Swiss approach to modern wastewater treatment is honoured

December 1, 2023 | Andri Bryner
Topics: Wastewater | Ecosystems | Pollutants | Organisation & Staff

A team of seven current and former Eawag researchers will receive the Swiss Chemical Society's Sandmeyer Prize in 2024 for the development of advanced wastewater treatment for the degradation of micropollutants using ozone. And the most amazing thing is: Just about 15 years have passed between basic research and large-scale technical implementation. This incredible timetable was only possible thanks to the wealth of knowledge already available at Eawag and the fact that interdisciplinary collaboration is a matter of course at the Swiss aquatic research institute.

If you were to search for "ozone" in the Eawag library system, the first research-paper results would date back as far as 1954. Back then, the head of the biology department, Karl Wuhrmann, and the subsequent director, Werner Stumm, published papers on the disinfection of well water using ozone. Subsequently, it was Jürg Hoigné, Hans-Peter Bader and many other researchers at Eawag who investigated the oxidative effect of ozone on undesirable trace substances in water. The focus was on drinking water.

Negative effects on ecology and drinking water

Eawag researchers were also involved in studies in the 1990s that demonstrated how even well-functioning wastewater treatment plants were unable to remove certain micropollutants from wastewater. Hormone-active substances, household chemicals and pharmaceutical products, as well as substances from commercial and industrial processes, find their way into bodies of water, damaging organisms and posing latent risks to drinking water production. One example of such effects is the occurrence of feminsed trout downstream from wastewater treatment plants.

The team

The 2024 Sandmeyer Award will be presented to the Eawag team comprising Prof. Urs von Gunten (Eawag/EPFL), Prof. Juliane Hollender (Eawag/ETHZ), Dr. Christa McArdell, Dr. Adriano Joss, Marc Böhler (all from Eawag) as well as Prof. Hansruedi Siegrist (Eawag/ETHZ) and Dr. Christian Abegglen (Eawag, currently Head of Process Engineering at the City of Zurich's WWTP Werdhölzli). However, the official award ceremony will not take place until 20 September 2024 at the Casino Bern.

By-products, costs and energy are all taken into account

The team worked on the wholly novel idea of using ozonation to improve the purification of wastewater in lieu of clean drinking water. Prof. Urs von Gunten emphasises that it took just around 15 years for the idea to become a practical technology. Such a quick turnaround is rare. Laboratory experiments were carried out, which led to the development of kinetic models. Early on, care was taken to ensure that potentially toxic oxidation by-products, which can arise during reactions with ozone, were rendered harmless by biological post-treatment. Tests were first carried out in pilot facilities and then on a larger scale. Quantities were defined with which the process can be monitored and controlled, and the team worked together with practitioners to prove that the process can be handled safely by the operators of WWTPs. "The costs of energy consumption were important criteria," says Urs von Gunten.

Three main aspects were emphasised in the reasoning for the prize nomination:

From research to practice
First, the work of the team serves as an important example of how in-depth research into chemical analyses, reaction mechanisms and effects, in this case chemical oxidation processes and ozonation in particular, have developed from a scientifically sound description of the problem to an innovative solution and on to large-scale technical implementation.
Interdisciplinary collaboration for the benefit of society
Second, the success story is the result of a concerted and interdisciplinary effort by chemists, engineers, and environmental scientists and an example of how chemical principles have been used in different disciplines to tackle a societal challenge.
"Swissness" at its best
Third, the team is a prime example of "Swissness." In other words, the studies were conducted very thoroughly and described in the leading international scientific journals. At the same time, they led to the development of a practical and cost-efficient chemical wastewater treatment process that is now internationally recognised as the "Swiss approach" to advanced wastewater treatment and is used in many places.

Praise from California…

Berkeley Professor David Sedlak, one of the world's most renowned water experts, emphasises that the Swiss approach has now been adopted outside of Europe as well. The basic principles developed at Eawag have led to the use of ozonation, particularly in areas where water is scarce and wastewater is turned back into industrial or drinking water, including in the USA: "The Eawag team has done pioneering work, demonstrating how

ozonation can be used as part of a comprehensive treatment system. It has thus provided the world with a tool to protect aquatic ecosystems, avoid water scarcity and ensure the responsible use of chemicals," says Sedlak.

... and from those employing practical measures

Today, people are quick to point out that the expansion of WWTPs with an additional stage against micropollutants is due to the change in law in Switzerland. As a project leader at the engineering company Holinger for many years, Michael Thomann has completed several WWTP upgrades with ozonation, which were scientifically supported by the Eawag team. He is now Professor of Environmental and Water Technology at the University of Applied Sciences and Arts Northwestern Switzerland. Thomann explains the sequence of developments: "Switzerland's internationally acclaimed amendment to the law on the elimination of organic micropollutants was made possible by the work of the Eawag team."

Expansion is progressing

The expansion of Swiss wastewater treatment to include an additional stage to combat micropollutants is underway. Around 25 installations have already been upgraded since 2014, and planning or construction has already begun for almost 50. Ozonisation is one of the processes used. Powdered activated carbon, granulated activated carbon or combined processes are also used. The objective is for the upgraded wastewater treatment plants to achieve an average 80% elimination of trace substances and thus make a significant contribution to the protection of aquatic ecosystems and drinking water resources.

Traugott Sandmeyer, a Swiss self-made man

The Sandmeyer Award of the Swiss Chemical Society (SCG) is presented annually for outstanding work in industrial or applied chemistry. It is endowed with 20,000 Swiss francs for groups of researchers. Traugott Sandmeyer from Wettingen in the Canton of Aargau (1854-1922) was originally a precision mechanic, but made a great contribution as a chemist through self-study as an assistant lecturer at the ETH. He worked at Geigy (now Novartis) for over 30 years and was twice awarded honorary doctorates. A team from Eawag already received the prize for their research into the contamination of drinking water resources with geogenic elements and their removal in 2019.

Cover picture: Ozone is blown into the treated wastewater through these diffusers (WWTP Neugut, Dübendorf; photo: Max Schachtler) .

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Ozonation pilot project at the Regensdorf WWTP

Ozonation at the Neugut WWTP, Dübendorf

Biotests to evaluate ozonation and post-treatment

About the Micropoll strategy

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