

Collection of Indoor Air Samples for Analysis of Semi-Volatile Organic Compounds (SVOCs) Using PUF Cartridges

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Introduction

This guide is intended for indoor air quality (IAQ) investigations involving the sampling of semi-volatile organic compounds (SVOCs) in air. A known volume of indoor air is pulled by a pump onto a PUF (polyurethane foam) cartridge for subsequent laboratory analysis of individual SVOCs (i.e., polycyclic aromatic hydrocarbons and/or phthalate esters) by gas chromatography/mass spectrometry (GC/MS). Determining the appropriate sampling strategy is a critical first step to achieving the study's objectives. Additionally, field air samples must be collected properly to obtain meaningful results. Specific procedures covered in this guide include selection of sample volumes, control and monitoring of the sampling process, reducing sources of SVOC contamination, and sampler storage and transport. The use PUF samplers for SVOC air sampling is described in U.S. EPA Method TO-10A available at <http://www.epa.gov/ttnamti1/files/ambient/airtox/to-10ar.pdf>.

Sampling Strategy

1. For many typical building investigations, it is recommended that samples be collected from several indoor locations and one outdoor location. As an example, if you are investigating a problem building, you may consider collecting samples from an area in the building with the highest suspected contamination and one sample from an area in the building with low suspected contamination to serve as a control. An outdoor sample may be collected to serve as a background reference (i.e., to be subtracted from indoor concentrations). The outdoor location should be carefully selected to be representative of the ventilation air entering the building. For example, avoid hanging samplers immediately outside of open windows since air may be flowing out of the building at the windows.
2. If a measure of sampling and analysis precision is required, it is recommended that two or more samples be collected at each location.
3. It is desirable to have a field blank in addition to an outdoor reference sample. Often only one blank sample is needed per building. The blank sampler should be handled, transported and stored identically to the other samplers, except that no actual sample is collected.

Description of the Sampler

1. We recommend using low-volume, ORBO PUF Cartridge Samplers (Part No. 20557, Sigma Aldrich, 800-325-3010) as these come with a manufacturer's 'Certificate of Analysis' and have been shown to have consistently low background levels of PAH and phthalate esters. They are sold in boxes of three samplers. Low-Volume, Sampling PUF Tubes (Part No. 226-92, SKC, 800-752-8472) also are acceptable samplers. Each sampler (either Sigma Aldrich or SKC) contains a single 2.2-cm O.D. × 7.6-cm length of pre-cleaned PUF in a glass holder.

2. As purchased, SKC PUF Tubes are individually wrapped in foil and contained in a sealed glass container with a label indicating the manufacturer's part number, production lot number and expiration date. The three ORBO PUF Cartridges are packaged together in one large sealed glass container with the manufacturer's information printed on the packing box. Berkeley Analytical may be able to supply samplers in small quantities at cost.
3. The pre-cleaned PUF plugs in the Sigma Aldrich and SKC samplers are ready to use as received. Pre-cleaned, PUF plugs are available (Part No. 20600-U, Sigma Aldrich) as replacement media. If reusing a glass holder, clean it with solvent (e.g., methanol) and dry it. Using clean gloves (Nitrile gloves are acceptable), insert the PUF plug into the glass holder by gently twisting it until the plug rests at the bottom of the holder. Slight compression is necessary in order to ensure a snug fit required for proper sample flow.
4. The sampler is installed so that the air being sampled enters the wide open end of the glass holder. The tapered end is attached to the inlet of the sampling pump. The low pressure drop of the small diameter PUF samplers allows collection with a personal sampling pump operating at 1 to 5 L/min.
5. Airborne particles may be collected by the PUF plug, but the sampling efficiency is low. For example, the collection efficiency of PUF for small-diameter (0.1 to 1- μ m) airborne particles is reported to be about 20%. An optional PUF filter cartridge assembly (Part No. 21031, Sigma Aldrich) can be attached to the inlet of the PUF sampler to trap SVOCs in the particulate phase. Replaceable 32-mm quartz micro-fiber filters are available (Part No. 21038, Sigma Aldrich). The 32-mm diameter quartz microfiber filter is placed in the open end of the union and supported by means of a screen or perforated metal plate. A 32-mm Viton® O-ring is placed between the filter and outer nut to create a seal.

Handling

1. Care must be taken to avoid contamination and cross-contamination of samplers. It is recommended that a pair of clean gloves be used with each sampler. Nitrile gloves are recommended. Clean white cotton or nylon gloves also may be used. Hold a sampler by the middle and try to minimize touching the ends near the openings.
2. Do not write on the samplers or attach labels directly to the samplers as this is a potential source of contamination. Wrap an individual glass holder with PUF media in aluminum foil then attach the label to the foil package. Use easily removable labels on the outside of exterior glass containers to facilitate their reuse.

Sampling Apparatus

1. Draw air directly into a sampler so as to avoid connecting tubing to the inlet of the sampler.
2. Connect the sampler upstream of the sampling pump. In some cases, the sampler can be connected directly to the inlet of the pump. Often it is desirable to locate the sampler away from the pump and connect the sampler to the pump with tubing. When sampling for phthalate esters, do not use tubing with plasticizers such as standard grade Tygon® tubing.

3. There are various AC and DC powered diaphragm and peristaltic pumps that are suitable for use with the sampler. Many battery-operated personal sampling pumps may be used.

Sample Volume and Flow Rate

1. It is necessary to know the flow rate of air through the sampler and the elapsed time of the sampling interval in order to calculate the sample volume. For the highest precision, the flow rate through the sampler should be maintained at a constant rate and monitored continuously, or at least frequently, during sampling. These objectives are best accomplished using electronic mass flow controllers in combination with a vacuum pump. Alternately, a pump with integrated flow control or a separate needle valve may be used to maintain a constant flow rate.
2. A positive displacement flow sensor, bubble flow meter, or a rotameter may be used to monitor the flow rate if the pump has an air outlet with a suitable fitting. Do not attach flow meters upstream of the sampler as this may contaminate the sample. If the pump does not have an air outlet, it will be necessary to calibrate the sampling system using a dummy sampling cartridge. The outside diameter of the glass holder is 22 mm. Appropriate fittings in this dimension are not readily available. Thus, it may be necessary to place a 1-hole stopper fitted with a small diameter tubing into the interior diameter of the glass holder.
3. For flow regulation schemes other than those using electronic mass-flow controllers, it is necessary to directly measure the flow rate. At a minimum, this measurement should be made both near the beginning and end of the sampling interval. These measured flow rates should not vary by more than 15%.
4. The minimum sample volume is determined by the sensitivity of the analytical system, the blank level, and the concentration of the target compound(s). A sample volume of 240 L produces a lower limit of quantitation of approximately $0.4 \mu\text{g}/\text{m}^3$ for signal component phthalates, $4 \mu\text{g}/\text{m}^3$ for phthalates that are isomer mixtures (DINP and DIDP), and $0.02 \mu\text{g}/\text{m}^3$ for the 16 PAH compounds listed in EPA Method 8310.
5. A sampling rate of 1 to 5 L min^{-1} is recommended. A maximum sampling time of 24 h is recommended. Typically, an indoor air sample is collected at 1 L min^{-1} over four hours yielding a 240-L sample.
6. The sampling system should be leak checked prior to use.
7. Record the measurement data including the air temperature and the atmospheric pressure so that the flow rate can be converted to standard indoor conditions (e.g., 25°C , 101.3 kPa).

Other Sampling Precautions

1. Do not expose samplers used outdoors to direct sunlight. Aluminum foil can be used to make a simple sun shield.
2. Avoid collecting samples in the rain or in high humidity situations.

Storage and Transport

1. Store, transport and ship samplers tightly enclosed in their glass storage containers. Avoid subjecting the samplers to elevated temperatures such as might occur in closed vehicles parked in the sun. It is highly recommended that samplers be transported and shipped in an ice chest using an ice pack to keep the samplers cool. Return the samplers to Berkeley Analytical for analysis as soon as possible after the collection of samples. If used samplers must be stored prior to shipment, keep them in a clean refrigerator or freezer.
2. When submitting samplers to Berkeley Analytical for analysis, be sure to clearly indicate what services are desired. An IAQ services COC form is available for download on the Berkeley Analytical website if you do not already have an appropriate form.

Figure 1. PUF Sampler for SVOCs

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