Analysis based on Atomic Activity of Nano-particles for Exhaust Emissions Reduction from Automobiles using Nano-Coated Catalytic Converter

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Abstract: ***The exhaust emissions from automobiles are growing day by day at a dangerous rate all over the world. This has led to development of various measures for reducing exhaust emissions from the tail pipe of automobiles. Some of them are based on the pre-pollution control and some on the post pollution control. One of the post pollution control methods is using the atomic activity of nano-particles inside a catalytic converter. The nano-particles exhibit special atomic activity which is different from other particles due to their small size. Particularly, for C. I. Engine based automobiles;the nano-particles have proved to be very effective in oxidizing harmful hydrocarbon compounds that are released from their exhaust, thereby, minimizing their harmful impact on the environment. This research paper is based on the analysis of atomic activity of nano-particles and its utility in exhaust emissions reduction from automobiles; thereby, leading to a clean and green environment.***

Keywords: atomic activity, automobiles, emissions, nano-particles, pollution**.**

1. Introduction

Due to the growth in the urbanization and commercialization, the whole world isfacing a severe crisis of air pollution. Air pollution can be explained as the presence of one or more contaminants in atmosphere for such duration that can be injurious to human health, animals or plant life. The oxidation process of gasoline to CO_2 and H_2O inside the engine is not proper leading to emission of various pollutants. Many laws and regulations have been made to cope up with this problem but all in vain. The pollutants that are emitted by the automobiles are hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter (PM) [1]. Amongst the above pollutants,carbon monoxide is considered as the most toxic pollutant whose effective reduction can be obtained by using nano-particles inside a catalytic converter [2].

Nano-technology is a term to define a wide range of technologies concerned with structures and processes on the scale of a nanometer (one billionth of a meter, 10^{-9} m). It is a collective term for tools and techniques that permit the atoms and molecules that comprise all matter to be manipulated. Nano-science and nano-technology are new approaches to research and development that aim to control the environmental pollution and reduction of energy consumption. Using nanotechnology tools and techniques, it is possible to manipulate the size-dependent properties of materials structured on the sub-100 nanometer scale, which can be assembled and organized to produce nano-devices and nano-systems that possess new or improved properties. Materials produced on a nanometer scale behave differently from the same materials produced on a larger scale [3].

2. Material and Methods

The properties of materials change as their size approaches the nano-scale and as the percentage of atoms at the surface of a material becomes considerable [4]. For bulk materials superior than one micrometer the percentage of atoms at the face is very small relative to the total number of atoms of the material. The attractive and occasionally unpredicted properties of nano-particles are partly due to the aspects of the surface of the material dominating the properties in lieu of the bulk properties. Nano-materials have unique physical and chemical properties that offer important possibilities for analytical chemistry. They are amazingly strong, tough, and flexible at high temperatures. They resist wear, erosion, corrosion and are chemically very active. In most cases, nano-materials smash their conventional counterparts because of their superior chemical, physical and mechanical properties and excellent formability [5].

Nano-particles exhibit a number of special properties relative to bulk material due to very high surface area to volume ratio[6]. All properties of a material change as the particle size approaches molecular dimensions and because it is often the exclusive properties of the nano-particle that make it useful for the realistic purpose, this is why the properties of nano-particle differ from those of bulk samples.This provides a remarkable driving force for diffusion, especially at higher temperatures. The process of sintering can take place when the temperatures are very low. This factor does not affect the density of the final product, though flow difficulties and the affinity of nano-particles to agglomerate complicates matters. The large surface area to volume ratio also reduces the incipient melting temperature of nano-particles [7].

The diesel engine based automobiles have become a major concern in today's scenario. The nano-particles can prove to be very helpful in this regards due to their very small size [8]. The different nano-particles that can be used for coating on the catalytic converter are platinum, palladium, gold, copper, iron oxide. The atomic activity of the nano-particles is very helpful in effective reduction of exhaust emissions which include carbon monoxide, hydrocarbons and nitrogen oxides [9].The two methods for pollution control from the tail pipe of C.I. Engines are the pre-pollution and post pollution control methods. The post pollution control method is more cost effective and easy to be implemented [10]. Catalytic converter coated with nano-particles is used in post pollution control method. A copper coated sieve was used in a catalytic converter to control the exhaust emissions. A gas analyzer was utilized to measure the concentration of exhaust emissions before and after using catalytic converter [11]. Incomplete combustion of the fuels leads to the emission of unburned hydrocarbons. The level of unburned hydrocarbons is generally specified in parts per million (ppm) of carbon atoms. The emission of the unburned hydrocarbons is also used for measuring the combustion efficiency. The exhaust gas treatment is basically a cleaning action after the exhaust emissions leave the engine cylinder. They are made to pass from catalytic converter before entering the atmosphere. In this work, the performance of a copper coated spark ignition engine with methanol blended gasoline on catalytic converter was analyzed [12].

3. Methodology

The idea behind the work is to create a structure that exposes the maximum surface area of catalyst to exhaust stream, also minimizing the amount of catalyst required. Air pollution can be reduced using nanotechnology in several ways. One is through the use of nano-catalysts with increased surface area for gaseous reactions. Catalysts work by speeding up chemical reactions that transform harmful vapors from cars and industrial plants into harmless gases.

The converter uses two different types of catalyst, reduction and oxidation catalyst. The catalyst increases the rate of reaction by adsorption of reactants in such a form that the activation energy for reaction is reduced far below its value in non-catalytic reaction. Due to this, the pollution level for the exhaust emission has found to be reduced that is better with nano-sized catalytic converter. The exhaust gases pass through a bed of catalyst and the catalytic action takes place at surface of copper which is porous and the higher catalytic activity towards the oxidation of carbon mono-oxide and hydro-carbons could be due to the higher catalytic surface area of small nano-particles.

The catalyst increases the rate of reaction by adsorption of reactants in such a form that the activation energy for reaction is reduced far below its value in uncatalyzed reaction.Nano-particle exhibit high temperature stability beyond that normally encounter in catalytic converter applications.

4. Results and Discussion

With the help of nano-particles, the concentration of the exhaust emissions decreases. It is due to the principle that the area to volume of nano-particle is inversely proportional to the radius of the nano-particle. This helps in increasing the rate of reaction between the exhaust emissions and the nano-particles and thereby, decreasing the concentration of the exhaust emissions at the tail-pipe of the automobiles.Nano-catalysts are generallyheterogeneous catalysts which are broken into metalnano-particles so as to speed up the process of catalysis. Metal nano-particles also have a higher surface area so that there is an increased catalytic activity. This is due to the occurrence of more catalytic reactions simultaneously. Nano-particle catalysts are also easily separable and can be recycled with higher retention of catalytic activity compared to their bulk counterparts. Nano-catalysts can play two different roles in the catalytic processes: they can be at the site of catalytic processes or they can act as a support for the catalytic processes. They are generally used under mild conditions to avoid the decomposition of the nano-particles at extreme conditions. A catalytic converteris an exhaust emissions control device used to reduce the concentration of exhaust emissions of an internal combustion engine by way of catalyzed chemical reactions. The specific reactions can vary with the type of the catalyst used.

5. Conclusion

This research paper throws light on the special atomic activity of nano-particles to prove their worth in the effective reduction of exhaust emissions concentration when used with a catalytic converter.

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