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Tisková zpráva

Revolution in water purification: Membrane removes dangerous bacteria and heavy metals

Olomouc (November 21, 2025) **- Dangerous bacteria and toxic heavy metals can be removed from water by using a filtration membrane developed by scientists from the Czech Advanced Technology and Research Institute (CATRIN) at Palacký University Olomouc and the Centre for Energy and Environmental Technologies (CEET) at VSB – Technical University of Ostrava. It also eliminates combined pollution, which poses a serious environmental and health threat, in a single step, without the need for energy sources or chemicals commonly used for water disinfection. The membranes are easily renewable, making this technology a breakthrough solution for affordable and safe drinking water anywhere in the world.**

The scientists aimed to use commonly available and inexpensive filter membranes, onto which they applied the Nobel Prize-winning carbon material graphene with chemical traps for heavy metals and bacteria. In developing the technology, they were inspired by a process they recently used in the development of atomic antibiotics. They presented the new technology to the scientific world in the prestigious Chem journal.

"*We have used graphene modified with carboxyl groups, which effectively capture heavy metals such as lead and cadmium. In the next layer of the membrane, we used a similar graphene material with manganese ions. These ions have a strong chemical bond with bacteria, which we have already proven in our research on atomic antibiotics*," said Radek Zbořil, author of the concept, who works at both CATRIN as well as CEET research centre.

Filtration membranes developed by Czech scientists can also function on a semi-industrial scale, which allows them to be used in practice. "*The technology achieves filtration efficiency of over 99.999 percent against a wide range of microorganisms in distilled, tap, and river water. In addition, the membranes have a high capacity for capturing heavy metals, thus meeting strict legislative limits. The entire process is very simple, which allows it to be used even in areas without access to electricity. The technology is inexpensive to maintain because*

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the membranes can be easily and effectively regenerated for re-use," explained David Panáček, the study's first author, who now works at the Imperial College London.

Thanks to its simple design and affordable materials, the new technology appears to be a cheap alternative to traditional water treatment methods, which are complex and demanding in terms of energy consumption. Moreover, this approach represents a completely new concept in water filtration and disinfection. Current technologies, such as ultrafiltration or nanofiltration, rely on small pores in membranes to capture bacteria, but they are very expensive.

"*Our technology does not address pore size, but rather relies on the chemical properties of manganese ions, which bind strongly to bacteria. This technology allows us to effectively remove even problematic strains, such as Pseudomonas aeruginosa, known for its ability to form biofilms in pipes and filters. This has enormous potential for improving water disinfection in hospitals or food processing plants*," added Milan Kolář from the Faculty of Medicine and Dentistry at Palacký University, who participated in the research.

Heavy metals enter surface waters from industrial production or mining, while bacteria often originate from inadequately treated wastewater, agricultural activities, and rainwater runoffs. Traditional methods for removing these contaminants are technologically demanding and financially costly. Chemical processes such as ozonation or chlorination are used to remove bacteria, while heavy metals are removed using multi-stage methods such as precipitation, flocculation, coagulation, and others.

"*Combining these demanding processes is very difficult, both technologically and economically. In developing countries, where there is a lack of funding and adequate infrastructure, combined pollution from heavy metals and bacteria is one of the biggest problems in terms of access to clean water. The aim of the research was to simplify the complex process of water treatment and develop inexpensive technology that can remove both types of pollution in a single step, which we have succeeded in doing*," added Zbořil.

The technology could be used, for example, in wastewater treatment in industrial areas, securing drinking water in developing countries, or providing quick and effective solutions in crisis situations such as armed conflicts or natural disasters, where access to electricity is limited.

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Link to paper: https://www.sciencedirect.com/science/article/pii/S2451929425003766?via%3Dihub

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