Olfactometry vs chemical analysis

In general, it is difficult to use the chemical analysis method for mixtures of odorous compounds due to the phenomena of synergy, inhibition and masking between different compounds (Gostelow et al., 2003). Complex mixtures, such as environmental air samples, contain many odorous compounds, generally at very low concentrations (Gostelow et al., 2001) (Schiffman et al., 2001) (Parker et al., 2002) (Filipy et al., 2006). To analyze all the odorous compounds that are present, the composition of the sample must be known in advance, and the detection limits of the chemical analysis devices are often too high to identify and quantify all these odorous compounds (Gostelow et al., 2003). Finally, the olfactory perception threshold values are not always available in the existing literature, the values
reported vary by several orders of magnitude (AIHA, 1989) (US EPA, 1992), and the available references are not recent.

The effects of synergy and masking between different odorous compounds can be observed in samples. For example, in a sample of food odor, the volatile compounds were identified and regrouped in five key odorous families. This was done to study the effect on odor resulting from different combinations of the five groups of compounds (Hallier et al., 2004). Synergy and masking effects were thus observed.

Numerous researchers have studied odorous mixtures and have created models to predict the effect that the mixtures’ composition has on the perceived odor (composition and concentration) (Gostelow et al., 2003). In general, the use of these models is limited and applies only to the experimental conditions of the study. As well, the mixtures of compounds are mostly studied in the laboratory because of the complexity of mixed odors.

Studies have identified dominant odorous compounds in environmental samples. For example, a positive relation can be established between the odor concentration determined by olfactometry and the odor principle identified in the odor samples of liquid hog manure (Hobbs et al, 2000) and odor samples of composting mushrooms (Noble et al., 2001). However, these studies also show that a relation between the mixture composition and the odor concentration is still misunderstood and difficult to predict. For wastewater treatment processes, where H2S is the predominant odor, Gostelow and Parsons (2000, from
Stuetz and Frechen (2001) show the values of \( r^2 \) between the H2S and the odor concentrations to be as low as 7 to 69%.

**Odor Perception Threshold Values**

The *American Industrial Hygiene Association* (AIHA, 1989) compiled numerous studies and established a critical analysis of odor threshold values. The AIHA document is a recognized reference today and is often used as a source for odor threshold values. The scale of acceptable odor threshold values was established for H2S from 0.001 ppmv to 0.130 ppmv (1 µg/m\(^3\) to 181 µg/m\(^3\)). The recommended value held by the AIHA (1989) is 0.0094 ppmv (13 µg/m\(^3\)). H2S is a well-studied odorous compound and yet the AIHA proposes a scale of values for the threshold of two orders of magnitude, after their critical review. The example of H2S illustrates why it is often inappropriate to work with odor threshold values because reliable values are not always readily available. New studies with dynamic dilution olfactometers shows 0.0004 ppmv as perception threshold values.

**Olfactometry analysis**

Olfactometry:

The measuring of the concentration of odours is referred to as olfactometry. Olfactometry is a sensory measurement procedure, which uses the human nose as a measuring device. Using olfactometry, it is determined with how many particles of odourless air must you dilute odorous exhaust air so that the mixture can barely be smelled by the trained panelists.
This threshold is the only objective perception that this sense provides us. As a result, you get the odorous concentration of a sample, which allows calculations to be performed just like with other concentration values.

Strict procedures are defined in the international standard EN13725 on how the panelist are trained, screened, and how the laboratory test procedures should be carried out.

Olfactometers:

Olfactometers are specialized instruments used for determine the odour concentration of a sample. Olfactometers provide accurately controlled diluted samples to the human panelists to determine the required detection threshold as the ratio of sample to odourless air. Human panelist must detect the odour and distinguish it from presentations of clean odourless air. The olfactometery will vary the concentration and perform complex statistical analysis to find the level where 50% of the panelists can correctly detect the odour.

Olfactometers can be either of the field or laboratory variety. Field olfactometers are used to determine ambient odour concentrations and perform direct olfactometry for odour impact assessment. Laboratory Olfactometers are used to analyse samples from sources that are collected in air sampling bags. Source sampling can provide crucial information of the impact of each source on the total odour impact of a plant.
Unique Challenges of Odour Sampling

Differences in odour sources directly affect the choice of method for assessing and sampling emissions. Recognizing the differences in the way that sources are released is as important as the method used for measurement. There are two main issues in odour sampling. The first issue is the collection of the odours from the source in a controlled manner, and the second is the transfer of the sampled odours to the measuring instrument. In many cases, the measuring instrument will be remote from the sampling site, so sample storage becomes an issue. The following points mainly center on the sampling of odours for threshold olfactometry.

The most challenging part of odour sampling is that all samples must be processed within 20 hours of sampling. Future odour standards are even working on reducing this limit much further. Therefore speed of olfactometry and its close proximity to the sampling location is critical. Samples transported by air freight, even in pressurized compartments, will generally lose more than 50% of their odour Concentration.
Olfactometric analyses are tested in the laboratory (EN 13725 and ASTM E679-04) or in the field during which the odor samples are gathered and then exposed to the target population in the study area.

**Applications**

In England, the Environmental Agency published a guide on the measure of H2S and the reduced sulphur totals at the source of ambient air (Environment Agency, 2001). This guide recommends that the measuring strategy be directly related to the objective of the measurement study. Thus, if the objective establishes the required abatement to eliminate the nuisance odor, it is specified in the guide that the odor concentration measurements expressed in odor units per cubic meter (o.u./m³) are more appropriate than the kind obtained through chemical measurement.
Conclusion

The main advantage of olfactometry is the direct correlation between the odor and the sensitivity of the detector used, i.e. the human nose.

Despite the advantages of the classic analytical methods (accuracy, reproducibility, etc.), olfactometry remains the best available approach to measure odors directly, in order to objectively quantify the perception of odors.

References


