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Book Review

ODOUR IMPACT ASSESSMENT HANDBOOK

Vincenzo Belgiorno, Vincenzo Naddeo, Tiziano Zarra (Editors)

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The emissions of odours from different sources of human activity are considered as one of the most important problems of the nowadays society. Even if in most of the cases the concentration of odorous compounds is very low and should not represent a threat to human health, the bad smells are a source of disturbance for the communities and represent a threat to the touristic activities. The main objective of the handbook under discussion is to set a theoretical and practical basis in the field of odour impact assessment.

The first part of the book (written by the Editors) has an introductory role and is dedicated to the definition of the odour, the means of quantification and corresponding effects and finally odour impact assessment approaches. By providing this important information, the authors make sure that the aim of the further book chapters is better understood. In this first introductive chapter of the book an odour is defined as a property of a substance or a mixture of substances that, depending on the concentration are capable of stimulating the olfactive sense and generate the corresponding sensation. In other ways, odours are perceived as a sensorial response to the inhalation of air containing a certain amount of chemical compounds usually denoted as odorous substance. In contrast, fresh air or clean air is perceived as free of smell, contaminants or at most having a pleasant odour such as that of flowers or fresh cut grass.

Quantification of odours is made be means of dynamic olfactometry, electronic noses and furthermore by using specific chemicals, to create a relative indication of the amount of odorous substance present in a certain environment. These aspects are discussed in detail in the third chapter of the book. Furthermore, the effects of odours, ranging to mild discomfort to embarrassment, health and economic trouble are briefly mentioned together with the means of impact approaches.

In the second part of the book, (authored by V. Naddeo, V. Belgiorno and T. Zarra) the means of *Odour Characterization and Exposure Effects* are described. The most important characteristics of odours are concentration, perceptibility and threshold, intensity, difusibility and volatility, quality and hedonic tone or offensiveness. The *Chemistry of Odours* subchapter describes the causes of odour formation and the main physical and chemical properties of odorous compounds such as water solubility, vapor pressure and means of chemical or biological degradation. Diffusibility is the parameter of a substance that defines its degree of volatility.

The concentration at which an odour is just detectable to a 'typical' human nose is referred to as the 'threshold' concentration. The highest value of the concentration at which the same odour is detected – is referred as $OT_{100\%}$ due to the fact that in a panel evaluation the odour is perceived by all of the panelists. A mean of evaluation is trough odour index defined by the relation $OI = P_{vap}/OT_{100\%}$, where P_{vap} is the vapour tension of the substance (ppm) and $_{OT100\%}$ is the odour threshold at 100% (ppm).

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and allows the means of cataloguing the scents in different classes.

Furthermore, in the sub-chapter *Odorous Compounds, Thresholds and Sources* the odour production activities and processes are described together with the main categories of organic and inorganic chemical compounds. It is emphasized that the main chemical-physical properties ocurring during the formation of odours are vapor pressure and water solubility which determine the passing from or to the liquid state. In case of degradation phenomena chemical or biochemical processes are involved. This is why attention of the authors is headed into providing some important data regarding the main classes of odorous substances. The final subchapters describe the importance of public health relevance of odour exposure and odour annoyance and nuisance. In general odourous compounds are capable of producing beyond annoyance and nuisance, serious injuries or even death. These aspects are pointed out by several examples of chemical compounds.

In the third part of the book, *Instruments and Methods for Odour Sampling and Measurement* (written by T. Zarra, V. Naddeo and V. Belgiorno) the main tools for odor sampling and measurement are described. The importance of the measurement is stated in the introduction chapter, this being logically followed by a description of sampling techniques and procedures. The results of the measurements are in a strong dependence on sampling, independently from the adopted measurement technique (dynamic olfactometry, chemical analysis or electronic nose). Appropriate and specific sampling programs are important and are preliminary defined according to the types of sources, measurement methods and other variables. In the sub-chapter *Measurement of Odorous Substances*, the measurement is regarded as a complex activity due to the fact that current measurement methods are generally divided into three categories: sensorial, analytical and mixed methods. The most advanced and used analytical technique to measure odorous compounds is gas chromatography coupled with mass spectrometry, followed by the colorimetric tubes, portable multi-gas detectors and gas analyzers. Dynamic olfactometry is currently the most used sensorial technique and involves the use a dilution instrument (namely, the olfactometer) to present an odour, at different concentrations levels, in a controlled way to a panel of assessors. The further described triangular odour bag method is another air dilution tehnique used for further estimation of emission rate. Field assessment is particularly important in approval and monitoring proceedings as well as urban development planning. Odour sensors (also called artificial noses), which are in use for many years incorporate a sensor element that reacts to odours. The gas sensor array consists of several different types of sensing materials that contribute to the different gases sensing.

In the fourth part of the book, the chapter *Strategies for Odour Control* (authors: J.M. Estrada, R. Lebrero, G. Quijano, N.J.R. Kraakman, R. Muñoz) are discussed. Since odour emissions are often a result of human activities the minimization and the control of odour dispersion is of particular importance in areas close to inhabited places.

Odour control strategies include the use of covers, turbulence-inducing structures and the establishment of buffer zones is examples of cost-efficient strategies for odour dispersion control. The means of control of odour effects on an exposed community is the use of chemical additives designed to mask, neutralize or minimize the perception of malodorous emissions. The measures for the control of odour emissions include end-of-pipe treatment technologies despite the associated investment and operating costs.

The fifth part of the book is dedicated to the subject of *Dispersion Modelling for Odour Exposure Assessment* (authors: M. Piringer and G. Schauberger). Starting with describing odour perception by humans, whereby odour intensity, frequency and duration are the dominant parameters, it aims at presenting the most important types of odour dispersion models, which are categorized in two classes of models: Gauss and Lagrange. These models are used depending on the distance to the source of emissions as well as on the meteorological conditions or pollutant types. Several examples of dispersion models are described together with information on the algorithms used estimate short-term odour concentrations. Aspects regarding the dose–response relationship between the odour frequency and the percentage of 'annoyed' and 'seriously annoyed' people are also included. Odour impact criteria are important in modelling and establishing separation distances by using dispersion models. Models have certain limitations as evidenced by the sub-chapter *Evaluation of Odour Dispersion Models* and sometimes the validation is difficult, while the confidence is low.

The sixth part of the book concerns the subject included in the chapter *Odour Regulation and Policies* (written by S. Sironi, L. Capelli, L. Dentoni and R. Del Rosso) and treated as an important issue in the industrialized countries. The importance of the subject is a direct consequence of the fact that odourous compounds are pollutants with a significant negative impact on both the quality of life and economic activity. However, due to the little threat on human healt in a large majority of cases, the odour problem has gained attention only in the last decades. This is why standardized procedures and regulations have emerged in the recent year. Most of the regulatory documents are based on air quality standards and limit values and aim at overall air quality. Regulations aimed at defining Maximum Emissions Standards (MES) represent an evolution on the subject of regulation of odour emissions. Furthermore, there are certain regulatory acts that are based on direct exposure assessment limits. The *Regulation Based on 'No Annoyance'* takes into account the so called "annoyances indexes" that need to be defined order to be quantified Source

identification is also important. The *Regulation Based on Application of Best Practice* sub-chapter takes into account various directives and other documents on the issues like best available technologies or practices, which generally target the industrial facilities regarded as possible sources of odours. In the end of the sixt part, a comparative Table is provided.

The *Procedures for Odour Impact Assessment* (authors: V. Naddeo, V. Belgiorno and T. Zarra) is a comprehensive synthesis on the problems regarding the impact assessment of odours. The factors contributing to odour impact are briefly reviewed as a prequel to the next chapter dealing with the odour *Impact Assessment from Exposure Measurement*. This type of asessment is to be used in the cases when the odorous activities exist and generate negative effects. The asessment is based on the significance of negative effects experienced by people occupying land near the activity. The determination of the type of the effect either acute or chronic is particularly important and helps the selection of the assessment tools such as field sniff testing, complaints and odour diaries, community surveys and continuous monitoring by e-noses.

In the section *Odour Impact Assessment from Sources* the methods for impact evaluation from dispersion modelling are discussed. The main stages of this procedure concern the identification and characterization of odour sources, estimation or measurement of odour emission rate; characterization of meteorological conditions; characterization of topography of a possible exposed area; identification of receptors and their sensitivity; evaluation of the exposure levels by modelling results; assessment of odour impacts. The results of complex study have multiple uses: prediction of the impact of new solutios or proposals, proposal, comparisons on exposure levels or regarding the cost effectiveness of odour mitigation options; evaluation of the effects of changing weather conditions on odour dispersion; as an indication on the need of improvement or to design of adequate chimneys.

In the final part of the studies on odours, impact measures to odour control should be included. In the chapter *Mitigation of Odour Impact* a general explanation of how it is possible tackle odour issues is provided. There is also information on the types of control measures and the response of industry on the different regulatory pressures.

Control of odourous substances generally considers the main three aspects: control of odour emission rate; control of odour sources; end of pipe treatment. *Odour Monitoring* and plans for odour monitoring have a particular importance and aim at impact and exposure assessment, helps investigation on sources and pathway, measure of the releases and process control.

The final part of the work is an applicative approach, which contains important case studies as good practices for assessment, control and prediction of odour impacts. These examples are focused on the main activities generating odourous emmisions: *Urban Wastewater Treatment Plant* (J. Lehtinen); *Composting Plant* (S. Giuliani, T. Zarra, M. Reiser, V. Naddeo, M. Kranert, V. Belgiorno); *Landfill of Solid Waste* (A.C. Romain and J. Nicolas); *Industrial Activities* (I. Sówka); *Concentrated Animal Feeding Operation (CAFO) Plants* (K. Y. Wang).

Finally, the last chapter in the eight part is dedicated to *Assessment, Control and Management of Odour in Sensitive Areas* (authors: N. Kalogerakis and M. Lazaridis*)*. In this chapter, the notion of sensitive areas refers to areas nearby waste water treatment plants. These facilities are often sources of odourous compounds emissions including sulfurous organic compounds, hydrogen sulfide, phenols and indoles, ammonia, volatile amines and volatile fatty acids; hydrogen sulfide (H_2S) and ammonia (NH_3) and are considered most frequent sources of annoyances.

By containing the work of 28 contributors from 13 different countries providing information from the population and from the technical-scientific world the book constitutes itself as an important instrument for a wide range of people either working in the research or educational institutions, for the authorities involved in environmental managing and monitoring or for any professional interested in assessing the environmental impact.

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