Air Pollution Mitigation Technology for TechConnect World 2022

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ABSTRACT

Particulate Matter ($PM_{2.5}$ and PM_{10}), and Greenhouse gases contribute to major pollution and climate change. We discovered that the dust particles present in the Sun rays passing through the window can be mitigated when smoke from incense sticks was passed through the dust filled Sun rays. We wanted to extend this idea with innovative technologies to solve the ambient air pollution in the atmosphere and scale it to mitigate the industrial and vehicular emissions by combusting materials collected from plants and trees in an open brazier (fumigation). This paper will discuss how incorporating clean and green aerosols into the atmosphere can mitigate the ambient air pollution. Most of the current solutions focus on indoor air pollution with limited success or very expensive, use large-scale machinery, and has complicated process that may not solve the global crisis from ambient air pollution.

Keywords: ambient airpollution, pollutants, particulate matter, fumigation, aerosols

1 INTRODUCTION

Air pollution is a mixture of solid particles and gases in the atmosphere and according to the United States Environmental Protection Agency (EPA) the following are considered as the six common air pollutants. It is important that we eliminate or at least reduce the air pollution as it is very harmful for the health of humans, animals, and plants on the earth. We focused our experiments on reducing the particulate matter as it is the major pollutant that makes up the AQI (air quality index) in general.

1.1 What are the Six Common [1] Air Pollutants?

1. Ground Level Ozone (O_3), 2. Carbon Monoxide (CO), 3. Sulphur Dioxide (SO_2), 4. Nitrogen Oxides (N_xO), 5. Particulate Matter ($PM_{2.5}$, PM_{10}), and 6. Lead

1.2 WHAT IS AIR QUALITY INDEX (AQI)?

The highest air pollutant in the atmosphere, from these six critical air pollutants, is considered as Air Quality Index (AQI). An air quality index (Table-1) is used by government agencies to communicate to the public how polluted the air currently is or how polluted it is forecast to become.

AQI	Value Consequence
301 – 500	Hazardous
201 – 300	Very Unhealthy
151 – 200	Unhealthy
100 – 150	Unhealthy for Sensitive Groups
51 – 100	Moderate
0 – 50	Good

Table 1: AQI Values and Consequences. Source: EPA, USA

1.3 Particulate Matter or PM

Most PM [2] particles form in the atmosphere as a result of chemical reactions among pollutants. Particulate Matter is a mixture of solid particles and liquid droplets present in the air. Some PM can be seen with naked eyes and some can only be seen with electron microscope. There are mainly two types of Particulate Matter and are called PM_{10} and $PM_{2.5}$.

1.4 What are the Harmful Effects of PM?

According to EPA, "Particulate matter contains microscopic solids or liquid droplets that are so small that they can be inhaled and cause serious health problems. Some particles less than 10 micrometers in diameter can get deep into your lungs and some may even get into your bloodstream. Of these, particles less than 2.5 micrometers in diameter, also known as fine particles or PM2.5, pose the greatest risk to health. Fine particles are also the main cause of reduced visibility (haze) in parts of the United States, including many of US treasured national parks and wilderness areas".

1.5 Aim of this paper is to show that incorporating clean and green aerosols will reduce PM in the air.

2 MATERIALS AND METHODS

We discovered that the dust particles present in the Sun rays passing through the window can be mitigated when smoke from incense sticks was passed through the dust filled Sun rays. We have taken this idea and extended it to solve the ambient air pollution from industrial and vehicular emissions. We then came up with an idea to combust materials collected from plants and trees in an open brazier (fumigation) to mitigate Particulate Matter in the atmosphere. With intensive independent research, we have identified the list of materials that we can use in the process to release environmentally friendly clean and green aerosols into the atmosphere that significantly reduce the air pollution.

We conducted several experiments that release environmentally friendly aerosols into the atmosphere. Over the past few years, we have been conducting these experiments to produce environmentally friendly aerosols. We arranged 30 inches round and 9 inches depth copper firepit (fig 1) or for obtaining more volume of aerosols we arranged multiple small braziers with different shapes and burned selected firewood like pinewood along with selected materials to produce environmentally friendly aerosols that are capable of reducing Particulate Matter in the ambient air. These aerosols are environmentally friendly and did not increase the AQI in the area; in fact decreased the AQI within a few hours of the experiment. As the temperature is not sufficient to melt and vaporize the copper in the firepit negligible amount of copper particles are included in the smoke plume aerosol or particulate matter, $PM_{2.5}$ or PM_{10}.

Figure 1:Firepit releasing environmentally friendly aerosols

The selected materials are grains, nuts, ghee (clarified butter), and some aromatic materials such as sandalwood. These materials are burned in specified quantities and at specified intervals for producing efficient results. The materials are either automatically or manually placed into the firepit.

Material	Appx. Total Qty. (kg)	Approximate Qty. disposed every 10 seconds	Approximate Total Time of Burning
Pinewood	10	NA	2 hours
Ghee	4	5.5 grams	2 hours
Wheat	3	4.1 grams	2 hours
Rice	2	2.75 grams	2 hours
Almond	1	1.35 grams	2 hours
Corn	1	1.35 grams	2 hours
Walnut	0.5	0.65 grams	2 hours
Barley	1	1.35 grams	2 hours
Sandalwood	0.1	NA	NA

Table – 2 Materials and Quantities used

2.1 Process

When these materials are placed in the fire, hot smoke and steam are produced. Due to the heat these materials get dried by releasing the vapors from them. These vapors mixing with the air enters into the atmosphere. In that vapor the water part is steam and particles mixed with steam part is smoke. These vapors and particles interact with the atmospheric particles and mitigate Particulate Matter in the ambient air by collecting them and raise high due to buouancy. These will likely grow into cloud drops at the atmosphere's LCL (lifting condensation level).

The combustion fire generally is between 200 to 1,000 degrees Celsius or so. At this temperature generally all materials (edible, herbs, etc.) are vaporized and the molecules/atoms/ions rise high into the atmosphere. These molecules have high kinetic energy and travel long distances and climb great heights as the density of these vapors are lesser than the surrounding air. These molecules/atoms/ions interact with the atmospheric Particulate Matter, stick to them, and carry to the cloud levels and concequently mitigate the air pollution. For example, Sulphur dioxide (SO_2) can be removed using Carbon (Sappok and Walker) [3].

Combusting herbs and scented materials give medicinal smoke to cure illness [4] such as pulmonary, neurological and dermatological apart from being beneficial to health and include smoke for social use. The authors also demonstrate that medicinal smoke can be extended to use in modern medicine as a form of drug delivery and is a promising source of new active natural ingredients.

Multiple experiements have been carried out by us from 2012 to 2019 at different instances (times and durations) of the year near atlanta in the state of Georgia, USA. Most of the time the experiment was performed in McDonough in the state of georgia, USA which is at a distance of 30 miles from Atlanta. The data about PM values before and after the experiment were collected from [5] which is an ambient

air monitoring program by the office of the Georgia state climatologist within the environmental protection division. Here we present a couple of the results from different experiements we have conducted in different years.

3 RESULTS AND DISCUSSION

3.1 Year 2012 Experiment

16 fire pits (Braziers) were placed with 11 of them having equal size truncated inverted pyramids (8-inch x 6-inch x 2 inch) made of copper metal. Remaining 5 fire pits are of different shapes made of bricks. 3 of them were rectangular, one semicircular and one is circular. The experiment was conducted on September 30th, 2012. The distance between the measuring instruments and the Yajna was about 8-10 miles.

McDonough Center Measurements of Particulate Matter:		
Date	Maximum Value (microgram / cubic meter)	Minimum Value (microgram / cubic meter)
30th September, 2012	20.5	2.4
1st October, 2012	7.3	0.2
2nd October, 2012	6.3	0.6
3rd October, 2012	14.7	2.2
4th October, 2012	19.8	7.8

Table-3 PM values in McDonough - 2012

Analysis and Discussion for McDonough center for the experiment results for the year 2012.

Results shown in Table-3 are for $PM_{2.5}$ values from the McDonough Center for 30th September 2012 to 4th October 2012. On 30th September the maximum value was 20.5 and 12 hours after the Yajna the value dropped to 2.4. A comparison shows that $PM_{2.5}$ has dropped to a minimum of 0.2 in 24 hours and its maximum didnot cross 7.3. The PM values remained low for about 72 hours before the maximum value of $PM_{2.5}$ reached to 19.8 (after 96 hours of the experiment).

3.2 Year 2015 Experiment

On April 4th the experiment was performed in McDonough with 43 triangular fire pits. The results of PM (Particulate Matter) in microgram/cubic meter on 2nd, 3rd, 4th, and 5th of April 2015 are as shown below at McDonough, GA. Experiment was performed on 4th April between 9:30 AM and 11:30 AM at 8 to 10 miles from the site of these measuring instruments.

Average PM Values from 2nd to 6th April 2015 in McDonough GA USA	
Date	Average PM values
2nd April to 4th April till 11AM	13.87
4th April 12 noon to 6th April	4.94
4th April 12 noon to 7th April	6.03

Table-4: PM values in McDonough – 2015

We can see from table 4 that the average PM values 60 hours before the experiment is 13.87 and 60 hours after the experiment the average PM values have fallen to 4.94. We can further see that 84 hours after the experiment the average PM value did not exceed 6.03 which is lesser than 50% of the value in the 60 hours before the experiment.

3.3 Year 2019 Experiment:

The fire pits were in the same shape and dimensions as mentioned in the year 2015.

On 6th October 2019 we did the experiment at McDonough, GA between 8:30 AM and 10:30 AM. The average PM (Particulate Matter) values for the 10 days is given below in the McDonough, Georgia region. The average PM (Particulate Matter) values for the five days from 1st to 5th and that from 6th to 10th October are given below.

Table-12 Average PM Values at McDonough – 2019

Date	Average PM Value
From 10/01/2019 to 10/05/2019	14.82
From 10/06/2019 to 10/10/2019	4.93

The average value of PM 5 days before the experiment was 14.82 and 5 days after the experiment was 4.93 which indicates that the PM pollution reduced by 66%.

Conclusion:

In the year 2012 experiment reduced PM pollution and the effect remained more than 72 hours within a radius of 10 miles (16 Kilometers) from the experiment site. In the year 2015 it is observed that after the experiment PM pollution is reduced for more than 84 hours in the radius of 10 miles (16 Kilometers) from the experiment site. In the year 2019 it is observed that the experiment reduced PM Pollution for about a week in a radius of 10 miles (16 Kilometers) after the experiment was performed. Even though the design of the firepits was similar to that in 2015, the reason for a prolonged period of the effect of the experiment could be the season in which the experiment was performed.

Ambient Air Pollution by various air pollutants - Particulate Matter (PM2.5 and PM10), and Greenhouse Gas emissions from industries and vehicles are increasingly putting more than 90% of the world population's health at risk along with contributing to the increasing levels of global warming. We have a disruptive environmentally friendly aerosol release automation technology to mitigate air pollution and make the air in the atmosphere clean and green to the maximum possible extent. Our aerosol release technology solutions can scale to meet the global needs in bringing the air clean and green, to reclaim the fundamental rights of human beings.

References

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