HOW CAN INNOVATIVE MATERIALS BE USED TO PURIFY WATER?

Our monthly science question: a series that demystifies complex topics with simple, effective answers.

INRS

ACCESS TO DRINKING WATER IS A GLOBAL CHALLENGE, AND A QUEBEC CONCERN TOO!

All over the world, access to safe drinking water is a growing challenge, and Québec is not immune. Despite its millions of freshwater sources, Québec still faces pressing water-related issues. Thousands of Quebecers lack reliable access to safe drinking water systems. It is more than an infrastructure problem, it is a matter of public health and social justice. Clean water is essential for building a healthy and equitable society.

CHEMICALS THAT PERSIST IN THE ENVIRONMENT

Despite Québec's abundant water resources, the risk of contamination is very real. Pesticides, antibiotics, microplastics, and forever chemicals (known by their acronym PFAS) are among the chemicals that are widely present in our daily life, and in our water supply. These risks increase further when water mains break, chemical spills occur, and firefighters use film-forming foam is to extinguish intense fires. This is where science steps in to help with innovative solutions.

TACKLING CONTAMINANTS WITH... ELECTRICITY

To decontaminate the polluted waters from persistent contaminants, we use... electric currents! Known as electro-oxidation processes, these techniques use anodes—i.e., special electrodes that inject electrical current into the water . When subjected to an electric field, these electrodes, which possess a combination of specific properties, generate highly reactive species that effectively degrade the contaminants in the water.

CREATING INNOVATIVE MATERIALS

Until now, synthetic diamond-based electrodes have been used for this process. However, the complexity of their synthesis and associated high production costs present serious limitations!. That's where the expertise of Professor My Ali El Khakani and his team at INRS's Centre for Energy, Telecommunications and Materials come into play. Their challenging mission: to develop corrosion-resistant, electrically conductive and cost-effective alternative electrodes.

Drawing on to their in-depth knowledge of material sciences, Professor El Khakani's team, in collaboration with Professor Patrick Drogui and his team, have developed titanium oxide-based coatings (a naturally abundant material) with a specific Ti_4O_7 composition known as the "Magnéli phase." These new anodes have been proven highly effective in degrading PFAS. Remarkably, they demonstrate performance and durability comparable to, or even exceeding, that of boron-doped synthetic diamond electrodes.

USING GREEN PROCESSES TO DECONTAMINATE WATER

In Québec, where electricity is exclusively generated from hydraulic sources, electro-oxidation techniques offer a particularly eco-friendly approach to water decontamination. The method developed by INRS researchers has shown impressive results, effectively treating both lightly contaminated and heavily polluted industrial waters. PFAS degradation rates of up to 98% have been achieved! What's more, these electro-oxidation processes have also been found effective in breaking down other pollutants, such as atrazine, a widespread contaminant in Québec's agricultural regions, and chlortetracycline, an antibiotic used in veterinary medicine. This discovery, the result of decades of research and expertise, directly contributes to ensuring access to clean and safe drinking water in Québec.