

Control and Measurement of Exhaust Emissions from the Compression Ignition Engine Based Automobiles Using a Multi-Gas Analyzer

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Abstract: This research paper is based on the analysis of the utility of a multi gas analyzer in the measurement of exhaust emissions emitting from the tail pipe of Compression Ignition engine based automobiles. Also, Light has been thrown on the importance and effectiveness of nano-particles towards the control of automobile pollution. Compression Ignition engine based automobiles are known to be the major contributors in the environmental pollution. So, the accurate measurement of the exhaust emissions is required to find an appropriate method for reducing pollution level. Also, accurate measurement is necessary for measuring the effectiveness of the suggested method for pollution control. This research paper highlights the scope of utilization of a multi-gas analyzer in the area of automobile pollution prevention and control.

Keywords: Automobile pollution, Compression ignition engine, Multi-gas analyzer, Nano-particles.

I. AIR POLLUTION FROM AUTOMOBILES

The transport sector counts as the major contributor towards the alarming rate of increase in environmental pollution. Day by day, the number of diesel engine vehicles are increasing as a result of increased transport needs but there lacks an effective measure to keep a check on the atmospheric pollution due to these vehicles. There are a large number of two wheelers and four wheelers operating on roads. Owing to many factors like poor maintenance, running conditions, operating environment, etc., the tail-pipe of automobiles start emitting harmful exhaust emissions which includes carbon monoxide, hydrocarbons, oxides of nitrogen, etc. [1].

Atmospheric pollution emitting from vehicles is mainly owing to the exhaust emissions emitted from the tail pipe and it is a function of many factors like changes occurred in driving cycles, running condition of engine, composition of fuel and the air-fuel ratio. Any malfunctioning of the engine devices like the

fuel-injection system leads to an increase in the concentration of the exhaust components [2].

II. NANO-TECHNOLOGY AND NANO-PARTICLES

Nano-technology includes different technologies dealing with the structures and processes generally on a nanometer meter (i.e., one billionth of meter). It involves application of different tools and techniques that are innovative in approach and having superior performance to the technologies based at macro level. Nano-technology and nano-science are the two approaches in the area of research and development that focus mainly on controlling the air pollution and reduction in the level of energy consumption [3].

The applications and utilities of nanotechnology are wide and increasing day by day. Soon, it is expected to have a huge impact on the lives of every individual. With the help of nanotechnology tools and techniques, it is quite possible to alter the size-dependent properties of materials which are structured on the sub-100 nanometer scale. These properties can be assembled and structured to develop nano-devices and nano-systems having innovative properties helpful for environment [4].

Materials that are generally manufactured on the scale of nanometer exhibit different from similar materials produced on a macro scale. Nano-technology will not only lead to a major technological development in the coming time, but it may also have a huge impact on the economic, ecological as well as social sectors [5].

Owing to the very minute dimensions of the nano-particles, their physical as well as chemical properties such as stability, hardness and conductivity, can be altered to change the overall properties of the traditional materials. Nano-particles are being given higher priority for potential use in devices such as catalytic converters mainly due to their excellent catalytic reactivity. This property can be utilized for effectively

decreasing the concentration of the exhaust gases emitted from the automobiles [6].

III. POLLUTION CONTROL USING NANO-PARTICLES

There are two commonly used methods for control of pollution known as the pre-pollution control and the post pollution control. Many researchers are analyzing the employment of precious metal nano-particles in the exhaust filters for vehicles as well as for the power plants [7].

The nano material catalyst employed in a catalytic converter is generally made of precious metals. Platinum is known as one of the most active catalysts, but it is not suitable for all applications primarily due to unwanted reactions and huge cost. Palladium and Rhodium are considered as the other precious metals. Rhodium is employed as a reduction catalyst whereas palladium is employed as an oxidation catalyst. Platinum can be used for both for reduction as well as oxidation. Manganese, iron and nickel may also be used, but each has its own limitations [8].

Automobile exhaust emissions consist of carbon dioxide, carbon monoxide, oxides of nitrogen, hydrocarbons, lead and other particulate matter. Inhaling carbon monoxide badly affects the supply of oxygen from human blood into the different tissues by combining along with the iron present in hemoglobin clearing the way for a variety of human ailments. Carbon dioxide also leads to the global warming [9].

IV. CATALYTIC CONVERTER AND ITS IMPORTANCE

To combat the menace of the problem of air pollution from automobiles, the states and government created several clean-air-laws that restricted the level of pollution that vehicles can emit. During recent years, automobile makers have done many refinements in car engines and fuel systems to adhere to these laws. One of such changes came in 1975 with the development of an interesting device termed as a catalytic converter. A catalytic converter generally works as a vehicle emissions controlling device that converts different toxic pollutants present in the exhaust gas in to comparatively less toxic pollutants by catalyzing a red-ox reaction (oxidation or reduction) [10].

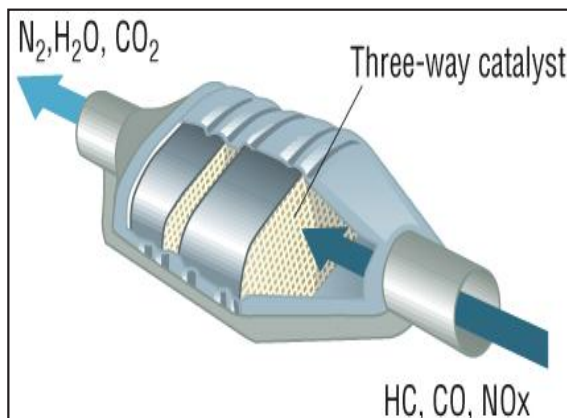


Fig. 1: Catalytic Converter

Catalytic converters are meant for employing in the internal combustion engines run by either petrol or diesel as a fuel. The catalytic converter was originally invented by Eugene Houdry, a French mechanical engineer and also, a specialist in the areas of catalytic oil refining. A catalytic converter utilizes generally two different types of catalyst known as reduction and oxidation catalysts [11].

The main concept behind the design of a catalytic converter is to prepare a structure that leads to maximum exposure of surface area of the catalyst to different exhaust emissions. The exhaust gases are made to pass through a bed of catalyst and a catalytic action occurs at surface of catalytic converter [12].

V. CONTROL OF POLLUTION USING MULTI GAS ANALYZER

A research on the nano-particles says that the surface area to volume ratio of a nano-particle is proportional inversely to its radius. Therefore, by minimizing the radius of the nano-particle, this ratio increases ultimately leading to an increased rate of catalytic reaction and thereby; the concentration of the automobile pollutants is decreased [13].

In automobiles, more particularly those powered by diesel, the nano-particles have promised to be very effective in oxidizing the harmful hydrocarbons compounds and other harmful gases that are released from the tail-pipe of vehicles and minimizing their negative impact on the atmosphere. The nano-particles coating on a catalytic converter of automobiles can prove to be very helpful in reducing the concentration of different pollutants concentration and thus reduce the pollution level in atmosphere [14].

Among the main metals such as gold, palladium, platinum and other metals, copper plays a very important role in modern day electronics circuits owing to its excellent electrical conductivity and also low cost [15].

VI. MULTI GAS ANALYZER

A multi gas analyzer of the model NPM MGA 2 was used in this research for the purpose of measurement of exhaust emissions which included carbon monoxide and hydro carbons. The concentration of carbon monoxide was measured in percentage and the concentration of hydro carbons was measured in PPM, i.e., parts per million [16].

For the purpose of analysis, the exhaust emissions from the tail pipe are measure with the help of an instrument known as the Multi-Gas Analyzer which is shown in Fig. 2. It is primarily used for measuring the concentration of Carbon monoxide, Hydrocarbons, Nitrogen oxides and other harmful gases. Different types of a Multi Gas Analyzer are available. Any model can be selected suitably as per requirement. The concentration of the exhaust gases is measured at different loads, like quarter load, half load, three-fourth load and full

load. Speed can also be changed accordingly.



Fig. 2: Multi Gas Analyzer



Fig. 3: Sample Reading from Multi Gas Analyzer

VII. EXPERIMENTAL PROCEDURE FOR MEASUREMENT OF EXHAUST EMISSIONS FROM DIESEL ENGINE AUTOMOBILES USING A MULTI GAS ANALYZER

To measure the concentrations of exhaust emissions using nano-coated catalytic converter, the experimental procedure is as follows:

1. Connect the instrumentation power input plug to a 230 V, 50 Hz single phase AC supply. Now all the digital meters namely, rpm indicator, temperature indicator display the respective readings.
2. Fill up the diesel to the fuel tank mounted side of the panel.
3. Check the lubricating oil level in the oil sump.
4. Start the engine with the help of given attachments.
5. Allow the engine to stabilize the speed.
6. Apply $\frac{1}{4}$ load, i.e. slowly vary the load attachment.
7. Note down all the required parameters.
8. Increase the load on the engine step by step with the use of load attachment such as,
 - (a) $\frac{1}{4}$ load
 - (b) $\frac{1}{2}$ load
 - (c) $\frac{3}{4}$ load
 - (d) Full load
9. Repeat the above procedure for different speed and load conditions.

VIII. RESULTS AND CONCLUSION

The menace of atmospheric pollution from the compression engine automobiles has emerged as a serious concern today. Many researchers have performed various analyses on various techniques to be used for the exhaust emissions measurement and the concentration reduction. The utilization of nano-particles is catching pace in the area of automobile based pollution control owing to their small size and also special characteristics. Catalytic converters having coated with nano-particles are getting popular as one of the most efficient means for reducing the concentration of the exhaust emissions. The accurate measurement of the exhaust emissions is required to find an appropriate method for reducing pollution level. Also, accurate measurement is necessary for measuring the effectiveness of the suggested method for pollution control. This research paper highlights the scope of utilization of a multi-gas analyzer in the area of automobile pollution prevention and control.

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