Ultra Chemistry Vol. 9(1), 37-42 (2013).

# Effect of Urbanization on Air Quality in District Bhopal, Madhya Pradesh (India)

MANZOOR AHMAD and TAYYEB SAIFY

Department of Botany, Saifia Science College, Bhopal, M.P. (INDIA)
Manzoorwani786786@gmail.com

**(Acceptance Date 3rd January, 2013)**

## Abstract

This work investigates that the concentration of the pollutants sulphur dioxide, nitrogen oxides, and total suspended particulate (TSP) generated from various sources like automobiles, industries over the ambient air quality of the Bhopal. As such Bhopal is a big city and it is not possible to measure the concentration of these major pollutants in all areas, so we have restricted our study at 3 sites only. The major pollutants as suggested by the Central pollution control board (CPCB) in an industrial area are sulphur dioxide, oxides of nitrogen ($NO_X$) and total suspended particulate (TSP). The rate of emission and concentration of these gases in the ambient air is studied by the following laboratory methods – (a) Modified West and Gaeke method for determination of sulphur dioxide in ambient air, (b) Modified Jacob and Hochheiser method for determination of nitrogen oxides in ambient air, and (c) High volume method for determination of TSP in the ambient air. The results will show the concentration of emissions of the above cited gaseous and suspended solid pollutants and will be compared with the permissible concentrations as per the standards given by CPCB for an industrial area and major precautions can be taken to reduce the concentration level of these pollutants.

## Introduction

The air we breathe is a mixture of gases and small solid and liquid particles. Some substances come from natural sources while others are caused by human activities such as our use of motor vehicles, domestic activities, industry and business. Air pollution occurs when the air contains substances in quantities that could harm the comfort or health of humans and animals, or could damage plants and materials. These substances are called air pollutants and can be either particles, liquids or gaseous in nature[1]. Keeping the air quality acceptable has become an important task for decision makers as well as for non-governmental organizations. Particulate matter and gaseous emissions of pollutant emission from

industries and auto exhausts are responsible for rising discomfort, increasing airway diseases and deterioration of artistic and cultural patrimony in urban centers[6]. As many cities around the world become more congested, concerns increase over the level of urban air pollution being generated and in particular its impact on localized human health effects such as asthma or bronchitis. The more this relationship is understood, the better chance there is of controlling and ultimately minimizing such effects. In the majority of the developed world, legislation has already been introduced to the extent that local authorities are required by law to conduct regular Local Air Quality Reviews of key urban pollutants such as $SO_2$, $NO_x$ or Ozone -produced by industrial activity and/or road transport ( Ghanem M. et al ,unknown ).

Bhopal city is the most urbanized districts of the state. As per 2001 census, 80.53%of the district population lives in urban areas, predominantly, in the city. In between 1901 to 1921, the urbanization declined as a result of plague out breaks. The urban population then rose steadily from its low 30.4% in 1921 to 43.3% in 1951. In 1956, Bhopal was made the state capital and, in the same decade, the Industrial township of BHEL was established. This led to substantial population-increase and by 1961 the urbanization of the district rose to 61.6%. In subsequent decades, rate of urbanization seems to be eventually stabilizing at about 80%

## Materials and Methods

High Volume Method for Determination of Total Suspended Particulate Matter in the Atmosphere

*PRINCIPLE:*

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10in) filter at flow rate which is typically 1132 L/ min (40 ft3 /min). Particles with aerodynamic diameters less than the cut-point of the inlet are collected by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of suspended particulate matter in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

*Analysis of sulphur dioxide in ambient air:*

Modified West & Gaeke Method

Sulphur dioxide from air is absorbed in a solution of potassium tetrachloromercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely coloured pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer.

*Analysis of Nitrogen dioxide in ambient air:*

Modified Jacobs & Hochheiser Method

Ambient nitrogen dioxide ($NO_2$) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The

concentration of nitrite ion($NO_2$) produced during sampling is determined colorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)-ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 n m.

Air Quality Index (AQI), although a useful tool devised to simplify interpretation of data, may result in some loss of scientific information. In this research, adaptability of some of the existing AQIs that have been used by various agencies is examined[6]. The quality of air in the study area can be estimated from the air quality index. The air quality index was calculated from the observed TSP, $NO_x$ and $SO_2$ values using the formula;

$AQI = 1/3 \times (ITSP / STSP + I\,SO_2 / S\,SO_2 + INO_X / SNO_X) \times 100$

Where:

ITSPM, I $SO_2$ and $INO_X$ = Individual values of suspended particulate matter, sulphur dioxide and oxides of nitrogen respectively.

STSP, S $SO_2$ and $SNO_X$ = Standards of ambient air quality.

*Data Resources and Study Area :*

The Bhopal city is situated on the sand stone ridge 425 m above M.S. level. It stands on the edge of two lakes. The climate is relatively moderate and dry except monsoon season, indicating a seasonal rhythm of weather. The normal rainfall of the district is1289 mm from the period of July 2011 to June 2012.The minimum temperature was 09.60 °C and maximum was 42.60°C during this period. During the Southwest monsoon the humidity is about 70%.During the rest of the period weather is generally dry. Geologically there are two prominent rock formations, the upper Vindhyan and the Malwa traps Topographically the Bhopal lies on the Malwa platea.

Table 1. Ambient air quality standard of central pollution control board (cpcb)

| Sampling stations | TSP | $SO_2$ | $NO_X$ |
|---|---|---|---|
| Industrial area | 500(8 hr) | 120(8 hr) | 120(8 hr) |
| | 300(24 hr) | 80(24 hr) | 90(24 hr) |
| Residence area | 200(8 hr) | 80(8 hr) | 80(8 hr) |
| | 140(24 hr) | 60(24 hr) | 60(24 hr) |
| Sensitive area | 100(8 hr) | 30(8 hr) | 30(8 hr) |
| | 70(24 hr) | 20(24 hr) | 20(24 hr) |

Table 2. Air quality category based on air quality index

| Category | AQI of ambient air | Description of ambient air quality |
|---|---|---|
| I | <10 | Very clean |
| II | Between 10-25 | Clean |
| III | Between 25-50 | Fairly clean |
| IV | Between 50-75 | Moderately polluted |
| V | Between 75-100 | Polluted |
| VI | Between 100-125 | Heavily polluted |
| VII | Beyond 125 | Severely polluted |

The monitoring sites chosen are:

1. Site 1: Jahangirabad Urbanized
2. Site 2: Koh-e-Fiza Urbanized
3. Site 3: Ekant Park protected

**Results and Discussion**

The rapid industrialization, urbanization, unplanned and excessive exploitation of natural resources has been causing pollution problems in cities and towns of developing countries. Manmade and natural sources of emissions have polluted the air with toxic substances.

During the present study the value of TSP, $SO_2$ and $NO_X$ were 121.33 µg/ cu-m, 12.30 µg/ cu-m and 23.32 µg/ cu-m at site 1.At site 2 the value of TSP, $SO_2$ and $NO_X$ were 108.42 µg/ cu-m,10.80 µg/ cu-m and 19.53 µg/ cu-m. Lower values were found at site 3 which are 64.63 µg/ cu-m, 6.32 µg/ cu-m and 7.33 µg/ cu-m for TSP, $SO_2$ and $NO_X$.

The Ambient Air Quality of Jyotivihar, Orissa in terms of TSP, $SO_2$ and $NO_x$ was studied during December–1994 to November–1995. The minimum and maximum values were 82.995 µg/cu-m and 182.7 µg/cu-m for TSP, 4.62 µg/cu-m and 25.74 µg/cu-m for SO2and 4.39 µg/cu-m and 16.89 µg/cu-m for $NO_x$ (Naik S., 2005). A report showed that SPM concentrations in Shanghai, New Delhi, Mumbai, Guangzhou, Chongquin, Calcutta, Beijing and Bangkok exceeded WHO limits (90 µg/cu-m) by three, five, three, three, four, four, four and two times respectively

Table 3. Concentration of tsp, $SO_2$, and $NO_X$ in ambient air at different monitoring sites

| Monitoring Site | T S P | $SO_2$ µg/ cu-m | NOX µg/ cu-m |
|---|---|---|---|
| 1. | 121.33 | 12.30 | 23.32 |
| 2. | 108.42 | 10.80 | 19.53 |
| 3. | 64.63 | 6.32 | 7.33 |

Table 4. AQI at different monitoring sites

| Monitoring Site | T S P | $SO_2$ | $NO_X$ | AQI | Ambientair quality |
|---|---|---|---|---|---|
| 1. | 121.33 | 12.30 | 23.32 | 35 | Fairly clean |
| 2. | 108.42 | 10.80 | 19.53 | 30 | Fairly clean |
| 3. | 64.63 | 6.32 | 7.33 | 16 | Clean |

The AIR QUALITY INDEX Shows that the Air at Site 1 and at Site 2 is fairly clean. The Air at Site 3 is clean; it is because of presence of plants and absence of transportation. At Site 1 and at Site 2 the air is not clean because of presence of transportation.

## Conclusion

Ambient air quality was assessed using three monitoring sites inside Bhopal, the studies have clearly revealed the levels of air pollutants for TSP, $NO_x$ and $SO_2$. At site 3 values of all these pollutants (particulates and gaseous) are observed to be very much below National Ambient Air Quality Standards. But at site1 and site 2 the values are much higher than site 3. This increase in AQI at site1 and site 2 is probably due to the increased transportation on the road.

## Acknowledgement

Authors are thankful to local people of Bhopal and Department of Botany, Saifia Science College, Bhopal for their sincere guidance.

## References

1. Alias Masitah, Hamzah Zaini and Kenn Lee See. PM10 and Total suspended particulates (TSP) measurements in various power stations, *The Malayasian Journal of Analytical Sciences*, Vol *11*, No. *1*, 255-261 (2007).
2. Ambient air quality assessment, CPCB (2002).
3. WHO, Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide, (2003).
4. WHO, Results from the WHO project "Systematic Review of Health aspects of Air Pollution in Europe". (2004).
5. Review of air quality management system in India.
6. Mukunda Rao, PV., Hima Bindu V., Sagareshwar G., Jayakumar Indracanti, Anjaneyulu Y. Assessment of ambient air quality in the rapidly industrially growing Hyderabad urban environment, (2003).
7. Shandilya Kaushik K., Khare Mukesh, Gupta khilendra Bhushan. Suspended Particulate Matter Distribution in Rural-

Industrial Satna and in Urban-Industrial South Delhi, *Environ Monit. Assess,* Vol. *128,* 431–445 (2007).

8. National ambient air quality objectives for particulate matter, *Science Assessment document*. (1998).
9. Gupta Usha. Valuation of Urban Air Pollution: A Case Study of Kanpur City in India *Environ Resource. Econ.* (2008).
10. Chaulya S.K. Spatial and temporal variations of SPM, RPM, $SO_2$ and $NO_x$ concentrations in an opencast coal mining area, *J. Eviron. Monit.,* No *6,* 134-142 (2004).
11. Air Pollution Control in the Transportation Sector. Third Phase Research Report of the Urban Environmental Management Project, (2007).
12. WBK and Associates Inc. Sulphur Dioxide: Environmental Effects, *Fate and Behaviour,* (2003).