Aspects of Passive Air Sampling

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Content

How does Passive Sampling work?

radiello® Passive Sampling Device

- How does it work
- Features & Benefits
- Official Methods, Studies & Projects
- Literature

Chromline SPME for Passive Sampling

Passive Sampling

Sampling by diffusion - No Pump required

Packings – Carbons, Polymers, Coated Materials

Badges

Tubes

SPME

Solid Phase Micro Extraction

Advantages of Passive Samplers

No pumps required

- Parallel sampling of many sites possible without high investment

No electrical supply needed

- Works independent
- Can be used in hazardous environments

Easy handling

- Can be done also by untrained personnel

Noiseless

- No disturbing noise during e.g. indoor sampling

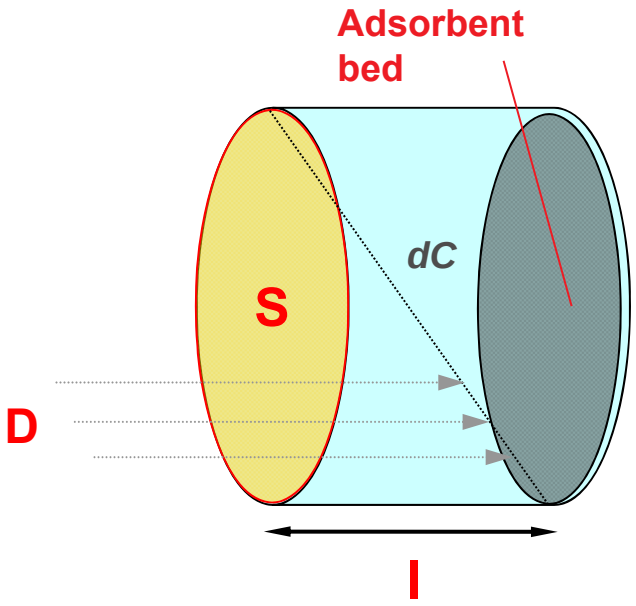
“But, diffusive samplers do need longer exposure/sampling times, don’t they?”

Maybe not!

Theoretical background of passive sampling

The Fick's diffusion law:

$$\frac{dm}{dt} = D \cdot S \cdot \frac{dC}{dl}$$



dm/dt = adsorbed mass m during time t

D = diffusion coefficient

S = diffusive surface

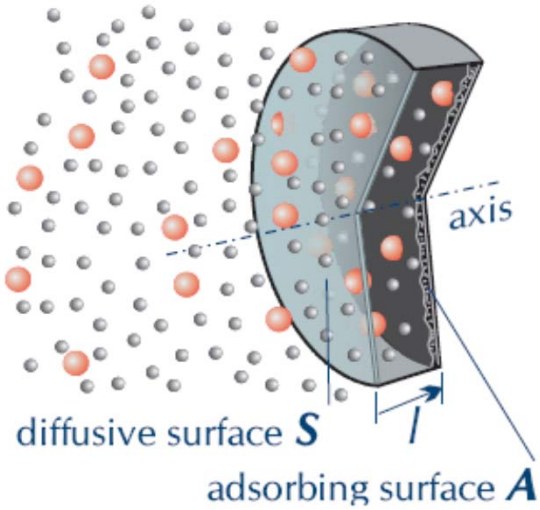
dC/dl = concentration gradient

Axial diffusive samplers

$$\frac{m}{t} = \boxed{D \cdot \frac{S}{l}} \cdot C$$

Q

$$C = \frac{m}{Q \cdot t}$$



S = A

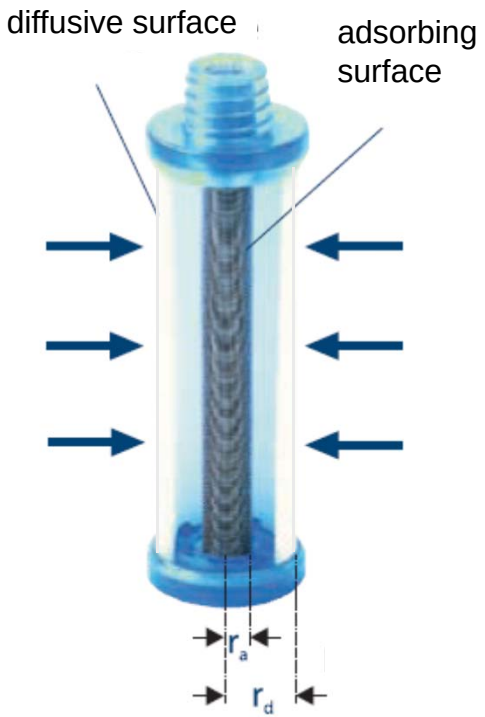
m = adsorbed analyte mass
D = diffusion coefficient
S / l = geometrical ratio (diff. surface/diff. path)
Q = D S/l =(uptake rate)

Radial diffusive sampler

$$\frac{m}{t} = \boxed{D \cdot \frac{2\pi \cdot h}{\ln \frac{r_d}{r_a}}} \cdot C$$

Q

$$C = \frac{m}{Q \cdot t}$$

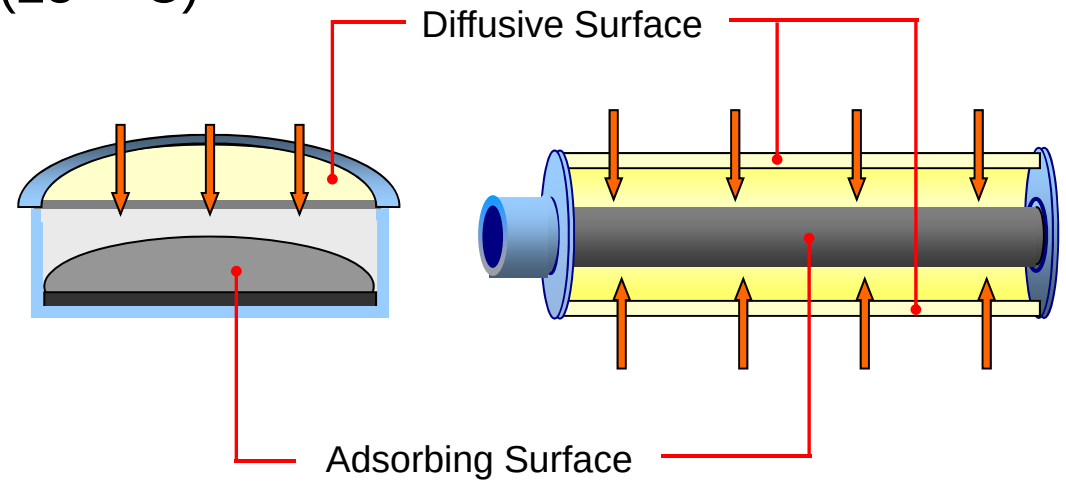


S > A

D = diffusion coefficient
h = cylinder height
r_d = diffusive cylindrical surface radius
r_a = adsorbing surface radius
Q = $D\ 2\pi h/(\ln r_d/r_a)$ = uptake rate

Sampling Rate Comparison

Diffusive sampling rate for benzene on act. charcoal/chemical desorption (25 ° C)



Axial Sampler
Q = 7-8 ml/min

Radial Sampler
Q = 80 ml/min

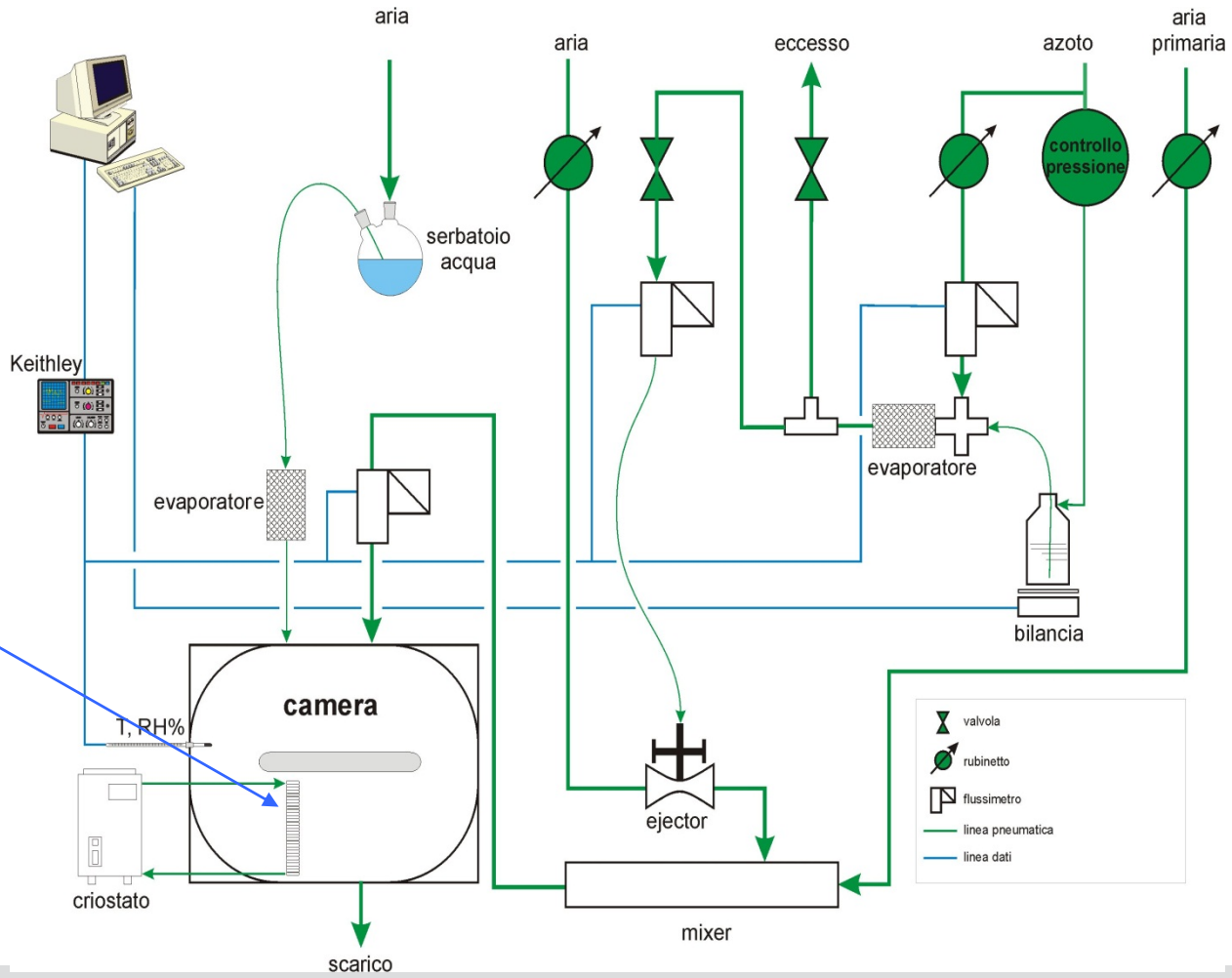
Sampling Rate Q

- Specific to compound
- Specific to sampler
- Values given by manufacturer (radiello® Manual & datasheet)
- Temperature dependent (correction equation in the manual)

	Q_{298} rate ml·min^{-1}	linearity range µg·m^{-3}·min	limit of quantitation[1] µg·m^{-3}	uncertainty at 2σ %
acetaldehyde	84	1,000÷12,000,000	0.1	15.9
acrolein	33	3,000÷3,000,000	0.3	16.5
benzaldehyde	92	1,000÷8,000,000	0.1	17.2
butanal	11	9,000÷10,000,000	0.9	23.5
hexanal	18	5,000÷15,000,000	0.6	20.2
formaldehyde	99	1,000÷4,000,000	0.1	13.8
glutaric aldehyde	90	1,000÷3,000,000	0.1	14.5
isopentanal	61	1,500÷12,000,000	0.2	17.0
pentanal	27	4,000÷12,000,000	0.4	22.9
propanal	39	3,000÷8,000,000	0.3	17.1

Given Q rates are corrected for desorption efficiencies

Measured Diffusive Sampling Rates for Radiello Samplers



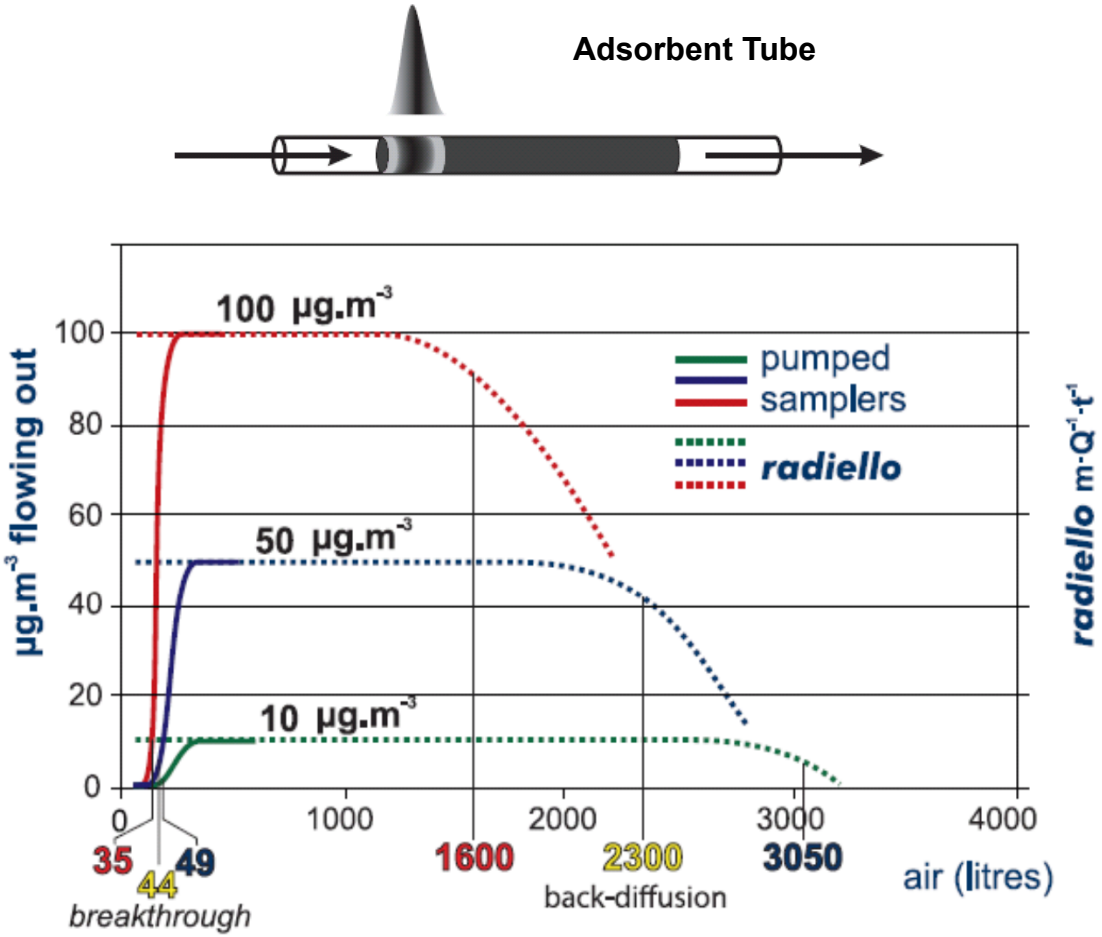
- **More precise and reliable**

Breakthrough vs. back diffusion

Capacity limits

- Breakthrough for active sampling with adsorbent tubes
- Back-diffusion for radiello diffusive sampler

Diffusive sampler shows higher capacity



Benzene at 25° C; Adsorbent beds of same size for active and diffusive sampling

FSM & Radiello History

Salvatore Maugeri Foundation

- Work and Rehabilitation Institute of Care and Scientific Research
- Established in 1965 as “Clinica del Lavoro” on the initiative of Prof. Salvatore Maugeri
  - Main aims:
    - protection of occupational health
    - rehabilitative medicine

Radiello History

- Mid 1990’s Dr. Vincenzo Cocheo Director of the Fondazione Salvatore Maugeri, Padova, Italy, in collaboration with the European Commission’s Joint Research Center (JRC) and other Institutions, developed and patented a revolutionary radial diffusive/sampling design

Typical Applications of *radiello*®

Outdoor air

Indoor air

Industrial hygiene

Equipment for Sampling

Example for Aldehydes

Adsorbent Cartridge

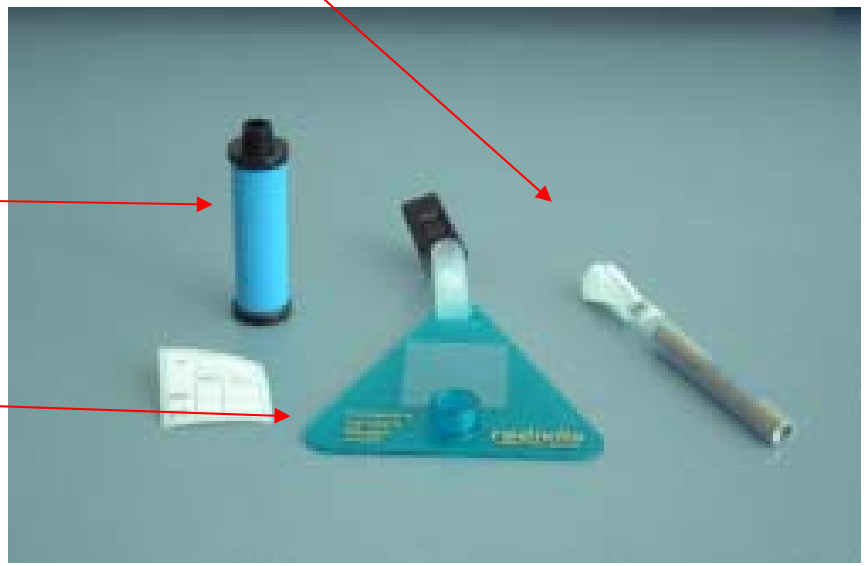
- 2,4-DNPH coated Florisil
- Supplied in storage container

Diffusive Body

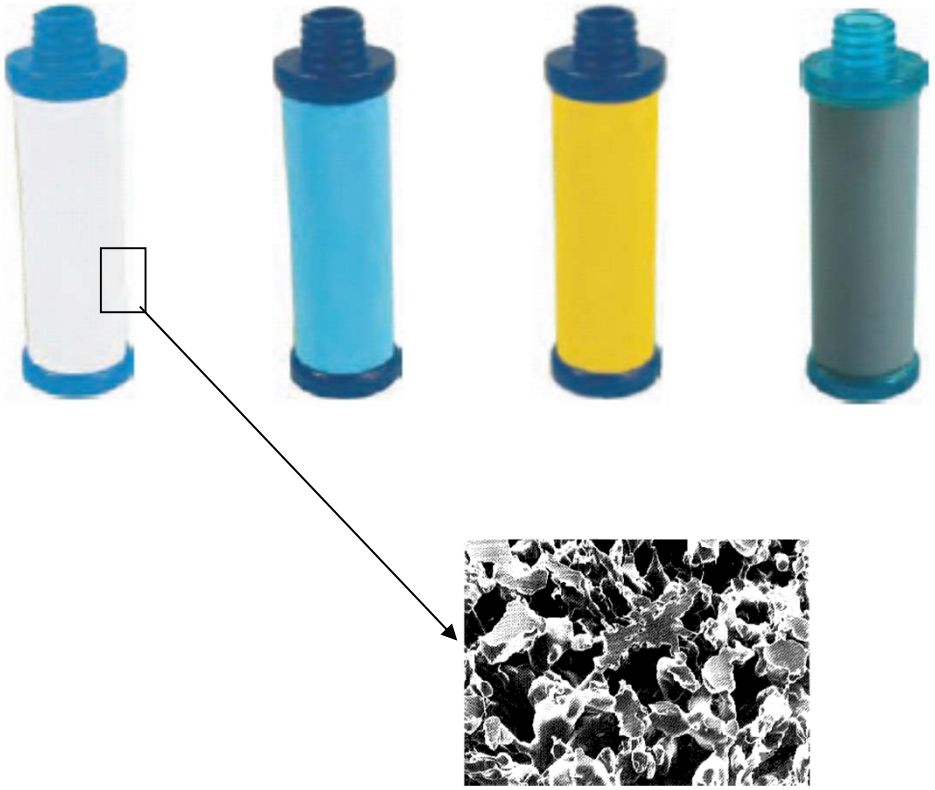
- blue diff. body

Support plate

- Triangular back plate
- w/ pouch for barcode label



Four different diffusive bodies



- **White** (standard)
  - for VOC/act. charcoal and others
- **Blue** (standard + colour)
  - for light-sensitive samplings (NO2, ozone, aldehydes)
- **Yellow** (high thickness)
  - for TD – VOCs sampling (to avoid retrodiffusion)
- **Silicone membrane** (grey)
  - for anaestethics

Radiello sampling configuration

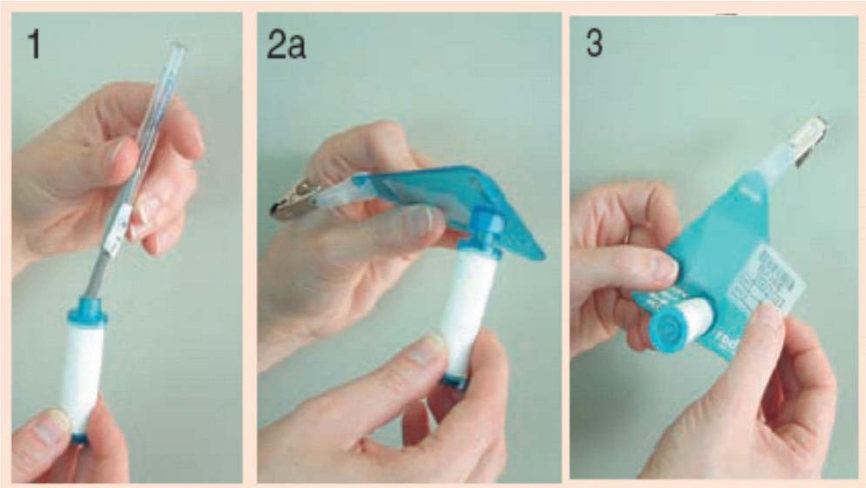
horizontal
(ambient air)

vertical
(personal monitoring)

Radiello sampling process

Before sampling

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



Sampling

After sampling

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

Analysis of sampled cartridges

In the Lab

- Technique depends on analyte
- Description of procedures in the radiello Manual

$$C\left[\mu g \cdot m^{-3}\right] = \frac{m\left[\mu g\right]}{Q\left[ml \cdot min^{-1}\right] \cdot t\left[min\right]} \cdot 1{,}000{,}000$$

Service by the Fondazione Salvatore Maugeri (FSM) / Padua, Italy

- Service provided directly by the FSM
- FSM supplies results by fax or email
- Process is described on the FSM web site www.radiello.com under lab service

Two options for desorption VOCs/BTEX

Chemical desorption

- p/w activated charcoal
- white diffusive body
- Desorption with CS_2

Thermal desorption

- P/w graphitized carbon black
- yellow diffusive body
- ATD-GC/FID or ATD-GC/MS
- also for phenolic compounds
- for diffusive sampler methods requiring TD

radiello diffusive samplers / adsorbent cartridges
for Organics

Compound class (Adsorbent)	**Diff. Body**	**Analysis by**
• **Aldehydes** (chemisorption on 2,4-DNPH)	B	→ *HPLC*
• **VOCs/BTEX** CS_2 chem. des. (activated charcoal)	W	→ *GC*
• **VOCs/BTEX** TD (graphitized carbon)	Y	→ *TD/GC*
• **Anaesthetic gases** (act. charcoal/mol. sieves)	M	→ *GC*
• **Phenols** TD (Tenax TA)	Y	→ *TD/GC*
• **1,3-Butadiene/Isoprene** TD (Carbopack X)	Y	→ *TD/GC*

W = white; B = blue; Y = yellow; M = membrane

See the radiello® Manual for more details

radiello diffusive samplers / adsorbent cartridges
for Inorganics

Compound class (Adsorbent)	**Diff. Body**	**Analysis by**
• **NO_2/SO_2/HF** (chemisorption on TEA)	B	→ *Photom/IC/ISE*
• **O_3** (chemisorption on 4,4'-Dipyridylethylene)	B	→*Photometry*
• **H_2S** (chemisorption on zinc acetate)	W	→*Photometry*
• **Ammonia** (chemisorption on phosphoric acid)	B	→*Photometry*
• **HCl** (adsorption on silica gel)	W	→ *Ion Chrom.*

W = white; B = blue; Y = yellow; M = membrane

See the radiello® Manual for more details

Ready-to-use Radiello Sampler

Preinstalled Cartridge in the diffusive body
Pack of 5
Shelf life 3 months
Special vertical adapter needed

- Is supplied with the sampler

Sterile components kit for anesthetic gases (RAD125)

- 10 single packages containing
  - 1 permeative body
  - 1 support plate
  - 1 vertical adapter
  - 1 adsorbing cartridge

Radiello Starter Kits

NEW! RAD170S – Hydrogen Sulfide for Visible Spectrometry

- 2ea. Cartridge Microporous PE Impregnated w/Zinc Acetate (like RAD170)
- 1ea. Vertical Adapter (like RAD122)
- 1ea. Triangular Baseplate (like RAD121)
- 1ea. White Diffusive Body (like RAD120)

RAD130S - VOC/BTEX for Chemical Desorption

- 2ea. Cartridge with Charcoal (like RAD130)
- 1ea. Vertical Adapter (like RAD122)
- 1ea. Triangular Baseplate (like RAD121)
- 1ea. White Diffusive Body (like RAD120)

RAD145S – VOC/BTEX for Thermal Desorption

- 2ea. Cartridge with Carbograph (like RAD145)
- 1ea. Vertical Adapter (like RAD122)
- 1ea. Triangular Baseplate (like RAD121)
- 1ea. Yellow Diffusive Body (like RAD1202)

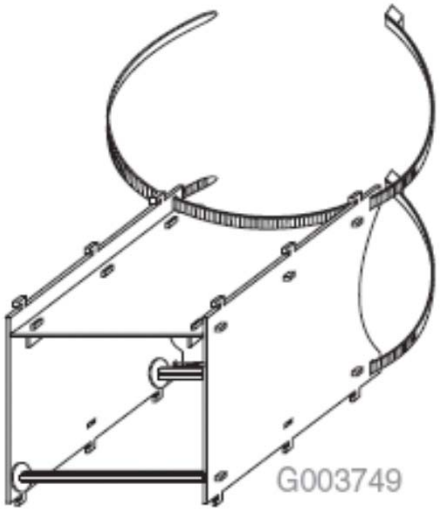
RAD141S – 1,3-Butadiene & Isoprene for Thermal Desorption

- 2ea. Cartridge with Carbopack X (like RAD141)
- 1ea. Vertical Adapter (like RAD122)
- 1ea. Triangular Baseplate (like RAD121)
- 1ea. Yellow Diffusive Body (like RAD1202)

radiello® Accessories

Outdoor Shelter

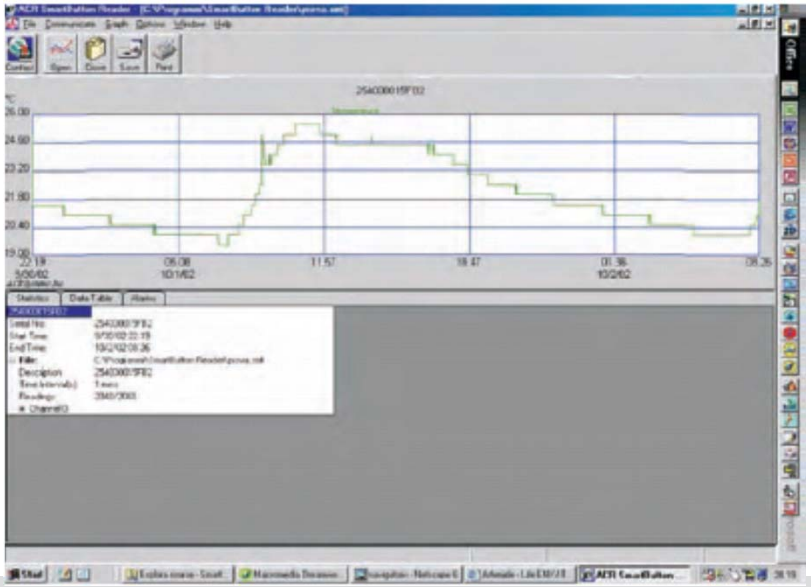
- Easy to assemble in the field
- No tools required
- Fits almost every post



radiello® Accessories

Thermometer & Reader

- Attached to a vertical adapter
- Software to program and read out



radiello® Accessories

Calibration Solution and Kits

- H_2S Analysis
  - Methylene blue solution for simplified calibration in photometry
- DNPH solution of 9 aldehydes for HPLC

- Pre spiked cartridge kits
  - BTEX (Chem. Des.)
  - BTEX (Thermal Des.)
  - VOCs (Chem. Des.)

Features & Benefits

High Uptake Rates

- Faster Sampling

Greater Capacity & Minimal reverse diffusion

- Uptake rates constant/more reproducible
  Higher accuracy of results, Broader sampling range

Uptake rate measured in controlled atmospheric chamber

- Uptake rate very precise

Stiff diffusive wall & Tortuosity of diffusive path

- More reproducible uptake rates, invariable to air speed

Water repellent diffusive body

- Amenable to bad weather

Low detection limits + high uptake rates + high capacity

- Sampling can range from 15 min – 30 days (1 ppb – 1000 ppm)

More Features

- Predominately solvent/chemical desorption
- Amenable to TD & GC/MS with low interferences
- Broad range of relevant gaseous pollutants
- Touch and chemically inert
- Available accessories (outdoor shelter) for ambient air analyses
- Reusable hardware components
  - Only cartridges need to be replaced for next sample

Official Methods

Method #	Description
EN 838:1995	Diffusive samplers for the determination of gases and vapors – requirements and test methods
EN 13528-1:2002 EN 13528-2:2002 EN 13528-3:2002	Ambient air quality – Diffusive samplers for the determination of concentrations of gases and vapours – Requirements and test methods- Part 1: General Requirements; Part 2: Specific requirements and test methods; Part 3: Guide to selection, use and mainte
EN 14412:2004	Indoor air quality- Diffusive samplers for the determination of concentrations of gases and vapours – Guide for selection, use and maintenance, (describes a radial sampler in general)
EN 14662-4:2005	Ambient air quality – Standard method for measurement of benzene concentrations – Part 4: Diffusive sampling followed by TD and GC
EN 14662-5:2005	Ambient air quality – Standard method for measurement of benzene concentrations – Part 5: Diffusive sampling followed by solvent desorption and GC; (describes Radiello as type B sampler)
ISO/FDIS 16000-4:2004	Indoor air – Part 4: Determination of formaldehyde – Diffusive Sampling method
EN ISO 16017-2:2003	Indoor, ambient and workplace air – Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas GC – Part 2: Diffusive sampling
ISO/FDIS 16200-2	Workplace air quality – Sampling and analysis of VOCs by solvent desorption/gas chromatography – Part 2: Diffusive Sampling Method; (describes Radiello as type D sampler)
Annual Book of ASTM Standards, 2004 - D6196-3	Practice of Selection of Sorbents, Sampling, and Thermal Desorption Analysis for Procedures for Volatile Organic Compounds in Air

EU Projects (LIFE) on Air Monitoring using Radiello Samplers

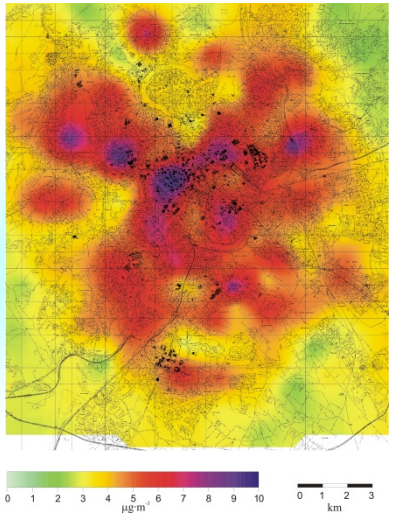
MACBETH project

- **M**onitoring of **A**tmospheric **C**oncentrations of **B**enzene in **E**uropean **T**owns and **H**omes (LIFE 96 ENV/IT/070)

RESOLUTION project

- Development of a high spatial resolution atmospheric monitoring model to verify the actual emissions reduction of **ozone** precursors foreseen by Auto-Oil program (LIFE99ENV/IT/081)

Dublin
Paris
Madrid
Rome



ARTEMIDE Project

- High temporal resolution monitoring of **VOC's** by diffusive sampler (LIFE 00 ENV/IT/000005)

Validation Studies by ERLAP for Ambient Air Monitoring using Radiello Samplers

EUR 19594 EN

- Validation of Radiello Diffusive Sampler for Monitoring Ozone in Ambient Air

EUR 20860 EN

- Laboratory and Field Inter-comparisons of NO_2 diffusive samplers

EUR 21754 EN

- Laboratory and Field Inter-comparisons of O_3 diffusive samplers

radiello® Information Material

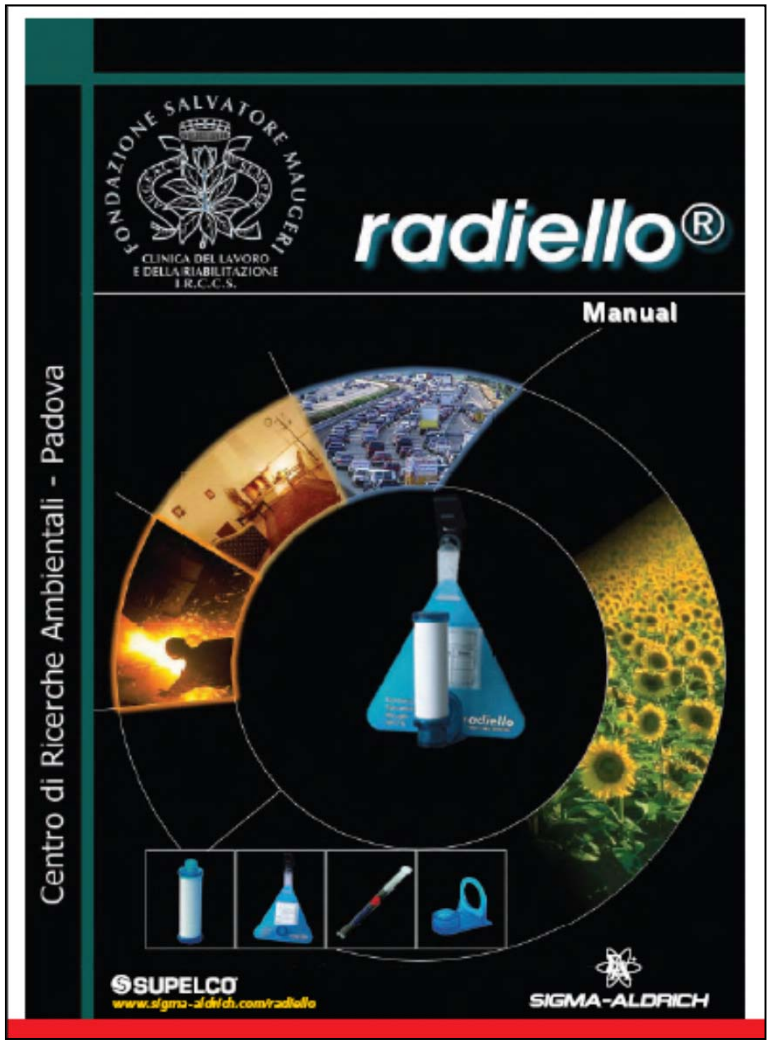
radiello® Manual

56 page documentation with all products and methods described

Available as pdf file

- On the radiello CD
- Website

www.sigma-aldrich.com/radiello



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radiello® Manual Content

Other indoor sampling experiments and outdoor campaigns

Thermal desorption is exceptionally suited for long exposure times at low concentrations, as in outdoor campaigns and some indoor environments (e.g. homes, schools, etc...), particularly if the subsequent analysis is performed by HRGC-MS.

The recommended exposure times range from 8 hours to the upper limits shown in the table below. It is advisable to reduce sampling time if the estimated overall VOCs concentration is higher than 2,000 µg·m⁻³.

Sampling rate values Q at 25°C (298 K)

	Q_{298} ml·min⁻¹	exposure time upper limit (days)	linear up to µg·m⁻³·min	uncertainty (2σ) %	limit of detection[1] µg·m⁻³
benzene	27.8	7	410,000	8.3	0.05
benzene	26.8	14	410,000[2]	7.5	0.05
butyl acetate	24.5	14	580,000	12.4	0.05
2-butoxyethanol	19.4	14	550,000	9.7	0.1
cyclohexane	27.6	7	470,000	14.7	0.1
n-decane	22.3	14	450,000	22.4	0.1
1,4-dichlorobenzene	22.0	14	650,000	9.5	0.1
dimethyl disulfide	23.7	7	500,000	9.1	0.04
n-heptane	25.3	14	420,000	7.6	0.05
n-hexane	25.5	7	420,000	10.9	0.05
ethylbenzene	25.7	14	550,000	9.1	0.01
2-ethyl-1-hexanol	14.3	14	550,000	17.4	0.07
2-ethoxyethanol	26.0	14	570,000	7.7	0.05
2-ethoxyethyl acetate	20.9	14	600,000	8.0	0.05
isopropyl acetate	25.8	7	540,000	9.6	0.1
limonene	12.8	14	550,000	24.8	0.2
2-methoxyethanol	4.0	7	1,000,000	--	1.0
2-metoxyethyl acetate	21.0	7	1,000,000	--	0.1
1-methoxy-2-propanol	26.6	7	600,000	11.6	0.2
n-nonane	21.0	14	440,000	11.8	0.07
n-octane	24.1	14	440,000	13.4	0.07
α-pinene	6.4	14	550,000	29.5	0.2
styrene	27.1	14	550,000	24.0	0.01
tetrachloroethylene	25.4	7	1,000,000	8.9	0.02
toluene	30.0	14	550,000	8.3	0.01
1,1,1-trichloroethane	20.0	7	300,000	13.0	0.1
trichloroethylene	27.1	7	800,000	9.5	0.02
1,2,4-trimethylbenzene	21.9	14	550,000	9.6	0.05
n-undecane	12.0	14	520,000	32.7	0.05
m-xylene	26.6	14	550,000	11.3	0.01
o-xylene	24.6	14	550,000	9.1	0.01
p-xylene	26.6	14	550,000	11.3	0.01

[1]after 7 days exposure and with MS detection; analytical conditions as described in the Analysis paragraph

[2]for overall VOCs concentrations not exceeding 500 µg·m⁻³

Storage

The cartridges have undergone a complex conditioning procedure that ensures an outstanding chromatographic blank level. If kept in a cool place without VOCs contamination, blank level and adsorbing capacity stay unaltered for at least eighteen months.

After exposure the cartridges, well capped and kept in a cool and solvent-free place, are stable for at least three months.

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Instrumental analysis

Analytical parameters for BTEX and VOCs are the same, apa
perature.

We recommended the following conditions:

Column

100% dimethylpolysiloxane, length 50m x 0.2.mm, film thickness 0.5 µm; (e.g. Petrocol DH 50.2, Supelco Cat.No. 24133-U) the column is directly fitted to the six-port valve of Turbomatrix apparatus.

Temperatures

- ✓ GC oven: 40 °C for 3 minutes, 8 °C/min up to 80 °C, mantain for 1 minute, 20 °C/min up to 250 °C for BTEX and up to 280 °C for VOCs, final isotherm 1.5 minutes for BTEX and 3 minutes for VOC
- ✓ GC-MS interface: 270 °C

Flows

- ✓ Carrier gas: helium, 0.8 ml·min⁻¹

On page E6 we display two total ion current chromatogra
urban site and an indoor sampling respectively.

In the first case, the benzene peak corresponds to an averag
µg·m⁻³; in the second the concentration of 1,4-dichloroben
the signal-to-noise ratio is very high in both cases. As a cor
ble.

Analysis

The analytical methods hereafter described have been set up with the Perkin-Elmer Turbomatrix thermal desorber and Agilent 5973 MSD mass spectrometer detector. They may be implemented on other instruments by introducing minor adjustements as suggested by the analyst's experience and characteristics of employed instrumentation.

In the following we propose two methods, one for **BTEX** analysis and another for **VOCs**. The former is suited to outdoor sampling in urban monitoring, where investigation is usually focussed onto benzene, toluene, ethylbenzene and xylene isomers. The latter is conceived for indoor monitoring, allowing quantification of all the compounds listed on page E3 and also extended qualitative analysis. The two methods differ by a few details, such as the higher desorption temperature for VOCs and the higher cryofocusing temperature for BTEX. The latter caution is introduced to avoid freezing of excess humidity gathered during the sampling in the cryofocusing trap.

Desorption

The thermal desorber is equipped with 1/4" OD SS sample tubes, they have to be hollow and free: discard the stainless steel gauze disk which is fitted to the groove and discard also the springs if present.

Code 145 cartridge has been dimensioned to fit the diameter of Turbomatrix thermal desorption tubes. Its length is such that, when the cartridge is introduced into the tube and is stopped by the groove, it is positioned exactly centrally with respect to the tube length.

Inner diameter of Perkin-Elmer tubes is not always exactly the same; it may be the case therefore that a cartridge code 145 does not slide easily into the tube. Some pushing tool may be helpful then, such as a 500 µl syringe piston, a glass bar or an iron wire 2-3 mm thick.

In some cases the tube inner diameter is sligthly larger than the cartridge outer diameter: the cartridge can therefore be pushed out from the tube during desorption due to the desorption gas pressure. If this is the case, make use of the springs provided along with the tubes.

Once capped, the Turbomatrix steel tube has to be positioned in the carousel with the grooves on the bottom.

The described conditions have been optimized for seven days exposures to typical concentrations of urban atmospheres and indoor environments. Shorter exposure times or considerably higher concentrations would require different settings of split flows, with the purpose of ensuring good analytical sensitivity or linearity of response.

Usually, the cartridge enters into the Turbomatrix tube by simple pouring. If it does not occur, use a pushing tool to press the cartridge till the nick on the tube.

BTEX

Temperatures and timing

- ✓ Desorption: 320 °C for 10 minutes
- ✓ Cryofocusing trap (Tenax TA): during primary desorption manitain 2 °C, secondary desorption at 99 °C/sec up to 290 °C, 1 minute at 290 °C
- ✓ Six port valve: 150 °C
- ✓ Transfer line: 200 °C

Flows

- ✓ Carrier gas: helium, 24 psi
- ✓ Desorption flow: 100 ml·min⁻¹
- ✓ Inlet split: 90 ml·min⁻¹
- ✓ Outlet split: 30 ml·min⁻¹

VOCs

Temperatures and timing

- ✓ Desorption: at 370 °C for 15 minutes
- ✓ Cryofocusing trap (Tenax TA): during primary desorption maintain at -20 °C, secondary desorption at 99 °C/sec up to 290 °C, 1 minute at 290 °C
- ✓ Six port valve: 150 °C
- ✓ Transfer line: 200 °C

Flows

- ✓ Carrier gas: helium, 24 psi
- ✓ Desorption flow: 100 ml·min⁻¹
- ✓ Inlet split: 90 ml·min⁻¹
- ✓ Outlet split: 30 ml·min⁻¹

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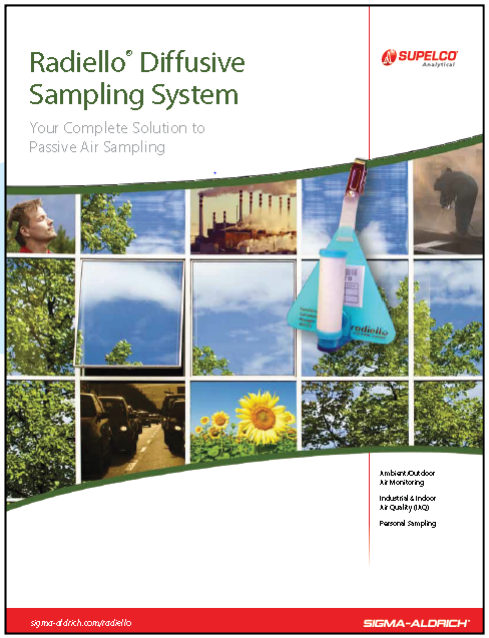
Description of sampling & analysis methods

radiello® Information Material

Radiello Brochure (T406090)

Provides an overview on the radiello line and background information



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radiello®-CD

- Radiello Manual
- Literature reference list
  - Journal articles, Symposium Poster, Official Methods
- Excel™ Template for reporting sampling data
- Chemicals & Supplies listing for Radiello Analysis
- Radiello Brochure
- Link to analytical service by FSM on www.radiello.com

(IXW)

www.sigma-aldrich.com/radiello

- Provides background information
- Product listings
- Link to pricing
- Literature downloads

Analytical / Chromatography

radiello Diffusive Air Samplers

radiello® passive/diffusive samplers for environmental monitoring, ambient and outdoor air monitoring, industrial hygiene, industrial air quality (IAQ), personal sampling and breathing zone assessment. The radial design offers higher capacity and faster uptake/sampling rates than traditional passive monitors. Applications include BTEX, VOCs, NO_2, SO_2, HF, aldehydes, ozone, H_2S, ammonia, HCl, phenols, anesthetic gases/vapors and 1,3-butadiene & Isoprene.

Products:

- radiello Products
- Cartridge Adsorbents
- Diffusive Bodies & Support Plate
- Ready-to-use Sampler
- Starter Kits
- Accessories for radiello
- Air Monitoring
- Calibration Solutions & Kits

Special Offers:

- Sigma-Aldrich Monthly Savings

Toolbox

- Analytical Service for radiello®
- Sample Data Collection Template (Excel)
- Standards Search

Learning Center:

- What is passive diffusive sampling?
- What is radiello®?
- How to use radiello®
- Applications & Methods
- Frequently Asked Questions NEW
- Literature & Downloads
- Brochure & CD Request
- Air Sampling Product Guides by Industry

Related Topics:

- Air Monitoring
- Solvent Center
- Labware

Quick Links:

- Request Literature
- Newsletter Subscription
- Interactive Supelco Catalog
- Join our Analytical Community

NEW radiello® brochure (request)

Summary

radiello® samplers

provide for a range of analytes

- Quicker results than axial passive samplers (up to 10x)
- Higher capacity
  - More precise results due to low back diffusion
  - Broader range of concentrations
- Experimentally determined sampling rates
- Easy handling

Are supported by analysis service available by FSM and other global locations

Passive Sampling with Chromline DFH

Chromline New Products

Based on SPME Fast Fit Assemblies
and feed for Multifiber EXchanger System MFX

Diffusive Fiber Holder (DFH) for air sampling
FFA Field Sampler
Storage container

DFH

FFA-FS

Storage

DFH

Diffusive Sampling Holder (DHF) - Overview

Passive Air Sampling with SPME !

- TWA Sampling (Time Weighted Average)

Uses Fast Fit Assemblies (SPME-FFA)

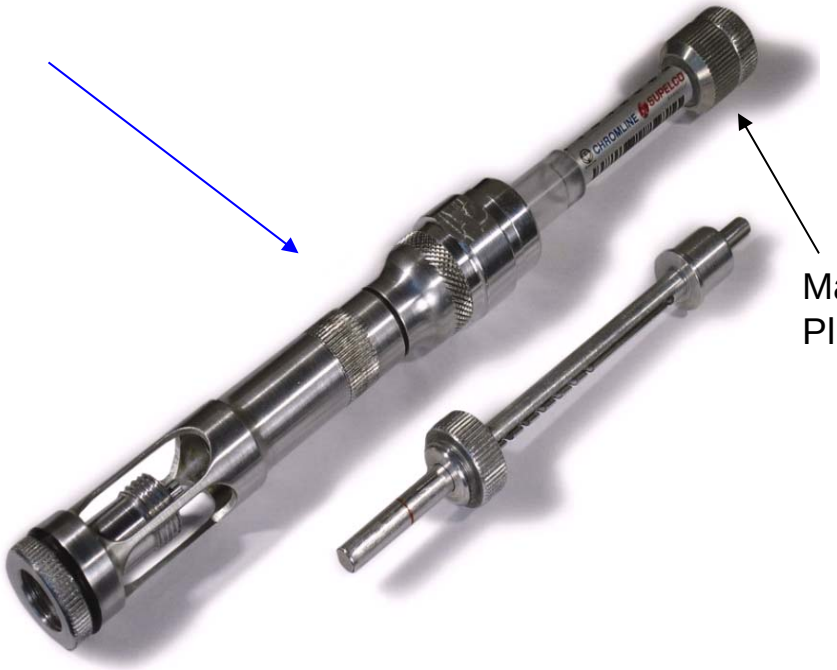
Sensitivity can be adjusted

Same sealing mechanism as for Storage container

- Self-contained for Transport & Storage

SPME FFA

Cat.No. 57584-U



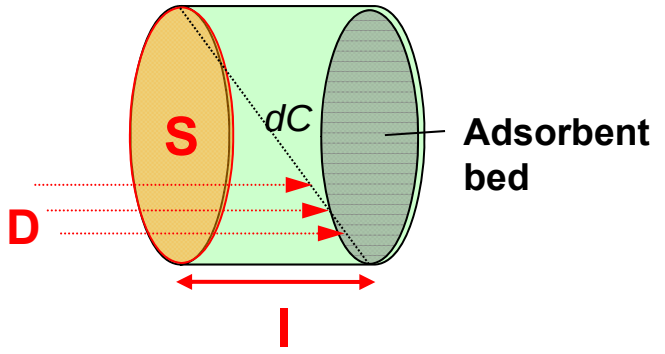
Diffusive Sampling

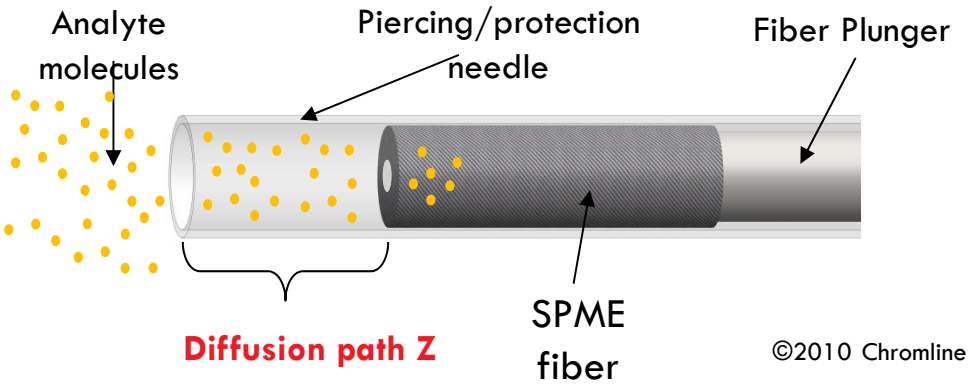
Fick' Diffusive Law

$$\frac{dm}{dt} = D \cdot S \cdot \frac{dC}{dl}$$

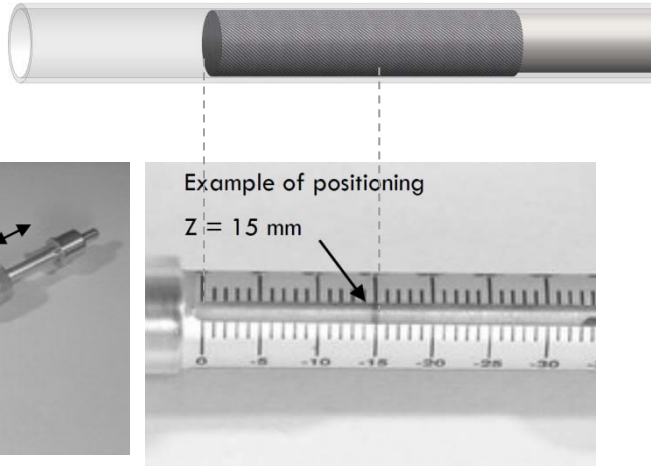
SR

$$\overline{C} = \frac{m}{SR \times t}$$





Sampling Rates DFH



Sampling rate adjustment

- using magnetic plunger
- After adjustment optional storage/transport of FFA in

Sampling rates for 97 analytes in the manual

Calculation of SR

$$SR = \frac{A}{Z} \times D$$

SR sampling rate (cm^3/min),
A surface area of the needle opening
A23ga= 1.464x10-3 cm^2
A24ga= 9.926x10-4 cm^2
Z diffusion path length (cm),
D diffusion coefficient of the analyte in air (cm^2/min).

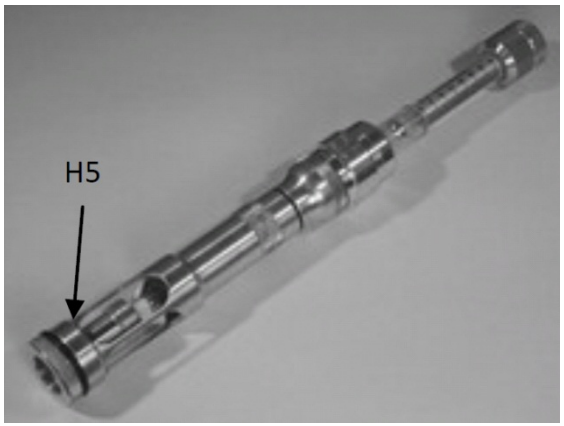
APPENDIX TABLE 1

Theoretical SR Values
at 25°C for a 23 ga 85 µm Carboxen/PDMS Fiber (Cat.# FFA57295-U).

How to estimate SR values is described on page 20.

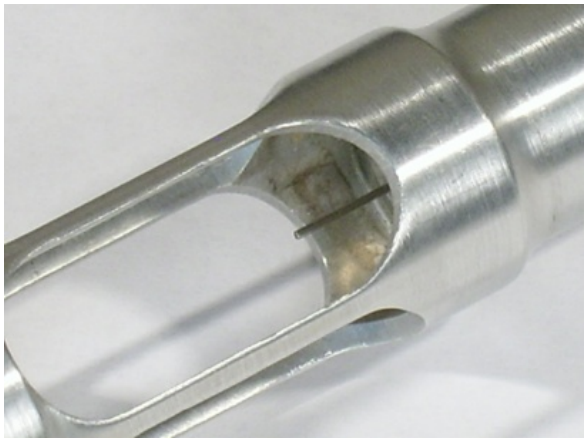
Compound	CAS #	Z_3 (mm)	SR theor. (ml/min)	Z_5 (mm)	SR theor. (ml/min)	Z_{10} (mm)	SR theor. (ml/min)	Z_{30} (mm)	SR theor. (ml/min)
Acetone	67-64-1	3	0,031037	5	0,018622	10	0,009311	30	0,003104
Acetonitrile	75-05-8	3	0,037186	5	0,022311	10	0,011156	30	0,003719
benzyl alcohol	100-51-6	3	0,021140	5	0,012684	10	0,006342	30	0,002114
n- Amyl acetate	628-63-7	3	0,019676	5	0,011806	10	0,005903	30	0,001968
Benzene	71-43-2	3	0,024068	5	0,014441	10	0,007220	30	0,002407
Bromochloromethane	74-97-5	3	0,028402	5	0,017041	10	0,008520	30	0,002840
1,2,3 trichloropropane	96-18-4	3	0,021755	5	0,013053	10	0,006527	30	0,002176
sec-butanol	78-92-2	3	0,026293	5	0,015776	10	0,007888	30	0,002629
n-butanol	71-36-3	3	0,026293	5	0,015776	10	0,007888	30	0,002629

Sampling With the DFH



On Site - Removal of Sealing Mechanism

Storage of Sealing Mechanism



Fiber Protection
during Sampling

After sampling

- reverse steps
- or place FFA in Storage container

Desorption of FFA used in DFH

Manual Desorption with DFH Adapter (57541-U)

Automated Desorption by MFX System (e.g. 25-Pos.)

Potential Application areas

Industrial Hygiene

Indoor / Outdoor Air Measurements

Air Monitoring research

- Long term sampling
- Multiple parallel Measurements
  - Potentially just expose adjusted FFAs with out the DFH

SPME - Chromline

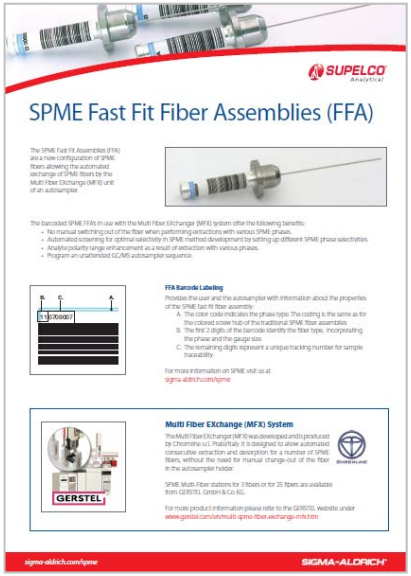
Available Information

FFA Flyer (MPK) – available from Klaus B.

Holder and Sampler Flyer (in Draft)

Reporter 44 (Jan 2011) Introduction of new holders & sampler

Product Manuals as pdf.



(MPK)

(Rep.44)

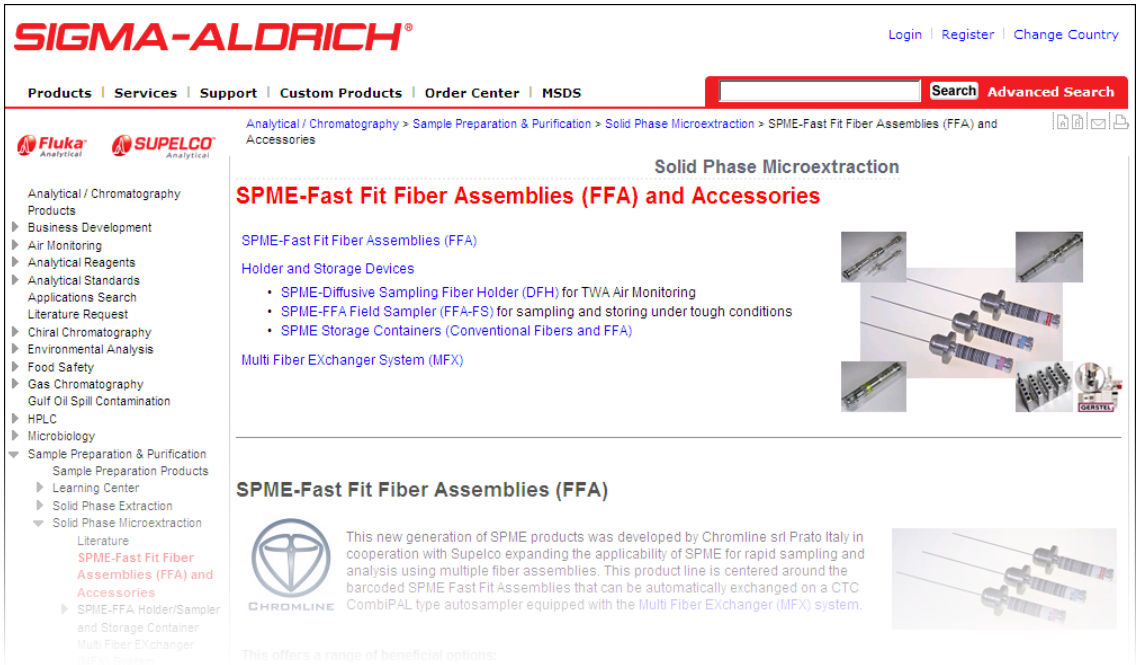
(Draft)

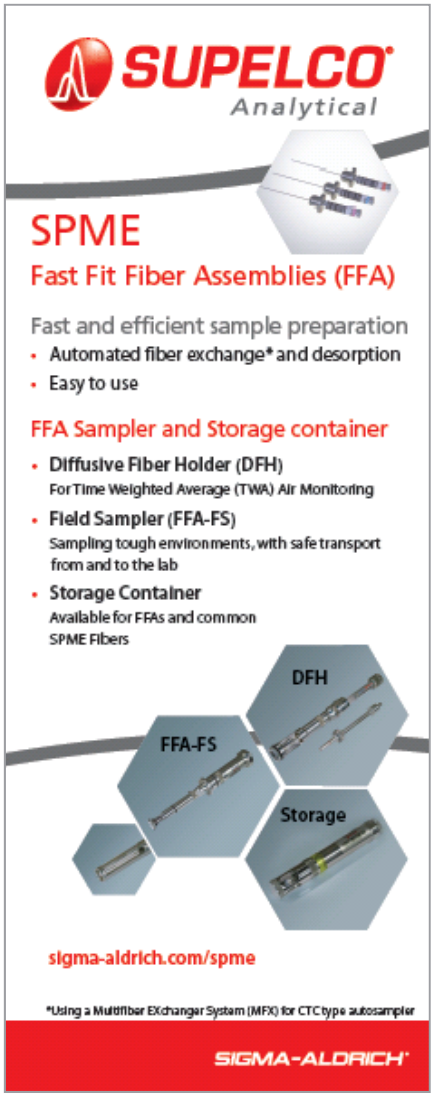
SPME - Chromline

Web site

Productline overview

- Manuals for download





Dziękuję za uwagę!

sigma-aldrich.com/radiello

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CLINICA DEL LAVORO E DELLA RIABILITAZIONE
I.R.C.C.S

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