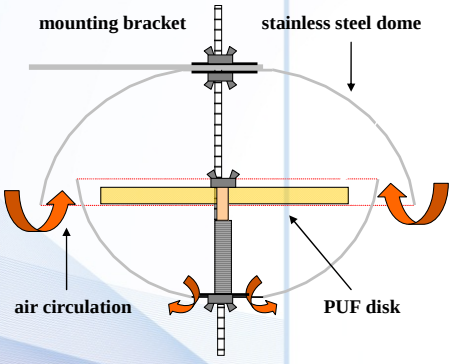
Research centre for toxic compounds in the environment

National centre for persistent organic pollutants

Methodology of passive air sampling



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1 Principle of method

Low sensitivity to accidental short-time changes in the concentration of pollutants is a basic characteristic of passive samplers. They provide information about the long-term contamination of the studied environmental compartment (for example air).

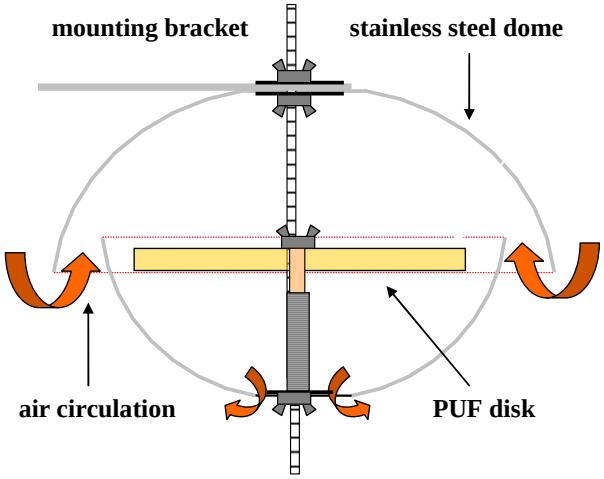
The air streams freely around a filter, membrane or other medium (sorbent), which captures pollutants during the period of passive air sampling. It is possible to use polyurethane foam (PUF) for persistent organic pollutant (POPs) sampling.

The relationship between the amount of POPs captured on PUF filter and their concentrations in sampled air has not been mathematically fully described yet. Due to this reason only empirical estimated information (for example based on parallel active and passive measurements) is available for results interpretation. Passive air sampling is a cheap screening method for a comparison of contamination on various sites or for verification of information obtained by active samplers [1-3].

2 Material

2.1 Sampler (description, maintenance)

Passive air sampling device consists of two stainless steel bowls attached to the common axes to form a protective chamber for the polyurethane foam filter. The filter is attached to the same rod and it is sheltered against the wet and dry atmospheric deposition, wind and UV light [4]. Exposure times between four and twelve weeks enable determination of many compounds from the POPs group. Average sampling rate was estimated to be 7 m^3/day which roughly corresponds to 200 m^3 of air sampled during four weeks of deployment.



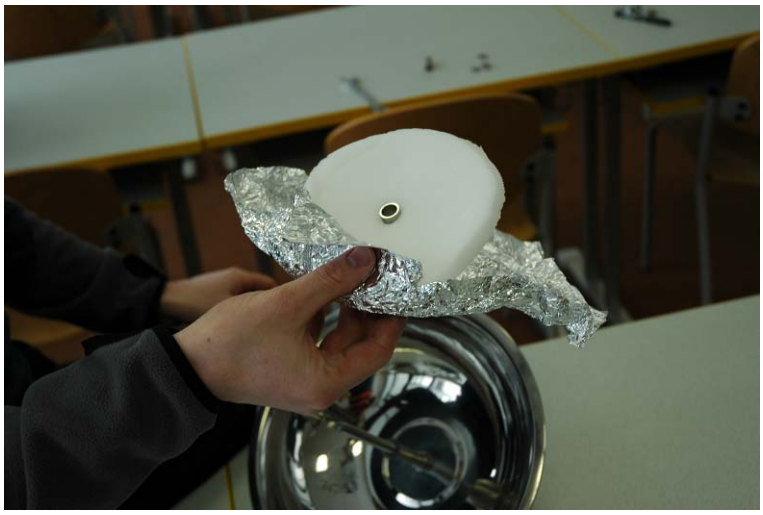
Scheme of the passive air sampling device

List of the parts positioned on the axis (from the top):

- hanging hook – to hang the sampler
- nut and safety-nut – to fix the upper bowl

- pad
- upper bowl (diameter 30 cm) placed up side down – it protects the filter from the rainwater and solar radiation, stabilizes a stream of air around the filter

- pad
- nut – to fasten the upper bowl
- distance tube (longer) – to fix the filter position below upper bowl
- pad
- PUF filter equipped with the metal insert (15 mm length tube prepared in the lab)



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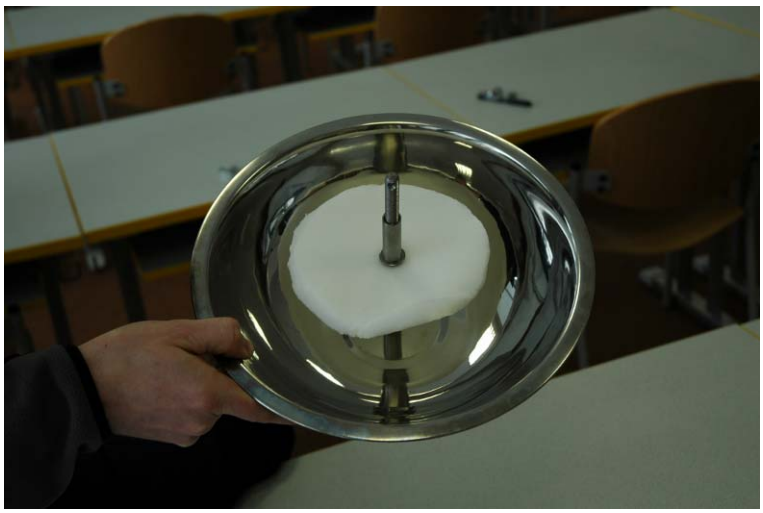

- pad
- distance tube (shorter one) – to fix the filter position above lower bowl
- nut – to fix the distance tubes before mounting the lower bowl
- pad
- lower bowl (diameter 24 cm) placed the bottom down – it protects the filter against the rain water and stabilizes stream of air around the filter (condensed water is drained through four holes in the bottom of the bowl)

- pad
- nut and safety-nut – to fix of position of lower bowl

- safety hook – protects the sampler against the falling apart due to vibrations caused by the strong wind, simultaneously enables to stabilize the sampler in a vertical position

All parts of the sampler are made from the stainless steel and they do not require special service. Removal of dirt and surface cleaning by ethanol are needed, especially inside the bottom bowl, during the filter change. When ever possible with the respect to sampling plan - we could clean-up in laboratory is recommended before new filter installation. In this case, we use the tap water for cleaning and consecutively hexane for better removal of smear from the surface of the sampler.

2.2 Filters (type, preparation)

Filters made of white, non-colored polyurethane foam (PUF) with density 0.030 g.cm^{-3} (type T - 3037; producer Molitan a.s., Czech Republic) are used as a sorbent for passive sampling of POPs. Filters are at circular shape, thickness a 15 mm and diameter a 150 mm.

All filters are cleaned before the placement into the passive air sampler. Filters are extracted 8 hours in acetone and 8 hours in dichloromethane for POPs analysis, and for PBDEs analysis (polybrominated dipfenyl ethers) are extracted 8 hours in acetone and 8 hours in toluene. Filters are dried after extraction and cleaned stainless steel insert (length 15 mm) is placed in their middle to fix the filters to the axis of the sampler.

Filter with the insert is packed in two layers of aluminium foil after cleaning. Date of cleaning and type of cleaning (TOL - only for filters, which were cleaned in toluene) are written with permanent marker on the packed filter. Labeled filter is placed into lock up polyethylene bag (zip-lock). Clean filters are stored in freezer at temperature –18 °C for up to three months.

3 Sampling

3.1 Sampler site selection and sampler deployment

Passive air samplers (their axis) are hanged only vertically with the bigger bowl up and placed 1.5 – 2.0 m above the ground in the man breathing zone. The metal constructions are commonly used for placement of samplers. Open terrain location without significant obstacles for free air stream around the sampler is optimal.

Placement of passive air sampler.

3.2 Duration of sampling

Duration of the passive air sampling (using PUF samplers) is four weeks (28 days). This time may be prolonged up to 3 month (84 days) for special measurements. Interpretation of results has to be done with the respect to this fact, especially when compared to the results obtained in the four weeks sampling cycle.

3.3 Filter installation

First step in the filter exchange in the sampler is a removal and packing of the exposed filter. Next step is an installation of the new clean filter using the following procedure:

1) detach the sampler from the hinge
2) remove the safety hook, nut, safety-nut and pad starting from the bottom
3) carefully remove the lower bowl without a contact with the filter
4) remove the pad and nut fixing the distance tubes
5) carefully remove the shorter distance tube and the pad next to the filter (again without a contact with the filter)

6) using gloves or aluminium foil remove the filter including the stainless insert placed in the centre and wrap it into two layers of aluminium foil

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7) label the wrapped filter (date, site, number of sample) using permanent marker

8) place the labeled filter into the polyethylene bag and put it in the transport cooling box.

9) carefully write all the data about the filter, (it means date of the beginning and the end time of sampling, meteorological conditions during sampling period) to the sampling protocol
10) control the visual state of the sampler and remove possible dirt before installation of the new clean filter
11) write date and time of the beginning of the sampling, name, description and GPS position of the site to the sampling protocol
12) pull the zip-lock polyethylene bag with the packed clean filter from the transport cooling box and write the date of cleaning to the sampling protocol
13) control the position of the longer distance tube and the pad on the axis of the sampler
14) unpack filter including the insert in the centre from aluminium foil and mount it on the axis of the sampler using gloves or aluminium foil
15) after the placement of the filter mount pad and the shorter distance tube on the axis of the sampler, screw the nut fixing the distance tubes

16) mount the lower bowl between the pads and fix the whole sampler with the nut and the safety-nut
17) insert the safety hook, and the place sampler on the hinge

At the beginning of sampling, remove the bottom part of sampler and follow the points 10 to 17. At the end of sampling, follow steps 1 to 9, then put the sampler together and take it to the lab for cleaning.

3.4 Transport of filters

Filter including the central insert is wrapped in two layers of aluminium foil, labelled (date, site, number of sample) using permanent marker and placed into the zip-lock polyethylene bag after exposure. Packed filters are transported to the laboratory in the cooling box at temperature 5 °C. Filters are kept in the freezer at temperature –18 °C till the analysis.

4 Analytical processing of filters

Processing of filters proceeds according to appropriate SOP of the analytical laboratory.

5 Results interpretation

Passive air samplers using PUF filter are suitable for the monitoring of some types of POPs. Particularly, more volatile compounds from the group of polycyclic aromatic hydrocarbons (PAHs; acenaphtylene – pyrene), polychlorinated biphenyls (PCBs), organochlorinated pesticides (OCPs), polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDDs/Fs), polybrominated dipfenyl ethers (PBDE) and perfluorooctanesulfonic acid (PFOS). Less volatile compounds (for example high-molecular PAHs) are also collected on the filter, but only partially (sorbate on captured dust particles).

6 References

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