Breaking down PFAS with supercritical gasification

Two birds with one stone:
breaking down PFAS in water and the beneficial use of the released components, which include hydrogen and methane.

Ending PFAS pollution

PFAS is the acronym for a group of substances with a wide range of applications: from water-repellent textiles to smartphone screens and firefighting foam. A major drawback is that PFAS components are extremely persistent, a fact that has led to them being dubbed 'forever chemicals'. Their widespread use and poor degradability, combined with the extremely high toxicity of components from the PFAS group, represent a threat to people and the environment. This is seen in, among other things, water and food systems, and more specifically in the treatment of wastewater, process water and drinking water.

Given the generally very low concentrations – often in the range of nanograms/L to micrograms/L – the PFAS have to be concentrated before they can be broken down. The concentration phase may involve, for example, membrane filtration or foam fractionation, a technology that makes smart use of the fact that many PFAS components can accumulate in foam.

PFAS breakdown with SCC technology: how can we go about it?

Water becomes 'supercritical' at high temperature and pressure: 374 oC in combination with 221 bar. In the process, the chemical and physical properties of water change drastically to such an extent that the conditions allow for the cracking of organic compounds. The SuperCritical Cleanup technology (SCC) is based on this principle and it has now emerged as a strong contender for breaking down PFAS. The following criteria apply: efficiency at scale, full breakdown, net energy consumption, practical feasibility, safety and costs.

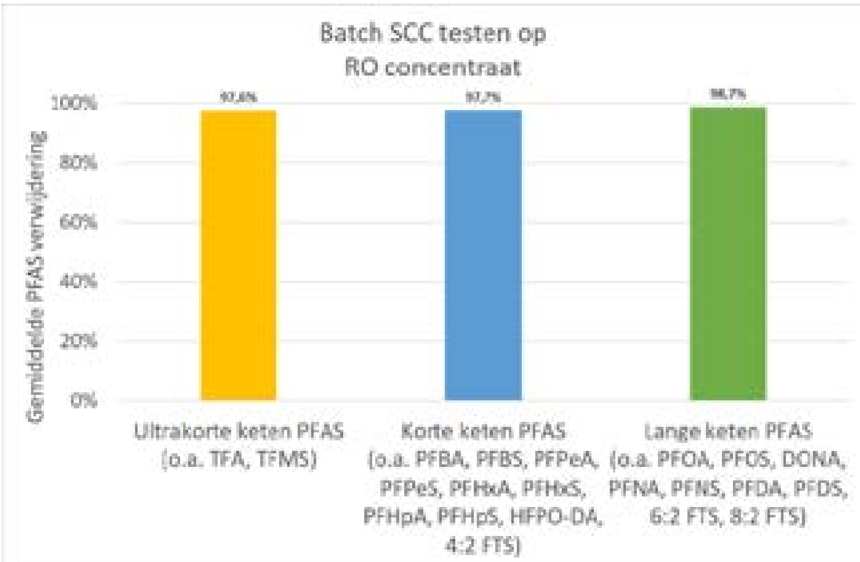
Status: what can we achieve with SCC

SCC on an industrial scale

The supercritical gasification of organic waste streams is already possible at industrial scale. The world's first industrial demonstration plant is located in Alkmaar, NL. The installations have a capacity of 2.5 m3 input per hour. The full process of converting waste streams to green gas, including input into the high-pressure natural gas network, has been successfully demonstrated in 24/7 production tests. SCC is suitable for a combination of the large-scale production of renewable gas and, at the same time, the neutralisation of waste flows.

Breaking down PFAS

We have already been able to demonstrate that PFAS can be broken down on a laboratory/pilot project scale by as much as >99%, depending on the matrix, the type of substance and the process conditions. In ongoing projects, we are working on the optimisation of the breakdown of a range of water flows containing PFAS by creating the right conditions. We are using the laboratory reactors for this purpose and working on the development of a compact (mobile) demonstration plant (Compact ONE, 12 litres an hour), which mirrors the industrial design. We deploy these systems in succession for a range of long-term tests.



The energy balance

SCC is an efficient technology in which the organic fraction in water is converted into gas. The process runs entirely on (green) electricity and it uses a heat exchanger to work up the incoming fluid into a supercritical condition. Electric heaters are then used to raise the temperature to the desired process conditions, for example for the destruction of PFAS. The consumption of electricity is offset by the fact that we feed the reactor with aqueous waste flows in which organic substances have been dissolved. In the reactor, most of these organic substances are converted into syngas, which contains, for example, the energy carriers hydrogen and methane. The SCC process allows the energy yield via the syngas to offset the input of electrical energy.

Prospects

Ongoing projects are focusing on the optimisation of both the pre-concentration phase and the destruction of PFAS using SCC. One example is P-FAST®, the combination of foam fractionation and breakdown with SCC developed by SCW Systems, Allied Waters and partners. Optimisation processes of this kind are essential on the road to achieving efficient PFAS breakdown and a robust process. These projects are supported by government grants through TKI Water Technology and Energy Innovation NL / TKI Energy. We expect to be able to conduct the first upscaling runs for PFAS breakdown from 2027 onwards.

About us

SCW Systems focuses on the conversion of industrial wastewater streams into renewable gas and transformation of hazardous materials into clean water and safe components using supercritical water gasification technology (SuperCritical Cleanup). In cooperation with its shareholders PGGM, InvestNL and Gasunie, SCW Systems has accelerated the development of the technology to industrial scale and acquired unrivalled operational experience.

Allied Waters (Allied Waters - Driving the circular economy) implements innovative concepts that are ‘driving the circular economy’ by creating an enabling environment for introducing solutions to water availability, resource recovery and energy, including green hydrogen. Allied Waters works in partnerships with its sister company, KWR Water Research, and commercial enterprises.