



Studying the indoor air quality in three non-residential environments of different use: A museum, a printery industry and an office

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ARTICLE INFO

Article history:

Received 3 March 2011

Received in revised form

11 May 2011

Accepted 16 May 2011

Keywords:

Occupational environment

Activities

Particulate matter

Organic-inorganic pollutants

Sources

ABSTRACT

The aim of the present study was to identify the main sources contributing to the air pollution of three indoor environments of different use: a museum, a printery industry and an office. For that purpose, particulate matter (TSP, PM₁₀, PM_{2.5}), inorganic pollutants (NO_x, SO₂, O₃) and organic compounds (BTX, formaldehyde) were monitored. Factors such as the kind of the activities occurred indoors, the emissions from the existing equipment, the number of occupants, the ventilation pattern and the outdoor background substantially varied among the three sites.

The average values of PM_{2.5} (151 μg m⁻³), benzene (69.4 μg m⁻³), toluene (147 μg m⁻³), SO₂ (47 μg m⁻³) and NO₂ (96.6 μg m⁻³) were the highest values recorded during the experimental campaigns while all of them measured in the printery industry. Formaldehyde presented the highest concentration value in the museum (50.5 μg m⁻³). O₃ was measured to have the highest concentration in the non smokers' office (238 μg m⁻³) while the lowest was found in the presser section of the printer industry (11.0 μg m⁻³). The location of the sites seems to play a significant role, too. Benzene/toluene ratio indicated traffic as a major source. Furthermore, ozone presented low levels in the printery and the museum (urban area) and relatively higher levels in offices (suburban area), indicating its outdoor origin.

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1. Introduction

Several studies underline the role of good indoor air quality, since an average person spends more than 80% of the day in an indoor environment, either in the home or in the work place, a public building, a vehicle etc [1]. It is a fact that the issue of indoor air contamination has gained increased attention, due to the health-related problems [2]. Sneezing, coughing and minor eye and skin irritation are some symptoms after the start of exposure to a polluted indoor environment [3,4]. Respiratory and cardiovascular problems, even potential carcinogenicity have been reported after long-term exposure to certain indoor air contaminants [5–7].

It is known that several factors (i.e. indoor sources and activities, building's design and ventilation pattern, outdoor environment) influence the quality of the indoor air. A respectable number of studies monitoring the indoor air pollution have been conducted so far in residences, schools, hospitals, public buildings, working places, means of transport etc [6,8–10]. The scientific interest is

focused on the different characteristics of the sources located or the activities occurred in the environments of different use, without excluding the outdoor environment's contribution.

Recently, increasing attention has been focused on the damage to museum collections due to indoor air pollutants such as formaldehyde, formic acid, acetic acid and chlorinated hydrocarbons [11,12]. Other pollutants originated from outdoors (i.e. ozone, nitrogen dioxide, sulfur dioxide, nitric acid and peroxyacetyl nitrate) have also been found in museum environments. Damage due to formaldehyde, nitrogen dioxide, ozone and organic acids has been documented for a wide variety of materials including metals, paper, textiles and organic colorants.

The indoor air of an industry can be quite contaminated, depending on the kind of activities occurred, the emissions of the sources and the type of equipment used. An aggravated atmosphere of an industrial environment can be connected with employees' health problems. In view of this, the removal of pollutants became a major requirement among industries [13]. Focusing on environments associated with printing activities, there is a proven connection between sick building syndrome and the presence of printery equipment (printers, photocopiers) [14]. A range of pollutants is known to be emitted from printery machines: VOCs, especially from

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