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Reduction of Perticulate Matter by Using Scrubbing Action

Prof. N. M. Sayyed [(1)], Prof. Mandakini Dubey[(2)], Pratham Kalambe [(3)], Rugved Sonkusare [(4)], Revan Padhya[(5)], Vaishnavi Sonkusare[(6)], Jitu Kumar [(7)], Prince Kumar [(8)]

Head of Department, Department of Civil Engineering, NIT Polytechnic College, Nagpur, India [(1)]

Assistant Professor, Department of Civil Engineering, NIT Polytechnic College, Nagpur, India [(2)]

Diploma Students, Department of Civil Engineering, NIT Polytechnic College, Nagpur, India [(3), (4), (5), (6), (7), (8)]

ABSTRACT: This study deals with the effects of fireworks on the air quality over the major cities of India during the festival of light known as "Diwali". The effects of firecrackers during the festival were assessed from the ambient concentration of various air pollutants such as Sulphur dioxide (SO), nitrogen dioxide (NO_2) and particulate matter (PM) with diameter less than 10pm. The concentration of gaseous pollutants such as (SO_2) and (NO_2) as well as particulate pollutant such as PM10 and PM2.5 was found about 2-6 times higher during the day of the festival because of the use of huge quantity of firecrackers that emit a large amount of pollutant into the atmosphere. Previous studies indicated that the concentration of above-mentioned air pollutants during Diwali festival was found several folds higher as compared to the 24-h standard of National Ambient Air Quality Standards (NAAQS) given by the central pollution control board (CPCB). India. The noise levels in the Indian cities during the night of Diwali festival were also found to be higher. The deterioration of ambient air quality due to the anthropogenic activity such as the use of firecrackers in the megacities of India has significant impacts on human health on a regional scale. This project suggested the development of a device to control the emission of particulate matter during the festival of light in the major cities of India to protect human health.

KEYWORDS: Air scrubber, Animal house, Particulate matter, PM10.

I. INTRODUCTION

This chapter puts emphasis on the basic terminologies and the introductory concepts in wet scrubbing. The chapter describes the various changes of the Ambient air quality and its health effects. comparison between PM_10 Water Soluble Ionic Consent Diwali is festival of light that is celebrated with great enthusiasm all over India during the month of October or November. Burning of firecrackers and illumination is a symbol of joy and prosperity. Firecrackers are associated with worldwide festivities such as new year's, Eve celebrations, the Las, Fallis in Spain, the lantern festival in China, bonfire night in UK, Tihar in Nepal, Day of Ashura in morocco, sky fest in Ireland, bastille day in France and Diwali in India, and also with many other communities of theworld.

Fireworks contain chemical species such as sodium oxalate, aluminum, arsenic, Sulphur, magnets, iron dust powder, potassium perchlorate, strontium nitrate and barium nitrate etc. the burning of firecrackers also produces gaseous pollutants such as SO_2 and NO, and produce huge number of ambient particulates into the atmosphere that generates dense cloud of smoke.Studies have been made in several parts of the world to determine the effects of fireworkactivities on the ambient air quality. A study revealed that highly toxic pollutants likepolychlorinated dioxins and furans are produce during the display of firework like "blue lighting rockets" and "fountains". It is found that firework activities on New Year's Eve in India were responsible for increase in total suspended particulate matter (TSPM) by an average of three times higher at fourteen locations and about seven times higher at one location. Firework display during Diwali festival in India reported to be increase in particulate matters, respectively over previous days.

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Respiratory Suspended Particulate Matter (Rspm):
Determination of RSPM (Da_< 10um) in the ambient air in necessary because they carry a complex mixture of toxic pollutants from firework which enters deep into respiratory system causing a pediatric respiratory disease. Results from previous studies during Diwali are shown in table 2

The concentration of PM0 was very high during Diwali as compare to normal days and the day before Diwali. The posts Diwali concentration are high due to the fact that aerosol release in the ambient air remains suspended in the air. An important that the PMID concentration remain high in the ambient air for even about one month after Diwali festival. The higher of PM1o as compare to NAAQS is a serious indication of air pollution which affects the health of the people. The result of ration sampling site, a rural area, which is a 45 km away from Raipur, shows that even a rural and religious area, which is supposed to be environmentally clean, is serious affected by firework during Diwali.

The high concentration of water-soluble ionic species was mainly due to the abundant use of salts in manufacture if fireworks. Higher concentration of Mg2, K^2 NH^1, SO42 and NO, is mainly due to their use in making of sparkles and crackers which mainly contain potassium nitrate, ammonium nitrate, and Sulphur.

The high value of PM10 in the ambient air as compare to NAAQS may be attributed to the increasing vehicles on the road and setting up of industries in the nearby areas whereas the high PM10 concentration particularly on the day of Diwali, as compare to normal days, it caused by fireworks. Delhi reported extremely high temperature, low mixing height, and low wind speed. Mumbai being a densely polluted city show fair result on the Diwali day. Bangalore is the only city in which PM10 concentration was below the permissible limit of PM10 of NAAQS (100ug/m^3). In almost all the cities, the concentration of PM10 on the day of Diwali is increasing every year which is challenging issue for the government.

Air Quality Index of Different Cities in India

Sr.no	City	Air Quality	Index value	Prominent pollutants	Based in no monitoring status
1	Delhi	poor	182	PM_{10}, $PM_{2.5}$	2
2	Bangalore	moderate	139	PM_{10}, $PM_{2.5}$OZONE	6
3	Chandrapur	moderate	148	PM_{10}, OZONE	2
4	Amravati	satisfactory	64	PM_{10}	1
5	Aurangabad	moderate	146	Ozone	1
6	Lucknow	poor	216	$PM_{2.5}$	2
7	Nashik	moderate	120	$PM_{2.5}$	1
8	Mumbai	satisfactory	80	PM_{10}	1
9	Navi Mumbai	moderate	104	CO	1
10	Pune	moderate	114	PM_{10}	1
11	Varanasi	Poor	285	$PM_{2.5}$	1

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Public Health Impact of Air Quality

Good	Minimal impact
Satisfactory	Minor breathing discomfort to sensitive people
Moderate	Breathing discomfort to the people with lungs, asthma, and lung diseases
Poor	Breathing discomfort to most people on prolonged exposure

The Effects of Various Components and By Products of Firework

Toxic elements	Fireworks usages	Toxic effects of fallout dust and fumes
Aluminum	Brilliant whites	Contact dermatitis
Antimony sulphone	Glitter effects	Toxic smoke, possible carcinogen
Arsenic compound	Used as colorants	Toxic ash can cause lung cancer, skin irritation and wart formation.
Barium nitrate	Glittering greens	Poisonous. Possible radioactive fallout.
Copper compounds	Blues	Cancer risk
Hexachlorobenzene (HCB	use was supposed to be banned globally	Persistent environmental toxin
Lead dioxide/chloride	oxidizer	Developmental risk to kids and unborn babies.

II. BRIEF LITERATURE SURVEY

The brief literature survey is published by Krishna Prasad Vadrevu, University of Maryland at College Park, UNITED STATE on August 13, 2018. This chapter present the critical analysis of the existing literature which is relevant to statics and data related to ambient air quality. Through, the literature consists of a lot many research contributions, but, here, we have analyzed some of the research and review papers. The existing approaches are categorized based the basic concepts involved in the mechanism. Finally, the summarized related to the scanned and analyzed research papers.

Diwali is the major festival in India, which is celebrate since ancient times. Earlier earthen lamps were used and the celebration was eco- friendly, whereas with the growing civilization and introduction of new fireworks in the market. The mode of celebration is harming the environment that too on the auspicious occasion of s festival day. For many people burning of fireworks has become very popular among the people. Generally, the Diwali is celebrated during the month of October or November. During these winter months, the air circulation is less and the gaseous pollutants from

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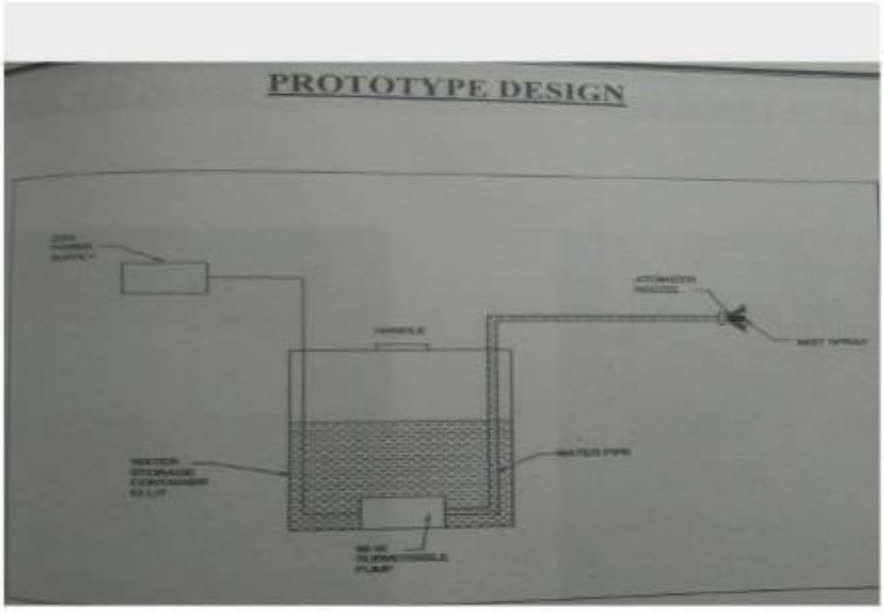
fireworks remain in the atmosphere fir about 15- 20 days. Moreover, the solids waste from the burnt crackers pollutants the roads and is required to be safelydisposed.

We have discussed the concentration of RSPM, water soluble ions, heavy metals as well as SO2 and NO_2 concentration on the day of Diwali across cities of India. The values are higher than the NAASQ in most of the Indian cities particularly the concentration of PM10 is increasing every year. Indian cities particularly the concentration of PM10 is increasing every year. The noise levels were found to be very high and dangerous for human health.

III. METHODOLOGY OF WORK



Along with air quality, noise quality is also affected by the fireworks activity during Diwali festival. Noise is an unwanted and unpleasant sound which acts as environmental pollutant in the atmosphere which creates interference in communication and created health problemsindustrial size wet scrubbers are very large and costly; hence not suitable for residential areas. In an attempt reduce the amount of RSPM in residential neighborhoods, we designed a machine which can reduce the amount of suspended pollutants, is portable, cost efficient and can be installed in homes. The household wet rubber is efficient and costs less than Rs.1000, the schematic of the machine is given in Fig. and the main components of the machineare:

1.Submersible pump: A 12V- 50W works as the powerhouse of the scrubber and provides with necessary pressure required for the generation of tiny waterdroplets.

2. Atomizer nozzle: An atomizer nozzle attached to the pump through a 7mm diameter rubber pipedisperses water in the form of tiny water droplets of size ranging from 50-100 micrometers.

3.Storage container, the storage container houses the submersible pump and the water which will be used for diffusion.

4.Power supply, A 220V power supply will provide power to the motor industrial

IV. RESULTS AND DISCUSSION

The primary objective of the present study is to inspect the effectiveness of wet scrubber with proposedsand filtration tank using CFD modelling and efficiency by comparing the volume fraction.

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i. Volume Fraction of Dust

In the simulation, dust particles were considered to be in the granular phase. InANSYS FLUENT, we canset the collision between two phases (water and dust particles). Due to the interaction of water and dustparticles, the dust particles settle at the bottom of the scrubber. Some of the dust particleswent out alongwith water through the side outlet. The blue and red color indicates the minimum (zero) and maximum(100%) volume fraction of the dust particles in the scrubber. The maximum volume fraction is at thebottom of thescrubber, which indicates the deposition of dust particles due to the interaction (collision)with the water 35–38.

ii. Surface integral of dust volume fraction

An area-weighted average result for the volume fraction ofdust particles was taken to check the amount of dust particles present in the inletand outlet of the wetscrubber. Approximately 25 percent of inlet dust particles come out. i.e. around 0.17 kg/s (inlet flow rate =0.6 kg/s).

iii. Volume fraction of flue gas

It clearlyshows that flue gasescapes through the water injection port. The red color shows the maximum (100%) concentration, andthe blue color indicates theminimum (zero) flue gas concentration.

iv. Velocity of water at the outlet

The surface integral of the area-weighted average velocity magnitude of the water at the side outlet. This outlet velocity will be used as the inlet velocity for the sand filter. The water fromthe wet scrubber comes out with an average velocity of 11.18 m/s.

v. Output parameter of wet scrubber

Quantity of Dust particle at the outlet – 0.17 kg/s (25% of the inlet valve). Thevelocity of water at theoutlet is 11 m/s. The above parameter will be used as an inlet parameter for sandfiltration.

vi. Pressure contours in sand filtration

The liquid in the filter can be pushed through by creating a difference in pressurebetween the inlet andoutlet sides of the filter. This pressure differential is greatly subjective to theresistance of the flow of thefilter or medium. Blue and red color in the contours indicate theminimum (41000 Pascal)and maximum (128000 Pascal) value of pressure, respectively. From the colorcontours, it is visuallypredicted that there is a high-pressure drop (87000 Pascal) between the inlet andoutlet, which means aneffective filtration has happened.

vii. Discrete phase concentration

In the simulation, dust particles of size 1 micron were considered as a discrete phase. ANSYS FLUENTmodel described the magnitude of the interphase exchange of momentum, heat, and mass in theindividual control volume. It is also able to analyze the total concentration of particles present in thedesignated discrete phase. Due to the resistance of the porous medium (sand filter), the particleconcentration was high(0.16 kg) in the sand filters area, and it is zero at the outlet. The green color in the figure indicates theconcentration of the discrete phase (dust particles). Since the variation of thediscrete phase is lessthroughout the height of the sand filter, the concentration contours are visualized as uniform.

viii. Surface integral of Discrete Phase Model (DPM)concentration

Anarea-weighted average result for discrete phase concentration was taken to check the amount of dustparticles present in the inlet and outlet of the sand filter. The below surface integral result shows thateffective filtration was done, i.e. dust particle was completely filtered from 0.17 kg at the inlet to zero atthe outlet.

V. CONCLUSION

The wet scrubber unit performance mainly depends on the purity of water. Therefore, a goodImprovement in the wet scrubber is mandatory. To achieve betterperformance of a wet scrubber, newconditions to eliminate the secondary pollutionformed on the wet scrubber is proposed. To eliminate thesecondary pollution, afiltration tank was fitted at the outlet of the wet scrubber. The multiphase modelwas used to simulate the deposition and escaping of dust particles in the wet scrubber unit. Then thesimulation of the filtration tank was done using the discrete phasemodel. From the simulation, thevolume fraction of the dust particle present in thewet scrubber and at the outlet of the unit wasmeasured.

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The outlet of the wetscrubber unit contains 0.17 kg of dust particles; it is about 25% (0.6 kg)of inlet dust particle concentration. Also, the outlet velocity of the water in the wet scrubber unit wasmeasured as 11.18 m/s. Then the computation of the filtration tank was done usingthe wet scrubberoutlet parameter. The filtration tank was simulated as a medium. The effective filtration wasidentified by measuring the dust particleconcentration at the inlet and outlet of the filtration tank. Fromthe computation of the filtration tank, it was found that effective filtration was done using sand filters, i.e.environmental chemicals and particle matter was completely filtered from 0.17kg at the inlet to zero atthe outlet.

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