DOI: 10.1590/1414-462X201400020017

Nota de Pesquisa

BTEX inside a spinning classroom

BTEX no interior de salas de aula de *spinning*

Eduardo Monteiro Martins[1], Simone Lorena Quiterio[2], Sergio Machado Corrêa[3], Júlio Domingos Nunes Fortes[1], Monica Monteiro[1], Barbara Prestes[1]

Abstract

Indoors Physical Activities are becoming more frequent. Studies have shown that pollutants concentrations in indoor environments are always greater than in open environments. In indoor locations where regular exercise are performed, there is no concern about air quality, principally when aerobic physical activity are performed. BTEX concentrations in a spinning classroom were measured in this study and were higher than those obtained in an outdoor environment. However, a painting activity of the room revealed that all BTEX concentrations, and in particular Toluene, become much greater. In the day after, the paint concentration of all BTEX increased significantly and the concentration of toluene was 274.9 μg/m^3. The BTEX concentration increased after all room was painted, and this increase was from 91% to benzene, 907% for toluene, 182% to ethylbenzene, 121% for m+p-xylene and 128% for o-xylene.

Keywords: Benzene; air pollution, indoor; physical activity; monitoring.

Resumo

Atividades Físicas realizadas em ambientes fechados estão se tornando mais frequente. Estudos têm mostrado que as concentrações de poluentes em ambientes interiores são sempre maiores do que em ambiente abertos. Em locais fechados, onde são realizados exercícios de forma regular, não existe a preocupação com a qualidade do ar, principalmente quando estão sendo realizadas atividades aeróbicas. Neste estudo, foram medidas concentrações de BTEX em uma sala de spinning e as concentrações obtidas foram maiores do que as encontradas em ambientes ao ar livre. No entanto, uma atividade de pintura realizada na sala de spinning gerou concentrações elevadas de todos os BTEX , e, em particular, o tolueno teve concentrações muito maiores. No dia seguinte a realização da pintura, as concentrações de todos os BTEX tinham aumentado significativamente e a concentração de tolueno foi de 274.9 μg/m^3. Após a pintura na sala de spinning, o aumento foi de 91% para o benzeno, 907% para o tolueno, 182% para o etilbenzeno, 121% para o m+p-xileno e de 128% para o o-xileno.

Palavras-chave: Benzeno; poluição do ar; interior; atividade física; monitoramento.

[1]Departamento de Engenharia Sanitária e Meio Ambiente, Faculdade de Engenharia, Universidade do Estado do Rio de Janeiro (UERJ) – Rio de Janeiro (RJ), Brasil.
[2]Coordenação de Meio Ambiente, Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro (IFRJ) – Rio de Janeiro (RJ), Brasil.
[3]Faculdade de Tecnologia, Universidade do Estado do Rio de Janeiro (UERJ) – Rio de Janeiro (RJ), Brasil.
Correspondence: Eduardo Monteiro Martins – Universidade do Estado do Rio de Janeiro – Rua São Francisco Xavier, 524, Bloco E, Sala 5008 – CEP: 20550-900 – Rio de Janeiro (RJ), Brasil – E-mail: edmmartins@gmail.com

INTRODUCTION

The anthropogenic activities have caused degradation of air quality, both in open and in confined environments. With the current urban centres lifestyle, the man has spent more time indoors than in open spaces, reaching 95% of their time indoors[1].

In closed environments, the emission sources can be diverse, such as construction material (in particular finishing materials), air conditioning systems, cleaning procedures, the low exchange between the indoor air with the outside air, among others[2,3].

From the environmental point of view, the BTEX have a prominent role in the high toxicity; being a potent central nervous system depressants, and benzene and toluene the two compounds that have the greatest toxicity[4].

The increasingly sedentary lifestyle that the man has been experiencing in recent decades raises risk factors and indication for regular physical activity is highly common so that the individual could dispose of a better quality of life and reduce the risks associated with health[5,6]. However the practice of exercises in confined places with high concentrations of air pollutants may compromise the performance and enhance health damage due to the large volume of contaminated air that is inhaled[7]. This study aims to do the assessment of BTEX concentrations in a gym room of spinning classes in Rio de Janeiro city.

MATERIALS AND METHODS

The samples were collected in a small gym located in a residential neighbourhood in the metropolitan region of Rio de Janeiro (RMRJ). The air quality is only influenced by the local mobile source emissions. The spinning room where the samples were collected is located on the third floor of the building and its dimensions are 2.80 m high, 2.70 m wide and 5.60 m long. The room remains closed all the time and the local cooling is done artificially by split model air conditioners (without air exchange). The room is filled with 10 stationary bikes and during the collection days all lessons were with the maximum capacity of the room. The public who attended classes during the sampling was between 25 and 55 years old and consisted mostly of women.

The samples were collected in the period of July to December of 2010 in the early evening, with a total of four hours sampling. During each collection period, there were two classes and between these classes a cleaning procedure was done on the bikes and on the floor. During this period were collected 34 samples inside the spinning room. In the middle of the sampling period was scheduled a maintenance for the room with the painting of the walls.

Samples were collected using double bed coconut shell charcoal cartridges using an air pump, model KNF UNMP 850 KNDF, at a constant flow of 1.0 L/min through the cartridge[8].

The beds of the cartridge were transferred to 2 mL vials and placed in a Petri dish with ice to reduce the losses by volatilization of more volatile compounds. In these vials were added 25 µL of a solution 50 ng/µL ααα-Trifluortoluene as internal standard and 1-chloro-4-fluorobenzene as recovery standard, both in dichloromethane (DCM). Finally, 1.0 mL of dichloromethane was added and the vials were closed and placed in an ultrasonic bath for 15 minutes and thereafter the vials were left at rest for deposition of the suspended matter in the solution.

For the chemical analysis was used an Agilent gas chromatograph model 6890 coupled to a mass spectrometer model 5973. U.S. EPA Method 8260, adapted. The injection of 1.0 µL was done in splitless mode at 250ºC and the carrier gas used was Helium 5.0. It was used a Restek RTX capillary column model VRX 20 m long, 0.28 mm of diameter and 1.0 µm in film thickness. The heating program started at 40°C isothermal for 3 minutes followed by a heating from 12°C/min to 80°C, then another heating from 6°C/min up to 162°C and a final heating of 40°C/min to 230°C maintained for 4 minutes[9].

Calibration was done with concentrations in the working range of 1.0 to 15 µg/mL using the internal calibration procedure with the ααα-Trifluortoluene concentration of 1.25 ng/L obtaining a quadratic correlation coefficient of 0,998. The limit of quantification was 1.0 mg/mL and the limit of detection was 0.1 mg/mL. The recovery of the compounds used in the laboratory was 45 to 125%.

A total of 33 samples were collected in the indoor environment. The painting procedure inside the spinning room was performed on October, 20 of 2010. Among the samples, 20 were collected before the painting and 14 were performed after it was done.

RESULTS AND DISCUSSION

The toluene is the main BTEX and its results are more detailed on Figure 1 with individual results for each of the 34 samples.

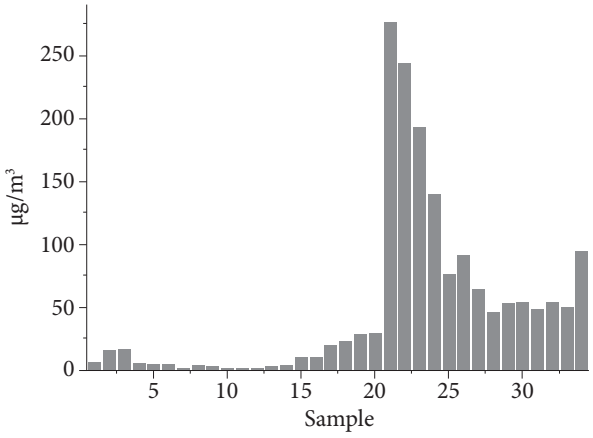

Figure 1. Concentrations of toluene inside a spinning classroom

Table 1. Descriptive statistics of the samples inside the spinning room before and after the room painting procedure

		Benzene	Toluene	Ethylbenzene	m+p-Xylene	o-Xylene
Before painting	Mean	1.71	9.15	1.87	2.02	0.96
	SD	1.17	9.28	2.16	1.79	0.84
	Maximum	4.61	28.8	7.87	6.57	2.68
	Minimum	0.28	0.42	0.09	0.14	0.14
	n	19	20	19	18	19
After painting	Mean	3.27	92.15	5.28	4.48	2.19
	SD	1.05	62.15	1.02	1	0.53
	Maximum	5.14	242.61	7	6.09	2.9
	Minimum	1.23	45.61	3.9	3.14	1.42
	n	14	13	14	14	14

SD: standard deviation.

It is possible to observe an increase of 954% in toluene concentration between samples 20 and 21. This is the exact point where it features the painting of the room. There is a decrease in the toluene concentrations, which is characterized by the reducing in the emissions due to volatilization of organic compounds.

Table 1 presents the descriptive statistics for the samples collected before the painting procedure of the room. In BTEX mass distribution is possible to observe that toluene is the most abundant compound, representing 58% by weight of total BTEX, and the second most abundant were the xylenes, with 19% of the total mass.

After the painting procedure, there was not a concern with the improvement of the natural room ventilation, and it was still being artificially cooled with windows and doors closed. The activities in the room normally returned the following day of painting.

As detailed in Table 2, Brazilian legislation for occupational exposure is zero for benzene. For toluene the maximum value found is bellow Brazilian limits (NR-15) and also bellow the NIOSH limit. The same analyses can be done to others substituted benzenes, with values bellow Brazilian and NOSH limits. One consideration can be done that this exposure values reported in Table 2 are for 8 h during a working day, period higher than the time usually spend by the users of a spinning classroom. But the teacher probably will has a higher exposure, as all others local workers. But the time spent by spinning classroom users are under a high respiration rate.

Table 2. Occupational exposure limits for BTEX – 8 hours

BTEX	NR-15	Hazard Degree	NIOSH
Benzene	0	Maximum	3.19 mg/m^3
Toluene	290 mg/m^3	Average	375 mg/m^3
Ethyl benzene	340 mg/m^3	Average	435 mg/m^3
Xylenes	340 mg/m^3	Average	435 mg/m^3

ACKNOWLEDGEMENTS

To FAPERJ and CNPq for partial financial support.

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Received on: 16/01/2014
Accepted on: 22/05/2014