

Fact Sheet

SP3: Odour measurement and assessment, evaluation of odour treatment technologies

1. Background

The objective of SP3, Odour measurement and assessment, evaluation of odour treatment technologies was to:

- Identify those substances likely to be the major contributors to odour levels in sewer bases.
- Evaluate methods for storage and analysis of field samples intended for odour analysis.
- Assess the performance of operating activated carbon filters (AC filters), biofilters and biotrickling filters to remove specific odourous substances.

2. Identification of odorous substances

Gas phase samples were collected from 18 sites on operating sewers in Sydney and Melbourne over a 12-month period. The sewers drained a range of catchments, some of which did not contain significant trade waste customers.

The gas phase samples were analysed using gas chromatography for a range of volatile sulphur compounds (VSC's). This approach was adopted since it was assumed that this class of substances would be the major contributor to sewer odour. In particular, the contribution due to volatile organic compounds (VOC's) such as benzene, toluene etc was assumed to be minor.

The test data indicated:

- Hydrogen sulphide was the most prevalent VSC, accounting for between 60% and 80% of the total concentration of sulphur compounds present in the gas phase.
- The next most prevalent species were methyl sulphide, which accounted for between 15% and 30% of the total concentration of VSC's and dimethyl sulphide, accounting for 2 to 4%. Other VSC's were present at much lower concentrations.
- The data showed significant variability and the observed total concentration of VSC's varied by a factor of up to 10 at some sites. There was evidence that the total VSC concentration was highest in August/September and in February to April. Low concentrations were observed in December and January.

The reason for the seasonal variability is unknown but the data suggests that samples collected during December and January should not be regarded as typical of average conditions unless there is other supporting evidence.

3. Storage of gas phase samples from the field

3.1 Laboratory based investigation

The objective of this component of SP3 was to evaluate the use of flexible bags for storage of gas phase samples collected in the field. The investigation focussed on determining the suitability of this approach for samples to be analysed for VSC's. It was assumed that samples intended for analysis of VOC's would be collected using sorbent tubes because background levels of VOC's in sample bags are difficult to eliminate.

The main features of the test program were:

- **Bag material**

Sample bags prepared from Tedlar (polyvinyl fluoride), Mylar (biaxially orientated polyethylene terephthalate) and Nalophan (polyethylene terephthalate) were evaluated.

- **Sample preparation**

The bags were filled with air and dosed with a known mass of several VSC's.

- **Storage conditions**

The sample bags were stored under a range of conditions and for a range of times prior to analysis to assess the proportion of each VSC still present in the gas phase.

The results indicated that:

- VSC recovery rates were highest for Tedlar bags but Mylar and Nalophan are suitable, lower cost alternatives.
- Storage of sample bags at temperatures above 20 C and storage times greater than 24 hours should both be avoided.
- Storage at 40% relative humidity is preferable but this variable is difficult to control.
- Exposure to indoor light does not affect observed VSC recovery rates.

3.2 Field based test program

The field based test program involved collecting gas phase samples from 2 sites in operating sewers. The samples were collected in Tedlar bags and stored at 20 C under dark conditions. Initial testing was performed at the time of sample collection and subsequently after a range of storage times.

The principal outcomes of the investigation were recovery rates after 24 hours were in the range:

- 75% to 110% for hydrogen sulphide and
- 85% to 130% for a number of typical VSC's

Similarly, odour concentration data determined by dynamic olfactory indicated that the storage conditions did not affect odour measurements over a period of 24 hours.

4. Storage of liquid samples from the field. Evaluation of the Odour Emission Ability (OEA) method

4.1 Description of OEA method

The OEA method is intended to avoid the complexity of collecting a gas phase sample in the field by collecting a liquid phase sample. The key aspects are:

- A field sample of sewage is collected.
- Gas phase samples for analysis are prepared in the laboratory by evaporating a known volume of the liquid sample into a gas filled sample bag.
- Gas phase sub samples from the sample bag are then analysed for characteristics of interest in the normal manner such as odour concentration, OU, or the concentration of specific substances, C.

The odour emission ability (OEA) of the liquid sewage can be estimated by:

$$\text{OEA} = \text{OU} \cdot V_G / V_L$$

where V_G is the volume of gas in the sample bag and V_L is the volume of liquid evaporated into the sample bag.

In a similar manner, the compound emission ability (CEA) of the liquid can be calculated from:

$$\text{CEA} = C \cdot V_G / V_L$$

Neither the OEA or the CEA is indicative of odour levels or substance concentrations in the gas phase within the sewage network. Rather, the method determines the maximum possible mass of odour or odourant that can be emitted from the liquid phase. Thus the data can be used, for example, to assess the performance of chemical dosing systems.

4.2 Evaluation of liquid injection alternatives

Two alternate approaches to adding the liquid sample to the gas bag were evaluated:

- **Dynamic injection**

The approach relies on evaporating the liquid sample into the gas stream prior to filling the sample bag.

- **Static injection**

In this case, the liquid sample is added to the sample bag and allowed to evaporate in situ.

The suitability of the 2 alternatives was evaluated by adding known masses of dimethyl trisulphide (DMTS) and bismethylthiomethane (BMTM) dissolved in a water aliquot to a gas filled Tedlar bag. The proportion of these substances recovered after a period of storage at 20 C and a humidity of 45% was then determined by gas chromatography.

The main features of the results were:

- Recovery rates for DMTS were similar for both the dynamic and the static methods. This was not the case for BMTM where only about 70% of the substance was recoverable.
- The use of elevated temperatures (ie 50 C and 75 C) to encourage evaporation in the static method caused large reductions in the observed recovery rates.

The general outcome was that the dynamic method is preferred.

4.3 Laboratory validation of the dynamic injection method

The efficacy of the dynamic injection method was assessed by preparing aqueous samples containing known masses of a number of VSC's and VOC's. These samples were collected in sample bags using the dynamic injection technique. In most cases, a single substance was used but a number of tests were also conducted using mixtures of substances. The recovery rate of the substances was determined by subsequent analysis of the gas in the sample bags by gas chromatography. A parallel set of trials based on assessing the odour concentration in the gas phase was also undertaken.

The data based on analysis for specific substances indicated that recovery rates were typically around 95% for single substances and about 5% to 10% lower when the substances were added as mixtures. OU values based on dynamic olfactory varied by about 25% to 30%. This is typical of dynamic olfactory results.

4.4 Field validation of the dynamic injection method

Filtered and unfiltered liquid samples were collected from two operating sewers in the Sydney area. Sewer headspace samples were also collected at the same time and the liquid samples were refrigerated prior to analysis following dynamic injection into sample bags.

The results indicated that:

- Filtering liquid samples reduced the OEA by up to 30% and this practice is not recommended.
- OEA values were not affected following storage of the liquid samples under refrigerated conditions for up to 10 days.
- OEA values overestimate the observed odour level in the sewer headspace. This is not unexpected since the method assesses the maximum possible odour impact of the volatile substances in the aqueous phase. In reality, this maxima is not realised because of factors such as limited evaporation rates and ventilation in the gas space.

4.5 Use of the OEA method to identify key odourants

Samples of the liquid and gas phases were collected simultaneously from 2 operating sewers in the Sydney area. Both samples were analysed for a range of VSC's and VOC's.

The outcome was that the principal VOC's identified using the OEA approach to analyse the liquid phase samples were very different to those identified by analysis of the gas phase samples. The discrepancy was less marked in the case of VSC's and both methods identified hydrogen sulphide and methyl sulphide as the most prevalent sulphur species.

The general outcome was that the OEA method is not particularly suited to identifying the principal substances responsible for odour levels in sewer gases.

5. Performance of activated carbon (AC) filters, biofilters and biotrickling filters

Analysis of gas samples collected at the inlet and outlet of a number of operating AC filters, biofilters and biotrickling filters for a range of VSC's and VOC's has been completed. The data will be analysed to determine typical removal rates for each substance. This analysis is expected to be completed in 2017.

Design and operating data has not be collected in parallel with the gas phase sampling and analysis to determine OU values has not been undertaken.

6. Further information

A summary report on this work is available [here](#). The summary report includes references to source material.