



Factsheet Fluorocarbons (PFCs)

Sympatex Technologies GmbH

PTFE-free Sympatex membrane

The Sympatex membrane is PTFE-free which means that it does not contain **any fluorine compounds**. It is made of perfectly safe polyether/ester, a compound of polyester and polyether molecules which makes it absolutely environmentally friendly and kind on the skin and also means it can be recycled like a PET bottle. Other membranes such as Gore-Tex and eVent are made of PTFE (polytetrafluoroethylene) whose manufacture, disposal, heating and incineration may release **PFCs** (per and polyfluorinated chemicals / fluorine compounds) which are regarded as ecologically problematic.

The performance of fluorine-free polyester membranes and PTFE-based membranes are very similar in terms of them being windproof, breathable and waterproof.

Water-repellent impregnations / General facts

To meet requirements relating to functionality and care, the outer materials used in outdoor clothing generally have a water-repellent treatment (impregnation) on the outside and a membrane on the inside.

The Sympatex membrane ensures that functional clothing is waterproof. Water-repellent treatments also ensure that the textile has durable water-repellent properties. A DWR (durable water repellent) treatment is an extremely thin coating of the individual fibres which ensures that water simply forms beads and falls off. This treatment prevents or delays the ingress of water into the outer material. The result of this is that the garment does not absorb water, it does not gain weight, the body does not start to feel clammy and the good breathability of the garment is retained.

DWR technologies and their performance can generally be divided into two groups:

- DWRs which contain fluorocarbons (PFCs)
- Fluorocarbon-free DWRs

DWRs which contain fluorocarbons

In addition to the water-repellent effect, DWRs which contain FCs can also have other properties:

- Dirt repellent
- Oil-repellent
- Simple dirt and stain removal

Ecological problem with C8 and C6 fluorine compounds

Long-chain C8 fluorine compounds

Per- and polyfluorinated chemicals (PFCs) are chemical compounds in which the hydrogen atoms on the carbon backbone are replaced by fluorine atoms in full (perfluorinated) or in part (polyfluorinated). PFCs have been used commercially since around the middle of last century. They are synthetic and do not occur in nature. Perfluorocarboxylic acids (PFCA, for example perfluorooctanoic acid – PFOA) are particularly prevalent in the clothing industry. The great stability of the carbon-fluorine bond not only results in the marked resistance to chemicals of many PFCs but also to their resistance to a large number of degradation mechanisms, such as heat, hydrolysis, UV radiation and biological processes. As a result PFCs which get into the environment remain there for long periods of time. These chemicals have been found all over the world in water, in the atmosphere and in animal and human tissue and blood.^{i,ii,iii}

They are mainly absorbed into the human body through the respiratory tract. To date it appears that absorption through the skin is low, on the other hand.^{iv} Alongside PFOS (perfluorooctane sulfonic acid) PFOA is a member of the substance class of C8 fluorocarbons whose molecular structure consists of 8 carbon atoms (see figure on page 3). With a few exceptions and transition periods, the sale and use of PFOS has been prohibited since 2006 (EU Directive 2006/122/EC) and 2008 (Hazardous Substances Regulation and Chemical Prohibition Regulation). In 2009 PFOS was included in the list of restricted substances by the Stockholm Convention^v.

PFOA has also been the target of a good deal of criticism but to date no statutory regulations have been issued against it. The German Federal Environment Agency (UBA) has proposed that PFOA, which is regarded as toxic for reproduction, should be included in the list of substances which are particularly suspect and therefore included in the REACH licensing process.^{vi}

Shorter-chain C6 fluorine compounds

DWR treatments which are based on shorter fluorine compounds, such as C6, differ from the C8-chain FC treatments in terms of their base material which cannot degrade in the environment into PFOS and PFOA.^{vii} Studies have also shown that shorter-chain PFCs enrich to a lesser extent in the body.^{viii} These shorter-chain PFCs are an environmentally friendlier alternative for applications which require resistance to oil and dirt and also high washing temperatures.^{ix} Though, shorter-chain PFCs are to be considered as more volatile compared to long-chain PFCs.^x Hence, the clear objective should be the total abandonment of fluorocarbon based DWR over the medium-to-long term. Instead, the use of fluorocarbon-free DWR (C zero) should become the norm (more explanations on the next chapters).

C8 - PFOS: $\text{CF}_3\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-SO}_3\text{H}$

C8 - PFOA: $\text{CF}_3\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-COOH}$

C6 - PFHxA: $\text{CF}_3\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-CF}_2\text{-COOH}$

C4 - PFBA: $\text{CF}_3\text{-CF}_2\text{-CF}_2\text{-COOH}$

Figure: Examples of some PFCs based on a backbone of 8 carbon atoms (C8) – perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), a backbone of 6 carbon atoms (C6) – perfluorohexanoic acid (PFHxA) and a backbone of 4 carbon atoms (C4) – perfluorobutanoic acid.



Fluorocarbon-free DWRs

Fluorocarbon based treatments can be replaced by waxes, paraffins, polyurethanes, dendrimers or silicones. Functional alternatives to products containing fluorine were tested in an independent test process initiated by Greenpeace. This showed that water forms bead comparatively well on fluorine-free products. The protection can be reactivated by reimpregnation with PFC-free products. Their rubbing resistance may even exceed the performance of conventional products which contain fluorine.^{xi}

Sympatex provides ecological alternatives

Fluorocarbon-free treatment with BIONIC FINISH ECO®

Sympatex has been supplying an environmentally friendly, fluorocarbon-free DWR treatment for textiles with its partner Rudolf GmbH, a specialist in bionic textile finishing, in the form of BIONIC FINISH ECO® since mid-2008.^{xii} Sympatex was the first pioneering functional textiles specialist to coat functional clothing fully with fluorocarbon-free treatments in 2008.^{xiii}

Apparel Business Unit

Fluorocarbon-free (C0) products are ideal for clothing for the vast majority of classic outdoor activities thanks to their water-repellent effect.

Without any loss of performance they guarantee the following:

- Comparatively high water-repellent effect similar to that of products which contain FCs
- No weight increase in the garment
- Excellent wearer comfort
- Superb breathability

Restriction of fluorocarbon-free treatments:

- No oil/dirt repellent effect
- Not resistant to dry cleaning
- Reduced permanence, particularly when washed at temperatures over 40°C



100% PFC-free Sympatex products

FC-free impregnations provide the same performance for the vast majority of outdoor requirements as impregnations which contain FCs. Oil and dirt repellent effects, which still necessitates the use of products which contain FCs, are not generally necessary. In its Apparel Business Unit Sympatex supplies products which are 100% PFC-free as a result of their PTFE-free membranes and FC-free treatments which have been in use since 2008.^{xiv}

Footwear and Contract & Workwear Business Units

If a textile only requires a water-repellent property, FC-free and therefore ecologically safer treatments are completely adequate. If functions such as dirt and oil repellence, easy-to-clean (simple dirt and stain removal) or suitability for dry cleaning are required, the use of FC treatments is still required at the current state of developments.

Future developments

In close cooperation with textile treatment manufacturers, Sympatex has been working for a considerable time on the development of improved FC-free paraffin, urethane or dendrimer-based products. The change from C8 to C6 fluorocarbon treatments for the Footwear and Contract & Workwear Business Units has been completed. The use of Bionic Finish Eco® for selected applications in these two divisions is also being investigated.



Background information on Greenpeace "Detox" campaign

Sympatex has been working on PFC-free products since 2008. The PFC problem is repeatedly highlighted to a wide audience in the Greenpeace study published in October 2012 entitled "Chemicals for all weathers"^{xv}. This shows yet again that Sympatex chose the correct route several years ago by adopting its ecological commitment. The results of the study have also encouraged the company to continue along this route.

Actions and reactions of the outdoor industry and chemicals suppliers

As part of its worldwide "Detox" campaign, the environmental organisation Greenpeace is calling on the textile industry to commit to zero discharge of hazardous chemicals within the supply chains and is also demanding action plans as to how these objectives can be achieved.^{xvi}

In this international campaign, Greenpeace in particular calls on the outdoor industry to replace harmful PFC production chemicals used in coatings with non-hazardous alternatives. PFCs are one of the eleven prioritised substance groups on the detox list. They are known to be toxic for reproduction and also have a hormonal effect.^{xvii}

At the end of 2011 several major international clothing and shoe brands, including Puma, Adidas, Nike, H&M and Li Ning, formed the Zero Discharge of Hazardous Chemicals (ZDHC) Group. The consequence of this is a joint declaration to end the discharge of all toxic substances into the environment by 2020.

The complete ZDHC declaration was followed up by a "joint roadmap" issued by all members and listing the various measures they had planned. This includes the replacement of long-chain C8 fluorocarbons by less harmful short-chain C6 or C4 fluorocarbons. The objective is to achieve "C0" (zero fluorocarbons) by 2020, in other words the use of completely FC-free "ecological" products by that date.^{xviii} These products are already available to the industry and the chemical industry has now increased its focus on their advanced development.

In U.S. EPA 2010/2015 PFOA Stewardship Programs, the major chemical manufacturers (DuPont, Achroma, e.g.), made a voluntary commitment in 2006 to work on the complete elimination of PFOA, PFOA precursors and higher links from the corresponding homologous series from emissions and products by 2015.^{xix}



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ⁱKoller, U.; 2006: Perfluorierte Verbindungen – Mögliche Risiken für Mensch und Umwelt; GSF - Forschungszentrum für Umwelt und Gesundheit in der Helmholtz-Gemeinschaft; in: <http://www.helmholtz-muenchen.de/fileadmin/FLUGS/PDF/Themen/Chemikalien/Perfluorierte-Verbindungen.pdf>

ⁱⁱKannan, K., Corsolini, S., Falandysz, J., Oehme, G., Focardi, S., Giesy, J.P., 2002. Perfluorooctanesulfonate and related fluorinated hydrocarbons in marine mammals, fishes, and birds from coasts of the Baltic and the Mediterranean Seas. Environ. Sci. Technol. 36, 3210–3216.

ⁱⁱⁱOlsen, G.W., Church, T.R., Miller, J.P., Burris, J.M., Hansen, K.J., Lundberg, J.K., Armitage, J.B., Herron, R.M., Medhdizadehkashi, Z., Nobiletti, J.B., O'Neill, E.M., Mandel, J.H., Zobel, L.R., 2003. Perfluorooctanesulfonate and other fluorochemicals in the serum of American Red Cross adult blood donors. Environ. Health Perspect. 111, 1892–1901.

^{iv}Greenpeace, 2012: „chemistry for any weather”

http://www.greenpeace.de/fileadmin/gpd/user_upload/themen/chemie/gp_outdoor_report_2012_engl_fol_fin_neu_02_es.pdf
p.8

^vThe Stockholm Convention on persistent organic pollutants (POPs) is a global treaty to protect human health and the environment from highly dangerous, long-lasting chemicals by restricting and ultimately eliminating their production, use, trade, release and storage. (engl. Persistent organic pollutants, POPs), www.pops.int/
<http://chm.pops.int/Convention/ThePOPs/TheNewPOPs/tabid/2511/Default.aspx>

^{vi}ECHA (European Chemicals Agency): <http://echa.europa.eu/de/opinions-of-the-committee-for-risk-assessment-on-proposals-for-harmonised-classification-and-labelling> REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals): http://www.reach-info.de/vorschlaege_svhc.htm

^{vii}P05 Water Repellency Project; 2012: Durable Water and Soil repellent chemistry in the textile industry – a research report, p.13

^{viii}2008: DuPont Surface Protection Solutions in:

http://www2.dupont.com/Capstone/en_US/assets/downloads/capstone_prod_stewardship_detail_doc_01oct2008.pdf

^{ix}Swedish Chemical Agency (KEMI), Report Nr 7/06: Perfluorinated Substances and their Uses in Sweden, November 2006. Retrieved October 2012 from

http://www.kemi.se/Documents/Publikationer/Trycksaker/Rapporter/Report7_06.pdf

^xGreenpeace, 2015, "Footprints in the Snow", p.13

http://detox-outdoor.org/assets/uploads/Report%20RAE/RAE_report_08_2015_english_final.pdf

^{xi}Greenpeace, 2012 Greenpeace, 2012: „chemistry for any weather”

http://www.greenpeace.de/fileadmin/gpd/user_upload/themen/chemie/gp_outdoor_report_2012_engl_fol_fin_neu_02_es.pdf
p. 25

^{xii}Rahn, S.;2008: Learning from nature, developing for man; in: <http://rudolf.de/products/details-brochure.htm?year=2008&ri=200819>

^{xiii}o.A.; 2008: Öko-Innovation: Sympatex präsentiert fluorcarbonfreies Bionic Finish Eco; Ski-Presse.de; in:

http://www.sportpresse-online.de/index.php/sportpresse-online-news/sportpresse-online-produkt/2603-%C3%96koInnovation-Sympatex_pr%C3%A4sentiert_fluorcarbonfreies_Bionic_Finish_Eco.html

^{xiv}Due to DWR containing fluorocarbon which are still required on the market, there might be a contamination of fluorocarbon-free DWR during the production process and/or during the supply chain with chemicals which contain fluorocarbon

^{xv}Greenpeace, 2012 Greenpeace, 2012: „chemistry for any weather”

http://www.greenpeace.de/fileadmin/gpd/user_upload/themen/chemie/gp_outdoor_report_2012_engl_fol_fin_neu_02_es.pdf

^{xvi}Greenpeace, 2011: „Dirty Laundry 2: Hung Out to Dry”

<http://www.greenpeace.org/international/Global/international/publications/toxics/Water%202011/dirty-laundry-report-2.pdf>

^{xvii}Greenpeace, 2012: „chemistry for any weather”

http://www.greenpeace.de/fileadmin/gpd/user_upload/themen/chemie/gp_outdoor_report_2012_engl_fol_fin_neu_02_es.pdf
p. 5 and 42



xviii www.roadmaptozero.com; <http://www.europeanoutdoorgroup.com/wp-content/uploads/ZDHC-Karin-Ekberg.pdf>
xix <http://www.epa.gov/stewardship/>