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# DETERMINATION OF BTEX IN URBAN AIR OF AGRA

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## ABSTRACT

*In the present study,the concentration of volatile organic compounds (vocs ) namely acronymn for benzene, toluene , ethyl benzene and xylene were measured in ambient air of Agra Uttar Pradesh , India at five locations viz. residential, commercial industrial, traffic intersection and refueling pump stations because of their role in atmospheric chemistry . BTEX were collected by using respo rae 3000 ultra voc monitor . Among BTEX, toluene has the highest concentration and followed by benzene, ethyl benzene and xylene. Highest BTEX concentrations were observed at refueling pump station and followed by traffic intersection, industrial, commercial and residential locations. Monthly variation of BTEX, were shown maximum concentration in winter and minimum concentration in summer.*

***Keywords :- volatile organic compound, VOC monitor , toxic, cigarette smoke , spina bifida.***

## I. INTRODUCTION

Benzene, toluene ethylbenzene and xylene , collectively called BTEX are the most abundant species among the aromatic volatile organic compounds(VOCs ) . These are the important species affecting the air chemistry on regional and global scales . Enhanced emissions of BTEX from various anthropogenic sources have not only reduced the air quality within source regions, but also have altered the composition of the atmosphere in remote region through medium and long distance transport. The dominant VOCs source were a combination of vehicle emissions, bio-fuel burning and industrial sources, biomass burning and biogenic emissions and gasoline evaporation and solvent emissions [1]. The main anthropogenic sources of volatile aromatic hydrocarbons such as BTEX include combustion of fuels and evaporation of fuels and solvents. Exhaust gases are the major source of hydrocarbons emissions in the urban areas and the hydrocarbon content of exhaust exhibits a wide variation which can be related to performance, age, speed, temperature and design of the engines as well as fuel control, combustion condition, driving mode and variation in fuel type [2].Thus, Benzene, toluene ethylbenzene and xylene (BTEX) are wide spread pollutants of which the main source in the outside environment is from petrol and so vehicle traffic and in the indoors is cigarette smoke .

They are also present in small quantities in drinking water and food, in paints and adhesive [3].Several studies have reported the effect of atmospheric volatile organic compounds . These effects are recognized, such as their contribution to atmospheric ozone depletion , tropospheric photochemical ozone formation, toxic and carcinogenic human health effects and enhancement of the global green house effect [4]. BTEX group is an

IJARSE
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important target in ambient air, in particular such as non – methane hydrocarbons (NMHC) have been found to be ubiquitious in the urban air. Many studies revealed that BTEX are known to be toxic and genotoxic and they also activily participate in the photochemical reactions [5]. Cyto- toxic studies have demonstrated that it is the fine and nanoparticles that play more important dangerous and deleterious role on a per mass basis and that even very low mass concentrations of nano particles are enfluential [6]. A number of health effects such as asthma, dizziness, fatigue, eye, nose and throat irritation, nausea and similar non- specific symptoms have been associated with BTEX these are suspected to be toxic or carcinogenic such as benzene, toluene and xylene[7].

Aside from independent toxicity, BTEX also serve as precursors of secondary ambient air pollutants such as peroxyacetylnitrite, ozone, free radicals, and nitrogen oxides {8}. Further, VOCs present in the atmosphere cause increased levels of ozone and photo chemicals oxidants, which are recognized as harmful to human helath and ecosystems [9]. The second air quality directive , adopted the 16 november 2000, by the European, sets a limit value for benzene in ambient air of 5 microgram per cubic meter as an annual mean. Although a typical maximum occupational exposure limit was set at 16microgram per cubic meter [10, 11]. Intergrated life time cancer risk for carcinogens benzene in Beijing exceeded rhe value of 1E-06 was reported [12].Exposure to BTEX compounds would increase the risks of cancer in gasoline station workers and exposure to benzene and toluene may cause fatigue in general population [13]. Maternal exposure to ambient levels of benzene is associated with the prevalence of spina bifida among offspring [14].

This article presents data on the impact of evaporative emissions arising from gas stations, vehicle exhaust gases, industrial exhaust gases and other source with a focus on gasoline which is a mixture of a number of aromatic hydrocarbons such BTEX, obtained at five locations and was used to assess the extent of the area affected by these evaporation emissions.

## II. METHODOLOGY

Agra is located at latitude if 27 10' N and longitude of 78 05 ' E with an altitude of 169 m above the sea levels in the semiarid zone of India . It is positioned with the Thar Desert of Rajasthan to the west, central hot plains to the south, Gangetic plains to the east and cooler hilly regions to the north . Agra has a continental type of climate characterized by extreme dryness in summer and cold winter with calm periods. The summer in Agra is hot with intense solar radiation and is dominated by strong southeastern winds. These winds speed ranges from 10-16 km/h. Intense solar radiation varies from 19-23 w/m2. The winters are associated with calm periods with wind speeds reduced to about 42% and ranges from 0.5-5Km/h. On the basis of rainfall, the study periods was devided into four reasons, namely summer ( March-June), mansoon ( July -August ), Post monsoon (September - October) and winter (November-February). In summer months, the average temperature ranged from 35-40 $^0$C and average humidity varied from 25-50 %, with strong dust storms. In winter month, the average temperature varied from 22-28 $^0$ C and relative humidity varied from 70-75%. During monsoon, the relative humidity reached up to 80-75 % and average rainfall was observed to be 160 mm.

On the basis of five different sectors that is residential, commercial, industrial, traffic intersections and petrol pump location, five different sites were selected namely, Heerabagh colony ( residential ), Sanjay Palace ( commercial ) Sikandara ( Industrial),Newagra crossing (traffic intersections) and Pratappura ( refueling pump

IJARSE
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station) respectively . 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. A real time measurements of benzene, toluene. ethylbenzene and xylene, collectively called BTEX, concentrations were performed by using Respo Rae 3000 Ultra VOC Monitor. The Rae 3000 Ultra VOC monitor is a programmable compound specific photoionization detector (PID) designed to provide instantaneous monitoring of BTEX. It monitors by utilizing a gas separation tube and the PID with a 9.8 eV. gas discharge lamp. Before using the instrument , 3000 VOCs monitor , was first calibrated with isobutylene level in usual fashion to read in isobutylene equivalent. Manually, multiply the reading by the correction factor (CF) to obtain the concentration of BTEX gas measured. The sample size for the preconcentration step was 4 hours for using Respo Rae 3000 Ultra VOCs monitor and the sample were colleted for five times during peak hours, in a month at all the selected locations in Agra. The collected data has been analysed satatistically and compared with other studies performed in India and abroad.

## III. RESULTS AND DISCUSSIONS

Table 1 summarises the average concertration of BTEX measured in agra by means of VOC monitor, during november 2008 to December 2009

**TABLE 1. COMPOSITION OF BTEX IN AGRA AT DIFFERENT SITES ( µg/m$^3$ )**

| S.no. | Sites | Benzene | Toluene | Ethylbenzone | Xylene | Total BTEX |
|---|---|---|---|---|---|---|
| 1. | Heerabagh colony ( Residention) | 3.19 | 8.83 | 1.47 | 0.93 | 14.42 |
| 2. | Sanjay Place ( Commercial) | 9.76 | 10.51 | 4.68 | 2.96 | 27.91 |
| 3. | Sikandra ( Industrial) | 12.90 | 24.49 | 6.09 | 4.07 | 42.35 |
| 4. | New Agra (Traffic Interseetha) | 14.57 | 17.05 | 6.81 | 4.07 | 42.50 |
| 5. | Pratappura ( Refeuling Pump Station) | 20.21 | 62.81 | 9.65 | 6.06 | 98.73 |
| | Total | 60.63 | 123.69 | 28.70 | 17.89 | 203.91 |

The results indicate the following BTEX composition : 29.73% benzene, 60.66% toluene, 14.07% ethylbenzene and 8.77% xylene.

overal average total BTEX Concentration measured is agra was 203.91 mg/m3 at all the location during november 2008 to october 2009, Toluene Constration percentage composition followed by benzene, ethyebenzene and rylene respectively Among all the five locations, the highest annual mean concentration of benzene was measured at pratappura ( Refueling pump station and same pattern followed by other aromatic specius.

overall. average total BTEX concentration measured in agra was 203.91 mg/m3 at all the locations during novermber 2008 to october 2009. toluene constitutes highest percentage composition followed by benzene, the

IJARSE
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benzene and rylene respeetively. Among all the five locaitons, the highest annual mean concertration of benzene was measured at pratap pura ( Refueling pump statation). and same pattern fallowed by other aromatic specius. Annual mean concertration of BTEX shown by figure 1-5, during november 2008 to october 2009 at all the locations in agra.

figure 1-5 summaries the trends of the average monthly concentration of benzene a toluene, the benzene and rylene measured in agra average yearly toluene, concenstration ( 8.83, 10.51, 24.49,17.05, 62.81, mg/m3 at all locations) were 2-3 times higher than those of benzene ( 3.19,9.76,12.90,14.75,20.21 mg/m3 at all locations). this is not surprising considering the toluene content of gasoline and auto exhoust is 3-4 times higher similarly, averege yearly concentration of toluene were 6-7 times higher than those of thy benzene and 7-9 times higher than those of rylene.

Figure1- Annual Mean Concentration of BTEX at Herabagh Colony ( Residential ) Nov. 2008to Oct.2009

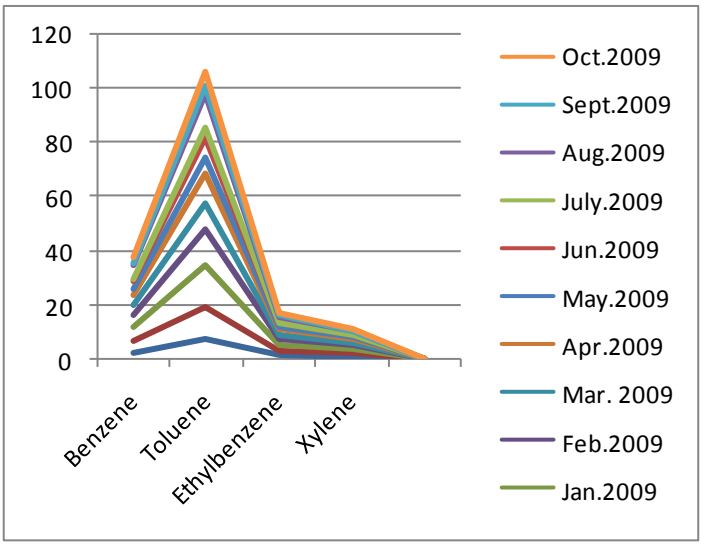


**Figure2- Annual Mean Concentration of BTEX at Sanjay Place ( Commerical ) Nov. 2008to Oct.2009**

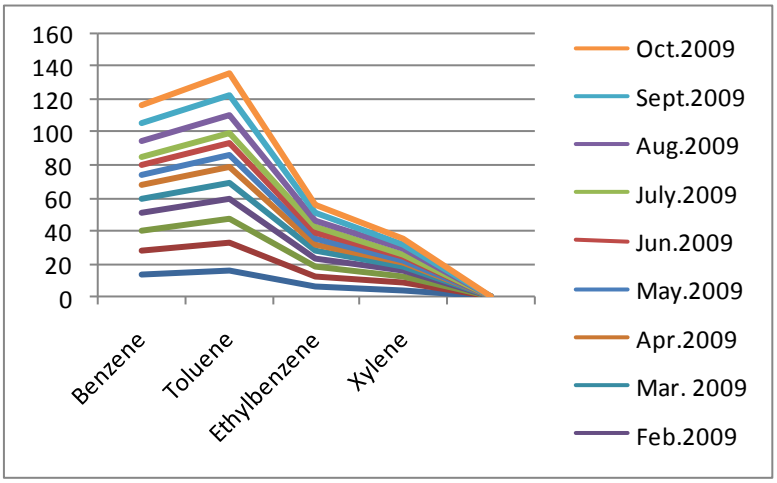


**Figure3- Annual Mean Concentration of BTEX at New Agra Crossing ( Traffic Intersection) Nov. 2008to Oct.2009**

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**Figure4- Annual Mean Concentration of BTEX at Sikandra ( Industrial ) Nov. 2008to Oct.2009**

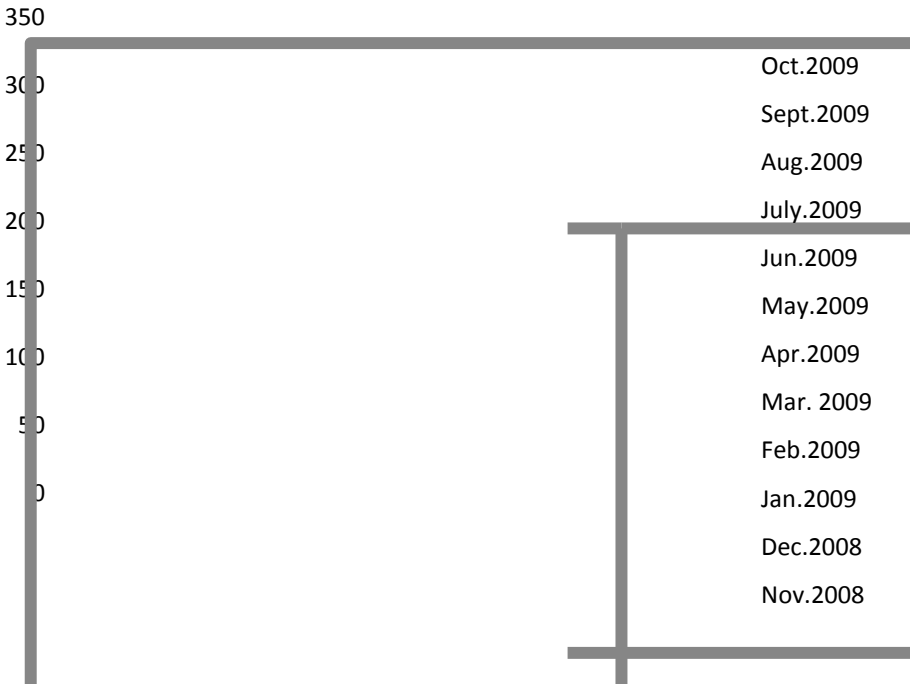


**Figure5- Annual Mean Concentration of BTEX at PratapPura ( Petrolpump ) Nov. 2008to Oct.2009**

IJARSE
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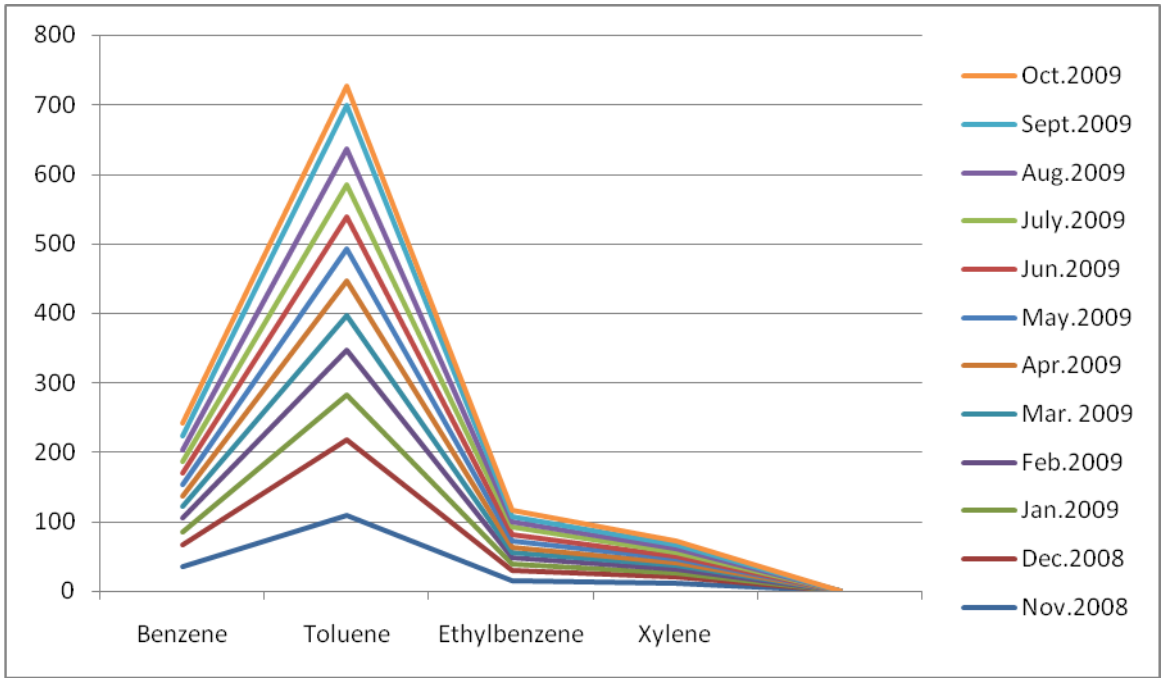


From the figuer 1-5, it can be seen that the BTEX concentration decline during the summer period due to the increased mixing depth and reduced emission. the rate of decline of benzene concentration is however significantly lower than that of toluene. The reason for this behaviour lies in the different reactivities of the two compounds. Similar behavior is observed for thybenzene and rylene. table 2 present tha comparision of benzene and toluene levels at Agra with other sites.

**Table -2 Comparision of benzene and toluene with other sites.**

| Sites | Benzene ( mg/m3) | Toluene ( mg/m3) | Reference |
|---|---|---|---|
| **Mumbai** | **13.4-38.6** | **10.9-33.5** | **(15)** |
| **Hannover** | **9.6** | **25.7** | **(16)** |
| **China** | **15.4-67.3** | **28.06-106.9** | **(17)** |
| **Mexico city** | **5.29** | **28.22** | **(18)** |
| **Kaohsing city** | **10.97** | **43.36** | **(19)** |
| **Delhi** | **174.7-369.4** | | **(20)** |
| **Hyderabad** | **120-173** | **110-126** | **(21)** |
| **Kolkata** | **13.8-72.0** | **21.0-83.2** | **(22)** |
| **Agra** | **3.19-20.21** | **8.83-62.81** | **peresent study** |

The levels of benzene, and toluene were observed to be comparable to Honnover (16), Mexico (18), and much lower than other megacities like Mumbai (15), Delhi(20), China(17), Taiwan(19), Hyderabad(21) and Kolkata (22) comparatively higher concentration of benzene and toluene might be due to more traffic volume and hence greater exhaust emissions.

IJARSE
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## IV. CONCLUSIONS

We have measured the ambient concentration of BTEX in Agra by using the Respo rae 300 ultra VOC monitor in november 2008 to october 2009 at five selected sites. In Agra the mean ambient levels of BTEX were quite lower comparable to studies in megacities in indian and other countries globally due to the use of petrol and automobiles at busy roads. sources other exhaust gases of vehicles also contribution to an extent to BTEX gases concentration in ambient air. The concentration of benzene, toluene, ethylbenzene and xylene were 8.19,8.83, 1.47 and 0.93 **µg/m$^3$** at residential site, 9.75,10.51,4.68 and 2.96 **µg/m$^3$** commercial site, 12.90,24.49,6.09 and 3.87 **µg/m$^3$** at industrial site, 20.21,62.81,9.65 and 6.06 **µg/m$^3$** at refueling pump stations. the variations of BTEX ambient air concentration were found at all the chosen sites. This is also indicated by significant difference observed between summer time and winter time, the two locations that is traffic intersection and refueling pump station in Agra quite higher concentration were measured and followed by industrial , commercial and residential sites, by modifying the definite fuel parameters like reducing BTEX content in petrol or phased out the BTEX content from petrol with another compound one may reduce the BTEX content in ambient air.

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