



# supelco Air MONITORING

Irina Galushko,  
[irina.galushko@merckgroup.com](mailto:irina.galushko@merckgroup.com)

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# Areas of Air Monitoring



## Industrial Hygiene

- Occupational
- Workplace



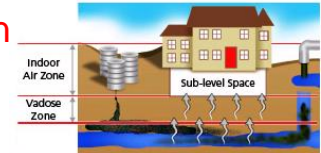
## Ambient

- Industry
- Farming
- Hazardous
- Waste Sites



## Source

- Industrial Stacks
- Motor Vehicles
- Vapor Intrusion



## Product Emissions

- Furniture (Car Seat)
- Flavor & Fragrances

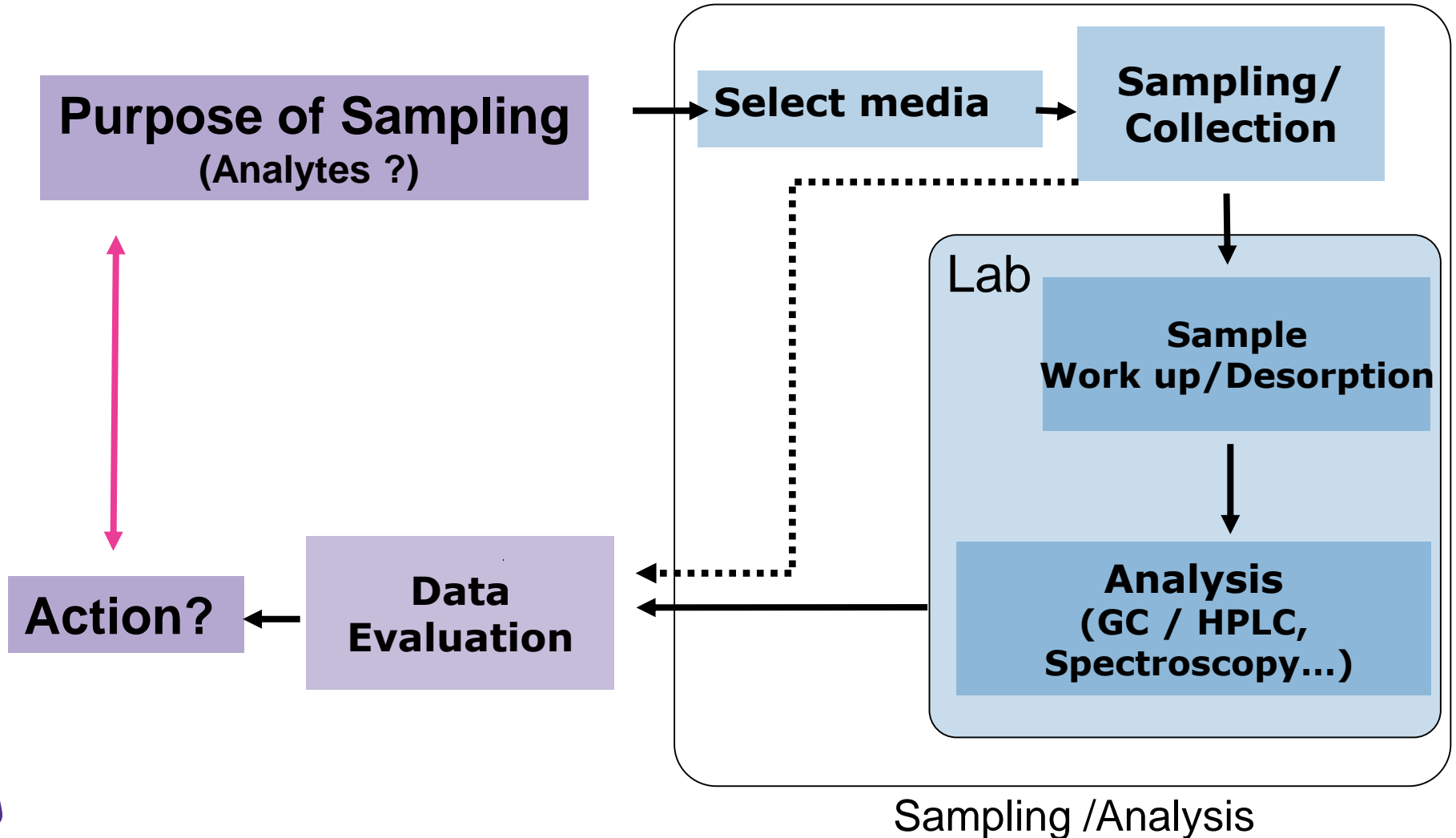
## National Security

- Chemical Agents
- Explosives
- Airport Screening (TSA)

## Healthcare

- Anesthetic Gases
- Cancer Screening

# Air Monitoring Workflow



# What are we sampling (people or places)?

## Personal Sampling

What concentration are people exposed to?

- Sampled taken in the breathing zone.



## Area Sampling

What is the concentration in the air?

- Indoor air
- Fence line monitoring
- Evaluating engineering controls
- Smoke Stacks



# Commonly Sampled Air Contaminants

## Ambient Air

- Particulates (PM10, PM2.5)
- BTEX/VOCs
- Pesticides, PAHs, PCBs
- Ozone
- Carbonyls
- Carbon Monoxide
- Nitrogen Dioxide
- Sulfur Dioxide
- Lead

## Indoor Air / Industrial Hygiene

- BTEX/VOCs
- Carbonyls
- Hydrogen sulfide
- Isocyanates – TDI, MDI, HDI
- Acid vapors
- Metals – Lead, Cadmium, Hexavalent Chromium

There are over 400 sampled contaminants

# Sampling: How Are the Air Samples Taken?

There are two categories of air sampling. Both are important.

|   |                    |
|---|--------------------|
| <b>Passive Sampling</b> <ul style="list-style-type: none"><li>• Air naturally diffuses into the sampler</li><li>• + Simplicity, flexibility, economy</li><li>• - Diffusion (slow process)</li></ul> | <b>NO<br/>PUMP</b> |
| <b>Active Sampling</b> <ul style="list-style-type: none"><li>• Air is mechanically drawn into the sampler</li><li>• + User controls time, volume, rate</li><li>• - Pump</li></ul>                   | <b>PUMP</b>        |

The different methods have their specific utility.  
We offer products for all types of sampling methods.

# Passive Sampling

No Pump required

- Suitable for explosive atmospheres
- Low investment e.g. for areal mapping
- Light weight for personal sampling

Sampling is by diffusion (naturally occurring movement of air)

For quantification sampling rates are needed for each compound

- Sampling rates are typically provided by the manufacture of the device

Typically used for longer term sampling (> 4hours)



Badges



TD Tubes



SPME

# Radial Sampler - *radiello*®

3 core pieces are needed for sampling:

## 1. Adsorbent Cartridge

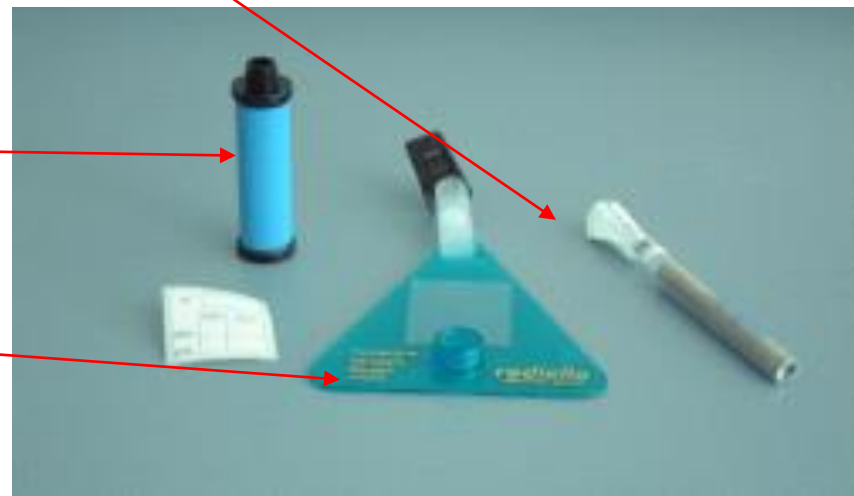
Type depends on analytes

## 2. Diffusive Body

Type depends on analytes

## 3. Support Plate

- Triangular back plate
- w/ pouch for barcode label



Diffusive Body & Cartridge combination is given by the method and can not be interchanged!



# Radiello sampling process

## Before sampling

- Place cartridge into diffusive body
- Attach diffusive body to support plate
- Note start time and date on the barcode label (and separate sheet)

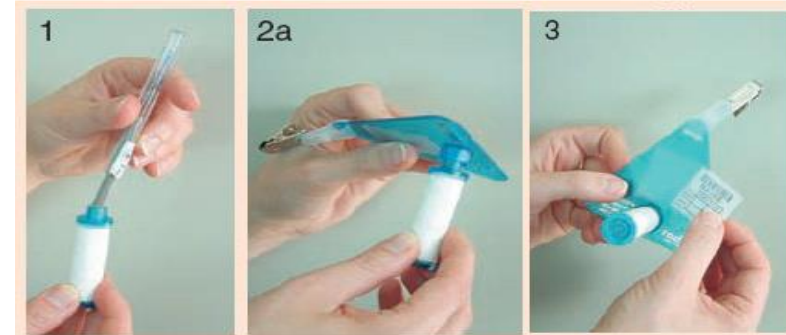
## Sampling

### After sampling

- Note stop time and date on barcode label - put cartridge back into storage vial & barcode label on vial
- Send storage vial with cartridge to lab for analysis

## Analysis

- Analytical protocols can be found in the radiello Manual



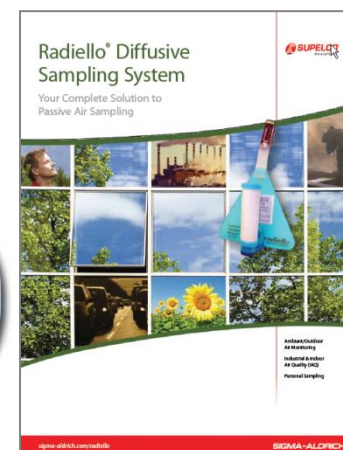
# Radiello Samplers

## Samplers are available for:

- Aldehydes
- VOCs/BTEX (chemically desorbed with CS<sub>2</sub>)
- VOCs/BTEX (thermally desorbed)
- NO<sub>2</sub>/SO<sub>2</sub>/HF
- Ozone (O<sub>3</sub>)
- Hydrogen Sulfide (H<sub>2</sub>S)
- Ammonia (NH<sub>4</sub>)
- Hydrochloric acid (HCl)
- Anesthetic gases and vapors
- Phenols (thermally desorbed)
- 1,3-Butadiene (thermally desorbed)

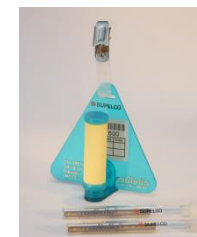


(IXW)



(IXV)

Starter Kits  
with 1 complete sampler  
available for blue marked compounds

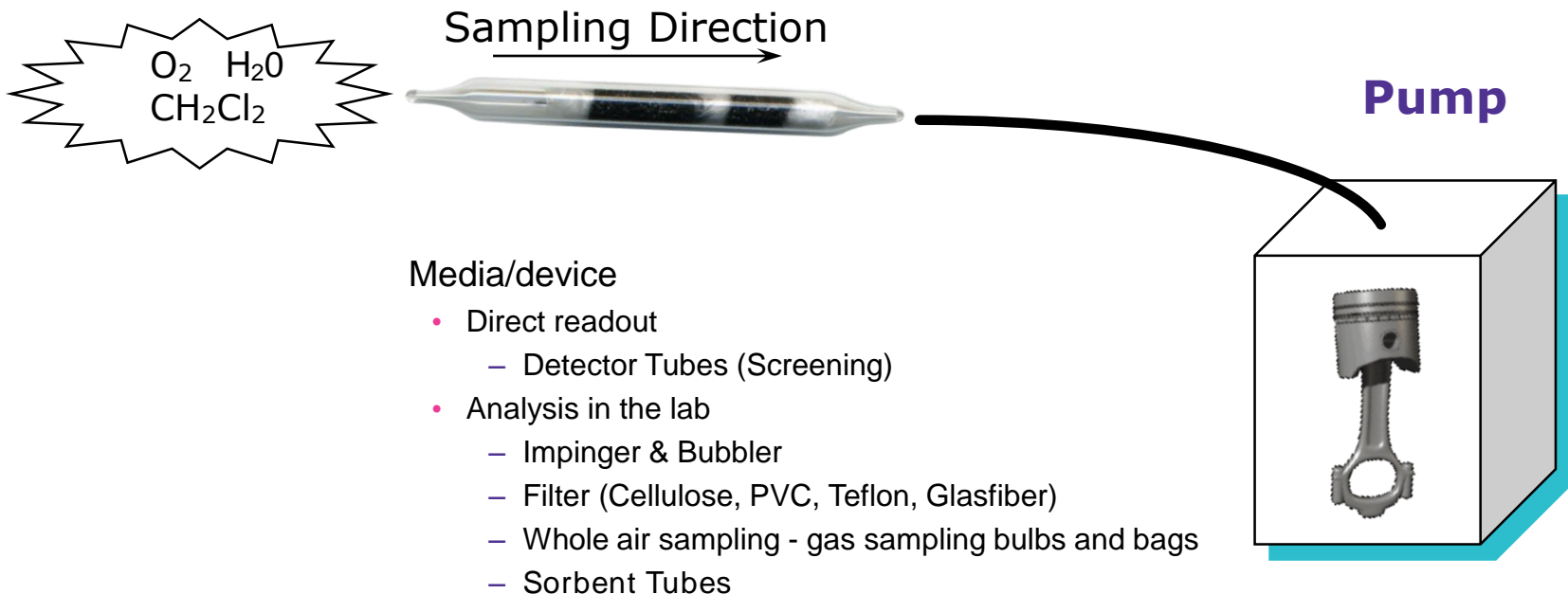


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# Active Sampling

Is performed by pulling air (vacuum) through/into the sampling media using an air sampling pump.

*The chemicals in the air are trapped/concentrated on the adsorbent media.*



# Impinger & Bubbler

Impinger -> Glass tip

Bubbler -> Fritted

} Filled with adsorber solution



# Filters & Cassettes

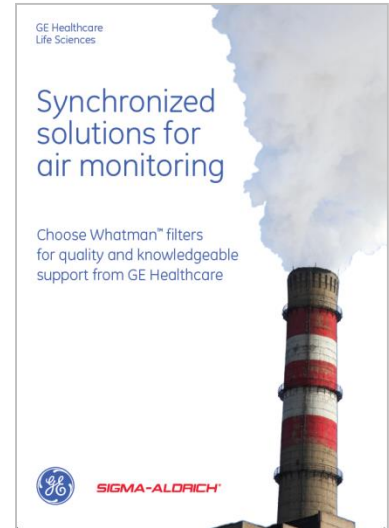
Mostly used for particles (dust) and aerosols

Different filter materials are available

- PVC, Cellulose ester, PTFE, Glass Fiber, coated Filter
- PALL & Whatman filter



High-quality cassettes, filters, and accessories for air sampling.



OTZ-  
EN, DE, FR



# Whole Air Sampling

## Glass Gas Sampling Bulbs

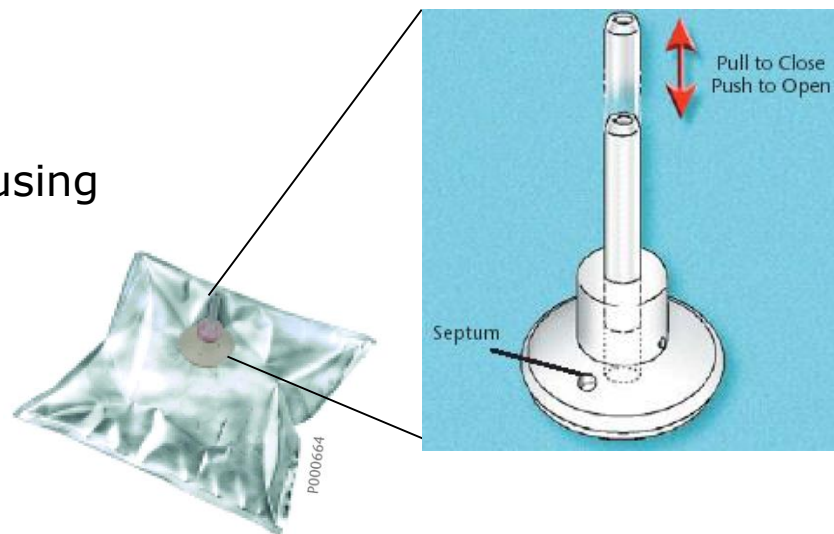
- Available with Glass or PTFE valves
- Sample is removed using a syringe
- Can also be used to prepare calibration standards



## Gas Sampling Bags

### Plastic Bags (Tedlar®, PVF)

- Volumes 1-25L
- Sample can be concentrated in the lab using instrumentation or a tube can be used.



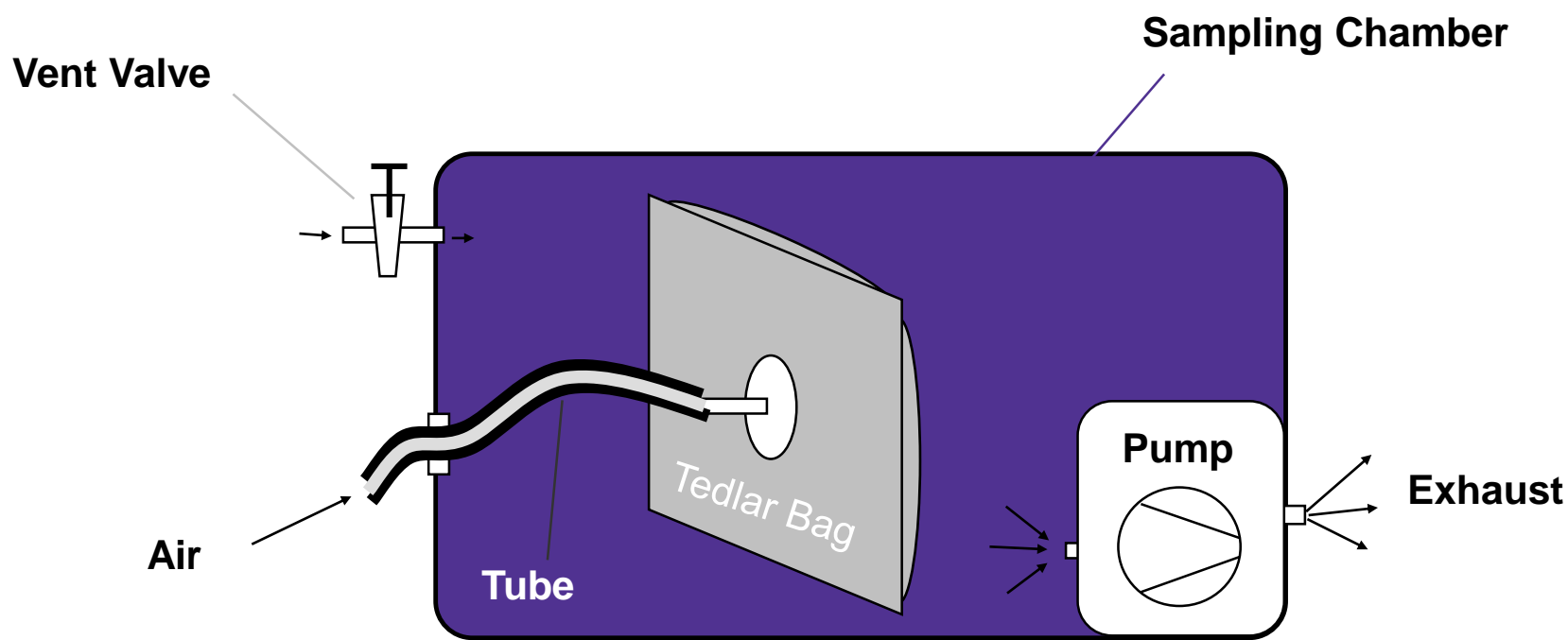
# Bag Sampler

Sample is not exposed to the pump parts

- Prevents contaminating the pump & sample
- Compounds do not get stuck in the pump



Model 1062  
10L-Bag  
1-5 L/min





# Supel™-Inert Air Sampling Bags (economic alternative to Tedlar)

NEW



## •Supel™Inert Bags

- Incorporates our **LB-2 Thermogreen™** septa in the valves
  - Low bleed
  - High puncture rates
- Now **two valve options** are available



## •Supel Inert FILM

- New fluoropolymer film as alternative for Tedlar

## •Supel Inert FOIL

- New aluminium lined bags



[sigma-aldrich.com/gassamplingbags](http://sigma-aldrich.com/gassamplingbags)



## Adsorbent Tubes

### Solvent vs. Thermal Desorption

#### Solvent Desorption

- Flexibility in analytical method
- Permits analyte derivatization
- Sample conservation
- No special desorption instruments



**SOLVENT**

#### Thermal Desorption

- Sensitivity typically 1000-fold higher
- No solvents needed
- Limited to GC analysis & thermal stable compounds
- Work up can be automated (routine measurements)



**HEAT**

Solvent vs. Thermal Desorption:

Both important, both with advantages. Analysts choose based on their method requirements.

# Adsorbent Tubes (Active Sampling)

## Solvent Desorption Tubes

- ORBO Tubes (Supelco's Trade name)
- Over 75 configurations available
  - Charcoal
  - Carbons
  - Silica Gel
  - Porous Polymers
  - Coated Adsorbents



## Thermal Desorption Tubes

- TD Tubes (Carbotrap-XXX Trade name)
- Single Bed Tubes
- Multi-Bed Tubes



P000848



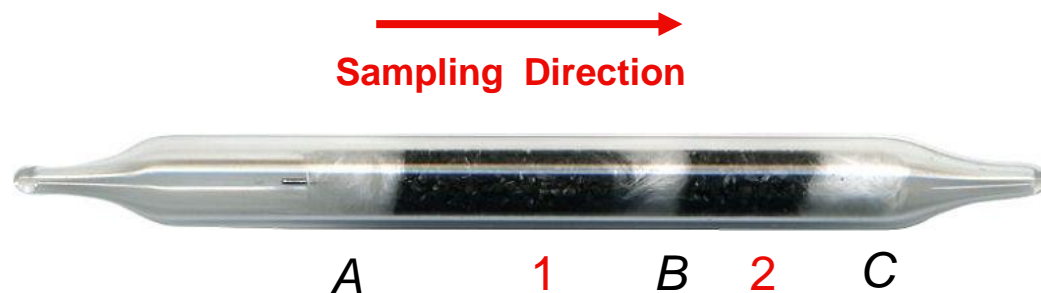
# Solvent Desorption Tubes: ORBO

Design and recipe often according to OSHA & NIOSH methods

Typically packed with two beds of the same adsorbent

- Ratio 2:1. The smaller bed is used to test for breakthrough.

Flamed sealed to keep the adsorbent clean



1 – Primary Bed 2 – Back-up/control Bed

A,B,C – Plugs (Glass Wool or PUF)

Adsorbents used

- Charcoal
- Carbons
- Silica Gel
- Porous Polymers
- Coated adsorbents





# Iso Cyanates Sampling by ASSET EZ4-NCO Dry

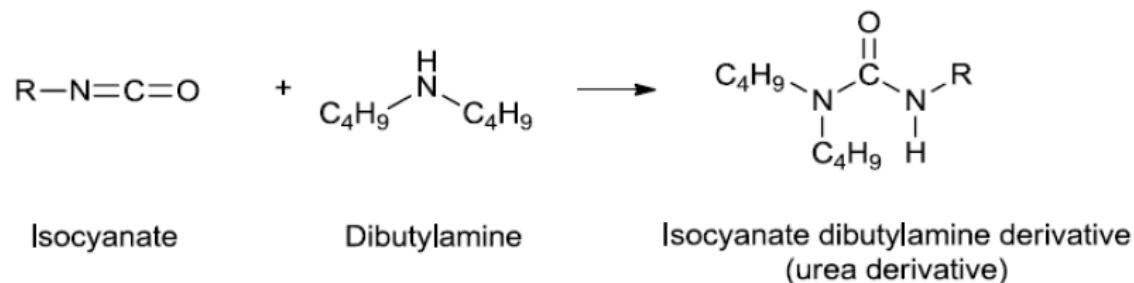
Determination acc. ISO17734-1

Commonly derivatisation with piperazine reagents

- Can require in-field stabilization and cooled storage

Dibutylamine (DBA) derivatives are more stable and can be stored at room temp.

- No need for in field derivatisation/stabelization
- Reliable derivatisation of particular isocyanates
- Analysis by LC-MS



## ISO 17734-1

Determination of organonitrogen compounds in air using LC-MS

Part 1: Isocyanates using dibutylamine derivatives



# ASSET EZ4-NCO Dry Sampler for Iso Cyanates

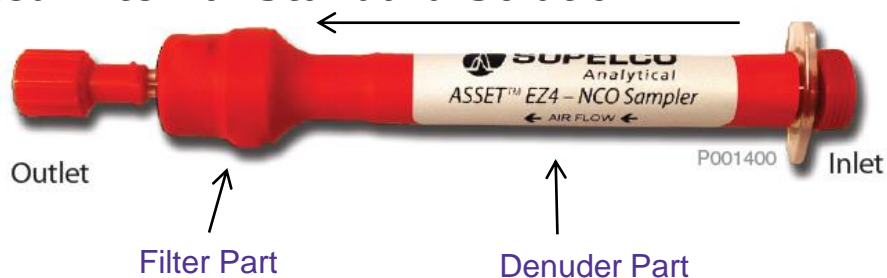
- Flow Rate Range 100-250 mL/min (200 mL/min suggested)

Low back-pressure (suitable for most air sampling pumps)

- ~9 inches of water @ 200 mL/min
- Sampling Time Range 5 min. up to 8 h (15 minutes is typical)
- After sampling put the caps back on the sampler & send to lab
- ASSET can be stored at room temp. at any time

Analysis by LC-MS

- Calibration Standards are available
- Calibration solution
- Deuterated Internal Standard Solution



# When are Solvent Desorption Tubes used?

Thermo labile compounds

Need for immediate derivatisation

→ better stability or yield (e.g. Formaldehyde, Isocyanates)

High Flow Sampling → PUF

Only occasionally measurements

No Thermo desorption equipment available

- Low initial costs
- Universal applicable

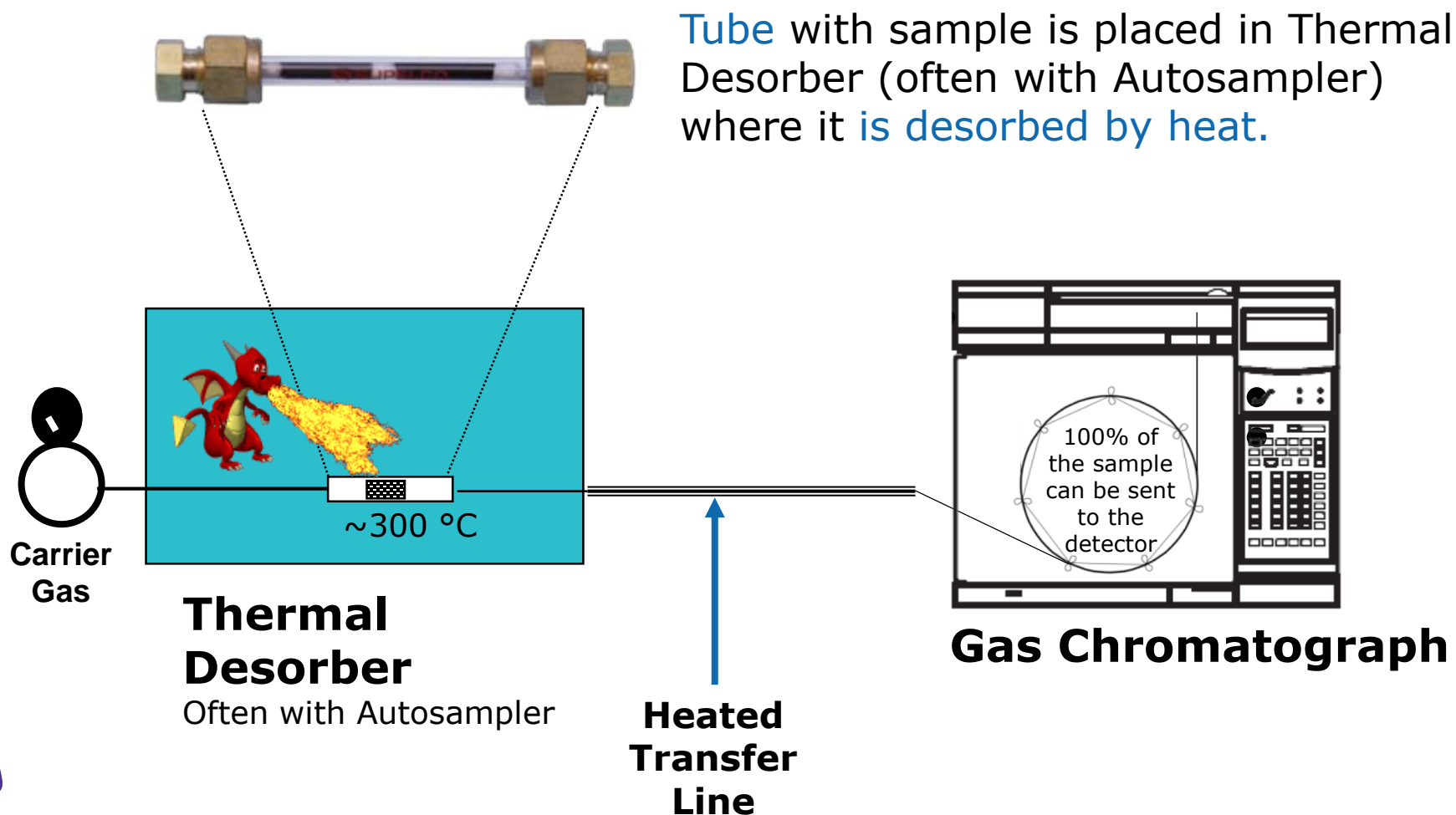
Limitation

- Manual processing of samples
- Need of clean solvents





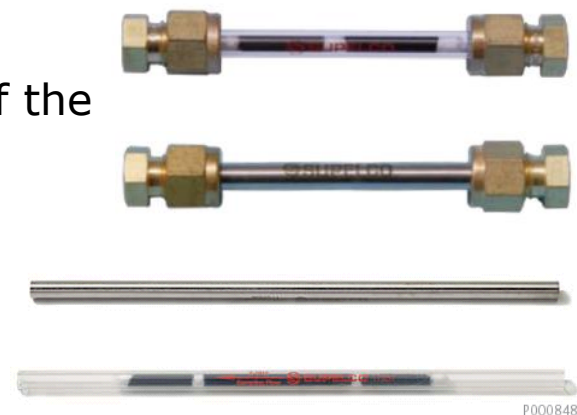
# Thermal Desorption - What is it?





# Thermal Desorption Tubes

- Requires a [thermal desorption instrument](#)
- Tubes are made of Glass or Stainless Steel
  - Glass is more inert, can visually see the integrity of the packing
  - Stainless Steel - more durable, will not break
- Reusable ~100 times
- [Single and Multi-beds](#) tubes available
- TD Tubes (named Carbotrap-XXX)





# Thermal Desorption Tube Offering by Manufacturer

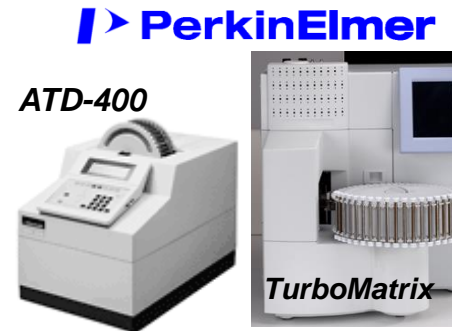
Tube Dimension 3.5"x1/4" (89 x 6.3mm)

PerkinElmer (ATD-400, TurboMatrix)

Shimadzu (TD-20)

DANI (Master TD)

Markes (Unity)



Other Dimensions

Gerstel (TDS2 & TDS A)

CDS/Dynatherm (850 & 890, ACEM-900)

Teledyne Tekmar (AEROTrap 6000)



Gerstel TDS-A



# Advantages/Limitations of Thermal Desorption

## Advantages

- Wide range of compounds can be analyzed at one time
- Detection limits decreased 1000 times - compared to solvent desorption
- No desorbing solvent required
- Suitable for routine measurements (Industrial Hygiene, IH)
  - Tubes are reusable
  - High sample throughput due to automation

## Limitations

- Initial investment of a thermal desorber (tubes are not always interchangeable)
- Commonly only one analysis per sample (modern TD units allow for sample split)
- Not suitable for analytes requiring derivatisation or that are thermal labile

# Information Resources for Methods

Official methods

- DIN, VDI
- European norms (EN, ISO,...)
- NIOSH / OSHA / EPA
  - <http://www.osha.gov/dts/sltc/methods/toc.html>
  - <http://www.cdc.gov/niosh/nmam/>

Literature (e.g. journal articles)

Literature of supplier (applications, recommendations)

Analytical common sense / knowledge

# Sigma-Aldrich Web site on Air Monitoring

[www.sigma-aldrich.com/airsampling](http://www.sigma-aldrich.com/airsampling)

Application specific

- Vapour Intrusion Monitoring
- Chinese Drywall Contamination
- Petrochemical
- Agricultural Contaminants
- Anesthetic Gases in Healthcare
- Paints & Coatings



Vapor Intrusion



Petrochemical Industry



Chinese Drywall Contamination



Anesthetic Gases in Healthcare



Agricultural Contaminants



Paints & Coatings

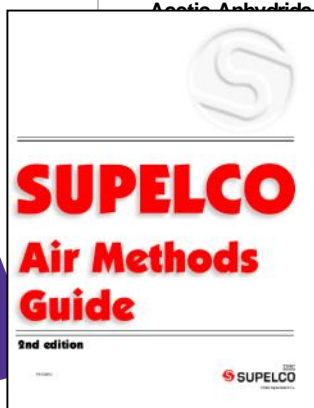
Literature

- "A Tool for Selecting an Adsorbent(s) for Thermal Desorption" (EQF, T402025)
- Supelco Air Methods Guide
  - Available on website



# Supelco Air Methods Guide - Example

| Compound         | Method     | Volume Liters | Rate Liters/Min | Medium and/or Sample Collection Device           | Supelco Model No. | Supelco Cat. No. | SKC Equiv              | Analytical Technique |
|------------------|------------|---------------|-----------------|--|-------------------|------------------|------------------------|----------------------|
| Acenaphthene     | NIOSH 5506 | 200-1000      | 2               | XAD-2<br>PTFE filter                             | ORBO-43<br>----   | 20258<br>23390-U | 226-30-04<br>225-17-07 | HPLC-UV/FI           |
| Acenaphthene     | NIOSH 5515 | 200-1000      | 2               | XAD-2<br>PTFE filter                             | ORBO-43<br>----   | 20258<br>23390-U | 226-30-04<br>225-17-07 | GC-FID               |
| Acenaphthylene   | NIOSH 5506 | 200-1000      | 2               | XAD-2<br>PTFE filter                             | ORBO-43<br>----   | 20258<br>23390-U | 226-30-04<br>225-17-07 | HPLC-UV/FI           |
| Acenaphthylene   | NIOSH 5515 | 200-1000      | 2               | XAD-2<br>PTFE filter                             | ORBO-43<br>----   | 20258<br>23390-U | 226-30-04<br>225-17-07 | GC-FID               |
| Acetaldehyde     | NIOSH 2538 | 1-12          | 0.01-0.05       | XAD-2 c/w 2-HMP                                  | ORBO-25           | 20357            | 226-27                 | GC-FID               |
| Acetaldehyde     | NIOSH 2539 | 5             | 0.01-0.05       | XAD-2 c/w 2 HMP                                  | ORBO-23           | 20257-U          | 226-118                | GC-FID               |
| Acetaldehyde     | NIOSH 3507 | 6-60          | 0.1-0.5         | fritted bubbler                                  | ----              | 64835-U          | 225-36-2               | HPLC-UV              |
| Acetaldehyde     | OSHA 68    | 3             | 0.05            | XAD-2 c/w 2-HMP                                  | ORBO-25           | 20357            | 226-27                 | GC-NPD               |
| Acetic Acid      | NIOSH 1603 | 20-300        | 0.01-0.1        | coconut charcoal                                 | ORBO-32S          | 20267-U          | 226-01                 | GC-FID               |
| Acetic Acid      | US Army    | 10-25         |                 | Chromosorb P c/w Na <sub>2</sub> CO <sub>3</sub> | ORBO-70           | 20256-U          | NA                     | GC-FID               |
| Acetic Anhydride | NIOSH 3506 | 25-100        | 0.2-1           | fritted bubbler                                  | ----              | 64835-U          | 225-36-2               | VIS                  |
| Acetic Anhydride | OSHA 102   | 7.5           | 0.05-0.5        | glass fiber filter<br>c/w DMBA & DOP             | 894               | custom           | 225-9010               | GC-NPD               |
| Acetic Anhydride | OSHA 82    | 0.75          | 0.05            | glass fiber filter<br>c/w 1-2PP                  | 821               | custom           | 225-9009               | GC-NPD               |
|                  | NIOSH 1300 | 0.50-3        | 0.01-0.2        | coconut charcoal                                 | ORBO-32S          | 20267-U          | 226-01                 | GC-FID               |
|                  | NIOSH 2549 | 1-6           | 0.01-0.05       | 3-bed thermal desorption tube                    | Carbotrap 349     | 20243            | NA                     | TD-GC/MS             |
|                  | OSHA 69    | 3             | 0.05            | Carbosieve S-III<br>(Anasorb CMS)                | ORBO-91           | 20360            | 226-121                | GC-FID               |
| in               | NIOSH 2506 | 0.30-12       | 0.2             | Porapak QS                                       | ORBO-1101         | 20061            | 226-59-09              | GC-NPD               |
| e                | NIOSH 1606 | 1-25          | 0.01-0.2        | coconut charcoal                                 | ORBO-32L          | 20228            | 226-09                 | GC-FID               |
| ide              | NIOSH 1003 | 0.2-5         | 0.01-0.2        | coconut charcoal                                 | ORBO-32S          | 20267-U          | 226-01                 | GC-FID               |
| ide              | NIOSH 2003 | 50-100        | 0.2-1           | silica gel                                       | ORBO-52S          | 20229            | 226-10                 | GC-FID               |
|                  | NIOSH 1019 | 3-30          | 0.01-0.2        | petroleum charcoal                               | ORBO-303          | 20040-U          | 226-38                 | GC-FID               |



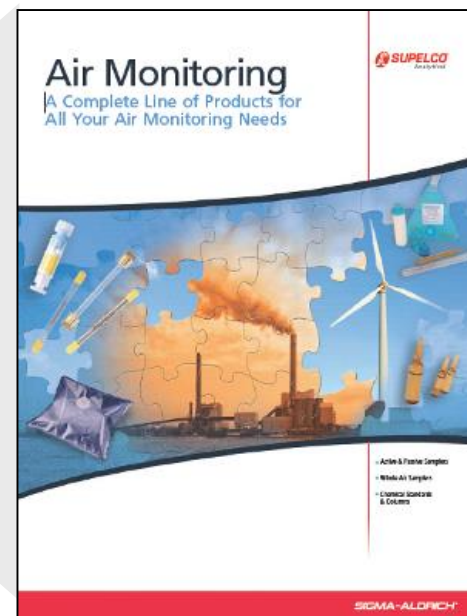


# Summary Air Monitoring

Air Monitoring is done in various fields

2 techniques used

- Passive sampling
  - Radiello, TD, SPME
- Active Sampling
  - Adsorbent tubes
    - ORBO solvent desorption, LpDNPH
    - Thermal desorption
  - Impinger, Filters
  - Gas bulbs & bags
    - Supel-Inert Film & Foil bags
  - Sampling Accessories
    - ATIS
    - Sampling Pumps & Bag Samplers
- Analytical supplies
  - Columns, Solvents, Accessories Standards



Air Monitoring Brochure (KQV)



[sigma-aldrich.com/air-monitoring](https://sigma-aldrich.com/air-monitoring)  
[sigma-aldrich.com/radiello](https://sigma-aldrich.com/radiello)  
[sigma-aldrich.com/gassamplingbags](https://sigma-aldrich.com/gassamplingbags)



Thank You!

[sigma-aldrich.com/air-monitoring](http://sigma-aldrich.com/air-monitoring)



*Hurricane Katrina*