Instant water cleaning method 'millions of times' better than commercial approach

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A water disinfectant created on the spot using just hydrogen and the air around us is millions of times more effective at killing viruses and bacteria than traditional commercial methods, according to scientists from Cardiff University.

Reporting their findings today in the journal *Nature Catalysis*, the team say the results could revolutionize water disinfection technologies and present an unprecedented opportunity to provide clean water to communities that need it most.

Their new method works by using a catalyst made from gold and palladium that takes in hydrogen and oxygen to form hydrogen peroxide —a commonly used disinfectant that is currently produced on an industrial scale.

Over four million tons of hydrogen peroxide are made in factories each year, where it is then transported to the places it is used and stored. This means that stabilizing chemicals are often added to the solutions during the production process to stop it degrading but these reduce its effectiveness as a disinfectant.

Another common approach to disinfecting water is the addition of chlorine; however, it has been shown that chlorine can react with naturally occurring compounds in water to form compounds which, in high doses, can be toxic to humans.

The ability to be able to produce hydrogen peroxide at the point of use would overcome both efficacy and safety issues currently associated with commercial methods.

In their study, the team tested the disinfection efficacy of commercially available hydrogen peroxide and chlorine compared to their new catalytic method.

Each was tested for its ability to kill Escherichia coli in identical conditions, followed by subsequent analysis to determine the processes by which the bacteria were killed using each method.

The team showed that as the catalyst brought the hydrogen and oxygen together to form hydrogen peroxide, it simultaneously produced a number of highly reactive compounds, known as reactive oxygen species (ROS), which the team demonstrated were responsible for the antibacterial and antiviral effect, and not the hydrogen peroxide itself.

The catalyst-based method was shown to be 10,000,000 times more potent at killing the bacteria than an equivalent amount of the industrial hydrogen peroxide, and over 100,000,000 times more effective than chlorination, under equivalent conditions.

In addition to this, the catalyst-based method was shown to be more effective at killing the bacteria and viruses in a shorter space of time compared to the other two compounds.

It is estimated that around 785 million people lack access to water and 2.7 billion experience water scarcity at least one month a year.

In addition to this, inadequate sanitation—a problem for around 2.4 billion people around the world—can lead to deadly diarrheal diseases, including cholera and typhoid fever, and other water-borne illnesses.

Co-author of the study Professor Graham Hutchings, Regius Professor of Chemistry at the Cardiff Catalysis Institute, said: "The significantly enhanced bactericidal and virucidal activities achieved when reacting hydrogen and oxygen using our catalyst, rather than using commercial hydrogen peroxide or chlorination shows the potential for revolutionizing water disinfection technologies around the world.

"We now have proven one-step process where, besides the catalyst, inputs of contaminated water and electricity are the only requirements to attain disinfection.

"Crucially, this process presents the opportunity to rapidly disinfect water over timescales in which conventional methods are ineffective, whilst also preventing the formation of hazardous compounds and biofilms, which can help bacteria and viruses to thrive."

More information: A residue-free approach to water disinfection using catalytic in situ generation of reactive oxygen species, *Nature Catalysis* (2021). DOI: 10.1038/s41929-021-00642-w , www.nature.com/articles/s41929-021-00642-w

Provided by Cardiff University

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