

## Indoor versus outdoor air quality measurements: number, mass concentrations and chemical composition of PM at the University of Perugia, Italy

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Keywords: Indoor, mass concentration, chemical composition

According to recent reports, people living in urban areas in Central Europe spend 80% to 90% of their time indoors. In these contexts indoor concentrations of pollutants are frequently higher than outdoor. Many aerosol chemical compounds cause respiratory irritations and can provoke discomfort and other symptoms, typical of the "Sick Building Syndrome". Studies conducted in different countries on people working inside indoor public buildings, evidenced that 15 to 50% of them suffer from some discomfort.

Based on these general observations, we evaluated the air quality in some rooms at the University of Perugia and compared it with measurements carried out outdoor in the university campus. The sample campaign started in October 2006 and is still in progress. Since then, more than 250 samples have been collected. Single stage low volume (38 l/min) samplers combined with selective inlets for PM<sub>10</sub>, PM<sub>2,5</sub> and PM<sub>1</sub>, high volume 7 stages cascade impactors (0,57 m<sup>3</sup>/min) and optical particle counters were employed and the samples collected on PTFE and PC filters, both indoor and outdoor. Samples on PTFE filters underwent chemical analysis by atomic emission spectroscopy (ICP-AES), UV-VIS spectroscopy, ionic chromatography (IC) and gas chromatography/mass spectrometry (GC-MS). Samples collected on PC filters underwent morphochemical analysis of the constituent phases by scanning electronic microscopy (SEM) coupled with EDS microanalysis.

Indoor annual mean values of PM<sub>10</sub> and PM<sub>2,5</sub> were slightly higher than those outdoors (+8%), while the PM<sub>1</sub> values are practically the same. The number concentration of the particles showed a higher values on weekdays and lower values on weekends (fig. 1). In addition a clear difference in the indoor/outdoor ratio of mass concentrations was evidenced between weekdays compared to weekends when the activity is reduced to minimum. The mass concentration have higher values in the fine fraction <0,39 μm (approximately 35-40% of the mass) and show a higher difference in the 4,2-10μm class (weekends days).

The presence of heavy metals (Pb, Zn, Ni), is constant in the various size ranges, and represent globally in average 0,4% in mass. Elements of

probable natural crustal origin (Al, Fe, Ca, Mg, Na) contributes for 13,7% to the mass of PM<sub>10</sub>, and for 6,4% to the mass of PM<sub>1</sub>. A distinguishing but not clear feature of PM<sub>1</sub> is the presence of Al and Zn in higher concentration (5-6 times) in indoor classrooms than outdoor. This could be perhaps related to some indoor source. For the heavier fractions of PM these ratios are inverted. Otherwise, the indoor presence in the PM<sub>1</sub> fraction of K, a typical element associated with fire burning which has been found in larger concentration outdoor, is a sign of a contribution from outside sources. The contribution of nitrates, sulphates, fluorides, and chlorides is lower indoor than outdoor, while ammonium is higher indoors.

Outdoor, anthropogenic sources mostly contribute to the organic fraction (PAHs, n-alkanes), whilst in the samples measured indoor the biogenic contribution is more evident, (fig. 2).

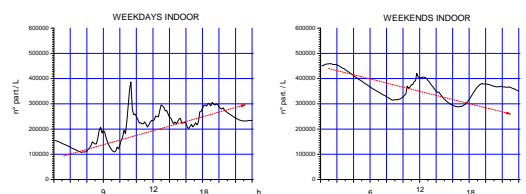


Figure 1. Indoor daily trend of particle number concentration (weekend- weekdays).

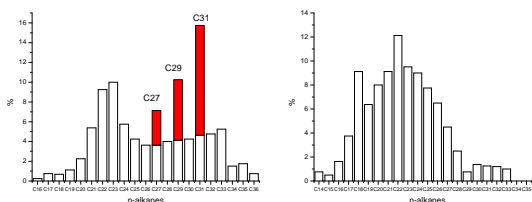


Figure 2. Comparison of n-alkanes distribution in PM<sub>1</sub> INDOOR (left) and PM<sub>10</sub> OUTDOOR (right).