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Health Risks and Human Exposure with PFOA and PFOS

Piyush Sinha
Associate Professor,
Deptt. of Physics,
School Of Science, H.N.B.
Garhwal University,
Pauri Campus

Neelam Sinha
Assistant Professor,
Deptt. of Physics,
S.D. College,
Muzaffarnagar.

Abstract

Perfluorinated compounds (PFCs) are a group of emerging pollutants detectable in the human environment and have received considerable attention recently. Besides the two well-known PFCs, viz., perfluorootane sulfonate (PFOS) and perfluorooctanoate (PFOA), other perfluorinated acids including short-chain (< eight carbons) and long-chain (≥eight carbons) sulfonates or carboxylates, have been found in human and aqueous environment all over the world. PFOS and PFOA have been detected in air, raw waters, soil, biota as well as in drinking water in several countries ranging from USA to Sri Lanka. In addition, in many countries PFOS, PFOA and other related substances have been observed in human blood samples of the general population.

The reasons for this widespread occurrence seem to be that perfluorinated substances are increasingly used and are environmentally persistent and bio-accumulative. A range of PFCs such as PFOS and PFOA are used in numerous industrial products and consumer products through drinking water, dust, food packaging, breast milk, cord blood, microwave popcorn, air and occupational exposure.

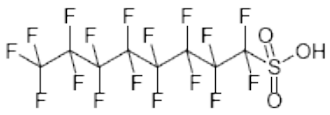
Exposure has been associated with increased cholesterol and uric acid levels, increased risk of chronic kidney disease, several types of tumours and bladder cancers in the general population.

A survey has been done to find the harmful effects in human blood for several countries due to the presence of PFOS and PFOA.

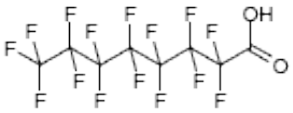
Keywords: PFCs, PFOS, PFOA.

Introduction

A perfluorinated compound (PFC) is an organofluorine compound containing only carbon-fluorine bonds (no C-H bonds) and C-C bonds but also other heteroatoms. PFCs have properties that represent a blend of fluorocarbons (containing only C-F and C-C bonds) and the parent functionalized organic species. For example, perfluorooctanoic acid functions as a carboxylic acid but with strongly altered surfactant and hydrophobic characteristics.



PFOS



PFOA

Global Sources and Occurence

PFOA contaminates every continent. PFOA has been detected in the central Pacific Ocean at low parts per quadrillion (ppq) ranges, and at low parts per trillion (ppt) levels in coastal waters[1]. Due to the surfactant nature of PFOA, it has been found to concentrate in the top layers of ocean water and in surface waters. PFOA is also present in numerous mammals, fish, and bird species. While,wildlife has much less PFOA than humans.

The main sources of PFOA to the people are food[2], drinking water, outdoor air, indoor air, dust, and food packagings[3]. When drinking water is a source, blood levels are approximately 100 times higher.

A Japanese study has shown that consumption of drinking water obtained from a polluted river may lead to a significantly increased daily intake of 0.2-1 mg PFO S/day and may contribute 8-16 jtg PFOS/L to blood serum levels and result in a 25-50% rise in normal levels (Harada et al. 2003).

According to a study by the Norwegian Institute of Public Health (2007), in a worst case scenario, the new study showed that an adult

human would be exposed to 66 ng PFOA/kg bw, when thinking 100 ml water cooked in a Teflon coated pan.

PFOA is also formed as an unintended byproduct in the production of fluorotelomers[4] and is present in finished goods treated with fluorotelomers, including those intended for food contact. Fluorotelomers are applied to food contact papers because they are lipophobic: they prevent oil from soaking into the paper from fatty foods. Also, fluorotelomers can be metabolized into PFOA[5]. In a United States Food and Drug Administration (USFDA) study lipophobic fluorotelomer-based paper coatings (which can be applied to food contact paper in the concentration range of 0.4%) were found to contain 88,000160,000 parts per billion PFOA, while microwave popcorn bags contained 6-290 parts per billion PFOA[6] .Toxicologists estimate that microwave popcorn could account for about 20% of the PFOA levels measured in an individual consuming 10 bags a year if 1% of the fluorotelomers are metabolized to PFOA. Fluorotelomer coatings are used in fast food wrappers, candy wrappers and pizza box liners[7].

PFOA as impurity in the non-stick surface layer of fluoropolymer treated cookware, such as frying pans. DuPont, the producer of the polymer, has detected PFOA content of 4-75 jtg/kg in PTFE cookware (Begley et al. 2005). In a recent study by Sinclair et al. (2007) gas-phase release of PFOA were measured from heating new non-stick frying pans. It was reported that PFOA vaporize at 189 °C and decompose at >234 °C.. In addition, PFOA was detected in water if boiled in non-stick pan brands for 10 minutes. A stainless steel or aluminium pan did not release any PFOS at even higher temperature.

Most industrialized nations have average PFOA blood serum levels ranging from 2 to 8 parts per billion[8]; the highest consumer sub-population identified was in Korea—with about 60 parts per billion[9]. In Peru[10], Vietnam[11] and Afghanistan[12] blood serum levels have been recorded to be below one part per billion. In 2003-2004 99.7% of Americans had detectable PFOA in their serum with an average of about 4 parts per bi1lion and concentrations of PFOA in US serum have declined by 25% in recent years.

PFOS and PFOA are mainly bound to serum proteins, especially albumin (Jones et al. 2003b). In most studies blood serum is analyzed but other studies analyze whole blood or blood plasma. When comparing such studies it is important to take into account that results will depend on what medium is analyzed. In a Japanese study concentrations of PFOS were measured in whole blood and serum from the same persons. It showed that levels in serum were two to three times higher (range: 19-41 ng/mL; mean: 27 ng/ mL) than in whole blood (range: 5-14 ng/mL; mean 11 ng/mL) (Taniyasu et al. 2003). Another study by Ehresman et al. (2007) showed that the plasma to serum ratios for PFHxS, PFOS and PFOA were 1:1 independent of concentration level. The serum/plasma to whole blood ratio, regardless the anticoagulant used, was approximately 2:1.

Figure 1 and Figure 2 shows the average concentrations of PFOS and PFOA in human Blood serum/plasma and in whole human blood from various countries.

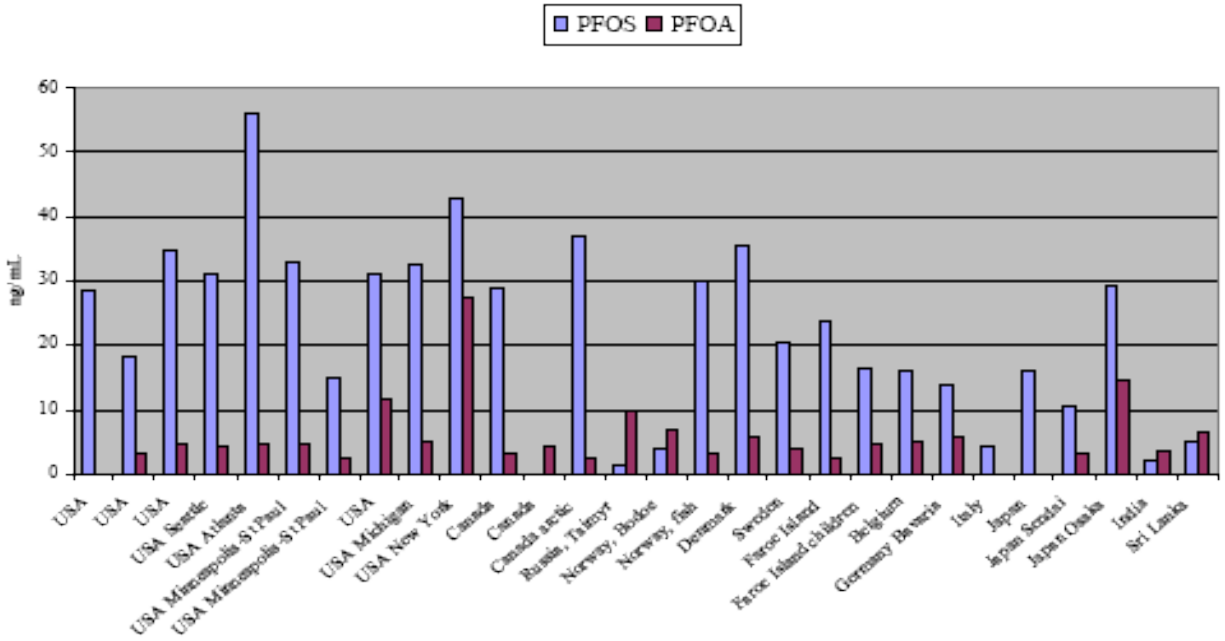


Figure1. Average concentration of PFOS and PFOA in human blood serum/plasma from various countries.

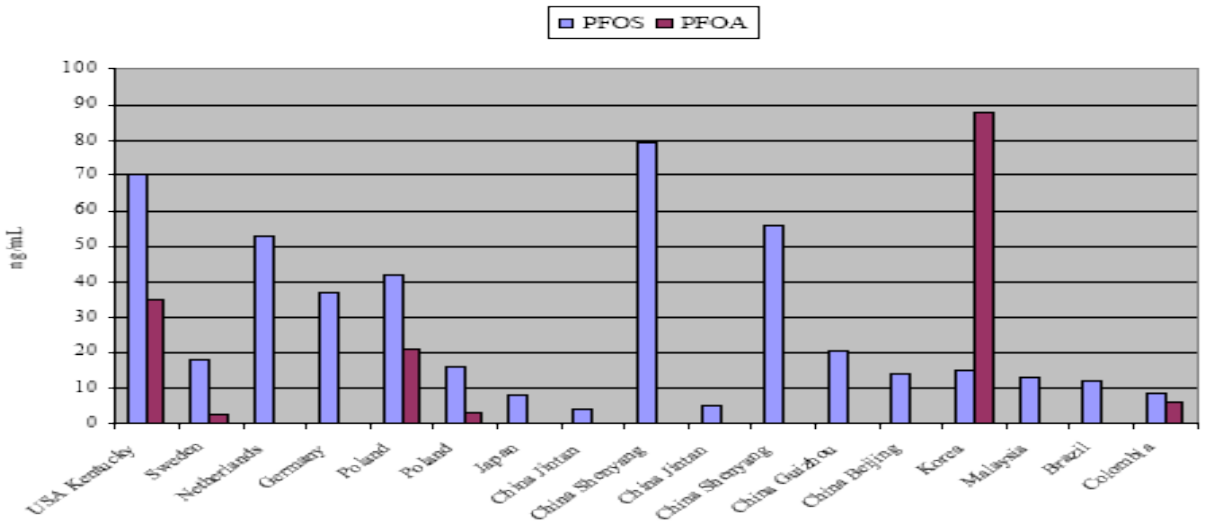


Figure 2: Average concentrations of PFOS and PFOA in whole human blood from various countries.

Conclusion

The growing environmental concern of perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) derivatives and related substances is due to the fact that these potential harmful compounds are now global environmental pollutants distributed in air, water, soils and biota. Because of their special chemical properties, for instance the ability to repel both water and oils, PFOS and PFOA are used in numerous industrial products and consumer products. From the studies it is seen that how polyfluorinated substance affect the human blood and are responsible for several diseases. Teflon coatings used in the production of non-stick cookware may be more likely to have elevated LDL cholesterol levels and cancer. Recent survey results reported detection of these chemicals in almost all people in the United States.

Hence,we should avoid extensive use polyfluorinated substances in any form.

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