

Benefits of radiello[®] Passive Sampling Devices

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Introduction

Most commercially available passive/diffusive sampling devices 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). The radiello system uses a cylindrical outer surface that acts as diffusive membrane in which gaseous molecules move both 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.

Radiello is amenable to ambient-outdoor, indoor air quality (IAQ) and industrial hygiene (IH) sampling.



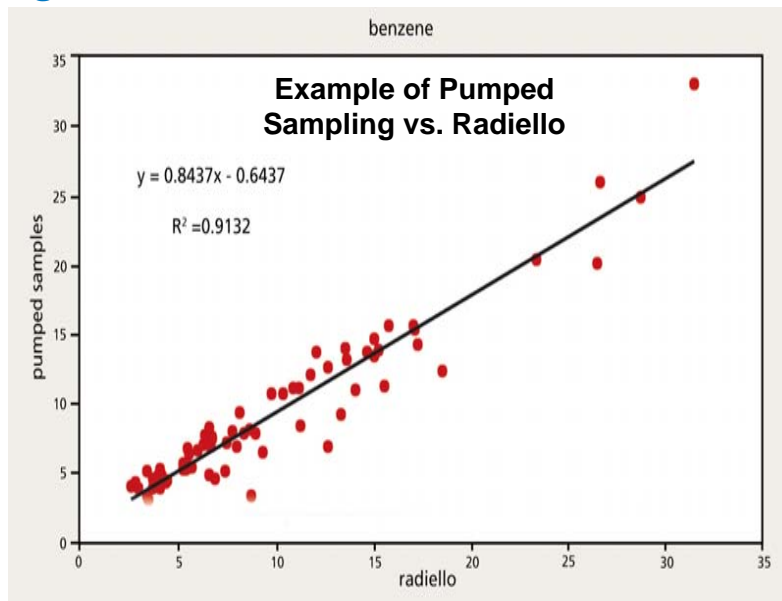
Experimental – Pumped Sampling vs. Radiello

How well does radiello correlate with existing validated active methods?

- Petroleum refinery study with 90 employees
- BTEX monitored with both radiello and active methods concurrently for 6-8 hrs.

Excellent correlation observed:

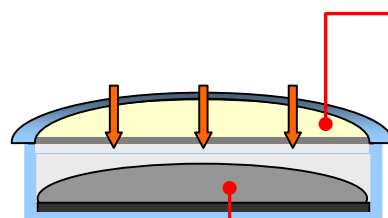
- benzene ($R^2 = 0.91$)
- toluene ($R^2 = 0.95$)
- xylenes ($R^2 = 0.92$)
- n-hexane ($R^2 = 0.95$)
- MTBE ($R^2 = 0.80$).



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

Q = 7-8 mL/min.

Axial Sampler

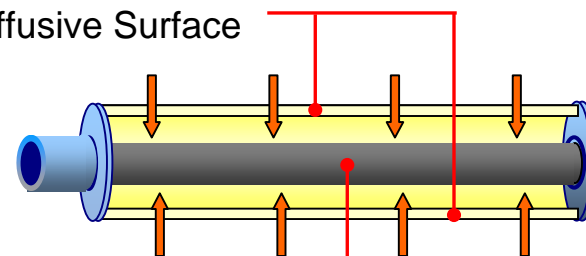


Diffusive Surface

Adsorbing Surface

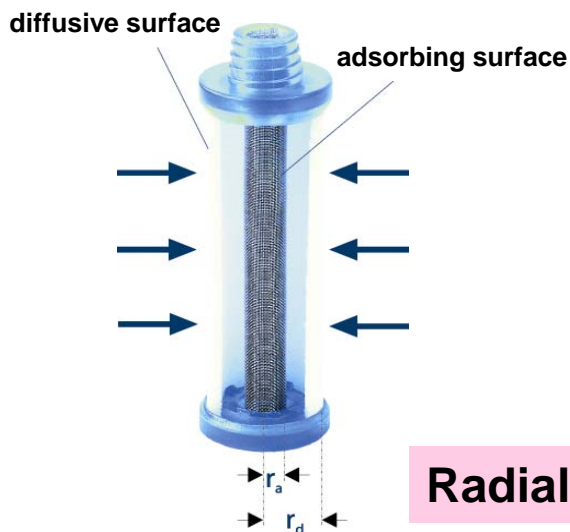
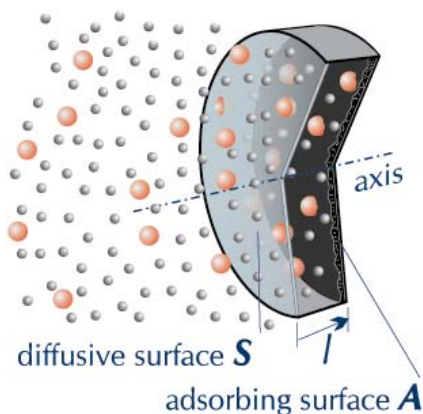
Q = 80 mL/min.

Radial Sampler



Axial/Planar Diffusion vs. Radial Diffusion

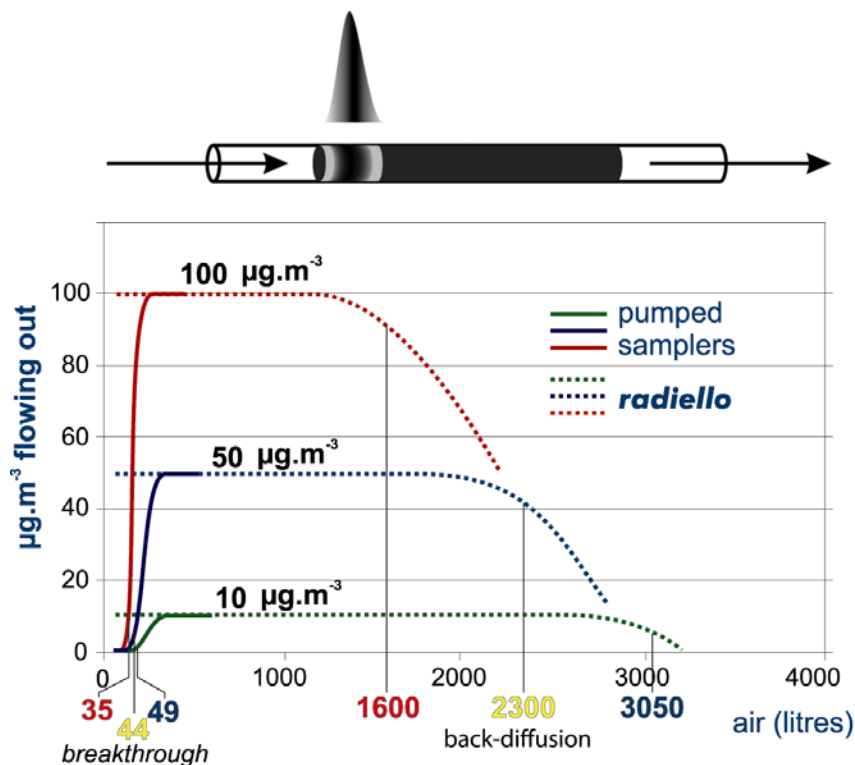
Axial



Radial

- Traditional axial/planar passive samplers are flat and the diffusive and adsorbing surfaces are equally sized resulting in a smaller geometric constant as compared to Radiello products.
- Radiello's radial design allows for very large diffusive surface relative to adsorbing surface.
- Radiello's radial cartridge body and adsorbent cartridge design maintains small diffusive distance between the diffusive and adsorbing surfaces.
- The radial design results in an exponential increase in sampling rate compared to traditional passive samplers.

Experimental – Radiello Offers High Capacity



- Back diffusion can occur if capacity is exceeded in passive sampling.
- Equivalent bed volume of activated charcoal packed into active sampling tube and compared against radiello for the sampling of benzene
- Active sampling breakthrough observed at **34, 44, and 49 L** of sampled air for benzene at concentrations of 10, 50, and 100 $\mu\text{g}/\text{m}^3$, respectively.
- Radiello sampling achieved sampling volumes of **1600, 2300, and 3050 L** (at 10, 50, and 100 $\mu\text{g}/\text{m}^3$, respectively) before back diffusion occurred.

Desorption and Analysis

At present, there are over 11 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 (FSM) has developed detailed desorption and analytical protocols involving analytical techniques typical of most independent, academic, industrial, and regulatory laboratories.

radiello Components



Radiello requires 3 components:

- Diffusive Body
- Cartridge Adsorbent
- Triangular Support Plate (RAD121)



Diffusive Bodies

- **White (standard) RAD120**
 - VOC's/activated charcoal and others
- **Blue (standard + color) RAD1201**
 - Light-sensitive sampling (NO₂, ozone, aldehydes)
- **Yellow (high thickness) RAD1202**
 - Thermal desorption – VOCs sampling (to avoid retrodiffusion)
- **Silicone membrane RAD1203**
 - Thermal desorption -anesthetic gases

Radiello Cartridge Adsorbents

<u>Compound Class (Adsorbent)</u>	<u>Analysis Method</u>
• Aldehydes RAD165 (chemisorptions on 2,4-DNPH)	→ <i>Chromatography</i>
• VOC's/BTEX RAD130 CS ₂ chem. des. (activated charcoal)	→ <i>Chromatography</i>
• VOC's/BTEX RAD145 thermal des. (graphitized carbon)	→ <i>Chromatography</i>
• NO₂/SO₂/HF RAD166 (chemisorptions on TEA)	→ <i>Photom. / IC / Ion Sel. Electrode</i>
• O₃ RAD172 (chemisorptions on 4,4'-Dipyridylethylene)	→ <i>Photometry</i>
• H₂S RAD170 (chemisorptions on zinc acetate)	→ <i>Photometry</i>
• Ammonia RAD168 (chemisorptions on phosphoric acid)	→ <i>Photometry</i>
• HCl RAD169 (adsorption on silica gel)	→ <i>Ion Chromatography</i>
• Anesthetic gases RAD132 (adsorbed on act. charcoal/MS)	→ <i>Chromatography</i>
• Phenols RAD 147 thermal des. (Tenax TA)	→ <i>Chromatography</i>
• 1,3-Butadiene, Isoprene RAD141 (<i>Carbopack X</i>) thermal des.	→ <i>Chromatography</i>

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



Sample – Outdoor, Indoor, IH environments

After Sampling

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



Features

- Greater sensitivity/lower detection limits
- High precision/accuracy
- Consistent performance in diverse environmental conditions
- High desorption efficiency
- Storage stability
- Minimal reverse diffusion
- Available analytical/desorption protocols
- Reusable hardware

Benefits

- Fast sampling rates
- Uptake/sampling rates very high compared to axial samplers
- Uptake rate invariable to air speed
- Blanks 3x lower than instrument noise
- Sampling can range from 15 min STEL to 8 hr TWA to 30 days (1 ppb – 1,000 ppm)
- Diffusive bodies and support plates reusable, only cartridge adsorbents require replacement

Conclusion

radiello correlates >95% to pumped sampling methods

radiello provides for a range of analytes

- Quicker results than axial passive samplers
- More precise results due to
 - higher capacity
 - experimentally determined sampling rates
- Easy handling – no pumps or other devices required