ISSN 2063-5346

ANALYSIS FOR DETERMINATION OF EFFECTIVENESS OF NANO-PARTICLES IN AIR POLLUTION CONTROL

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Article History: Received: 15.05.2023 **Revised:** 20.06.2023 **Accepted:** 30.06.2023

Abstract
Air has become much polluted due to severe increase in the number of automobiles. The level of air pollutants contributed from S.I. engine automobiles is very high, so, an appropriate remedial action is necessary to lower its severity. The aim of the present research work is lower the level of level of pollution from petrol engine automobiles by using catalytic converter and nano-particles. During the research work, Copper nano-particles were coated on a catalytic converter and experiments were conducted after using it in a S.I. engine test rig. The results of the experiment demonstrate the effectiveness of using Copper nano-particles on a suitable catalytic converter for pollution control. This research also paves the way for further research to modify a catalytic converter for achieving further reduction in the level of exhaust gases released from vehicles. On the suitable modification of catalytic converter, the performance of a catalytic converter can be improved.

Key words: Automobiles, catalytic converter, pollution.

1. Introduction

Dey and Mehta described that the air pollution from automobiles has increased owing to the rise in the fleet of vehicles plying on road, may it be bikes, cars, trucks, buses or others. Due to this increase, air quality has deteriorated and various diseases associated with it have emerged. To address this problem, either the vehicles plying on road have to be regulated or some suitable control measures need to be adopted so that the pollution level can be brought to a low level. Dey and Mehta proposed catalysis as a suitable option for air pollution control. Emission control system in automobiles employing a suitable catalyst can help reduce the air pollution to a significant level [1].

Ipsita et al. pointed out that pollution level has risen tremendously due to rise in the number of Spark Ignition engine automobiles on road. Spark Ignition engine automobiles mainly emit harmful emissions including Carbon monoxide and Hydrocarbons. Ipsita et al. conducted an experimentation to understand the effect of using butanol blend in the concentration of pollutants. The experiment was conducted on a S.I. engine test rig. After the extensive experimentation, it was observed that the emissions concentrations reduced on using the butanol blend [2].

Venkateswara Rao et al. studied and experimented for reducing emissions concentrations from a Spark Ignition engine using magnetism. They elaborated that the pollutants from S.I. engine automobiles pose several threats to human health and lead to various ailments. Carbon monoxide emitted from the Spark Ignition engine may lead to formation Carboxy Hemoglobin which may be a cause of death. The Hydrocarbons emitted from automobiles are also very dangerous to health. During the course of extensive experimentation conducted by Venkateswara Rao et al., they found that magnetism has lead to a decrease in the concentration of the exhaust emissions. So, they suggested that some suitable treatment of exhaust gases in necessary before they enter the atmosphere [3].

Warju et al. conducted an experiment to understand the affect of using Titanium Oxide coated catalytic converter in reducing the concentrations of the pollutants released from the gasoline engine based automobiles. They concluded that Titanium Oxide coating was helpful in bringing down the pollution level from gasoline engine vehicles. They also suggested that the treatment of exhaust gases from automobiles is necessary for human health and welfare [4].

Elham et al. studied and analyzed the utility of nano-technology in Air Pollution control. The elaborated that nano-technology is very advanced technology based on nano-particles. Nano-particles possess improved properties over macro particles on account of their small size. The catalytic activity of the nano-particles is very high and it leads to an effective reduction of exhaust emissions including Carbon monoxide and Hydrocarbons. Nano-technology has also been used in various fields to improve performance of existing systems and methods [5]. Evangelos et al. have analyzed the various technologies for controlling the exhaust emissions concentrations and their treatment. They have elaborated that nano-technology is a very effective technology for controlling the exhaust emissions due to small size of nano-particles. Nano-particles have high catalytic activity which helps in treatment of exhaust emissions [6].

Nagareddy et al. analyzed that the catalytic converters can be coated with a suitable catalyst and their interaction between exhaust emissions lead to reduced emissions concentrations. Catalytic converters can be modified in shape and dimensions as per the space and design requirements of the automobiles [7].

Durairajan et al. have explained that nano-particles can act as a game changer in the area of pollution control when used in catalytic converters. They have conducted extensive experimentation and observed that the level of exhaust emissions reduced significantly when nano-particles were used in catalytic converters. Also, the nano-particles are helpful improving the overall process of air pollution control [8].

Prabhu et al. have reported that nano-coatings are very effective in reduction of the exhaust emissions concentrations by interaction with the harmful emissions. Nano-particles have unique properties by virtue of their size and these properties are very helpful in exhaust emissions treatment. Different nano-particles have been used to check the utility of nano-particles. The results reveal that the highly active surface of nano-particles is responsible for achieving reduced concentrations of exhaust emissions [9].

Various experimentations have been carried out using nano-particles to lower the air pollution level from automobiles. The results of the experiments demonstrate the superiority of nano-particles for dealing with air pollution. Also, nano-particles have high surface area to volume ration which increases further with the decrease in size of the nano-particles [10-13].

Kishore et al. have described and demonstrated the Copper nano-particles are a very suitable option for exhaust emissions reduction. Copper has high thermal conductivity. It is easily and readily available. Copper is also cheaper as compared to other metals. So, Copper can be utilized in catalytic converters for air pollution control [14].

2. Methodology

In this research, experimentation has been conducted for evaluating the utility of copper nano-particles used on a suitable catalytic converter. First of all, an innovative catalytic converter was fabricated as shown:

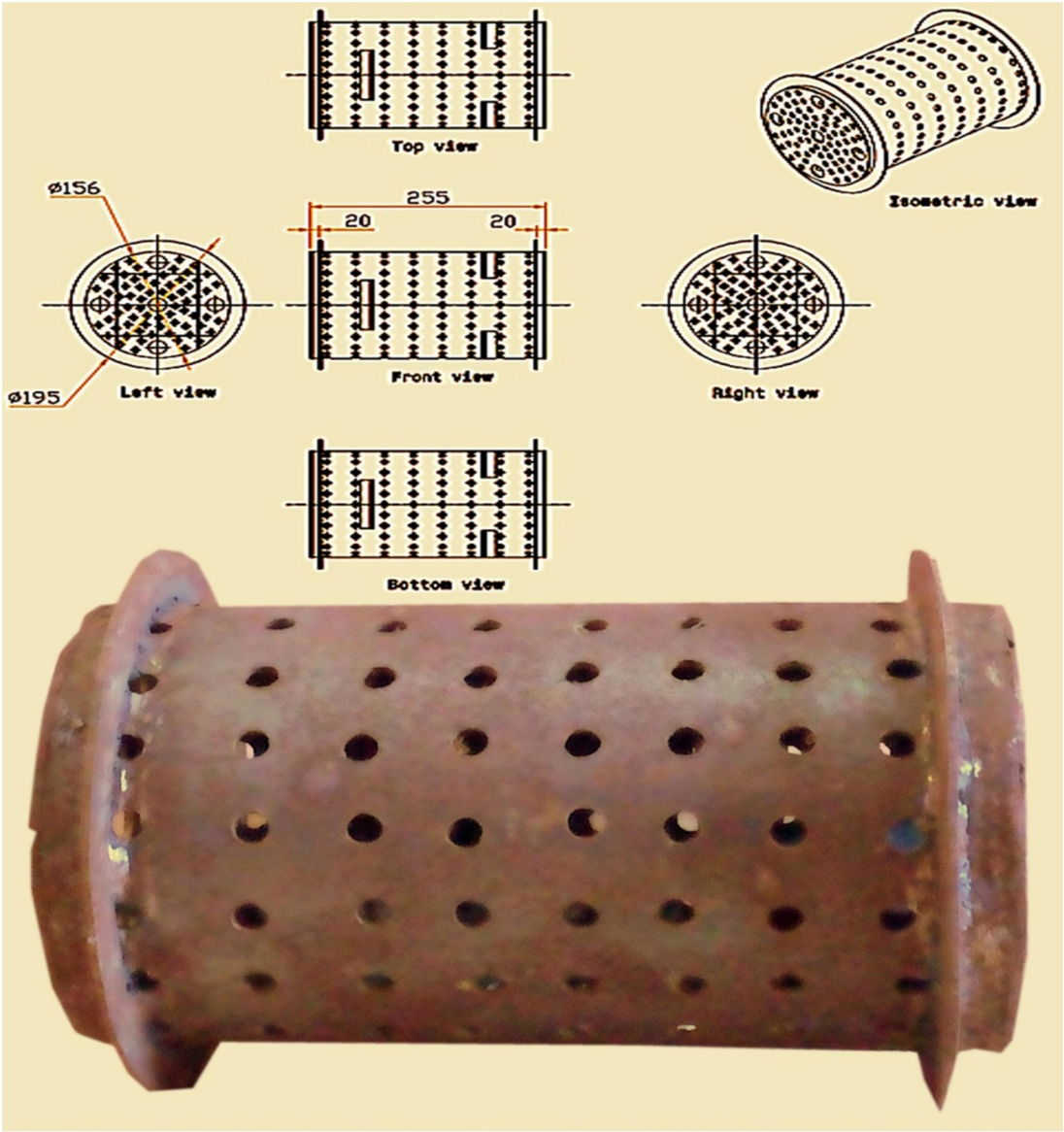

Figure 1. Innovative Catalytic Converter

The following figure shows the complete setup.

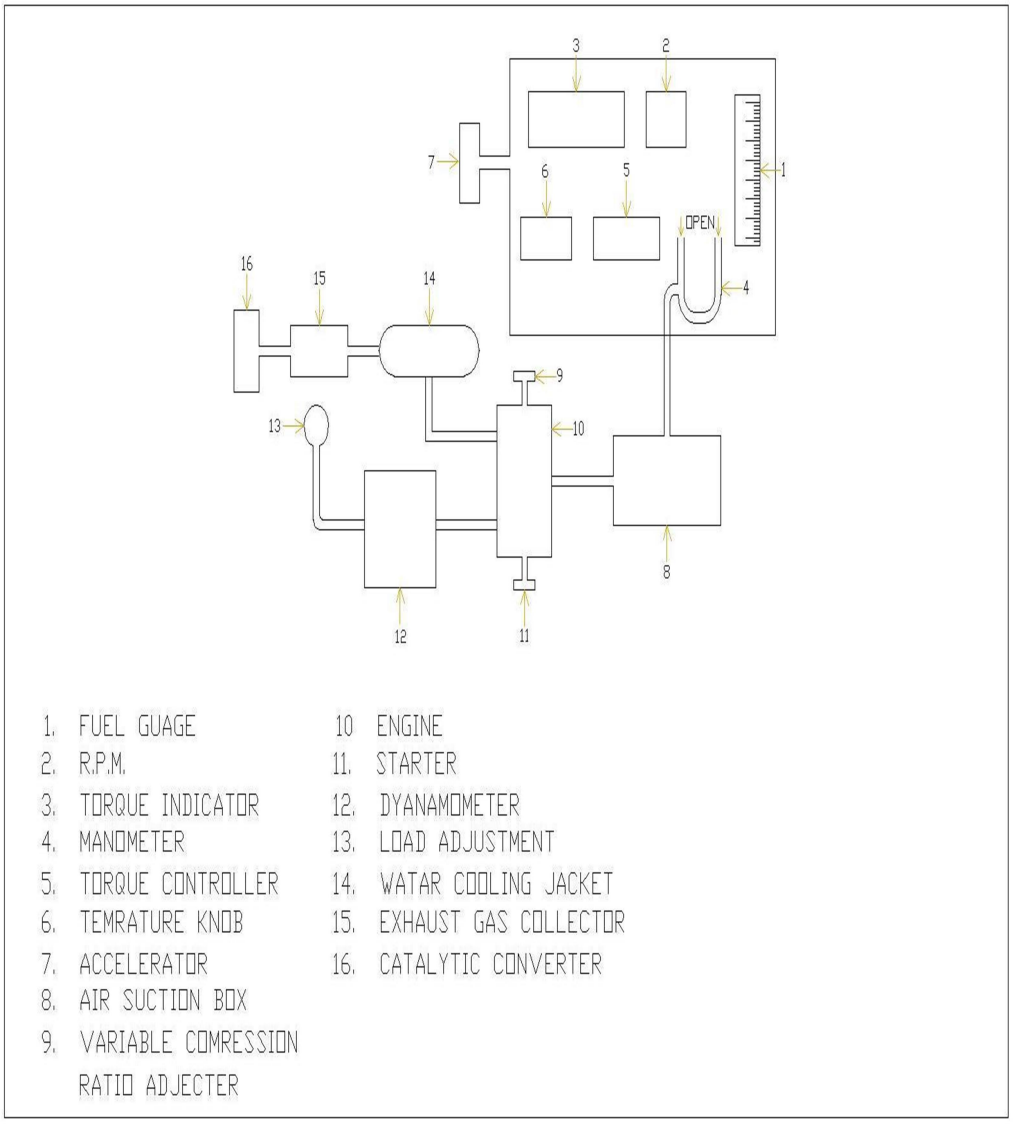

Figure 2. Setup of Four Stroke Spark Ignition Engine test rig

Nano-particles of Copper were used as coating on the fabricated catalytic converter by the use of drop casting method. The following diagram shows the muffle furnace used for heat treatment of the copper nano-particles for better adhesion to the surface of catalytic converter.

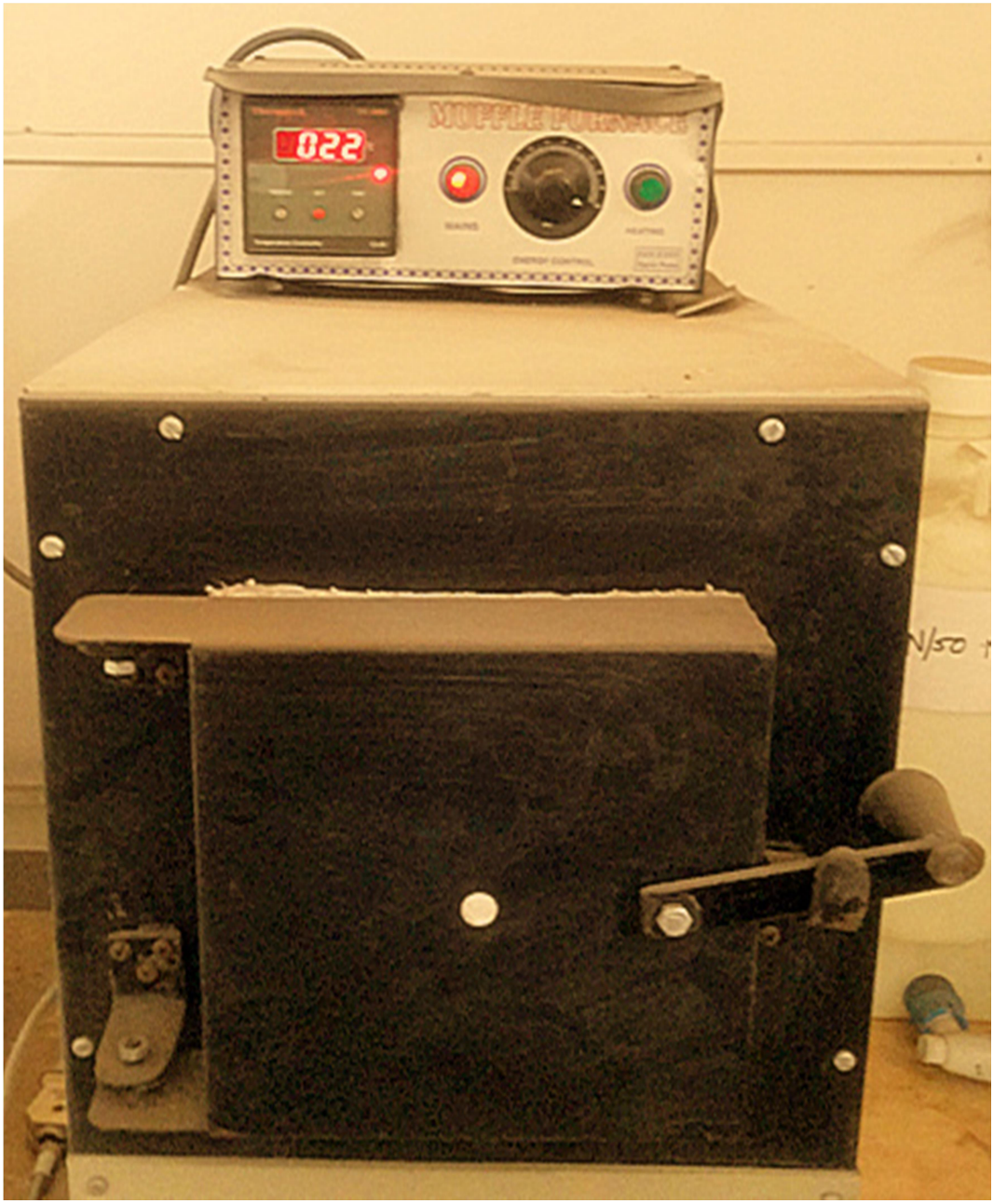

Figure 3. Heat treatment of copper nano-particles in a muffle furnace

After the process of coating, the difference achieved in air pollutants levels after coating of copper nano-particles was found using multi-gas analyzer. The muti-gas analyzer is shown in the following figure:

Figure 4. Multi gas analyzer

3. Results and Conclusion

The emissions concentrations, i.e., CO and HC were compared before and after coating of copper nan-particles. The following figures depict the comparison before and after coating of Copper nano-particles on catalytic converter:

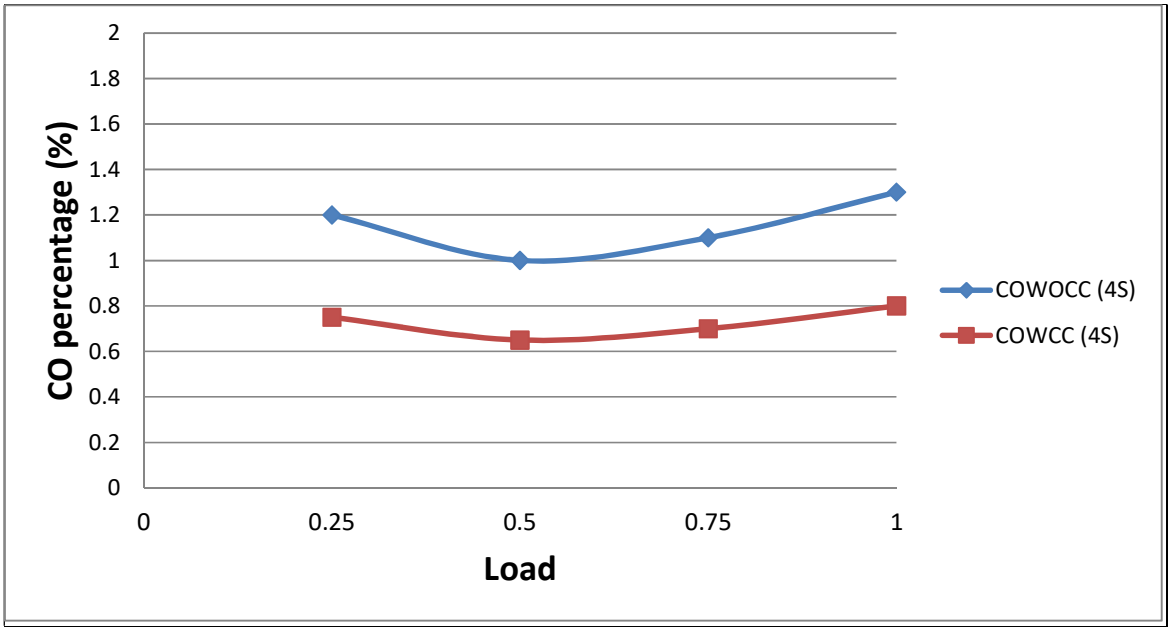

Figure 5. CO percent Without Catalytic Converter (WOCC) and With Catalytic Converter (WCC) comparison at 1500 RPM

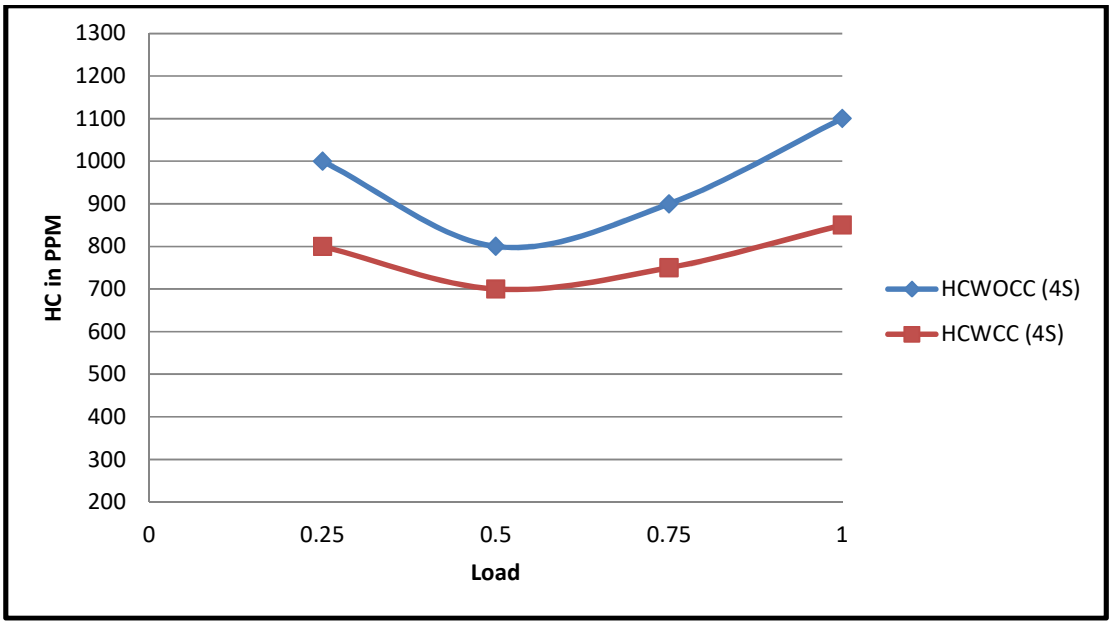

Figure 6. HC PPM Without Catalytic Converter (WOCC) and With Catalytic Converter (WCC) at 1500 RPM

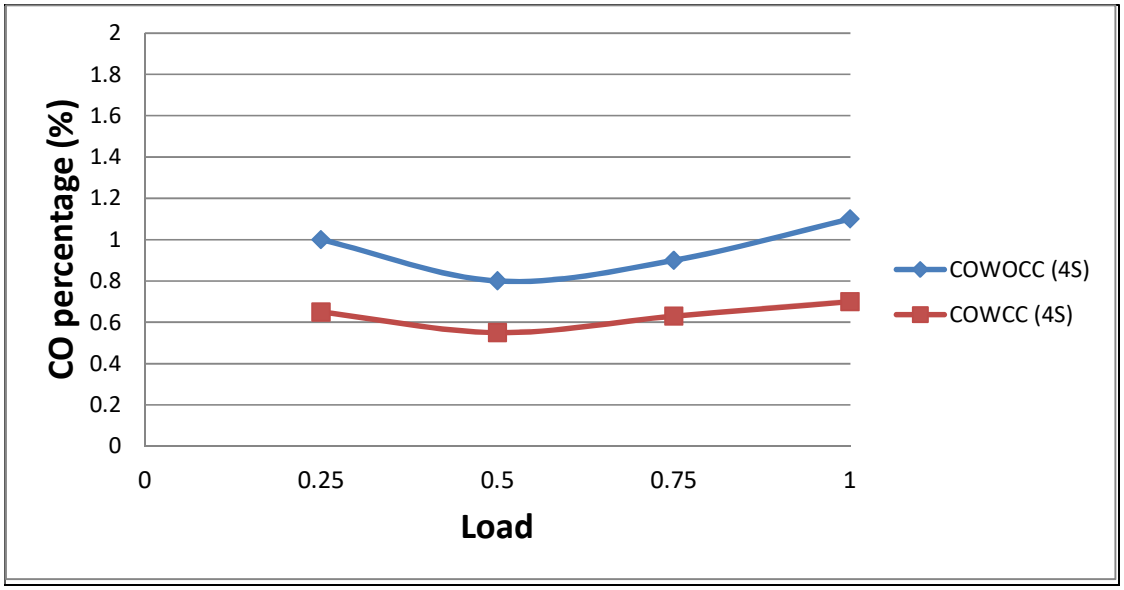

Figure 7. CO percent comparison Without Catalytic Converter (WOCC) and With Catalytic Converter (WCC) at 1800 RPM

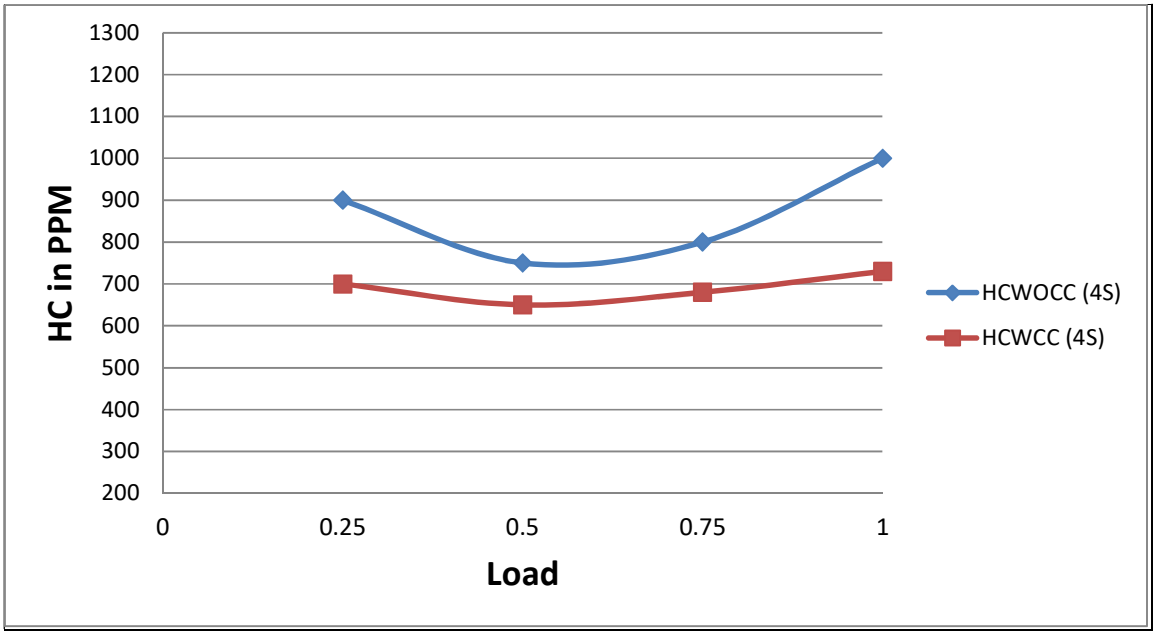

Figure 8. HC PPM Without Catalytic Converter (WOCC) and With Catalytic Converter (WCC) at 1800 RPM

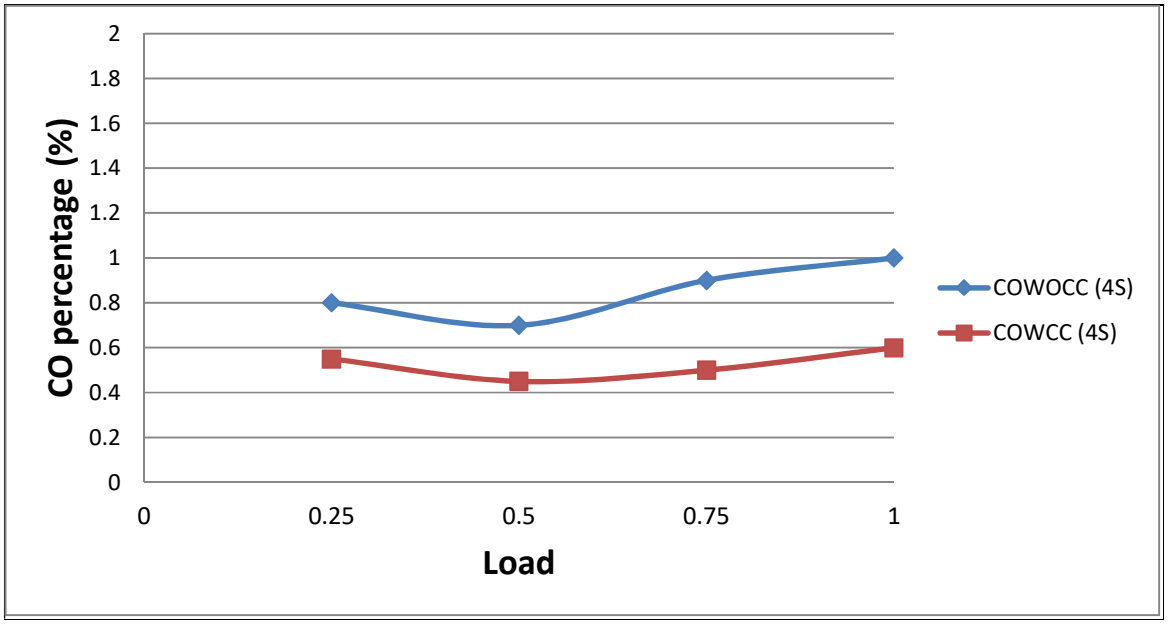

Figure 9. CO percent comparison Without Catalytic Converter (WOCC) and With Catalytic Converter (WCC) at 2000 RPM

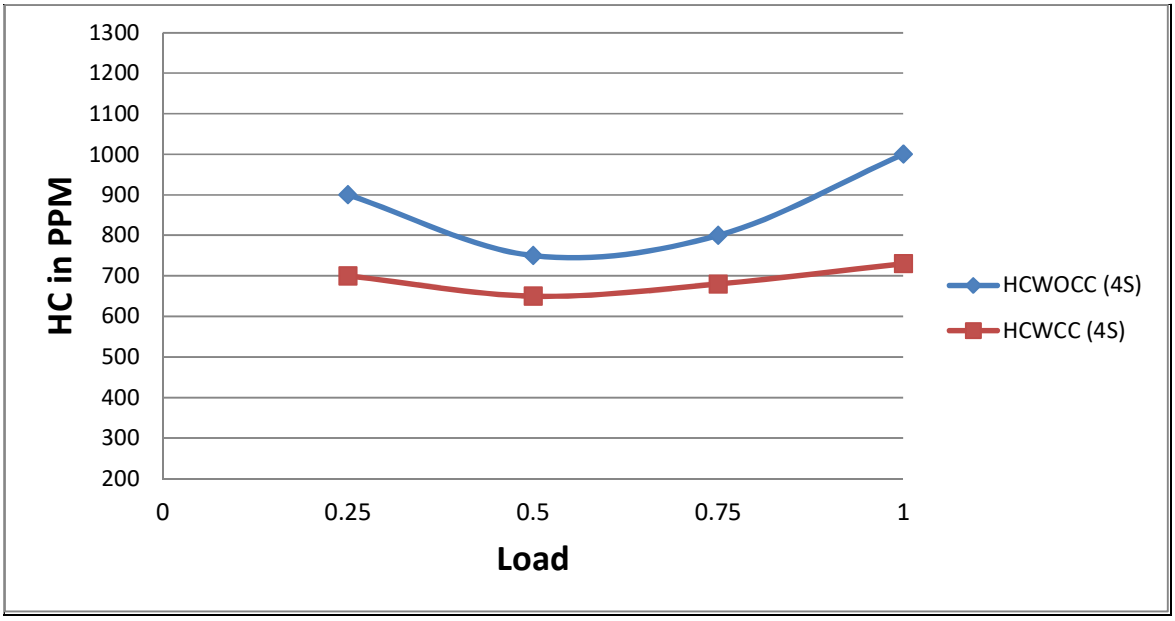

Figure 10. HC PPM Without Catalytic Converter (WOCC) and With Catalytic Converter (WCC)
at 2000 RPM

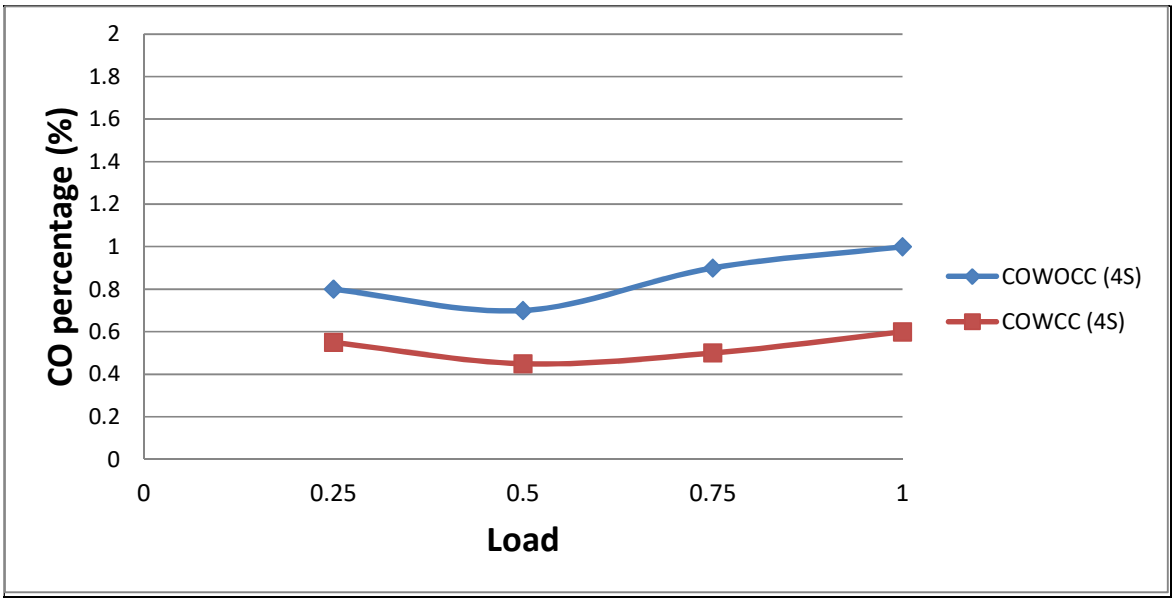

Figure 11. CO percent comparison Without Catalytic Converter (WOCC) and With Catalytic Converter (WCC) at 2200 RPM

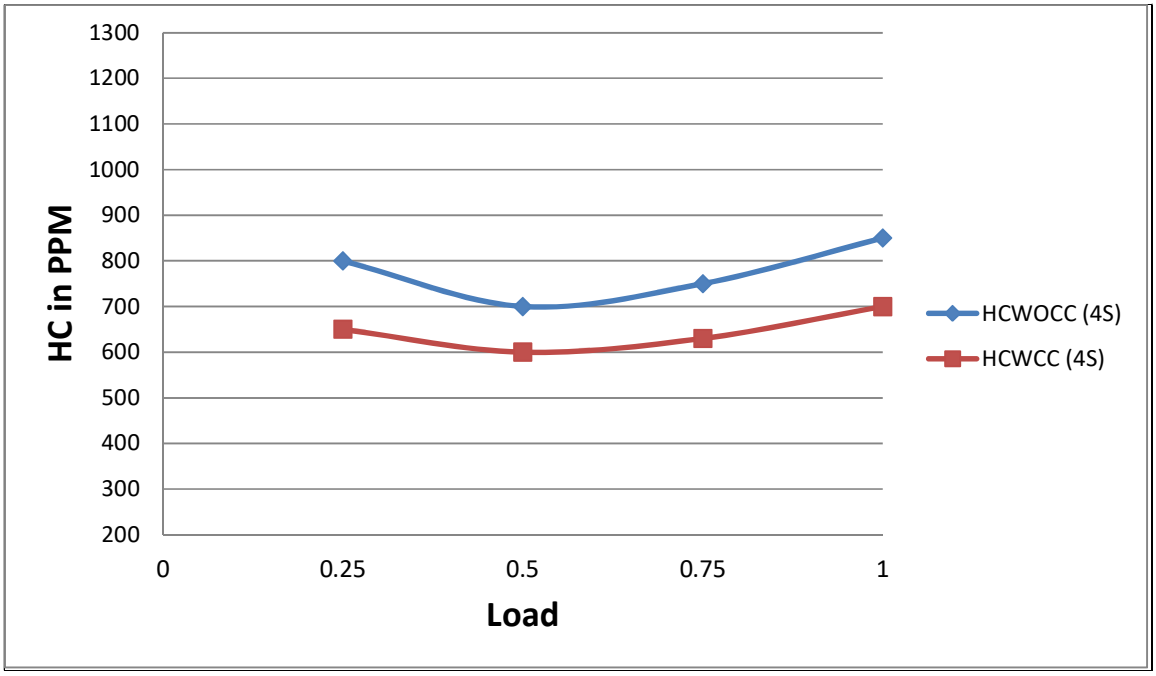

Figure 12. HC PPM Without Catalytic Converter (WOCC) and With Catalytic Converter (WCC) at 2200 RPM

It can be clearly seen from the graphs of the level of CO and HC emissions with respect to the load on engine at different speeds, the CO and HC emissions have decreased for each load. The reduction in the level of emissions has been in the range of 10-15 %.

The level of emissions has been on the higher side during small and high loads on the engine and it has been on the lower side for medium loads applied on the engine. There are many factors responsible for the significant reduction achieved in the level of emissions, some of which are as follows:

1. Highly active surface area of catalytic converter.
2. Use of Copper nano-particles as they possess high high thermal conductivity and superior catalytic properties favorable for reduction of emissions level.

   So, it can be concluded that Copper nano-particles are a suitable option for use in air pollutants concentration reduction from S.I. engine automobiles.

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