CLIMA 2016 - proceedings of the 12th REHVA World Congress

volume 7

Heiselberg, Per Kvols

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

Indoor/Outdoor Concentration of Particulate matter and Polycyclic Aromatic Hydrocarbons at roadside site in Agra India

Jamson Masih(1), Ashish S. Uzgare(1) and Ajay Taneja(2)

(1)Department of Chemistry, Wilson College, Mumbai India

(2)Department of Chemistry, IBS Khandari, Dr. B.R. Ambedkar University, Agra Presenting Author Email: jamson12@gmail.com

Abstract

PM_1, $PM_{2.5}$ and PM_{10} Particulate mass concentrations and twenty-three polycyclic aromatic hydrocarbons (PAHs) were measured In Indoor and outdoor environment of Agra, India known as the home to the world famous heritage monument 'The Taj Mahal'. Sampling was done for all three seasons i.e. winter, summer and rainy during the year 2007 and 2008. Particulate mass concentrations were measured online by using Grimm aerosol spectrometer. PAHs were collected by using XAD-2 resin tubes (600 mg) for gaseous phase PAHs and PTFE filter paper (37 µm dia) for particulate PAHs. The individual PAHs were identified by using a gas chromatograph with mass spectrometry detector (GC/MS). The mean concentration of PM_1 was 101.52 µg/m^3, $PM_{2.5}$ 138.46 µg/m^3 and PM_{10} 235.17 µg/m^3 in indoor, whereas at outdoor the mean concentration of PM_1 was 104.01 µg/m^3, $PM_{2.5}$ 150.23 µg/m^3 and PM_{10} 250.81 µg/m^3. The total PAHs concentration of 23 PAHs was 1527.74 ng/m^3 in indoor and at outdoor it was 1691.50 ng/m^3. A great variation of individual PM and PAHs concentration was observed in indoor and outdoor environment pointing out different sources. In the study it was seen that the lighter molecular weight PAHs were found in gaseous phase whereas heavy molecular weight PAHs were associated with the particulate phase. Monthly and seasonal variations of coarse and fine particulate matter have been studied. Significant seasonal variations were found for particulate and PAHs concentrations which obtained using the daily and monthly average particulate concentrations. The B(a)P-equivalent exposure, calculated using Toxic equivalent factors (TEFs). The Total B(a)P equivalent exposure was 15.9 ng/m^3 in indoor and at outdoor it was 16.25. To find out the possible factors accounting for PAHs Principal Component analysis and PAHs diagnostic ratio were applied. The results obtained from principal component analysis and PAHs diagnostic ratio showed that in indoor PAHs were mainly generated from smoking, cooking and oil fumes and also influenced from outside. At outdoor the sources were vehicular activity, biomass burning and also from diesel fuel operated gen sets.

Keywords - Indoor/Outdoor; Particulate matter; PAHs; Seasonal variation

1. Introduction

Air pollutants such as Particulate matter is the most ubiquitous and most complicated [1] other than its health effects, its role is to control a number of atmospheric processes such as deposition of different compounds, the optical properties etc. [2] The primary sources of $PM_{2.5}$ outdoor include, fuel combustion processes in transportation (traffic related) and energy production, whereas cooking, smoking and cleaning activities contribute primarily to the indoor $PM_{2.5}$ levels [3]. The concentration of particles outside the house, the rate of air exchange and the depositional characteristics of the particles are governing issues to generate particles concentration within the house generation governed the particle concentration inside a house [4]. Most houses in the developing world are naturally ventilated, allowing particles from out-of-doors to readily penetrate the house through given spaces and cracks in the structure [5]. In addition to it PM in developing countries is also generated due to the burning of biomass fuel in the form of wood, agricultural waste, animal dung and coal. These countries are undergoing rapid urbanization and industrialization, and indoor air quality is strongly influenced by motor vehicles and industrial sources outdoors as well as smoking and gas cooking indoors. The smoke from these fuels contains hazardous suspended PM including carcinogenic Polycyclic Aromatic Hydrocarbons. [6,7,8]. In general, airborne fine particles are considered to have greater health significance [9] than any of the other air pollutants.

As there is strive to establish Indoor air quality (IAQ) objectives for different types of indoor micro environments in urban area, limited data is available on the general understanding about present IAQ of domestic homes especially PAHs in India. Therefore comprehensive assessment of indoor PAH concentrations in urban areas with different microenvironment and their relationship to different types of outdoor emission sources would significantly contribute to the present understanding of people exposure to pollutants of indoor and outdoor origin. This data can be a step towards focusing intervention in the domestic homes in the developing countries where the problems of urbanization and fuel usage are almost similar.

2. Methadology

Sampling was carried out once in a week simultaneously in indoor and outdoor air of the homes in Agra. Envirotech handy sampler APM 821 was set at a flow rate of 2L/min for 24 hrs aspirating air through XAD-2 resin (150 mg) for gaseous phase and PTFE filter paper for particulate phase simultaneously at a height of 1.5-1.8 m above the ground to simulate the humans breathing zone. The XAD-2 resin tubes with Teflon were extracted with methylene chloride (DCM) and the extracts was analyzed by (GC/MS). For PM ($PM_{1.0}$, $PM_{2.5}$, PM_{10}) Grimm 31-Channel Portable Aerosol Spectrometer model No. 1.109 was used for monitoring at a flow rate of 1.2 L/min.

3. Results and Discussion

The average concentration of Particulate Matter (PM) in $\mu g/m^3$ for indoor and outdoor environment is shown in Table 1**.** The range of PM concentration in indoor air was 67.25-151.60 $\mu g/m^3$ with a mean of 96.89 $\mu g/m^3$ (PM_1), for $PM_{2.5}$ 71.45-291.14 $\mu g/m^3$ with mean of 291.14 $\mu g/m^3$ and for PM_{10} mean concentration was 235.17 $\mu g/m^3$ and ranged between 119.61-372.21 $\mu g/m^3$. In outdoors the concentration range was 54.99-205.05 $\mu g/m^3$, 72.31-283.36 $\mu g/m^3$ and 125.27-368.74 $\mu g/m^3$ with their mean of 104.01, 150.23, 250.81 $\mu g/m^3$ for PM_1, $PM_{2.5}$ and PM_{10} respectively. The average concentrations of PAHs in indoor and outdoor are shown in Figure 1. The Total concentration of PAHs (TPAHs) indoor was1527.74 ng/m^3 and at outdoors it was 1691.50 ng/m^3. The concentration PM and PAHs were found to be higher in outdoors than indoors. The monthly and seasonal concentration of particulate matter for different size is shown in Figure 2. From the figure it can be observed that highest concentrations of PM were found to be in winter months followed by summer and rainy seasons. The variations in average monthly concentrations at roadside and urban sites showed similar seasonal trends during the study period. In the winter PM_1, $PM_{2.5}$ and PM_{10} concentrations were maximum and they were observed in months of December and January and the minimum was observed in month of February. The concentration of PAHs in winter season was 39.47%, and 34.26% higher from summer season in indoor and outdoor and in rainy season it was 255.59% and 174.38% higher from winter season. The consistently elevated levels of PAHs in indoor and outdoor air in winter season were due to the indoor and outdoor heating which requires the burning of wood, coal and room heaters for several domestic purposes. The other reason of higher PAHs concentration in winter season because of the fact that most homes keep their windows and doors closed all the times to protect from cold. PAHs generated from indoor sources and with reduced air exchange as windows and doors are closed may result in enhanced indoor concentrations. Local pollution emissions are responsible for the highest peak occurrence in the months of December and January in winters, because the largest amount of anthropogenic pollutants emissions of the whole year happens in winter due to increased human activity and more space heating, for which finer particles are concentrated in the homes [10]. Moreover, low wind speed and high humidity during the winter season in comparison to other seasons due to which the removal of aerosol particles by wet scavenging is also reduced. Whereas, for summers maximum concentration is recorded in the month of March and the minimum is mostly observed in June, but the pollution load is lower than the winters. Summers with lower concentrations may have the possible reason that due to increase in temperature and moderate wind speed, particles are dry, contributing less to increase their concentrations. Moreover in summers the prevailing winds mixing height is deeper and strong due to thermal circulations and the wind turbulence with large mixing height results in proper dilution and dispersion of pollutants. [11]

4. Source Apportionment

Figure 2 shows the results of Principal component analysis which reveals three factors for indoor environment with Eigen value > 1 accounting for 94% of the variance. The first factor, which accounts for 32.21% of the total variance contains NAP, 2MNAP, ACE, FLU, CHR, and may be attributed from oil fumes during combustion activities (cooking). The second factor, contributing 29.58% of the variance, contains ACE, B(a)A, B(b)F, B(e)P, B(a)P and B(ghi)P with smoking and incense burning as combined probable source. The third factor contributes 25.20% of the total variance and can be explained by the use of diesel generators used for power supply and also transported from outdoor diesel engine vehicular emissions. In outdoor environment two factors were accounted with Eigen value > 1 accounting for 90% of the variance. The first factor was accounted for 48.65% with the high loading of NAP, 2MNAP, 1MNAP, ACY, ACE, DBF, FLU, PHE, ANT, CAR, CHR, B(b)F and B(e)P. The probable source of these PAHs might be from diesel powered vehicles. The second factor had loading of 1MNAP, 2MNAP, ACY, ANT, CAR, FLT, PRY, B(a)A, CHR, B(b)F, B(k)F, B(a)P and I(123cd)P which account for 41.34% of the total variance and was probably due to the petrol and natural gas combustion engine vehicles on road.

5. Conclusion

PM and PAHs concentrations in indoor and outdoor air samples were collected in Agra the north central part of India. Significant seasonal variations of PM and PAHs concentration were observed with higher levels during winter seasons due to residential fuel combustion for heating and other household purposes. Results obtained from principal component analysis revealed that in indoor environment PAHs was attributable mainly from gas utilities, cooking, smoking and incense burning at urban and roadside homes whereas at outdoor point the most common sources of PAHs was both from petrol and diesel combusted fuel vehicles. Household activities like cooking on stoves, indoor smoking and outdoor vehicular traffic, garbage burning and were also cause to be the major sources of particulate emissions indoor as well outdoors. The study concluded that there is a need to address the issue of fine and ultrafine particles monitoring and its comprehensive investigation to study its toxic effects and control along with coarse particles. Air-quality management should, therefore, be implemented in those cities, like study area where strategic planning is weak or non-existent. Due to the insufficiency of air-quality information in many cities of the world, there is also an immediate worldwide need to improve the monitoring and evaluation systems for urban air pollution.

6. Acknowledgment

The Financial support of University Grant Commission (UGC) sponsored PDF project No. F 4-2/2006(BSR)/13-329/2008(BSR) are duly acknowledged. The author also thanks Principal Wilson College, Mumbai.

7. References

[1]. Ho KF, Lee SC, Chan CK, Yu JC, Chow JC, Yao XH. Characterization of chemical species in PM2.5 and PM10 aerosols in Hong Kong. Atmospheric Environment 2003;37:31–9.

[2]. Molnar A, Meszaros E, Hansson HC, Gelencser A, Kiss GY, Krivesy Z. The importance of organic and elemental carbon in the fine atmospheric aerosols particles. Atmospheric Environment 1999;33:2745–50.

[3]. Gertler AW, Gillies JA, Pierson WR. An assessment of the mobile source contribution of PM10 and PM2.5 in the United States. Water Air and Soil Pollution 2000;123:203–14.

[4]. Thatcher TL, Layton DW. Deposition, re-suspension and penetration of particles within a residence. Atmospheric Environment 1995;29:1487–97.

[5]. Byrne M. Aerosol exposed, Chemistry in Britain; 1998 August. p. 23–6.

[6.]. Sofoluwe, G.O., 1968. Smoke Pollution in the dwellings of infants with bronchopneumonia. Archive of Environmental Health, **16**, 670-672.

[7]. Kang. S., Li. C., Wang. F., Zhang. Q., Cong, Z., 2009. Total suspended particulate matter and toxic elements indoors during cooking with yak dung. Atmospheric Environment, **43**, 4243-4246.

[8]. Tian, L., Lan, Q., Yang, D., He, X., Yu, L.T., Hammond, S.K., 2009. Effect of Chemney on Indoor air Concentrations of PM10 and benzo(a)pyrene in Xuan Wei, China. Atmospheric Environment, **43**, 3352-3355.

[9]. Begum, A., Paul, S.K., Hossain, M.D., Biswas, S.K., Hopke, P.K., 2009. "Indoor air Polllution from Particulate Matter emissions in different households in rural areas of Bangladesh." Building & Environment. **44**, 898-903.

[10]. Guinot, B., Cachier, H., Sciare, J., Tong, Y., Wang, X., and Yu, J., 2007. Beijing aerosol: atmospheric interactions and new trends, Journal of Geophysics Research **112**, D14101-D14316.

[11]. Mantis, J., Chaloulakou, A., and Samara, S., 2005. PM_{10}-bound polycyclic aromatic hydrocarbons (PAHs) in the greater Area of Athens, Greece. Chemosphere, **59,** 593-604.A. Author and C. Corresponding. Title of the article. J. Irreprod. Res. 46 (1997) 140–145.

Table 1. Concentration of different size Particulate Matter in µg/m^3.

PM	Indoor			Outdoor		
	$PM_{1.0}$	$PM_{2.5}$	PM_{10}	$PM_{1.0}$	$PM_{2.5}$	PM_{10}
MEAN	101.52	138.46	235.17	104.01	150.23	250.81
MEDIAN	96.89	131.81	239.32	100.92	130.78	245.29
MAX	151.60	291.14	372.21	205.05	283.36	368.74
MIN	67.25	71.45	119.61	54.99	72.32	125.27
SKEWNES	0.69	1.48	0.16	1.47	0.85	-0.15

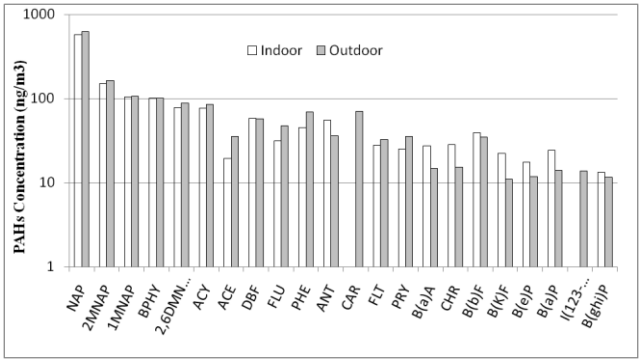

Figure. 1 Individual Concentration of 23 PAHs in ng/m^3.

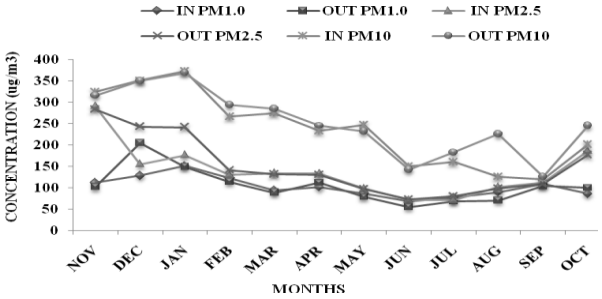

Figure 2. Monthly Concentration of different size particulate Matter.

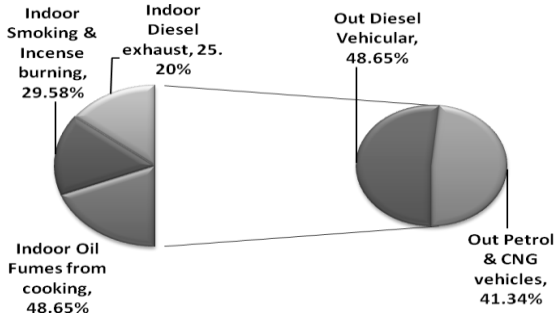

Figure 3. Source apportionment of PAHs in indoor and outdoor.