ISSN No:-2456-2165

A New Device for Reducing Air Pollution Using Principles of Electrostatics and Aerodynamics

Arin Chaudhary

Abstract:- Carbon Monoxide, Sulphur Oxides, Lead, Nitrogenous Oxides, and Carbon Dioxide gases are common byproducts of several processes that pose a potent risk towards Environmental degradation. This is because they have adverse effects on the ozone layer and can cause several respiratory problems as well. There are multiple sources of these harmful gas, such as refineries, power plants, mines, wastewater treatment plants, etc. However, one major source of pollution is cars. A passenger car emits about 4.6 Metric tons of carbon dioxide per year (according to 2018). One factor which makes them pose a potential damage to the environment is that these are nonpoint sources, sources that are distributed over a wide range of geographical area. This makes it very difficult to contaminate the harmful gases emitted by them.

Understanding the problems and making a device that focuses on a way to contain these gases, convert them into particulate matter, and then use them for some useful processes can prove to be really helpful for the environment.

Keywords:- *Engineering; Pollution; Automobiles; Aerodynamics; Absorption; Systems Engineering*

I. INTRODUCTION

Carbon Dioxide, Carbon Monoxide, and Sulphur oxides are just some of the gases that emit pollutants into the air. These gases are major byproducts of several processes such as combustion of gas, emission from factories, cars, space shuttles, etc. These gases produce a considerable environment threat and makes it critical for us to mitigate the emissions of such gases. A recent World Bank publication found that air pollution cost the globe $8.1 trillion in 2019, being 6.1 percent of global GDP. Of the total emissions, 27% are due to transportation, generating the largest share of greenhouse gas emissions. These pollutants primarily come from burning of fossil fuels. Air pollution causes acid rain which further leads to the acidification of lakes, affecting the amount of Oxygen in water which makes it difficult for aquatic animals to breath.

Air pollutants from factories can still be reduced using Regenerative Thermal Oxidizers and Catalytic Oxidizers; however, since cars cannot contain such massive devices, there are either no or very limited solutions to limit the pollutant emission by cars. Moreover, Automobiles pose an even larger threat to the environment because these are not stationary, which is why any device will have to retrieve power from the car itself and the pollutants can't be disposed until the vehicle comes to rest.

Many believe that electric vehicles (EV's) will have a positive impact on the environment; however, available battery capacity will have to increase by several hundred-fold for even light duty vehicles (LDVs), which account for less than half of the global transport energy demand, to be run on electricity alone. Furthermore, the Green House Gases impact of battery electric vehicles (BEVs) would be worse than that of conventional vehicles if electricity generation and the energy used for battery production are not sufficiently decarbonized. Liquid fuels are a better option for transportation because of their high energy density and ease of transportation and storage. Currently around 95% of transport energy comes from liquid fuels derived from petroleum and around 60% of all oil produced goes to make transport fuels.

The world requires over 4.8 billion liters of diesel as well as gasoline and around 1.3 billion liters of jet fuel each day which can't be met by electricity alone. Thus, the need for research on a device that limits the pollution emission for Internal Combustion Engine Cars (ICEC's) is of utmost importance. This research focuses on a device that uses electrostatics and some principles of aerodynamics to reduce the pollution emission by cars and uses the stored pollutants for something productive.

This research stands out because I will not only focus on the theoretical part of the device, but also make a 3D model which will help with the visualization and add the structural and functional requirements of the devices, including the use cases.

II. METHODS

In the past, motor vehicles were once the main contributors of lead emissions. Due to this, the Environmental Protection Agency (EPA) decided to rule our lead in gasoline. This was implemented in the 1970's. Impurities of lead in gasoline were finally prohibited in 1995. As a result, levels of lead decreased by 94%.

Several initiatives have been taken to control air pollution. The first initiative was the "Positive Crankcase Ventilation" (PCV). In this system the part of the engine block that is below the cylinders leaked combustion gases that were combined with ventilating air and returned for reusing in the combustion chamber. However, one of the most common problems with PCV is that the valves get clogged,

ISSN No:-2456-2165

which is why they are not able to hold moisture. Due to this, a sludge gets formed which increases the pressure and might force the heated oil to break seals.

Another effort to control exhaust emissions was the "Exhaust Gas Recirculation" system. According to this system, a certain portion of the exhaust gases are directed back to the cylinder head, where they are combined with the fuel-air mixture. Consequently, these gases are recirculated. This reduces the temperature of combustion, which helps in reducing the production of nitrogen oxides. However, this process has adverse effects on the engine efficiency.

In the air injection systems, an engine-driven pump injects air into the exhaust manifold, where air combines with unburned hydrocarbons and carbon monoxides. This continues the combustion process and a large number of pollutants formed are burned. However, they do not result in the production of any extra energy.

Another initiative taken was the invention of a catalytic converter. These consist of an insulated chamber ceramic honeycomb structure coated with a thin layer of inert metals such as Platinum and Palladium. As the gases are passed through this structure, the metals act as catalysts to induce the hydrocarbons, carbon monoxide, and nitrogen oxides in the exhaust to convert to Water vapor, Carbon Dioxide, and Nitrogen. But these systems are not completely efficient because sometimes the temperatures are so low that emissions cannot be catalyzed.

Despite these methods being used, the transportation sector is one of the largest sources of air pollution.

However, the present devices face a major problem of dilution of gases. Due to the excess water vapor present, the carbon gets very diluted and takes a lot of time to be separated and to be made concentrated.

A similar device already exists which collects solidified carbon and then uses it for charcoal art or as ink for brush pens. However, the procedures of my device are different. I will be using principles of electromagnetism such as velocity filters to filter the different impurities from the gaseous emissions. Moreover, I will also be using the principles of aerodynamics to separate out H2O water vapor and NO2 gas. The rest of the gases such as Carbon monoxide and Carbon Dioxide can be separated out using principles of organic chemistry and attaching nucleophiles (nucleus loving species) with a high molecular mass to the carbon atom to make it heavy such that it falls down.

To detect the gases that have been observed, there will be a sensor in the funnel which captures H2O and NO2. This sensor will have two parts: The first part will emit alpha particle rays, which when collide with the particles, reflect the rays onto another sensor. The second sensor will detect these reflected rays and respond if the particles have been collected or not.

The filter for the CO2 gas and the CO gas will have a glass microfiber surface, helping in collecting the PM2.5 particles. The second filter will have constituents of protic solvents. This way the carbon gas will not dissolve into the polar solvent and will form solidified carbon through a chemical reaction.

The device will also make the carbon concentrated by adding a taper to the exhaust which will decrease the diameter of the pipe making the carbon molecules go with high velocity and the molecules stuck to the inner tube will be pulling them backwards, making other impurities stick out of the atom.

- *Procedures*

The device will have two electric plates which are opposite charged. These will create an electric field. For the magnetic field, a solenoid will be surrounding the pipes to create a magnetic field opposite in direction to the electric field. There will be 3 pipes, one will be for the Nitrogen oxides, second would be for water vapors and the third one would be for the Hydrocarbons. The NO2 pipe will have an inner coating of anhydrous chlorobenzene. The double bond in the CO2 molecule will be broken by bringing Hydronium ions near the CO2 molecules, due to excess of hydronium ions, the Oxygen atom will break its bond with the carbon leaving us with a positive charge on the carbon atom. This positive charge will then attract a nucleophile which is heavy in mass, increasing the mass of the hydrocarbon. Due to this the hydrocarbon will slowly descend and pass through the two filters. For the water vapors and NO2, we will be using principles of aerodynamics as the gases will come at an intersection wherein the NO2 particles will be attracted to chlorobenzene coated in the inner lining of the pipes which will attract the NO2 molecule. There H2O molecules will be sucked into the other pipe using a pipe that has lower pressure as compared to the other two pipes.

III. RESULTS AND DISCUSSION

The device will require several functional and structural requirements for it to operate efficiently. This is extremely crucial since the collection of these harmful pollutants needs to be effectively maintained. The structural and functional requirements are listed below:

Serial number	Name	Description	Specifications
1.	Glass microfiber	This will act as stage 1 for the filtration of the gases. It will be positioned at the end of the pipe containing carbon monoxide and carbon dioxide	These have a diameter ranging from 0.25 mu meter to 0.5 mu meter.
2.	Protic solvents	These are polar solvents. Carbon molecules will be insoluble in these because they have London forces between them instead of ionic forces.	The best protic solvent for this purpose would be ethanol but solvents such as water can also be used as this is readily available.
3.	Oppositely charged plates	These plates will help in the production of an electric field inside the pipe. These will be present on the inner part of the pipes.	The radius of exhaust pipes is usually 1.5 inches which is why the breadth of the electric plates would have to range from 1 inch to 0.5 inches.
4.	Solenoid	These will produce a magnetic field perpendicular to the electric field.	The length of the solenoid would depend upon the exhaust pipes and can be varied. The strength of magnetic field and electric field needed is not significant.
5.	Three-way pipe connectors	The pipe carrying the gases will get divided into three sections. One will contain the NO2 gas, the other one will have the H2O gas, and last one will have the hydrocarbons	The radius of these pipes will get smaller as gradually to help in the effective filtration of the gases as these will increase the velocity of gases. The length of these pipes will vary depending upon the length needed for the exhaust.

Table 1:- Structural Requirements of the Device

The device also has some functional requirements. These requirements will help in the absorption of gases and play an integral role in the device.

Serial number	Name	Description	Specifications
1.	Chlorobenzene	This is a compound that is in liquid state. Since the benzene ring has delocalized Pi electrons, the NO2 will get attracted to the benzene ring and join on either the Para or the Ortho position. The major product will be on the para position and minor will be on ortho due to steric hinderance.	The chlorobenzene will be applied on the inner part of the pipe to attract the NO2 molecules
2.	Nucleophile	This will help in the bond cleavage of CO2 molecule and make it heavier. I will use H2O (HOH) molecule for this purpose. The OH group will break the Pi bond and attach on the carbon atom and the hydrogen atom will attach itself on the Oxygen atom.	There will be two moles of HOH for each hydrocarbon because there are two oxygen molecules. The molar mass of water is 18 so molar mass of two moles of water is 36.

Table 2:- Functional Requirements of the Device

For better visualization of the device, I have also built a 3D model which shows the overall structure of the device. However, this device does not show the curved pipes that will be attached to the exhaust.

- *Harmful Gas Emission Absorber (HGMA):*

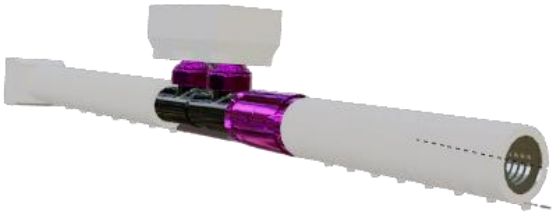

Fig 1:- *Harmful Gas Emission Absorber*

IV. CONCLUSION

This device has the potential to reduce the number of pollutants in the air by using methods based on the principles of electromagnetism. The current devices have either not been completely prepared or face several problems in the process. However, the study showed that the device has a promising ability to absorb all the gases effectively and separate them by using techniques of Organic Chemistry

ACKNOWLEDGEMENTS

I would like to thank Prof. Faisal Alkaabneh and my parents for their support and encouragement.

REFERENCES

[1]. https://www.sciencedirect.com/science/article/abs/pii/S1352231011002378
[2]. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/source-of-pollution
[3]. https://www.sciencedirect.com/science/article/abs/pii/S0195925520307848
[4]. https://www.sciencedirect.com/science/article/pii/S2666916120300062#!
[5]. https://www.sciencedirect.com/journal/resources-environment-and-sustainability
[6]. https://www.sciencedirect.com/science/article/abs/pii/S0195925520307848
[7]. https://www.sciencedirect.com/science/article/abs/pii/S004565350000432X
[8]. https://www.airlabs.com/filters-directly-exhaust-reduce-air-pollution/
[9]. http://www.chmlab.com/en/Filtration/Glass-Microfiber/
[10]. https://www.thecmmgroup.com/reduce-air-pollution-factories-industrial-operations/
[11]. https://www.environmentalpollution.in/water-pollution/harmful-effects-of-water-pollution-on-man-and-aquatic-life/140
[12]. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions
[13]. https://education.nationalgeographic.org/resource/air-pollution/
[14]. https://education.nationalgeographic.org/resource/air-pollution
[15]. https://www.wermac.org/equipment/scrubbers_part1.html
[16]. https://www.cpilink.com/blog/air-pollution-control-technology-review-absorption
[17]. https://www.sebokwiki.org/wiki/INCOSE_Systems_Engineering_Handbook
[18]. https://www.incose.org/systems-engineering
[19]. https://iopscience.iop.org/article/10.1088/1742-6596/1015/5/052029/meta