Indoor air quality in school buildings in the city of Sosnowiec, Poland

P.Z. Brewczyński[1], E. Krakowiak[1], J. Kurek[2], A. Wlazło[1], M. Zaciera[2]

[1]Department of Biohazards and Immunoallergology & [2]Department of Chemical Hazards and Genetic Toxicology, Institute of Occupational Medicine and Environmental Health, Sosnowiec, 41-200, Poland
Keywords: school, indoor air pollutants.
Presenting author email: p.brewczynski@imp.sosnowiec

Children spend about 6-8 h daily in school more than in any other indoor environment except home. For that reason indoor air quality in classrooms influences quality of life and health of pupils. Major sources of indoor air pollution are building construction, decoration materials, furnishings, and the occupants themselves and their activities. Other major outdoor contributing factors include traffic-related and industrial pollution, as well as the type of ground on which the school sits.

The aim of this study was to assess the level of the indoor air quality parameters (PM2.5, formaldehyde, benzene, toluene, xylene, NO_2, O_3, CO, CO_2, benzo(a)pyrene, radon) in a naturally ventilated school buildings in the city of Sosnowiec.

Studies were carried out in three schools (in 9 classrooms). The main criterion of the schools selection was their location, type of construction and operating conditions. Monitoring was performed during the winter months, since heating plays a crucial role on indoor air pollution level. The concentrations of formaldehyde, NO_2, O_3, and volatile organic compounds were measured with the use of passive diffusion samplers. The concentrations of formaldehyde were measured using AT 1200 High Performance Liquid Chromatograph with diode array detector. The concentrations of benzo(a)pyrene were detected using AT 1200 High Performance Liquid Chromatograph with fluorescence detector. Volatile organic compounds like benzene were measured using Varian Star 3600 Cx Gas Chromatograph with Flame Ionization Detector. Radon was determined by passive – track counts on film exposed method. The concentrations of nitrogen dioxide and ozone were measured using spectrophotometer analysis. Concentrations of PM2.5 were measured from Monday to Friday (during teaching hours) using filter-based samples charged with a pump and by gravimetric analysis of PTFE filter samples.

PM2.5 concentrations were usually lower indoors than outdoors (I/O ratio less than 1), because no indoor sources were detected. However, higher indoor concentrations (I/O ratio value was 1.1) were found in one school where the air exchange was not efficient, as confirmed by indoor CO_2 data significantly higher than in other schools.

Benzene and formaldehyde concentrations inside of schools were much higher in comparison to outdoor concentrations which shows that the emission source of these harmful chemicals are furnishings, building materials or finishing materials.
Trichloroetylene, tetrachloroetylene and naphthalene did not exceed limit threshold values of methods used for their determination.

Table 1. Selected IAQ parameters.

IAQ parameters	Range	
	Indoor	Outdoor
PM2.5 ($\mu g/m^3$)	34.31-113.55	38.00-127.17
Formaldehyde ($\mu g/m^3$) *	13.87-53.30	1.58-4.82
Benzene ($\mu g/m^3$)	9.58-38.03	5.53-10.42
Toluene ($\mu g/m^3$) *	2.61-100.71	2.19-5.90
Xylene ($\mu g/m^3$) *	0.00-9.94	0.00-2.84
NO_2 ($\mu g/m^3$) *	8.81-26.97	17.10-58.50
O_3 ($\mu g/m^3$) *	2.7-6.7	21.9-166.4
Radon (Bq/m^3)	40-107	40-90
B(a)P ($\mu g/m^3$) *	0.006-0.045	0.015-0.026
CO (ppm)	0.0-1.1	0.2-1.0
CO_2 (ppm) *	1158-2590	383-532
RH (%) *	31.9-49.2	76.9-85.1
Temperature (ºC) *	19.0-23.3	-1.6-3.5

*$p < 0.05$ for a statistical analysis the non-parametric Mann-Whitney U test was used.

Faulty working ventilation may distribute pollutants from any sources to other parts of the building, too.

Nitrogen dioxide, ozone, and benzo(a)pirene concentrations are higher outdoors than indoors (in classrooms) therefore so the source of their formation can be attributed to atmospheric air.

The worst outdoor air quality was found in one school located in the city centre with high traffic flow and naturally high car fumes generation.

The majority of presented pollutants, are potentially capable to induce toxic processes leading ultimately after a long exposure to long term clinical effects triggered by even small doses. And because of this it is extremely important to identify the possible threat and undertake the relevant preventive measures.

This study was supported by the SINPHONIE project, Schools Indoor Pollution and Health: Observatory Network in Europe & IOMEH statutory activity.

References available by the authors