Helsingør Statement on Poly- and Perfluorinated Alkyl Substances (PFASs)
Scheringer, M; Trier, X; Cousins, I.T.; de Voogt, W.P.; Fletcher, T; Wang, Z; Webster, T.F.

Published in:
Chemosphere

DOI:
10.1016/j.chemosphere.2014.05.044

Link to publication

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
Helsingør Statement on poly- and perfluorinated alkyl substances (PFASs)

Martin Scheringer\textsuperscript{a,∗}, Xenia Trier\textsuperscript{b}, Ian T. Cousins\textsuperscript{c}, Pim de Voogt\textsuperscript{d}, Tony Fletcher\textsuperscript{e}, Zhanyun Wang\textsuperscript{a}, Thomas F. Webster\textsuperscript{f}

\textsuperscript{a} Institute for Chemical and Bioengineering, ETH Zürich, 8093 Zürich, Switzerland
\textsuperscript{b} Technical University of Denmark, Division of Food Chemistry, 2860 Søborg, Denmark
\textsuperscript{c} Department of Applied Environmental Science (ITM), Stockholm University, 10691 Stockholm, Sweden
\textsuperscript{d} Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, 1090 GE Amsterdam, The Netherlands
\textsuperscript{e} London School of Hygiene & Tropical Medicine, London WC1H 9SH, United Kingdom
\textsuperscript{f} School of Public Health, Boston University, Boston, MA 02118, USA

\begin{abstract}
In this discussion paper, the transition from long-chain poly- and perfluorinated alkyl substances (PFASs) to fluorinated alternatives is addressed. Long-chain PFASs include perfluoroalkyl carboxylic acids (PFCAs) with 7 or more perfluorinated carbons, perfluoroalkyl sulfonic acids (PFSAs) with 6 or more perfluorinated carbons, and their precursors. Because long-chain PFASs have been found to be persistent, bioaccumulative and toxic, they are being replaced by a wide range of fluorinated alternatives. We summarize key concerns about the potential impacts of fluorinated alternatives on human health and the environment in order to provide concise information for different stakeholders and the public. These concerns include, amongst others, the likelihood of fluorinated alternatives or their transformation products becoming ubiquitously present in the global environment; the need for more information on uses, properties and effects of fluorinated alternatives; the formation of persistent terminal transformation products including PFCAs and PFSAs; increasing environmental and human exposure and potential of adverse effects as a consequence of the high ultimate persistence and increasing usage of fluorinated alternatives; the high societal costs that would be caused if the uses, environmental fate, and adverse effects of fluorinated alternatives had to be investigated by publicly funded research; and the lack of consideration of non-persistent alternatives to long-chain PFASs.
\end{abstract}

http://dx.doi.org/10.1016/j.chemosphere.2014.05.044

0045-6535/© 2014 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-SA license (http://creativecommons.org/licenses/by-nc-sa/3.0/).
1. PFASs are ubiquitous.

A wide range of PFASs, including fluorinated alternatives to long-chain PFASs, is present in environmental matrices (Giesy and Kannan, 2002; McLaughlan et al., 2007; Ahrens, 2011; Li et al., 2011; Eschauzier et al., 2012; Müller et al., 2012; Zhao et al., 2012; Gawor et al., 2013; Wang et al., 2013; Zareitalabad et al., 2013), wildlife (Giesy and Kannan, 2002; Houde et al., 2011), and human tissue (Giesy and Kannan, 2002; Kannan et al., 2004; Martin et al., 2010; Kato et al., 2011; Loi et al., 2013; Yeung et al., 2013a,b) all over the globe.

2. Regulation has caused levels of some PFAS to decline, but others remain stable or continue to increase.

Because perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and PFCAs with 11-14 perfluorinated carbons have been shown to be highly persistent and also bioaccumulative and toxic, these substances are now regulated in the EU and Canada and there have been several voluntary actions by the manufacturing industry to phase out or reduce the emissions of these substances (EU, 2006; Canada Gazette, 2013; ECHA, 2014; US EPA, 2006); PFOS is also regulated globally under the Stockholm Convention on Persistent Organic Pollutants (UNEP, 2014). These regulations were established already after a decade of intense scientific research. As a consequence of phase-out actions and regulations, levels of PFOS and PFOA in human blood samples have now declined in many Western countries (Glynn et al., 2012; Kato et al., 2011; Harada et al., 2010; Yeung et al., 2013a). However, PFCAs with longer perfluorinated chains than PFOA, with 8 or more perfluorooalkyl carbons, have not yet shown signs of decline in human blood samples globally (Kato et al., 2011; Glynn et al., 2012; Yeung et al., 2013b).

3. More information on fluorinated alternatives is urgently needed.

Currently, a wide range of fluorinated alternatives to long-chain PFASs are being developed and commercialized (OECD, 2013; Wang et al., 2013). Many of these fluorinated alternatives are short-chain homologues of long-chain PFASs (typically with 6 or fewer perfluorooalkyl carbons). This has the advantage of making the substances less bioaccumulative than long-chain PFASs, but the perfluorinated chain is still recalcitrant to degradation. Moreover, shorter-chain alternatives are not always less bioaccumulative; there is evidence of higher uptake into maize shoots compared to long-chain PFASs (Krippner et al., 2014). In many cases there is only very limited knowledge in the public domain on the structures, properties, uses and toxicological profiles of fluorinated alternatives. The levels of some fluorinated alternatives or their degradation products, such as perfluorobutane sulfonic acid (PFBS) or perfluorobutanoic acid (PFBA), have been shown to be rising in recent years in the environment and human tissues in Europe (Glynn et al., 2012; Ahrens, 2011; Kirchgeorg et al., 2013). There is an urgent need to provide the necessary knowledge on the environmental and human health risks of this rapidly expanding range of fluorinated compounds, in a way that makes the information publicly accessible.

4. Less efficient fluorinated alternatives may lead to increased use, emissions, and exposure.

While the shorter-chain PFASs are being introduced because they are generally less bioaccumulative, in some cases their technical performance is lower (Renner, 2006; Daikin, 2009; Archroma, 2013) and so there is a concern that larger quantities and/or more substances will need to be used to provide the same performance, potentially cancelling out the benefit of lower bioaccumulation potential.

5. Concerns about low testing requirements.

In the EU the testing requirements under REACH are defined by the production volume of a chemical. In cases where mixtures or combinations of fluorinated alternatives are used to replace a single long-chain PFAS, the amounts of the individual substances may be smaller than the amount of the long-chain PFAS to be replaced so that also the testing requirements are lower. Furthermore, we are concerned that current testing requirements are not sufficient to identify effects such as immunotoxicity and endocrine disruption, which have been linked to PFAS exposure (Grandjean and Budtz-Jørgensen, 2013; White et al., 2011).

6. Regulations need to be established in an increasing number of countries producing and applying PFASs.

PFASs including fluorinated alternatives are manufactured by an increasing number of producers and in more and more regions of the world. As a consequence, the regulation of PFASs needs to be implemented in more countries than in the past. The types of products available on the global market are also more diverse and difficult to characterize.

7. PFASs, including fluorinated alternatives, lead to highly persistent transformation products, which implies increasing human and environmental exposure.

In spite of the diversity of the fluorinated alternatives, current knowledge demonstrates that the perfluorinated parts of fluorinated alternatives are recalcitrant and will form terminal transformation products, including PFCAs and PFSAs (Lee et al., 2010; Young and Mabury, 2010; Liu and Mejia Avendaño, 2013; Butt et al., 2014), which are persistent in the environment (Hurley et al., 2004; Liou et al., 2010; Vaalgamaa et al., 2011; Liu et al., 2013). Extensive and increasing use and emissions of fluorinated alternatives will lead to increasing levels of PFCAs, PFSAs and other stable perfluorinated degradation products in the environment, biota and humans.

8. Increasing exposure implies increasing risk of adverse effects.

It is therefore likely that the fluorinated alternatives or their transformation products will lead to large-scale environmental and human exposure to a range of PFASs and possibly result in adverse effects caused by these substances. As a consequence, we are concerned that the current introduction of fluorinated alternatives eventually may lead to similar problems as occurred in the cases of PFOS and long-chain PFCAs. If the highly persistent and environmentally mobile fluorinated alternatives are shown to cause adverse effects in the future, it may take decades to reverse global contamination to safe levels.

9. It is costly for society to produce new toxicological data; therefore data produced by chemical manufacturers should be made publicly available.

It would be an expensive and time-consuming process to initiate years of publicly funded research into the properties and potential effects of the fluorinated alternatives. Therefore, all data...
on the chemical and toxicological properties of fluorinated alternatives collected by manufacturers and suppliers that are not currently publicly available should be made accessible. In addition to the cost to society of publicly funded risk assessment, there is the risk that there will be an irreversible global environmental problem caused by the widespread occurrence of these fluorinated alternatives and/or their transformation products.

10. Non-persistent alternatives to long-chain PFASs should be used to protect clean food and water resources for a growing human population.

The goal should be to introduce non-persistent alternatives that can be fully degraded and mineralized, and this may imply non-fluorinated products. Therefore, development of non-persistent alternatives should be strongly encouraged and PFASs should only be used in applications where they are truly needed and proven indispensable.

References