ISSN 2348 – 8034
Impact Factor- 3.155

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

MONITORING OF BENZENE, TOLUENE, ETHYL BENZENE AND XYLENE (BTEX) CONCENTRATIONS IN AMBIENT AIR IN KANPUR, INDIA

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ABSTRACT

Mixing ratio of BTEX (benzene, toluene, ethyl benzene xylene) were measured for the first time in ambient air of Kanpur City, Uttar Pradesh, India at five sites (residential, industrial, commercial, refueling pump station and traffic intersection) from March to June 2009. Day-time and night-time sampling was done at five selected sites during working time and four emission sources to provides for analysis, using Ultra RAE3000 (VOC monitor) under operating condition for the identification of BTEX concentration in ambient air, as parts per million (ppm) quantity is often found in environment samples. The concentration ranges of BTEX 0.189 ppm (residential), 0.018 ppm (industrial), 0.078 ppm (commercial), 0.762 ppm (refueling pump station) and 0.276 ppm (traffic intersection), respectively. The observed concentrations of benzene 0.287 ppm, toluene 0.289 ppm, ethyl benzene 0.285 .ppm and xylene 0.294 ppm, respectively.

The significant difference observed between the five sites for the residential, industrial, commercial, refueling pump station and traffic intersection areas implies that the five areas have different emission sources. This is also indicated by the significant differences observed between day-time and night-time BTEX concentrations. The four months variation indicates a decrease in concentration of BTEX during summer season of the reactive o-xylene compound. We conclude that air pollution as measured by BTEX levels do not necessarily predict but instead may predict mortality rates. Due to the toxic effect of the BTEX studied, an assessment for health risk due to exposure to the population were calculated. These results are useful in the design of emission source control measures for BTEX in Kanpur, India.

Keywords: *Benzene, Toluene, Ethyl Benzene etc.*

I. INTRODUCTION

The sources and behaviour of anthropogenic aromatic compounds in the atmosphere are of interest because of their association with human health problems and the use of fossil fuels. The major sources of benzene, toluene, ethyl benzene and xylenes are from evaporative losses from petrol as well as the internal combustion process itself. The burning of biomass also results in a release of benzene. The only known important atmosphere loss process for benzene and toluene is by reaction with the OH radical with respect to which an atmospheric lifetime of about 10 days is typical for benzene and about 1-2 days is for toluene[1].

For both occupational and non-occupational exposures to volatile organic compounds (VOCs), the gasoline vapor emission and motor vehicle exhaust have long been recognized as the two most important sources. For VOC exposure assessments, BTEX (the acronym for benzene, toluene, ethyl benzene and xylene) are the four most intensively investigated compounds by researchers because of their high contents in gasoline fuel[2].

BTEX is a group of compound including benzene, toluene, ethyl benzene and xylene. All are volatile organic compounds (VOCs). Motor fuels are complex organic mixtures comprising of hundreds of specific compounds. Indicator compounds are usually defined as those compounds which can be considered the most toxic. For these reasons, many state cleanup standard or guidelines focus on benzene, toluene, ethyl benzene and xylene, commonly known as "BTEX" . The relative mobility of these compounds is known, and they are widely recognized as the toxins of concern in fuels such as gasoline. The BTEX compounds represent some of the most hazardous components of gasoline. A variety of test are used to identify BTEX contaminations chronic effects of benzene, toluene, ethyl benzene and xylene include changes in the liver and harmful effects on the kidneys, heart, lungs and nervous system. Except for short term hazards from concentrated spills, BTEX compounds have been more frequently associated with risk to humans' health. Certain carcinogenic effects have been associated with BTEX compounds are often found in association with a PAH compounds[3].

The main objective of this study was to obtain quantitative information about the concentrations that would be both spatially and temporally representative for various ambient environments in the air. The measurements were therefore conducted during four months at five sites (residential, industrial, commercial, refueling pump station and traffic intersection) from March to June 2009.

II. MATERIAL AND METHODS

In order to investigate the BTEX concentrations in the ambient air across the Firozabad city were completed. The sampling points were chosen because ambient BTEX concentration levels were expected to be different at the selected five sites (residential, industrial, commercial, refueling pump station and traffic intersection) from March to June 2009.

Study Site : BTEX was sampled in a different area in Kanpur, Uttar Pradesh, India. The sampling was conducted in the working place. Samples were collected for two times (in a month) during eight hours of normal working period time for in March, April, May and June 2009. The five selected sites used in this study represent residential (Agricultural University), industrial (Dada Nagar), commercial (Naveen Market), refueling pump station (Kalyanpur petrol pump) and traffic intersection (Rawatpur Crossing).

BTEX Measurement : In this research, real-time measurements of benzene, tolene, ethyl benzene and xylene concentrations were performed using the Ultra RAE 3000, is a hand-held, programmable compound specific PID monitor designed to provide instantaneous exposure monitoring of a specific organic gas. It monitors a specific gas by utilizing a gas separation tube and the photo-ionization detector (PID) with a 9.8 eV gas discharge lamp (range- 50 ppb to 200 ppb).

The Ultra RAE 3000 can perform compound-specific measurement in addition to general VOC measurement. This requires using a REA-Sep separation tube (such as benzene, toluene, ethyl benzene and xylene etc.) and having the Ultra REA 3000 in Tube-Mode, operating with a 9.8 eV lamp and that the appropriate tube is selected.

III. RESULTS AND DISCUSSION

In the present study, mixing ratios of BTEX (benzene, toluene, ethyl benzene and xylene) were measured in ambient air the five selected sites in

Kanpur for 24 hours duration in Table 1. The mean concentration of benzene (ranging from 0.197 ppm to 0.207 ppm), toluene (0.198 ppm to 0.209 ppm), ethyl benzene (0.195 ppm to 0.285 ppm) and xylene (0.195 ppm to 0.205 ppm) were found all the five selected sites. From Table 2 the BTEX concentrations ranged from 0.139 ppm to 0.148 ppm (residential), 0.0127 ppm to 0.013 ppm (industrial), 0.073 ppm to 0.075 ppm (commercial), 0.675 ppm to 0.784 ppm (refueling pump station) and 0.185 ppm to 0.287 ppm (traffic intersection) were found all the five selected sites in Kanpur, Uttar Pradesh, India. BTEX levels in Kanpur showed lower values with respect to the studies undertaken in different cities[4] in India and in different countries. When compared to the other mega-cities of India, the BTEX levels in study of Kanpur were much lower than those obtained in Mumbai (13.4 - 38.6 μgm^{-3} benzene, 10.9 - 33.5 μgm^{-3} toluene, Mohan Rao[5] et al. 1996), BTEX obtained in Delhi (TVOC values varied from 174.7 to 369.4 μgm^{-3}, Srivastava[6] et al. 2005) and BTEX obtained in Collate (mean concentration of BTEX 97.92 μgm^{-3}, Dutta[7] et al. 2008). In different countries like Taiwan (10.97 and 13.28 $\mu g\ m^{-3}$ for benzene and 43.36 and 54.49 $\mu g\ m^{-3}$ for toluene over two sites of Kaohsiung city, Lai and Chen[8] 2004), Northern Germany (9.6 $\mu g\ m^{-3}$ benzene and 25.7 $\mu g\ m^{-3}$ toluene at Hannover, Ilgen[9] et al. 2001), and Mexico (benzene 5.29 $\mu g\ m^{-3}$ and toluene 28.22 $\mu g\ m^{-3}$ at Mexico city Metropolitan Zone, Bravo[10] et al. 2002).

The higher values of BTEX concentration represent at the refueling pump station site 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 concentration represent at the industrial site. The four month variation indicate a lower concentration of BTEX during summer season of the reactive o-xylene compound due to the photochemical reactivity of BTEX towards OH radical (Darnall[11] et al. 1971). Hydroxyl radicals are extremely short-lived species and play the role as the chemical scavengers of the atmosphere in cleansing earth, s atmosphere of harmful organic pollutants, in the season of summer. O – Xylene participates in ancillary photo-oxidation reactions including the conversion of nitric acid to nitrogen dioxide (Altshuller[12] et al. 1962).The BTEX concentrations turned out to be not normally distributed. The two factors, effect of seasons and effect of sampling places, always effected on the concentrations of BTEX on the ambient air.

Effect of season on the concentrations in ambient air : According to the Kruskal-Wallis test the effect of the season on the BTEX concentrations in ambient air foe all sites sampling places separately. At all sampling places, no effect of the season was found a significant level of $p > 0.05$ for the BTEX concentrations in the ambient air[13].

Effect of sampling places for all sites: At all sampling places, all ambient air BTEX concentration data were observed per site, resulting in a data set with two factors, country and site. As for the ambient air, the factor "site" cannot be considered independent of the factor "country" for the ambient air concentrations. Therefore, all "sampling places" had to be used[14].

IV. CONCLUSION

We have evaluated the ambient concentration of BTEX in Kanpur, Uttar Pradesh, India, by using day-time, night-time and four-monthly measurements in March to June 2009 at five selected sites, by UltraRAE 3000 VOC monitor. In Kanpur city, the average ambient levels of BTEX were quite low and comparable to studies in mega-cities in India and different countries due to use of petrol and automobiles at busy roads (residential, industrial, commercial, refueling pump station and traffic intersection sites). Sources other than exhaust of petrol driven vehicles, contribute to som eextent to BTEX concentrations in ambient air.

The concentration ranges of BTEX 0.189 ppm (residential), 0.018 ppm (industrial), 0.078 ppm (commercial), 0.765 ppm (refueling pump station) and 0.272 ppm (traffic intersection), respectively were observed. The average concentrations of benzene found were 0.287 ppm, toluene 0.289 ppm, ethyl benzene 0.285 .ppm and xylene 0.294 ppm, respectively. The variations of BTEX ambient air concentrations were found at five selected sites. This is also indicated by the significant differences observed between day-time and night-time BTEX concentrations. The BTEX concentrations in ambient air were found to be dependent on the season. In spring and summer, concentrations were much lower than in autumn and winter. Especially also, the sampling sites was found to influence the BTEX concentrations in ambient air of Kanpur. In ambient air at the refueling pump station in Kanpur quite higher concentrations were measured than at the other sites. The probability of additional source of BTEX indicates adulteration of the fuels which used in vehicles and released exhaust in an ambient air. Modifying certain fuel parameters, like reducing BTEX content in petrol will reduce BTEX content in ambient air[15]. The prevailing level of BTEX, may pose both cancer risk and non-cancer hazards for the health of general population as estimated at all five sites.

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