

Collection of Airborne Contaminants using Passive/Diffusive Samplers

Unparalleled Sensitivity
and Detection with
Innovative Devices



The life science business of
Merck KGaA, Darmstadt,
Germany operates as
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Supelco®
Analytical Products

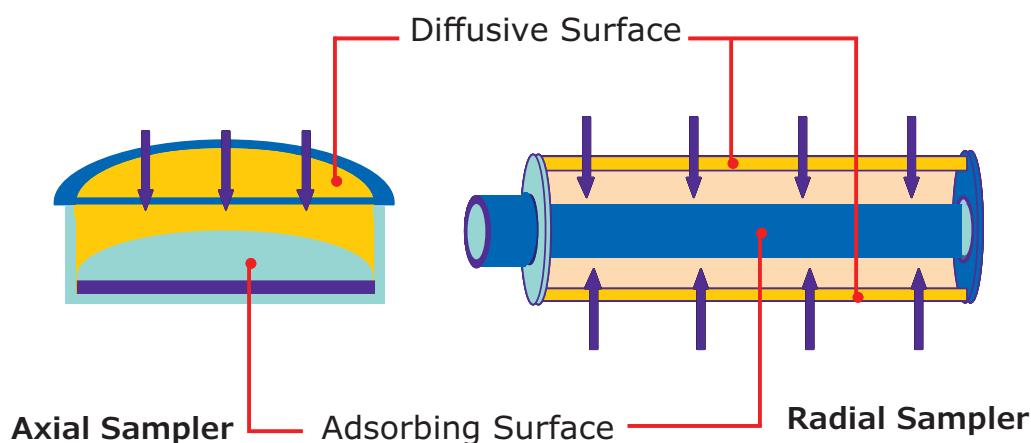
Table of Contents

Introduction to Passive / Diffusive Sampling	3
radiello® Passive Sampling Devices	4
Cartridge Adsorbents and Key Accessories	6
radiello® Accessories and Replacement Parts	8
Quick Product Look Up	9
radiello® Calibration Solutions and Kits	10
Diffusive Sampling Devices (DSD).....	12
Overview of DSD Passive Sampling Devices.....	13
DSD Samplers with In-Device Elution Design.....	13
DSD Samplers with Adsorbent Transfer Design	14
Axial Passive Sampling Devices.....	16
Analytical Columns Recommendations for Instrumental Analysis	19
Analytical Columns for GC Analysis	19

Introduction to Passive / Diffusive Sampling

The first passive / diffusive air samplers were developed in the early 1970's but they did not become popular until 20 years later in the 1990's. Unlike active sampling, which requires a pump set to a pre-determined flowrate to collect a known volume of air over time (from 15 minutes up to 24 hours). Passive samplers do not require an air sampling pump and rely on Fick's Law of Diffusion for the migration of the contaminants from the environment into the adsorbent bed inside the device.

Passive sampling devices differ by geometry and are categorized as: 2D axial/badge Type passive samplers which have a two-dimensional diffusive surface; and Radial passive samplers which have a three-dimensional radial geometry. Radial passive samplers have a larger diffusive surface and collect contaminants at a faster sampling rate and have greater analyte sensitivity



Uptake/Sampling rates are higher for radial samplers compared to axial samplers
(e.g. Benzene @25 °C <10 mL/min vs. >70 mL/min)

Features and Benefits:

- Compact, portable, unobtrusive and inexpensive
- Wide range of sampling capabilities from 15 minutes (Short-term Exposure Levels – STEL) to 8 hrs (Time-weighted average – TWA) up to several weeks
- Suitable for sampling for Industrial Hygiene (IH), Indoor Air Quality (IAQ) and Ambient Air Monitoring
- Adsorbent cartridges available for sampling for passive sampling a wide range of contaminants
- Fully supported workflow, we offer: sample collection accessories for indoor and outdoor sampling; analytical standards for calibration; solvents for sample preparation; HPLC and GC columns, vials and syringes, etc

Supelco® offers both Radial Passive Sampling Devices featuring - radiello® and DSD and Axial passive sampling devices – single-bed Thermal Desorption Tubes featuring the FLM™ Carbo-pack™ X for Fenceline Monitoring (EPA method 325 A/B)

radiello® Passive Sampling Devices

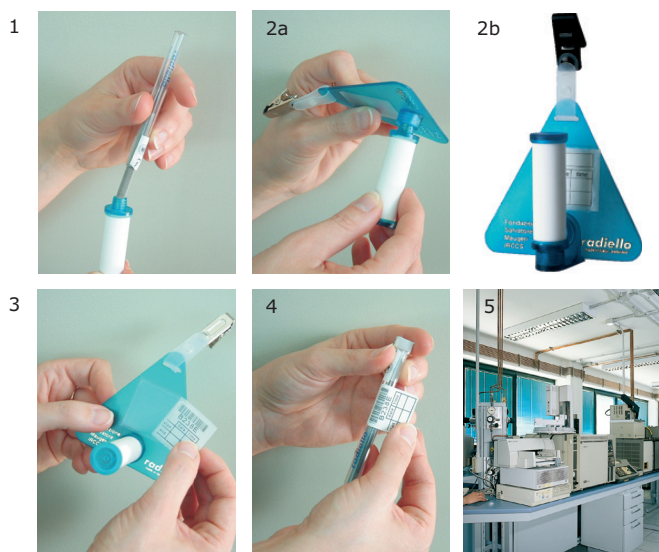
How to use radiello® Samplers

Assembly of the radiello® sampler is simple. Sampling using radiello® monitors begins with a quick assembly of the support plate. The adsorbent cartridges used to collect samples are housed in a sealed glass tube that is used to store the cartridge before and after sampling. Prior to sampling, the adsorbent cartridge needs to be transferred to the appropriate diffusive body, which is then screwed onto the triangular support plate horizontally for stationary sampling, or vertically (with adapter) for personal sampling. The overall design of the radiello® sampler allows users to easily transfer the adsorbent cartridges from the diffusive body without touching the adsorbent itself (**Figure 2**). Protective outdoor shelters are recommended for environmental/ambient air sampling (**Figure 3**).

How to use radiello samplers (ref Figure 2)

1. Transfer adsorbent cartridge from the storage container into the diffusive body.
- 2a. Screw diffusive body into triangular support plate.
- 2b. Use vertical adapter for personal sampling.

Figure 2. Preparation of radiello® Sampler



3. Insert label into sampler pocket and document date and time on the enclosed barcode label. Sampling has begun.
4. At the conclusion of sampling, transfer the adsorbent cartridge from the diffusive body to the original sealed glass tube, and document date, time, and temperature on the barcode label. Transfer label to the original sealed glass tube housing the adsorbent cartridge.
5. Desorb and analyze adsorbing cartridge or submit to laboratory for analysis.

Desorption and Analysis

There are over 10 different cartridge adsorbents and 4 different diffusive bodies to sample hundreds of different gaseous compounds under a variety of environmental conditions. For each compound, detailed desorption and analytical protocols are available at **SigmaAldrich.com/Radiello**

Analytical services are available in Europe, United States and Australia with new laboratories adding radiello® testing services on a regular basis. For more information visit our website for the most current list of analytical laboratories.

Figure 3. Outdoor Shelter for Environmental/Ambient Air Sampling

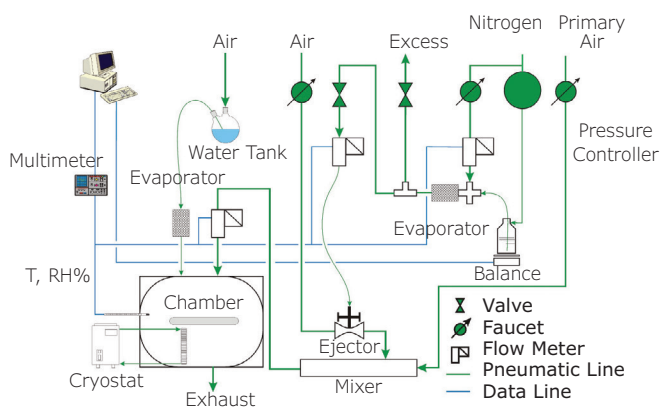


The protective outdoor shelter is easily transported and assembled directly at the sampling site.

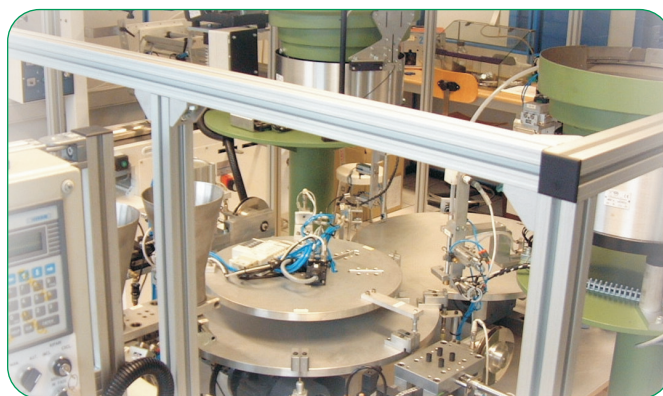
radiello® Features & Benefits

- Omnidirectional design offers high uptake rates resulting in faster sampling
- Greater adsorbent capacity ensures minimal back diffusion and greater uptake rate consistency resulting in more reproducible results
- Tight design specifications and a stiff diffusive wall promote greater uptake rate reproducibility
- Uptake rates are also invariable to air speed allowing users to sample in diverse conditions
- All uptake rates are precisely measured (not calculated) in a controlled atmospheric chamber under a range of conditions including analyte concentration, temperature, relative humidity, air speed, with and without interfering compounds, etc.
- The water repellent diffusive body makes radiello® amenable to bad weather
- All cartridge adsorbents undergo a complex conditioning and QC procedure resulting in cartridge background levels three times lower than instrument noise
- The combination of low detection limits, high uptake rates and high capacity allows for sampling time ranges from 15 min. to 30 days (1 ppb – 1000 ppm)
- Detailed desorption and analytical conditions are available in the radiello® manual (IYP) which can viewed and downloaded at SigmaAldrich.com/radiello
- Other benefits include, but are not limited to:
 - Predominantly solvent/chemical desorption which does not require thermal desorption equipment
 - Amenable to TD & GC-MS with low interferences resulting in precise and very sensitive measurements
 - Touch and chemically inert making the sampler robust in use
 - Reusable hardware for more economic sampling
 - Available accessories (shelter) for ambient air analyses making radiello® samplers suitable for a wide range of application areas

Atmospheric Chamber Set Used to Measure Uptake Rates Under Controlled Sampling Conditions



Manufactured in a Clean Environment



radiello® is Suitable for Sampling...

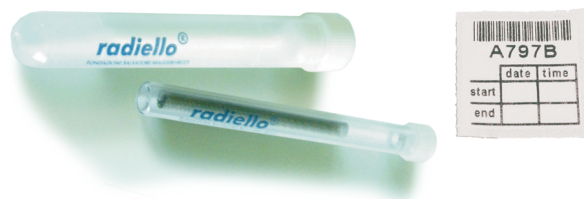
- VOCs – over 70 different volatile organic compounds, e.g. tetrachloroethylene (PCE), trichloroethylene (TCE)
- Aldehydes – acetaldehyde, acrolein, benzaldehyde, butanal, hexanal, formaldehyde, glutaric aldehyde, isopentenal, pentenal, and propanal
- BTEX – benzene, toluene, ethylbenzene, o-xylene, m-xylene, and p-xylene
- 1,3-Butadiene and Isoprene
- Phenols – phenol, methylphenol, and dimethylphenol
- O₃ – ozone
- NH₃ – ammonia
- NO₂ and SO₂ – nitrogen and sulfur dioxides
- Anesthetic Gases/Vapors – nitrous oxide, isoflurane, ethrane, halothane, and sevoflurane
- H₂S – hydrogen sulfide
- HCl and HF – hydrochloric acid and hydrofluoric acid

For more information on radiello® applications and the use please refer to SigmaAldrich.com/radiello

Cartridge Adsorbents and Key Accessories

To conduct air sampling using the radiello® system, the minimum requirements are: cartridge adsorbent, diffusive body, adhesive labels for tracking sampling date/time, and a support plate for attaching the diffusive body-cartridge assembly.

Cartridge Adsorbents and Adhesive Labels



Cartridge Adsorbents

Several different cartridge adsorbents are available, each of which are specific for different classes of compounds. The dimensions for each cartridge are 60 mm L x 4.8 or 5.8 mm diameter. Each cartridge is designed for one time use with the exception of Thermal Desorption (TD) cartridge adsorbents

Each cartridge arrives in a sealed glass or plastic tube wrapped in a transparent thermally sealed polyethylene

(PE) bag. The same sealed bag can be used to store the cartridge after sampling prior to desorption and analysis. A sufficient number of adhesive labels with barcode are included with every pack of cartridges for easy tracking of sampling date and time.

Compound Class	Description of Adsorbent Bed	Pkg Qty.	Cat. No.
VOCs /BTEX for CS ₂ Desorption	SS net (5.8 mm diameter), activated charcoal	20	RAD130
VOCs /BTEX for Thermal Desorption	SS net (4.8 mm diameter), Carbograph® 4	20	RAD145
Aldehydes	SS net w/ 2,4-DNPH coated Florisil®	20	RAD165
Ammonia	Microporous PE impregnated with phosphoric acid	20	RAD168
Anaesthetic Gases/Vapors	SS net w/mix of mol sieve & activated charcoal	20	RAD132
Hydrochloric Acid (HCl)	SS net w/silica gel	20	RAD169
Hydrofluoric Acid (HF), Nitrogen Dioxide (NO ₂), and Sulfur Dioxide (SO ₂)	Microporous PE coated w/ wet TEA	20	RAD166
Hydrogen Sulfide (H ₂ S)	Microporous PE impregnated with zinc acetate	20	RAD170
Ozone (O ₃)	Micropore PE tube with 4,4'-dipyridylethylene coated silica	20	RAD172
Phenolic Compounds for Thermal Desorption	SS net (4.8 mm diameter), Tenax-TA®	20	RAD147
1,3-Butadiene / Isoprene	SS net (4.8 mm diameter), Carbo-pack™ X	20	RAD141

Diffusive Bodies

The diffusive bodies are designed to house radiello® cartridge adsorbents during sampling. The diffusive bodies are threaded at one end for easy attachment to the radiello® triangular support plate. Unlike most of the cartridge adsorbents, the diffusive bodies are reusable and cleaned with a mild detergent as necessary. The diffusive bodies will collect dust (especially during outdoor sampling), and replacement is recommended after 4-5 washings. Dimensions are 60 mm height x 16 mm diameter.

There are 4 different diffusive bodies available. Each of which are application specific in design. Please refer to the radiello® Manual (IYP) or use the listing of the ready-to-use samplers on page 10 for selection.

Diffusive Bodies are Available in Four Different Application Specific Designs



Description	Pkg Qty.	Cat. No.
White Diffusive Body	20	RAD120
Blue Diffusive Body	20	RAD1201
Yellow Diffusive Body	20	RAD1202
Permeative Diffusive Body (gray)	20	RAD1203

Triangular Support Plate

The triangular support plate acts as both a closure and means of suspension for the diffusive body and cartridge adsorbent during sampling. Each support plate is threaded for easy diffusive body attachment. Each plate includes a clip and transparent adhesive pocket to hold the barcode label.

Description	Pkg. Qty.	Cat. No.
Triangular Support Plate	20	RAD121
Replacement Clips	20	RAD195



1,3-Butadiene Sampler for Measuring Workplace Atmospheres



Manufacturing of elastomers makes wide use of 1,3-butadiene and isoprene (2-methyl-1,3-butadiene). Both are classified as carcinogenic by the International Agency for Research on Cancer (IARC).

The radiello® butadiene sampler represents a sensitive, simple and affordable tool for measurement of workplace air also in hazardous environments.

The sampler consists of a cartridge adsorbent (RAD141) filled with Carbo-pack™ X, a graphitized carbon black developed and manufactured by Supelco®, 1,3-Butadiene Sampler for Measuring Workplace Atmospheres (RAD141).



After sampling, the cartridge adsorbent is placed in a TD empty tube and analyzed by thermal desorption (TD)/GC-MS. Read more about this sampling on our website SigmaAldrich.com/radiello.

radiello® Starter Kits for Chemical and Thermal Desorption



To make the first steps with radiello® samplers easier, starter kits for radiello® samplers are available, containing one complete sampler with an additional adsorbent cartridge. No additional parts are needed. By this, analysts that would like to try the radiello® system will have a handy pack size for their first tryout.

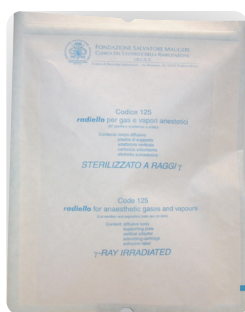
A kit contains 2 adsorbent cartridges and barcode label, a triangular base plate, a diffusive body, 1 vertical adapter and an instruction sheet.

Description	Pkg. Qty.	Cat. No.
For Chemical Desorption		
VOC/BTEX sampler	1	RAD130S
Hydrogen Sulfide sampler	1	RAD170S
For Thermal Desorption		
VOC/BTEX sampler	1	RAD145S
1,3-Butadiene/Isoprene sampler	1	RAD141S

Anesthetic Gases and Vapor Sampler

Sampler separately packaged in sterile bag (one complete sampler per bag).

Description	Pkg. Qty.	Cat. No.
Anesthetic Gases and Vapor Sampler	10	RAD125



radiello® Barcode Labels

Each label is self-adhesive with a unique barcode for the unmistakable identification of the cartridge adsorbent during sampling, desorption, and analysis.

Description	Pkg. Qty.	Cat. No.
radiello® Labels	198	RAD190



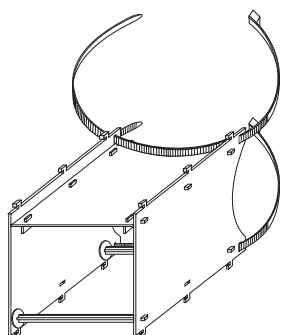
radiello® Accessories and Replacement Parts

Outdoor Shelter

A polypropylene protective outdoor shelter is available for housing up to four radiello® samplers during outdoor/ambient air sampling. The shelter allows for adequate ventilation while simultaneously protecting the samplers from harsh weather conditions. The shelter can be mounted to a variety of street fixtures including lamp posts, traffic lights, and telephone poles of various diameters. The shelter can be easily transported from the lab and mounted without the use of tools. The dimensions of the shelter are 159 mm x 230 mm. The shelter comes in a pack of 10 and includes 20 mounting strips.

Description	Pkg. Qty.	Cat. No.
Outdoor Shelter	10	RAD196
Spare Mounting Strips	100	RAD198

The Outdoor Shelter Allows for Adequate Ventilation and Protection of Samples



Filtration Kit

The filtration kit consists of polypropylene syringe barrels and 13 mm diameter syringe filters with 0.45 µm porosity. The filtration kit is ideal for filtering aqueous samples prior to reversed-phase HPLC and ion-chromatography.

Description	Pkg. Qty.	Cat. No.
Filtration Kit	20	RAD174



On-Field Thermometer and Reader

Uptake rates are dependent on temperature; therefore, concentration values obtained during sampling will be more accurate if precise temperature values are recorded during sampling. Note that temperature variations of 4-5 °C can be recorded from one area of an urban population to another.

The radiello® thermometer acts like a mini (< 1 cm³ in size) temperature measurement station that can be mounted on the triangular support plate in conjunction with the diffusive body via a pre-attached vertical adapter. The thermometer offers a precision of ± 0.5 °C between -20 to 80 °C, and can log up to 2048 temperature data points allowing you to record one temperature reading every 15 min. for 22 days, every 30 min. for 43 days, or every 60 min. for 85 days. The thermometer requires no batteries, and is amenable to harsh weather conditions.

The temperature reader (purchased separately) connects the thermometer to your PC via USB port allowing the user to program the thermometer before sampling and download temperature readings after sampling. Each thermometer has a unique serial number for easy identification.

Description	Pkg. Qty.	Cat. No.
radiello® Thermometer	3	RAD126
radiello® Thermometer Reader	1	RAD127

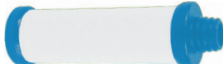





Empty Storage Tubes

Description	Pkg. Qty.	Cat. No.
radiello® Glass Tube, 2.8 mL, with stopper	20	RAD1991
radiello® PP Tube, 12 mL, with stopper	20	RAD1992



Quick Product Look Up

Compound Class/Application	Former radiello® Code	Description	Pkg Qty.	Cat. No.
radiello® Starter Kits				
VOC/BTEX Sampler for CS ₂ -Desorption	NA	Starter kit (2 cart., 1 diff. body, 1 plate, 1 vert. adapter)	1	RAD130S
VOC/BTEX Sampler for Thermal Desorption	NA	Starter kit (2 cart., 1 diff. body, 1 plate, 1 vert. adapter)	1	RAD145S
1,3-Butadiene/Isoprene Sampler for Thermal Desorption	NA	Starter kit (2 cart., 1 diff. body, 1 plate, 1 vert. adapter)	1	RAD141S
Hydrogen Sulfide Sampler	NA	Starter Kit (2 cart., 1 diff. body, 1 plate, 1 vert. adapter)	1	RAD170S
Cartridge Adsorbents				
VOCs/BTEX for CS ₂ Desorption	130	SS net (5.8 mm diam), activated charcoal	20	RAD130
VOCs/BTEX for Thermal Desorption	145	SS net (4.8 mm diam), 350 mg Carbograph 4	20	RAD145
Aldehydes	165	SS net w/2,4-DNPH coated Florisil	20	RAD165
Ammonia	168	Microporous PE impregnated with phosphoric acid	20	RAD168
Anaesthetic Gases/Vapors	132	SS net w/mix of mol sieve & activated charcoal	20	RAD132
Hydrochloric Acid (HCl)	169	SS net w/silica gel	20	RAD169
Hydrofluoric Acid (HF), Nitrogen Dioxide (NO ₂), and Sulfur Dioxide (SO ₂)	166	Microporous PE coated w/ wet TEA	20	RAD166
Hydrogen Sulfide (H ₂ S)	170	Microporous PE impregnated with zinc acetate	20	RAD170
Ozone (O ₃)	172	Micropore PE tube with silica coated with 4,4'-dipyridylethylene	20	RAD172
Phenolic Compounds for Thermal Desorption	147	SS net (4.8 mm diameter), Tenax-TA®	20	RAD147
1,3-Butadiene / Isoprene	NA	SS net (4.8 mm diameter), Carbo-pack™ X	20	RAD141
Diffusive Bodies				
	120	White Diffusive Body, microporous PE 1.7 mm thick	20	RAD120
	120-1	Blue Diffusive Body, Same specifications as White Diffusive Body but darkened with blue dye to protect the cartridge from sunlight	20	RAD1201
	120-2	Yellow Diffusive Body, microporous PE 5 mm thick	20	RAD1202
	120-3	Permeative Diffusive Body, silicone membrane by SS net	20	RAD1203
Support Plate and Vertical Adapter				
	121	Triangular Support Plate	20	RAD121
	122	radiello® Vertical Adapter	20	RAD122
Key Accessories				
	196	Outdoor Shelter	10	RAD196
	198	Spare Mounting Strips	100	RAD198
	126	radiello® Thermometer	3	RAD126
	127	radiello® Thermometer Reader	1	RAD127
	174	Filtration Kit	20	RAD174
	190	radiello® Labels	198	RAD190
	199-1	radiello® Glass Tube, 2.8 mL	20	RAD1991
	199-2	radiello® PP Tube, 12 mL	20	RAD1992
Standards and Calibration Kits				
	171	H ₂ S Methylene Blue Calibration Standard, 100 mL	1	RAD171
	302	Aldehyde Calibration Standard, 10 mL	1	RAD302
	405	BTEX Calibration Kit (CS ₂ Desorption)	1	RAD405
	407	BTEX Calibration Kit (Thermal Desorption)	1	RAD407
	406	VOC Calibration Kit (workplace environment)	1	RAD406

radiello® Calibration Solutions and Kits

H₂S (Hydrogen Sulfide) Calibration Standard

Methylene blue concentrate that, once diluted 1:50, provides the same absorbance value of hydrogen sulfide at 665 nm at a concentration of 1.145 µg/L sulfide ions. This concentration value is the highest absorbance value with the linear range of the spectrophotometer and can be used as the stock solution to prepare standards for the calibration curve, and is suitable for preparing 50 calibration curves using the recipe described in the table. The standard is stable for at least one year.

Solution	mL of	mL of water	Equivalent to µg/mL of S ²⁻
A	2 of RAD171	98	1.145
B	25 of A	25	0.572
C	10 of A	40	0.229
D	5 of A	45	0.115

Description	Pkg. Qty.	Cat. No.
H ₂ S Methylene Blue Calibration Standard, 100 mL	1	RAD171

Aldehyde Calibration Standard

The Aldehyde Calibration Standard consists of nine 2,4-dinitrophenylhydrazones (2,4-DNPH) diluted in 10 mL acetonitrile. Certified concentrations of each compound are listed in the table below. Actual concentrations are certified for each lot. The standard stock solution is shipped in a pierceable-septum crimped cap vial, and is stable for at least 4 months when stored in the dark at 4 °C.

2,4-DNPH of aldehyde	µg/mL as aldehyde
Formaldehyde	50
Acetaldehyde	50
Acrolein	10
Propanal	50
Butanal	50
Isopentanal	50
Pentanal	50
Hexanal	50
Benzaldehyde	50

Description	Pkg. Qty.	Cat. No.
Aldehyde Calibration Standard, 10 mL	1	RAD302

BTEX Calibration Kit (CS₂ Desorption)

The BTEX Calibration Kit (CS₂ Desorption) was designed for the analysis of BTEX in urban environments. The mass of each compound loaded onto each cartridge spans the extreme ranges represented in most urban environments. The kit may be used for both routine calibration and quality control. The kit consists of twelve Cartridge Adsorbents (like Cat. No. RAD130). Three of which are blanks and nine, divided into three concentration groups, are preloaded with BTEX to simulate 7 day exposures (100,080 minutes). Concentrations are listed in the table below. The values shown are indicative. Actual concentrations are certified for each lot. Maximum shelf life for this cartridge is twelve months when stored at 4 °C.



Simulated Concentrations in µg/m ³ (7 Days Exposure Equivalent)			
	Group 1	Group 2	Group 3
Benzene	1	10	50
Toluene	2	20	100
Ethylbenzene	1	10	50
m-xylene	1	10	50
p-xylene	1	10	50
o-xylene	1	10	50

Description	Pkg. Qty.	Cat. No.
BTEX Calibration Kit (CS ₂ Desorption)	1	RAD405

BTEX Calibration Kit (Thermal Desorption)

The BTEX Calibration Kit (thermal desorption) was designed for the analysis of BTEX in urban environments followed by thermal desorption. The kit may be used for both routine calibration and quality control. The kit consists of twelve Cartridge Adsorbents (like Cat. No. RAD145). Three of which are blanks and nine, divided into three concentration groups, are preloaded with BTEX to simulate 7 day exposures (100,080 minutes). Concentrations are listed in the table below. The values shown are indicative. Actual concentrations are certified for each lot. BTEX is spiked on the cartridges by injecting vaporized BTEX standards in methanol under nitrogen flow.

A methanol peak may be visible during chromatographic analysis. Maximum shelf life for this cartridge is twelve months when stored at 4 °C.

	Simulated Concentrations in $\mu\text{g}/\text{m}^3$ (7 Days Exposure Equivalent)		
	Group 1	Group 2	Group 3
Benzene	1	5	25
Toluene	2	10	50
Ethylbenzene	1	5	25
m-xylene	1	5	25
p-xylene	1	5	25
o-xylene	1	5	25

Description	Pkg. Qty.	Cat. No.
BTEX Calibration Kit (Thermal Desorption)	1	RAD407

VOC Calibration Kit (Workplace Environment)

The VOC Calibration Kit is ideal for conducting scheduled quality control runs when analyzing workplace environments. The kit consists of twelve Cartridge Adsorbents (like Cat. No. RAD130). Three of which are blanks and nine, divided into three concentration groups, are preloaded with VOCs to simulate 8 hour exposures (480 min.). Concentrations are listed in the table below. The values shown are indicative. Actual concentrations are certified for each lot.

The composition of VOCs represents a broad range of polarity, and the spiked concentrations represent 0.5, 1.0, and 2.0 times the threshold limit values (TLV) for each compound. VOCs are spiked on the cartridges by injecting vaporized VOC standards in CS_2 under nitrogen flow. Maximum shelf life for this cartridge is four months when stored at 4 °C.

	Simulated Concentrations in $\mu\text{g}/\text{m}^3$ (8 Hours Exposure Equivalent)		
	Group 1	Group 2	Group 3
Benzene	0.1	0.2	0.4
Toluene	19	38	76
Ethylbenzene	12	24	48
m-xylene	12	24	48
p-xylene	12	24	48
o-xylene	12	24	48
Butanol	15	30	60
2-etoxyethyl acetate	2.5	5	10

Description	Pkg. Qty.	Cat. No.
VOC Calibration Kit (Workplace Environment)	1	RAD406

For additional calibration standards and solutions, please or visit
[SigmaAldrich.com/standards](https://www.sigmaaldrich.com/standards)

Diffusive Sampling Devices (DSD)

The DSD is a passive/diffusive radial air monitoring device developed in Japan in the 1990's to monitor for contaminants in indoor air related to "Sick House Syndrome". The related sickness results from exposures to building materials that emit VOCs, such as carbonyls like formaldehyde, from sources like adhesives, paints, coatings, plywood, and flooring. In addition to monitoring for carbonyls, DSD devices are available for sampling a wide range of compounds (may not be available in all regions)

- DSD-DNPH for sampling carbonyls
- DSD-VOC-SD for sampling VOCs followed by solvent desorption
- DSD-VOC-TD for sampling VOCs followed by thermal desorption
- DSD-BPE/DNPH for sampling ozone followed by solvent desorption
- DSD-TEA for acid gases followed by ion chromatography

The DSD devices are radial in design and are Ready-to-Use (RTU) right out of the packaging. To sample, remove the outer storage container from the device, connect to an adaptor/clip and take your air sample. When sampling is complete, install the DSD sampler back to its original storage container with sampling data to be sent to the laboratory for analysis.

Advantages of DSD Samplers:

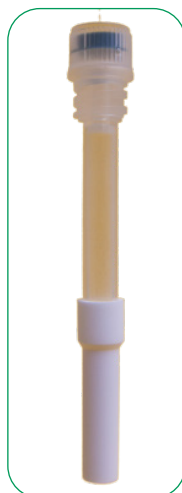
- Ready-to-Use (RTU)
- Streamlined radial design delivers fast sampling rates 2-3x faster than badge type samplers
- Designed for sampling 24 hours
- Select devices can sample for 7 days or longer
- Versatile for use in indoor air, ambient air and personal sampling



Overview of DSD Passive Sampling Devices

DSD Samplers with In-Device Elution Design

This design of the DSD In-Device Elution samplers are comprised of a porous polyethylene tube which acts as the diffusive membrane and controls the sampling rate of the analytes of interest into the selective adsorbent bed packed inside. And to this diffusive membrane is attached a small propylene syringe body that is used for the elution of analytes from the adsorbent after sampling into the sampling tube. The benefits of this device design is that it reduces sample preparation time and reduces waste in that it's an all-in one device from the field to the laboratory.



DSD-DNPH Passive Sampler

The DSD-DNPH sampler contains silica gel coated with 2,4-dinitrophenylhydrazine (DNPH) which acts as the aldehyde selective adsorbent. Aldehydes and ketones diffuse through the membrane reacting with DNPH to form stable derivatives. The DNPH-derivatives are then eluted with acetonitrile and analyzed by high performance liquid chromatography (HPLC). DSD-DNPH is fully validated and specified in *OSHA method 1007* for passive sampling of formaldehyde.

Features & Benefits:

- Specified in OSHA 1007 Method for Determination of Formaldehyde
- Convenient, easy-to-use configuration enabling a simple elution procedure
- Collection and analysis of carbonyls without transfer of the adsorbent, minimizing the risk of contamination & errors
- High-purity adsorbent allows collection of ppb levels of a wide range of carbonyls
- Stable blank data to ensure low limit of quantitation (LOQ)
- Excellent uptake rates (range from 34 to 72 mL/min); also,
- Stable to wind, temperature and humid conditions
- Versatile – use for indoor air, personal sampling, and ambient air
- Recommended for sampling up to 7 days, not recommended for STEL sampling.

Aldehydes that can be sampled with the DSD-DNPH sampler

Description	Pkg Qty	Cat. No.
DSD-DNPH Passive Sampler	10	28221-U

DSD-BPE/DNPH Passive Sampler

Like DSD-DNPH, the DSD-BPE/DNPH sampler is packed with a homogeneous mixture of 2,4-dinitrophenylhydrazine coated silica gel with the addition of trans-1,2-bis(2-pyridyl) ethylene-coated silica gel for sampling ozone and carbonyls in air. *Check your region for product availability*

Description	Pkg Qty	Cat. No.
DSD-BPE/DNPH Passive Sampler	10	28294-U

DSD-TEA (Acid Gases by Ion Chromatography) Passive Sampler

The DSD-TEA sampler contains triethanolamine (TEA) impregnated silica gel selective adsorbent for collection of acid gases in air. The analytes Cl⁻, NO₂⁻, NO₃⁻, SO₂ are analyzed by ion chromatography or UV-Vis and NO₂ by Salzman method. *Check your region for product availability*

Description	Pkg Qty	Cat. No.
DSD-TEA Passive Sampler	10	28318-U

Reference

1. Uchiyama, S.; Aoyagi, S.; Ando, M. Atmos. Environ. 2004, 38, 6319-6326.

Accessories for Use with In-Device Elution DSD Passive Samplers

For use with DSD-DNPH, DSD-BPE/DNPH, DSD-TEA

Description	Pkg Qty	Cat. No.
Perforated Protective Cover	10	28222-U
Lapel/Pen Clip	6	21019-U
Plastic Color-Coded Cap Insert for	100	000J004
Visiprep™ DL 12-Port Vacuum Manifold	1	57044
Visiprep™ DL 24-Port Vacuum Manifold	1	57265
Visi-1 Sample Processor	1	57080-U
6 mL Polypropylene Reservoir Tube	30	57242
Female Luer Fitting for 5/32 in Tubing	20	28224-U

DSD Samplers with Adsorbent Transfer Design

The design of the DSD-VOC samplers differs from the In-Device Elution sampling devices in that they do not contain the small polypropylene syringe for direct elution after sampling. They are a simple design consisting of a porous polyethylene tube which acts as the diffusive membrane and controls the sampling rate of the analytes of interest into the selective adsorbent bed packed inside. To analyze the sample, the adsorbent must be transferred from the diffusive body into a vial or stainless or glass tube for analysis. *Check your region for product availability.*

DSD-VOC-SD (VOCs by Solvent Desorption)

The diffusive body is packed with Carboxen® 564 as the selective adsorbent. After sampling, the adsorbent is transferred by the laboratory into a vial for solvent desorption with carbon disulfide and analyzed by GC. Suitable for sampling in higher concentration environments. Check your region for product availability.



Description	Pkg Qty	Cat. No.
VOC-SD Passive Sampler	10	000J005

DSD-VOC-TD (VOCs by Thermal Desorption)

The thermal desorption DSD-VOC sampler is packed with Carbopack™ B as the selective adsorbent. After sampling, the adsorbent is transferred to a stainless steel TD tube by the laboratory for thermal desorption and analyzed by GC-TD. Suitable for sampling in higher concentration environments. *Check your region for product availability.*

Description	Pkg Qty	Cat. No.
VOC-TD Passive Sampler	10	000J006

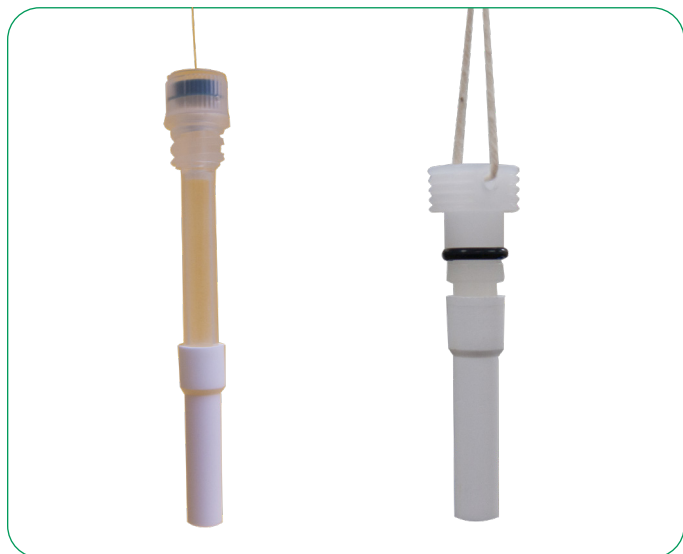
Accessories for Use with Adsorbent Transfer DSD Passive Samplers

For use with DSD-VOC devices

Description	Pkg Qty	Cat. No.
Perforated Protective Cover	10	28222-U
Lapel/Pen Clip	6	21019-U
Empty Glass Thermal Desorption Tube w/Frit (0.25 in O.D x 3.50 in L)	10	29538-U
Empty Stainless Steel Thermal Desorption Tube (0.25 in O.D x 3.50 in L)	10	21822-U
TDS3 Storage Container for (0.25 in O.D x 3.5 in L) Thermal Desorption Tubes	1	25097-U

How to Use DSD Devices for Air Sampling

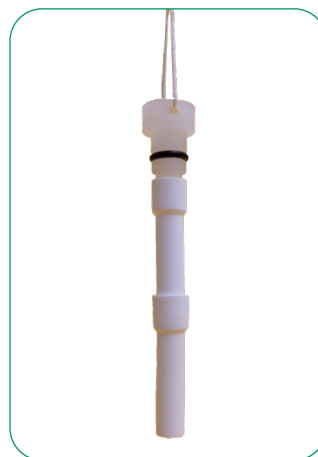
For Indoor Air and Ambient Sampling, the DSD cap is designed for flexible options for positioning the DSD device in your sampling area. A string can be threaded through the holes in the cap, tied and then hung in the desired location. The In-Device Elution cap has a snap-in string design (cat no. 000J004) available as an accessory.



For Personal Sampling the DSD Passive Sampling Device with optional recommended perforated protective cover (28222-U) can be attached to your shirt with a pen clip (21019-U) that is secured around the barrel of the device.



Serial Connection Sampling DSD Passive Samplers are unique in that you can attach two devices in a series as the design of the device is amenable to a stacking connection by removing the cap from the diffusive body and inserting to the bottom of the upper device. After sampling, replace the bottom cap before sending to the laboratory for analysis.



2 DSD-VOC devices in series



DSD-DNPH and DSD-VOC in Series

How Prepare DSD Devices for Laboratory Analysis



After sampling, insert the DSD device back into its original storage container.



Make sure storage container is secure by pressing in tightly.



Place in original storage bag, labelled with sampling information.

Axial Passive Sampling Devices

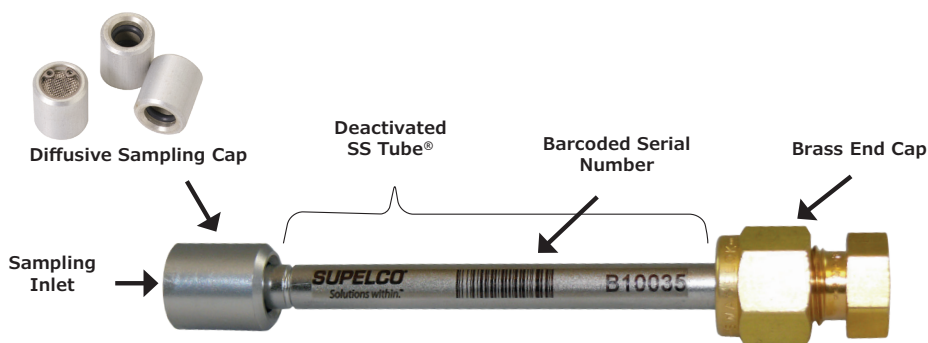
Stainless steel single adsorbent thermal desorption tubes, as 2D axial-type passive sampling devices, have been widely employed since the 1980's for monitoring VOCs in air. The United States Environmental Protection Agency (US EPA) performed numerous studies with these tubes as an alternative to bulky canisters and less sensitive solvent desorption methods.

Advantages of Axial Thermal Desorption Tube Passive Samplers:

- Field sampling is simple and easy
- Tubes are pre-conditioned providing low background contamination
- Thermal desorption delivers high sensitivity with no need for extraction solvents

- Does not require a sampling pump
- Inexpensive to ship and store before and after sampling
- Low cost, can be reconditioned and deployed from 50 to up to 100 times
- Laboratory analysis is simple with TD-GC/MS
- Greater flexibility for customization as users can select adsorbents, tube configuration and perform studies to determine their own sampling rates

Passive sampling with the standard stainless steel thermal desorption tubes, ¼ inch O.D x 3.5 in L, when in use, a diffusion cap is installed at the sampling end of the tube, an air gap, a retaining screen/gauze mesh, the adsorbent bed, and another retaining screen/gauze mesh and spring.



Fenceline Monitoring Around Petroleum Refineries (US EPA Method 325 A/B)

FLM Carbopack™ Thermal Desorption Tubes

The Fenceline Monitor (FLM) Carbopack™ X and Carbopack™ B thermal desorption tubes, meet the requirements of Method 325B for passive sampling. The deactivated stainless steel TD tubes have been deployed in the field for the EPA DEARS study in 2003 as well as in the development of EPA Method 325B. with passive sampling uptake rates validated by the US EPA for the VOCs of interest for Fenceline Monitoring; they have over two decades history of repeated and proven performance.

When passive sampling - use a diffusive endcap (sold separately) on the inlet of the tube, and maintain the outlet sealed using the brass endcap (supplied).

Carbopack™ X and B deliver trusted sampling performance from the inside while the easy to read tube markings and barcode delivers confidence and traceability on the outside.

Features and Benefits

- Carbopack™ X and Carbopack™ B adsorbents manufactured in-house
- Only sampling device with sampling rates for Carbopack™ X and B officially validated by the US EPA
- Durable barcode to ensure traceability and minimize litigation risk
- Easy-to-read tube markings
- Certificate of Analysis included in every box
- Low-cost monitoring solution, tubes are reusable up to 100x



Table of Diffusive Sampling Rates for FLM Carbopack™ X and Carbopack™ B Deactivated SS TD Tube³

Compound Name	CAS#	75% RH Eff. Sampling rate ^a /cm ³ min ⁻¹	75% RH Eff. Uptake rate ^a /ng ppmv ⁻¹ min ⁻¹	Martin et al. ref. 3 [ref 9-11]	35% RH rate = 75% RH Rate Times
1,2-Dichloro-1,1,2,2-tetrafluoroethane (CFC 14)	76-14-2	0.44 ± 0.08	3.12 ± 0.60		1.06
1,3-Butadiene	106-99-0	0.61 ± 0.11	1.36 ± 0.24	1.24 ± 0.16	0.88
Trichlorofluoromethane (CFC 11; Freon-11; R-11)	75-69-4	0.51 ± 0.07	2.87 ± 0.39		0.98
1,1-Dichloroethene (1,1-DCE)	75-35-4	0.57 ± 0.14	2.27 ± 0.54		0.91
3-Chloropropene	107-05-1	0.51 ± 0.30	1.61 ± 0.96		0.83
1,1,2-Trichloro-1,2,2-trifluoroethane (CFC 113; Freon-113)	76-13-1	0.46 ± 0.05	3.58 ± 0.42		0.98
1,1-Dichloroethane	75-34-3	0.57 ± 0.10	2.34 ± 0.42		1.12
cis-1,2-Dichloroethene (1,2-DCE)	156-59-2	0.58 ± 0.08	2.31 ± 0.30		0.96
1,2-Dichloroethane (DCE)	107-06-2	0.57 ± 0.08	2.34 ± 0.33		0.97
1,1,1-Trichloroethane	71-55-6	0.51 ± 0.10	2.80 ± 0.54		1.11
Benzene	71-43-2	0.67 ± 0.11	2.15 ± 0.36	1.99 ± 0.48	1.12
Carbon Tetrachloride (CCl ₄)	56-23-5	0.51 ± 0.06	3.24 ± 0.36		1.17
1,2-Dichloropropane	78-87-5	0.52 ± 0.10	2.41 ± 0.45		0.91
Trichloroethene (TCE)	79-01-6	0.50 ± 0.05	2.74 ± 0.30		1.07
1,1,2-Trichloroethane (1,1,2-TCA)	79-00-5	0.49 ± 0.13	2.69 ± 0.72		0.91
Toluene	108-88-3	0.52 ± 0.14	1.98 ± 0.51	2.23 ± 0.52	1.01
Tetrachloroethene (PERC)	127-18-7	0.48 ± 0.05	3.27 ± 0.36		1.01
Chlorobenzene (MCB)	108-90-7	0.51 ± 0.06	2.35 ± 0.30		0.99
Ethylbenzene	100-41-4	0.46 ± 0.07	2.03 ± 0.30		0.99
<i>m,p</i> -Xylene	<i>m</i> -108-38-3; <i>p</i> -106-42-3	0.46 ± 0.09	2.00 ± 0.39		0.99
Styrene	100-42-5	0.50 ± 0.14	2.12 ± 0.57		0.96
<i>o</i> -Xylene	95-47-6	0.46 ± 0.12	2.01 ± 0.54	1.79 ± 0.41	0.99
4-Ethyltoluene	622-96-8	0.41 ± 0.11	2.03 ± 0.57		0.93
1,3,5-Trimethylbenzene	108-67-8	0.41 ± 0.10	1.72 ± 0.42		0.96
<i>m</i> -Dichlorobenzene (mDCB)	541-73-1	0.44 ± 0.07	2.68 ± 0.45		0.97
<i>p</i> -Dichlorobenzene (pDCB)	106-46-7	0.45 ± 0.05	2.71 ± 0.30		0.97
<i>o</i> -Dichlorobenzene (oDCB)	95-50-1	0.45 ± 0.06	2.72 ± 0.36		0.98

^aAt 22 ± 2 °C at 760 Torr. Also ± values are based on 3σ values

Products for Fenceline Monitoring

Description	Pkg Qty	Cat. No.
Pre-conditioned FLM™ Carbopack™ X TD Tube	10	28686-U
Pre-conditioned FLM™ Carbopack™ B TD Tube	10	28666-U
Diffusive End Caps	10	28017-U
Pre-conditioned Swagelok® Assembly	10	23094-U



Diffusive Sampling Cap

Single-Bed Sorbent Thermal Desorption Tubes for Passive Sampling

The US EPA method 325B is the most commonly used method for passive sampling however, there are other commercially available thermal desorption tubes with a single-adsorbent bed suitable for passive sampling. These tubes employ the same sampling configuration with the use of a diffusive endcap at the sampling end. There are numerous sources available that provide experimental and validated sampling rates for these tube types. It is recommended that you perform your

own studies on sampling rates as there is no guarantee given of the accuracy. We recommend that you review your original source reference material to determine the level of confidence and range of applicability of the uptake rate values.

Description	Pkg Qty	Cat. No.
Pre-conditioned Tenax® TA SS TD Tube	10	29741-U
Pre-conditioned Tenax® GR SS TD Tube	10	29742-U
Pre-conditioned Carbosieve® SIII TD Tube	10	29743-U

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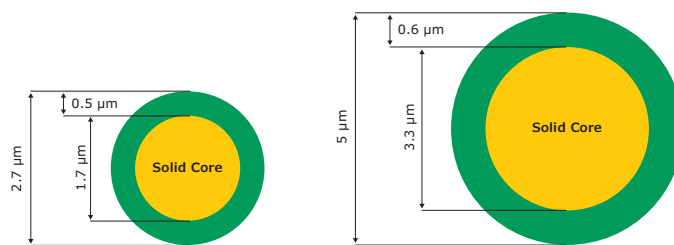
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Volatiles by GC-MS				●	●																
Volatiles by GC				●	●																
Semivolatiles by GC-MS		●																			
Semivolatiles by GC**		●	●			●	●	●	●	●									●		
Fuels (GRO, DRO, TPH)		●	●	●	●																
Dioxins by GC-HRMS		●									●						●				
PCBs by GC-HRMS	●	●											●		●			●			
PBDEs by GC-MS		●																			
PAHs by GC or GC-MS		●																		●	●
Oil Spill Dispersants												●									
Odor Compounds (Geosmin, 2-MIB)		●																			

* See "by Application" section

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