ASSESSMENT OF BTEX IN AMBIENT AIR OF AGRA

Vineet Bhardwaj¹, Ashok Kumar ²

¹,²School of Chemical Science, Department of Chemistry, St.John’s College Agra 282002, Uttar Pradesh, (India)

ABSTRACT

Volatile organic compounds (VOCs), which are habitually found in both indoor and outdoor environments, may represent a significant health risks. In this context, we assess the BTEX in ambient air of Agra. The objective of this study is to present the levels of BTEX from five locations of Agra. BTEX sampling was carried out by using the Respo Rae Ultra VOCs Monitor for four hours at each sampling sites for five times in a month. The BTEX levels were higher in industrial location as well as refueling pump stations. The annual mean levels of BTEX at five locations were ranged from 7.5 µg/m³ – 17.2 µg/m³, 11.2 µg/m³ – 39.7 µg/m³, 3.4 µg/m³ – 8.7 µg/m³, and 2.3 µg/m³ – 5.8 µg/m³ respectively. We found that, in comparison with other studies, our levels of BTEX were quite low. Still, due to the small sample size of the present study, further studies are needed to be carried out in this regard to prepare the strategic plan to control the BTEX levels not only in Agra but also other cities of India and abroad.

Keywords: - Correction factor, dermal, Environmental tobacco smoke, t-test, ubiquitous, VOCs.

I. INTRODUCTION

Agra, India suffers from high ambient concentrations of atmospheric pollutants, including BTEX, particulates, carbon monoxide, oxides of nitrogen, ozone and sulphur dioxide. Amongst them, volatile organic compounds mainly benzene, toluene, ethylbenzene and xylene, collectively called BTEX, play an important key role in tropospheric chemistry. Industrial processes, combustion of fossil fuels, vehicular exhaust, domestic heating and electricity generation, fuel distribution, solvent use, landfills, waste treatment plants, environmental tobacco smoke, fuel combustion, building materials, furnishing, furniture and carpet adhesives, paints and solvents, cleaning agents, air fresheners and cosmetics are the various sources of BTEX in ambient air[1]. In recent years, the number of days with ozone hourly concentration exceeding the National ambient air quality standard. Ozone is not emitted directly into air, it is formed in the troposphere as a result of complex photochemical reactions that involve VOCs and NOx as its precursors. VOCs have a wide range of variation in reactivity with respect to ozone formation [2].

Organic solvents such as benzene, toluene, ethylbenzene, and xylene (BTEX), are a heterogeneous group of pollutants, known as hazardous air pollutants (HAPs). These are emitted from several sources. Human exposure to BTEX can result from inhalation., ingestion and dermal absorption. Benzene is one of the most prevalent HAPs in urban areas [3] and is of particular interest because it has been associated with several adverse health outcomes including pediatric cancer and intrauterine growth restriction [4,5]. In addition, IARC classify benzene as known human carcinogens and ethylbenzene, toluene and xylene as possibly carcinogenic to humans [6]. Exposures to BTEX is ubiquitous and can results in a wide range of acute and chronic health effects such as
sensory irritation, nervous system impairment, asthma and cancer [7]. Therefore, there is an international recognition of the potential health risks associated with exposure to BTEX and of need for action to assess the ambient concentrations of BTEX as well as their exposures in the general population and to minimize their risks.

Several researchers attempted to assess the exposures of BTEX to humans and its ambient levels. Maternal exposure to ambient levels of benzene and neural tube defects among offspring studied and reported that, mothers living in census tracts with the highest benzene levels were more likely to have offspring with spina-bifida than were women living in census tracts with lowest benzene levels [8]. Indoor and outdoor BTEX exposures in children living in a petrochemical area in Spain was investigated and found that, industrial emissions contribute exposure on children [9]. Patterns of VOCs and BTEX concentration in ambient air around industrial sources in Daegu, Korea were determined and significant difference observed between the ratios for the residential and commercial areas implies that the two areas have different emission sources [10]. The main aim of the present study to assess the ambient levels of BTEX in ambient air of Agra and to identify their sources.

II. METHODOLOGY

In this study, ambient air samples were collected during the period of November 2008 to October 2009 at five locations, in Agra, Uttar Pradesh, India. The selected five locations were, Vibhab Nagar (Residential), Raja Ki Mandi (Commercial), Nunhai (Industrial), Rambagh Crossing (Traffic Intersection), and New Agra (Refueling pump station). A real time measurements of benzene, toluene, ethylbenzene and xylene, collectively regard as BTEX, concentration levels were performed by using Respo Rae 3000 Ultra VOCs Monitor, which is a programmable compound specific photo-ionization detector (PID) and monitor BTEX by utilizing a gas separation tube with 9.8 eV gas discharge lamp. However, correction factor (CF) have been determined the quantity of BTEX gases in ambient air. Prior to start sampling of BTEX gases in ambient air, first we calibrate the monitor with isobutylene gas by input an equivalent corrected span gas concentration when prompted for the value of BTEX gases.

The sample size for pre-concentration step was four hours for using the Respo Rae 3000 Ultra VOCs Monitor. Samples were collected for five times in a month, during peak hours at all the selected five locations in Agra. The collected data has been analysed under SPSS 15 software and performed one-sample t-test.

III. RESULTS AND DISCUSSIONS

In this study, concentrations of BTEX were measured in ambient air at the five selected locations in Agra, during November 2008 to October 2009. Table 1. Summarizes the levels of BTEX measured in ambient air of Agra at all the selected locations viz. residential, commercial, industrial, traffic intersections and refueling pump station respectively.
From the Table 1, it was evident that the concentrations of benzene ranged from 4.0 µg/m³ – 25.2 µg/m³. The minimum concentration of benzene was observed at Vibhab Nagar residential location and the maximum concentration of benzene was observed at Nunhai industrial location. The concentrations of toluene, ethylbenzene and xylene ranged from 5.6 µg/m³ – 55.4 µg/m³, 1.7 µg/m³ – 11.8 µg/m³, 1.2 µg/m³ – 7.8 µg/m³ respectively. In this study, the levels of BTEX were much lower than those observed in other studies performed in different cities of India [11] and different countries of the world. When compared to the other mega-cities of India, the BTEX levels in Agra were much lower than those observed in Mumbai [12], Delhi [13] and Kolkata [14] and different countries like Taiwan [15], Northern Germany [16] and Mexico [17] etc. Figure 1 to 4, shows

<table>
<thead>
<tr>
<th>NAME OF SITE</th>
<th>Conc (µg/m³)</th>
<th>Benzene</th>
<th>Toluene</th>
<th>Et.benzene</th>
<th>Xylene</th>
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<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
<td>Mean</td>
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<tr>
<td>1. Vibhab Nagar[Residential]</td>
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<td>4.0</td>
<td>12.9</td>
<td>7.5</td>
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<td>2. Raja Ki Mandi[Commercial]</td>
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<td></td>
<td>4.9</td>
<td>19.4</td>
<td>9.6</td>
<td>5.6</td>
<td>1.5</td>
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<td>3. Rambagh Crossing [Traffic Intersection]</td>
<td>7.8</td>
<td>16.7</td>
<td>10.4</td>
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<td>3.6</td>
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<td></td>
<td>10.4</td>
<td>19.7</td>
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<td>4. Nunhai [Industrial]</td>
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<td></td>
<td>10.3</td>
<td>25.2</td>
<td>17.2</td>
<td>23.7</td>
<td>6.3</td>
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<tr>
<td>5. New Agra [Refueling Pump Station]</td>
<td>8.4</td>
<td>18.1</td>
<td>11.3</td>
<td>10.7</td>
<td>3.9</td>
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<tr>
<td></td>
<td>11.3</td>
<td>21.7</td>
<td>14.2</td>
<td>8.1</td>
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TABLE 1. Min. Max. and Mean Concentrations of BTEX at all the selected locations in Agra during Nov. 2008 to Oct. 2009 (µg/m³)
the annual mean concentrations of BTEX in selected locations of Agra, during the study periods. Figure 1.
Shown that the annual mean concentration of benzene was highest at industrial site due to industrial activities as well as human activities. The levels of benzene follow the given trend:

**Industrial > Refueling Pump Station > Traffic Intersection > Commercial > Residential**

**Figure-1. Annual mean concentrations of benzene \([\mu g/m^3]\) at different locations.**

**Figure-2. Annual mean concentrations of toluene \([\mu g/m^3]\) at different locations.**
Figure 2, shown that the annual mean concentration of toluene was highest at industrial location and lowest at commercial location. Toluene followed the given trend:

**Industrial > Residential > Refueling Pump Station > Traffic Intersection > Commercial**

Ethylbenzene and xylene were followed the given trend:

**Industrial > Refueling Pump Station > Traffic Intersection > Commercial > Residential**
The higher levels of BTEX represent at the industrial location because the decisive source of atmospheric emissions of BTEX is exhaust gases from petrol driven automobiles. The other sources include evaporative emissions produced during petrol handling, storage, distribution and solvent usage. The lower values of BTEX concentrations represent at the residential site because use of petrol, diesel driven vehicles only observed.

IV. CONCLUSIONS
We have determined the ambient levels of BTEX in Agra, Uttar Pradesh, India, by using Respo Rae Ultra VOCs Monitor at five locations. In Agra, the mean ambient levels of BTEX were quite low and comparable to studies done in mega-cities of India and other countries of the world, due to use of petrol and automobiles at busy roads. Other sources and anthropogenic activities, also contributes to an extent to BTEX levels in ambient air. The variations of BTEX ambient air levels were found at five locations. The levels of BTEX in ambient air were found to be dependent on the season. Sampling sites also were found to be influenced the BTEX levels in ambient air of Agra. Thus, we have to need to prepare the strategic plan to control the BTEX levels in ambient air of Agra.

V. ACKNOWLEDGEMENT
We are grateful to the people in Agra city for their voluntary participation in this study in monitoring of BTEX levels at different locations. We are also grateful to Dr. Hemant Kulshreshtha [Head department of Chemistry, St. John’s College, Agra] and other’s at the laboratories of college for their kind help in determining the levels of BTEX studied. We also set up thanks to the Dr. Peter Edward Joseph [Principal, St. John’s College, Agra] for supporting this study. The authors would like to express their appreciation of Dr. Ajay Taneja for helping this study and experiments successfully.

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[6.] IARC, IARC monographs on the evaluation of carcinogenic risks to humans, complete list of agents evaluated and their classification, *IARC, 2006*.


