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Review

Current air quality analytics and monitoring: A review

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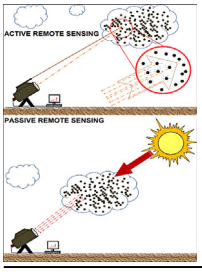
HIGHLIGHTS

- The different approaches to air quality monitoring are presented.
- The role of portable analytical devices in air quality monitoring is emphasized.
- Biomonitoring and remote sensing are complementary to traditional monitoring networks.

GRAPHICAL ABSTRACT



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ABSTRACT

This review summarizes the different tools and concepts that are commonly applied in air quality monitoring. The monitoring of atmosphere is extremely important as the air quality is an important problem for large communities. Main requirements for analytical devices used for monitoring include a long period of autonomic operation and portability. These instruments, however, are often characterized by poor analytical performance. Monitoring networks are the most common tools used for monitoring, so large-scale monitoring programmes are summarized here. Biomonitoring, as a cheap and convenient alternative to traditional sample collection, is becoming more and more popular, although its main drawback is the lack of standard procedures. Telemonitoring is another approach to air monitoring, which offers some interesting opportunities, such as ease of coverage of large or remote areas, constituting a complementary approach to traditional strategies; however, it requires huge costs.

Contents

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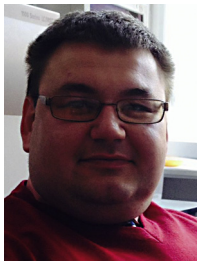

Mariusz Marć (born 1986) graduated from the Gdansk University of Technology with an M.Sc. Eng. in Environmental Protection Technology in 2010, after which he started his Ph.D. studies at the same University (GUT). His research interests include the application of passive sampling technique in a monitoring of indoor air quality and atmospheric air quality. Also he is interested in application passive sampling technique in the field of estimating the emission rate of organic compounds using passive flux samplers.

Bożena Zabiegała (born 1963) obtained her degrees from the Gdańsk University of Technology (M.Sc., 1988; Ph.D., 1997; D.Sc., 2010), working in the Department of Analytical Chemistry. Her major research interests include the problems of air quality (indoor and atmospheric air), application of solventless sample preparation techniques based on solid- and vapor-phase extraction, ecotoxicology and endocrine disrupting compounds (PBDEs in the samples of house dust and human hair).

Jacek Namieśnik (born 1949) obtained his Ph.D. in 1978 and has been a professor since 1996. He was Dean of the Chemical Faculty, Gdańsk University of Technology, from 1996 to 2002 and since 2005 has been Head of the Department of Analytical Chemistry. He has also been Chairman of the Committee on Analytical Chemistry, Polish Academy of Sciences (PAS) since 2005. His major research interests include the development of new analytical procedures for determining trace and ultratrace constituents in samples with complex matrix compositions, the design and testing of customized analytical units and measuring devices. He is the author of over 300 papers and 10 patents.

Marek Tobiszewski (born 1984) obtained his Ph.D. degree in 2012, after which he started his research in Analytical Chemistry Department in Gdańsk University of Technology. His research interests include environmental analytical chemistry, sample preparation before gas chromatographic analysis, and the environmental fate of organic pollutants, in particular chlorinated solvents and polycyclic aromatic hydrocarbons. He is also interested in green analytical chemistry and application of multivariate statistics in environmental monitoring.

Prof. Dr. Miguel de la Guardia is Full Professor at Valencia University (Department of Analytical Chemistry) from 1991. He has published 482 papers in journals of the Science Citation Index, 5 Spanish patents, 3 books on Green Analytical Chemistry (Elsevier, RSC and Wiley) and 1 book on Food Analysis (Elsevier) additionally than 12 book chapters. He has supervised 33 Ph.D. thesis and is member of the Editorial board of Spectroscopy Letters (USA), Ciencia (Venezuela), J. Braz. Chem. Soc. (Brazil) Journal of Analytical Methods in Chemistry and Chemical Speciation and Bioavailability (UK), SOP Transactionson Nano-technology (USA) and SOP Transactions on Analytical Chemistry (USA).

1. Introduction

Degradation of environmental quality can be one of the reasons for civilization diseases [1]. Therefore, there is a strong need to keep the quality of the environment at acceptable levels. To reach this goal, many tools required to quantitatively measure the quality of air, water, land and biota, and to perform this, chemical analysis is of key importance.

The main role of air analysis and monitoring is to obtain reliable analytical information concerning some mechanisms and processes. The first one is the identification of pollutant emission sources and assessment of the range of their influence. The second one is the assessment of the environmental quality and the investigation of the environmental fate of pollutants. Another very important aspect is the bioaccumulation in tissues of living organisms and the assessment of the ecotoxicity of pollutants. Finally, the role of monitoring involves the assessment of the environmental impact of new regulations and policies.

The accomplishment of the aforementioned tasks is not easy because several problems and challenges need to be overcome. These are trace or ultratrace concentrations of analytes in samples, which are usually characterized by a complex composition of the matrix. There might be high temporal and spatial fluctuations of pollutant concentrations and there is a possibility of the occurrence of interferents, characterized by similar physicochemical properties and similar or even higher concentration levels. As the analytes may enter into chemical reactions in the environment, it is necessary to determine both primary and secondary pollutants, as well as metabolites and degradation products. Finally, there are no analytical standards and reference materials available for many pollutants.

2. Air monitoring devices

Measurement devices used for monitoring purposes have special requirements, such as very short response times, preferably allowing for obtaining analytical results in real time or with high resolution. It is required that the analytical device should be highly automated, this means it should be able to operate automatically for the long period of time. Some instruments should be supplied with self-calibration devices, filling-up systems, auto-regeneration of reagents and independent power supply systems.

The trends in the development of instrumental tools for monitoring and analysis of environmental samples are summarized in Fig. 1 and all steps of the analytical procedure from sampling and sample preparation to the final determination are presented. Direct techniques of determination also involve quality control and quality assurance of measurements and the chemometric evaluation of data.

The growing interest in portable instruments is due to the fact that stationary analytical devices used in routine quality analysis of atmospheric air are expensive and difficult to transport and install on site [2]. Portable analytical equipment used in air quality assessment can be classified into two groups of portable gas