

## Industrial Hygiene Air Monitoring Methods For MDI and TDI

MDI and TDI generally react quickly with compounds that contain an active hydrogen group (or groups). Therefore, to allow for meaningful workplace measurements, methods used for monitoring airborne concentrations must be capable of trapping and derivatizing the diisocyanate(s) to a stable derivative(s) in the field.

The Occupational Safety & Health Administration has listed Permissible Exposure Limits (PEL) for MDI and TDI. Additionally, recommended values may be found in the American Conference of Governmental Industrial Hygienist's Threshold Limit Values Book. Note the presence of ceiling limits (C), 8-hour time-weighted averages (TWA) and Short Term Exposure Limits (STEL) where applicable.

To assess workplace exposures, a combination of personal and area samples may be taken. It is recommended that personnel carrying out different tasks be assessed. Examples may include, but are not limited to, process line operators, process line supervisors, maintenance staff, electricians, instrument-persons, quality control staff, warehouse staff, forklift truck drivers, sawline operators and grinding/finishing operators.

Area samples may be collected at key locations along production lines to evaluate the risk of exposure to personnel who may be required to work in specific locations for long periods or to highlight any potential "hot spots" and areas that may require special attention. For example, a variety of samples collected from key locations may help assess the efficiency or the need to introduce additional engineering controls such as local exhaust ventilation, use of personal protective equipment, etc.

At present, a number of analytical methods and techniques are available for sampling and analyzing diisocyanates in workplace atmospheres. However,

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great care should be taken to ensure that a representative sample is collected. When selecting an appropriate method, the environmental analyst or occupational hygienist should consider the nature of the process, applicable regulations and the likely physical state of the airborne diisocyanate (i.e., vapor, condensation aerosol, dust, etc.).

In general, the following methods can be used for monitoring diisocyanates:

- Direct reading instruments (DRIs) or devices
  - Detector tubes and badges
  - Passive badges
  - Paper Tape Instruments
- Indirect (derivatization) methods (pumped impinger and/or filter paper trapping medium) — these methods require laboratory analysis.

Examples of these methods/instruments are described on pages 2 and 3.

*Note that this listing of devices and methods is illustrative and is not intended to be comprehensive. Inclusion in this listing is not intended to be an API endorsement of any particular method, nor an API warranty on the effectiveness or fitness for a particular purpose of any listed device or method.*

## Direct Reading Instruments or Devices

These instruments are generally more appropriate for monitoring vapors than particulates. As a rule, direct sampling instruments are not as accurate or precise as indirect (derivatization) sampling methods. However, their ease of use and immediate results make them beneficial for screening, emergency response, and fugitive emissions. Consideration should be given to the application, and consultation with the device manufacturer or diisocyanate producer is recommended.

### Pumped (Active) Detector Tubes and Badges



**TDI Dräger Tube 0.02/A** (Dräger) — The detector tube contains an ampule containing a liquid that is drawn into the indicating layer. The resulting yellow tube changes to orange (varies with concentration) to indicate the presence of TDI. Air is drawn through the tube with the manufacturer's pump (25 strokes) to produce the colorimetric reaction. (measurement range ~0.02-0.2 ppm — not recommended for assessing personal exposures)

This method takes more than 20 minutes and 25 pump strokes to reach the lower detectable limit.



**SureSpot** (Scott/Bacharach GMD) — A calibrated sampling pump (1.5 LPM) is required. The badge undergoes a color reaction with TDI and MDI and corresponding pink color is visually matched with the reference color comparator. (lower detectable limit is 2 ppb for TDI and 4.5 ppb for MDI)

### Passive Badges

Passive badges have several advantages: they are inexpensive; may be used for 15 minutes or up to

8 hours; good for personal or area monitoring; verifying barricade distance during a spill; accompanying shipments to assure containment of material/decontamination of equipment. However, they are limited in that they provide a TWA, but do not show "peaks."



**K&M SafeAir Colorimetric Badge** — The badge relies on diffusion to produce a color reaction with diisocyanates and is measured using a color comparator. (measurement range — (2.5 to 300 ppb-hr for MDI; 2.5 to 700 ppb-hr for TDI)

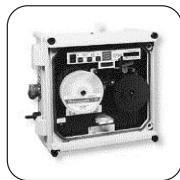


**Bacharach Sure-Spot Dosimeter** — The badge relies on diffusion to produce a color reaction with TDI and is measured using a color comparator. (measurement ranges — 10-70 ppb-hrs TDI & 55-385 ppb-hrs TDI)

### Paper Tape Instruments



**Zellweger MDA Scientific Model 7100** Paper Tape Monitor — 30 day and 2 week cassettes. Measures TDI, MDI and other diisocyanates. Instrument is being phased out of production. Datalogging option to include TWAs. Alarm function. (measurement range ~1 to 200 ppb)



**Zellweger MDA Scientific SPM** — Single Point Monitor — 2 week cassettes. Measures TDI, MDI and other diisocyanates. Sealed enclosure (NEMA 4). Datalogging option to include TWAs. Alarm function. (measurement range ~2 to 60 ppb)



**Zellweger MDA Scientific TLD-1** Toxic Gas Detector — Measures TDI, MDI and other diisocyanates. Cassette life up to 2 weeks. Portable. Datalogging option to include TWAs. Alarm function. (measurement range 2 to 60 ppb)



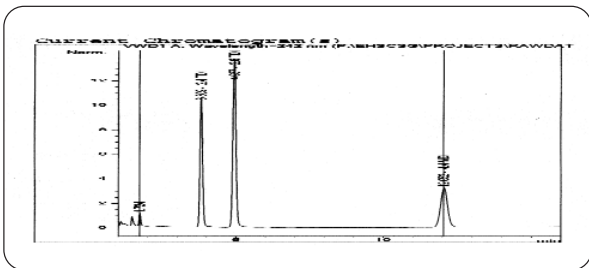
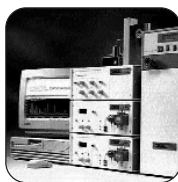
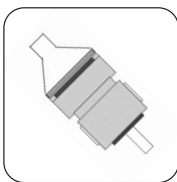
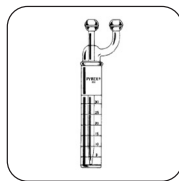
**Scott/Bacharach — GMD AutoStep Plus®** — Handheld portability. Measures MDI, TDI & other diisocyanates. Cassettes last up to 8 hours. Datalogging option to include TWAs. Alarm function. (measurement range ~1 to 200 ppb)



**Scott/Bacharach — GMD Remote Intelligent Sensor (RIS)** — Area Monitor. Measures MDI, TDI & other diisocyanates. Cassettes last up to 30 days. Datalogging option to include TWAs. Alarm function. (measurement range ~1 to 2000 ppb for TDI, ~1 to 200 ppb for MDI)

**Note:** All paper tapes have a limited shelf life. Manufacturer's instructions should be consulted for appropriate use.

## Indirect (Derivatization) Methods (pumped impinger and/or filter paper trapping medium)



## Indirect methods generally require standards and analytical facilities:

**HPLC** — Impinger or impregnated filter sampling — in-field derivatization of the diisocyanate followed by HPLC analysis — several methods available:

- **OSHA 42 & 47** — 1,2-PP coated glass fiber filter
- **ASTM D5836-95** — 1,2-PP coated glass fiber filter
- **ASTM D5932-96** — glass fiber filter treated with MAMA
- **NIOSH 5521** — Impinger — 1,2MP toluene
- **NIOSH 2535** — Tube containing nitro reagent coated glass wool
- **NIOSH 5522** — Impinger (tryptamine in DMSO)
- **UK MDHS 25/3** — 1,2MP coated GFF or impinger

**Colorimetric** — Modified Marcali Method (UK MDHS 49) impinger sampling — color reaction with diisocyanate and measured using a spectrophotometer.

### Abbreviations

- DMSO = dimethyl sulphoxide;  
 GFF = glass fiber filter;  
 HPLC = high performance liquid chromatography;  
 1,2MP = 1-(2-methoxyphenyl)piperazine;  
 1,2-PP = 1-(2-pyridyl)piperazine;  
 MAMA = 9-(N-methyl-amino-methyl)-anthracene  
 Nitro reagent = N-[(4-nitrophenyl) methyl] propylamine

## Useful Websites

### Instruments and Equipment

#### MDA

[www.zelana.com/ind/foam.asp](http://www.zelana.com/ind/foam.asp)

#### Scott-Bacharach — GMD

[www.scottbacharach.com](http://www.scottbacharach.com)

#### Dräger

[www.draeger.com](http://www.draeger.com)

#### K&M Environmental

[www.kandmenvironmental.com](http://www.kandmenvironmental.com)

(continued on page 4)

# technical

b u l l e t i n

## **Sampling pumps & equipment:**

### **SKC**

[www.skcltd.com](http://www.skcltd.com)

### **Supelco**

[www.sigmaaldrich.com/brands/supelco\\_home.html](http://www.sigmaaldrich.com/brands/supelco_home.html)

## **Methods**

### **NIOSH**

[www.cdc.gov/niosh/homepage.html](http://www.cdc.gov/niosh/homepage.html)

### **OSHA**

[www.osha.gov](http://www.osha.gov)

### **UK HSE**

[www.hse.gov.uk](http://www.hse.gov.uk)

### **HSE BOOKS**

[www.hsebooks.co.uk/homepage.html](http://www.hsebooks.co.uk/homepage.html)

Summary of Methods: AM. IND. HYG. ASOC. J.  
56:581-589 (1995)

### **AIHA Accredited Labs**

[www.aiha.org/laboratoryservices/html/lists.htm](http://www.aiha.org/laboratoryservices/html/lists.htm)

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