Available online at www.derpharmachemica.com

ISSN 0975-413X
CODEN (USA): PCHHAX

Der Pharma Chemica, 2016, 8(18):72-77
(http://derpharmachemica.com/archive.html)

A New Device in Catalytic Converter to Reduce Biochemical Effect of Particulate Matter

R. K. Tyagi

Department of Mechanical Engineering, Amity University, Noida, Uttar Pradesh

---

ABSTRACT

This article focuses on reducing the particulate matter from the diesel engines. In modern era there is sharp escalation in the number of vehicles, due to that particulate matter emission is also increasing significantly which results in the growth of human diseases like chronic cough, bronchitis, chest illness, sinusitis, asthma, allergy, changes in vision, memory, cancer etc. The new device has been implanted in existing catalytic converter of heavy duty truck and passenger diesel engine car to reduce particulate matter. The experimental method indicates that particulate matter quantity reduced significantly by applying suggested device and varying magnitude of electric and magnetic field.

Keywords: Particulate matter, bronchitis, asthma, cancer

INTRODUCTION

Particulate matter has newly turned out to be an issue of increasing reputation in pollution studies due to its visible effects on human health. Various scholarships on air pollution effects on health have indicated a tough relationship amongst air pollutant concentrations and detected health effects. There is also robust evidence that fine particles with size less than 2.5 µm play an important role in the observed health effects [1]. Coarse particles(2.5 µm < dp < 10 µm) are efficiently removed in the upper part of respiratory track while fine particles (dp < 2.5µm) are deposited on the bronchi walls in the bronchi tree [2]. Particles smaller than 0.1µm experiences Brownian motion as outcome of which they get composed in the bronchi. However, particles lying between 0.1 -1 µm are too large for Brownian Motion and too small to be stuck in the upper part of the trachea. Hence, they get deposited in the lungs, thus growing airway resistance [3]. Human anatomy shows the respiratory system of a human being showing the degree of the penetration dimension fractionated total suspended particulates (dp < 100 µm), coarse particles (2.5 µm < 2.5 µm). Particles activities in the lung are reliant upon the aerodynamic characteristics of particles in flow streams. The aerodynamic properties of particles are related to their size, shape and density. The deposition of particles in unlike regimes of the respiratory organism depends on their sizes. The nasal openings authorization very large dust particles to enter the nasal region, along with much finer airborne particulates, particles in the atmosphere series from less than 0.01 µm to more than 50 µm in diameter [4].

Table 1. Shows relationship between type of particulate matter and health issues [5]

S. No	Type of Particulate Matter	Health Issues
1	Ultrafine Particles (Nanometer range)	Chronic cough, bronchitis, chest illness, DNA methylation, heart disease, dysrhythmias, heart failure, cardiac arrest, increased carotidintima media thickness(CIMT), neutrophilia, activation of mast cells and neutrophils and the production of cytokines and chemokine associated with neutrophil accumulation and activation .
2	Fine particle (2.5 µm-10 µm	Fine particles are associated with increased ischemic heart diseases among the elderly population and with higher risk of myocardial infraction. Increased concentration of dust particulates in the air contribute human health hazards involving acute respiratory disorders such as sinusitis, bronchitis, asthma and allergy and damage to the defensive functions of alveolar macrophages leading to increase respiratory infections.
3	Heavy Particle (.10 µm)	Presence of heavy metals in air borne particulates causes protein denaturation resulting in malfunction or death of cell. It also causes a number of health effects such as cancer, neurotoxicity, immune toxicity and cardio-toxicity, leading to increased morbidity or mortality in community.
4	Mercury (26% mercury generated by burning of coal)	Neuro development and subtle changes in vision, memory, and language.

A major cancer cause is due to diesel engine particulate matter, particulate matter damage DNA of human being. A schematic diagram how particulate matter promote cancer has been shown in schematic diagram.

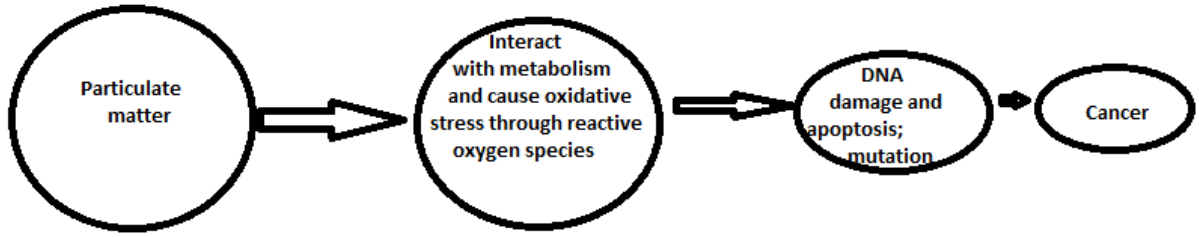

Figure 1. Relationship between particulate matter emission and cancer

Table 2. Shows relationship between particle type and source [6]

S.No	Particle Type	Source
1	ultrafine particles of size range less than 0.1 mm	automobile exhaust, wood smoke and emission from diesel engines and generators.
2	Fine particles size range 0.7-1 µm	formed by accumulation or coagulation of ultra fine particles. In close vicinity of the road, contribution of traffic to fine particle concentration was 58–68%, Biomass burning is another important source of fine organic aerosols, Coarse particles ranging from 1 to 200 mm are predominantly rock or soil material of natural origin emitted into the atmosphere by mechanical grinding or spraying, wind-blown dust from agricultural processes, uncovered soil, unpaved roads or mining operations.
3	Heavy particles	coarse particles showing seasonal variation from about 20% of the total PM10 mass in winter to 50% in summer, reflecting the impact of drier summer climate on the re-suspension process, re-suspension of paved-road dust contributing up to 25–63% of the PM10,

The coal is key source of electrical energy, 40 percent energy has been produced by coal. Specific pollutants from burning coal that root a negative health effect on the respiratory system comprise particulate matter (PM), sulfur dioxide (SO2), and oxides of nitrogen such as NO2,the mechanism injury to the airways and lungs via damage to cells caused by oxidizing molecules in pollutants. This leads to inflammation, cytotoxicity, and cell death. Particulate matter is generated from the combustion of coal and is characterized by size, small particles less than 2.5 micrometers (PM2.5) and larger particles up to 10 micrometers (PM10). PM2.5 travels deeper into the airways than PM10 and is therefore mostly supposed to cause a larger threat to human wellbeing. A study of various power plant emissions in China found that of total particulate matter emitted, PM10 comprised 62-84% and PM2.5 comprised 8-44% [7].

Wind speed play a vibrant role in pollution spreading and should be considered measure factor. When the wind blows directly from the source towards the receptor, the focus gradient is more pronounced and extends further away than when the wind blows parallel to the road, or away from it. According to some investigation, the

concentration of fine and ultra-fine particles drops by half at a distance of 100–150 m from the source when dimensions are taken downwind [8]. The reduction to half the concentration happens 50–100 m from the road when the wind is blowing parallel to the line source [9]. The study by Hitchins et al. [10] showed that the lower the wind speed, the higher the particle concentration is closer to the source. Different wind speeds were also found to have different effects on PM10 concentrations in Iceland. Strong winds (above 6 m/s) lead to higher PM concentrations due to resuspension and erosion from the ground. Slower winds (under 2 m/s) also tend to show higher concentrations due to PM accumulation, while winds between 2–6 m/s show lower concentrations due to dilution of PM by the wind [10, 11].

Zhou and Levy [12]used the following equation for estimating pollutant concentrations downwind from the source for relatively inert pollutants,

$$C = \frac{2Q}{\sqrt{2\pi}\, U\sigma_z}$$

where C is the downwind concentration (μg/m3), Q is the source strength per unit distance (μg/(m·s)), U is the average wind speed (m/s) and σz is the vertical dispersion coefficient (m).

There are various methods to reduce effect of harmful gases, which are heating of catalytic converter [13], cleaning of catalytic converter [14], of applying hydrogen as alternative fuel in existing automobiles [15].

In automobiles harmful emission can be reduced by doing some modifications in intake system of automobiles, which increase turbulence of intake air and fuel both [16].

In future word will more focus on green energy, that green energy may be wind energy, solar energy, or hydraulic energy etc [17].

Particulate matters are of three types which are very fine, fine and coarse particles. But most harmful PM is very fine particles, generated by automobiles. In this article effort was made to minimize effect of most harmful emission by deploying a device in catalytic converter of automobiles [19].

MATERIALS AND METHODS

An extremely simple model has been fabricated. This model is very straightforward; the line diagram of model is shown in figure 2.

In this model a transformer had been used for increasing the DC voltage from 12 V to 24000 V range. When high voltage electric arc generated inside the catalytic converter, it will charge particulate matters. The charge particulate matters can be easily collected on a metallic grid/rod etc., and after this complete process exhaust gas in automobiles absolutely mitigate particulate matter from exhaust.

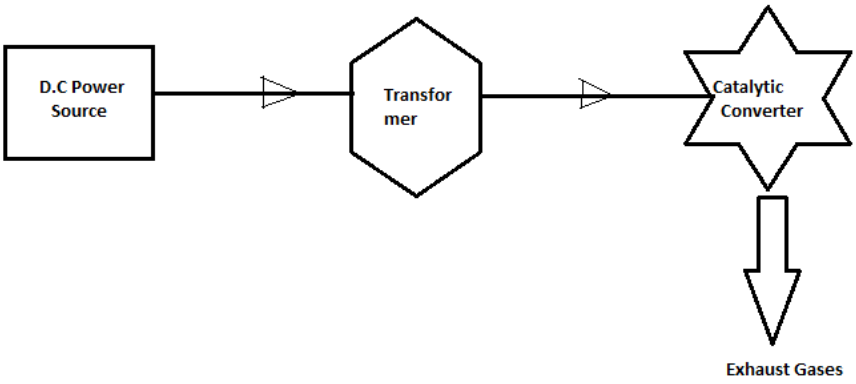

Figure 2. Schematic line diagram of device implanted in catalytic converter

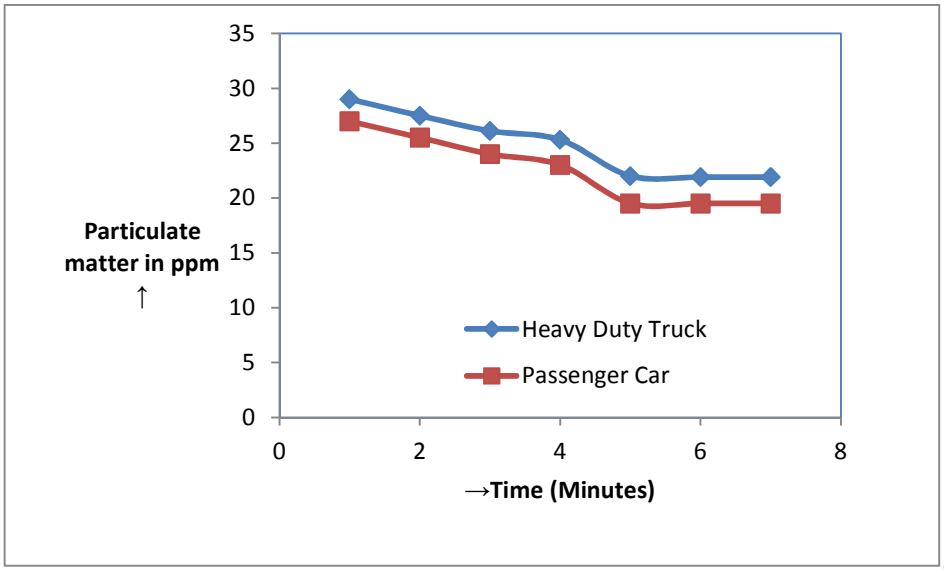

Figure 3.Relationship between particulate matter emission and engine running time by fixing parameters: Engine speed=2000 rpm, Heavy duty truck engine capacity=5883cc, Passenger car engine capacity=1396cc

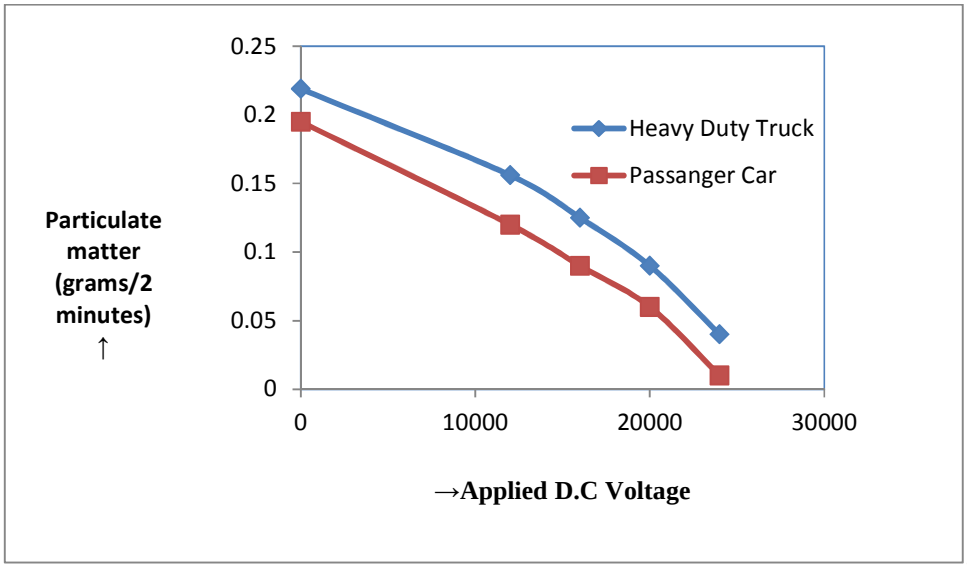

Figure 4.Relationship between particulate matter emission and applied D.C voltage by fixing parameters: Engine speed=2000 rpm, Heavy duty truck engine capacity=5883cc, Passenger car engine capacity=1396cc

RESULTS AND DISCUSSION

With the help of fabricated device, relationship between particulate matters versus time in minutes, particulate matters versus D.C voltage have been investigated. The experimental analysis had been calculated by using mentioned parameters, which are, engine running time varies from 0 to 8 minutes, D.C electric field varies from 0 V to 24000 V. In this experiment a high voltage D.C energy source i.e. D.C battery and transformer were used to convert 12 V to 24000 V. The prime functional of so much high voltage is to convert particulate matter particles into charged particles, because charged particulate matter can be easily collect on a suitable electrode. The particulate matter can be charge by applying both electric and magnetic field. The basic equations on which particulate matters convert in charge particles are-

If electric and magnetic field both applied on particulate matters, the governing equations should be [18]

$$F = e(E + v \times B)$$

and if only electric field will apply on particulate matters, the governing equations should be

$$F = e(E)$$

F is force applied, E is applied D.C electric field, v is velocity of particulate matter particles, B is applied magnetic field.

Figure 3 shows variation of mass of particulate matter versus running time in minutes by considering engine speed 2000 rpm, zero external applied D.C voltage respectively for both heavy duty truck engine and passenger car engine . In this experimental procedure the engine is running on no load condition both heavy duty truck and passenger car respectively. The experimental results shown in figure also indicates that as the running time increase from starting to few minutes, particulate matters reduced drastically but after some time later there is very marginal effect on quantity of particulate matter because temperature of catalytic converter attained near by 750^0C.

Figure 4 demonstrates deviation in particulate matters versus D.C electric field intensity for different values of DC volts. In this diagramdiffenent voltages have been considered, the range of voltage variation varies from 0 V to 2400 V. The outcome achieveed by experimental analysis demonstrates that particulate matters quantity is directly related to D.C voltage intensity. The results in figure also indicates that after certain value of D.C electric field particulate matter quantity is approximately constant for existing catalytic converter. After ceratain value of D.C electric field intensity there is no effect on quantity of particulate matters because at ceratin critical value of D.C elecrtic field all particulate matters will be charged. In catalytic converterparticulate matter is the parameter when attain minimum quantity. The value of critical D.C electric field depends upon quantity of particulate matter.

CONCLUSION

A detailed study on catalytic converter particulate matter emission has been investigated when a device implanted. In experimental study it was found that particulate matter quantity reduced sharply with escalation of D.C electric field and increment of running time in diesel engine. The result achieved by present study will be revolutionary to diminish/mitigate dieses produced by automobile particulate matter discharge. The dieses whose outcome can be condensed are chronic cough, bronchitis, chest illness, sinusitis, bronchitis, asthma, allergy, changes in vision, memory, cancer etc.

REFERENCES

[1] A. C Stern, R.WBoubel, D.B Turner, Fundamental of Air Pollution, 2nd Edition, Academic Press, Inc, **1984**.
[2] F.A Akeredolu,Environmental Engineering Notebook,Obafemi Awolowo University, Ile-Ife, Nigeria, **1996**
[3] A.S Ackerman, O.B Toon, D.E Stevens, A.J Heymsfield, V Ramanathan, E.J Welton, Reduction of tropical cloudiness by soot, Lewis Publisher, **2000**.
[4] L. A Jimoda, Facta Universitatis, **2012**, 9, 27 – 44.
[5] P. K Rai, Environmental Skeptics and Critics, **2015**, 4, 1-26.
[6] R. Mohanraj, P. A. Azeez, Current Science, **2004**, 87, 741-748.
[7] E Burt, M.P.H Orris, MPH Susan Buchanan, University of Illinois at Chicago School of public health Chicago, **2013**.
[8] A.A Karner, D.S Eisinger, D.A Niemeier, *Environmental Science & Technology*, **2010**, 15, 5334-5344.
[9] T Reponen, S.A Grinshpun, S Trakumas, D Martuzevicius, Z.M Wang, G LeMasters, J.E Lockey, &P.J Biswas, *Environ Monit*, **2003**, 5, 557-562.
[10] J Hitchins, L Morawska, R Wolff, D Gilbert, *Atmospheric Environment*, **2000**, 34, 51-59.
[11] M Bhandwal, M Kumar, M Sharma, U Srivastava, A Verma, R.K Tyagi, *International Journal of Ambient Environmen*, **2016**, 37, 1-12.
[12] Y Zhou, &J Levy, *BMC Public Health*. **2007**, doi: 10.1186/1471-2458-7-89
[13] R.K Tyagi, R. Ranjan, *International Journal of Ambient Energy*, **2013**, 34, 235-241.
[14] S.K. Sharma, P. Goyal, R.K. Tyagi, *International Journal of Ambient Energy*, **2015**, 36, 507-512.
[15] R. K. Tyagi, R. Ranjan, *Journal of Petroleum Technology and Alternative Fuels*, **2013**, 4, 125-130.

[16] R.K. Tyagi, S.K. Sharma, A. Chandra, S. Maheshwari, P. Goyal, *Journal of Engineering Science and Technology*, **2015**, 10, 1188-1202.
[17] Ram K. Tyagi, *Journal of Energy Southern Africa*, **2015**, 26, 100-104.
[18] R.K Tyagi, K.K Srivatava, R.S Pandey, *Surface Engineering and Applied Electrochemistry*, **2011**, 47, 370-377.
[19] J Malahotra, M Bhandwal, R.K Tyagi, A Kalia, S Pandey, A Rahul, *Der Pharma Chemica*, **2015**, 7, 56-61.

Abbreviations

PM= Particulate matter
C= Downwind concentration (μg/m3)
Q =source strength per unit distance (μg/(m·s))
U= average wind speed (m/s)
σz= vertical dispersion coefficient (m
F = force applied
E= applied D.C electric field
V= velocity of particulate matter particles
B= applied magnetic field.