Turning urban sewage into clean water thanks to "electric" bacteria

European researchers have developed a full-scale application of an eco-friendly technology that treats sewage water with zero-energy costs

At first look they seem just small gardens in Carrión de los Céspedes, close to Seville, Spain. In fact, they are five small tanks, each around 24 square metres, in which "electric" bacteria are purifying sewage water from the nearby town of around 2,500 inhabitans.

"In 2010 when I discovered the beauty of constructed wetlands, I decided to apply my knowledge on microbial electrochemical technologies," explained professor Abraham Esteve-Núñez from the University of Alcalá in Madrid. He improved traditional filter systems using conductive material to fill the wetlands. This acts as physical supports for **bacteria that produce electricity when breaking down organic waste**.

"Combining electroactive bacteria with electroconductive material has resulted in **depuration rates that are ten times higher than with traditional techniques**" said Arantxa Aguirre from the Foundation Center for New Water Technologies (CENTA), Spain, explaining the research. "We also planted *Cyperus papyrus* and *Iris pseudacorus*. These plants help to remove nitrogen and phosphorus, and their main effect is the aeration of the bed, because the oxygen goes through the plants in the bed of the tank."

Moreover, the system avoids clogging the biofilters with sediment, as the results is very low biomass. The bacteria remove pollutants from the wastewater and, after electro-oxidative treatment, the process produces water, pathogen-free and suitable for irrigation. Up to 25 000 litres can be cleaned per day.

What makes the technology especially innovative is the way the electroactive bacteria's metabolism converts pollution into electricity. The more the bacteria eat, the more electricity is harvested. **Operators can monitor the efficacy of the bacteria in removing contaminants through specially designed smart IT tools.**

The research of the team of Dr Esteve Núñez was supported by the EU project iMETland that aligns with the water and wastewater treatment priorities of the EU's EIP-Water initiative.

"One of the challenges of the project was coping with real conditions such as unexpected seasonal changes, so we tested our open-field wetland in different climates in Europe, **from the hot Mediterranean summer of Spain to the freezing winter of Denmark**" Dr Esteve-Núñez explained.

The technology was experimented with success in the village of Ørby, North East of Haderslev, Denmark, by the Aarhus Universitet. "In Spain and in Denmark we used the same bacteria, even if the quality of domestic sewage water is different, because in Spain they use more olive oil, and fried food then in Norther Europe," explained Dr Carlos Arias.

The main difficulties, he added, were mostly bureaucratic, "because it's an unknown system, and the local municipalities were afraid of being responsible for something that might not work. So we had to go through several meetings to convince the local authorities, and finally we got permission to demonstrate the system in the field, and we delivered what we promised."

The concept is being currently tested also in Argentina and Mexico. But the technology has already passed both research and pilot scale and is ready to try a full-scale demonstration.

Santiago Otero, from professional services company PwC, underlined the high sustainability impacts in terms of CO_2 reduction and water savings of the solution, and its great commercial potential: '"It has been estimated that only about 200.000 euros are needed for building the infrastructures and also few people are needed to run the biofilter."

"We set up a spin-off company, METfilter, owned by the same researchers of the project, so we have now a further instrument to enter the market," said Dr Esteve-Núñez.

The company also joined another project called ELECTRA (Electricity driven Low Energy and Chemical input Technology foR Accelerated bioremediation), which aims at improving bioremediation of ground waters, wastewater as well as sediments and soil. It encompasses a consortium of 17 universities, research centres and companies in the EU and China that work together to implement the technology.

"We **will treat not only domestic sewage, but also industrial wastewater**. Instead of sending it to general municipality water treatment, companies will have a sustainable tool to treat it on site and reuse the clean water for the own purpose," concluded Dr Esteve-Núñez.

By Margherita Sforza