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Ambient Odour Assessment Similarities and Differences Between Different Techniques

Anna H. Bokowa

Manager, Odour Assessment, ORTECH Environmental 804 Southdown Road, Mississauga, Ontario, Canada L5J 2Y4
abokowa@ortech.ca

This paper compares the results for ambient odour concentrations measured by three different techniques, one of which is a new developed technology; Scentroid SM110. This new instrument was developed recently in Canada for assessing ambient odour concentrations. The results obtained by this instrument were compared with two other techniques presently used for assessing ambient odours: the first technique which combines source odour testing with dispersion modelling to predict off- site odour concentration and a second technique; direct ambient odour measurement which includes collection of odour samples at the sensitive receptors with olfactometry analysis. In recent years in Canada, direct ambient odour measurements are more common and are usually combined with source testing and dispersion modelling analysis. A previous study that I carried out determined a correlation between off - site odour concentrations estimated by dispersion modelling analysis which were based on the measured odour emission rates at each potential odour sources and the direct ambient measurements using odour sampling at the sensitive receptors with olfactometry analysis. Since this time however, a new instrument- the Scentroid SM110 was developed for assessing ambient odours, and as a continuation of my previous study, this paper shows the results between the measurements obtained by the new instrument compared to traditional ambient sampling and olfactometry analysis. In addition to the comparison of these two techniques, a third technique is also contrasted to this study; the Nasal Ranger technique, which in a previous study showcased some deviancies.

1. Introduction

Different techniques are used around the world to determine ambient odour concentrations. The most common approach used around the world for assessing ambient odour concentrations is source sampling with dispersion modelling analysis. This method includes the collection of odour samples at each potential odour source inside the facility including point sources, area sources and/or fugitive sources; evaluation of collected odour samples by a dynamic olfactometry to determine the odour detection threshold values (ODTV) and calculation of odour emission rates for each potential odour source. The emission rates are then used in dispersion modelling analysis to predict off - site odour concentrations. This method may be accurate if sampling is done properly without any odour loses during the sampling or analysis or if some of the significant odour sources, especially fugitive sources are not omitted. However, if some of the odour sources are missed during assessment, the odour emissions are then underestimated, and thus the off-site odour concentrations would be also underestimated. Therefore, it is very important to verify model predictions by simply measuring the

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ambient odour concentrations at the sensitive receptors on the day of source sampling and compare those results with the predicted by model off site odour concentrations. This can be done however, only for the day and hours of ambient sampling. There are several models approved in Ontario, Canada for prediction of off - site odour concentrations and one of the models used for this purpose is the AERMOD model.

Another method for measuring ambient odour concentrations is using an instrument called the Nasal Ranger. The Nasal Ranger is a portable olfactometer used mostly in the United States to determine the ambient odour levels and it gives a reading of the odour detection to threshold. According to the manufactures criteria the Nasal Ranger range is 2 D/T to 500 D/T. During evaluation, the ambient air is filtered through two small carbon filters attached to the instrument and that air is used as dilution air. However, based on a previous ORTECH study, small carbon filters sometimes are not capable of filtering air completely when dealing with high odour concentrations.

Recently in Canada, a new portable instrument for measuring ambient odour concentrations was developed- the Scentroid SM110. The self-contained manual olfactometer uses compressed air from a high-pressure carbon-fibre tank to dilute samples prior to and present it in this way to the panellist. A sample is drawn using a vacuum generated by the flow of compressed diluting air through a venture pump. The dilution ratio of clean air to sample air is controlled via the Scentrioid's patented flow regulator valve. A panelist can select fifteen discrete dilution ratios. The overall range of the unit is selectable via changeable restrictor plates. Minimum dilution for this instrument is two (2) and maximum dilution is four thousand (4000).

This paper is based on three separate studies showing similarities and/or differences in the results when different methods for assessing ambient odours are used. In the first study, the results from traditional odour sampling at the potential odour sources and dispersion modelling analysis are compared with the results obtained by ambient odour sampling and dynamic olfactometry analysis. In the second study the results of the dynamic olfactometry analysis on the collected samples are compared with the results obtained by the Scentroid instrument. In the third study, three techniques are compared: dynamic olfactometry analysis on collected samples versus Scentroid analysis on the same set of samples and Nasal Ranger readings on the same set of samples.

2. Methodology

The data presented in this paper were composed from three independent studies. During each study, odour samples were collected in 40 L Tedlar bags with each sample evaluated by eight panel members using a dynamic olfactometer for odour detection threshold values (ODTV). The same sample bag was also analysed by the Scentroid SM110 by inserting the Teflon tube attached to the Scentroid into the Tedlar bag. The analyses by the Scentroid were performed by four panellists to a point where the panellists could detect the odour, which was then recorded as the ODTV for that bag. These results were then compared with the results obtained from the standard odour evaluation by dynamic olfactometry with eight panellists.

In case study 3, the same sample bag was then analysed for detection to threshold (D/T) using the Nasal Ranger instrument by inserting this instrument into the sample bag. All Nasal Ranger readings were based on analysis by four panellists.

3. Studies

3.1 Study 1- Comparison of two Methods: Source Sampling with Dispersion Modelling and Ambient Sampling with Odour Panel Evaluation

This study is based on odour assessments carried out at an Organic Waste Facility. This facility had biofilters installed to control emissions from most of the areas in the plant, however there were some

fugitive sources present, ranging from open doors in receiving areas to trucks waiting to unload. The odour emissions from biofilters were discharged through stacks, and were estimated using a conventional method, which is by collection of odour samples at stacks, odour panel evaluations and measurement of volumetric flowrates. Odour emissions from fugitive sources were also estimated during the program. In addition to sampling inside the facility, ambient odour samples were collected at the most impacted sensitive receptors.

This facility was assessed during four different episodes representing different months. During each episode, ambient samples were taken during different times during the day to cover different meteorological conditions. All the ambient odour samples were collected at 1.5 m above ground using the lung technique and were evaluated using a dynamic olfactometry to determine the off-site odour concentration.

All predicted by AERMOD model off-site concentrations were compared during different episodes with actual measured off-site odour concentrations. The paired comparison of the modelled and monitored odour concentrations is tabulated in Table 1.

Table 1. Ratio of Predicted by Model Off-site Odour Concentration to Measured

Sampling Episode	Ratio of Predicted to Measured Odour Concentrations
Episode 1	1.1
Episode 2	1.2
Episode 3	0.6
Episode 4	0.8
Average	0.9

As shown in Table 1, the ratios of predicted by model to measured odour concentrations ranged from 0.6 to 1.2, with an average of 0.9. This combined analysis was very much in line with the often quoted "factor-of-two" accuracy for AERMOD model.

3.2 Study 2- Comparison of two Methods: Source Sampling with Dynamic Olfactometry Evaluation of Samples and Analysis by Scentroid SM110

In this study the odour samples were collected at different odour sources. Each collected sample bag was evaluated first using the dynamic olfactometry with eight panellists.

The same bag was later analysed by four panellists using a new instrument- Scentroid SM110. A Teflon tube attached to the Scentroid was inserted into the Tedlar bag. The point where the panellists could detect the odour was recorded as the ODTV for that bag. The results were then compared with the results obtained from the standard evaluation by dynamic olfactometry with eight panellists.

Table 2 shows the results for *ODTV obtained* by dynamic olfactometry evaluation and Scentr*oid* SM110

Table 2: Odour Concentrations – Comparison of the Scentroid Results with Odour Panel Evaluations

Description	ODTV Scentroid SM110 *ou*	ODTV Odour Panel Evaluations ou
Sample 1	94	116
Sample 2	164	108
Sample 3	131	139
Sample 4	164	201
Sample 5	600	512
Sample 6	350	315
Sample 7	515	724
Sample 8	515	642
Sample 9	515	552
Sample 10	600	631
Sample 11	515	512
Sample 12	450	416
Sample 13	450	431
Sample 14	721	512
Sample 15	600	512

Based on test results, the odour detection threshold values (ODTV) obtained by the Scentroid SM110 are within the range of the results obtained by the dynamic olfactometry evaluations with eight panelists. However, this study was based on the samples with the odour detection threshold values being in the range of as low as 94 ou to above 700 ou.
The table below introduces the results from a similar study, which was performed when the odours in the Tedlar sample bags were in the range of 2000 ou to 4000 ou and different plates of the Scentroid were used for estimation of the odour concentrations.

Table 3: Odour Concentrations – Comparison of the Scentroid Results with Odour Panel Evaluations

Sample Description	ODTV Scentroid SM110 ou	ODTV Odour Panel Evaluations ou	Difference
Sample 1	3750	2363	37 %
Sample 2	3330	2048	38%
Sample 3	2700	1846	32%
Sample 4	3000	1955	35%
Sample 5	3750	2843	24%

Based on the test results the Scentroid results are generally higher (24% to 38%) than the results obtained by the traditional odour panel evaluations using a dynamic olfactometer with eight panelists.

3.3. Study 3- Comparison of three Methods: Source Sampling with Evaluation of Samples by Dynamic Olfactometry, Scentroid SM110 Instrument and Nasal Ranger Instrument

The odour samples collected at the different sources were evaluated by three techniques; the first technique being the standard dynamic olfactometry evaluations, the second technique- the Scentroid SM110 and a third method using the Nasal Ranger instrument. When the first technique was used, the odour samples were evaluated by a dynamic olfactometer with eight panellists. At the same time, the four selected panellists evaluated samples using the Scentroid and the Nasal Ranger. When using the Scentroid, the Teflon tube was inserted directly into the bag. When the Nasal Ranger was used the whole instrument was inserted into the bag that the carbon filters were inside the bag. Table 4 presents the results when three different techniques were used.

Table 4- Odour Concentrations – Comparison of the Scentroid Results with Odour Panel Evaluations and Nasal Ranger Results

	ODTV Odour Panel Evaluations ou	**ODTV Scentroid ou**	**Nasal Ranger D/T**
Sample 1	81	98	30
Sample 2	91	98	30
Sample 3	15	10	ND
Sample 4	13	10	ND
Sample 5	14	13	ND
Sample 6	16	10	2
Sample 7	13	13	ND

*ND represents not detectable

Based on these test results there is a very good correlation between the results obtained by the Scentriod SM110 and the traditional odour evaluations using a dynamic olfactometery whereas the Nasal Ranger results are significantly lower (by a factor of 3 or higher).

Conclusions

Based on the three case studies presented, two methods for assessing ambient odours: the odour sampling at potential odour sources with dispersion modeling analysis and ambient sampling method using the lung technique are very comparable. However, all odour sources inside the facility need to be assessed and included in the modeling analysis, otherwise the odour emissions would be underestimated and therefore the off-site odour concentrations would be also underestimated.

A new method for assessing ambient odour- the Scentroid SM110 shows a good correlation with results obtained by a dynamic olfactometry evaluation. However, there is up to 38 percent difference in obtained results when dealing with high odours in the range of 2000 ou to 4000 ou. The other high ranges such as range above 4000 ou of the Scentroid were not studied yet. The very low ranges of that unit (2 ou to 60 ou) were also not studied in this paper.

The Nasal Ranger results are significantly lower than the results obtained by other techniques: sampling and dispersion modeling and ambient sampling with odour panel evaluations or when comparable to the Scentroid SM110 results.

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