



**Ministry of Environment
and Food of Denmark**

Environmental
Protection Agency

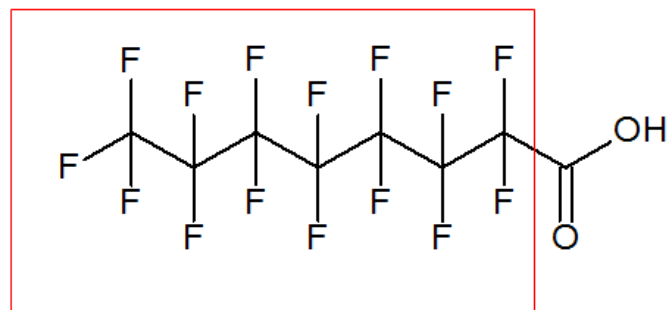
Per- and poly-fluorinated substances

Toke Winther, Danish EPA

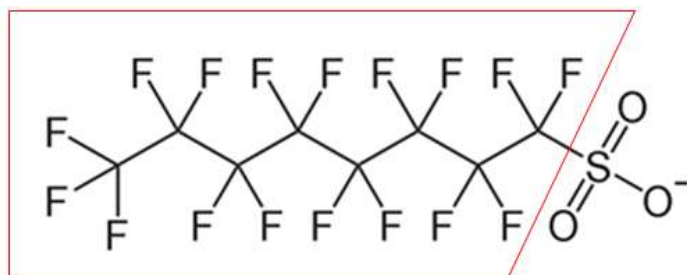
Survey of PFOS, PFOA and other per- and polyfluoroalkyl substances (PFASs)

- Large group of substances that differs in length of (partially) fluorinated carbon chain and/or functional group
- The C-F bond is one of the strongest chemical bonds known
- Unique properties – water and oil repellent and PFASs are extremely resistant towards to heat, chemicals and abrasion
- The per-fluoroalkyl chain are persistent in the environment
- Poly-fluoroalkyl substances may degrade to per-fluoroalkyl substances such as PFOS/PFOA
- Therefore PFASs are found everywhere
 - in the environment and in animals
 - in water, dust, food and food packaging
 - in human blood

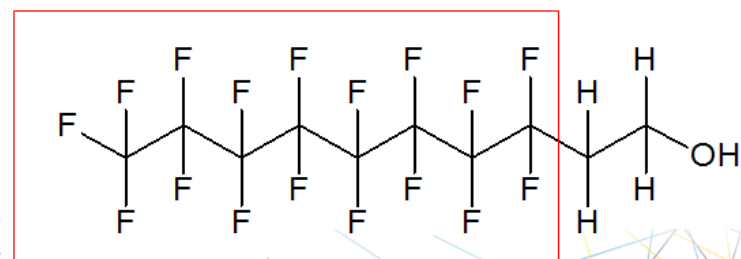
Perfluorooctanoic acid (PFOA)



Perfluorooctan sulfonic acid (PFOS)

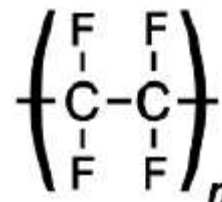


8:2 fluorotelomer alcohol (8:2 FTOH)

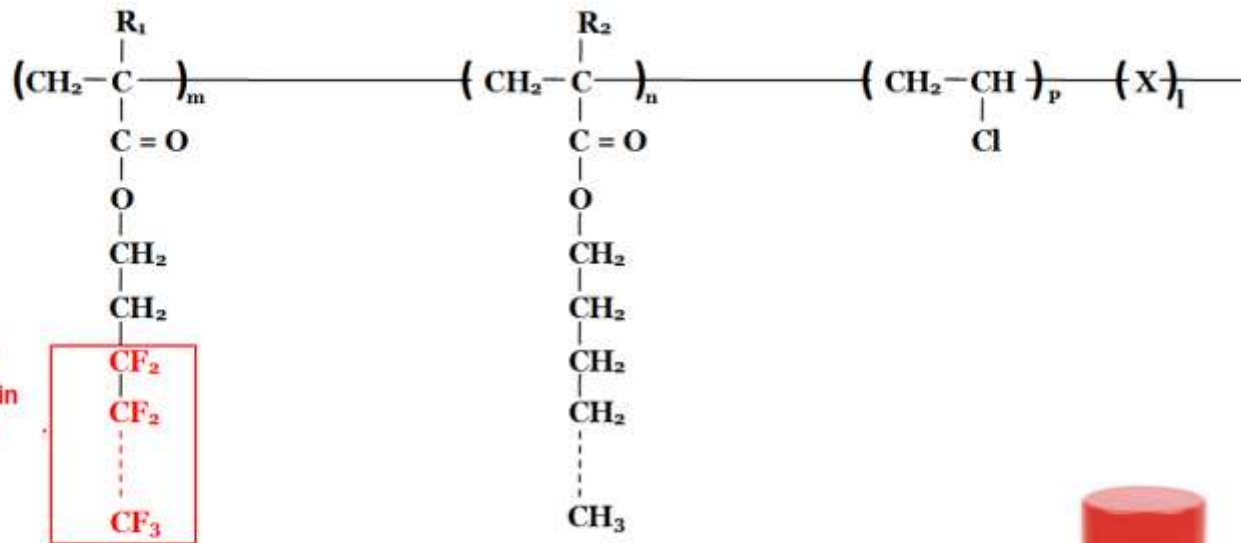


Survey of PFOS, PFOA and other per- and polyfluoroalkyl substances (PFASs)

- Large group of substances that differs in length of (partially) fluorinated carbon chain and/or functional group
 - OECD survey (2007): 960 substances
 - Pre-registered under REACH: 623 substances
 - Registered under REACH: 21 (2013) – of these 7 not included in OECD survey
 - Danish Product Register: 54 (2012)
- The LOUS survey did not include fluoropolymers (e.g. PTFE)
- Some PFASs (e.g. polyfluoroacrylates) can be used for preparation of side-chain fluorinated polymers – included in LOUS survey



Side-chain fluorinated polymers



Fluorinated carbon chain of varying length



Major applications (EU consumption)

- Side-chain fluorinated polymers account for the majority of consumption (2,000-4,000 t/y): Textiles (50%); carpets and carpet care products, coatings, including those for paper products
- PFOS and related substances: 2-10 t/y registered, metal plating
- PFOA and APFO: 25-50 t/y, fluoropolymer production
- Longer chained PFCA and related substances: no data
- Short-chain PFAS: registration 30-120 t/y, probably more, surfactants, processing aids
- Fluorotelomers: no data - used for manufacture of side-chain fluorinated polymers

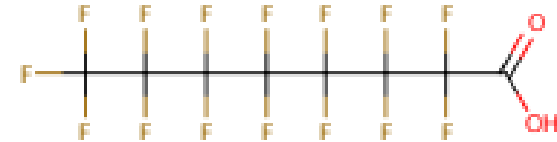


Environmental and health effects

Long-chain vs. short-chain PFASs

- Short-chain PFASs have a higher potential for aqueous long-transport
- Short-chain PFASs are as persistent as the long-chain, but do not bioaccumulate to the same extent as they are excreted more rapidly from the organisms studied
- From data available short-chain PFASs appear to have less potential to cause developmental toxicity and to have less genotoxicological potential
- After repeated exposure, large doses of short-chain PFASs may damage the liver and kidneys
- In general, human health data are limited for short-chain PFASs and more studies are needed

Perfluorooctanoic acid (PFOA)



Perfluorohexane sulfonic acid (PFHxS)



Contamination of soil and groundwater – point sources

- Point sources considered relevant for PFASs contamination: Fire training facilities, chromium plating industry, carpet industry, painting industry and landfills.
- Findings:
 - PFASs detected in 5/8 fire training facilities
 - PFASs detected at one sample from carpet industry
 - No PFASs detected at the tested landfills, painting or chromium plating sites
- New limit values for the sum of 12 PFASs: *PFBS, PFHxS, PFOS, PFOSA, 6:2 FTS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA and PFDA*
 - Drinking water 0.1 µg/l
 - In soil 0.4 mg/kg
- Pilot project to test content of Total Organic Fluorine in ground water samples



Non-fluorinated alternatives to PFASs in textile impregnation

Type	Technical properties	Health properties	Environmental properties
Paraffin-based repellents	Durable water repellent - no oil and alcohol repellency	The compositions are mainly confidential. Main ingredient, paraffin oil/wax, is relatively harmless in its pure form. Some products also contain isocyanates, dipropylene glycol, metal salts or other unspecified substances, which may be harmful.	Most components are readily biodegradable, are not bioconcentrated or accumulated in organisms and food chains, and aquatic toxicity is insignificant
Silicone-based repellents	Durable water repellent - no oil and alcohol repellency	The silicones used in textile impregnation agents are based on polydimethylsiloxanes (PDMS). These are inert and generally have no adverse effects. Unclear to what extent cyclic and small linear siloxanes may be present at trace levels in the agents. Specifically D4 is suspected of damaging fertility, and D5 is a potential carcinogen	Not enough data for a detailed evaluation. Low-molecular-weight poly(dimethylsiloxanes) and polydimethylsiloxanes (PDMS) have low toxicity and are not considered PBT or vPvB substances.
Dendrimer-based repellents	Durable water repellent - no oil and alcohol repellency	According to the producer, these products should not be classified as harmful. Not enough data for an assessment. Some of the products contain unknown siloxanes, cationic polymers, isocyanates or powerful irritating organic acids.	Not enough data for a detailed evaluation. According to the producer's information, these products should not be labelled or classified as harmful for the environment.
Polyurethane-based repellents	Durable water repellent - no oil and alcohol repellency	According to the producer's information, the product should not be labelled or classified as harmful to health. Nevertheless, several health hazard phrases are mentioned in the SDS'.	Not enough data for a detailed evaluation. According to the producer's information, these products should not be labelled or classified as harmful for the environment.





Links

- [Status of the PFAS LOUS project](#)
- [Survey of PFOS, PFOA and other per- and polyfluoroalkyl substances \(PFAS\)](#)
- [Short-chain per- and polyfluoroalkyl Substances \(PFAS\)](#)
- [Screeningsundersøgelse af udvalgte PFAS-forbindelser som jord – og grundvandsforurening i forbindelse med punktkilder](#)
- [Perfluoroalkylated substances: PFOA, PFOS and PFOSA](#)
- [sum-kriterium for drikkevand, grundvand og jord for 12 specifikke PFAS-forbindelser](#)
- [PFAS in textiles for children](#)
- [Alternatives to per- and polyfluoroalkyl substances \(PFAS\) in textiles](#)





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