Indoor Particles of Outdoor Origin in Depositories.

Mašková, Ludmila
2019

INDOOR PARTICLES OF OUTDOOR ORIGIN IN DEPOSITORIES

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Keywords: Indoor air quality, Indoor/outdoor ratio, Infiltration factor

INTRODUCTION

Pollution in indoor environment can cause irreversible degradation of materials stored there. The air quality in depositories housed in historical buildings depends mainly on outdoor pollution infiltrated through the building envelope. There are several strategies to control the indoor air pollution. However, most of them including reconstruction, which is problematic in historical monuments. Thus detailed information about indoor air quality and factors influencing it is needed.

METHODOLOGY

The measurements were carried out in five historic depositories representing different outdoor environments: (1) the Baroque Libary Hall of the National Library in Prague (urban area with traffic), (2) the State Regional Archives in Třebon (residential area with tourism), (3) the Depository of the Research Library of South Bohemia at Zlata Koruna (rural area), (4) the Library in the Regional Museum in Teplice (industrial area), and (5) the Central Depository of the National Museum in Terezin (residential area).

Indoor and outdoor particle number concentrations were measured by a Scanning Mobility Particle Sizer (SMPS, model 3934C, TSI, USA) and an Aerodynamic Particle Sizer (APS, model 3320, TSI, USA). Alternatively, Ultrafine Particle Monitor (UFPM, model 3031, TSI, USA) was used insteated of the SMPS. Both instruments sampled from both inside and outside simultaneusly using an electrically actuated three-way ball valve connected to a common programmable controller. The SMPS/UFPM and APS number-based concentrations were converted to mass concentrations with aerodynamic diameter using an algorithm described by Sioutas et al. (1999).

RESULTS AND CONCLUSIONS

Temporal variation of size resolved indoor and outdoor PM showed that in the most depositories the main source of indoor fine and coarse PM is the infiltration from the outdoor environment. Seasonal averaged mass size distributions were bimodal in all cases, with peaks in the size range 0.1 – 1 μm and 1 – 10 μm and minimum between fine and coarse particles at around 1 μm. Indoor concentrations were lower than the outdoor ones, with dominant fine particles, accouting for more than 70% of outdoor and 90% of indoor PM10. Following the bimodal mass size distributions we split fine and coarse particles into two fractions PM1 and PM10-1.

The I/O relationship was described by the infiltration factor (Finf). At steady-state conditions and no particles generated indoors it simply equals to I/O

concentrations. As can be seen from Fig. 1 a) infiltration factors of fine particles are higher compared to coarse particles, b) both factors show relative low seasonal variability, and c) factors show marked differences among depositories. Thus yearly averaged values were calculated representing site specific infiltration factors parameter for each location.

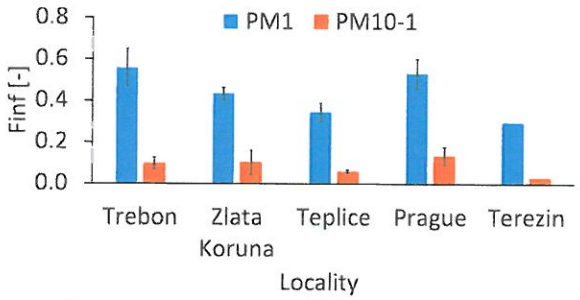

Fig. 1: Infiltration factors for PM1 and PM10-1 (±SD calculated for seasons).

To asses the effect of outdoor air pollution on indoor air quality during different periods e.g. to estimate the dose of pollutants, collections were exposed in past or could be exposed in future the site specific factors need to be combined with data on local air pollution. We used long-term (about 20-years) air quality data provided by the monitoring network of the Czech hydrometeorogical institute (CHMI). For every location the closest CHMI station was selected and daily outdoor concentrations were compared by the linear regresion. The results showed that the data strongly correlated.

For the assesment long-term outdoor PM10 concentration was estimeted using CHMI average and the regression. Than the concentration was split into average contribution of PM1 and PM10-1 fractions. In the next step the contribution of outdoor PM10 was estimated using site specific PM1 and PM10-1 infiltration factors. The resulted estimated long-term PM1 and PM10-1 (Table 1) revealed that the recommended limits are excceded in all depositories (ASHRAE, 2011, Tétreault, 2003).

Tab. 1: Estimated long-term indoor concentrations of PM1 and PM10-1 ($\mu g \cdot m^{-3}$).

	Prague	**Trebon**	**Zlata Koruna**	**Teplice**	**Terezin**
PM1	13.2	9.2	6.0	8.7	4.0
PM10-1	1.8	0.7	0.4	0.5	0.2

ACKNOWLEDGEMENT

This work was supported by the Ministry of Culture of the Czech Republic under grant DG18P02OVV048.

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