ODOUR STUDIES AS PART OF FEASIBILITY ANALYSIS FOR NEW PROJECTS

Introduction

The term “odour” refers to the perception experienced when one or more chemicals come in contact with receptors on the olfactory nerves. From various air pollutants categories, odours are generally ranked as one of the biggest generator of public complaints (J.A. Nicell, 1994).

Although it is not a very common practice, the description and assessment of effects derived from odours generation is required by the environmental impact assessment legislation. In the event that there is an obvious impact related to the smell, an odour study is strongly recommended to address potential social and health concerns. Generally, emission factors and air emission models are the main tools considered for odours evaluation. Emission estimates are important to define permitting and control programs applicability, developing emission control strategies and evaluating mitigation strategies, among other related applications.

Less often are those studies included in the feasibility analysis of these new projects in order to consider not only the potential impact associated to the operation of the new activity, but also the potential effect that it would receive as a consequence of the operation of the former surrounding activities.

In this work, a review of technical tools available to identify and quantify potential odour impacts on new projects is presented.

Legal framework

Legislation related to odours is being discussed and gradually implemented throughout the world. Some countries and regions have specific and detailed legislation on the subject, while in other countries legislation is not as detailed or it is inexistent.

Although there are different criteria to manage the nuisance caused by odours (individual substances concentration, minimum separation distances, duration and frequency of the odour etc.), in general terms the odour concentration, consisting on adopting a concentration threshold for odour perception, is the most common criterion.

Odour concentration is defined through the minimum concentration of odorant required for detection by a specific percentage of the population under investigation. The odour concentration is typically determined in a laboratory environment by dynamic dilution olfactometry using an apparatus known as olfactometer. The sensors are the noses of human assessors trained to perform such evaluations. The determination procedure of odour concentration by dynamic olfactometry was standardized in some countries by specific standards. In Europe, this procedure has been standardized by EN 13725:2003 (CEN, 2003).

In Europe there are several countries with different guidelines and regulations regarding limit values applicable to odours. It should be noted that, in most cases, these values have been defined for immision concentrations, and are referred to exceedance probability (percentile). This means that compliance is evaluated through a dispersion model that forecasts odour concentrations at the receptors. These limit values wouldn’t therefore be comparable to measurement of odours in the field.

In Spain there are no specific instruments to legislate on odours. The Spanish regulation in this regard is based on activity licenses or integrated environmental authorizations, if any. In

Catalonia, the Environment and Housing Department produced a draft of Law against odorous pollution (Generalitat de Cataluña, 2005). However, to date, nothing consolidated was established. The Draft establishes objective target values of odour immission to be applied in residential areas depending on the kind of activity generating the odour emission:

- 3 ouE/ m^3 for waste management, rendering of animal by-products, distillation of animal and vegetal products, slaugh-terhouses, paper and pulp industry;
- 5 ouE/ m^3 for livestock, processed meat, smoked food, rendering of vegetal by-products, treatment of organic products, waste-water treatment plants;
- 7 ouE/ m^3 for roasting and processing coffee or cocoa facilities, bread ovens, pastry and cookies, beer, production of flavors and fragrances, drying plant products, other activities of Annex 1 of the Draft.

These limit values are referred to percentile 98 of hourly mean concentrations during a year. A 98th percentile value of a year of hourly averaged concentrations means that hourly averaged concentrations will be less than or equal to that value for 98% of the year. For 2% of the year, hourly averaged concentrations will be higher than or equal to that value. In other words, the 98th percentile is the predicted concentration which won't be exceeded during more than 175,5 hours per year.

Methodology

A methodology to perform a feasibility analysis of new projects regarding odour emissions is proposed below, in order to consider the potential effects associated to the operation of the former surrounding activities on the new one.

1. Review of environmental permits regarding air emissions and odours in current industrial activities surrounding the new project. Facilities emitting odours are usually required to comply with emission limit values. These limit values are typically referred to specific substances causing odours (e.g. sulfides, mercaptans, ammonia, amines, volatile organic compounds etc.) but they may also consider odour concentration (UO/m^3). Odour limit values are usually established considering similar facilities where odour emission has been previously monitored. Also, odour limit values can be established as a required performance associated to an installed odour reduction system (e.g. gas scrubbing system). In addition, air emission limits shall be reviewed for all activities since they are directly related to odours generation and represent a very valuable source of information for facilities where no odour control is required. If available, analytical data evaluation is also recommended to evaluate compliance with established limit values.

2. Analysis of new potential odour emission sources not considered in the environmental permits. Channelized emissions are easier to identify and control since they are usually associated to a known and specific process (e.g. incineration process). However diffuse emissions (e.g. emissions associated to waste storage or transportation) are difficult to identify and quantify and therefore they are not usually considered within the environmental authorizations, although their contribution to the total odour emission rate may be significative.

3. Evaluation of the Best Available Techniques (BATs) implemented at the surrounding facilities. Environmental permits shall consider recommendations included in BREFs documents (Best Available Techniques Reference Documents). The so-called BREFs are

reference documents developed under legislative instruments within the European framework. These documents are developed for each industrial sector and include the BAT conclusions document, which summarizes the conclusions on best available techniques. These BATs consider different environmental aspects including air emissions and are therefore directly related to odour emissions.

4. Evaluation of odour abatement methods and odour control techniques implemented at the surrounding industrial activities. In addition to the specific odour reduction systems applicable to the industrial processes (e.g. biofilters, gas scrubbing systems) there are many odour abatement measures that can be implemented at an industrial facility providing an effective method to reduce their odour emissions. These measures may include self-closing lockable doors, underpressure chambers or good practices associated to the storage and management of the substances producing odours.

5. Review of former models performed as part of the environmental permit's application. Among the methods applied for odour impact assessment, the use of mathematical models to predict concentrations in ambient air downwind of the emission source is the most commonly used (Brancher et.al, 2017). Consequently, as mentioned above, the majority of odour regulations around the world nowadays are based on the application of the dispersion modelling.
   There are different approaches to develop air dispersion models (Lagrangian, Eulerian, Gaussian models etc.). Although the technical approach may be different, most of them provide similar kind of results including both tabular and graphic results showing immision concentrations. Graphical results are usually presented as frequency isolines (contour plots) displaying the spatial distribution of odour concentrations in accordance with the permitted level of exceedance of this concentration (i.e. percentile).
   Air dispersion models represent a powerful tool to predict odour dispersion for new facilities, for example, where measuring odours in the field is not possible. However, air dispersion models present also some limitations that should be considered when making a technical assessment:

   - Air emission models are typically built considering different input data to describe the behavior of air emissions, which are usually affected by uncertainties linked to their own nature:
     - ✓ Air emissions (odour emission rates in this case). As indicated above, air emissions models are generally performed as part of the environmental permits for new facilities, and therefore no real data on air emission or odour concentrations are available. In these cases, emission data are estimated through emission factors according to previous studies for similar facilities. These estimations are consequently subject to a high uncertainty, since each industrial process may have specific characteristics generating a different odour concentration. In addition, these models usually consider just punctual or channelized sources, but they don't contemplate diffuse emissions due to their complexity.
     - ✓ Meteorological data. Models usually consider different meteorological parameters such as wind speed and direction, temperature, cloud cover, sun radiation and precipitations, among others. In many cases in absence of available data close to

the site subject of study these data are estimated using specific meteorological models or data from meteorological stations located in the surroundings.

- Air emission models make it possible to forecast odour concentrations associated to a specific activity. However, new projects are usually located in industrial areas where several facilities are operating at the same time. Although all these facilities counted on an odour modelling, which is highly unlikely, calculation of the total odour concentration in immission is still complex due to the odours own nature. Odours can be affected by synergies or masking processes involving that the linear sum of immision concentrations is not representative of the real concentrations.

6. Collection and analysis of complaints data, if available.

7. Review of the immision surveys results, in case immision surveys have been carried out. Field data offer the most accurate way to evaluate odour levels in the surroundings of a new project. Immision surveys should be complete and representative, considering different times of the year/week, different daytime hours, night time schedule and adequate repeatability. There are different approaches to perform immision sampling surveys, including:

    - VDI 3940 Part 1: Measurement of Odour Impact by Field Inspection. This standard establishes the guidelines to perform immission surveys through a calibrated panel that performs direct odour tests in the field. Since odour concentrations are directly determined by the panel, a long period survey (one year) is required to guarantee representativeness of the results. (Laura Capelli et al, 2013).
    - EN 13725:2003 (CEN, 2003). Air quality - Determination of odour concentration by Dynamic olfactometry. In this case a sampling survey would be performed, and samples would be analyzed in a laboratory. Limitations of this method are related to the analytical detection limit, as immision concentrations could be below the detection limit of the laboratory. In this case, the result would show that the concentration would be below the detection limit, but it wouldn't be possible to get a more accurate result.
    - Use of field olfactometers to perform direct measurements on field through a portable dilution device. Although this device is not directly associated with any specific standard, it follows the same methodology than a standard olfactometer, and it can be used to get immediate results on the field. It can be useful for odour impact assessment purposes in cases where dispersion modelling is hardly applicable (diffuse sources such as tanks or fugitive emissions).
    - Use of electronic noses. Again, this kind of device can be useful in odour evaluations where other analytical methods are difficult to apply. It doesn't perform a chemical air analysis, but it produces a kind of "olfactory pattern" which can be subsequently classified based on a reference database acquired by the instrument in a previous training phase. (Laura Capelli et al, 2013). The most crucial aspects limiting widespread application of electronic noses is the fact that results don't show odour concentration but the kind of odour detected and the lack of an associated standard. In recent years an effort has been made to develop a framework for the standardization of the use of e-noses as monitoring devices and there are working groups aiming to propose a new European standard for instrumental odour monitoring (Bartosz Szulczy et. al, 2017).

8. Odour assessment. Once all the previous information has been reviewed, an environmental diagnosis regarding the situation of the new project with reference to the potential odour affection can be performed. This assessment shall considered all the uncertainties identified throughout the evaluation process as well as recommendations to the promoter that could be used to complete the assessment and guidelines to evaluate potential odour affection in the future. In most cases, an immision survey is recommended to establish the odour baseline of the industrial area and count on real data for the evaluation.

Conclusions

A methodology to identify and quantify potential odour impacts on new projects was presented to address the feasibility analysis of new projects in relation to odour affection. This methodology establishes eight steps to evaluate the situation of the new project. In many cases a high uncertainty is associated to this process due to the own nature of odours, the lack of information from current activities in terms of odour emissions and the absence of a clear odour regulation framework. In these cases, an immision survey is usually recommended to establish the odour baseline of the industrial area.

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