Beyond conventional IAQ metrics: individual Volatile Organic Compounds in Spanish dwellings

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ABSTRACT

Indoor air quality (IAQ) in residential buildings is critical for occupant health, particularly during the winter season, when reduced ventilation rates are common. Conventional IAQ assessments tend to focus on pollutants that can be measured by low-cost sensors, like CO_2, HCHO, TVOC, PM's, CO, O_3 and NO_2. However, other contaminants, which are relevant to human health, have usually been omitted because their study requires less accessible technologies for accurate measurement. Previous initiatives developed by the INDEX and EBC ANNEX 68 projects have studied in depth this kind of compound, but there is still a lack of knowledge about their presence in Spanish dwellings.

A selection of Volatile Organic Compounds (VOCs), which are not usually monitored in residential environments, has been measured, since Spain has not participated in the aforementioned international projects. The selection of VOC compounds (Formaldehyde, Benzene, Naphthalene, Toluene, Xylene, Limonene and α-Pinene) was quantified using a combined technology of Solid-Phase Micro-Extraction coupled with Gas Chromatography and Flame Ionization Detection (SPME-GC-FID) and colorimetric tubes. Measurements were conducted in 29 occupied typical dwellings, considering the number of bedrooms and occupancy patterns.

Among the compounds analysed, Acetone was the most prevalent, detected in approximately 86% of the dwellings. Its concentration distribution was asymmetrical. These peaks were mainly associated with the extensive use of cleaning products and personal care cosmetics, highlighting the strong influence of occupant behaviour on indoor pollution levels. Limonene was also detected in a large proportion of dwellings (~79%) and showed a clear correlation with Acetone. The relatively high concentrations observed are consistent with its widespread presence in air fresheners, household cleaning products, and detergents.

Overall, the results reveal substantial variability in indoor VOC concentrations. The findings underline the dominant role of domestic sources related to cleanliness and personal hygiene in shaping IAQ in Spanish dwellings. These sources are often overlooked in conventional IAQ assessments. The study therefore suggests that current risk assessment frameworks should place greater emphasis on further occupant-related emission sources, particularly under winter conditions characterised by limited ventilation, which are typical of cold and temperate climates.

KEYWORDS

Indoor air quality, Volatile organic compounds, Residential buildings, Domestic emission sources