PER- AND POLYFLUORINATED ALKYL SUBSTANCES (PFAS) EXTRACTED FROM TEXTILE SAMPLES

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Introduction

Picture: Dorte Herzke

Due to their ability to repel water and oil, per- and polyfluorinated alkyl substances (PFAS) are used for surface treatment of textiles, leather, carpets and paper. Fluorotelomer alcohols (FTOHs) are such fluorochemicals that are used in polymeric textile proofing. Furthermore, polytetrafluoroethylene (PTFE)-based membranes are often used in rain coats due to their water resistance and ability to breathe.

The aim of this study was to identify PFAS used in the production of different types of textiles from the Swedish and Norwegian market. The selection of test materials covered most of the common brands in Scandinavia, focusing on outdoor clothing and rain jackets. The amount of freely extractable fluorochemicals was roughly estimated.

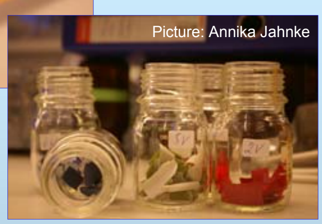
Picture: Dorte Herzke

Experimental

- *Test materials*: 17 textile samples from 15 producers that cover all important brands on the Scandinavian market.
- *Analytes* (combined to groups in Table 1): 10:2 FTolefin; 4:2, 6:2, 8:2, 10:2 FTOHs; 6:2, 8:2 Fluorotelomer sulfonates and (unsaturated) carboxylates, FTS/FT(U)CAs; C4, C6, C8, C10 Perfluorosulfonates, PFS; C4-C15 Perfluorocarboxylates, PFCAs; N-Alkyl fluorooctane sulfonamides/sulfonamidoethanols, FOSAs/FOSEs (incl. PFOSA).
- *Extraction*: Ultrasonic extraction of 10x10 cm (cut in small pieces) with methanol for LC-MS analysis or ethyl acetate for GC-MS analysis.
- *Quantification*: LC-TOF-MS of sulfonates, carboxylates, sulfonamides and -ethanols (and FTOHs for confirmation) as described in [1] and GC-MS of FTolefin and FTOHs as described in [2].

Picture: Annika Jahnke

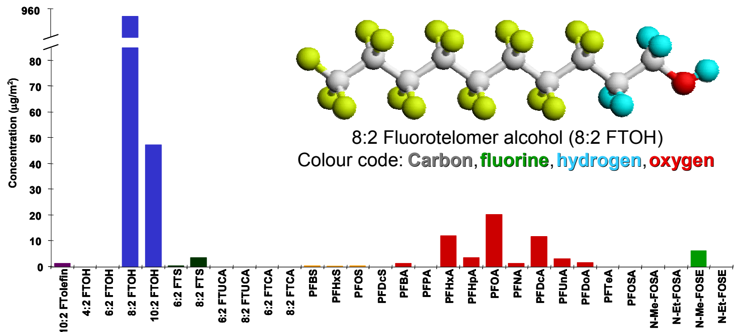
Extracts ready for analysis



Picture: Annika Jahnke

Extracted samples

PFAS patterns



8:2 Fluorotelomer alcohol (8:2 FTOH)
Colour code: Carbon, fluorine, hydrogen, oxygen

Figure 1. Freely extractable PFAS from a sailing jacket for kids (qualitatively representative for most synthetic textiles).

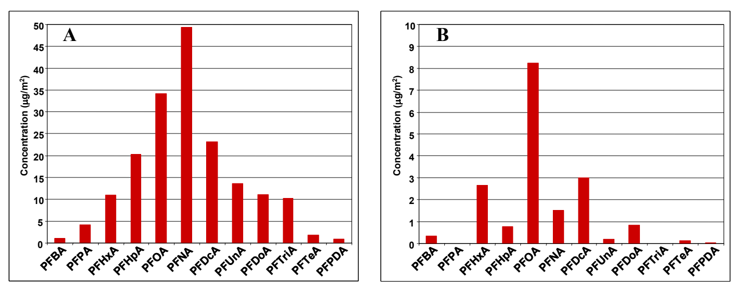


Figure 2. PFCA pattern in the extract from a PTFE table-cloth (A) and an impregnated and coated jacket (B).

Results for PFAS groups

Table 1. Freely extractable PFAS from different textile samples summarised in groups (µg/m² textile). Dark backgrounds indicate high sum concentrations. Detailed results and sample information are given in [3,4].

	10:2 FTolefin	Sum FTOHs	Sum FTS/ FTCAs	Sum PFS	Sum PFCAs	Sum FOSAs/ FOSEs
Alpine trousers for kids	n.d.	n.d.	n.d.	0.06	6.84	n.d.
Overall for kids	n.d.	97.8	n.d.	n.d.	2.97	0.06
Rain and outdoor jacket	n.d.	10700	2.72	30.5	34.9	22.8
PTFE table-cloth	n.d.	285	5.56	0.04	170	0.03
Alpine jacket	n.d.	42.2	0.33	0.03	10.8	n.d.
Sport jacket	n.d.	86.8	0.09	n.d.	18.9	n.d.
Trousers kids	n.d.	426	0.38	0.17	3.41	0.03
Overall for kids	n.d.	207	n.d.	0.07	2.71	0.04
Waterproof jacket	n.d.	155	n.d.	0.07	6.97	1.08
Impregn. and coated jacket	n.d.	33.0	0.06	0.06	17.6	0.36
Mixed synth./cotton textile	n.d.	168	0.97	0.26	94.7	0.74
Cotton textile	0.13	41.1	1.54	23.3	428	107
Synthetic textile	n.d.	73.9	n.d.	0.12	48.5	5.73
Breathable rain jacket	1.11	91.0	1.87	0.02	16.4	1.43
Waterproof rain jacket	0.26	385	1.92	0.28	55.9	14.1
Sailing jacket for kids	0.85	1000	3.87	0.67	53.3	6.10
Waterproof rain jacket	n.d.	27.1	n.d.	0.44	1.89	4.30

- Large variations in PFAS concentrations and compositions between samples
- FTOHs dominate in the textile extracts with concentrations up to 11 mg/m² textile
- LC-MS measurements confirmed the free extractability of FTOHs
- PFCAs highest in a cotton textile (0.4 mg/m²) and a PTFE table-cloth (0.2 mg/m²)
- Only minor amounts of PFS (dominated by PFOS) extracted. PFS correlate positively (R^2 0.51) with the possible PFOS precursors FOSAa/FOSEs.

Conclusions

- PFAS were extracted from all tested textiles with sum concentrations up to 11 mg/m².
- Freely extractable FTOHs (mainly 8:2 FTOH) dominated and could evaporate during the lifetime of the textile.
- PFCAs from C4 to C15 were found. They could enter the aqueous environment during washing of the textiles. The PFCA pattern allows conclusions about their production process (electrochemical vs. telomerisation, see Figure 2).

Acknowledgments

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References

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