Report of the workshop 'Beating Micropollutants', on Tuesday 5 November 2019 in Amsterdam, organized by the Foundation for Applied Water Research STOWA. More information can be found on www.stowa.nl/beatingmicropollutants

Beating micropollutants: how do you do that? International experiences

The removal of medicine residues and other micropollutants from wastewater is high on the agenda worldwide. On November 5, representatives from Switzerland, Germany, Belgium, Australia, Singapore and the Netherlands explained how they deal with this problem. This took place during the STOWA workshop "Beating Micropollutants" at the Aquatech trade fair in Amsterdam.

By: Bert-Jan van Weeren

What is happening in Europe and the rest of the world in terms of micropollution removal? Which techniques are being used? Which wastewater treatment plants (wwtps) are equipped with these techniques and why? Which substances are efforts focusing on? Chairman Jelle Roorda, who in his daily life is director of the Limburg regional water authority, outlined the goal of the workshop at the start of the day: learning from each other's knowledge, learning from each other's approach and learning from each other's experiences. He says that the risks of micropollution in water have long been discussed. But concrete steps have also been taken in recent years. In more and more places in the world wwtps are being adapted and expanded with new techniques. These are techniques that separate medicine residues (filtration techniques), break them down (ozone, UV) or bind them (activated carbon).

SWITZERLAND

The Aquatech, the leading international trade fair in the field of water technology, was the stage for six international presentations on this subject. Christa McArdell of the Swiss research institute EAWAG set the pace and outlined the situation in her own country. It soon became apparent that Switzerland is a frontrunner in this field. The country adopted a water protection law early in 2016. The aim is to ensure that by 2040 an average of 80 percent of all micropollutants will be removed. To achieve this goal, the Swiss are working on a *focused upgrade*. Measures are being taken at large wwtps (> 80 thousand inhabitants), at wwtps discharging into drinking water sources and at wwtps discharging into sensitive waters. It concerns 130 of the total of around 800 wwtps, whereby ultimately the wastewater from 70 percent of the population is treated, according to McArdell. It

focuses on a list of twelve substances (including diclofenac, carbamazepine and venlafaxine) that are considered representative of organic micropollutants.

Selection process

Switzerland currently opts for ozone (41%) and powdered activated carbon (35%), both in combination with sand filtration. In addition, limited use is made of granular activated carbon (7%) or a combination of both (17%). When choosing techniques, one looks at the type of water supplied, the type of wwtp and also the receiving surface water. For each technique, tools have been developed that help with the more detailed selection process. The total costs of the focused upgrade are estimated at 1.2 billion euros. The financing is based on "the polluter pays" principle. The selected 130 wwtps (which usually fall under the responsibility of municipalities) must pay a wastewater tax in the period 2016-2040 which expires once the upgrade has been carried out. Three quarters of the investment required for this is subsidized. The wastewater tax is passed on to the residents and amounts to around 8 euros per person per year.

GERMANY

How are things going in Germany? More specifically in the state of Baden-Württenberg (southwest Germany). Lilia Acosta of the Spurenstoffe Baden-Württenberg Kompetenzcentrum, which is funded by the state government, took the word, The activities of this centre consist of advising and supporting the (municipal) treatment managers in the approach to micropollution, bundling knowledge and experiences in this area and policy advice. There are around 900 large and smaller wwtps in the state. Sixty percent of these discharge into water that consists of more than ten percent of treated wastewater.

Two-track policy

The state government pursues a two-track policy. The first track is a source-oriented and user-oriented approach, in which, among other things, discussions are held with medicine producers and "prescription writers". Residents are informed about the best way to deal with medicine residues. The second track is the upgrade of wwtps that discharge into sensitive bodies of water, for example small areas of waters or waters which are used for drinking water production. In 2018, a framework for the implementation of measures to remove micropollutants was published. This consists of detailed criteria that determine which measures should be taken at wwtps (ultimately at around 125 out of the 900 wwtps), which substances wwtps should focus on and what the removal efficiency should be (eighty percent). But the framework also specifies the way in which that efficiency should be measured and which substances should be looked at (a total of seven substances including carbamezapine and diclofenac). Currently, 15 wwtps have been upgraded, 17 more will follow in the coming period. This makes a total of 32, of which 21 have or will receive powdered activated carbon (PAC), seven using granular activated carbon (GAC) and four using ozone.

BELGIUM / FLANDERS

Marjoleine Weemaes of the water treatment company Aquafin continued with the approach to micropollution in Flanders. Aquafin is responsible for wastewater treatment in Flanders. That takes place at 318 wwtps. At the moment there is no official policy in Flanders for tackling micropollution at wwtps, Weemaes said. There is also little happening in the field of resource management. There are, however, monitoring programs in place to identify the nature and extent of the problem. A full-scale experiment is being conducted at the wwtp Aartselaar, a municipality near Antwerp. The immediate reason is that the wwtp discharges into vulnerable surface water, namely the river De

Grote Struisbeek, and that there is regular leaching of suspended solids with the effluent into the river. At the same time, according to Weemaes, Aquafin wanted to gain the necessary experience with removing micros. It was decided to do this at the wwtp Aartselaar, which needed an upgrade anyway due to the problem of the discharge of suspended solids.

They have opted for a pragmatic approach and use the knowledge and experiences from abroad to immediately go full sale. Prior to this, various research was carried out into design capacity, possible techniques, the targeted substances, yields and monitoring. The wwtp is equipped with disc filters, ozone and granular activated carbon (GAC).

THE NETHERLANDS

After Flanders, it was Cora Uijterlinde's turn to illustrate the present situation in the Netherlands. In the Netherlands, the central government approach is not as guiding as in, for example, Switzerland and Germany. The government has a more directing role that is aimed at taking measures together with other interested parties. For example, from 2016 central government has been working together with the regional water authorities, drinking water companies and healthcare parties in the 'Chain Approach to Removal of Residual Medicine from Water' (Ketenaanpak Medicijnresten uit Water). It encompasses a pragmatic approach whereby the entire medication chain (development & authorization, prescribing & use, wastewater treatment) looks at which measures are feasible and affordable. This approach has resulted in, among other things, the "Green Deal Sustainable Care" (Green Deal Duurzame Zorg) . In this, the government has made agreements with 130 healthcare parties on how to tackle the problem at the source.

An important part of the chain approach is the contribution scheme "Treatment of Residual Medicine" (Zuivering Medicijnenresten) from the Ministry of Infrastructure and Water Management, says Uijterlinde. This scheme has made a total of 60 million euros available to support new removal techniques on a practical scale. Regional water authorities, who are responsible for wastewater treatment in the Netherlands, can receive a contribution from this scheme according to certain conditions.

In addition to the chain approach, more fundamental research into micropollution is taking place within the university research program 'Contaminants of Emerging Concern (CECs) in the Water Cycle'. In which the technology foundation STW, the Foundation for Applied Water Research STOWA, TKI Water Technology (research consortium) and research institute KWR are working together. For more information, visit www.stowa.nl/cecs.

Innovation program

Last year, the Dutch Ministry of Infrastructure and Water Management, STOWA and the regional water authorities launched the innovation program "Removal of Micropollutants at wwtps". Through practice-oriented research, promising removal techniques are given an extra boost. This is to ensure that more effective, efficient and sustainable technologies become available in the short term. The innovation program focuses on a number of specific issues. Central to this is the removal of micropollutants and the improvement of effluent quality, by, among other things, more cost-effective use of powdered activated carbon and ozone. Other techniques that lead to better effluent quality are also being tested. In addition, attention is paid to the CO_2 footprint. For example, research is being carried out to determine if there is a more sustainable alternative to powdered activated carbon, because a lot of CO_2 is released during its production. Another spearhead is further research into oxidation techniques such as ozone and UV light that break down micropollutants. These techniques work well, but there is a risk of harmful by products. This requires further investigation.

AUSTRALIA

Participants made a virtual journey from the Netherlands to the other side of the world. To Australia to be precise. Adam Lovell, director of the Water Services Association of Australia, an alliance of some 80 water companies, spoke about the state of affairs regarding this theme in his country. What made his story clear was that the attention for and the approach to micropollution is strongly linked to climatic, but also political circumstances in the country or region in question. To begin with the latter: "Water tends to be a very political issue in Australia," according to Lovell. He added: "We live in a short-term political vision instead of a long-term water quality vision." This has an impact on the attention and resources available for a specific theme.

Climate change

For many years, Australia has been hit by drought and its effects: water shortages, forest fires and the like. The effects of climate change are taking hold. To combat water shortage, desalination plants are used. A recent addition to this is that wastewater is being extensively treated in water factories so that it can be used for different purposes. According to Lovell, the micropollution issue is strongly linked to this, because its removal is a condition for the production of 'safe, treated, recycled water'. Lovell indicated that a lot of money is now available for water factories, but it takes time to realize them.

Finally, the micropollution issue is overshadowed by a related problem that is currently much higher on the political and social agenda in Australia, namely poly- and perfluoroalkyl substances, better known as PFAS. PFAS / fluorinated foaming agents are often used when extinguishing large fires, which is very effective for fighting large (forest) fires for several reasons. But PFAS is very toxic and enters the groundwater and surface water via fire extinguishing water. More and more people are now very worried about that, says Lovell.

SINGAPORE

The last presentation was given by Siao Yun Chang of the Water Quality Department in Singapore. Just as in Australia, specific circumstances also play a major role in dealing with this theme in Singapore. Singapore is a city-state on a small island (about 50 times smaller than the Netherlands), surrounded by sea. There is a lot of rain (around 2300 mm annually), but this falls mostly in the wet season. The options for buffering water on the small island are limited. The National Water Agency PUB is responsible for the entire water chain. That also means that, according to Chang, they have to think integrally, 'from the water cradle to the water grave'. There is limited reservoir capacity. This is in fact a large lake in the middle of the city, in which rainwater is collected. This water is used as a source for drinking water production. In addition, water is desalinated. These are the sources for domestic and industrial use. The wastewater is partially discharged into the sea, but also partially reprocessed in NEWATER factories (with MBR) for non-drinkable reuse (e.g. process water for industry). All in all, it is almost a closed system. The University of Singapore is currently conducting a study commissioned by the government into the occurrence of micropollutants in the wastewater to be treated and into the extent of removal by the actived sludge systems and membrane bioreactors being used now.

According to Chang, there is currently little pressure from the government to pay extra attention to the removal of micropollutants. But, according to Chang, the water agency feels responsible for giving account to the general public about this theme. Chang put the risks of micropollutants to public health in perspective. She cited a statement from an American scientist who stated in 2008

that the highest concentration of medicine residues in wastewater is still 5 million times lower than the therapeutic dose (see her presentation at www.stowa.nl/beatingmicropollutants). She also indicated that, in her view, decisions and legislation in this area should be based on the protection of public health, not on detected substances. She ended her speech with some reassuring conclusions. The most important: *CECs are not a concern in Singapore waters. An efficient monitoring regime has been put in place for detection and analysis of CECs in Singapore waters.*

DISCUSSION

After the plenary presentations, the participants split up into groups to further exchange ideas with the speakers about 'hot topics', 'missing topics' and opportunities for collaboration. The following were mentioned as hot and missing topics:

- Sand filtration after ozone: is it necessary or not?
- One technique fits all: attention is paid to techniques that can remove multiple types of pollutants at the same time in a single treatment step, for example nutrients and micros.
- Research into the optimization of existing activated sludge systems for removal of micros. One activated sludge system sometimes does much better in this respect than the other. What is the reason for this and can we use this knowledge to increase the overall removal efficiency for micros by traditional activated sludge systems?
- Research into bromate formation in ozonation of wastewater, to ensure that the product (ozone) is ultimately not worse than the problem (micropollutants).
- Attention to the chain approach that runs from medicine production, prescriptions and use, to removal. Don't just focus on so-called end-of-pipe solutions.
- Attention for the production of high-quality 'customized' water, water that has been “tweaked” for its ultimate purpose of use.
- Attention to the fact that we produce 'dead' sterile water through high-quality wastewater treatment. How do we ensure that it becomes biologically living water again (for example via treatment wetlands)?

After this round of discussions, the speakers were briefly asked for a final response. It emerged that everyone finds it valuable to learn from each other's knowledge, experiences and chosen approach. You can build on this without having to reinvent the wheel yourself. But it was also emphasized that the challenges in this area can always be different per country or region and that this constantly requires different solutions.

This report and all presentations given can also be found on www.stowa.nl/beatingmicropollutants