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Experimental Investigation of Exhaust Emissions Using Nano-Particle Coated Catalytic Converter for Four Stroke Spark Ignition Engine

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Abstract: ***Automotive playing a severe role in contribution to the toxic compounds. Pollution is primarily produced by means of the exhaust of motorized cars in addition to the combustion of fossil fuels. Pollution management is the important for future era to regulate cytotoxic emissions like CO, NO_x and HC. There are tactics of manage of pollutants particularly, pre-pollution manipulate and post pollution manage. This studies work is primarily based totally on the submit pollutants control technique the use of nano-particle as a catalyst. An assessment on nano-particle exposed that the ratio of surface region of nano-particle to the quantity of the nano-particle is inversely proportional to the radius of the nanoparticle. Copper turned into thought of for this evaluation work due to the fact it's far less expensive than platinum, palladium and rhodium. This paper opens an access to study the modifications inside the attention of exhaust emissions due to the nano-fabric coating.***
Keywords: ***Modified Catalytic converter, Copper nano-particles, Spark-ignition engine, Coating Method***

I. INTRODUCTION

One of the intense issues facing the globe is that the forceful increase in environmental pollution by burning engines. All transport vehicles; each SI (Spark ignition) and CI (Compression ignition) area unit equally answerable for emitting completely different reasonably pollutants[1]. A number of the best known kinds having direct hazardous influences take for instance, carbon mono oxide (CO), hydrocarbons, nitrogen oxides (NO_x), and so on. Other the secondary pollutants which go through a series of reactions within the ecosystem and come to be unsafe to health[2]. The emissions exhausted into the surroundings to pollute the ecosystem and cause global warming, acid rain, smog, odours breathing and distinctive health dangers. A pollutant is a phenomenon which modifications the stability of the environment and nature under normal condition[3]. Carbon di oxide is not perceived as a pollutant in nature recycles in cases where CO_2 goes above 5000 ppm then it turns out to be a wellness and fitness issues. In addition to air pollutants, there may be additionally water pollutants because of different factors, which incorporates waste disposal, oil spills, and leakage of fertilizers, herbicides and insecticides, by-products of industrial approaches and combustion and extraction of fossil fuels. Contaminants are normally found combined in the air, water and soil. Thus, we need awareness our studies and improvement efforts increasingly to screen, detect and, if possible, take away the contaminants from the air, water and soil. In this context, nanotechnology gives a huge range of skills and technologies to improve the best of current surroundings. It is also beneficial in enhancing the overall performance of conventional technologies used in clean-up manner

Because of their small size, nanoparticles have very high

surface area compared with their bulk equivalent. Thus nanoparticles are being explored as a way to remove or break toxic substances from the environment[4]. Nanoparticles are extra reactive and react to a more volume because of their smaller size. Nanoparticles have greater surface to be had for chemical interactions. Nanoparticles will also be able to exhibit more significant chemical reactivity on account of unusual crystal structures and lattice order.

II. NANO-PARTICLE COATED CATALYTIC CONVERTER

Nanotechnology presents excellent prospective in offering revolutionary approach towards minimizing the toxins in air water and land. It's conjointly useful in rising the performance of typical technologies employed in cleanup method[5]. Metallic nano particles particularly the exorbitant expensive metals including gold, platinum and palladium are progressively being used as catalysts in many different industries as well as ecological utility. The ratio at which the automotive sector is obstructing the environment makes the uses of nano technology mandatory, to evade further problem. Malfunction of the engine systems like the fuel injection system causes an increase in the exhaust emissions. The exhaust emissions from the automobiles include gases like Carbon dioxide (CO_2),

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Carbon monoxide (CO), Nitrogen oxide (NO_x), lead (Pb) and unburnt hydrocarbons. A complete review on the application of nanotechnology in automotive pollution prevention was explained. Initially the essential aspects of ecological toxins problem mainly because of automobile sector were talked about, after that the use of nano technology towards the prevention and control of these problems were presented[5]. During the conversion of toxic to non-toxic gases nano technologies play a crucial role. The effect of catalysts normally relies upon on the size of the surface. If the fabric used for the catalytic characteristic is scaled to the nanometer range, the precise surface will increase significantly[6]. The composition as well as shape are picked up such that exhaust gases have interaction optimally with the catalytically active layer and their chemical transformation into innocent materials is expanded. Copper were taken into consideration to do this research work since it is less expensive as compared to rhodium platinum, and palladium[7]. Catalytic converters with a spray of copper nanoparticle on copper sieve lead to a lot better performance of vehicles and reduced pollution in atmosphere.

III. METHODOLOGY

A. Coating Material

Out of the various materials that can be used for coating, copper metal is selected for the present work as it is much cheaper than rhodium, platinum, and palladium[7]. Also it adsorbs the reactants molecule strongly enough to hold and active the reactants but not so strongly that the product can't breakaway also the diffusion of Reactants and products into and through the pore structure of copper happened efficiently[8]. As a result of this, the pollution intensity for the tailpipe release of spark ignition engine has observed to be minimized that could be superior with nanosized catalytic converter.

B. Preparation of Cu Nano-particle

The nano-copper is prepared by chemical reduction process using ethylene glycol solution of copper (II) sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$) and ethylene glycol solution of Sodium hydroxide (NaOH) and Hydrazine hydrate solution ($N_2H_4.H_2O$) [9].

C. Coating Method

Copper nano-particles were coated over the steel mesh and steel plate. Drop casting method was used to coat copper nano-particle, since, the method is very simple and no waste is generated. Cut section model of every assembly was coated with copper nano-particle. The Copper nano-particles having size range of 25 – 40 nm was suspended in to Ethylene glycol was spreaded in to assembly in multiple layers to get uniform distribution of copper nano-particles over the assembly surface and dried at 200°C for two hours in a hot air oven[8] . After drying the first layer in the oven another layer was coated with copper nano particles by repeating the dropping method drying again at 200°c for 2 hours. As obtained copper nanoparticle coated assembly was then subjected to heat treatment for proper adhesion.

D. Modification of Catalytic Converter

in the present work a couple of modifications as well as alterations have been designed in order to improve the retention period of tailpipe emission to allow some more time for its oxidation and in that way to decrease the hazardous release. For the modification catalytic chamber is open using arc welding and cutting then the two sets of stainless steel wire mess having 1.5x1.5mm opening is installed inside the convertor and fitted with the help of nuts and bolts[9]. It is designed in such a way so that the area of cross section at the point where the wire mess is fitted is about two times the area of cross-section of exhaust manifold of the engine[12] as shown in fig.1

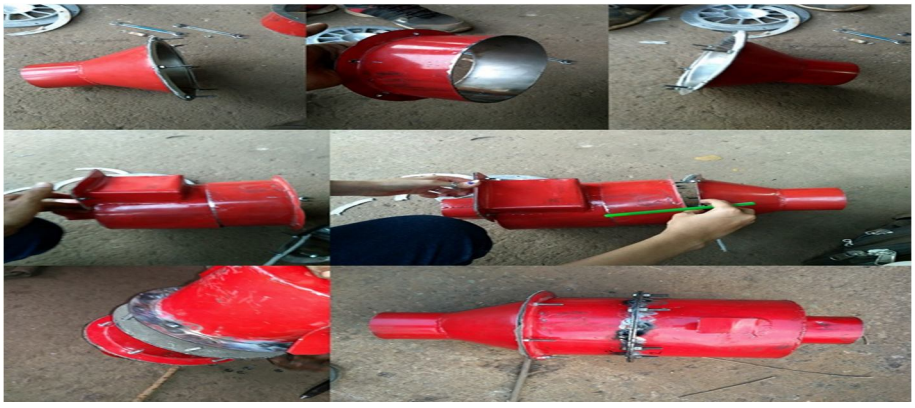

Fig.1 Fabrication of catalytic converter

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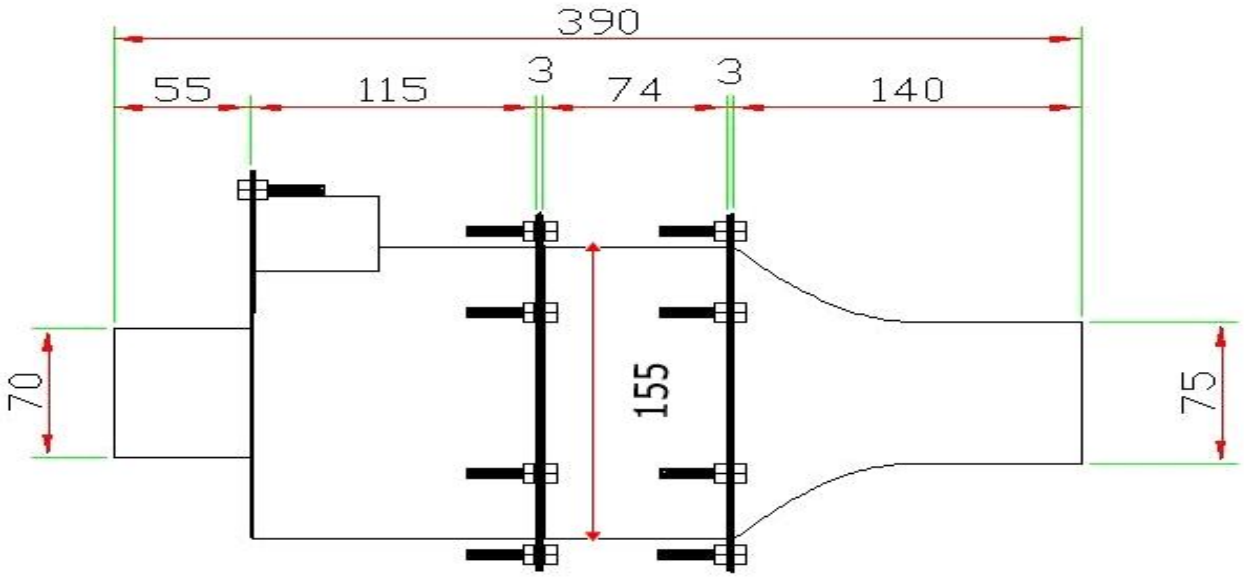

Fig.2 Design of modified catalytic converter

E. Testing of Modified Catalytic Converter

The experiments were carried out on a four stroke, horizontal water cooled electronic ignition engine before connecting the engine test rig to the three phase electrical supply be sure that the water level in the manometer is roughly about half of the full scale in each of those manometer limb and also check oil level in the engine sump, pour required volume of petrol in to the fuel tank, then switch on the console switch, all of the digital indicators glowing and therefore show respective readings[11]. The engine was started by electronic ignition technique wait until the engine stabilize at its rated speed, i.e., 1500 rpm to 1800 rpm by adjusting the accelerator. Record Rpm indicator, Voltmeter and Manometer reading on no load condition. Now continue loading the engine and note all the readings at every single step. Start the gas analyzer and connect with the ordinary catalytic convertor to check the efficiency. Repeat the above procedure for modified catalytic converter and note down all the readings[11].

Fig.3 Experimental Test Rig

Fig.4 Gas Analyser EPM 1601

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IV. RESULT AND CLCULATION

Table I Exhaust Emission Data For Four Stroke Engine

Speed In RPM	Load	COWOCC in %	COWCC in %	HCWOCC in PPM	HCWCC in PPM
1500	0.25	1.4	0.9	1000	900
	0.5	1.1	0.75	850	750
	0.75	1.3	0.73	900	800
	1	1.5	1	1100	1000
1800	0.25	1.3	0.95	900	850
	0.5	0.9	0.7	750	700
	0.75	1	0.8	800	800
	1	1.4	1	1050	1000
2000	0.25	1.25	1.06	1650	1500
	0.5	0.95	0.75	1500	1400
	0.75	1.05	0.8	1600	1480
	1	1.3	1	1750	1650
2200	0.25	1.5	1	1200	950
	0.5	1.3	0.9	950	800
	0.75	1.4	0.95	1050	900
	1	1.6	1.05	1300	1050

Abbreviation:

COWCC – CO emission with catalytic converter
COWOCC – CO emission without catalytic converter
HCWCC – HC emission with catalytic converter
HCWOCC – HC emission without catalytic converter

From the above table of exhaust emission data it was observed that the results obtained from the gas analyzer, the amount of pollutants corresponding to specific RPMs and loads, the values obtained were significantly low in the case of modified catalytic converter. Copper metal was designated for the experiment work because it is cheaper than platinum, palladium and rhodium and the experiment clearly shows that, by using nano copper coated catalytic converter CO is reduced from 1.25% to 0.8% and HC reduced from 962 ppm to 862 ppm also, the NOx and CO_2 emissions were consistently reduced. The test results indicate that the development of nano copper coated catalytic converter is significantly feasible in comparison with the all the other expensive catalytic convertor.

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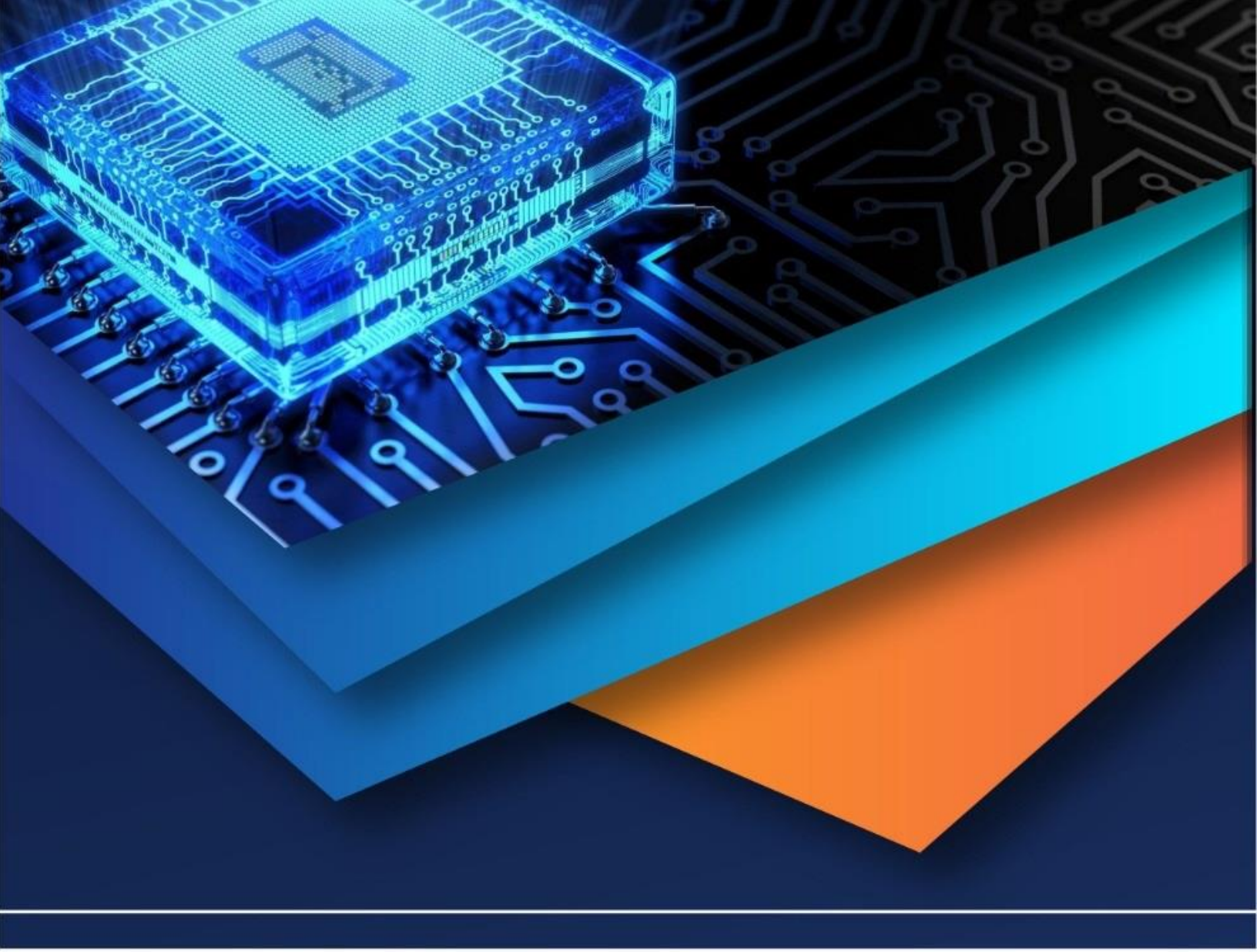

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