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Analytical Systems for Continuous Monitoring of ppt- to ppm-levels of Formaldehyde and other Aldehydes in Air

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Accurate and continuous monitoring of indoor air quality is crucial to understand and prevent airborne diseases, since humans spend most of their routine time indoors. Aldehydes are of particular interest as they are irritants and usually present in indoor air at concentrations from 2 to 10 times higher than in outdoor air. Formaldehyde, the most abundant one, is classified as carcinogenic category 1B under European Regulation (EC) No 1272/2008. An exposure limit of 30 $\mu\text{g}/\text{m}^3$ for chronic exposure has been established. In indoor air, aldehydes mainly originate from construction materials such as plywood, insulating materials, paints... Some aldehydes have a pungent and fruity odor at high concentrations but may be undetected at low concentration, yet already be toxic. To be able to implement preventive measures, there is a need for continuous, fast, accurate and robust techniques for quantification of aldehydes in indoor air.

In this work, we present three different systems which have been developed for monitoring of formaldehyde and other aldehydes: a portable microdevice based on the derivatization of formaldehyde for continuous fluorometric detection, a transportable high-performance liquid chromatography (HPLC) system using 2,4-dinitrophenylhydrazine (DNPH) sampling tubes and an Automatic Gas 2D-chromatograph equipped with a thermodesorption unit and flame ionization detector (auto-TD-GC-FID). These techniques were compared by means of laboratory measurements and field campaign. The portable microdevice specifically quantifies formaldehyde down to ppb levels. It is compact, can accurately monitor concentration over long periods of time, and has a battery autonomy of 4 hours. The transportable HPLC-DNPH system (two suitcases of less than 18 kg) is designed to satisfy the requirements of the reference method ISO 16000-3, based on sampling with active DNPH tubes followed by elution, separation on a C18 column and UV detection. This method allows the quantification of at least 13 aldehydes down to ppt levels, including formaldehyde, acetaldehyde and hexanal. The auto-TD-GC-FID can quantify formaldehyde and acetaldehyde from ppb to ppm levels. It runs continuously with successive 15-min cycles. The system only requires a power supply and water tank when it is equipped with gas generators. Each of these instruments employ distinct technologies and vary in terms of complexity, portability, and accuracy. They have their own advantages and are applicable for the measurement of aldehydes in indoor air.

Keywords: Indoor Air, Gas Chromatography, Microfluidics, Formaldehyde, Aldehydes, On-line Gas Monitoring, High Performance Liquid Chromatography, Portable instrument.