

PFAS: Per-Fluorinated-Alkyl Substances

White Paper On One of the So Called Toxic Forever Chemicals or Persistent Organic Environmental Pollutants

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Introduction

PFAS are widely used chemicals which do not biodegrade naturally with time. They consist characteristically of Carbon and Fluorine which together form a very strong bond that enzymes in bacteria in nature cannot metabolize easily. Because of their widespread use and their persistence in the environment, many PFAS end up in the blood of human beings and animals all over the world and are present at low levels in water and a variety of food and consumer products.

Historically, they were developed/manufactured by US companies such as 3M and DuPont which had to pay billions of dollars in damages for environmental cleanup efforts and plaintiffs that suffered health problems because of exposure. **TEFLON** coated pans is one type of popular product that uses them. They are also used on pizza boxes because they are Lipo-Phobic.

PFAS are found in water, air, fish, animals, and soil across the globe and originate in some man made products. For example: **Food packaging** - specifically in grease-resistant paper, fast food containers/wrappers, microwave popcorn bags, pizza boxes, and candy wrappers. They are also found in **Personal Care Products** – in certain shampoos, dental floss, and cosmetics. Also they are also found in some **Household products** – for example PFAS are used as stain and water-repellent additives in carpets, upholstery, clothing, and other fabrics, cleaning products, non-stick cookware, paints, varnishes, and sealants. PFAS are also used in some **Fire Fighting Systems** especially foam based ones. Because PFAS cannot be removed by conventional sewage treatment plants (bacteria cannot break them down), they end up in our rivers and eventually in our bodies. It has been shown that 99% of people in the USA have traces of PFAS in their blood.

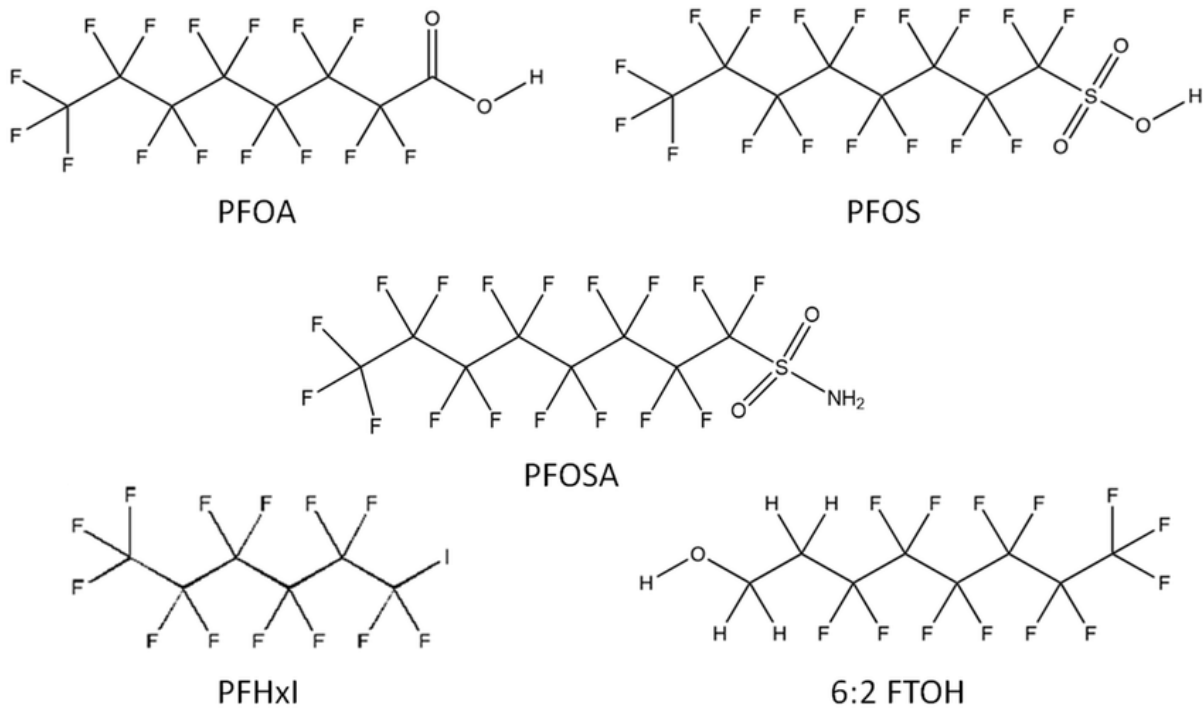


Figure 1: Chemical Structure of Per-Fluorinated Chemical Compounds

Health Effects/Toxicity

Scientific studies have shown that exposure to some PFAS in the environment/food chain may be linked to harmful health effects in humans and animals. There are thousands of PFAS chemicals. This makes it challenging to study and assess the potential human health and environmental risks of all of them. Due to their widespread production and use, as well as their ability to move and persist in the environment, blood surveys conducted by the Centers for Disease Control and Prevention (CDC) in the USA show that most people in the United States have been exposed to some PFAS.

Current peer-reviewed scientific studies have shown that exposure to certain levels of PFAS may lead to several health issues: One of these is reproductive effects such as decreased fertility or increased high blood pressure in pregnant women. A second toxic effect of PFAS is the developmental effects on children, including low birth weight, accelerated puberty, bone variations, or behavioural changes. PFAS are also linked to increased risk of some cancers, including prostate, kidney, and testicular cancers. They may also reduce the ability of the body's immune system to fight infections and can lead to reduced vaccine response. PFAS may interfere with the body's natural hormones (i.e they are endocrine disrupting chemicals). Finally PFAS are linked to increased cholesterol levels and/or higher risk of obesity. They have been recently found in the breast milk of nursing mothers and in the placenta of pregnant moms.

How to Remove Them from Water and Destroy Them

Without being too technical, there are standardized ways to remove PFAS from Water. I will focus on two of the most widely used technologies: Active carbon filtration and Reverse Osmosis.

Activated Carbon Filtration is based on a filter which contains a form of black carbon (like charcoal) called granular activated carbon which has a high surface area. It works by adsorbing (sticking) the PFAS on its surface, kind of like a magnet but one based on chemical forces.

Reverse Osmosis technology also works to remove PFAS from water. It is a technology based on a membrane with tiny pores in it that filter out the PFAS molecules. The PFAS are concentrated in the reject stream.

Once the PFAS are filtered out they need to be destroyed and for this you need strong chemicals like Ozone or extremely high heat/oxidizing conditions, to zap them out.

An emerging technology for PFAS removal is E-AOP, Electrochemical Advanced Oxidation Processes. Boron Doped Diamond (BDD) electrodes create .OH Hydroxyl radicals on the Anode which attack and oxidize PFAS.

Legislation/Directives/Conventions

The Stockholm Convention is a global treaty that aims to protect the environment and human health from the effects of Persistent Organic Pollutants (POPs) which includes PFAS. It has been in force since 2004 and is undersigned by 152 countries of the world including the UK. The convention requires parties to adopt a range of control measures to reduce and, where feasible, eliminate the release/manufacture/use of POPs like PFAS in various products.

There is also the EU Drinking Water and Groundwater Directives which are intended to protect European waters from harmful pollutants by setting limit values for PFAS under the Groundwater Directive, the Environmental Quality Standards Directive and the Food Contaminants Regulation. These directives also address emissions and reporting of PFAS under the Industrial Emissions Directive and the European Pollutant Release and Transfer Register.

In 2021, the UK, Welsh and Scottish Governments tasked the Health and Safety Executive (HSE) and Environment Agency to perform a **regulatory management options analysis** (RMOA) on PFAS to assess how to best manage any identified risks related to PFAS.

What Can We Do About PFAS?

As scientists and engineers we need to detect them and remove them from the environment. We also need to find green chemistry alternatives to PFAS. As consumers, we need to raise awareness about this topic and lobby our government representatives to legislate laws that will lead to their removal from commercial products. We can also boycott products that contain them. This way business leaders will be forced to abandon them. So next time you go to buy dental floss, ask your pharmacist: does it contain PFAS? Or when you order a pizza delivery, inquire if the box has PFAS in it...

Finally I hope you have found this article useful. Feel free to follow the links below for more information.

Bio:

Rami Elias Kremesti is a water and waste water treatment specialist with a background in chemistry. He has worked on a myriad of water treatment and power station projects internationally. He is a British Citizen based out of High Wycombe, UK.

References/Further Reading:

<https://www.epa.gov/pfas/pfas-explained>

<https://www.veoliawatertech.com/en/expertise/applications/pfas-removal>

<https://www.puraffinity.com/>

<https://www.pfasfree.org.uk/regulations>

[PFAS - Chemicals - Environment - European Commission \(europa.eu\)](#)

[PFAS: The secret toxins in your body - YouTube](#)