

# Nanotechnology's campaign for safe drinking water

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**A NEW WAVE of science innovation is based on something much smaller than ever before. Nanotechnology is the hottest buzz in laboratories around the world. Scientists are using this cutting edge technology not only to develop incredible new products, but also to work towards clean water, renewable energy, safe food and smart medicines for the growing number of people on our planet.**

## Water and nanotechnology

Most countries around the world, including South Africa, are faced with the growing challenge of access to clean, safe drinking water. Recent statistics indicate that more people are dying annually from unsafe water than from all forms of violence combined, including war. In South Africa, an estimated 5.7 million people lack access to basic water services, and about 17 to 18 million people lack basic sanitation services. These figures are likely to increase due to industrial expansion, rising population and climate change, which is set to drastically affect sub-Saharan Africa. Finding new ways to address the challenge of providing clean water has become a global priority. One of the approaches being explored in many countries, including South Africa, is the application of nanotechnology.

## What is nanotechnology?

Nanotechnology is the manipulation of materials at a very tiny scale – essentially at the atomic and molecular levels. At the nanoscale, the normal rules of physics and chemistry often do not apply, and as a result many materials display unique properties that make them well suited for treating water.

Nanotechnology provides an opportunity to refine and optimise current techniques, and also offer new and novel methods, for treating domestic, industrial and mining wastewater. Essentially, nanotechnology can offer solutions that are tailor-made to remove a specific contaminant or solutions that “multi-task”, using different nano-based techniques. This is ideal for water purification because water contains different forms of contaminants at different locations, such as heavy metals (e.g. mercury, arsenic), biological toxins including waterborne disease-causing pathogens (e.g. cholera, typhoid), as well as organic and inorganic solutes.

## Nanotechnology in South Africa

In South Africa, the National Nanotechnology Strategy (NNS) was launched in 2006, although nanotechnology has been embedded in national strategy and policy since the publication of the White Paper on Science and Technology in 1996. Water is one of six focus areas highlighted in the NNS where nanotechnology can offer the most significant benefits for South Africa. This is reflected in the high volume and quality of research at various institutions around the country.

To date, through the Department of Science and Technology (DST), the government has invested over R170 million in different aspects of nanotechnology research and development (R&D). Two nanotechnology innovation centres have been commissioned and have formed



*Children fetching water.*

collaborative partnerships with industry, universities and bodies such as the Water Research Commission (WRC) to conduct cutting-edge research. Much of this has focused on water purification, and as a result, a range of water treatment devices that incorporate nanotechnology are already commercially available around the country.

A project between the University of Stellenbosch and the Water Research Commission has produced a membrane and filter system which is already commercially available in South Africa. It uses capillary ultrafiltration (CUF) technology to enable the removal of metal oxides (iron, manganese and aluminium), and reduce colour. It is also suitable for pre-treatment of seawater, desalination and the treatment of industrial water and wastewater.

A partnership between the University of the North West and the Council for Scientific and Industrial Research (CSIR) has developed a treatment plant in the rural village of Madibogo in North West Province which incorporates ultrafiltration membranes to clean brackish groundwater, as the majority of the inhabitants depend on groundwater or borehole water for their water needs. Several types of membrane have been tested in this pilot study, including reverse osmosis membranes and ultrafiltration membranes to see which would most successfully remove the polluting solutes while retaining the essential nutrients.

A team at the University of Stellenbosch, headed by Prof Eugene Cloete, have developed a “tea bag” water filter which can be placed in the neck of a bottle to kill disease-causing microbes as



*The Vestergaard-Fransden's LifeStraw is an example of a personal water purification and filtration product which allows users to drink from otherwise disease-ridden water sources. Recently researchers at University of Stellenbosch have designed a similar product called the 'tea bag' filter based on nanomaterials.*





*The 'tea bag' filter based on nanomaterials developed by researchers at University of Stellenbosch for water purification. The filter looks like a tea bag but contains material that blocks harmful chemicals and microorganisms.*

water passes through the filter, making the water safe to drink. The inside of the tea bag is coated with a thin film of biocides encapsulated with nanofibres, so as the filter traps bacteria, they are killed by the biocide coating. This may provide a very cheap solution to purify water in remote areas. It could also potentially be used worldwide by relief organisations where clean water supplies are threatened by water-borne diseases such as cholera as a result of natural disasters such as earthquakes and floods. The potential global impact is huge.

### Benefits of using nanotechnology

Nanotechnology offers a number of benefits to the water sector, for instance, by enabling more effective removal of contaminants at lower concentrations due to increased specificity and "smart filters" tailored for specific uses. Novel reactions at the nanoscale due to increased numbers of surface atoms may also enable the removal of contaminants that were previously very difficult to treat. The number of treatment steps, the quantity of materials, as well as the cost and energy required to purify water could be radically reduced using nanotechnology – making it easier to implement in remote rural communities.

### What are the risks?

There are concerns that the same properties (size, shape, reactivity, etc.) that make nanoparticles so useful could also make them harmful to the environment and toxic to humans, for example, if they enter and build up in drinking water supplies and the food chain. Risk assessment research is crucial for establishing the potential impact of nanoparticles upon human health and the environment: the technology's benefits must be balanced against any unintended consequences. The government, through the DST, is funding a research platform to

*Water from a pipe.*



*Waste-water treatment plant.*

investigate the environmental, safety and health aspects of nanotechnology. This will include an inventory of nanoparticles in production or use in South Africa, as well as focused research and development of the required infrastructure and human capital. An ethics committee is also being established by government, made up of diverse stakeholder representatives to ensure that the technology adheres to ethical principles. It is important that nanotechnology be developed in a safe, responsible, acceptable and sustainable manner.

### The future and nanotechnology

Although substantial initial investment would be required to incorporate or switch to nanotechnology-based water treatment methods, once adopted, maintenance costs would be considerably lower over the long term and a higher-quality water product would be provided, particularly to rural communities. It is vital that the water sector should become familiar with this technology as it is set to change how water is cleaned, and clearly stands to offer significant advantages for a country such as South Africa.

"South Africa is heading for an era of great nanotechnology discoveries," predicts Mithuzeli Zamxaka, programme coordinator of the Nanotechnology Public Engagement Programme (NPEP). "We have the opportunity to use nanotechnology to supply specific solutions to African problems".

*The Nanotechnology Public Engagement Programme (NPEP) is an initiative funded by the Department of Science and Technology (DST) and implemented by the South African Agency for Science and Technology Advancement (SAASTA), the business unit of the National Research Foundation (NRF). Launched in early 2008, the NPEP aims to promote credible, fact-based understanding of nanotechnology through awareness, dialogue and education to enable informed decision making on nanotechnology innovations to improve the quality of life.*

*Waste-water treatment plant.*

