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Environmental Pollution Control Using Nano-Particles in SI Engines

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Abstract: ***The purpose of this paper is to present nanotechnology is covering various technologies which are in progress at nano-scale. It plays a essential role in the creation of new methods to produce new-fangled products, to replace existing production equipments and to develop new materials having a much better performance leading to lesser amount of consumption of energy and reduced ecological degradation. This research paper focuses on the utility of the nano-particles in the area of automobile pollution control. The change of particle size from micro to nano causes significant change in the material properties. These properties can be vital in the reduction of pollution from environment which has become a serious problem today. Use of Catalytic Converter was found the best way to control the automotive exhaust emission among all of technologies and the coating of nano-particles on the catalytic converter of automobiles will help in decreasing the level of exhaust emission concentration and thereby, reduce the pollution level in atmosphere. This review paper deals with the automotive exhaust emission and its effects, automotive exhaust emission control by use of catalysts used in catalytic converter, atomic activity of nano particles and also the various nano-particles used in the automobile pollution control.***

Keywords: Automobile; nano-particles; catalyst; catalytic convertor; pollution; properties

1. Introduction

The automobiles exhaust gases contains carbon monoxide (CO), and organic compounds which are unburned or partially burned hydrocarbons (UHC).Which cause of environmental Pollution from the tail-pipe of exhaust. These exhaust emissions from the automobiles depend on many factors like the running condition of the engine, combustion conditions, maintenance of automobiles, composition of fuel and the air-fuel ratio. At the point when the fuel infusion arrangement of a car does not work appropriately, it leads to an increase in the emissions rate of the exhaust components. The emissions from automobiles also compose of pollutants like lead particles, carbon monoxide and many other pollutants. Breathing carbon monoxide disrupts the supply of oxygen from blood to the tissues by consolidating with the iron of hemoglobin causing a variety of ailments like cancer, inhalation problems, skin problems which can prove to be fatal [1]. Carbon dioxide present in the air is the main reason for to global warming. Apart from individuals, the significant supporters of carbon dioxide in condition are the two-wheeler automobiles. Carbon monoxide emitted from automobiles is also measured to be the most toxic pollutant. The emission of harmful gases and exhaust emissions from the automobiles can be reduced by using catalytic converter in the automobiles. The catalytic converter helps in the oxidation and in that way making the pollutants less hurtful to the environment [2].

Incomplete burning of the fuels leads to the production 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 [3]. Nanotechnology is the also considered as the generation next technology or the technology for the future. It is vastly gaining popularity and acceptance due to improved results, better performance, reduced pollution and widespread utility. It composes of a wide range of technologies which are presently under development in nano-scale. It is also very helpful in the development of innovative methods to develop new products, systems, processes, to replace the existing production method with improved performance methods, thereby, leading to a reduced consumption of energy and environmental protection.

Nanotechnology offers great potential in providing innovative approach towards reducing the pollution in air, water and land. It is also beneficial in improving the performance of conventional technologies used in cleanup process. Metal nano particles, specially the expensive metals including gold, platinum and palladium are increasingly being used as catalysts in various industrial and environmental applications. The rate at which the automotive industry is hampering the surrounding makes the application of nano-technology mandatory to avoid further damage. 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, Nitrogen oxide, Carbon monoxide, unburnt hydrocarbons and lead. A complete review on the application of nanotechnology in automotive pollution prevention was explained. Initially, the important aspects of ecological pollution problems due to automobile industry were discussed and then the application of nanotechnology towards the prevention and control of these problems were presented [4].

2. Nano-Partical as Catalysts

A evaluation on nano-particle exposed that the ratio of surface area of nano-particle to the volume of the nano-

particle is inversely proportional to the radius of the nano-particle. Therefore, when decrease of the radius of the nano-particle, this ratio will increase leading to an increased rate of reaction and the concentration of the pollutants is decreased. 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 unanalyzed reaction. Copper was considered for this researchwork as it is cheaper than platinum, palladium and rhodium. Catalytic converters with a spray of copper nano-particle on copper sieve lead to much higher performance of automobiles and reduced pollution in atmosphere [5]. Catalysis involves the process of modification of a chemical reaction rate, most of the times, accelerating the reaction rate by a substance known as a catalyst which is not consumed throughout the reaction.

Generally, the catalyst works in the reaction by interact with one or more of the reactants and at the end of process; it is normally regenerated without any changes. There are two main types of catalysts known homogeneous and heterogeneous catalysts.

The homogeneous type of catalyst is generally dispersed in the same phase as the reactants. The dispersal is normally in a gas or a liquid solution.

Heterogeneous catalyst is in a different phase as compared to the reactants and is generally, separated by a phase boundary. Heterogeneous catalytic reactions generally occur on the surface of a solid support like silica or alumina. These solid materials have very high surface areas that usually are due to their impregnation with acids or coating with catalytically active material e.g. platinum-coated surfaces. Metal nano-catalysts are increasingly used in automobile emission control systems and in other pollution control and treatment applications to facilitate petroleum extraction and production and to produce chemicals and chemical products. It is expected that with the increased affordability of the precious metals in these applications, it will lead to increase overall demand for these metals. Catalysts generally have two major roles in nanotechnology areas:

1) In macro quantities, they can be utilized in some processes for the preparation of a variety of other nanostructures like quantum dots and nanotubes.
2) Some of the nanostructures themselves can also serve as catalysts for some chemical reactions.

Automotive catalysts include platinum, rhodium and palladium to increase the chemical reaction of pollutants such as hydrocarbons carbon monoxide and nitrogen oxide,. 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 fast to react. In most cases, nano-materials smash their conventional counterparts because of their superior chemical, physical and mechanical properties and excellent formability. Although, gold is known to be chemically static and is usually regarded as a poor catalyst but when gold is used in the form of small particles with diameters below 10 nanometers, it becomes very active. At low temperature applications, like the environmental and automotive pollution control, reactions in chemical processing, gold exhibits a very high activity. Of the many important reactions known to be catalyzed by gold particles, the oxidation of carbon monoxide is of outstanding significance from research point of view.

This work centered on the application of gold nano particles as a catalyst from automotive pollution control [6].

3. Catalytic converters with nano-partical coating

To control the emissions from exhaust of two stroke single cylinder spark ignition engine having copper nano-particles coated on copper sieve as catalytic converter was used. The engine was designed to run at medium load for a longer time due to less emission of HC and CO. At full load, emission of CO and HC was higher so it is not advantageous to run engine at full load. The converter used two different types of catalyst, reduction and oxidation catalyst. Multigas Analyzer (NPM-MGA-2) was used for the measurement and comparison for CO and unburned hydrocarbon in the exhaust of the engine at various speeds and loads. The idea behind the work was to create a structure that exposes the maximum surface area of catalyst to exhaust stream, also minimizingthe amount of catalyst required. [7]. The efficiency of translation was evaluated for a catalytic converter used with spark ignition engine under steady operating situation. Apart from this, three way converters have been compared to understand the influence of substrate particles on the exhaust gas conversions for different operating conditions of vehicle. This research work was based on the evaluation of spark ignition gas emissions upstream and downstream of the catalytic converter [8]. In this research work, many tests were performed on a four stroke engine to compare its performance in two cases; with and without the use of copper nano-particle coating.

The outcomes uncovered that the copper nano-particle coated engine exhibited a much better performance than a normal engine. During the tests, the catalytic efficiency was found to increase as the size of the nano-particle powder decreased [9]. For pollution avoidance from automobiles and to achieve a clean and green environment, a nano coated catalytic converter was designed and manufactured [10]. Nano particles were effectively employed to reduce surface roughness of engine components and to act as protective coating against wear of components. Apart from this, the importance of nano-coatings for engine applications was analyzed [11].In this work, different experiments were conducted to improve the performance of the engine and reduce the level of emissions of hydrocarbons and carbon monoxide from automobiles. The focus of the experiments was on evaluating the engine performance parameters and studying the emissions reduction methods for spark ignition engines [12]. Thakur and Saikedkar made some alterations and modifications in the design of a spark ignition engine so as to increase the retention period of exhaust gases to provide more time for its its oxidation and in this manner to decrease hurtful outflows. Their approach was to control the exhaust emissions from four stroke, single cylinder and spark emission petrol engine having copper nano-particles

coated on copper sieve as catalytic converter. For this purpose, a Multigas Analyzer (NPM-MGA-2) was used for measurement and comparison for CO and unburnt hydrocarbon in the exhaust of the engine at various speeds and loads. The engine was designed to run at medium load for a longer time due to less emission of HC and CO. At full load, outflow of HC and CO was higher so it is not attractive to run motor at full load. The converter used two different types of catalyst, reduction and oxidation catalyst. The thought behind the work was to make a structure that uncovered the most extreme surface territory of impetus to fumes stream and furthermore limiting the measure of impetus required [13]. In this research, displaying was accomplished for a four stroke spark ignition engine with nano-sized copper coated catalytic converter. The behavioral displaying begins from examining the functional conduct of four stroke engine with designed catalytic convertor and then approximating obtained behavior in terms of mathematical equations. These obtained equations actually represented the behavior of concerned system. The proposed method proved to be very effective in the prevention of environmental pollution contributed from two-wheeler automobiles. It included the utilization of copper nano-particles which is less expensive than the platinum, palladium and rhodium nano-particles utilized as a part of automobiles. 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. Copper metal was selected for the research work as it is cheaper than platinum, palladium and rhodium 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 out of the pore structure of copper took place efficiently. Due to this, the pollution level for the exhaust emission of S.I. engine was found to be reduced [14]. The non-noble metal nano copper- silver composite based catalytic converter is feasible. Since it gave satisfactory results for the given operating conditions and reduction of HC and CO emissions. Therefore it is concluded that nano copper- silver composite based catalyst system can be an effective approach in the place of expensive metal based catalytic converter[15].

4. Results and Conclusion

The thought behind the work is to make a structure that exposes the larger surface area of catalyst to exhaust flow and also reducing the amount of catalyst which is required in process. Air contamination can be remediated using nanotechnology in several ways. One is using the 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. To accomplish this goal, three fabricated designs of catalytic converter namely the planned design, the improved design and the innovative design of catalytic converter for automobiles is proposed using nano-particle as a catalyst. 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. Copper metal is chosen for the work since it is less expensive than platinum, palladium and rhodium and it adsorbs the reactants atoms strongly enough to hold and active the reactants but not so strongly that the product can't breakaway additionally the diffusion of reactants and products into and out of the pore structure of copper took place efficiently. Due to this, the toxic waste level for the exhaust emission of spark ignition engine has found to be reduced which is improved with nano-sized catalytic converter. This research paper focuses on the utility of the nano-particles in the area of automobile pollution control. The change of particle size from micro to nano causes significant change in the material properties. These properties can be very important in the reduction of automobile pollution which has become a serious concern today. The coating of nano-particles on the catalytic converter of automobiles will help in minimize the level of exhaust emission concentration and thereby, reduce the pollution level in atmosphere.

References

[1] Gilmour P., Ziesenis A., Morrison E., Vickers M., Drost E., Ford I. (2004). Pulmonary and Systemic Effects of Short Term Inhalation Exposure to Ultrafine Carbon Black Particles. Toxicological Applications Pharmacology. 195: 35-44.

[2] M., Twigg. (2006). Roles of Catalytic Oxidation in Control of Vehicle Exhaust Emissions. Catalysis Today. 117 (4): 407-418.

[3] Kishore K., Krishna M. (2008). Performance of Copper Coated Spark Ignition Engine with Methanol Bended Gasoline with Catalytic Converter. Journal of Scientific and Industrial Research. 67: 543-548.

[4] Thakur, M., Saikhedkar N. (2012). Recent Trends in Application of Nano-Technology to Automotive Pollution Control. International Science Congress, Bon Maharaj Engineering College, Mathura:123

[5] Thakur, M., Saikhedkar N. (2012). Reduction of Pollutant Emission from Two-wheeler Automobiles using Nano-particle as a Catalyst. Research Journal of Engineering Sciences. 1 (3): 32-37.

[6] Fazeli, Fariba, Shahram, Fakdehi. (2013). Application of gold nano-particles as a catalyst for automotive pollution control. Engineering Research Journal. 1(2): 23-35.

[7] Thakur, M., Saikhedkar N. (2012). Atomic Activity of Nano-particles for Vehicular Pollution Control. Abhinav Journal. 1 (11): 32-38.

[8] C.M. Silva, M. Costa, T.L. Farias, H. Santos, J. Energy Conversion and Management, 47, 2281-2282 **(2008)**

[9] M. Samim, M.K., Kaushik, AmarnathMaitra. (2007). Effect of Size of Copper Nano-particles on its Catalytic Converter in Ullman Reaction. Bull. Mater. Sci. 30(5): 535-540.

[10] Durairajan,A, Kavita T, Rajendran, A, Kumarswamidas, LA. (2012). Design and Manufacturing of Nano Catalytic Converter for Pollution Control in Automobiles for Green Environment. Indian J. Innovations Dev. 1(5): 315-319.

[11] S. Prabhu, B.K. Vinayagam. (2009). Nano-coatings forengine application. International Journal of

Nanotechnology and Applications. 3(1): 17-28.M. Samim, M.K., Kaushik, Amarnath Maitra, J. Mater. Sci., 30, 5, 535-540 **(2007)**

[12] M.S. Shehata and Razak. (2008). Engine Performance Parameters and Emissions Reduction Methods for Spark Ignition Engine. Engineering Research Journal. 120: M33-M57

[13] Thakur, M., Saikhedkar N. (2013). Rapid Control of Exhaust Emissions and Enhancement of Retention Time in the Catalytic Converter using Nano-sized Copper Metal Spray for Spark Ignition Engine. International Journal of Mechanical Engineering Research & Development. 3 (1): 1-10.

[14] Thakur, M., Saikhedkar N. (2013). Control of Exhaust Emissions and Enhancement of Retention Time for Four Stroke Engine Using Nano-sized Copper Metal Spray. International Journal of Scientific & Engineering Research. 4 (2): 1-9.

[15] Sreyas M Pillai, Athul Aravind, Akil R Krishnan, Pranav K (October 2016) .Modified Catalytic Converter Using Nano-Copper and Silver Composite Coating. International Journal of Innovative Research in Science, Engineering and Technology. 5(10):1-6

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