koebel et al in their research paper proposed a promising technique to reduce NOX emissions from automobiles. Urea-SCR, the selective catalytic reduction using urea as reducing agent. The major goal is the reduction of the required catalyst volume while still maintaining a high selectivity for the SCR reaction over a wide temperature range. Tomasiae et alin their paper discussed about the advantages of using aluminium for coating the ceramic monolith. According to them Aluminum nitrate has shown its suitability for coating of the catalytic layer on the monolith surface.Junhua Su et al briefly described about the SCR setup commercially used for emission control. According to them Selective catalytic reduction (SCR) of NO by NH3 is an effective approach to solve stationary NOx emission problems. Honeycomb V2O5/TiO2 has been used for this purpose for more than 20 years which results in the formation of relatively thin but firm Al2O3 coatings.

## II. MATERIALS AND METHODS

In this research work study has been conducted to study the level of pollution emitted from petrol driven vehicles using five gas analyzer. With the use of five gas analyzer, the air pollutants such as CO, CO2, HC, NOX and SOX coming out from the vehicle exhaust both in static and dynamic condition are measured.

### *A. Engine*

Selection of a 2-Stroke Petrol Engine was made at the earlier stages of our project. This Engine was subjected to the Emission test to know the percentage of various gases in the exhaust.

### *B. Chemistry Involved*

The NOx reduction reaction takes place as the gases pass through the catalyst chamber. Before entering the catalyst chamber the ammonia, or other reactant (such as urea), is injected and mixed with the gases. The Chemical reaction for using urea for a selective catalytic reduction process is

$$4NO + 2(NH2)2CO + O2 \rightarrow 4N2 + 4H2O + 2CO2 \text{ ------- (1)}$$

The ideal reaction has an optimal temperature range between 630 and 720 K, but can operate from 500 to 720 K with longer residence times.

### *C. Catalysts*

There are many catalysts which are used in the form of coatings inside the catalytic convertors. Some of them are Titanium oxide (TiO2), Vanadium Pent oxide (V2O5),Aluminum Oxide(Al2O3) and some precious metals like Platinum, Palladium, Rhodium etc. We have employed a coating of Al2O3 for aiding the oxidation reactions inside the exhaust system.

### *D. Compressor Set Up*

By means of a Compressor, air is passed into the exhaust duct and the oxygen in this pressurized air helps to burn quite a bit of any unburnt hydrocarbons (fuel) and thereby converting the poisonous carbon monoxide into good old carbon dioxide.

$$4HC + 5O2 \rightarrow 4CO2 + 2H2O \text{ ---------- (2)}$$

$$2CO + O\,2 \rightarrow 2CO2 \text{ ------- (3)}$$

## III. EXPERIMENTAL SETUP

Our setup was fabricated on the basis of the chosen engine (2-Stroke, Petrol Engine)

The diagram illustrates our proposed experimental set up for reducing the harmful exhaust gases such as HC, CO and NOX. Major parts of our system are:

ISSN No: - 2456 - 2165

1. Compressor set up for supplying air
2. Duct or the catalytic convertor
3. Urea injection system

*Block Diagram:*

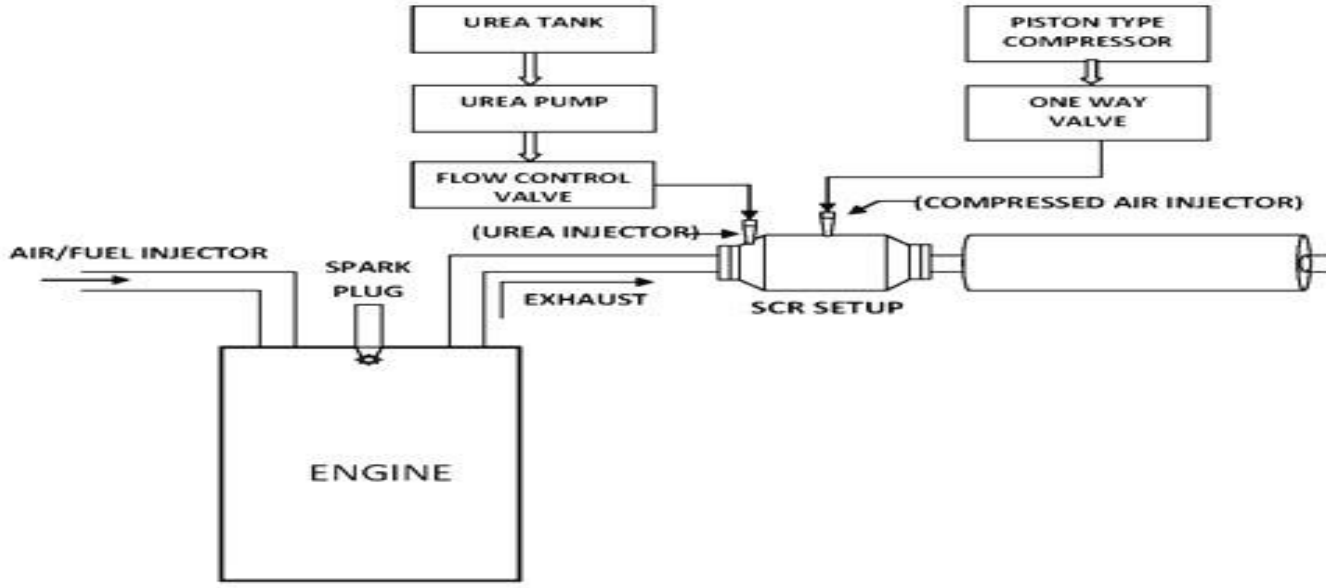


Fig 1 Block diagram of the experimental setup;

From (fig 1) SCR setup consists of four valves out of them three are inlet valves and the other is an exhaust valve(outlet valve).The three inlet valves are connected to the urea injector, compressed air injector and exhaust gases of engine respectively. Urea has been injected into the SCR setup through the pump, which will reacts with the exhaust gases to reduces the amount of NOx. Then compressed air is sent into the SCR setup to reduces the amount of hydrocarbons. Then these reduced non toxic gases are passed out through the outlet valve.

*A. Compressor Set Up*

We have implemented the reduction of hydrocarbon emission in the exhaust by passing compressed air in the exhaust system. As a result of this the amount of unburnt hydrocarbons decreases in the total percentage of the exhaust. The power for the compressor is derived from the battery. Which delivers maximum output of 300 PSI, Voltage of 12v and the power source used is DC current.

*B. Duct*

Selective Catalytic Converter which can be called simply as a "Duct" or"Enclosure"(fig2). Mild steel sheet was bent and welded according to the duct design. The duct design is primarily based on the shape of the ceramic filters. As per our Engine bore size square cross-section ceramic blocks of size 40*40(thickness 14 mm) were used. The Porous Ceramic Filters have received particular attention when it comes to pollution abatement in automobiles. In addition to the outstanding high temperature and chemical resistance offered by the ceramics, it also offers a degree of porosity and larger surface area compared to the extruded monolithic structures. The fig2.1 shows the arrangement of the duct.

FIG 2. DUCT

ISSN No: - 2456 - 2165

FIG 2.1. Duct Arrangement

*C. Ceramic Wool*

To protect the filter from shocks and other external disturbances the ceramic wool was rolled over the surface of the filter. This lightweight needled blanket is manufactured from fibrefrax refractory ceramic fibres and provides effective solutions to a wide spectrum of thermal management problems. This wool offers superior insulating performance, flexibility and resilience. These blankets are unaffected by most chemicals.

| | |
|---|---|
| Temperature, $^{O}C$ | 1260 $^{O}C$ |
| Colour | White |
| Percentage Composition % | |
| Alumina | 42-47 |
| Silica | 53-58 |
| Melting Point, $^{O}C$ | 1760 $^{O}C$ |
| Thermal Conductivity in W/mK | 0.12 |

Table 1 :- Properties Of Ceramic Wool

Fig 3. Ceramic Wool

*D. Urea Injection System*

The pump used in the urea injection system is a electronic fuel pump. The pump is driven by a DC motor. The outlet of the pump was connected to a flow control valve. The optimum position of the injector is chosen based on the conversion of the urea into ammonia. In the SCR setup we mixed urea and water, in the mixing amount of urea is 30% and remaining are water.

*E. Urea- Defined*

Urea is a white dry organic compound and a crystalline substance and has minimum of 46% Nitrogen calculated in dry state.

CO (NH2)2 or NH2CONH2--------- (4)

Fig 4 Full Setup

## IV. RESULTS AND DISCUSSIONS

Data were collected by using five gas analysers. With the help of five gas analyzer, the air pollutants (CO, CO2, HC, NOx and SOx) coming out from the vehicle exhaust will be measured.

*A. Five Gas Analyzer*

After the equipment is being setup, the five gas analyzer is allowed to warm- up (radioactive bed). The purpose of the radioactive bed is to convert the molecules from the vehicle exhaust in to particles.

BEFORE TESTING

| Parameter | Regulation unit | Actual value |
|---|---|---|
| CO | 3.5% | 1.44 |
| NOx | 0.50g/km | 0.43 |
| HC | 6000ppm | 3980 |

TABLE 2 Amount of gases before using urea SCR setup

ISSN No: - 2456 - 2165

AFTER TESTING

| Parameter | Regulation unit | Actual value |
|---|---|---|
| CO | 3.5% | 0.85 |
| HC | 6000ppm | 1024 |
| NOx | 0.50g/km | 0.18 |

TABLE 3 Amount of gases after using urea SCR setup

## V. CONCLUSION

Our project has successfully reduced the emission level of harmful gases such as Carbon monoxide, Oxides of nitrogen, unburned hydrocarbons.SCR setup reduces NOx highly by using urea injection and compressor setup used mainly reduce the carbon monoxide and unburned hydrocarbon. As a result of this many adverse environmental impacts can be prevented to a certain extent and a cleaner, safer environment will be available for our future generations to live.

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