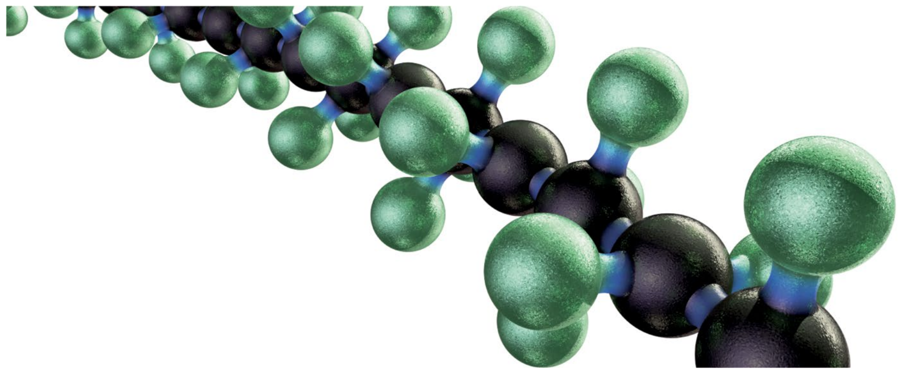
https://doi.org/10.1038/s44221-023-00178-2

The U-turn on PFAS

Check for updates

As per- and polyfluoroalkyl substances (PFAS) emerge as a global concern, it is crucial to foster collaborative endeavours aimed at discontinuing their persistent usage while devising effective methods for treating legacy PFAS in the environment.



Ball-and-stick model of a polytetrafluoroethylene molecule, also known as PTFE or, most commonly, Teflon.

CREDIT: THEASIS/E+/GETTY

Per- and polyfluoroalkyl substances, commonly referred to as PFAS, are a class of man-made chemicals with an aliphatic fluorinated carbon chain. They exhibit attractive features like thermal and chemical stability, and resistance to water and stains. They have existed for nearly eighty years and their origin dates back to World War II when they were used to build the atomic bomb[1]. After that, companies started to use them to produce commercially available products such as the 3M's Scotchgard and DuPont's Teflon.

Thanks to the strong carbon–fluorine bonds in their structures, PFAS are hard to break down, leading to their persistence in the environment and accumulation in living creatures. The realization that certain chemicals accumulate in living organisms and cause numerous harmful effects in biological systems prompted the implementation of regulations and the discontinuation of several PFAS. In 2009, perfluorooctane sulfonate (PFOS) was included in the Stockholm Convention's list of Persistent Organic Pollutants, and PFOA was subsequently added in 2019. Between 2006 and 2015, the US Environmental Protection Agency (USEPA) collaborated with eight major chemical manufacturers to voluntarily discontinue the production and usage of long-chain PFAS and their precursors[2]. As alternatives, other PFAS compounds have been developed, but the fate of many is still unknown.

Because of their persistence and mobility, PFAS widely exists in the environment. The US Geological Survey estimates at least 45% of tap water in US could have one or more PFAS[3]. PFAS have been detected in rainwater in remote regions like Antarctica and Tibet[4]. As the evidence of the detrimental health effects of PFAS increases, regulations on the permissible levels of PFAS in water are becoming more stringent. On 14 March 2023, the EPA proposed a National Primary Drinking Water Regulation to establish a new maximum contamination level (MCL) of 4 ng/L for PFOS and PFOA, respectively. This is especially concerning because in the US, thousands of public water systems have mean concentrations of PFOA and PFOS exceeding the new MCL[5].

Water treatment facilities face growing pressure due to increasingly stringent regulations on PFAS levels in drinking water. Conventional drinking water treatment processes are ineffective in eliminating PFAS, prompting drinking water treatment plants (DWTPs) to contemplate integrating unconventional treatment chambers. However, most DWTPs are not readily equipped with the knowledge and resources that are needed to update facilities. The Perspective by Feng Xiao and co-authors discusses the challenges associated with removing PFAS from water in full-scale DWTPs, including outdated infrastructure, precursor complexity, and post-treatment of spent media and waste streams. To ensure regulatory compliance by DWTPs, they propose a multi-barrier treatment train incorporating oxidation–adsorption–destruction-based methods, and at the same time address the importance of non-technical solutions like early detection and database development.

Certainly, research efforts have accelerated since awareness of the issue has spread across communities. However, uncertainties persist regarding the health effects and regulations of many PFAS, especially the short-chain chemicals that are not as well studied as the long-chain PFOS and PFOA. Continuous efforts should also be dedicated to addressing the challenges associated with treating PFAS-contaminated water, aiming for destruction of PFAS, such as complete defluorination[6].

3M has declared its intention to cease the production of all PFAS substances and eliminate them from its product portfolio by 2025[7]. However, we would still need to fight the PFAS threat for a long time because discontinuing the use of PFAS does not guarantee their complete removal from the environment. Meanwhile, as companies consider transitioning to non-PFAS alternatives, research efforts should also focus on evaluating the environmental impact and health implications of these substitutes.

Published online: 20 December 2023

References

1. Black, J., Moreland, A., Ransom, M. M. & Sanchez, E. *Health Matrix* **31**, 341 (2021).
2. *Risk Management for Per- and Polyfluoroalkyl Substances (PFAS) under TSCA* (USEPA, 2020); https://go.nature.com/3Th9aud
3. Smalling, K. L. et al. *Environ. Int.* **178**, 108033 (2023).
4. Cousins, I. T., Johansson, J. H., Salter, M. E., Sha, B. & Scheringer, M. *Environ. Sci. Tech.* **56**, 11172–11179 (2022).
5. *PFAS National Primary Drinking Water Regulation Rulemaking* (USEPA, 2023); https://go.nature.com/3NnSGg7
6. Gao, J. et al. *Nat Water* **1**, 381–390 (2023).
7. 3M announces exit from PFAS manufacturing. *3M News Center* (20 December 2022); https://go.nature.com/3uO1Ufb