Indoor Air Quality in the Baroque Hall of the National Library in Prague – Preliminary Results

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Introduction

The Baroque Hall of the National Library in Prague is our object of interest. To assess the indoor environment for the preservation of books and manuscripts, a measurement campaign was designed and is currently ongoing. The measurements are performed:

- Monthly during one year in two locations (indoors and outdoors; Figure 1) and;
- In four additional indoor locations for sampling in two different seasons (Figure 1).

The environmental assessment will be based on the results obtained by EWO-dosimetry and pollutant concentrations obtained by passive diffusion samplers (NO_2, O_3, SO_2, acetic and formic acids, HNO_3, NH_3).

Results

EWO-dosimetry indicates that the environment inside the Baroque Hall is acceptable for the preservation of organic materials in a "purposed built museum" (Figure 2).

The results show infiltration of outdoor generated pollutants (Figure 3) and high concentration of indoor generated pollutants (Figure 4). The concentrations of NO_2 and SO_2 are above the values proposed as standard for preservation of paper based archival material by NBS (1983; NO_2: 5 µg m^{-3}; SO_2: 1 µg m^{-3}), and above the values proposed for museums, libraries and archival collections by ASHRAE (2003; 1 year; NO_2: 10 µg m^{-3}; SO_2: 10 µg m^{-3}).

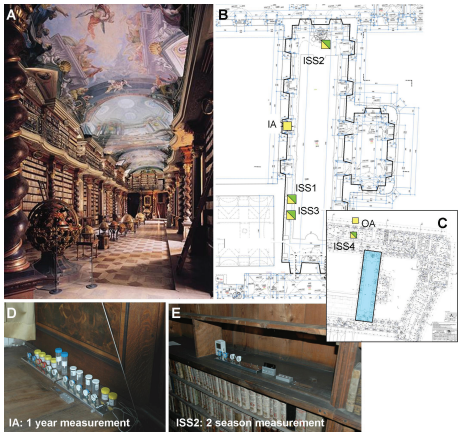

Figure 1: A: Baroque Hall of the National library (Prague). B and C: Sampling locations; yellow square: locations of year measurement campaign; yellow/green squares: locations of two-seasonal measurement campaigns. Blue area in C: Baroque Hall. D and E: passive diffusion samplers and dosimeter.

Seasonal differences are observed (Figure 5). Indoor NO_2 concentration is much higher in winter than in summer, whereas the concentration of organic acids shows an inverse relationship. This difference may be explained by higher ventilation during winter than in summer.

High concentration of NH_3 is observed inside the Baroque Hall, whereas the indoor HNO_3 concentration is below the detection limit (Figure 6). The indoor concentration of NH_3 may be explained by infiltration of NH_4NO_3 aerosol, which possibly moves from outdoors to the warmer indoor environment and the equilibrium shifts toward the gas phase.

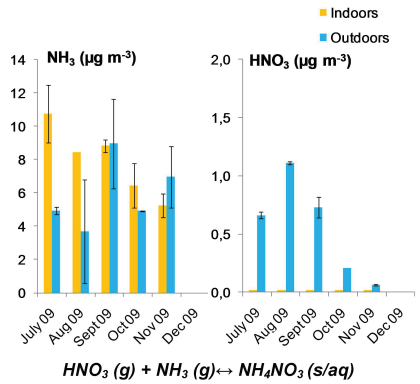

Figure 6: Indoor and outdoor concentrations of NH_3 and HNO_3 outside and inside the Baroque Hall.

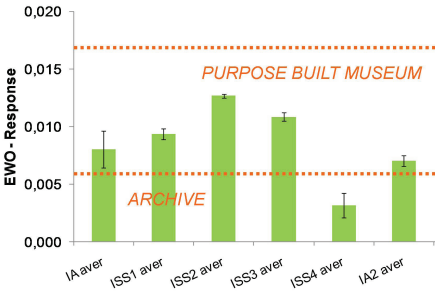

Figure 2: EWO dosimeter results obtained in the Baroque Hall.

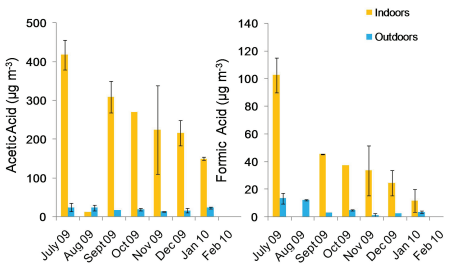

Figure 4: Acetic and formic acids inside and outside the Baroque Hall.

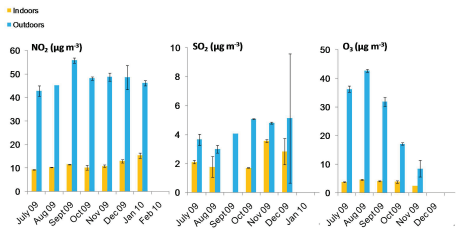

Figure 3: Concentration of NO_2, SO_2 and O_3 inside and outside the Baroque Hall.

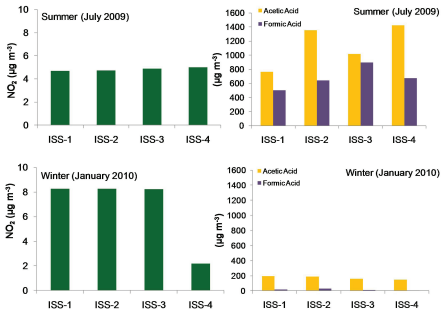

Figure 5: Seasonal differences in the concentrations of NO_2 and organic acids (acetic and formic acids) in the Baroque Hall.

Conclusions

- Concerning the protection of organic materials from photo-oxidant effects, the environment is "acceptable" for a "purpose built museum". However, the Baroque Hall of the National Library could be classified as an "Archive" in which case levels are not "acceptable".
- High concentration levels of NO_2 (> 10 µg m^{-3}) and SO_2 (>1 µg m^{-3}) were measured inside the Baroque Hall and may constitute a risk for the preservation of books and manuscripts.
- High concentration of NH_3 is measured indoors, whereas HNO_3 is below the detection limit. The source of NH_3 is uncertain but could be explained by infiltration of ammonium nitrate and shifting of the equilibrium to the gas phases. Possible loss of HNO_3 by surface deposition may explain the low concentration levels observed. If confirmed, surface deposition of HNO_3 may be a risk for the books and manuscripts.
- High concentrations of acetic and formic acids are observed in the Baroque Hall. Concentration levels similar to those reported inside enclosures (e.g. showcases) are observed on bookshelves during summer (i.e. acetic acid > 1000 µg m^{-3}).
- The preliminary results indicate seasonal variations. Higher infiltration during winter than in summer could explain the results obtained (i.e. NO_2 and organic acids). Further investigation in collaboration with the Baroque Hall is needed.

Acknowledgements

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