ABSTRACT

Offensive odours from waste water treatment plant (WWTP) and solid waste treatment facilities are a frequent cause for complaints by the community and may cause environmental nuisance. Odours generate a variety of undesirable reactions in people, from annoyance to documented health effects. In communities exposed to odorous emissions, even though there may be no immediately apparent diseases or infirmities, it is clear that physical, as well as mental, wellness is not promoted.
The particular and complex nature of the substances cause of the smell impact, their variability in time and related to the meteo-climatic conditions, and the subjectivity of the smell perception are the elements that delayed their regulation.
There are few international laws that fix the limits of odour emissions from industrial sources and/or define criteria of quality related to the smell. On the other hand, the definition of normative limits on the smell emissions is a problem hardly to solve because of the difficulties related to the subjectivity of the smell perception and the ways for determination of odours in the environment. Odours are difficult to measure. A person's response to an odour is highly subjective - different people find different odours offensive, and at different concentrations.
Currently, available techniques for odour characterisation and quantification are of three different kinds: analytical, sensorial and sensorial – instrumental that have different advantages and problems.
Analytical measurements (GC-MS, colorimetric methods) concern the physical or chemical properties of the odorous compounds, although the most common measurement made by far is odorant concentration. Analytical measurements allow a preliminary screening of the existing substances, but do not allow to get information about the induced annoyance.
Sensorial techniques, such as dynamic olfactometry, according to EN 13725: 2003, use the human nose as a sensor, and therefore enable to characterize odours by referring directly on their effects on a panel of qualified examiners.
Senso-instrumental techniques primarily use artificial noses, which perform instrumentally the functions of human olfaction. There is a growing interest towards the environmental applications of electronic noses and many studies have been done on how to characterize odours using an array of gas sensors and a pattern recognition algorithm. Electronic nose is the only technique that allows continuous monitoring of odours.
The electronic nose has the best potentialities to answer to the expectations of the various actors of the environmental problems in relation with the odours annoyance. However, several limitations in environmental sector are associated with the properties of chemical sensors, the signal processing performances, and the real operating conditions of the environmental field.
Therefore, the scientific community is devoting its effort to find the way to implement new systems able to continuously monitor odor emissions.
This is the one of the main motivations behind the present research activities, which aims to contribute to a substantial innovation into the field of odor monitoring systems through the proposal of a new design and operational procedure for a multisensorial array system.
Going through an in-depth analysis of the present work, a further clarification of several problems affecting the odor determination and the main issues related to its subjectivity has been performed as a first step. Moreover, a thorough examination of all the available sampling and quantifying techniques has been developed. Experimental activities, on the other hand, performed with the use of the e-nose, made clear some critical issues, essentially related to meteorological factors, such as air humidity and temperature; this has been made possible thanks to the introduction of a number of sensors, which were adversely affected by the "drift of the sensors" phenomenon. Another problem that has to be stressed is represented by the lack of standardized procedures for the training, acquisition and elaboration phases of the process.

The e-nose has been tested both in laboratory and on the field, the latter activity being performed at the waste treatment facility located in Habay-la-Neuve (Belgium).
Thanks to the interpretation of the results of the experimental activity, a multisensorial array system has been designed, named seedOA® (Sanitary environmental electronic device for odour application).
The main innovative elements of the patented instrumentation are basically connected with both the number and the features of the introduced sensors, specifically selected in order to deal with sanitary environmental engineering plants. Another worthy innovation is represented by the hydrodynamic study proposed for the design of the sensors chamber. These aspects were proposed bearing in mind other practical elements needed for its future market placement, such as its robustness, the compactness of the instrumentation, its ease of transport and the like.
The e-nose provides a set of 12 metal oxides non-specific gas sensors and 2 specific gas sensors, all of them allocated into the same sensors chamber. Clearly, all the selected sensors were chosen according to their suitability for sanitary environmental engineering applications.
The sensors chamber has been designed in order to optimize both the influent and effluent gas flux patterns, through a dedicated diffuser, located right in the centre of the chamber. The diffuser has been designed using the FLOW3D® software.
The conclusion of the research activity consisted in the implementation of an innovative integrated procedure, exclusively directed to odor monitoring applications in sanitary environmental engineering plants; the study allowed, therefore, the validation of the proposed model.