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# A REVIEW ON CHARACTERIZATION OF AEROSOLS AND TRACE GASES IN THE REGION OF HISTORICAL BUILDING: THE TAJMAHAL

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## ABSTRACT

This review article deals with measurements of aerosols, their chemical properties and precursor trace gases at Agra near to the zone of the historical monument: The Taj. This article explains the transportation of urban plumes may be responsible for high concentration some of acidic gases like as SO2 and NO2. Along with the gases, the high wind speed from North West direction influences the aerosol load too. Even, TSPM load is higher during prefoggy/foggy days and lower during post foggy. Ambient aerosol samples were collected from urban and suburban sites in the Agra region. The samples were collected on Whatman-41 filters using a CPS-105 size-segregated impactor. The effects of urban aerosols are many and varied. Aerosol deposits on land downwind of cities are modified the chemical and radiative properties of the downwind atmosphere and alter regional cloud precipitation which causes the degradation of building materials.

***Keywords-***.. *Aerosols, PM, Urban and suburban sites, Tajmahal.*

## Introduction

Atmospheric aerosols are explained as dispersions (or suspensions) of solid or liquid in the atmosphere and the term particulate matter (PM) is commonly used to represent the solid phase suspended matter in the atmosphere. In the literature, the term aerosol and PM are often interchangeably used even though the term aerosol has a broader definition and scope. These aerosols are produced from a wide range of natural and anthropogenic activity on earth and within the atmosphere. The study of aerosols in the atmosphere from an environmental and public aspect has not been in the news for the last several decades but now it is into the focus especially due to effects that are global in scale.

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Some of the fundamental issues are explained the behaviour of atmospheric aerosols and their interaction with gas-phase chemical components in the environment, which are now widely used as textbook material related to atmospheric aerosols and their chemistry.[1–4] Indeed, there are various surveys accessible on the recent patterns in aerosol science of the atmosphere. Out of these reviews, some are in focus on particular issues of atmospheric aerosols. These include the characterization of organic components in atmospheric aerosols, their estimated procedures[5-7], affect on territorial climate, surface reactivity and science of aerosols, impact on regional weather[8-10], surface reactivity and chemistry of aerosols.[11] The study of atmospheric aerosols has two common objectives: (i) impact of exposure near the surface of earth and (ii) role of the chemical and physical processes in the atmosphere. For any of these, the initial step is to gather a large volume of data related to the ambient atmosphere and this data may be the concentration of aerosols, their size and composition as a function of location and time.[12] As a rule, the example of aerosol behaviour or dynamics observed in one a part on the planet may likewise be seen in an alternate part of the world. Nonetheless, regularly there are specific regional patterns that might be helpful to comprehend the nearby conduct of aerosols and give profitable knowledge into the procedures influencing neighborhood and regional pollutant dynamics.[13] Following this approach, there have been done a number of studies on atmospheric aerosols in India. Out of these reviews, the aim is to highlight the some of the important aspects that have been addressed in studies conducted in Agra. The review is explained on the basis of some of the points raised above and discusses the works conducted in the last decade or so.

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## AMBIENT AEROSOL MEASUREMENTS AND ANALYSES

The measured data of aerosols in the ambient environment can be accomplished with a variety of objectives which define the detailed scope, methodology and analysis of the results. The following discussion looks at few of the data collected in different campaigns.

### Sample measurements

The primary interest is to monitor the mass concentrations of suspended matter in ambient air as a direct indicator of the potential hazard to human health. The several agencies all over the world have designated several particle sizes and issued ambient air quality standards as PM10 and PM2.5, where the subscript refers to the particle size represented as an aerodynamic diameter (in microns) cut-off limit. [14] For the characterization of the PM, samples collected at all locations with special focus at Tajmahal was conducted for a roughly one-year period. Generally, filters were collected every sixth day each month for both PM2.5 (fine particulate matter having diameters less than 2.5 μm) and total suspended particulate matter (TSP), and analyzed for major anions, and trace elements. The most commonly used method to collect PM2.5 is the time-averaged method using a high or low volume sampler which intercepts the desired size PM on a filter medium in which mass collected on the filter medium is measured gravimetrically using a 4-digit or 7-digit balance. Time-averaged measurements are useful in evaluating general trends in ambient air quality in a given region or a season, and for comparing trends between regions. This filter can be analysed to check for the integrated mass measurement or for chemical analysis, while the TSP directly sampled ambient air.[15]

Multichannel speciation samplers are also used to collect PM samples, especially when a multi-component chemical analysis of the sample is the objective. Up to four channels of PM samplers are operated simultaneously with different filter media suitable for the analysis of different chemical species. Lower timescale measurements are useful in evaluating specific events in an environment.[16]

These instruments are useful for measuring almost real-time analysis of PM.

### Field description and measurements

Agra district is situated in western U.P. between 27.45' to 27.23’degree Latitude North and 77.27' degree to 78.53' degree Longitute East. Its Altitude is 168 meters above sea level, situated in south-western most part of U.P. it is bounded on the west by Bharatpur (Raj.), on the East by Firozabad and Etawah Districts and on the North 3 by Mathura, Etah districts and on the South by Hilly terrains of M.P. and Raj. It is situated on the banks of Yamuna river, 200 km away from the national capital New Delhi. The local traffic in Agra city mostly depends on two and three wheelers, which emitted lots of smoke and other pollutants. There are a total of 386,635 registered vehicles in Agra. According to conservative estimates, at least 25 metric ton (MT) of diesel is sold in the city every day. The reported sampling sites, namely, Dayalbagh (DB), St John’s College (SJC), Rambagh (RB), Sikandara (SD) and Tajganj(TG) according to their different population patterns and traffic densities have been discussed for monitoring PM.[17] The locations of these sites have been shown in Fig. 1.

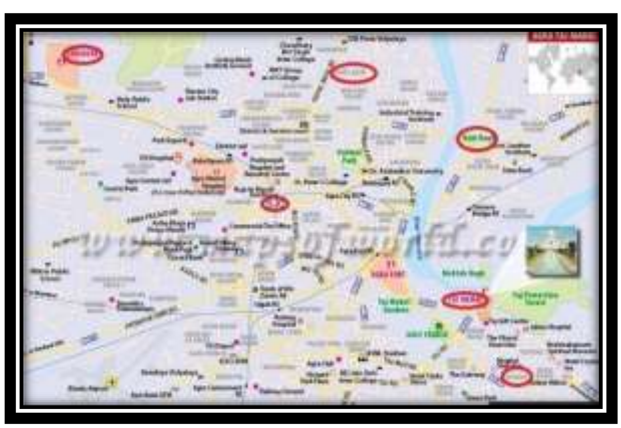

*fig.1: Different reported sites of Agra near the Taj*

### Dayalbagh (DB)

The site is of residential area located in the north of the city. The site is h a v i n g agricultural practices carried out at a distance of about 1 km towards the north of the sampling site. The vehicular population is due to two and three wheelers. In this sampling site, there are no industries and heavy vehicle population is negligible. A national highway (NH-2) is also situated at a distance of 3 km south of the sampling site.

**St John's College (SJC)**

It is traffic prone site and situated in the heart of the Agra city. The sampling site lies by the side of a road that carries mixed vehicular traffic. The traffic volume of the road is very high. A major road junction halts traffic results in production of smoke and total suspended particulate matter. A major railway station is also located at a distance of 0.2 km towards the west direction from the sampling site having almost 80 trains per day. Thus, the particulate level at this site is mainly done by vehicular emissions.

**Rambagh(RB)**

It is a u r b a n a r e a u n d e r t h e commercial and residential site experiences high traffic load of heavy diesel vehicles, two stroke vehicles and diesel driven three and four wheelers through-out the day. Major urban activities are held in the West of the sampling site.

**Sikandara(SD)**

It is located on NH-2 about 80 km away from kanpur toward west and towards south from Jhinjhakat a distance 20 kilometer. Auraiya city is towards west from Sikandara and Pukhrayan town is towarad east. Due to congested area, the pollution levels are very high.

**Tajganj(TG)**

Located to the east of the center of the city, Tajganj is only a few kilometers away from the heart of the city. The buses are connected from Taj Road to reach the center of the city. It is also connected by railroads. The Agra Fort railway station is the nearest railway station which is having a distance of 4 kms from Tajganj.

## RESULTS AND DISCUSSIONS

According to the advanced studies of literature, the statistics of different mass concentration and the gaseous concentration on the particular sites are entirely different from the standard air quality assessment applicable on spacial sites in different seasons. [18-23]

| Local Site | Std. values(µg/m3) | | Reported range (µg/m3) | |
|---|---|---|---|---|
| | PM10 | PM2.5 | PM10 | PM2.5 |
| DB | 100.2±5.2 | 25.7±2.2 | 105.3-121.4 | 30.7-40.2 |
| SJC | 110.7±3.4 | 40.5±1.2 | 127.9-135.4 | 46.4-50.5 |
| RB | 115.3±3.6 | 47.8±1.2 | 132.6-140.3 | 57.8-62.4 |
| SD | 124.5±4.5 | 50.9±1.5 | 137.5-145.6 | 62.9-68.7 |

| | | | | |
|---|---|---|---|---|
| TG | 135.8±2.8 | 55.5±1.1 | 140.8-150.4 | 69.5-75.8 |

***Table1: PM data on different reported sites with their standard parameters***

| Local Site | Reported gases in atmosphere at Agra ( approx value in µg/m3) | | | |
|---|---|---|---|---|
| | $O_3$ | $NO_2$ | $SO_2$ | CO |
| TG | 35.6 | 25.7 | 46.7 | 1.8 |
| SD | 32.7 | 19.5 | 35.4 | 1.5 |
| RB | 28.3 | 16.8 | 22.6 | 1.3 |
| SJC | 24.5 | 14.9 | 15.6 | 0.9 |
| DB | 15.8 | 10.5 | 5.4 | 0.8 |

***Table2: Average conc. of gases on different reported sites at Agra.***

There are other studies that look at specific environments and the levels of aerosol concentration in pre-foggy and post-foggy days which indicates that pollution is very high in pre-foggy days as comparison to post-foggy days by the long-range transportation of pollutants from nearby polluting regions.

**Effect of Aerosols**

**Effect on Buildings**

Buildings have always been subject to attack by weathering. Throughout the world, emissions of sulphur dioxide and nitrogen oxides contribute to the international problem of acidification. Structural harm to underground pipes, links and foundations submerged in corrosive waters can likewise happen, in addition to harm to buildings, bridges and vehicles above the ground.

While dry deposition contributes to the corrosion of materials. The sulphated layers are more readily caused the permanent alteration of stone surfaces by the action of acid deposition is known as sulphation.[24]

Sulphur dioxide is the main pollutant in respect to corrosion including nitrogen oxides, carbon dioxide, ozone and so on. Research has revealed that when nitrogen dioxide is available with sulphur dioxide, expanded corrosion rates happen. This is because that the nitrogen dioxide oxidizes the sulphur dioxide to sulphite which promotes further sulphur dioxide absorption.

The connections between building materials and pollutants are complex and numerous variables are involved.[25-27] Deposition of pollutants onto surfaces relies on atmospheric concentrations of the pollutants and the atmosphere and microclimate around the surface. Once the pollutants are on the surface, interactions will fluctuate depending on the amount of exposure, the reactivity of various materials and the measure of moisture present.[28] The last factor is especially essential because the sulphur dioxide that falls as dry deposition is oxidised to sulphuric acid in the presence of moisture on the surface. [29-31]

**Effect on Climate**

One of the main focal points in recent decades has been the effect of air pollution on regional weather patterns and global effects such as greenhouse gas effect. One of the key components in this discussion is the presence of aerosols at a particular location on the earth's surface. There are a number of uncertainties in this regard, to measure the effects of radiative forcing by aerosols[32, 33]. Regional interest is primarily from a point of view of prediction of the weather patterns, especially the monsoons on which India depends critically. Reports of local weather changes due to large aerosol clouds lead to questions of pollution sources, local regulation and management. A large number of independent and cooperative studies have looked at aerosols in general and specific constituents in the atmosphere.

**Effects on Human**

Health effects are arising from exposure to PM or aerosols have been widely reported and vary from mild respiratory ailments to very severe chronic effects. There are a few examples of studies where direct physiological evidence is available for connecting aerosol exposure to an ailment. The respiratory health of workers employed in a municipal solid-waste disposal landfill facility was monitored as a function of age, gender and socioeconomic conditions. In comparison to a control group, the landfill workers had a higher incidence of symptoms such as respiratory trouble and a host of other ailments. Spirometry tests revealed impairment in lung function for a significant section of these people. Sputum cytology studies revealed other pathological evidences of deposition, inflammation or infection on different components of the respiratory system. One such study simulated the effect of the particles emitted from biofuel combustion and the activity of surfactants present on the surface are badly affected the other parts of the respiratory tract. There have been a number of studies that measure the exposure of different groups of population to PM as a function of occupation, location and socio-economic background[34]. In combination with the health effects studies, these exposure studies are also valuable in designing better tools for combustion, or better residential design, or a change in public policy.

## CONCLUSIONS

A large body of aerosol work in India is focused on the radiative forcing effect and on the effect on the earth. There is also a reasonably large set of studies involved in aerosol characterization. Thought this is done in a manner at different locations, it has covered wide sections of the country especially near the historical monument: The Taj. There has been research on specific issues that do not come under the parameter of ambient air quality, but those which focus on the processes and mechanisms are underlying the cause of pollution. The general principles are known through the former studies conducted elsewhere and available in the open literature, that the biggest need at this time is the collection of reliable data with good spatial and temporal solution. A big difference between the state of the science in aerosol literature in general and the studies in India is the current reliance on techniques of chemical characterization that are not real-time. In this review, aerosol science as an environmental science application academic discipline is yet to be airborne in India. General pollutant transport theories are well established and validated all over the world. There are, however, very specific local microenvironments such as that in a busy urban road, where pollutant transport assessment can lead to better prediction of exposure and risk. Field experimental validation of such studies is challenging and can be substituted by conducting studies in the simulated environments. The simulation and experimental validation of a large number of such studies can be useful in the formulation of efficient strategies of the optimization.

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