

### Project information

Less-PFAS - Sustainable management of PFAS-contaminated materials, 2019–2022  
In cooperation with partners from Sweden, Finland and Norway, and with the support of the industry, the aim of this project is to optimize the existing and most promising PFAS destruction methods, and scale them up to practical solutions in the field. The specific aims are to:

1. Develop a sorbent that, combined with a specific degradation technique, could be applied to clean water and simultaneously destroy PFAS.
2. Optimize existing PFAS degradation techniques and scale them up to practically applicable methods in the field.
3. Demonstrate and validate the techniques on pilot scale.
4. Provide companies with ready-to use techniques to clean PFAS-contaminated soil and water.
5. Spread information about the chemical itself and about the possibilities to manage PFAS-contaminated materials sustainably.

### What are PFAS? Where do PFAS come from?

Per- and polyfluoroalkyl substances (PFAS) are a group of anthropogenic compounds in which at least one or all hydrogens attached to the carbon chain are substituted with fluorine. Due to the high thermal stability, low chemical activity and good waterproof properties, PFAS have been widely used in food packaging, firefighting foams, personal care products, daily necessities, construction and the textile industry (Fig. 1 a). Among all PFAS, two representative compounds, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) (Fig. 1 b), have been widely produced since the 1940s.

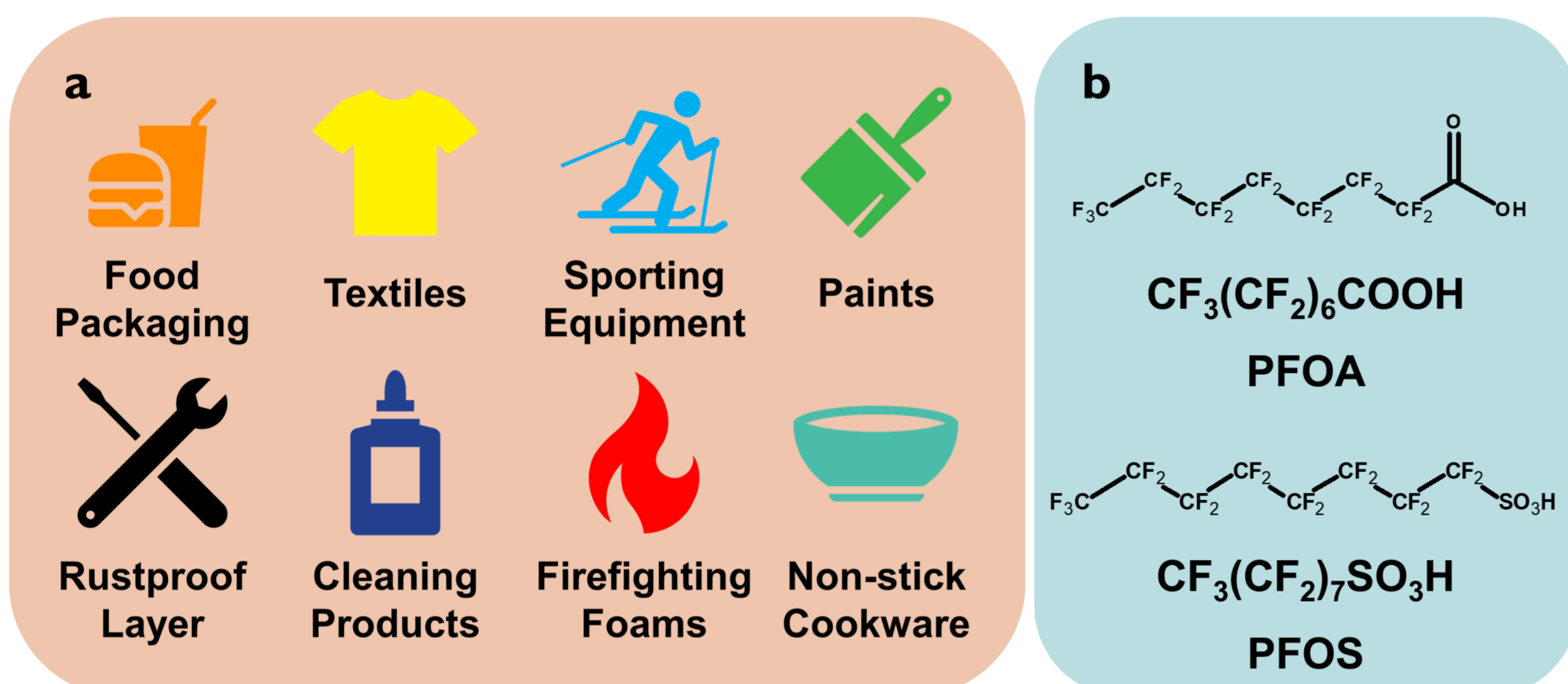


Fig. 1 (a) The main usage of PFAS; (b) Chemical structure of Perfluorooctanoic acid (PFOA) and Perfluorooctanesulfonic acid (PFOS)

### PFAS contamination, hazards and risks

The global production and application of PFAS have been causing worldwide contamination since the 1940s and have attracted increasing attention in recent years due to their persistence, bioaccumulation and toxicity. The decomposition of PFAS is extremely slow in the natural environment due to the high strength of the carbon-fluorine bond, which makes the PFAS contamination persistent. Once PFAS has been taken in by plants or animals, it will accumulate in their organs and lead to harmful effects. Ultimately, PFAS will accumulate in the human body through the food chain and cause diseases. It has been reported that kidney cancer, testicular cancer, ulcerative colitis, thyroid disease, hypercholesterolemia (high cholesterol) and pregnancy-induced hypertension are related to high PFOA exposure (Fig. 2). Additionally, recent news has indicated that exposure to PFAS could increase the risk of severe Covid-19.

Over the decades, many studies have reported the detection of PFOS and PFOA in surface water, ground water, treated water, soils, animal tissue and human blood.

### Acknowledgements

This work is being conducted under the Less-PFAS project (Sustainable management of PFAS-contaminated materials, 2019–2022, funded by the Interreg Nord program (in Finland: EU and Regional Council of Lapland)) with the main participants of: **Luleå University of Technology** (coordinator, Sweden) **University of Oulu** (Finland), and **UiT The Arctic University of Norway** (Norway).

Due to the wide contamination around the world and harmful effects on the environment and humans, PFOS and PFOA were listed as persistent organic pollutants (POPs) in the Stockholm Convention to restrict their production. Meanwhile, many countries and regions have started to limit the production and application of PFAS. However, PFAS contamination exists all around the world so it is essential to develop feasible methods to remove PFAS from surface water and wastewater.

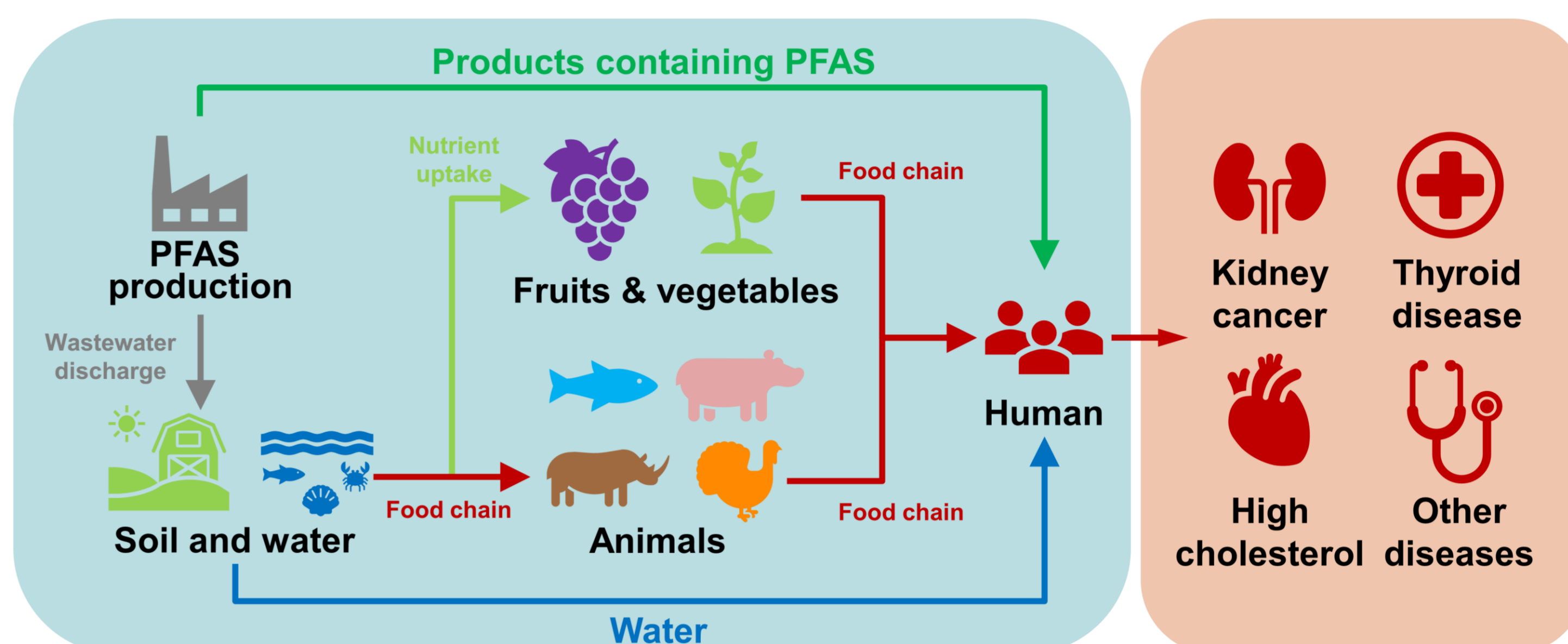


Fig. 2 PFAS cycle, human exposure and health concerns

### Treatment technologies

To date, several treatment techniques such as adsorption, membrane separation, advanced oxidation processes (AOPs), advanced reduction processes (ARPs) and photodecomposition have been investigated for the elimination of PFAS contamination. Of these, the AOPs show good degradation performance but a poor defluorination ratio for PFAS, which means that most of the long-chain PFAS were degraded to short-chain PFAS. By comparison, by using hydrated electrons ( $e_{aq}^-$ ,  $E = -2.9$  V) for PFAS degradation, ARPs exhibit higher defluorination and decomposition efficiency, making them a promising method for controlling PFAS pollution.

### Current study and perspective

In the water phase, sulfite was able to generate  $e_{aq}^-$  efficiently by UV<sub>254nm</sub> radiation and was not sensitive to other ions. Thus, sulfite was selected as the source chemical for  $e_{aq}^-$  generation in this study. The UV/sulfite system for PFOA degradation is shown in Fig.3. The results show that higher pH is beneficial for PFOA degradation. At pH 10, the concentration of PFOA dropped to 0.4 mg/L after 30 minutes of reaction time ( $C_0$ : 10 mg/L, sulfite dosage: 10 mM). After 1 h, the concentration of PFOA was below the detection limit. Furthermore, the defluorination ratio reached 85% after 24 h of reaction time.

In future investigations, we will study the treatment of PFAS in high salinity water, adsorption of PFAS by resin and PFAS removal from the desorption eluent.

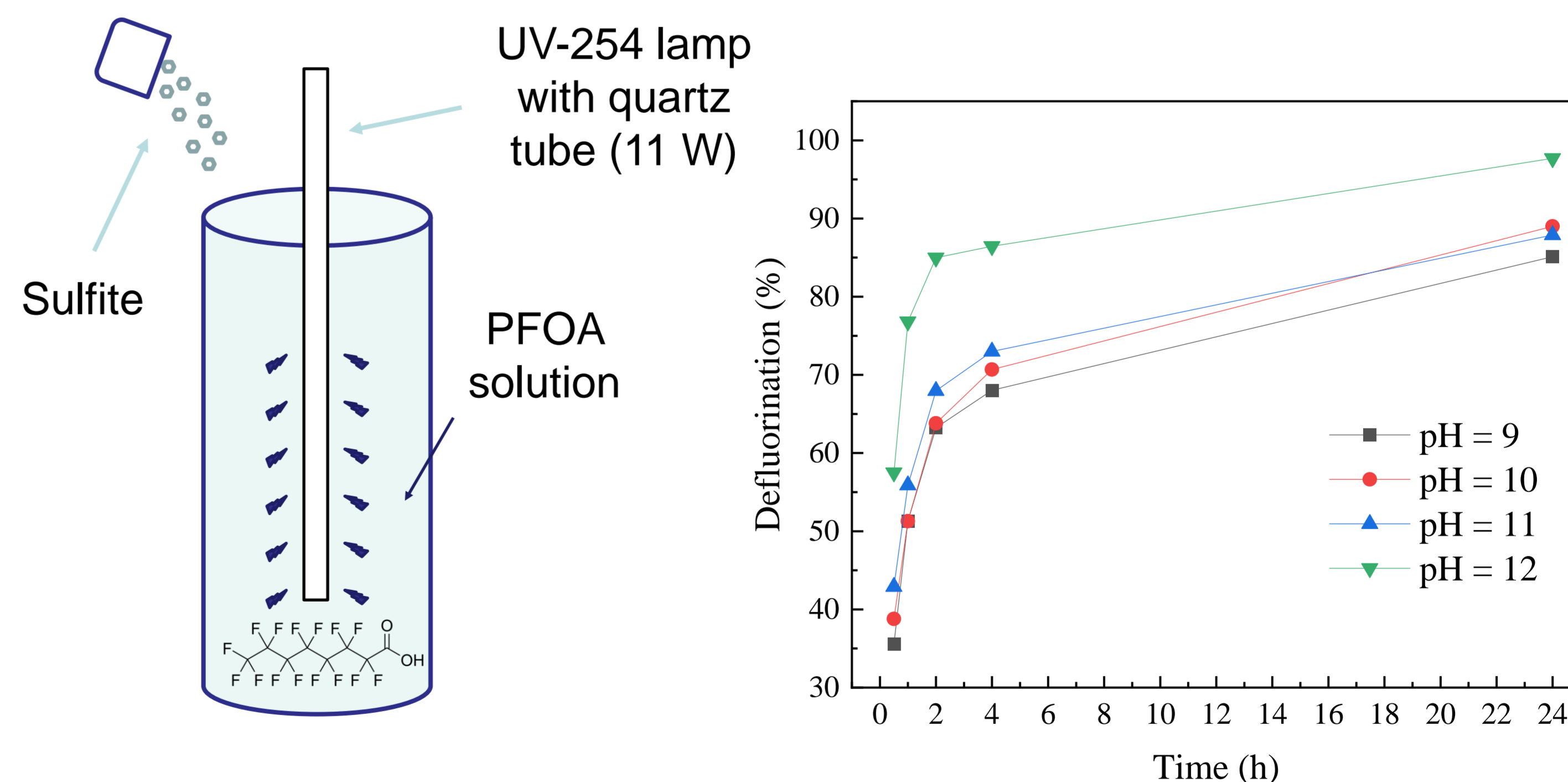


Fig. 3 Diagram of UV/sulfite reactor and effect of pH on PFOA defluorination