AQUA-CLEAR

Advanced Cavitation for PFAS Treatment and Circular Water Management

Water4All
Water security for the planet

Abstract

Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals with highly stable carbon-fluorine bonds, making them exceptionally persistent in the environment. Due to widespread use over decades, PFAS are now prevalent across various ecosystems.
Effective removal requires treatment across diverse water sources, such as drinking water, wastewater, and leachate. To ensure lasting impact, it is crucial that such treatment approaches are holistic, targeting the extraction of PFAS from the entire water cycle and preventing their recirculation back into the environment.
However, there are currently no resource-efficient removal technologies that are realistic from a socio-economic point of view. Current methods are limited by low efficiency, high energy demands, reliance on harsh chemicals, and significant costs while they do not provide an actual destruction or mineralization of PFAS but only a transformation of PFAS from water to other media such as adsorbents or concentrated retentate that require further treatment such as incineration to avoid PFAS-emissions.
To overcome these challenges, there is a pressing need for innovative solutions that combine energy efficiency, economic feasibility, environmental sustainability, and adaptability across diverse water matrices and implementation scales. Among emerging technologies, cavitation-based methods stand out as a promising, sustainable, and environmentally friendly approach for PFAS treatment.

With this project, we aim to address the questions around PFAS degradation with various radicals and develop a new generation of Hydrodynamic Cavitation reactor (HC) to remove PFAS from various water matrices, which will be validated in pilot scale and then adapted for installation in the facilities of a company participating as a partner in the consortium.
The consortium will develop and optimize a next-generation HC reactors at a scale for PFAS degradation in various wastewater (WW) matrices by investigating key mechanisms, including radical generation during cavitation bubble collapse. A prototype will be designed, validated at pilot scale and adapted for installation at the facilities of Borçelik, the consortium's end-user.
The goal will be to use a novel bottom-up strategy to remove persistent micropollutants, and specifically PFAS, from municipal and industrial WW, DW (discharging wastewater) and other relevant WW matrices such as LL. By integrating HC with selected reagents (oxidants/reductants), we seek to create effective conditions for PFAS breakdown, protecting natural water sources and preserving long-term water quality.

The practical results and impacts of this project can contribute to the creation of modern and innovative infrastructure for water treatment, including WWTPs (wastewater treatment plants).
As new regulations such as the recently adopted urban wastewater treatment directive (UWWTD) require enhanced removal of micropollutants (Urban wastewater treatment directive (recast)), HC-technology deployment will help to comply with new EU policies.
The environmentally friendly technology presented in this project can offer a cost-effective solution with minimal impact on energy consumption and CO2 emissions for WWTPs.

Project coordinator

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Project partners

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- GDANSK UNIVERSITY OF TECHNOLOGY - POLAND
- IVL SWEDISH ENVIRONMENTAL RESEARCH INSTITUTE - SWEDEN
- KTH ROYAL INSTITUTE OF TECHNOLOGY - SWEDEN
- BORÇELIK - TURKEY

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