By way of Introduction

Welcome to the fourteenth edition of *The Diffusive Monitor*, which is a free publication of the Health and Safety Executive CAR Committee (Committee on Analytical Requirements), Working Group 5. This working group is concerned with workplace, indoor and environmental applications of diffusive sampling for assessing air quality.

The newsletter was started in May 1988 as a consequence of the Diffusive Sampling Symposium held in Luxembourg the previous year and is published approximately once a year. It contains articles on diffusive monitoring techniques and applications, and is a useful source of information on European and international standardisation in this area and of sampling rate data. Contributions are mostly from members of the Working Group, which has an international membership.

Contributions to the newsletter are not, however, intended to be exclusively from HSE/CAR/WG 5, and any reader is welcome to submit an item for consideration. The only limitations are that articles should have some diffusive sampling application and should not be too obviously commercial.

The newsletter has a world circulation of some 200 people, all of whom have specifically requested the publication, so if you wish to contribute articles, you can be assured of a wide and receptive audience. Articles are not peer-reviewed, but are subject to the Editor’s discretion.

Copies of the newsletter may be obtained from the Editor by registering at mike.wright@hsl.gov.uk (see page 18).

Current News

CEN air quality standards

As described in issues 12 and 13 of *The Diffusive Monitor* the responsibility for developing European Standards devolves to expert working groups (WGs) reporting to Technical Committees of the Comité Européen de Normalisation (CEN). The work programmes of TC137 (workplace exposure) and TC264 (air quality) derive mainly from the requirements of the Chemical Agents Directive (98/24/EC) and the Ambient Air Directive (96/62/EC) respectively. With regard to the Ambient Air Directive, data quality objectives (performance requirements) are described in several daughter directives [3-5]. Consequently TC264 has been mandated to develop standards for both reference methods and performance requirements. In the case of the diffusive sampler performance requirements developed by TC264/WG11 these have now been published as EN 13528 parts 1 and 2 [6, 7], prEN 13528 Part 3 is at the formal vote stage. The 5 part benzene draft standard of TC264/WG13 (prEN 14662) is well advanced [8-12]. At the request of the Commission, the question of equivalence of methods has been addressed by an ad hoc group of TC264. Their findings will be published in the near future as a CEN report following approval by the Commission.

In TC137 the development of measurement procedures for specific substances was left to ISO and in particular to WGs of ISO TC146/SC2 and SC6. The text of the Chemical Agents Directive does not contain data
quality objectives for measurement procedures and early drafts of the
Directive delegated this task to CEN (ie. TC137). Later the direct references to
CEN were omitted, however, Article 6(4) requires that measurements be
carried out, particularly in relation to the
occupational exposure limit values.
Article 3(10) establishes the need for
standardised methods for this purpose and Article 12(2) requires the
Commission to draw up practical
guidelines of a non-binding nature. As
is well known, TC137 first developed
the strategy and general requirements
standards EN689 [13] and EN 482 [14]
then proceeded to standards for specific
performance requirements [15-22].
Since the last issue of this newsletter in
2002, TC137 have published EN 14042
- a guide to selection of methods [23]
together with performance
requirements for metals and metalloids
[24] and there are a new draft standards
for bioaerosol sampling devices [25]
and diesel particulate matter [26].
Recently the European Commission has
moved to implement Article 3(10) of
the Chemical Agents Directive by
issuing a mandate to WG2 of TC137.
The task is to compare the performance of workplace (air) measurement
procedures with EN 482 criteria and to
revise EN 482 with regard to the ISO
Guide to Uncertainty in Measurement
(GUM) [27]. Selection of representative
substances and procedures is in
progress.

The reader may or may not be
wondering why TC137 has changed its
name from workplace air to workplace
exposure. The answer, which is not
particularly relevant to diffusive
sampling, is that a new working group
on dermal exposure proposed in July
2001 at the 11th meeting of the parent
TC is now active and drafting CEN
technical specifications for strategy,
requirements and test methods. In fact
the full title may yet be further qualified
by adding to chemical and biological
agents in order to exclude radiation and
other physical agents.

Finally, mention should be made of a
the new parent CEN/TC347 – methods

for analysis of allergens. Although
primarily the TC is concerned with the
analysis of allergens in products and
materials there will be much in common
with work previously done in
ISO/TC146 on specific analysis
procedures for isocyanates, aldehydes
and volatile organic compounds.

ISO air quality standards

Those who are confused by the
proliferation of similar standards and
numbers for VOCs can refer to Richard
H Brown’s article in Journal of
Environmental Monitoring [28] which
is an excellent summary of the position
up to 2002. The generic VOC
measurement guides for workplace and
indoor air developed in ISO TC146/SC2
and SC6 are ISO 16200-1 [29]
(pumped, solvent desorption), ISO
16200-2 [30] (diffusive, solvent
desorption) ISO 16017-1 [31](pumped,
thermal desorption) and ISO 16017-2
[32](diffusive, thermal desorption).
Each guide provides the basic
information for a test laboratory to
develop its own procedure and be
accredited to the competence standard
ISO 17025.

It is also worth noting that the indoor air
formaldehyde diffusive standard ISO
16000-4 [33] has reached the Final
Draft International Standard Stage
(FDIS) and complements the aldehyde
active sampling ISO 16000-3 [34]
already published.

of the health and safety of workers from the
risks related to chemical agents at work
values for sulphur dioxide, nitrogen dioxide
and oxides of nitrogen, particulate matter
and lead in ambient air (1999).
limit values for benzene and carbon monoxide
in ambient air (2000).
Parliament and of the Council of 12 February
2002 relating to ozone in ambient air.
6. Ambient Air Quality – Diffusive samplers for
the determination of concentrations of gases
and vapours – Requirements and test
methods. Part 1: General requirements (EN
13528-1:2002).
7. Ambient Air Quality – Diffusive samplers for
the determination of concentrations of gases
and vapours – Requirements and test
methods. Part 2: Specific requirements and test
methods (EN 13528-2:2002).
8. Air Quality – Determination of benzene in
ambient air by the capillary gas chromatog-
raphy method – part 1: pumped sampling
and thermal desorption. (prEN 14662-1).
9. Air Quality – Determination of benzene in
ambient air by the capillary gas chromatog-
raphy method – part 2: pumped sampling
and solvent desorption. (prEN 14662-2).
10. Air Quality – Determination of benzene in
ambient air by the capillary gas chromatography
method – part 3: in situ measurements by
automated gas chromatographic
techniques. (prEN 14662-3).
11. Air Quality – Determination of benzene in
ambient air by the capillary gas chromatog-
raphy method – part 4: diffusive sampling
and thermal desorption. (prEN 14662-4).
12. Air Quality – Determination of benzene in
ambient air by the capillary gas chromatog-
raphy method – part 5: diffusive sampling
and solvent desorption. (prEN 14662-5).
13. Workplace atmospheres – Guidance for the
assessment of exposure by inhalation to
chemical agents for comparison with limit
values and measurement strategy (EN
689:1995).
14. Workplace atmospheres - General
requirements for the performance of
procedures for the measurement of chemical
agents (EN 482:1994).
15. Workplace atmospheres – Diffusive samplers
for the determination of gases and vapours –
Requirements and test methods (EN
16. Workplace atmospheres – Pumped sorbent
tubes for the determination of gases and
vapours – Requirements and test methods (EN
1232:1997).
17. Workplace atmospheres – Pumps for personal
sampling of chemical agents – Requirements
and test methods (EN 1232:1997).
18. Workplace atmospheres - Requirements and
test methods for pumps for sampling of
chemical agents with a volume flow rate of
over 5 l/min (EN 12919:1999).
19. Workplace atmospheres - Electrical apparatus
used for the direct detection and direct
centration measurement of toxic gases and
vapours. General requirements and test
methods (EN 45544:1999).
20. Workplace atmospheres - Assessment of
performance of instruments for measurement of
airborne particles (EN 13205:2001).
21. Workplace atmospheres - Guidelines for
measurement of airborne micro-organisms
and endotoxin (EN 13098:2001).
22. Workplace atmospheres - Requirements and
test methods for the measurement of chemical
agents present as mixtures of aerosol and
23. Workplace atmospheres - Guide for the
application and use of procedures and devices
for the assessment of chemical and biological
agents (EN 14042:2003).
24. Workplace atmospheres – Procedures for
measuring metals and metalloids in airborne


26. Workplace atmospheres - Determination of diesel particulate matter – General requirements (prEN 14530).


Methods for the Determination of Hazardous Substances (MDHS)

For a list of titles and revision history in the UK MDHS series see http://www.hsl.gov.uk/publications/mdhs_list.htm

There are quite a few changes in presentation of the MDHS series in progress. HSE plans to make many of the later methods or revisions, issued from about 1993 onwards, available for free download from its website early in 2004. Older methods may exist partially in electronic form with or without figures, but a decision to totally scan these older documents has yet to be made. Any MDHS with critical colour photography, such as MDHS 77 (Asbestos identification) may still need to be professionally printed since ordinary 3-colour printing of an office desktop does not reproduce the polarisation colours with sufficient accuracy. Fortunately this restriction does not apply to any MDHS relevant to The Diffusive Monitor.

1,3-Butadiene

MDHS 63/2 (1,3-butadiene, diffusive sampling, thermal desorption) is in the final stages of revision and should be published by March 2004. New workplace data for Carbopack X has been added, partly based on in-house studies at HSL Sheffield and partly on sampling intercomparisons at the VITO Institute, Belgium. The revised method retains the original Molecular Sieve 13X validation, but an upper limit of 10 hours has been set for the sampling time, due to excessive water adsorption. Therefore MDHS 63/2 using Molecular Sieve 13X is explicitly a workplace method. This sorbent cannot be recommended for long-term ambient air monitoring by diffusive sampling, due to the risk of false negative results from interference by water. For an ambient air validation of butadiene on the Perkin Elmer type tube samplers with Carbopack X see the article by N. Martin and co-workers later in this issue.

Sure about uncertainty?

You can never have too many guides to uncertainty in measurement, say the metrologists. To take one example, the famous ISO GUM, first published in 1993 and corrected in 1995, appears with identical text but disguised in at least seven different covers internationally. To order a copy from your home country without the assistance of a knowledgeable librarian can be frustrating. Here is the position, at least in Europe and the USA. CEN published the ISO GUM as EN 13005:1998. However, in the UK it also appears as PD 6461:Part 3:1995 with an added national foreword. In the USA it was adopted as ANSI/NCSL Z540-2-1997. The ISO International vocabulary of basic and general terms in metrology (the VIM) in the UK is confusingly known as PD 6461 Part 1:1995, but is also known in the UK as BS ISO 3534-1:1993. I hope that’s clear.

Although the GUM was intended to apply to nearly all measurements, it emphasises those that are described by a model equation where the components of the uncertainty budget are readily identifiable and either traceable to reference mass, length, voltages etc. or capable of estimation by judgement. It seemed inconsistent with the laboratory intercomparison approach of ISO 5725-2 [1] so an ad hoc group of CEN TC264 produced CEN Report CR 14377 [2] in order to resolve the issue with respect to ambient air quality. Meanwhile the metrologists of ISO TC69/SC6 have also been reconciling the two approaches [3]. In mid 2003 this report had reached the final draft stage. ISO TC146/SC4 have published two air quality uncertainty standards [4, 5] and are working on a third [6]. If you are confused by reading all these standards then you are not alone. Several guides to the Guide have emerged since the mid-1990s, three are mentioned here because they are available as free downloads:

- the Nordtest Handbook: http://www.nordtest.org/register/techn/librar y/tec537.pdf (version 1.2);
- the GUM Workbench software (demonstration) from Metrodata. http://www.metrodata.de/

1. Accuracy (trueness and precision) of measurement methods and results – Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method (ISO 5725-2:1994).
2. Air quality – Approach to uncertainty estimation for ambient air measurement methods (CEN CT 14377:2002).
Determination of 7- and 14-day 1,3-butadiene diffusive uptake rates for the sorbent Carbopack X in Perkin Elmer-type axial samplers

Nicholas A Martin, Philippa Duckworth, Malcolm H Henderson, David J Marlow, and Brian A Goody

Environmental Standards Team, Centre for Optical and Analytical Measurement, National Physical Laboratory, Queens Road, Teddington, Middlesex, TW11 0LW, UK

Introduction

This article presents validation work using the sorbent Carbopack X for making diffusive sampler measurements of 1,3-butadiene, at environmental level concentrations. Perkin-Elmer- type diffusive samplers filled with this sorbent were exposed in the National Physical Laboratory’s Controlled Atmosphere Test Facility (CATFAC) with a view to measuring the 7- and 14-day 1,3-butadiene diffusive uptake rates over a range of concentrations that are relevant to UK ambient air monitoring conditions.

1,3-Butadiene is of topical interest since it has been classified as a possible human carcinogen by the United States Environmental Protection Agency (US EPA). In the UK the dominant source of 1,3-butadiene is road traffic emissions but it is also one of the major products of the petrochemical industry and has a number of important uses such as in the manufacture of synthetic rubber for vehicle tyres. The present UK Occupational Exposure Limit is 10 parts per million (ppm) for an 8 hour weighted average, while the UK Annual Mean Limit for ambient air is 1 part per billion (ppb) which is targeted to be reached by 2005, as part of the National Air Quality Standard objectives [1].

Passive samplers currently used to make measurements of 1,3-butadiene usually rely on the zeolite Molecular Sieve (13X) as the sorbent. In the UK, monitoring at workplace exposure levels is covered by a draft method, MDHS 63/2 [2], which has not been fully validated for measurements at environmental levels. It is now well known that Molecular Sieve (13X) is hydrophilic and that moisture can affect its sampling efficiency. Also, issues such as loss of the analyte species during sampler storage are relevant to its use. With this in mind, we also report here the results of 14- and 28- day storage tests carried out with 1,3-butadiene and the sorbent Carbopack X.

Experimental

A detailed description of the CATFAC has already appeared elsewhere [3,4]. Very briefly, traceable 1,3-butadiene single and multi-component atmospheres (also containing benzene near the annual mean limit value set by the European Union “Daughter” Directive [5]) were generated for a period of either 7- or 14- days at a constant concentration, temperature, nominally 50% relative humidity and a wind speed of 1.0 m s⁻¹ (See Figure 1) Each test atmosphere was produced by diluting “certified” commercial bulk gas mixtures containing the relevant species with scrubbed air, free of hydrocarbons.

Continuous on-line monitoring of the atmosphere in the CATFAC was performed by gas chromatography, where gas samples were automatically extracted into a pre-concentrator coupled to a gas chromatograph (GC). The GC was fitted with a capillary column (Chrompack (WCOT Fused Silica 50 m x 0.32mm id. coating CP-SIL 19CB Dp=0.4)) to separate the trace gas components, followed by a flame ionisation detector. Calibration of the concentration of species was achieved by injecting similar sample volumes of traceable NPL primary VOC gas standards through the pre-concentrator and into the GC. The scrubbed air, employed as the dilution gas to generate each test atmosphere, was also analysed by gas chromatography to ensure that it did not contain 1,3-butadiene or benzene as contaminants.

At the end of the exposure time, the samplers were removed and sealed. Subsequently they were analysed with unexposed samplers, which had been retained as traveling blanks. The technique used thermal desorption at 350°C, followed by separation on a KCl/PLOT alumina column and detection by gas chromatography. The analysis was performed in accordance with established procedures [6], using separate traceable gravimetric VOC liquid and gas standards.

During this and earlier validation trials carried out on samplers filled with Carbopack X, it was found that the typical desorption efficiency for doping with benzene was effectively 100%, and blank values for benzene were found to be (1.70 ± 0.15) ng tube⁻¹ (based on 48 tubes). The corresponding blank value found in this work for 1,3-butadiene was < 0.1 ng tube⁻¹ (based on 15 tubes).

For the sampler storage tests, tubes were dosed with calibrated amounts of 1,3-butadiene (50 ng and 150 ng) and then kept at either ambient temperature, in a refrigerator or in a freezer for 14- or 37-days. Figure 2 shows an example of the 1,3-butadiene recovery rate, after thermal desorption, for twelve samplers stored for 14-days. Within the uncertainty, the recovery rate was effectively 100% for all the three temperature environments. Similar results were obtained for samplers stored for 37 days, although there was a slight fall-off in recovery to (89 ± 20) % for those stored at ambient temperatures. It is therefore recommended that samplers measuring 1,3-butadiene with the sorbent Carbopack X should be stored in a refrigerator or freezer prior to desorption.
Results and Discussion

Fick’s 1st Law of Diffusion describes the uptake of each component, for a given sorbent. For Perkin Elmer type devices the concentration is given by:

\[ C[ppm] = \frac{m[ng]}{U_p[ng.ppm^{-1}.min^{-1}] t[min]} \]  

(1)

In Equation (1) the concentration, \( C \), is measured in units of ppm; the amount of substance on the tube, \( m \), is given by the mass in nanograms; the time interval, \( t \), is defined in minutes; and, \( U_p \) is the uptake rate (in units of ng ppm\(^{-1}\) min\(^{-1}\)) for each hydrocarbon, using a defined sorbent. A summary of the measured uptake rates, obtained in this work, using this equation is given in Table 1.

Within the experimental uncertainty the 1,3-butadiene 7- and 14-day uptake rates for Carbopack X each appeared to be invariant with concentration for the measurements carried out at 20 °C and around 50% relative humidity. In the multi-component atmospheres the uptake rates obtained for benzene are also all close to the earlier published data [4], adding further confidence to the results. A two-tailed Student t-test was applied to each of the 7-day and 14-day sets of 1,3-butadiene uptake rate data. At the 95% confidence level, no significant difference was found for all possible combinations.

Conclusions

The 1,3-butadiene 7-day and 14-day diffusive uptake rates, using the sorbent Carbopack X for environmental applications, have been measured at 20°C and 50% relative humidity, over a wide range of concentrations \((0.20 \pm 0.01)\) ppb to \((1.29 \pm 0.03)\) ppb), at a wind speed of nominally 1.0 m s\(^{-1}\). Combining the separate determinations the mean 1,3-butadiene 7-day uptake rate was found to be \((1.24 \pm 0.16)\) ng
ppm⁻¹ min⁻¹ while the mean 14-day uptake rate was (1.02 ± 0.12) ng ppm⁻¹ min⁻¹. All the uncertainties quoted refer to standard uncertainties multiplied by a coverage factor of two, giving a level of confidence of approximately 95%.

Table 1  Measured 1,3-butadiene diffusive uptake rate data for Carbopack X

<table>
<thead>
<tr>
<th>Exposure Time / days</th>
<th>Measured 1,3-butadiene uptake rate / ng ppm⁻¹ min⁻¹</th>
<th>CATFAC 1,3-butadiene concentration / ppb</th>
<th>Measured benzene uptake rate / ng ppm⁻¹ min⁻¹</th>
<th>CATFAC benzene concentration /ppb</th>
<th>RH / %</th>
<th>Temperature / °C</th>
<th>No. of diffusive samplers</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>(1.25 ± 0.34)</td>
<td>(1.29 ± 0.03)</td>
<td>-</td>
<td>-</td>
<td>(50 ± 5)</td>
<td>(20 ± 1)</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>(1.20 ± 0.30)</td>
<td>(0.62 ± 0.03)</td>
<td>(1.82 ± 0.42)</td>
<td>(1.98 ± 0.44)</td>
<td>(50 ± 5)</td>
<td>(20 ± 1)</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>(1.25 ± 0.34)</td>
<td>(0.61 ± 0.02)</td>
<td>(1.88 ± 0.50)</td>
<td>(1.98 ± 0.44)</td>
<td>(50 ± 5)</td>
<td>(20 ± 1)</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>(1.24 ± 0.29)</td>
<td>(0.43 ± 0.01)</td>
<td>-</td>
<td>-</td>
<td>(50 ± 5)</td>
<td>(20 ± 1)</td>
<td>10</td>
</tr>
<tr>
<td>14</td>
<td>(1.07 ± 0.29)</td>
<td>(1.29 ± 0.03)</td>
<td>-</td>
<td>-</td>
<td>(50 ± 5)</td>
<td>(20 ± 1)</td>
<td>8</td>
</tr>
<tr>
<td>14</td>
<td>(1.12 ± 0.29)</td>
<td>(1.29 ± 0.03)</td>
<td>-</td>
<td>-</td>
<td>(50 ± 5)</td>
<td>(20 ± 1)</td>
<td>9</td>
</tr>
<tr>
<td>14</td>
<td>(0.89 ± 0.21)</td>
<td>(0.60 ± 0.03)</td>
<td>(1.93 ± 0.44)</td>
<td>(1.34 ± 0.06)</td>
<td>(50 ± 5)</td>
<td>(20 ± 1)</td>
<td>9</td>
</tr>
<tr>
<td>14</td>
<td>(0.98 ± 0.22)</td>
<td>(0.20 ± 0.01)</td>
<td>-</td>
<td>-</td>
<td>(50 ± 5)</td>
<td>(20 ± 1)</td>
<td>7</td>
</tr>
</tbody>
</table>

Acknowledgements

We gratefully acknowledge the support received from the Valid Analytical Measurement (VAM) Programme of the UK Department of Trade and Industry.

References


© Crown copyright 2003. Reproduced by permission of the Controller of HMSO
A new passive sampler for long-term ambient monitoring of atmospheric ammonia

Y. S. Tang, and M. A. Sutton
Centre for Ecology and Hydrology, Edinburgh Research Station, Bush Estate, Penicuik, Midlothian EH26 0QB, UK

Introduction

The measurement of atmospheric NH₃ with passive diffusion samplers is notoriously problematic, with sampler contamination being a major issue [1,2]. In the UK, diffusion tubes (7.1 cm open-ended, and 3.5 cm membrane-capped) have been frequently used for monitoring NH₃. However, positive bias at low ambient NH₃ concentrations with diffusion tube sampling is widely reported (e.g. [1,3,4]). A number of potential causal factors include: 1) wind-shortening effect on open diffusion tube, 2) sampling of NH₃ aerosol, 3) uncertainty due to low sampling rates, and 4) uncertainty with regards to field and laboratory tube blanks. Negative bias at higher ambient NH₃ concentrations encountered in the Netherlands has also been reported [5], which was thought to be due to the increased resistance of the membrane inlet of membrane diffusion tubes. The low sampling rates of diffusion tubes also make them too uncertain for use at background NH₃ concentrations (< 1 µg NH₃ m⁻³). Badge-type samplers such as the ‘Willems badge’ samplers perform well at low ambient NH₃ concentrations, but can only be used for short-term sampling because the samplers become saturated very quickly [6]. The Willems badge is also sensitive to the effect of wind speed which has to be corrected for in the derivation of an effective sampling rate for the sampler [7,8].

Taking into consideration the limitations and constraints of existing ammonia samplers, the new CEH ALPHA (Adapted Low-cost Passive High Absorption) sampler (Figure 1) was designed with an optimized sampling rate for long-term sampling (1 or 2 monthly periods) and which was sufficiently sensitive enough to resolve low concentrations (< 1 µg m⁻³ NH₃) in background areas [9]. The membrane inlet is placed directly at the mouth of the sampler, so that the formation of a boundary layer in front of the membrane is minimized and a stable, turbulent-free diffusion path length is achieved behind the membrane. To make handling easier, the sampler body was extended behind the coated filter. Its application in the UK National Ammonia Monitoring Network (NAMN) is reported here.

![Diagram of the new CEH ALPHA sampler](image)

**Fig. 1** The new CEH Adapted Low cost Passive High Absorption (ALPHA) Sampler.

Experimental

The new CEH ALPHA samplers (Figure 1) have been used at key locations in the UK NAMN to monitor monthly atmospheric NH₃ concentrations. There are currently 100 sites across the UK. At 59 of these sites, an active sampling methodology using the CEH DELTA (DENuder for Long Term Atmospheric sampling) system [10] is used to provide the spatial and temporal patterns of ammonia across the UK, while ALPHA samplers are used to assess regional and local scale variability in air NH₃ concentrations [9,11].

To provide an ongoing validation of the ALPHA sampler, its performance is continuously assessed at 9 UK sites within the network and at a farm site with high NH₃ concentrations. It has also been tested within the EC ECOMONT project at several UK and European sites [12] against the CEH DELTA system, and is currently used in the EU CARBOMONT and NOFRETETE projects.
Results and Discussion

An annual assessment of the ALPHA calibration is made against the DELTA method. Figure 2 shows the annual calibration curves for the ALPHA data, based on the theoretical sampling rate of the ALPHA sampler, not including any membrane or boundary layer resistance. There is no systematic trend over time in the calibration (which is important to support the detection of temporal trends in ammonia concentrations). In addition, the differences between years are rather small. The mean ALPHA calibration (at 10 μg m\(^{-3}\)) amounts to a correction of 10% (ALP1: first ALPHA sampler) and 15% (ALP2: second ALPHA sampler) respectively, compared with the DELTA system, with the standard deviation of the different annual calibrations being < 1%. The calibration factor can be attributed to an additional boundary layer resistance at the membrane inlet of the sampler, equivalent to an additional path length of 0.6 – 0.9 mm. The annual regressions are used to calibrate the ALPHA sampler data, which are mapped together with the data for active denuder sampling. The results of this mapping at a UK and local scale are shown in Figure 3. Data from the network confirmed the high spatial variability in NH\(_3\) concentration across the country, reflecting the large regional variability in NH\(_3\) emissions [10].

Conclusion

A new high sensitivity sampler, suitable for long-term ambient monitoring of NH\(_3\) has been developed, and applied at a large number of monitoring sites in the UK NAMN and across Europe. The reliability of the method is supported by ongoing reference data by active sampling across the full range of concentrations encountered.

Fig. 2 - Comparison of annual empirical calibration curves for the ALPHA samplers against the reference estimates from DELTA sampling at 10 sites in the UK National Ammonia Monitoring Network. ALP1 is the first prototype ALPHA sampler that was made with a 22 mm diameter exposure surface (1998-2000), while ALP2 is produced commercially from injection moulding with a 21 mm diameter exposure surface (2001 – present).

References

Diffusive sampling of semi-volatile organic compounds on Perkin Elmer-type tube samplers

Andrew T. Simpson
Health and Safety Laboratory, Broad Lane, Sheffield S3 7HQ UK

Introduction
This work originated out of a previous investigation into the diffusive uptake of hydrocarbon vapour on thermal desorption tube samplers of the Perkin Elmer type (ATD) in the presence of oil mist [1]. In preceding work, the uptake rates determined for the C_{10} – C_{16} n-alkane components in the vapour were inconsistent with the values for more volatile n-alkanes (C_{7} – C_{10}) first published in MDHS 80 [2] and subsequently compiled in The Diffusive Monitor [3]. In the presence of oil mist, the results from empty control ATD tubes suggested that oil had collected in the tubes by condensation of vapour as well as by deposition of mist droplets. This project was planned with the assumption that the anomalous uptake rates were the result of some interference, and that vapour had condensed in the tubes.

Experimental
The diffusive uptake rates for n-alkanes in the range C_{10} – C_{16} on Tenax TA were determined individually by exposing

Fig 3 Interpolated atmospheric NH\textsubscript{3} concentrations from the UK National NH\textsubscript{3} Monitoring Network at 10 km x 10 km grid resolution.
ATD tubes to test atmospheres of about 2-3% of the compound’s saturated vapour concentration to avoid the production of analyte droplets by condensation. The test atmospheres were controlled at 20°C and 50% relative humidity. The alkane vapour was introduced using the syringe injection technique, with the addition of electrical heating tape wound around the apparatus to aid vaporization.

Six diffusive tubes were exposed to the test vapour simultaneously together with six pumped Tenax TA ATD tubes sampling at 5 ml/min for four hours. The pumped tubes were to provide a reference value for calculating the uptake rate. Both sets of tubes were analysed by gas chromatography with flame ionisation detection (ATD-GC-FID).

Condensation of hydrocarbon vapour on the internal walls of the ATD tube (in the diffusion gap) was investigated by simultaneously exposing six empty tubes during the test atmosphere experiments described above. The reversibility of any deposition was investigated by exposing a second batch of six tubes in the atmosphere for four hours, followed by two hours in clean air.

Results and Discussion

Uptake Rates

The uptake rates determined are presented in Figure 1 and compared with those found in previous work by this author [1] and with MDHS 80. The error bars represent combined standard error for the current work, calculated from the pumped and diffusive tube analytical results. The mean value determined for decane was 0.34 cm³/min, whereas the value quoted in MDHS 80 is equivalent to 0.40 cm³/min.

The values determined for n-C₁₀ – n-C₁₆ are of a very similar magnitude to those produced previously in the oil mist study. Previously it was considered that experimental design may have influenced the results; the work was done simultaneously on a mixture of eight components, resulting in widely differing peak heights in the resulting chromatograms. This suggests that the values were indeed correct. The uptake rates obtained for pentadecane and hexadecane follow the trend established by the lighter analytes better than reported previously, but they are still subject to a large uncertainty. This is most likely due to the low levels of analyte involved being closer to the instrumental detection limit.

Condensation within the Sampler

In tests using dodecane to hexadecane, the proportion of material found on the empty tubes remained relatively constant (Figure 2), but in relation to the vapour concentration (generally 2-3% of the saturated vapour concentration), the proportion increased with molecular weight (Figure 3), as might be expected. The other empty tubes exposed in parallel and then left in clean air for a further two hours before capping were found to have lost sample by re-evaporation in the cases of dodecane, tridecane and tetradecane, but had similar levels to the tubes capped immediately after exposure in the cases of pentadecane and hexadecane.

The empty control tubes did not reveal the degree of bias anticipated from the previous oil mist study. Previously, quantities ranging from 0.4 to 1.4 µg were found within the empty tubes. It is believed that the lower levels of material collected in the current work may have been due to the use of new unused empty ATD tubes, whereas previously the
tubes used were old ATD tubes which had been emptied and cleaned.

Preliminary results from follow up work appear to confirm this, where old and new empty tubes and Tenax packed tubes were exposed to dodecane at about 20 mg/m³. The Tenax packed tubes collected an average of 0.92 µg (std. dev. 0.13 µg), the new empty tubes collected 0.003 µg (at the detection limit) and the old empty tubes 0.19 µg (std. dev. 0.19 µg). Hydrocarbon collected on the old empty tubes had a high variance that is consistent with the empty tubes from the oil mist study. It is uncertain whether the condition of the metal surface (scratches etc) or the presence of minute traces of sorbent was the cause of the additional material being collected on the old tubes. The old tubes had been swept, washed and ultrasonicated before re-use in an attempt to remove all sorbent particles.

**Conclusion**

Although this work is provisional the following conclusions can be drawn. Vapour from compounds such as C₁₂ – C₁₆ alkanes can be sampled diffusively at concentrations below their saturated vapour concentration. Bias from condensation within the diffusion gap of an ATD tube type sampler is likely to be insignificant for more volatile analytes such as dodecane, but may become a source of bias for less volatile compounds such as pentadecane and hexadecane. Accurate background correction using empty control tubes is likely to be problematic due to the large variance in the amount collected.

**Acknowledgements**

This work was financially supported by the Field Operations Directorate of the UK Health and Safety Executive.

**References**


![Graph](image)

**Fig. 3** Ratio of diffusive mass uptake on empty vs. Tenax-packed ATD tubes, 4 hours at 2-3% saturated vap. concentration.

The amount of dodecane collected in four hours on new empty tubes represented 0.3% of that collected on the Tenax packed tubes, whereas the amount of dodecane collected on the old empty tube represented 21%. However, the quantity of dodecane collected may have been influenced by the additional available surface area of an empty tube compared to that of the diffusion gap of a packed tube. If the amount collected by the old empty tubes is scaled down proportionally to account for the larger available metal surface area then the hydrocarbon adsorbed on the free metal surface of a packed tube may represent less than 5% of the total. In the case of higher molecular weight hydrocarbons the proportion of material condensing in the tube will increase with decreasing volatility.

**The effect of sorbent tube back-pressure on apparent recovery of toluene in thermal desorption**

*Mike D. Wright, Neil T. Plant and Kate Gostlows*

*Health and Safety Laboratory, Broad Lane, Sheffield S3 7HQ UK*

**Introduction**

This article deals with a potential calibration anomaly in thermal desorption – gas chromatography (TD-GC) and is an abridged version of a report [1] commissioned by the WASP Proficiency Testing Scheme [2]. The question posed here is: given thermal desorption tubes of more than one type loaded with the same amounts of measurand, is the operator sure that they can be mixed together in the same sequence to give the same results (within uncertainty criteria) when calibrating with sorbent A and applying response factors to sorbent B. For quantitative analysis it is critical that the various gas flows during the primary desorption phase are stable during an analysis sequence. In commercial thermal desorbers the gases are usually pressure controlled. If the sample and calibration tubes have a different resistance to flow, this may or may not lead to significant bias in
quantitative analysis. Tubes containing the sorbed air sample or calibration material, are pressurised in the thermal desorber at whatever level is required for best operation of the GC column. There will be a small latitude, but the operator’s choice of column and run time usually defines this set pressure. To maintain a constant split ratio, given a constant supply pressure, requires a constant back-pressure across the flow-path components. Given that the setting of the split valves is fixed during the analysis sequence, only the inlet flow through the tube in the primary desorption phase should be subject to change caused by back-pressure variation.

There is evidence of differences in calibration (ie. apparent recovery) between sorbents such as Tenax, Chromosorb and carbons, but the evidence has not yet been framed in terms of back-pressure effects. Before blaming back-pressure, there are other possible reasons for calibration differences between sorbents [3]. For example, if tubes are loaded by liquid spiking of methanol solutions, the amount of methanol remaining on the tube after purging can affect the secondary desorption by sudden expansion and momentarily increasing the split ratio. Alternatively, sorption of the analyte on the secondary trap may be reduced by competitive sorption of methanol. It can be difficult to avoid mixing sorbent types. Firstly, when participating in proficiency testing schemes, or analysing a certified reference tube, the operator has little choice over the type of sorbent or its quantity. Secondly, calibration tubes might be prepared using a stronger sorbent than the samples to avoid breakthrough in the loading step. The back-pressure effect might be significant with mass spectrometer detectors where, due to the vacuum at the detector, the required column inlet pressure is reduced by about 100 kPa, relative to a conventional ambient pressure detector such as FID or ECD. In this work, thermal desorption tubes packed with Chromosorb 106 were loaded with standard amounts of toluene. The tube back-pressure was varied by packing with different amounts of the same sorbent, rather than the same amounts of different sorbents. The apparent recovery of toluene is reported as a function of the column inlet pressure and tube back-pressure.

Experimental

Perkin Elmer–type thermal desorption steel tubes (89 x 6.4 x 5.0 mm i.d.) were packed with Chromosorb 106 (60–80 mesh, Chrompack UK). Six were packed with 100 ± 4 mg to a bed length of ~15 mm. Six further tubes were packed with 530 ± 4 mg to a bed length of ~70 mm. Back-pressure p was measured in a spiking/purging rig adapted from a GC injector. Measurements were made with a Druck transducer, sensitivity 0.1kPa (RS Components). Liquid phase spiking of ~17 µg toluene was performed using the usual method described elsewhere [4]. 5.0 µl of a solution containing 3.4 mg ml⁻¹ toluene in methanol was spiked (5 µl SGE syringe) on each tube fitted in the purging rig described above. For gas phase spiking of ~17 µg toluene, 10 µl was allowed to completely evaporate in a sealed 1.0 litre flask with a PTFE stirrer. After mixing, 2.0 ml gas samples were withdrawn (Hamilton Pressure-Lok gas-tight 2 ml syringe) and injected on each tube whilst fitted in the purging rig.

Three TD-GC systems (A, B, C) were used in the test desorption of toluene from Chromosorb 106. Systems A and B were both equipped with the Perkin Elmer ATD-400 desorbers and FID. System/column inlet pressures were 317 kPa (A) and 145 kPa (B). System C was equipped with the Perkin Elmer Turbomatrix desorber and mass spectrometric detection. System pressure of system C was 55 kPa. The TD inlet, desorb and outlet split flows were measured for each tube before the desorb step.

Back-pressure p measurements at a controlled 50 ml min⁻¹ were carried out on a selection of tubes either packed in-house (Tenax TA, 35-60 mesh, Chrompack; Chromosorb 106, Chrompack; Carbogrob 1, Alltech Associates; Carbopack X, Supelco; Molecular Sieve 5A, Chrompack) or commercially available off-the-shelf (Carboxen 1000, glass, Supelco; Carbopack B/Carboxin 1003 µg, glass, Supelco; Carbopack B/Tenax GR, glass, Supelco; Carbopack B, glass, Supelco; Carbogrob 5, Markes International; Carbotrap 300, glass, Supelco). * Supelco proprietary name Air Toxics

Results and discussion

Liquid spiking of Chromosorb 106 introduced the confounding factor of residual methanol from an initial spike of 5.0 µl. Figure 1 shows how the apparent recovery of toluene varies as a function of purge volume for a “standard” 230 mg packed tube. The purge volume needs to be at least 2 litres for the 530 mg packed tubes. In order to eliminate residual methanol as a factor, tests continued with gas phase loading only, however, the repeatability of manual injection with a gas syringe was poor, relative to liquid spiking.

![Figure 1](https://example.com/figure1.png)

**Fig. 1** Recovery of toluene from 230 mg Chromosorb 106 as a function of purge volume in the loading step, 220°C, 10 min desorb.

Liquid spiking and gas phase loading of 100 mg and 525 mg Chromosorb 106 tubes gave the following results for toluene recovery, normalised to recovery from the 100 mg tubes.
(summarised in Table 1). Methanol spiked tubes on system A (highest system pressure) showed a 26% reduction in toluene recovery for the 525 mg tubes, relative to the 100 mg tubes. However, this is most likely due to the larger quantity of retained methanol and not the greater flow resistance. In gas phase loading for system A or system B (medium system pressure) the mean reduction in recovery was 3-4% although the expanded uncertainty of the difference was greater than 5%. For System C (low system pressure, GC-MS) the reduction in recovery of 14% is marked and significant.

Table 1  Mean recoveries of toluene from Chromosorb 106 TD tubes packed with different sorbent weights, as a function of TD system pressure, normalised to recovery from 100 sorbent mg tube, 220°C, 10 min desorb (∓ expanded uncertainties).

<table>
<thead>
<tr>
<th>TD-GC System</th>
<th>system press. kPa</th>
<th>% recovery 100 mg tube p = 0.3 kPa</th>
<th>% recovery 525 mg tube p = 1.6 kPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>A liq. spike</td>
<td>317</td>
<td>100 ± 1</td>
<td>74 ± 3</td>
</tr>
<tr>
<td>A gas phase</td>
<td>317</td>
<td>100 ± 7</td>
<td>96 ± 5</td>
</tr>
<tr>
<td>B gas phase</td>
<td>150</td>
<td>100 ± 4</td>
<td>97 ± 7</td>
</tr>
<tr>
<td>C gas phase</td>
<td>55</td>
<td>100 ± 7</td>
<td>86 ± 6</td>
</tr>
</tbody>
</table>

The back-pressures measured for the Table 1 sorbent tubes and also some other types selected at random from the HSL in-house stock are shown in Table 2. Sorbent weights are given where tubes were packed in-house. Tubes are steel unless otherwise stated. Near 100% elution of toluene in the primary desorption step is assumed.

Table 2  Mean back-pressures of selected batches of tubes with estimated range of values (k ∼ 3).

<table>
<thead>
<tr>
<th>Sorbent, Perkin Elmer-type TD tube</th>
<th>Backpressure kPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromosorb 106, 100 mg (Chrompack)</td>
<td>0.3 ± 0.2</td>
</tr>
<tr>
<td>Chromosorb 106, 230 mg (Chrompack)</td>
<td>1.1 ± 0.2</td>
</tr>
<tr>
<td>Chromosorb 106, 525 mg (Chrompack)</td>
<td>1.6 ± 0.2</td>
</tr>
<tr>
<td>Tenax TA, 170 mg (Chrompack)</td>
<td>1.0 ± 0.3</td>
</tr>
<tr>
<td>Carbobraph 1 (Alleich)</td>
<td>0.6 ± 0.1</td>
</tr>
<tr>
<td>Carbobraph 5 (Markes International-packed)</td>
<td>0.2 ± 0.1</td>
</tr>
<tr>
<td>Carbobaph B (glass, Supelco-packed)</td>
<td>3.4 ± 0.3</td>
</tr>
<tr>
<td>Carbobaph X (Supelco)</td>
<td>0.9 ± 0.2</td>
</tr>
<tr>
<td>Carboxen 1000 (glass, Supelco-packed)</td>
<td>2.6 ± 0.3</td>
</tr>
<tr>
<td>Air Toxics ® (glass, Supelco-packed)</td>
<td>1.6 ± 0.2</td>
</tr>
<tr>
<td>Carbotrap 300 (glass, Supelco-packed)</td>
<td>9 ± 4</td>
</tr>
<tr>
<td>Molecular Sieve 13X, 500 mg (Chrompak)</td>
<td>1.0 ± 0.4</td>
</tr>
</tbody>
</table>

There was a significant difference between back-pressure of typical porous polymers and some carbon-based sorbents. Tenax, Chromosorb 106 and some of the graphited carbons (Carbobraph, Carbobaph X) are similar to each other generally, when the tubes have been packed in-house. In the case of Carbotrap 300 some factory-packed sorbent tubes exhibited very high back-pressure and more than 20x higher than the porous polymers. Note that all these values are characteristics of just the tube. It was essential to correct for the back-pressure of the empty spiking rig.

The TD-GC-MS system C, operating at the relatively low system pressure of 55 kPa, was vulnerable to a difference of 1.3 kPa when mixing the large and small weights of Chromosorb 106, however, it should be noted that the calculated split ratio was not affected by these differences. It confirms that the thermal desorber split ratio measured according to manufacturers’ recommendation is only a guide. System B at a pressure of 150 kPa was not significantly affected by a back-pressure difference of 1.3 kPa. Based on findings from three different TD-GC systems, criteria for acceptable tube back-pressure have been estimated.

Conclusions

In thermal desorption, calibration and sample tubes should contain the same type and amount of sorbent where possible. Where it is not possible the following guidance may be useful.

In quantitative thermal desorption, based on results from System B, differences in back-pressure from tube to tube should not exceed 1% of the system pressure (indicated by a transducer in most thermal desorbers).

In practical terms this means that, on a low pressure GG-MS system, the operator must be cautious about mixing calibration and sample tubes of different sorbent types, or mixing tubes of the same sorbent, but different bed lengths. The 1% criterion was equivalent to 0.5 kPa for System C. Within-batch tubes of the same type all met the 1% limit, except factory-packed Carbotrap 300. For porous polymers the extremes of bed length should not in general exceed a ratio of 2:1. Some factory-packed carbon tubes contain much smaller particles than typical porous polymers and have much higher back-pressure. These should not be mixed with porous polymers on low pressure systems unless the operator has verified the back-pressure difference. The 1% criterion applied to System A (317 kPa, high pressure) is equivalent to 3 kPa. Different combinations of most sorbents would be acceptable. Only Carbotrap 300 falls outside the limit, with Carbobaph B on the borderline.

Acknowledgements

This work was financially supported by the Field Operations Directorate of the UK Health and Safety Executive.

References

2. Workplace Analysis Scheme for Proficiency, Health and Safety Laboratory, Sheffield S3 7HQ UK.
Pollution by Ozone: Measurement and Reduction of its Precursors

Dr. Norbert Gonzalez-Flesca

Institut National de l'Environnement Industriel et des Risques (INERIS), Parc Technologique ALATA, BP 2, 60550 Verneuil en Halatte, France; Tel: +33344536557; fax: +3344556600;
E-mail address: norbert.gonzalez-flesca@ineris.fr

The relationship between atmospheric pollution episodes and the rise of morbidity and/or mortality is a well established fact [1]. As far as ozone is concerned, European regulations [2] impose an obligation to inform the public when ozone concentrations reach 180 μg/m³ during one hour and an obligation to alert at 240μg/m³ for one hour. To inform is a good thing, but to forecast is even better! Within the framework of a co-operative project with the MEDD', ADEME', CNRS and the Institute Pierre Simon Laplace, INERIS has launched an operational air quality forecasting programme named PREV'AIR. Its vocational is a daily diffusion, via the Internet, of maps showing the distribution of average and peak concentrations of ozone and NO₂ in Europe for the next 24h, 48h and 72h. The Internet address is http://prevair.ineris.fr.

The rise of the ozone concentration in the troposphere is due to an increase of its oxidant capacity. Under solar radiation of short wavelengths and in the presence of NOₓ, harmless substances like alkanes or alkenes of low molecular weight will turn into irritant and toxic compounds like formaldehyde, acetaldehyde and organic acids. PANs (peroxycetyl-nitrates), inorganic acids like HNO₂ or HNO₃ ( nitrous and nitric acids ) as well as photochemically produced aerosols such as sulphates and nitrates will also appear.

Ozone is just one part of the problem. One should talk in terms of photochemical pollution. The reduction of this kind of pollution is one of the objectives of the European Directive. One of the difficulties associated with regulatory aspects of ozone is that it is not locally produced. Ozone is produced in areas of variable size where there is an accumulation of precursors: NO₂ and VOCs. When these substances are irradiated with solar radiation of appropriate wavelength, ozone is formed at a variable rate depending on the nature of the VOCs, precursor concentrations and the values of the radiation parameters.

Once it is formed, ozone will be transported following a trajectory imposed by the circulation of the mass of air in the atmosphere. During its voyage the mass of air will come across other sources and other conditions that will modify the concentration in photo-oxidants. The dynamics of formation and dispersion of photo-oxidants poses a real problem for the management of ozone precursors. For example: if in a mass of air the formation of ozone is governed by NOₓ, a reduction of the emissions of VOCs will not have any effect on the levels of ozone produced. On the other hand, if the formation of ozone is governed by VOCs a reduction of the emissions of NOₓ will leave unaffected the production of ozone. Even more astonishing is the fact that, under certain circumstances, if the mass of air encounters new sources of VOCs which have positive ozone potential creation, the concentration of ozone could be reduced! All these results are developed in a recent report by R. D. Derwent et al.[3]. In their study, the chemical module used was the Master Chemical Mechanism ( MCVv1.0 ) which includes 2400 chemical species and about 7100 chemical reactions. The main objective was to explore the possibility of determining a reactivity index for the control of the emissions of VOCs at local level.

In a second study by B. E. A. Fisher et al. [4], authors have tried to determine groups of VOCs using data mining techniques, with the general objective of simplifying emission regulations. The report was inconclusive and one can think that the reactivity of individual compounds evaluated in a plausible scenario is so far, the most credible method to be applied.

Measuring ozone precursors

The production of tropospheric ozone is a natural process that would have existed even in the absence of anthropogenic emissions. European regulations and managerial policies at national or local level, aim to reduce levels of pollutants due to human kind activities. As far as ozone is concerned, only NO₂ and VOC reductions are taken into consideration in environmental protection strategies; filtering solar radiation has not been proposed yet. A detailed knowledge of natural and anthropogenic emissions seems then necessary. The European Directive recommends the measurement of about 30 VOCs . The Environment Agency has selected 120 compounds that may have a positive ozone potential creation.

A detailed measurement of VOCs in ambient air, can be used to validate emission inventories, dispersion models and even the identification of sources [5,6]. The question now is: would it be possible to measure so many compounds in vast areas, in the middle of forests, in urban centres, in peri-urban regions and in industrial areas at reasonable costs? The answer is yes. Though not well developed in France, the passivated metallic canister is the reference method of the Federal American Government for volatile and toxic organics in ambient air. The version of the unattended or passive canister is very interesting since they can be deployed in areas without any infrastructure ( shelter, electricity, etc. ) (see Figure 1).

a: Ministère de l'Ecologie et du Developpement Durable;
b: Agence de l'Environnement et de la Maîtrise de l'Energie;
c: Centre National de la Recherche Scientifique.
There are two main types of passivated canisters:

1. Electropolished (SUMMA™) which are excellent for storing VOCs in ambient air and
2. Silicosteel canisters (SILCOCAN™) offering improved storage stability especially for low levels of electronegative compounds.

This technique can be advantageously completed by passive samplers for NO₂ and VOCs of more than four carbon atoms [7] (see Figure 2). In addition, EPA, CEN, and ISO methods and standards are available to carry out the job under QA/QC procedures.

Fig. 1 A passivated canister is a metallic container with passivated walls which prevent any possible loss of air pollutants by adsorption.

Fig. 2 This map of the French region of Lille-Roubaix-Tourcoing shows the results of the monitoring of several ozone precursors including toluene. The monitoring was carried out with Perkin Elmer passive samplers covering an area of approximately 40 x 40 km. The high concentrations observed and the orientation of the iso-concentration curves revealed the accidental release of toluene in the centre of Lille.

References

7. A. Frézier, N. François, J.C. Pinard, N. Gonzalez-Flesca. Two Complementary Techniques for Monitoring Ozone Precursors. INERIS poster available as hard copy in A3 format upon request at the secretariat of the Bulletin: labienne.carette@ineris.fr
MIAP 2004, Monitoring Indoor Air Pollution, The 2nd International Conference

The second international conference on monitoring indoor air pollution is being organised by ISBE with the support of ARIC at the Manchester Metropolitan University, the Royal Society of Chemistry (Automation and Analytical Management Group) and the Gas Analysis and Sensing Group (GASG)

20-21 April 2004, Manchester Metropolitan University, Manchester UK

The Indoor environment is increasingly being recognised as an area where people are exposed to air pollutants but techniques for monitoring in indoor environments are not well developed. For example many techniques have been adapted from occupational exposure settings and do not allow adequate investigation of the lower levels present in other indoor settings. The aim of the conference is to explore methods for investigating indoor air pollution problems through discussion of indoor monitoring needs, new techniques, existing methods and case studies. Papers and posters are accepted. There will be a poster discussion session.

Topics:
- Particles
- VOCs
- Odours
- Moulds, fungi and bacteria
- Exposure assessment
- Modelling indoor spaces
- Personal monitoring

Registration may be made through the conference website.

Conference Secretariat:
Dr Ivan Gee, MIAP 2004
ARIC, Department of Environmental and Geographical Sciences
Tel +44 (0) 161 247 1592
Fax +44 (0) 161 247 6332
E-mail I.L.Gee@mmu.ac.uk

The deadline for abstracts has closed (1 October 2003).
For further information see the conference website home page [http://www.doc.mmu.ac.uk/aric/conference/miap2004.html](http://www.doc.mmu.ac.uk/aric/conference/miap2004.html)
AIHce 2004

Co-sponsored by the American Industrial Hygiene Association and the American Conference of Governmental Industrial Hygienists

8-13 May 2004, Georgia World Congress Center, Atlanta, USA

Key themes - Industrial hygiene
- Safety
- Environmental health
- Engineering
- New standards and regulations
- Consulting
- Innovation
- General business management
- International security

Scientific programme To be announced

Registration http://www.aiha.org/aihce04/registration.htm

Conference Secretariat infonet@aiha.org

The deadline for abstracts has expired (7 October 2003)
For further information see the conference website home page http://www.aiha.org/aihce04/aihce.htm

13th World Clean Air and Environmental Protection Congress and Exhibition

Hosted and organized for the International Union of Air Pollution Prevention and Environmental Protection Associations by the National Society for Clean Air and Environmental Protection (UK) and the Israel Society for Ecology and Environmental Quality Sciences.

22-27 August 2004, London Hilton Metropole Hotel

Key themes:
- The interaction of climate change and air pollution
- Air pollution assessment and management
- Energy resource efficiency and waste
- Transport and environment in cities and megacities

Scientific programme http://www.kenes.com/cleanair/prog.htm

Registration http://www.kenes.com/cleanair/reg.htm

Conference Secretariat:
Kenes Building, Airport City 70151
PO Box 56 Ben Gurion Airport 70100
Israel
Tel +972 3 9727500
Fax +972 3 9727555
E-mail cleanair@kenes.com

The deadline for abstracts is 14 March 2004.
For further information see the conference website home page http://www.kenes.com/cleanair
THE DIFFUSIVE MONITOR

The Diffusive Monitor is available on free subscription and is distributed electronically by E-mail.

It is also available on the HSL web site at: http://www.hsl.gov.uk/publications/diffuse-monitor.htm

If you wish to add your name to the electronic mailing list or delete your name from the list, or have any other comments, send the reply slip below (or a photocopy) with details of your name and address, tel., fax and E-mail to: M D Wright, Health and Safety Laboratory, Broad Lane, Sheffield S3 7HQ, UK. fax +44 114 289 2362, E-mail contact mike.wright@hsl.gov.uk.

THE DIFFUSIVE MONITOR

Response form

... Please add my name to the electronic mailing list

... Please delete my name from the mailing list

... E-mail...

Other comments....

Correct address as follows:

Name and Title....

Organisation....

Address....

Post code....

Country....

Telephone....

FAX....

SIGNED....

Return to: M D Wright, Health & Safety Laboratory, Broad Lane, Sheffield S3 7HQ, UK. fax +44 114 289 2362, e-mail mike.wright@hsl.gov.uk

HSL Sheffield will relocate to Buxton Derbyshire in November 2004. Its postal address from December 2004 will be Health & Safety Laboratory, Harpur Hill, Buxton SK17 9JN UK.

Data Protection Act: The above details will be collated on a computer database for the purpose of distributing The Diffusive Monitor only.