$PM_{2.5}$ in modern office buildings: elemental characterization and oxidative potential

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OFFICAIR is a European collaborative project focusing on indoor air quality in modern office buildings throughout Europe. It started on 1st November 2010 and it will end on 31st October 2013.

One of the main tasks of the project was the collection of indoor and outdoor $PM_{2.5}$ aerosol samples for detailed analysis. In Hungary, $PM_{2.5}$ sampling was performed in 5 selected offices (one/building) with a Skypost high-volume aerosol sampler (TCR Tecora Srl, Milan, Italy). Corresponding outdoor sampling was also undertaken close to the air intake of the of HVAC system situated on the roof of each building. Sampling time was 8 hours / day coinciding more or less with the daily shift of the workers (from 9 AM to 5 PM). Sampling was conducted with two filter types (both 47 mm) quartz fibre filters (Whatman QM-A) and Teflon (Whatman). Filters were conditioned at 20 ± 1 °C and 50 ± 5% relative humidity. Each day, 18.34 m^3 of air was pumped through the filters. Field blanks inserted into the sampling head were also employed.

The first analysis was the determination of the mass concentration. Indoor $PM_{2.5}$ mass concentration values ranged between 3.0 μg m^{-3} and 22.7 μg m^{-3} whereas outdoor concentrations (with one exception) were always higher and ranging from 4.7 to 28.2 μg m^{-3}. Outdoor $PM_{2.5}$ mass concentration values were comparable with our previous study (Szigeti *et al.* 2013) conducted in Budapest. Independently of the filter material, indoor / outdoor (I/O) mass concentration ratios varied between 0.26 and 0.96 (one exception: 1.47). This outcome is also in good agreement with literature data: 0.37-0.88 (Horemans *et al.* 2008). In 4 out of 5 buildings, relatively uniform I/O ratios were observed. Further, one building characterized with equilibrated I/O values (Figure 1) indicating proper ventilation a finding supported by perfluorocarbon tracer (PFT) measurements performed at BRE (UK).

After the $PM_{2.5}$ gravimetric analysis, samples were shipped on ice to Kings' College London where they were subjected to oxidative potential analysis (Godri et al, 2011). This consisted of a 4-h incubation at 37 °C of 5-mm discs cut from the loaded filters in 0.5 mL of a model solution simulating the respiratory tract lining fluid containing as antioxidants 200 μmol dm^{-3} of urate (UA), ascorbate (AA) and glutathione each. After centrifugation, the remaining amounts of UA and AA were determined by reversed-phase high performance liquid chromatography with electrochemical detection. Glutathione (GSX, GSSG, GSH) was determined by enzyme-linked 5,5'-Dithio-bis(2-nitrobenzoic acid) (DTNB) assay by using a microplate reader.

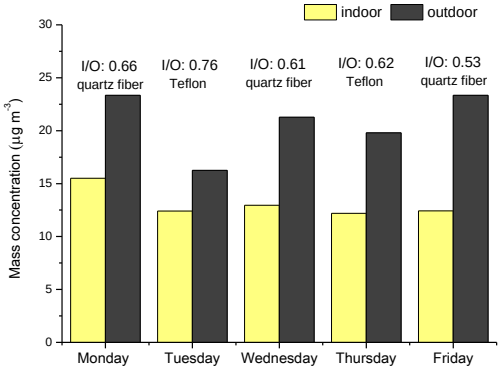

Figure 1. Daily indoor/outdoor $PM_{2.5}$ mass concentration ratios (I/O) calculated for samples collected onto quartz fibre filter and Teflon filters in one building in Hungary.

Particle induced X-ray emission was applied for the quantification of some major and minor elements in the collected aerosol samples. In the case of samples collected onto Teflon filters, elements ranging from Al to Zn could be determined. In spite of the high blank values for Fe, Ca, Cl, K and S in the aerosol samples collected onto quartz fibre filters, a wider range of elements could be determined (from Al to Pb).

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Horemans, B., Worobiec, A., Buczynska, A., Van Meel, K. and Van Grieken, R. (2008) *J. Environ. Monitor.* **10**, 867-876.
Szigeti, T., Mihucz, V.G., Óvári, M., Baysal, A., Atılgan, S., Akman, S. and Záray, G. (2013) *Microchem. J.* **107**, 86-94.
Godri, K.J., Harrison, R.M., Evans, T., Baker, T., Dunster, C., Mudway, I.S., Kelly F.J. (2011) *PLoS ONE* **6**, e21961. doi:10.1371