ISSN(Online) : 2319-8753
ISSN (Print) : 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

Indoor Air Quality Monitoring in College Campus

Sushma R [1], Shilpa Shet S [2]

Assistant Professor, Department of Civil Engineering, Acharya Institute of Technology, Bengaluru, Karnataka, India[1]

Assistant Professor, Department of Civil Engineering, Acharya Institute of Technology, Bengaluru, Karnataka, India[2]

ABSTRACT: The study characterizes the exposure of a typical gaseous co-pollutant like carbon dioxide, carbon monoxide, on students with in college campus, under various microenvironments in Bangalore city. By the aid of Standalone Air Quality Monitor, monitoring was done to determine the concentration of the gases such as CO_2, CO. Furthermore, health analysis of the monitoring survey area and comparison of the result with prescribed standards available were also carried out to determine the various ill-health effects caused by it. The results showed during the real time monitoring period, the measurements carried out in different microenvironments were quite stable and hardly any major variation was found, except those at the college canteen and chemistry laboratory. The peak values of CO_2 determined in canteen (kitchen) and computer laboratory (without A.C) were reported higher than found in any other microenvironment. The concentration of CO_2 and CO in college canteen (kitchen) were found to be exceeding the standards by almost twofold. Health survey conducted revealed problems like headache, dizziness, respiratory discomfort, confusion etc. due to elevated gaseous concentration in various microenvironments can prove to be a promising human health risk assessment measure based on the relative time spent in a particular environment.

KEYWORDS: Indoor air quality, Indoor Environment, real time monitoring, Occupancy, Productivity, College Building.

I. INTRODUCTION

Indoor air quality (IAQ) is a term which refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. IAQ can be affected by gases such as carbon monoxide, radon, volatile organic compounds, etc. The data collected from point sources are used to determine compliance with air pollution regulations set by WHO, ASHRAE, OSHA & NAAQS/EPA.

There is sufficient epidemiological evidence indicating a significant effect of air pollution upon human health (Dockery et al. 1993, 2000). Carbon monoxide (CO) and carbon dioxide (CO_2) are some of the key criteria pollutants where elevated concentrations are a potential threat to human health, and the environment. Exposure to these pollutants can lead to various deleterious health effects like respiratory symptoms and lung disorder (USEPA, 2012). Exposures to these pollutants vary in outdoor and indoor environments, duration of stay, and involvement in particular activities. Even prolonged or continuous exposure to some daily activities can cause an increase in health risks like CO exposure due to electric and gas stoves, respiratory infections due to parental smoking and smoke due to cooking activities (A.P. jones, 1999), prevalence of cough and phlegm among women using open fire (Bruce et al. 1998). The time spent in a particular microenvironment is a major factor which governs the exposure and risk levels for an individual. A regular personal monitoring of these pollutants is required to avoid such health risks.

II. MATERIALS AND METHODS

Procedure

Real time monitor is used for the study of indoor air quality monitoring. Standalone Indoor Air Quality Monitor (SAQM), manufactured by FORBIX SEMICON, India bearing serial number- SKU: CB-YD1F.L93Q and model number- FBXAQM01G. The monitor was factory-calibrated before the day's work. The study was conducted during

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pre-monsoon season for a period of 4 weeks. The readings were taken at an interval of 30 min for 6 hours period in a day. Following parameters has been measured: Carbon dioxide (CO_2), Carbon Monoxide (CO).

Description of the site location

The indoor air quality monitoring was conducted in the city of Bangalore, located 12.967° N to 77.567° E, capital of Karnataka, India. The study was conducted for the students (age group 22-30 years), in different microenvironments within the campus The campus is located in an approximately 120 acre land having lush green gardens, parks, and trees with no major sources of air pollution. College canteen, computer science laboratory, chemistry laboratory, computer science block (classroom), mechanical block (classroom).

Analysis of the collected data

The readings have been analysed and the graphs of Concentrations versus time period for different locations are plotted. The health risk caused due to the gases for longer duration will be correlated according to the prescribed standards viz. WHO, ASHRAE, OSHA, NAAQS/EPA (2000).

III. RESULTS AND DISCUSSIONS

Canteen area

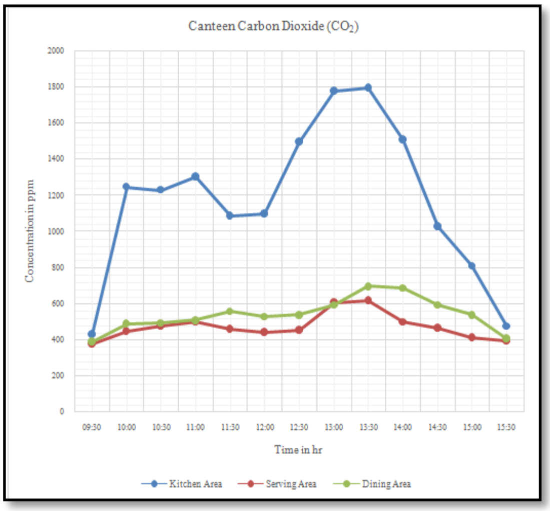

Figure 1: Graph of concentration of CO_2 in canteen.

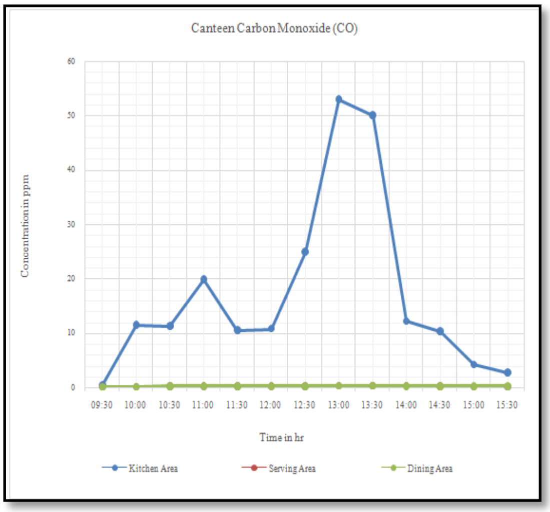

Figure 2: Graph of CO in canteen.

Figure 1 represents that plot of graph of concentration (in ppm) versus time (hr in IST) of kitchen, serving & dining area. It clearly depicts that amount of carbon dioxide concentration in kitchen is far more with compared to serving and dining area which are more spacious and well ventilated. Peak has been observed for 12:30 to 14:00 is possibly due to lunch hour which usually follow with heavy rush in canteen. According to the ASHRAE report maximum exposure of CO_2 is 1000 ppm for the time of 8hr exposure in this study it has been observed that from 10:00 to 14:30 (4.5hr) the concentration was above the 1000 ppm. Thus health effects are likely more adversely in kitchen in comparison with serving and dining area, it requires change in ventilation system (Sumit Sharma, R Suresh, Griha Summit, 2014).

Figure 2 depicts that plot of graph of concentration (in ppm) versus time (hr in IST) of kitchen, serving & dining area. It clearly states the amount of carbon monoxide concentration in kitchen is far more with compared to serving and dining area due to combustion activities related to cooking. Peak has been observed for 12:30 to 13:30 is possibly due to lunch hour which usually follow with heavy rush in canteen and elevated cooking activities. Whereas the CO concentration remained negligible in dining and serving area.

IJIRSET

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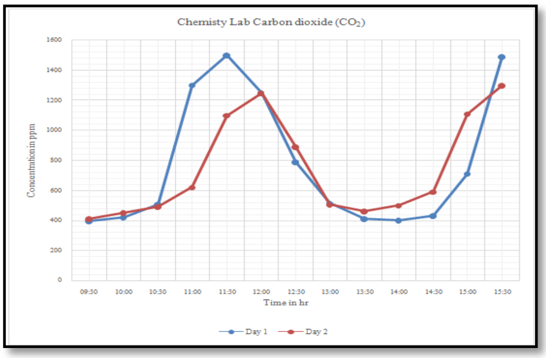
According to the OSHA journal maximum exposure of CO is 50 ppm for the time of 8hr exposure. In this study it has been observed that from 12:30 to 14:00 (1.5hr) the concentration was above the 50 ppm. While, the health effects observed among workers such as headache and shortness of breath in kitchen area is possibly because of elevated rise in CO concentration.

Chemistry laboratory



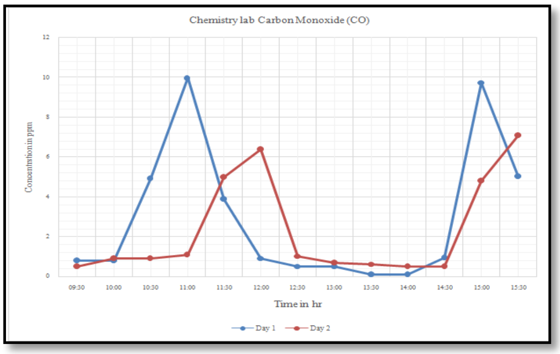
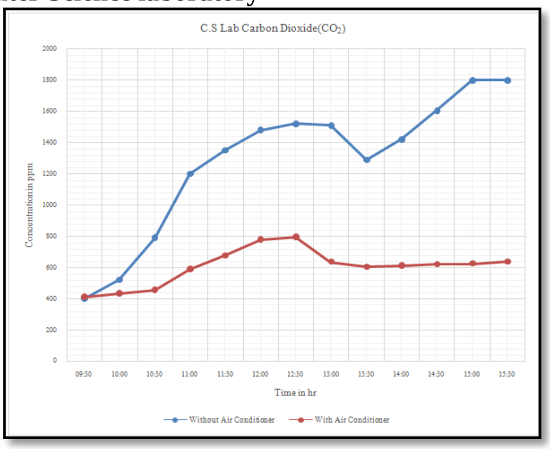


Figure 3: Graph of concentration of CO_2 in chemistry laboratory. Figure 4: Graph of concentration of CO in chemistry laboratory.

Figure 3 there has been a graph plotted between concentration of carbon dioxide in ppm & time in hours. From the graph it is cleared that the concentration of carbon dioxide increases. It is due to fumes which were evolved during the conduction of experiments & improper ventilation. A declination is also visible in the graph after 12:00h to 14:00h because of conclusion of class & onset of lunch hour. Health survey conducted shows problems such as feeling of discomfort, dizziness can be directly related because of increase of CO_2 concentration in the laboratory. (Indoor air quality, ventilation and health symptoms in schools: an analysis of existing information, J. M. Daisey, W. J. Angell, M. G. Apte)

In the figure 4 there is a plot of concentration of carbon monoxide (in ppm) versus time (in hours). For both the days the value of carbon monoxide is amplified due to the preparation of solutions and lightening the burner for heating up of chemicals. The carbon monoxide concentration for rest hour of the day has been seen less as there was no burning or heating activity performed. Health effects such as mental confusion and headache clearly showed the higher level of CO concentration within the laboratory.

Computer Science laboratory



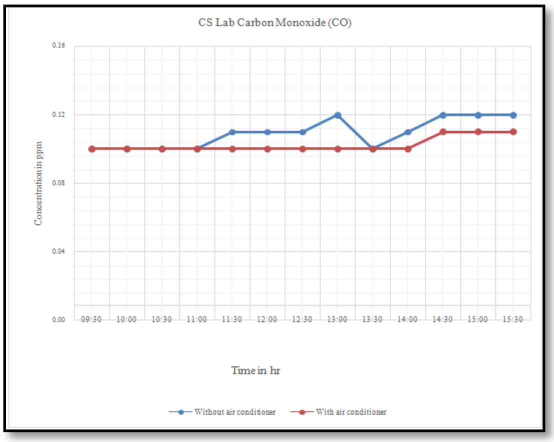


Figure 5: Graph of concentration of CO_2 in computer laboratory. Figure 6: Graph of concentration of CO in computer laboratory.

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In the below figure 5 there is plot of carbon dioxide concentration (ppm) versus time (h). It clearly shows that CO_2 concentration is found much high in case of without A.C. condition w.r.t. with A.C. condition. It is due to closure of windows and door with occasional opening. It also depicts the fall in curve at 13:30 h which was followed by lunch hour subsequently. Increase in concentration from 14:00 h is due to onset of class hours.

In the figure 6 a graph of carbon monoxide concentration (ppm) versus time (h) has been plotted. It clearly shows that CO concentration is found low in case of both the cases. It can be clearly incurred that there is no primary source of emission of carbon monoxide. A slight variation is possibly due to inter-mixing of air when the door was opened during lunch hour.

Computer Science block (classroom)

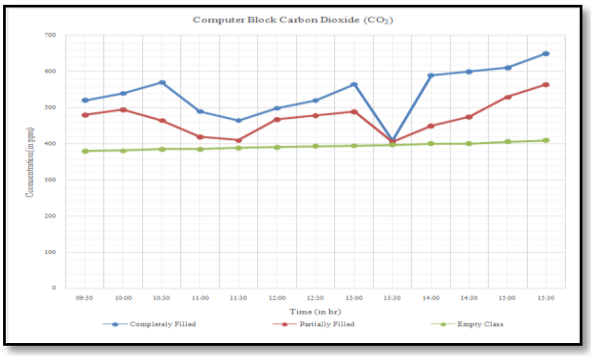

Figure 7: Graph of concentration of CO_2 in computer block classroom.

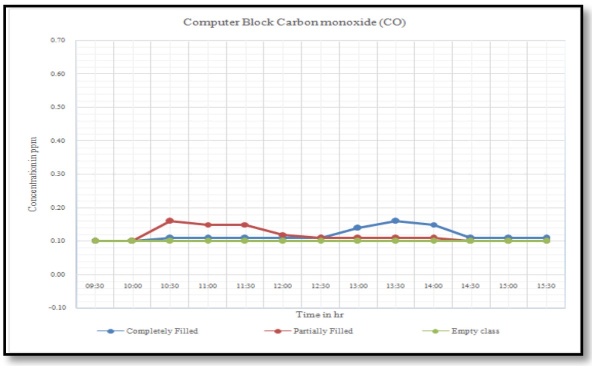

Figure 8: Graph of concentration of CO in computer block classroom

Figure 7 shows the concentration of carbon dioxide in (ppm) versus time in (hours) of three different conditions. The graph figures that the concentration of carbon dioxide was increased for the completely filled class due to more number of students when compared to partially and empty classes. While there was decline of concentration after 11:00 and at 13:00 indicates the onset of break and lunch time respectively. Health survey showed the problems like drowsiness, headache may be due to increase of concentration of CO_2 in completely filled class.

Figure 8 shows the plot of graph of concentration of carbon monoxide in (ppm) versus time in (hours). The concentration of carbon monoxide is found to be on rise at time interval from 10:30 to 11:30 in case of partially filled condition whereas, for fully condition from time 13:00 to 14:30 due to the process of diesel generator which was located outside the classroom while the monitoring period. The concentration of carbon monoxide for the empty class is negligible as there was no generator in operation. Various health symptoms such as headache, drowsiness and mental confusion may be directly incurred due to rise in CO concentration.

Mechanical block (classroom)

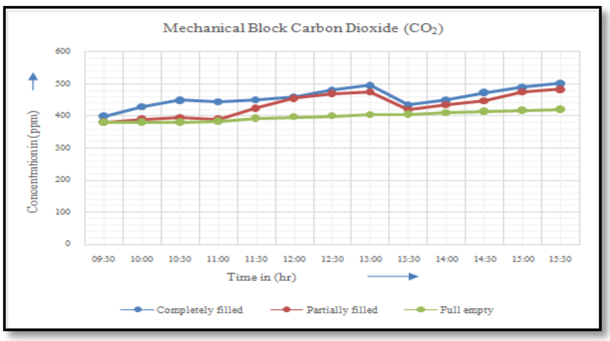

Figure9: Graph of concentration of CO_2 in mechanical block classroom

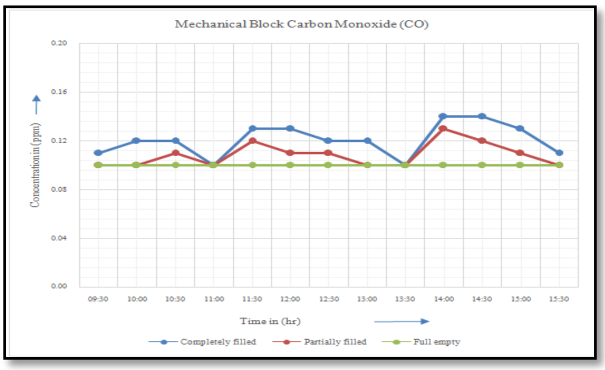

Figure: 10: Graph of concentration of CO in mechanical block classroom

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Figure 9 shows the concentration of carbon dioxide in (ppm) versus time in (hours) of three different conditions. The graph figures that the concentration of carbon dioxide was increased for the completely filled class due to more number of students when compared to partially and empty classes. While there was decline of concentration after 11:00 and at 13:00 indicates the beginning of break and lunch time respectively. This class was having a good ventilation facility as the CO_2 concentration was found within limits prescribed.

Figure 10 shows the plot of graph of concentration of carbon monoxide in (ppm) versus time in (hours). We can infer that in all the three cases there is no remarkable increase in concentration of CO as there was no major sources of carbon monoxide emission.

IV. CONCLUSION

During the real time monitoring period, the measurements carried out in different microenvironments were quite stable and hardly any major variation was found, except those at the college canteen and chemistry laboratory. Also, from the preceding results, it can be clearly seen that different human activities mostly increases the concentration of gas parameters.

The peak values of CO_2 determined in canteen (kitchen) and computer laboratory (without A.C) were reported higher than found in any other microenvironment. The concentration of CO_2 1800 ppm and CO 53 ppm in college canteen (kitchen) were found to be exceeding the NAAQS by almost twofold. These high levels of concentrations were due to the burning of gas stoves within very small kitchen area.

The study also clearly depicts that gaseous concentration are high in no air-conditioning due to lack of proper ventilation and small intake of fresh air along with many computer within the microenvironment. Hence, it can be concluded that spending long hours in no air-conditioning units can cause ill-health effects due to elevated CO_2 concentrations.

Health survey conducted revealed problems like headache, dizziness, eye, respiratory irritation, discomfort, confusion etc. due to elevated gaseous concentration in various microenvironments can prove to be a promising human health risk assessment measure based on the relative time spent in a particular environment.

REFERENCES

1. Angelo Colombo, Maurizio De Bortoli, Helmut Knoppel, Herbert Schauenburg and Henk Vissers, " Small chamber Tests and Headspace Analysis of volatile organic compounds emitted from household products" *Indoor Air*, Vol 1, Issue 1, pp 13-21, March 1991.
2. Ashmore, M. R., & Dimitroulopoulou, C. "Personal exposure of children to air pollution". *Atmospheric Environment, Vol 43*, pp.128–141, (2009).
3. Basu R, Samet J, "A review of the epidemiological evidence on health effects of nitrogen dioxide exposure from gas stoves", *Journal of Environmental Medicine*, Vol **1**, pp.173–187, (1999).
4. Brown, K. W., Sarnat, J. A., Suh, H. H., et al. "Ambient site, home outdoor and home indoor particulate concentrations as proxies of personal exposures" *Journal of Environmental Monitoring, Vol 10*, pp.1041–1051, (2008).
5. Brown, S.K., "Indoor air quality", *Australia: State of the Environment Technical Paper Series (Atmosphere)*, Department of the Environment, Sport and Territories, Canberra, pp 6-49, (1997)
6. Bruce N, Perez-Padilla R, Albalak R, "Indoor air pollution in developing countries: a major environmental and public health challenge"*Bulletin of the World Health Organization*, Vol 78, pp.1078–1092, (2000).
7. Chakraborty, A., & Gupta, T. "Chemical characterization and source apportionment of submicron (PM1) aerosol in Kanpur region, India" *Aerosol and Air Quality Research, Vol 10*, pp.433–445, (2010).
8. C.kubwaho,P.E.Rasmussen,X.Fan,I.Kosarac,F Wu,A.Zidek and S.L.Kuchta, " Analysis of selected phthalates in Canadian indoor dust collected using household vacuum and standardized sampling techniques" Indoor Air, Vol.23, Issue 6,pp 506-514, Dec (2013).
9. Daisey, J. M., Angell, W. J. and Apte, M. G. "Indoor air quality, ventilation and health symptoms in schools: an analysis of existing information", *Indoor Air*, Vol 13, pp.53–64. doi: 10.1034/j.1600-0668.2003.00153.x, (2003).
10. Devi, J. J., Gupta, T., Jat, R., et al. "Measurement of personal and integrated exposure to particulate matter and copollutant gases" *Environmental Science and Pollution Research, Vol 20*, pp.1632–1648, (2013).
11. Ezzati M, Kammen D, "Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure-response study",*The Lancet*, Vol **358**,pp.619–624, (2001).
12. Gangwar, J. N., Gupta, T., & Agarwal, A. K., "Composition and comparative toxicity of particulate matter emitted from a diesel and biodiesel fuelled CRDI engine", *Atmospheric Environment, Vol 46*, pp.472–481, (2012).

13. Northcross, A., Chowdhury, Z., McCracken, J., et al. "Estimating personal PM2.5 exposures using CO measurements in Guatemalan households cooking with wood fuel", *Journal of Environmental Monitoring, vol 12*, pp.873–878, (2010).
14. Peder Wolkoff, " Volatile organic compounds sources, measurements, emissions and the impact on indoor air quality" Indoor Air, Vol 5, Issue S3, pp 5-73,Dec (1995).
15. Vaishali Ashok, Tarun Gupta, Shefali Dubey and Rajmal Jat., "Personal exposure measurement of students to various microenvironments inside and outside the college campus" Environ Monit Assess, 186:735–750, (2014).
16. Xu, X., Gao, J., Dockery, D. W., et al., "Air pollution and daily mortality in residential areas of Beijing, China." Archives of Environmental Health, 49, 216–222, (1994).
17. Zhu, Y., Hinds, W. C., Krudysz, M., et al. "Penetration of freeway ultrafine particles into indoor environments" Journal of Aerosol Science, 36, 303–322, (2005).