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Emission Reduction in Diesel Engine Using Nano Particle (TiO_2) Coated Filter in Exhaust Unit

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Abstract—*Automotive pollution is the accumulation of hazardous substances from engine into the atmosphere that affects human life and other living matter. Emissions from vehicles play an important role to pollute the earth. The emission formation in an engine is due to the insufficient air supply during combustion process and lag of time to complete the combustion. In this project an effort is taken to reduce the emission by using the titanium dioxide (TiO_2) nano particle coated fabric cotton is placed in diesel engine exhaust outlet to pick up toxic pollutants from exhaust gas. The Emission test is conducted by using normal air filter and then TiO_2 coated air filter. By comparing both results the satisfactory result is achieved. The scanning electron microscope (SEM) analysis is taken to examine the absorption of nanoparticle.*

Keywords: *Titanium Dioxide (TiO_2), Scanning Electron Microscope (SEM), Fabric Cotton.*

1. INTRODUCTION

Pollution is one of the biggest global killers, affecting over 100 million people. People who live in places with high levels of air pollutants have a 20% higher risk of death from lung cancer than people who live in less-polluted areas. . More than 3 million children under age five die annually from environmental factors. Fossil fuel combustion of energy generation causes about 70-75% of the carbon dioxide emissions. Environmental concerns regarding CO_2 emissions have stimulated considerable interest in the people. Technologies are also getting fever and coming up with the innovations to reduce emission.

The nanotechnology is a latest one that plays an important role in reduction and removal of CO from the atm. As new material nano sized TiO_2 is of great interest of many scientists in the recent years. Here TiO_2 nano is synthesized using sol-gel method. The synthesized nano particle is characterized by SEM to determine its phase and size of the particle. Among the various methods, Nano particle with the coated fabric is determined using emission test, scanning electron microscope results.

1.1 Pollution

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat or light. Pollutants, the components of pollution, can be either foreign substances/energies or naturally occurring contaminants. Pollution is often classed as point source or nonpoint source pollution.

1.1.1 Forms of Pollution

The major forms of pollution are listed below along with the particular contaminant relevant to each of them:

Air pollution: It happens due to the release of chemicals and particulates into the atmosphere. Common gaseous pollutants include carbon monoxide (CO), sulfur dioxide (SO_X), chlorofluorocarbons (CFCs) and nitrogen oxides (NO_X) produced by industry and motor vehicles. Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight. Particulate matter or fine dust is characterized by their micrometer size in ug/m^3.

Light pollution: Includes light trespass, over-illumination and astronomical interference.

Noise pollution: This encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar.

1.2 Pollutants

A pollutant is a waste material that pollutes air, water or soil. Three factors determine the severity of a pollutant: its chemical nature, the concentration and the persistence.

1.2.1 Sources and causes

Air pollution comes from both natural and human-made (anthropogenic) sources. However, globally human-made pollutants from combustion, construction, mining, agriculture and warfare are increasingly significant in the air pollution equation.

Table 1 Gaseous air pollutants and their sources and effects

Pollutant	Source	Harmful Effect
Carbon compound	Automobile exhaust burning of wood and coal	Respiratory problems Greenhouse effect
Sulphur compounds	Power plants and refineries, volcanic eruptions	Respiratory problems in human, Acid rain
Nitrogen Compound	Motor vehicle exhaust atmospheric reaction	Irritation in eyes and lungs Low productivity in plants

1.2.2 Pollution control

Pollution control is a term used in environmental management. It means the control of emissions and effluents into air, water or soil. Without pollution control, the waste products from consumption, heating, agriculture, mining, manufacturing, transportation and other human activities, whether they accumulate or disperse, will degrade the environment. In the hierarchy of controls, pollution prevention and waste minimization are more desirable than pollution control. In the field of land development, low impact development is a similar technique for the prevention of urban runoff.

1.2.3 Pollution control devices

Dust collection systems, Bag houses, Cyclones, Electrostatic precipitators, Scrubbers, Baffle spray scrubber, Cyclonic spray scrubber, Ejector venturi scrubber.

1.3 Nanotechnology

"Nanotechnology is basically the control and understanding of the meter at the smallest level of about 1 to 100 nanometers, where, where this unique technology enhances novel applications."

1.3.1 Potential Benefits of Nanotechnology

There are a number of fields in which nanotechnology now a day's involving and having its potential benefits regarding these fields. According to the different researches, the nanotechnology is involved in the manufacturing of new materials, new medical, pharmaceutical, agricultural, environmental processes and procedures, new electronic devices, new sensors, and new computer technologies.

Now a day there is a huge advancement is looking the fields of the mobiles where a numerous number of advancements are coming regarding nanotechnology. Due to this technology we are able to have overlooked on it more precisely this far-reaching nanotechnology that is now making it one of the most successful and innovative areas of science, and one that has the most commercialization about its products and the concept.

People now like it due to its convenience, accessibility and attractive smaller designs. The Nanotechnology has an ability to transform the current trends of the manufacturing of the products in such a way that is almost impossible to imagine. Nanotechnology is already being used in our everyday items like sunscreen to needles. And it has also wide application in the field of architecture that has been appreciated a lot.

In the near future, it will take us to use the building resources like coating, bricks and other essentials things to be developed in such way that it will not remain too much complicated. Although by these means and ways, these initiatives.

1.4 Nanoparticle

In nanotechnology, a particle is defined as a small object that behaves as a whole unit with respect to its transport and properties. Particles are further classified according to diameter.

Coarse particles cover a range between 2,500 and 10,000 nanometers. Fine particles are sized between 100 and 2,500 nanometers. Ultrafine particles, or nanoparticle, are between 1 and 100 nanometers in size. The reason for this double name of the same object is that, during the 1970-80s, when the first thorough fundamental studies with "nanoparticle" were underway in the USA (by Granqvist and Buhrmann)and Japan, (within an ERATO Project)they were called "ultrafine particles" (UFP). Nanoparticle research is currently an area of intense scientific interest due to a wide variety of potential applications in biomedical, optical and electronic fields.

Particle of any shape with dimensions in the $1 \times 10{-}9$ and $1 \times 10{-}7$ m range.

1.5 Titanium Dioxide

Nano titanium dioxide is currently used in many products. Depending on the type of particle, it may be found in sunscreens, cosmetics, and paints and coatings. It is also being investigated for use in removing contaminants from drinking water.

Titania / Titanium dioxide (TiO_2) nanoparticle is a promising material, widely used in many applications due to its

- High photo catalytic activity ,
- Excellent gas-sensitive properties ,
- Dielectric properties ,
- high stability,
- Low cost
- Non-toxicity.
- The unique optical property and chemical stability of Titania makes it well suited in the splitting of water and in the photo-oxidation processes.

1.6 Chemical Process-Desizings

Desizings is the process of removing the unwanted materials from the fabric cotton. The period of dying some chemical compound was taken place on fabric cotton. It must be removed.

1.6.1 Steps Involved In Desizings

- Take chemicals of sodium hydroxide, sodium carbonate to water ratio 2:100 in the beaker.
- Maintain water heat bath to the temperature of 50^0c.

- The sample of fabric cotton is dipped into the beaker solution.
- The beaker is placed on heat bath of water for 20 min.
- Then the sample is taken out and subjected into water wash.

2. ETHODOLOGY

2.1 Preparation of TiO_2

The titanium dioxide nanoparticle is prepared by using sol-gel technique. Such methods are used primarily for the fabrication of materials (typically a metal oxide) starting from a chemical solution (sol, short for solution), which acts as the precursor for an integrated network (or gel) of either discrete particles or network polymers.

There are several methods to prepare nanoparticle. In this project the titanium dioxide nanoparticle is prepared by using sol-gel technique.

2.1.1 Sol-Gel Method

Solution [A]

Initially 26 ml of ethanol is taken in beaker. Add 20 ml of tetra butyl titanatein beaker solution and then 4 ml acetic acid is added at regular interval with help of burette using continuous stirrer for 2 hours. Obtained solution is taken as 'A'.

Solution [B]

The solution 'b' is prepared by the mixing of 8 ml demonized water, 12ml ethanol, 12ml acidic acid. 'B' is taken in burette Now 'B' is added drop wise into 'A' under magnetic stirrer for 5min .Obtained solution is stirred another 30 min at room temperature. The derived result is in the form of gel. This is dried in an oven at 1000c for 36 hours. Final gel heat treated in furnace at 150,250,350,500 for 30 min.

2.2 Dip Coating Method

The Solution is prepared in the ratio of 1:100 (TiO_2 and H_2O).Prepared solution is stirred for 20 minutes. Solution is taken out. Fabric sample is soaked for five to seven times. Fabric is dipped for ten minutes. Finally the fabric is dried in the absence of sunlight.

2.3 Fitment of Exhaust Unit

A particulate air filter is a device composed of fibrous materials which removes solid particulates such as dust, and bacteria from the air. A chemical air filter consists of an absorbent or catalyst for the removal of airborne molecular contaminants such as volatile organic compounds or ozone. Air filters are used in applications where air quality is important.

The exhaust system routes exhaust gas from the engine and exhaust it into the environment, while

Providing noise attenuation and after treatment of the exhaust gas to reduce emissions.

In this project to reduce the emissions from exhaust unit, the titanium dioxide coated fabric cotton is used. This unit is placed at the end of tailpipe. This is control the some of the emission from exhaust gas.

3. EXPERIENTIAL PROCEDURES

In this project the TiO_2nano coated fabric cotton is used in exhaust outlet to pick up toxic emissions from exhaust gas.

3.1 Examination of Absorption of Nanoparticle Using SEM

Scanning Electron Microscopy - SEM - is a powerful technique in the examination of materials. It is used widely in metallurgy, geology, biology and medicine.

Fig. 1: Scanning Electron Microscope

3.2 Emission Test

The vehicle can be tested by computerized emission test. The test compared with normal and titanium dioxide nano finished exhaust unit. This test is done by vehicle emission monitoring centre.

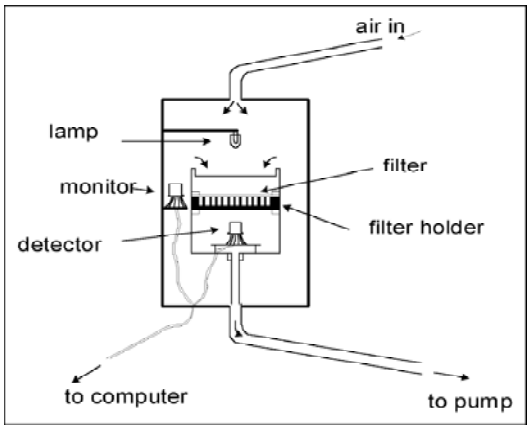


Fig. 2:The head of the light absorption instrument (SIMCA)

4. RESULT AND DISCUSSION

4.1 Light Absorption Coefficient

The optical absorption coefficient, particulate matter with an aerodynamic diameter <2.5μ m, and elemental carbon (EC) has been measured simultaneously during winter and spring. The optical measurements were carried out with a low-cost instrument recently developed. From the data, a site-specific

mass absorption coefficient of (4.45 ±0.01 m^2/g) has been found for EC.

Because the absorption coefficient depends strongly on EC, it is desirable to understand how the emission of EC varies during the year. In a city, the main sources of EC are normally diesel vehicles and combustion caused by heating or industrial or commercial burning. The emission caused by heating is expected to increase during winter because of lower temperatures. Therefore, during winter, the emission caused by engine heating increases considerably, and the EC concentration increases accordingly. The emission from vehicles depends on the driving conditions, temperature of the engine, and so on. Thus, it is expected that emissions from diesel vehicles will be higher, and EC emission from this source should be higher.

4.2 Correlations between the Absorption Coefficients and Particle Mass

A relationship of this type is useful if one wants to obtain EC using an instrument that measures the absorption coefficient.

However, this pollutant is not included in the regression model, because more than 90% of the light absorption is caused only by EC. Also, EC and OC are highly correlated (because they are produced by the same or very similar sources). As mentioned before, Ka, and EC have been measured simultaneously from May to September of 2000 to test the validity of equation when Ka is measured with SIMCA.

$K = (4.46 \pm 0.10)\ EC$

Where

K =light absorption coefficient

4.46 m^2/g=mass absorption coefficient

EC=elemental carbon

Tab1e 2 (Normal Emission Test)

Free Acceleration Test No	K-Value	Actual Rpm
T1	1.75	4460
T2	1.73	4480
T3	1.95	4420
T4	1.95	4440
	Avg=1.84	

Tab1e 3: (Emission Test with TiO_2 coated exhaust unit)

Free Acceleration Test No	K-Value	Actual Rpm
T1	1.67	4580
T2	1.60	4520
T3	1.62	4540
T4	1.60	4560
	Avg=1.62	

4.3 Calculations

4.3.1Normal Emission Test

Elemental carbon (EC) =K/4.46

=1.84/4.46

EC = 0.4126

Where

k =light absorption coefficient

4.46 m^2/g=mass absorption coefficient

EC=elemental carbon

4.3.2 Emission Test (TiO_2) Coated Exhaust Unit

Elemental carbon (EC) =K/4.46

=1.62/4.46

Elemental carbon (EC) = 0.3622

4.4 Morphological Analysis

The microstructure of the TiO2 nanoparticle synthesized by sol gel method in the present study was observed by FESEM which is shown in figure.3.Nanoparticle characterization is necessary to establish understanding and control of nanoparticle synthesis and applications. Characterization is done by using a variety of different techniques, mainly drawn from materials science. Common technique is electron microscopy SEM.

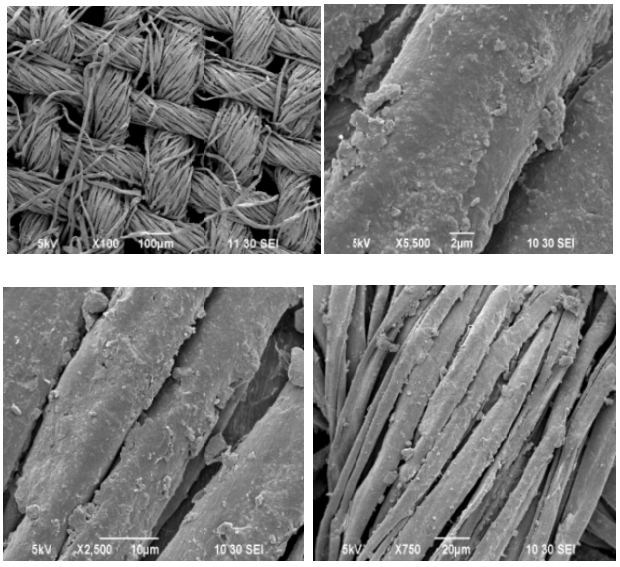
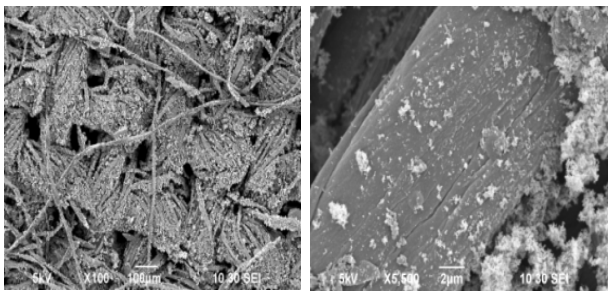


Fig. 3:TiO_2 Coated Fabric Cotton



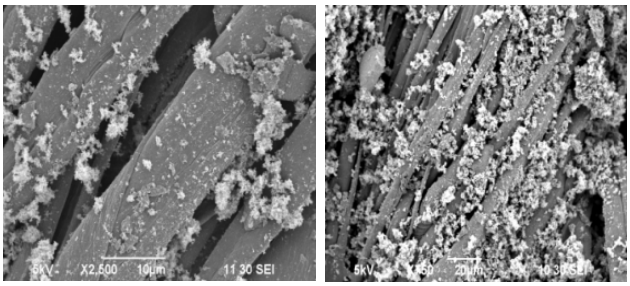


Fig. 4: TiO_2coated Fabric Cotton after Test

5. CONCLUSION

In this paper an effort is taken to reduce the emission by using Titanium dioxide nano-particles coated exhaust unit. Here sol-gel process used for making nano particle of Titanium dioxide. The derived nano particle was coated with fabric cotton by using dip coating process. The nano particles coated fabric cotton is placed in diesel engine exhaust manifold to trap up toxic pollutants from exhaust gas. The emission measurement is made and using scanning electron microscope characterization of TiO_2 is derived.

Tab1e 4: Comparative table of Emission test result

Normal Emission Test	Emission Test with (TiO2) coated exhaust unit	Reduction of elemental carbon
0.4126	0.3622	0.0504 (12.22%)

By using TiO_2 nano particles coated fabric cotton in exhaust unit 0.0504 (12.22%) of exhaust emissions is reduced when compared with the engine operated without exhaust unit.

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