radiello®

Diffusive Sampling System

Ambient/Outdoor Air Monitoring

Industrial & Indoor Air Quality (IAQ)

Personal Sampling

Your Complete Solution to Passive Air Sampling

FONDAZIONE SALVATORE MAUGERI
CLINICA DEL LAVORO E DELLA RIABILITAZIONE
I.R.C.C.S

sigma-aldrich.com/supelco

SUPELCO®

radiello® Sampling System in Action

The Radiello Process

Affix Radiello sampler to clothes or fixture (wall, telephone pole, tree, lapel, etc.). Record time and temperature.

Organic gases/chemical agent(s) diffuse onto sorbent.

At end of sampling period, sampler is removed, resealed, and time/temperature is noted.

Radiello sampler is sent to laboratory for analysis.

Analysis technique dependent on chemical agent(s). Mostly chromatography.

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Why go passive?

The use of passive or diffusive air sampling technology has gained in popularity over the last 20 years. Unlike active sampling, passive samplers require no electricity (expensive pumps), have no moving parts, and are simple to use (no pump operation/calibration).

Other benefits of passive/diffusive sampling include:

- Compact, portable, unobtrusive, and inexpensive
- Offers indication of average pollution levels over time periods of 8 hours to weeks/months
- Requires no supervision, non-flammable, and noiseless
- Low cost allows sampling at a number of locations
  - *For highlighting pollutant "hotspots" where detailed study may be needed*
  - *For determining long term data trends in specific geographical areas such as industrial zones*
- Amenable to personal monitoring "breathing zone", indoor air analysis, and outdoor ambient air analysis

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Radiello Technology –

The next generation of passive/diffusive sampling

Most passive/diffusive samplers are about the size of a pager and filled with granular solid sorbents where one or more sections of the device is open to the air. Unlike active sampling techniques, passive/diffusive samplers rely on unassisted molecular diffusion of the gaseous agent to migrate from the air onto the sorbent material.

Passive/diffusive samplers were first developed as "axial or planar" shape configurations, and as a result, were often characterized as having very low capacity (risk of reverse diffusion and analyte breakthrough) and slow sample rates (poor sensitivity) when compared to pumped sorbent techniques (active sampling). Results can also flux depending on environmental conditions resulting in overall poor sensitivity and reproducibility.

In the mid 1990's, Dr. Vincenzo Cocheo, Director of the Fondazione Salvatore Maugeri, Padova, Italy, in collaboration with the European Commission's Joint Research Center and other Institutions, developed and patented a revolutionary diffusive/sampling design: Radial Symmetry now registered trademarked as Radiello®. The main benefits of Radiello technology include:

- Higher capacity and sampling rates
- Greater selectivity and sensitivity
- Consistent sampling rates

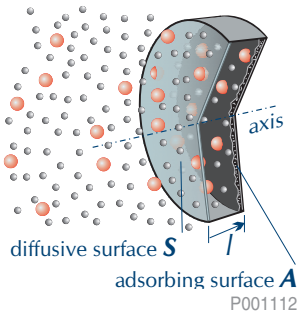
In 2006, Supelco, Bellefonte, PA, USA in collaboration with the Fondazione Salvatore Maugeri (FSM), Padova, Italy, partook in a joint venture in which Supelco has become the exclusive worldwide distributor of Radiello products and accessories. As a result, researchers have and will continue to receive the same level of service and product quality expected of an analytical product manufacturer and supplier. By merging the strengths of both organizations (Supelco's experience and expertise in chromatography based adsorbents; and FSM's expertise and reputation in air monitoring and analysis), a new generation of innovative Radiello products and applications will emerge. In this collaboration, we expect new applications and adsorbents to broaden the application scope of the Radiello system and further improve overall performance.

FSM is a non-profit private institute involved in scientific research about human health. The Institute co-operates with the Italian Health Ministry and many universities. The Institute has twelve hospitals that collaborate in its research. It also has a scientific laboratory for environmental research located in Padova, Italy, which employs eleven researchers and has a modern structure and equipment.

The Principle of Radiello Technology

How does Radiello work?

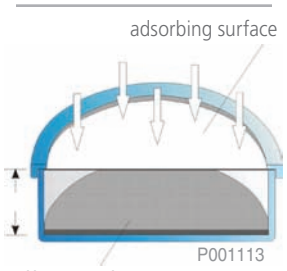
From Fick's Law, we know that the sampling rate (Q) is a function of the diffusion coefficient of a given analyte (D) and the geometric constant of the sampler (K): Q = D·K.



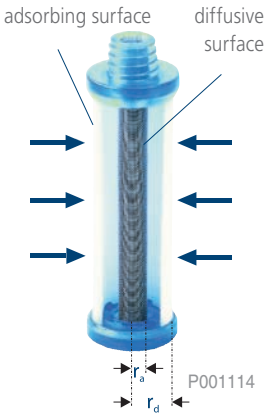
The diffusion coefficient (D) always remains constant for a given analyte; therefore, to improve sampling rate (Q), the geometric constant (K) must be improved: K = S/l where S is diffusive surface and l is the distance between the diffusive and adsorbing surface.

Most commercially available passive/diffusive samplers are planar or axial in shape and offer lower sampling rates and limited sampling capacity. As a result, sensitivity can suffer during short-term analysis (due to low sampling rates), or long-term sampling (analyte back diffusion to low capacity). Radiello technology has circumvented this issue by improving the geometry to a patented radial coaxial design.

Improved sampling rates through superior hardware geometry



Axial/Planar Q=<10 mL/min*



Radiello Q=80 mL/min*

*Diffusion rates for benzenes at 25 °C

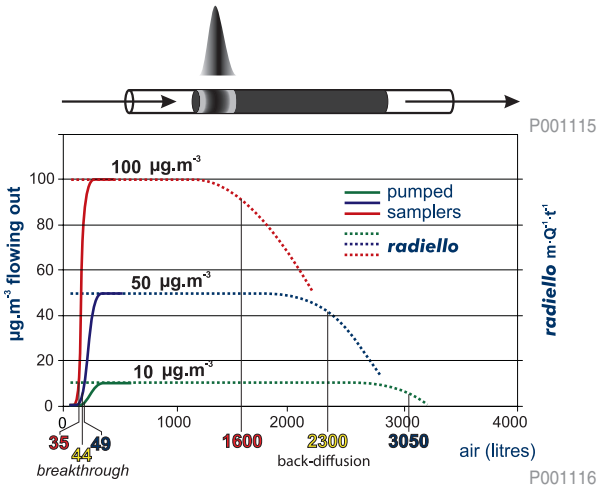
The Radiello system uses a cylindrical outer surface that acts as diffusive membrane in which gaseous molecules move axially and parallel towards the adsorbent bed (cylindrical collection cartridge) and coaxial to the diffusive surface. The radial design allows for a very large diffusive surface relative to the adsorbing surface while maintaining a small diffusive distance between the diffusive and adsorbing surfaces. Traditional axial and planar passive samplers are flat and the diffusive and adsorbing surfaces are of equal size resulting in a smaller geometric constant as compared to Radiello products. The radial design allows for an exponential increase in uptake rate when compared to traditional passive samplers effectively translating to shorter sampling times.

By combining improved geometry with its thick tubular micro-porous polyethylene diffusive body, the Radiello sampling system offers very high and consistent sampling rates.

Radiello offers high capacity

With active sampling, i.e. using a pump, adsorbed gaseous compounds move through the axial sampler as a gaussian peak. When the analyte compound concentration of the outlet air reaches 10% of the sampled air, analyte breakthrough has occurred. Further sampling will lead to loss of analyte and consequent underestimation of the environmental concentration. With passive/diffusive sampling, a similar phenomenon called back diffusion can occur. This happens when the absorbed mass of the compound exceeds the capacity of the adsorbent bed.

For example, benzene was sampled by activated charcoal using both Radiello diffusive technology (code 130) and active methods packed at identical bed volumes. Under active sampling conditions, breakthrough was observed at 34, 44, and 49 L of sampled air for benzene at concentrations of 10, 50, and 100 µg/m³, respectively. In contrast,



Radiello technology was able to achieve sampling volumes of 1600, 2300, and 3050 L (at 10, 50, and 100 µg/m³, respectively) before back diffusion occurred.

Radiello technology correlates well with pumped (active) methods

One of the most common questions analysts have is how well does Radiello technology correlate with existing/validated active methods. In this study, Radiello hardware packed with activated charcoal (code 130) sampled benzene, toluene, xylene, ethyl benzene, and MTBE at a petroleum refinery plant. Personal monitoring was conducted in parallel using both Radiello and

active samplers concurrently for approximately 90 employees. The sampling rate of the pumps was adjusted to the average sampling rate of the monitored substances determined for Radiello. The sampling time ranged from 6-8 hours followed by carbon disulfide solvent desorption and GC-FID.

The comparison study between active and passive (Radiello) sampling (Figure 1) showed excellent correlation for the analytes tested: benzene (R^2 = 0.91), toluene (R^2 = 0.95), xylenes (R^2 = 0.92), n-hexane (R^2 = 0.95), and MTBE (R^2 = 0.80).

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).

Desorption and Analysis

At present, there are over 10 different cartridge adsorbents and four different diffusive bodies to sample hundreds of different gaseous compounds under a variety of conditions. For each compound, the Fondazione Salvatore Maugeri has developed detailed desorption and analytical protocols involving analytical techniques typical of most independent, academic, industrial, and regulatory laboratories.

Analytical services are also available to European customers directly through the Fondazione Salvatore Maugeri. For more information, please contact:

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web www.radiello.com

Detailed desorption and analytical conditions are available in the Radiello manual (IYP) which can viewed and downloaded at **sigma-aldrich.com/radiello**

Figure 1. Example of Pumped Sampling vs. Radiello

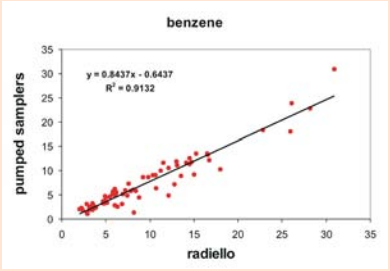

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Figure 2. Preparation of Radiello Sampler

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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

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.

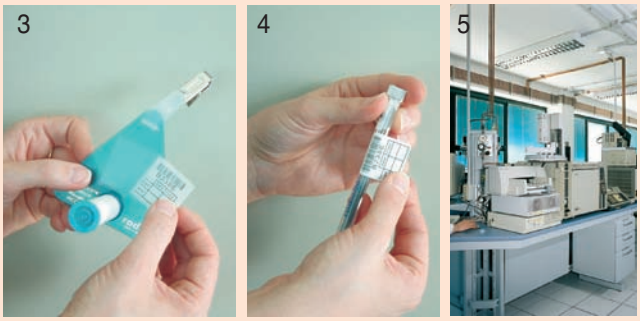

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Figure 3. Outdoor Shelter for Environmental/Ambient Air Sampling

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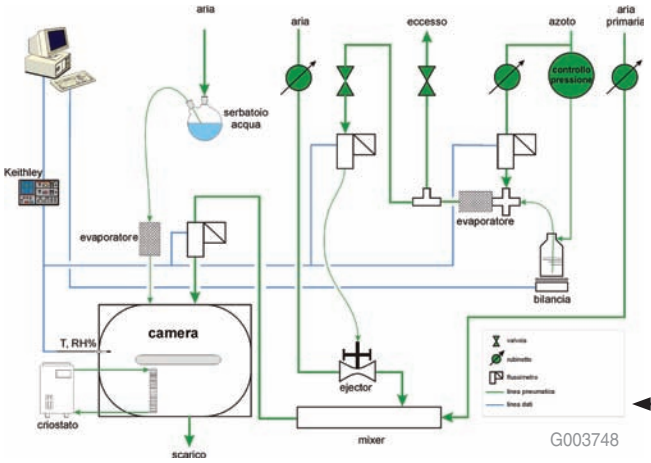
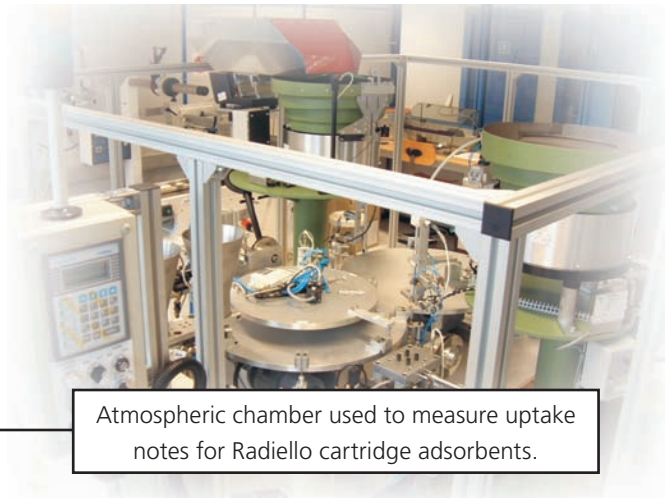
The protective outdoor shelter is easily transported and assembled directly at the sampling site. See more details on page 10.

Radiello Features & Benefits:

- The Radiello design offers high uptake rates resulting in faster sampling
- Greater adsorbent capacity offers minimal reverse 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 allowing 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 sigma-aldrich.com/radiello
- Other benefits include, but are not limited to:
  - *Predominately 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 amendable for a wide range of application areas*





Atmospheric chamber used to measure uptake notes for Radiello cartridge adsorbents.

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Radiello can be used to sample…

- **VOCs** – over 70 different volatile organic compounds
- **O_3** – ozone
- **Aldehydes** – acetaldehyde, acrolein, benzaldehyde, butanal, hexanal, formaldehyde, glutaric aldehyde, isopentenal, pentenal, and propanal
- **BTEX** – benzene, toluene, ethylbenzene, o-xylene, m-xylene, and p-xylene
- **NH_3** – ammonia
- **HCl and HF** – hydrochloric acid and hydrofluoric acid
- **Anesthetic Gases/Vapors** – nitrous oxide, isofluorane, ethrane, halothane, and sevorane
- **NO_2 and SO_2** – nitrogen and sulfur dioxides
- **H_2S** – hydrogen sulfide
- **Phenols** – phenol, methylphenol, and dimethylphenol

Other compounds might be possible but would need experimental tests for determination of the specific Q values. For other already available Q values please inquire or contact FSM directly.

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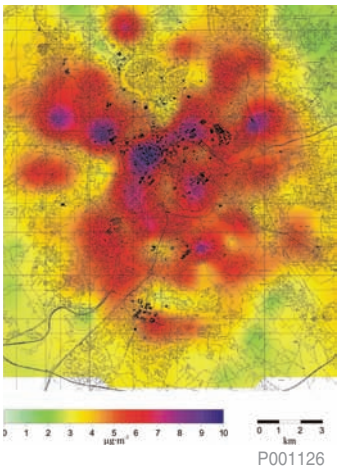
Radiello samplers are manufactured in an ultra-clean environment.

Published Radiello Applications

The use of diffusive sampling techniques has grown considerably in recent years. Since 2000, CEN, ISO, and ASTM have published many normative reference standards. Radiello diffusive samplers are amenable with most if not all of these new methods.



Benzene concentration gradient at Rome, Italy using Radiello diffusive samplers

In recent years, the European Reference Laboratory for Air Pollution (ERLAP) has conducted numerous studies using Radiello technology. Examples include: Validation of Radiello Diffusive Sampler for Monitoring Ozone in Ambient Air (EUR 19594 EN), Laboratory and Field Inter-comparisons of NO_2 diffusive samplers (EUR 20860 EN), and Laboratory and Field Inter-comparison of O_3 diffusive samplers (EUR 21754 EN).

Radiello samplers were used in the MACBETH project (Monitoring of Atmospheric Concentrations of Benzene in European Towns and Homes, LIFE 96 ENV/IT/070) and the ARTEMIDE Project (High temporal resolution monitoring of VOC's by diffusive sampler, LIFE 00 ENV/IT/000005) funded by the European commission's LIFE program for environmental projects. The later was recognized as one of 24 of the best LIFE projects in 2004/2005. In addition, Radiello samplers were also used in the RESOLUTION project where a high spatial resolution atmospheric monitoring model was developed to very actual emission reduction of ozone precursors foreseen by Auto-Oil programs, LIFE99ENV/IT.081.

Other common applications include:

- Indoor Air Quality (IAQ) of public facilities, homes, schools/classrooms, offices, etc.
- Personal monitoring (breathing zone assessment) of employees to hazardous substances
- Air sampling of work place environment (industrial hygiene)
- Urban sampling to map concentration gradients within a city or other geographic area.
- Identification of "hotspots" for further assessment and resolution
- Outdoor sampling around high traffic area (pedestrian or auto) and/or industrial site
- Measuring gaseous components derived from materials used in buildings, new homes, carpets, furniture, and other fixtures.
- Monitoring of anesthetic gases in hospitals
- Air quality assessment in museum environments – artwork exposure to aggressive gases such as formic and acetic acid

European Normative (EN) Methods Amenable or Specific to Radiello Samplers:

Reference No.	Title
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 maintenance
EN 14412:2004	Indoor air quality- Diffusive samplers for the determination of concentrations of gases and vapors – 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)
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 16000-4:2004	Indoor air – Part 4: Determination of formaldehyde – Diffusive Sampling method
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
EN 838:1995	Diffusive samplers for the determination of gases and vapors – requirements and test methods
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)

Validation Studies Carried Out by ERLAP for Ambient Air Monitoring Using Radiello Samplers:

Reference No.	Title
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

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

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

P001127

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.

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Compound Class	Radiello Code	Description of adsorbent bed	Pkg Qty.	Supelco Cat. No.
VOCs /BTEX, CS_2 Desorption	130	SS net (100 mesh, 5.8 mm diameter),activated charcoal (35-50 mesh)	20	RAD130
VOCs /BTEX, Thermal Desorption	145	SS net (3 x 8 µm mesh, 4.8 mm diameter), 350 mg Carbograph 4 (35-50 mesh)	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 (35-50 mesh)	20	RAD132
Hydrochloric Acid (HCl)	169	SS net w/silica gel (0.1-0.4 mm particle size)	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_2S)	170	Microporous PE impregnated with zinc acetate	20	RAD170
Ozone (O_3)	172	Micropore PE tube with silica coated with 4,4'-dipyrldylethylene	20	RAD172
Phenolic Compounds, Thermal Desorption	147	SS net 100 mesh, 4.8 mm diameter), 250 mg Tenax-TA (20-35 mesh)	20	RAD147

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.

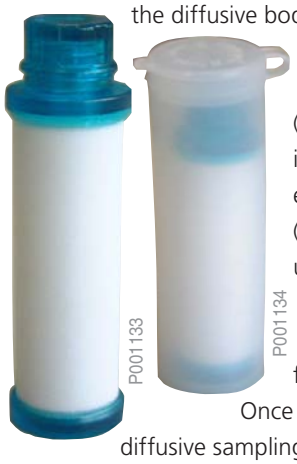
There are 4 different diffusive bodies available. Each of which are application specific in design. Please refer to the Radiello Manual (IYP) or use the listing of the ready to use sampler on page 9 for selection.


P001129 P001130 P001131 P001132

Radiello Code	Description	Pkg Qty.	Supelco Cat. No.
120	White diffusive body, microporous PE 1.7 mm thick, avg. porosity 25 ± 5 µm, diffusive path length 18 mm	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, avg. porosity 10 ± 2 µm, diffusive path length 150 mm	20	RAD1202
120-3	Permeative diffusive body, silicone membrane by SS net, 50 µm thick	20	RAD1203

Radiello Ready-to-Use Diffusive Samplers

The Radiello ready-to-use diffusive samplers come pre-assembled with the cartridge adsorbent pre-contained within the diffusive body, and sealed with a polycarbonate screw-thread cap. To avoid premature sampling, the entire unit (diffusive body with pre-sealed and installed cartridge adsorbent) is enclosed in an airtight polypropylene (PP) container. Just before use, the unit is removed from the PP container, and snapped into the ready-to-use vertical adapter pre fixed to the triangular support plate. Once sampling is complete, the diffusive sampling unit is removed from the support plate and resealed into the PP container.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Each ready-to-use sampler includes: a sampler unit (sealed diffusive body with cartridge adsorbent), glass or plastic tube for storage prior to analysis, ready-to-use vertical adapter, and barcode label and PP container. Please order the triangular support plates separately.


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Note that the ready-to-use diffusive samplers are ideal for workplace sampling campaigns, but are not for sampling low concentrations in outdoor or domestic environments. Shelf-life for the ready-to-use samplers are 3 months.

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.

P001136

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
121	Triangular Support Plate	20	RAD121
195	Replacement Clips	20	RAD195

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.

P001137

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
190	Radiello Labels	198	RAD190

Vertical Adapter

For personal sampling (breathing zone assessment), a vertical adapter is available to position the diffusive body vertically on the triangular support plate.

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P001138

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
122	Radiello Vertical Adapter	20	RAD122
1221	Radiello Snapring adapters for ready to use samplers	20	RAD1221

Radiello Ready-to-Use Diffusive Samplers

Application	Radiello Code	Description	Pkg Qty.	Supelco Cat. No.
VOCs /BTEX, CS_2 Desorption	123-1	Code 120 White Diffusive Body (Cat. No. RAD120) and Code 130 Cartridge Adsorbent (Cat. No. RAD130)	5	RAD1231
VOCs /BTEX, Thermal Desorption	123-2	Code 120-2 Yellow Diffusive Body (Cat. No. RAD1202) and Code 145 (Cat. No. RAD145) Cartridge Adsorbent	5	RAD1232
Hydrofluoric Acid (HF), Nitrogen Dioxide (NO_2), and Sulfur Dioxide (SO_2)	123-3	Code 120-1 Blue Diffusive Body (Cat. No. RAD1201) and Code 166 Cartridge Adsorbent (Cat. No. RAD166)	5	RAD1233
Aldehydes	123-4	Code 120-1 Blue Diffusive Body (Cat. No. RAD1201) and Code 165 Cartridge Adsorbent (Cat. No. RAD165)	5	RAD1244
Ozone (O_3)	123-5	Code 120-1 Blue Diffusive Body (Cat. No. RAD1201) and Code 172 Cartridge Adsorbent (Cat. No. RAD172)	5	RAD1235
Hydrogen Sulfide (H_2S)	123-6	Code 120 White Diffusive Body (Cat. No. RAD1201) and Code 170 Cartridge Adsorbent (Cat. No. RAD170)	5	RAD1236
Ammonia	123-7	Code 120-1 Blue Diffusive Body (Cat. No. RAD1201) and Code 168 Cartridge Adsorbent (Cat. No. RAD168)	5	RAD1237
Hydrochloric Acid (HCl)	123-8	Code 120 White Diffusive Body (Cat. No. RAD120) and Code 169 Cartridge Adsorbent (Cat. No. RAD1369)	5	RAD1238

Radiello Accessories and Replacement Parts

Outdoor Shelter

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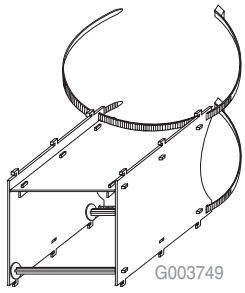

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A polypropylene protective outdoor shelter is available for housing up to four Radiello samplers during outdoor/ambient air sampling. The shelter allows for adequate ventilation while simultaneously protecting the samplers from harsh weather conditions. 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 shelter comes in a pack of 10 and includes 20 mounting strips.

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
196	Outdoor Shelter	10	RAD196
198	Spare Mounting Strips	100	RAD198

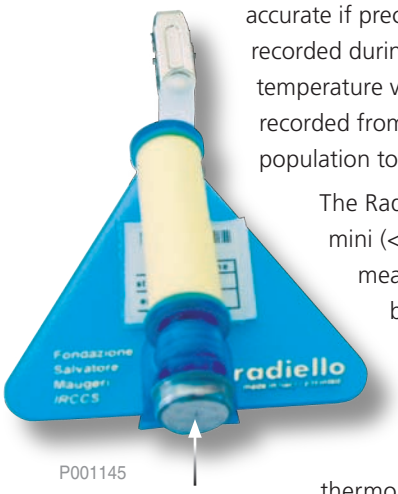
Empty Adsorbent Cartridges

Empty Radiello cartridges allow users to self-pack their own cartridges with the desired adsorbent. Each cartridge includes two end caps and glass storage tube.

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
175	Empty Cartridges, stainless steel net, mesh 100, 5.9 mm diameter	20	RAD175
176	Empty Cartridges, stainless steel net, mesh 100, 4.8 mm diameter	20	RAD176
177	Empty Cartridges, stainless steel net, 3 x 8 µm porosity, 4.8 mm diameter	20	RAD 177

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.



P001145

Thermometer

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.

RAD127

P001146

A temperature reader (purchased separately) connects the thermometer to your PC (via RS232 serial 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. A user-friendly software package is included with the reader to perform statistical and graphic analysis.

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
126	Radiello Thermometer	3	RAD126
126-1	Radiello Thermometer for ready-to-use sampler	3	RAD1261
127	Radiello Thermometer Reader	1	RAD 127

Empty Storage Tubes

RAD1991

P001147

RAD1992

P001148

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
199-1	Radiello Glass Tube, 2.8 mL, with stopper	20	RAD1991
199-2	Radiello PP Tube, 12 mL, with stopper	20	RAD1992

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.

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
174	Filtration Kit	20	RAD174

P001149

Radiello Calibration Solutions and Kits

H_2S (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^{-1} of S^{2-}
A	2 of code 171	98	1.145
B	25 of A	25	0.572
C	10 of A	40	0.229
D	5 of A	45	0.115

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
Code 171	H_2S 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 described in the table. Actual concentrations are certified for each lot. The standard stock solution is shipped in a pierce-able-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^{-1} as aldehyde
Formaldehyde	50
Acetaldehyde	50
Acrolein	10
Propanal	50
Butanal	50
Isopentanal	50
Pentanal	50
Hexanal	50
Benzaldehyde	50

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
Code 302	Aldehyde Calibration Standard, 10 mL	1	RAD302

BTEX Calibration Kit (CS_2 Desorption)

P001150

The BTEX Calibration Kit (CS_2 Desorption) was designed for the analysis of BTEX in urban environments. The mass of each compound loaded onto each cartridge span 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 Code 130 Cartridge Adsorbents (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 described in the listed tables. The values shown are indicative. Actual concentrations are certified for each lot. The cartridges are stable for at least four 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

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
Code 405	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 Code 145 Cartridge Adsorbents (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 described in the listed table. 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. The cartridges are stable for at least four months when stored at 4 °C.

	Simulated Concentrations in µg/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

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
Code 407	BTEX Calibration Kit (Thermal Desorption)	1	RAD407

VOCs 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 Code 130 Cartridge Adsorbents (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 described in the listed table. 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. The cartridges are stable for at least four months when stored at 4 °C.

	Simulated Concentrations in µg/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-etoxylethyl acetate	2.5	5	10

Radiello Code	Description	Pkg. Qty.	Supelco Cat. No.
Code 406	VOC Calibration Kit (workplace environment)	1	RAD406

For additional calibration standards and solutions, please refer to the Sigma-Aldrich Analytical Standards Catalog, or visit **sigma-aldrich.com/standards**

Quick Product Look Up

Compound Class/ Application	Radiello Code	Description	Pkg Qty.	Supelco Cat. No.
Cartridge Adsorbents				
VOCs/BTEX, CS_2 Desorption	130	SS net (100 mesh, 5.8 mm diam), activated charcoal (35-50 mesh)	20	RAD130
VOCs/BTEX, Thermal Desorption	145	SS net (3 x 8 µm mesh, 4.8 mm diam), 350 mg Carbograph 4 (35-50 mesh)	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 (35-50 mesh)	20	RAD132
Hydrochloric Acid (HCl)	169	SS net w/silica gel (0.1-0.4 mm particle size)	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_2S)	170	Microporous PE impregnated with zinc acetate	20	RAD170
Ozone (O_3)	172	Micropore PE tube with silica coated with 4,4'-dipyrldylethylene	20	RAD172
Phenolic Compounds, Thermal Desorption	147	SS net (100 mesh, 4.8 mm diameter), 250 mg Tenax-TA (20-35 mesh)	20	RAD147
Diffusive Bodies				
	120	White Diffusive Body, microporous PE 1.7 mm thick, avg. porosity 25 ± 5 µm, diffusive path length 18 mm	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, avg. porosity 10 ± 2 µm, diffusive path length 150 mm	20	RAD1202
	120-3	Permeative Diffusive Body, silicone membrane by SS net, 50 µm thick	20	RAD1203
Radiello ready-to-use Diffusive Samplers				
VOCs/BTEX, CS_2 Desorption	123-1	Code 120 White Diffusive Body (Cat. No. RAD120) and Code 130 Cartridge Adsorbent (Cat. No. RAD130)	5	RAD1231
VOCs/BTEX, Thermal Desorption	123-2	Code 120-2 Yellow Diffusive Body (Cat. No. RAD1202) and Code 145 (Cat. No. RAD145) Cartridge Adsorbent	5	RAD1232
Hydrofluoric Acid (HF), Nitrogen Dioxide (NO_2), and Sulfur Dioxide (SO_2)	123-3	Code 120-1 Blue Diffusive Body (Cat. No. RAD1201) and Code 166 Cartridge Adsorbent (Cat. No. RAD166)	5	RAD1233
Aldehydes	123-4	Code 120-1 Blue Diffusive Body (Cat. No. RAD1201) and Code 165 Cartridge Adsorbent (Cat. No. RAD165)	5	RAD1244
Ozone (O_3)	123-5	Code 120-1 Blue Diffusive Body (Cat. No. RAD1201) and Code 172 Cartridge Adsorbent (Cat. No. RAD172)	5	RAD1235
Hydrogen Sulfide (H_2S)	123-6	Code 120 White Diffusive Body (Cat. No. RAD1201) and Code 170 Cartridge Adsorbent (Cat. No. RAD170)	5	RAD1236
Ammonia	123-7	Code 120-1 Blue Diffusive Body (Cat. No. RAD1201) and Code 168 Cartridge Adsorbent (Cat. No. RAD168)	5	RAD1237
Hydrochloric Acid (HCl)	123-8	Code 120 White Diffusive Body (Cat. No. RAD120) and Code 169 Cartridge Adsorbent (Cat. No. RAD1369)	5	RAD1238

Compound Class/ Application	Radiello Code	Description	Pkg Qty.	Supelco Cat. No.
Key Accessories				
	121	Triangular Support Plate	20	RAD121
	190	Radiello Labels	198	RAD190
	122	Radiello Vertical Adapter	20	RAD122
	1221	Radiello Snapping Adapters for ready to use samplers	20	RAD1221
	196	Outdoor Shelter	10	RAD196
	198	Spare Mounting Strips	100	RAD198
	126	Radiello Thermometer	3	RAD126
	126-1	Radiello Thermometer for ready to use sampler	3	RAD1261
	127	Radiello Thermometer Reader	1	RAD 127
	175	Empty Cartridges, stainless steel net, mesh 100, 5.9 mm diameter	20	RAD175
	176	Empty Cartridges, stainless steel net, mesh 100, 4.9 mm diameter	20	RAD176
	177	Empty Cartridges, stainless steel net, 3 x 8 µm porosity, 4.9 mm diameter	20	RAD 177
	199-1	Radiello Glass Tube, 2.8 mL	20	RAD1991
	199-2	Radiello PP Tube, 12 mL	20	RAD1992
	174	Filtration Kit	20	RAD174
Standards and Calibration Kits				
	171	H_2S Methylene Blue Calibration Standard, 100 mL	1	RAD171
	302	Aldehyde Calibration Standard, 10 mL	1	RAD302
	405	BTEX Calibration Kit (CS_2 Desorption)	1	RAD 405
	407	BTEX Calibration Kit (Thermal Desorption)	1	RAD407
	406	VOC Calibration Kit (workplace environment)	1	RAD406

For more information on Radiello products, please request the Radiello CD (IXW) which contains a copy of the comprehensive Radiello manual and additional technical information and applications.

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