ODOUR MEASUREMENT IN WASTEWATER TREATMENT PLANT USING BOTH EUROPEAN AND JAPANESE STANDARDIZED METHODS: CORRELATION AND COMPARISON STUDY

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ABSTRACT

Odours discharged from wastewater treatment plants generally cause severe damage to locals. When facility odors affect air quality and cause citizen complaints, an investigation of those odors may require using standardized scientific methods. Odour intensity is one of the main odour characterization parameter, and represents a important sensory indicator of environmental odours. Odour intensity reflects people's perception of odours and contributes to effective odour management.

Presently, different international standards have been developed and used for decades in the world for the measurement of odours. Main consolidated methods are the measurement of odour index assessed by panelists, standardized in Japan and developed there more than 40 years ago; and the measured of odour concentration by dynamic olfactometer according to European standard EN13725:2003.

In this study odour samples were collected on a municipal wastewater treatment plant located in southern Italy at four different treatment units to investigate the relationship between odour index assessed by Japanese standard methods and odour concentration measured with dynamic olfactometry according to European standard EN13725:2003. A monthly sampling and relative odour measurement were carried out for consecutive 8 months at the Laboratory of the Sanitary Environmental Engineering Division (SEED) at theUniversity of Salerno (Italy).

Results show a strong linear correlation between the two investigated odour measurement methods, in the case of the measurement of high concentrations (e.g. odour concentration detected at the sludge treatments) . While att lower odour concentrations (e.g. emission from oxidation tank) were observed a difference between the two methods.

Keywords: odour, human assessor, olfactometer, wastewater treatment plant.

1. Introduction

Wastewater treatment plants (WWTPs) are considered one of the main odour sources in urbanized area (Zarra et al., 2008). Odour measurements are essential for odour regulation and control (Ueno et al., 2009).

In Europe, odour analyses are performed by introducing an odour sample to screened panel members using dynamic olfactometry (Zarra et al., 2012). There are currently several different methods for dynamic olfactometry analysis that are universally used. In several countries from Europe (EN13725: 2003) to North America (USA ASTM 679-04: 2011), including Australia and New Zealand (AS/NZS4323:2001), there are standardised methods that are commonly used for dynamic olfactometry (DO) analysis (Bokowa et al., 2014; Dincer et al., 2006). All of these methods use a decreasing dilution series to determine an odour detection threshold value (Bokowa et al., 2014).

On the other hand, in several Asian countries, an increasing dilution series is used for odour evaluations. The triangle odour bag method (TOBM) is an olfactory method to measure odour concentration, which has been adopted for the offensive odour control law in Japan described in the “Odour Index Regulation and Triangular Odour Bag Method” and the document: GB/T14675-93 guideline. (Bokowa et al., 2014; Zarra et al., 2012).

All of these methods determine the odour concentration by sniffing diluted air samples. However the dilution equipment, estimation methods of the threshold and panel selection procedures are different (Ueno et al., 2009).

In this paper, the relationship between odour concentrations emitted by WWTP assessed by Japanese standard methods and odour concentration measured with dynamic olfactometry according to European standard EN13725:2003 are discussed.

2. Material and methods

2.1. Sampling program

Research studies were carried out at conventional WWTP designed for 700.000 PE, located in the industrial area of the municipality of Salerno (Italy). To investigate the correlation between the two methods were selected four treatment units of the plant which present the highest odour emissions according to previous studies (Zarra et al., 2008): grit channel (P1), primary sedimentation (P2), aeration tank (P3), sludge conditioning (P4). Air samples were collected one a month for eight consecutive months at each sampling point. A total of 32 samples were collected over the research period. For each month, all four samples were taken during the same day in stable meteorological conditions with not significant wind speed. During the sampling program the WWTP was operating with an average daily flow of 8000 m^3/h.

Air samples were collected according to the methods recognized by the technical-scientific literature and using the ‘lung’ technique, whereby the sampling bag is placed inside a rigid container, and the container evacuated using a vacuum pump in accordance with EN 13725:2003. Nalophan® sampling bags with 20 liters volume are used for the sampling.

2.2. Odour Measurement

Air samples, collected during the sampling program at WWTP, were characterized by both dynamic olfactometry (DO) and triangular odour bag methods (TOBM) at the SEED Laboratory of the University of Salerno.

DO analyses were conducted using the dynamic olfactometer TO8 (ECOMA, GmbH) with the ‘’yes/no’’ method for the measurement of Odour Concentrations (C_{od}) .

Odour concentrations (C_{od}) were also measured by the triangle odour bag method according to Japanese offensive odour control law.

Odour measurements were carried out by the same group of panellists, in order to minimize any deviation caused by other factors than the test methods. The results were compared in terms of Odour Index (OI), calculated with the following equation:

$$OI = 10 \, Log(C_{od})$$

3. Results

Variability of odour index measured with both methods at each investigated sampling point of WWTP is represented with a Box-Whisker Plots (Figure 1).

Considering all measurement carried out at WWTP, the results shown greater variability of DO versus TOBM respectively with odour index ranged from 13,8 to 40,0 for DO and from to 18,4 to 40,1 for TOBM. P2 and P3 are characterized by lower concentration of odour in both methods and for these investigated units the results highlight a major divergence between the methods. The same methods show a better match of the measures for the samples from sources P1 and P4, characterized with an odour index generally greater than 25 (Figure 2).

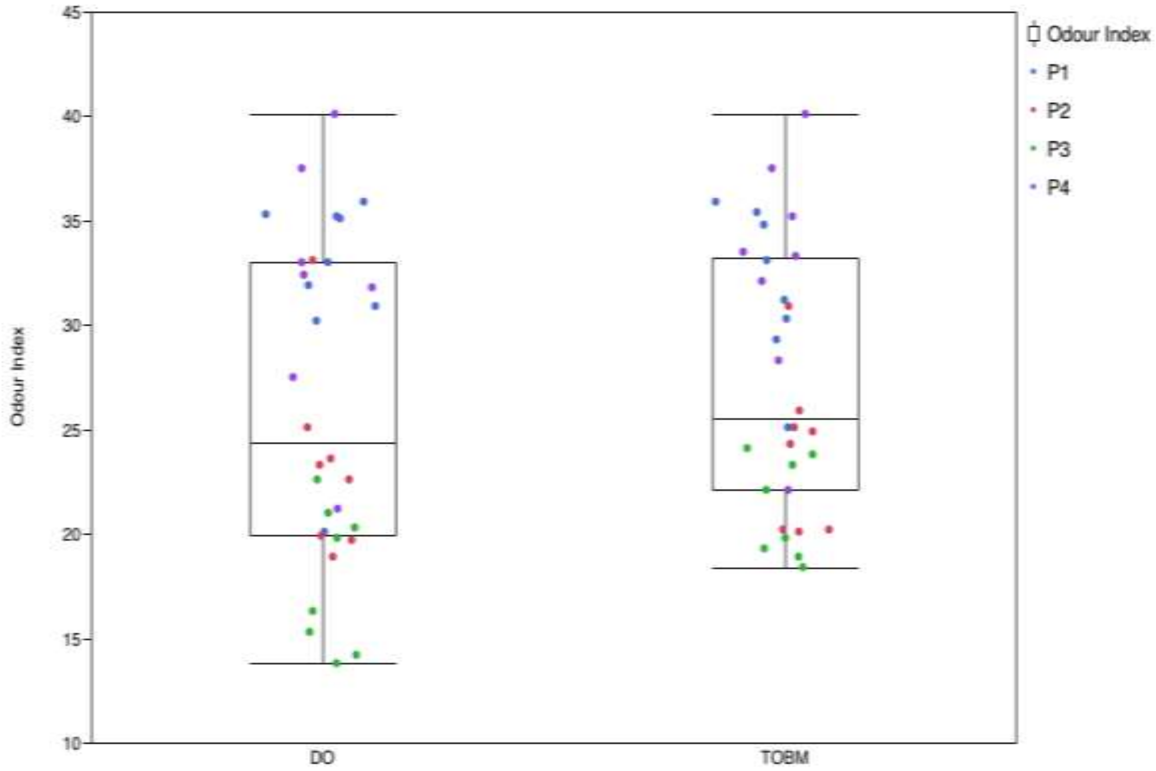

Figure 1. Box-Whisker diagrams of odour index measured at WWTP with both methods.

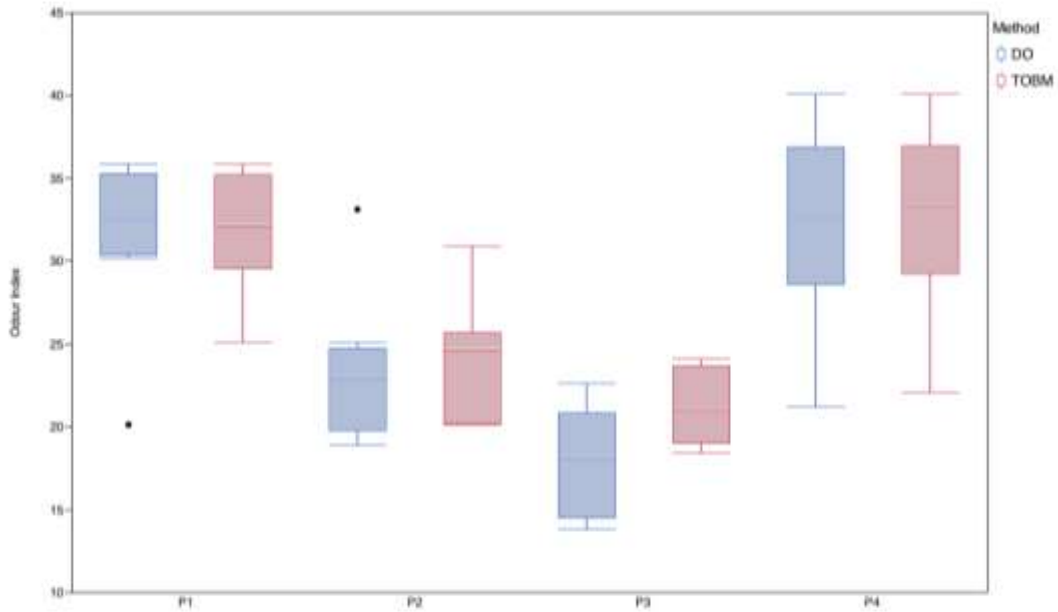

Figure 2. Box-Whisker diagrams of odour index for each sampling point detected by both methods.

Comparing the results obtained by both methods (Figure 3), a strong correlation (R^2=0,987) was observed. However, as observed by analyzing the individual sampling points, the correlation between the TOBM and the DO is lower for samples with concentrations less than 100 OU/m^3 (corresponding to 20 odour index). For samples with lower concentration, the dynamic olfactometry highlight less affability and repeatability of measurements. While there are not significant differences between the DO and the TOBM with odour concentration greater than 30 odour index (corresponding to 1000 OU/m^3).

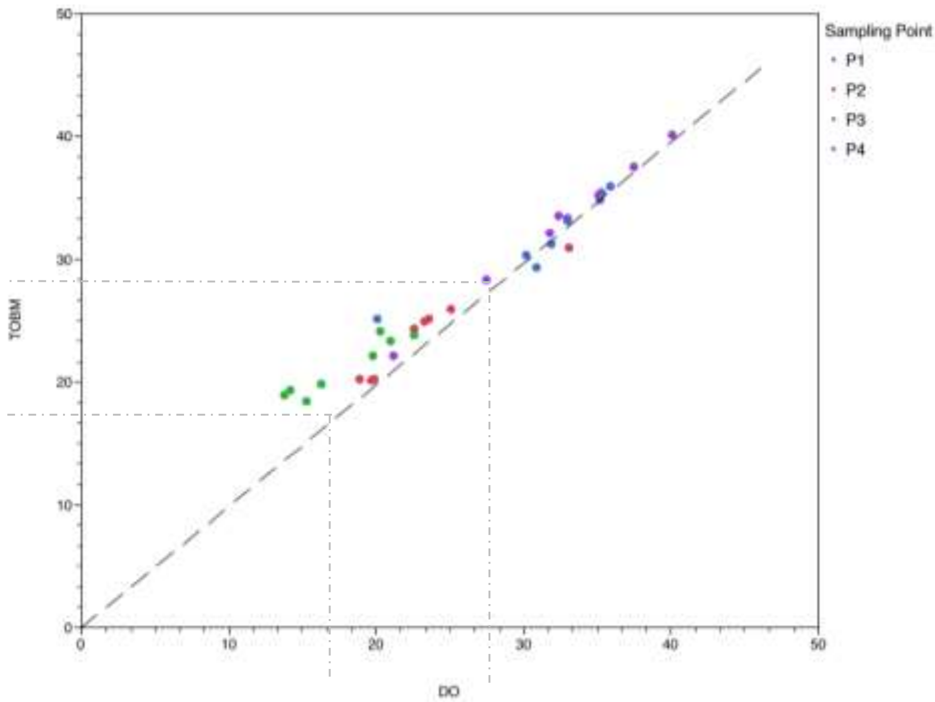

Figure 3. Correlation between the Odour Index measured by DO and TOBM.

4. Conclusions

Odour concentrations detected from air samples analyzed by the triangle odour bag method (TOBM) show comparable results respect of samples measured by the dynamic olfactometry (DO) for the sources with higher concentration.

Dynamic olfactometry highlight less affability and repeatability of measurements for samples with lower concentrations, versus the TOBM method.

However the implementation of the TOBM method require longer analysis times for the preparation and for the number of the samples to analyze.

Future studies on the procedure for the panellist selections and on the economic and human resources necessary for the analysis are need for a complete comparison.

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