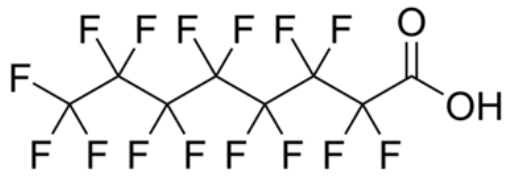
Perfluorinated compounds (PFCs) in consumables- fabrics

Introduction:

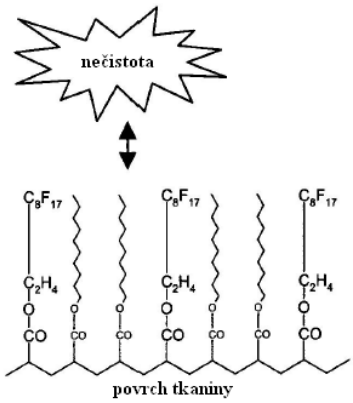
Perfluorinated substances (PFCs) belong to persistent organic pollutants (POPs) and as such are monitored by world organizations (UNECE; OECD; UNEP). Their production and use are limited by several international conventions (Stockholm Convention on persistent organic pollutant; CLRTAP). Directive 2006/122/EC of the European Parliament and the Council of December 12, 2006 is binding on the European Union and thus on the Czech Republic.

PFCs are relatively new compounds. Although they have only been industrially produced since the 1950s, their widespread use has resulted in significant environmental contamination. Thanks to the fluorine atoms in the molecule, these substances are very stable. They are resistant to chemical, photochemical, thermal and biochemical decomposition. They have the potential for long-distance transport, which is why they are present even in areas where they have never been produced or used. This aspect also enhances the ability of bioaccumulation in animal tissues.

Perfluorinated substances are compounds containing a hydrophobic alkyl chain with a variable number of carbons (usually C4 to C16), where all hydrogen atoms are replaced by a fluorine atom. If the hydrophobic part is only partially fluorinated, then the molecules are called polyfluorinated. For substances that only have a partially fluorinated hydrophobic part of the molecule, its properties are determined by the position and number of fluorines. In addition to the hydrophobic part, the molecule also contains a hydrophilic part, e.g. a carboxyl, sulfone or alcohol group.



PFCs include several basic groups of compounds, the most important of which are perfluoroalkyl carboxylic acids (PFCAs), perfluoroalkyl sulfonates (PFASs) from the point of view of consumables . These are substances of an oleophobic and hydrophobic nature. This property is widely used in protective coatings, surface treatment of fabrics, carpets or food packaging materials.


nečistota
C_8F_{17}
C_2H_4
O
CO
povrch tkaniny

Principle:

PFCs are often applied to textile materials to protect them from water and dirt. PFCs from consumables are extracted into an organic solvent in an ultrasonic bath. After filtering, they are analyzed using high-performance liquid chromatography with tandem mass detection (HPLC-MS/MS).

Equipment:

- laboratory scales
- polypropylene centrifuge tubes (50 ml)
- ultrasonic bath
- Pasteur pipettes, automatic pipettes
- tweezers, scissors
- ruler
- syringe (2 ml)
- syringe nylon filter (0.45 μm)
- LabEva Nitrogen Evaporation System
- vortex

Chemicals:

- methanol
- mixed standard for method recovery (M8PFOA, M8PFOS) with a concentration of 100 ng /ml
- 0.1 M hydrochloric acid
- 5 mM ammonium acetate
- mixed internal standard (MPFBA, MPFHxA , MPFOA, MPFNA, MPFDA, MPFDoDA , MPFHxS , MPFOS)

Notice:

- all containers and tools must be washed with methanol before use (applies to PP tubes, Pasteur pipettes, scissors, tweezers)

Procedure:

- put about 2 g of the sample, which is cut into small pieces of about 1x1 cm, into a 50 ml polypropylene tube, write down the exact weight and the measured surface area
- prepare a second test tube for blind determination of the blank
- add the extraction solvent - 20 ml of methanol with the addition of ammonium acetate (1 g of ammonium acetate per 2.5 l of methanol) and 5 ml of 0.1 M HCl
- the centrifuge tubes in the ultrasonic bath and let them extract for 15 minutes
- centrifuge the samples at 4000 rpm for 10 minutes
- transfer the clear supernatant to a clean labeled tube

- repeat the extraction two more times with a new solvent of 10 ml and combine the extracts
- concentrate the extract under a stream of nitrogen to the last drop
- dilute the residue with 1 ml mobile phase methanol: 5 mM ammonium acetate 1:1 and vortex the sample
- remove any impurities by filtering through a syringe nylon filter
- a mixed internal standard is added to the sample using an automatic autosampler

Evaluation and questions:

Calculate the concentration of individual PFCs per mass (ng/g) and surface (ng/m^2) of the material.

Write an example of materials or consumer products where you would expect higher concentrations of PFCs.

How can PFCs get into the environment? Outline the possible life cycle of PFCs in the environment and determine in which environmental matrices the highest concentrations are expected.

Are there any legislative limits on the use of PFCs?