Removing PFAS with ceramic adsorbers and ultrasound

Dr. Patrick Bräutigam, M.Sc. Maximilian Dommke, Dr. Thomas Kutschin

PFAS (per- and polyfluoroalkyl substances) are a class of synthetic compounds which are used in various industries and applications. They have water- and oil-repellent properties and a high chemical and thermal stability. This resistance to thermal, chemical and biological reactions and their high mobility in the environment have led to the accumulation of various PFAS in humans, animals and the environment, which is why PFAS are also known as "eternal chemicals".

The compounds perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) were among the first PFAS to be widely used and subsequently regulated by legislators. In light of new guidelines and threshold values for PFOA and PFOS, new PFAS have been introduced. One such substitute is GenX (hexafluoropropylene oxide dimer acid, HFPO-DA), which is now used in place of PFOA to produce fluoropolymers, such as Teflon, and is often found in water bodies near suspected PFAS sources.

In a joint study with the Technical University of Munich, Fraunhofer IKTS has investigated the degradation of the chemical GenX for the first time using high-frequency ultrasound and compared it with the degradation of PFOA and PFOS. Initial results indicate that with further optimization of the process, ultrasonic technology could be used as a robust, easy-to-use and additive-free method for treating highly contaminated PFAS streams.

Further research is focused on the enrichment of these compounds. To this end, IKTS researchers develop adsorbers based on porous ceramic materials that can be customized for specific pollutants (individual substances and groups of substances). In the future, these adsorbers should be able to desorb pollutants and be switchable, i.e., it should be possible to alternate between adsorption and desorption via external initiators. This means that the adsorbers do not have to be removed from the process but can be operated alternately in the long term.

The removal of PFAS using ultrasound and switchable ceramic adsorbers is a promising approach for dealing with these persistent, anthropogenic and often health-damaging chemicals. At Fraunhofer IKTS, the processes will be further developed in collaboration with Friedrich Schiller University Jena and industrial stakeholders.

Figure 1: Ceramic adsorbers for the removal of micropollutants (source: Jens Meyer, Friedrich Schiller University Jena).

Literature

Nebojša Ilić et al. (2023): Ultrasonic degradation of GenX (HFPO-DA) – Performance comparison to PFOA and PFOS at high frequencies, 10.1016/j.cej.2023.144630.