ATMOSPHERIC LEVELS OF BENZENE, TOLUENE, ETHYLBENZENE AND XYLENE (BTEX) IN THE SLUM AREAS OF AGRA

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ABSTRACT

BTEX are the most abundant volatile organic compounds in the urban atmosphere. Combustion of coal, biomass, and keroscene are the major source of BTEX observed. The measurement of BTEX compounds were conducted during the year from November-2008 to October-2009, by using the Respo Rae 3000 Ultra VOC monitor at two slum areas of Agra viz. Lashkarpur and Karbala. The sampling size for the preconcentration step was eight hours and sampling frequency is eight times in a month during the study period. Toluene constitutes the highest percentage composition and followed by benzene, ethylbenzene and xylene. The mean levels of BTEX were 2.3 µg/m^3 and 3.0 3 µg/m^3 for benzene; 4.0 3 µg/m^3 and 5.3 3 µg/m^3 for toluene; 1.0 3 µg/m^3 and 1.8 3 µg/m^3 for ethylbenzene; 0.7 3 µg/m^3 and 1.3 µg/m^3 for xylene for Lashkarpur and Karbala (Slum Areas) respectively. All measured BTEX had shown the clear seasonal variation. There is need to be improved control of area source emissions.

Keywords: Ambient, BTEX gases, Biomass, Precipitation, Volatile organic compounds.

INTRODUCTION

A heavily populated urban informal settlement characterized by substandard houring and squalor is called a slum while slums differ in size and other characteristics, most lack reliable sanitation services, supply of clean water, reliable electricity, law enforcement and other basic services. Slum residences vary from shanty houses to professionally built dwellings that because of poor quality construction or provision of services have deterioated into slums. More recently, slums have been predominantly found in urban regions of developing and undeveloped parts of the world, but are also found in developed economics. According to United Nations habitat, around 33% of the urban populations in the developing world in 2012, lived in slums (1). Thus slums are often faced many problems socially and environmentally, which attract the researchers interest towards their lives.

Their lives also influenced by the air pollution more as compared to general population of other urban areas. In this context, the problem of air poluution in slum areas is a major and serious problem. Poor sanitation, unsafe drinking water, lifestyle and activities are the major cause of air pollution mainly, benzene, toluene, ethylbenzene and xylene (collectively called BTEX) compounds in ambient air. BTEX are the most abundant

volatile organic compounds (VOCs) in the urban atmosphere. BTEX are the typical volatile organic compounds. These VOCs in the environment were generally originated from the leakage of petroleum and it's product, vehicle exhaust, coal burning, biomass burning, painting, gasoline/ diesel fuel evaporation and petrochemical industries (2,3). BTEX were the most abundant species in the emissions.

In the general environment, it was found that benzene partitions mainly into the air (99.9 %). And it was also observed that the levels were influenced by several factors, such as distance from the sources, ambient temperature and air diffusive condition (4). In addition, diurnal and seasonal profiles were presented by different researchers of the world. In Windsor (Canada), the lower concentrations were observed in the warmer months (5). Similar seasonal profiles were also observed in Beijing and Delhi (6, 7). The peaks were mainly contributed by the emissions from vehicles. And more notably, BTEX can be easily accumulated in the air due to the weak photochemical reaction with lower temperature and low light intensity in cloudy day. In comparison with non-haze days, remarkable accumulation of BTEX was found under haze days, with enhancement factors of 1.9 to 5.7 (8). Surely , most of BTEX were probably ended in the atmosphere rather in other medium.

Different studies indicated that the main atmospheric sink for these mono-aromatic hydrocarbons (say BTEX) was chemical oxidation primarily by the $OH^{\cdot}$ radical rather than wet depositions removal by precipitation. In Mediterranean coast, BTEX levels were influenced by temperature and precipitations (9). Assessment of BTEX in slum areas in Agra is so far and there is no data published for slum areas of Agra city. Thus , keeping this view, the main objective of this study was to obtain quantitative information about the concentrations of BTEX in slum environments in the ambient air of Agra.

METHODOLOGY

The measurements of BTEX compounds were conducted during year at two slum locations, viz. Lashkarpur and Karbala of Agra city from November- 2008 to October-2009. The sites were chosen because ambient BTEX concentration levels were expected to be different at the selected two locations. Samples were collected for eight times in a month during eight hours of peak time. In this study, a real time measurements of benzene, toluene, ethylbenzene and xylene (BTEX) concentrations were performed by using the Respo Rae 3000 Ultra VOC Monitor, which is a hand-held, programmable compound specific PID monitor.

Respo Rae 3000 Ultra VOC Monitor was designed to provide instantaneous exposure monitoring of BTEX and other VOCs. It monitors BTEX gases by utilizing a gas separation tube and the photo-ionization detector (PID) with 9.8 eV gas discharge lamp. This requires, using a Respo Rae 3000 Ultra VOC Monitor, a Rae-Sep separation tube say benzene, toluene, ethylbenzene and xylene etc. and habing the Ultra Rae 3000 in tube-mode, which operate with a 9.8 eV lamp and the appropriate tube is selected. To quantify the BTEX gases, the correction factors (CF) values multiplied in the obtained BTEX values which gives the final data on BTEX gases (10). The obtained data on BTEX gases were analysed statistically.

RESULTS AND DISCUSSIONS

The measurements of benzene, toluene, ethylbenzene and xylene (BTEX) compounds were determined at two slum areas (Lashkarpur and Karbala) of Agra, Uttar Pradesh, India. The composition of BTEX ($\mu g/m^3$) at two slum areas of Agra during November-2008 to October-2009 was summarized in Figure-1. From the figure-1. It was evident that among the BTEX gases, toluene constitute the highest percentage composition at two distinct slum areas of Agra. The percentage composition of toluene was 48.7 % , followed by benzene (26.9 %) , ethylbenzene (14.2 %) and xylene (10.2%).

Further , the Table-1, summarizes the annual ambient levels of BTEX ($\mu g/m^3$) at two slum areas of Agra city (Lashkarpur and Karbala) during the study period. Higher concentrations of BTEX gases were analysed at the slum areas viz. Lashkarpur and Karbala in Agra city (Table-1). It is due to the combustion of more fossil fuels such as keroscene and biomass. At two selected locations, the BTEX gases follow the given patterns :

Toluene > Benzene > Ethylbenzene > Xylene .

Figure-1 : Percentage Composition of BTEX ($\mu g/m^3$) at Lashkarpur and Karbala in Agra during November-2008 to October-2009

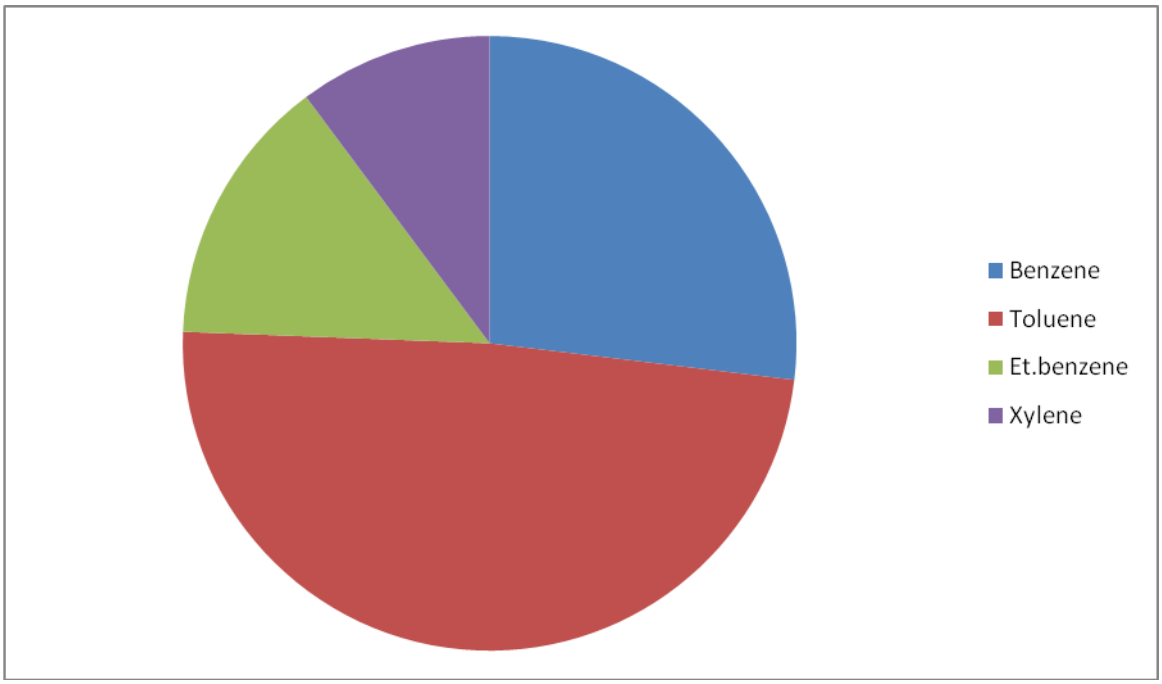
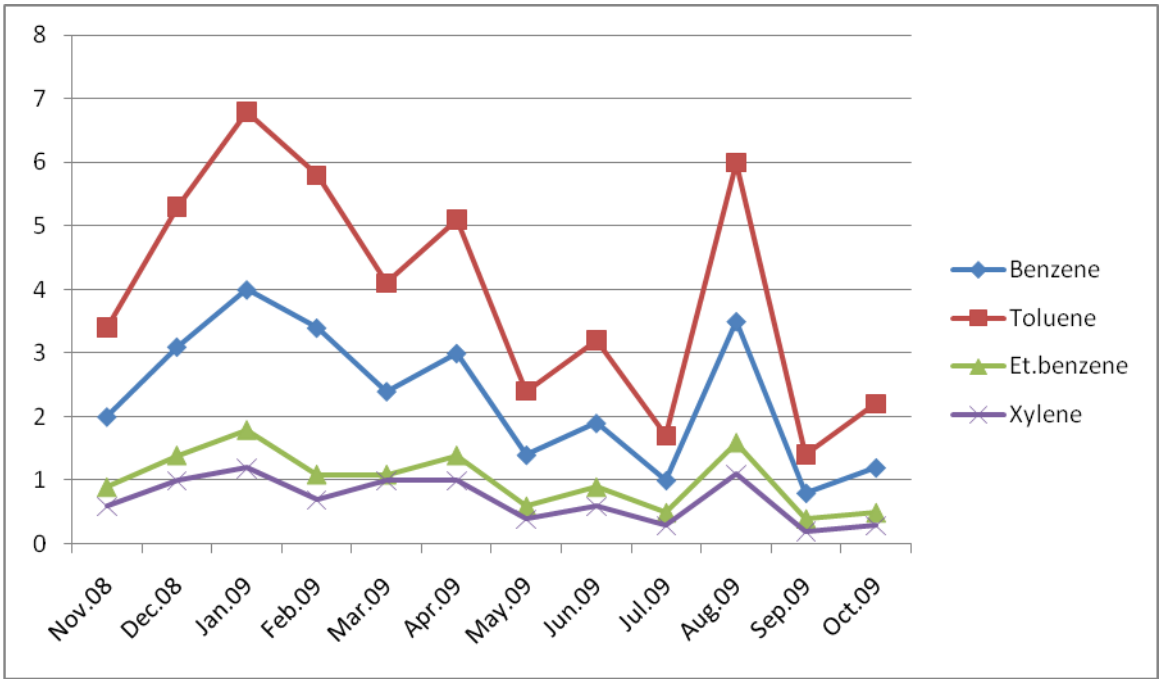


Table-1 : Annual BTEX concentrations (µg/m^3) at Lashkarpur and Karbala in Agra during Nov.-2008-Oct.-2009.

Site		Benzene	Toluene	Ethylbenzene	Xylene
Lashkarpur	Min.	0.8	1.4	0.4	0.2
	Max.	4.0	6.8	1.8	1.2
	Mean	2.3	4.0	1.0	0.7
Karbala	Min.	1.0	1.9	0.6	0.4
	Max.	5.2	9.8	3.1	2.2
	Mean	3.0	5.6	1.8	1.3

The monthly mean variations of BTEX gases were shown in the given Figure-2 and Figure-3.

Figure-2 : Monthly mean variation of BTEX (µg/m^3) at Lashkarpur during Nov.-2008-Oct.-2009.

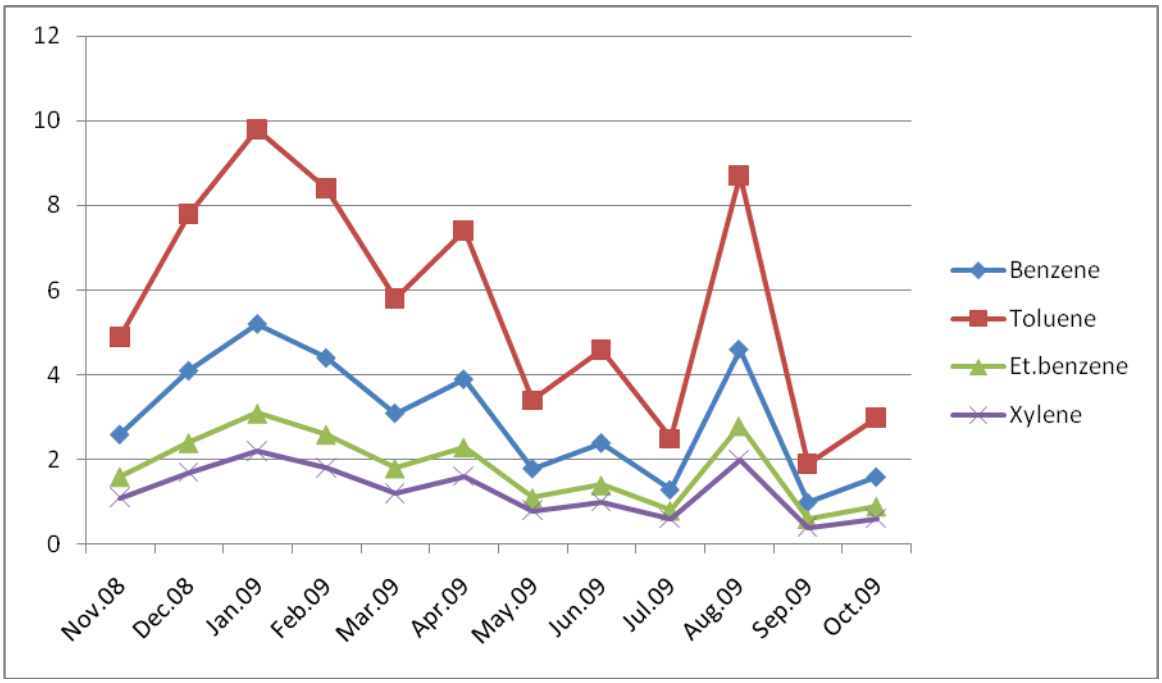


Several researchers reported the ambient levels of benzene, toluene, ethylbenzene and xylene (BTEX) in different countries over the world , are shown in Table-2.

Table-2 : Levels of BTEX ((µg/m^3) reported in literature.

Country	City	Benzene	Toluene	Et.benzene	Xylene	Reference
India	Delhi	48	85	7	30	(11)
Turkey	Ankara	2.18	7.89	0.85	2.62	(12)
Greece	Athens	37.38	79.91	17.37	49.68	(13)
China	Honkong	26.7	77.2	3.10	12.1	(14)
Mexico	Merida	32.86	3.29	8.29	4.48	(15)
Present work	Agra	3.0	5.6	1.8	1.3	

Figure-3 : Monthly mean variation of BTEX (µg/m^3) at Karbala during Nov.-2008-Oct.-2009.



When we compared the obtain data , with other studies, we observed that the levels of BTEX at two slums areas are much lower than that of Athens, Greece (13), Hongkong, China (14), Merida, Mexico (15), and Delhi, India (11), but approximately same as obtained in Ankara, Turkey (12).

CONCLUSION

Toluene was the dominant compound at both sampling sites. Relative abundance of BTEX compounds had the following order : **Toluene > Benzene > Ethylbenzene > Xylene** in both sampling areas. Mean levels of BTEX were 2.3 and 3.0 **µg/m^3** for benzene; 4.0 and 5.6 **µg/m^3** for toluene; 1.0 and 1.8 **µg/m^3** for ethylbenzene; 0.7 and 1.3 **µg/m^3** for xylene for Lashkarpur and Karbala sites respectively. All measured BTEX had a clear seasonal variation with higher levels during winter season probably due to lower wind speed values and lower temperatures. It is necessary to strengthen existing environmental policies, promote the establishment of a national standard that regulates BTEX levels in ambient air, as well as to improve the quality of fuels, subsequently promoting the usage of alternative sources and especially improved control of area source emission.

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