

Indian scientists develop low-cost arsenic water filter

Using nanotechnology, scientists at IIT-M have developed an effective and affordable arsenic filter to combat the growing problem of groundwater pollution.



Children bathing using water from a groundwater pump in Jalpur, India. An Indian university is using nanotechnology to remove arsenic concentration from groundwater sources. Image: Cinemarketing / Shutterstock.com

While historians continue to debate whether arsenic toxicity killed Napoleon Bonaparte, 65 million people in Asia are facing day-to-day health risks due to arsenic contamination of their drinking water.

Of this, an estimated 35 million people are in Bangladesh, five million in India and 550,000 in Nepal. Also emerging is a picture of increasing contamination in the Indus delta in Pakistan.



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Now, help could be at hand with a team of scientists at the Indian Institute of Technology-Madras (IIT-M) developing Amrit, a low-cost arsenic filter using nano-filtration technology. This unit has been tested in West Bengal, and found effective. As a result, the Indian government is recommending it for use in different parts of the country.

T. Pradeep, leader of the team at IIT-M, is optimistic that an effective solution to arsenic contamination can be found in five years if this technology gets scaled up to all affected parts of India. Pradeep, who is professor of chemistry at IIT-M, draws his confidence from his team's successful work in two districts of West Bengal — Murshidabad and Nadia. They are currently also working in the state's South 24 Parganas

district.

"While we were field-testing our nano-filtration technology, unknown to us the district collector of Murshidabad was assessing our work," said Pradeep. "Our results were stable and this gave him confidence for supporting the technology for propagation."

The district administration in Murshidabad is installing 2,000 units designed by the IIT-M team, with each unit catering to the needs of 100-300 people. The team also tested filtration units of different capacities — from 300 to 100,000 litres per hour.

It was in the neighbouring district of Nadia that the team, again with the support of the district administration, had tried and found effective filtration units connected to hand pump outlets. The idea was to remove arsenic from the drinking water from hand pumps that are used by school children.

The challenge was to filter water as it flowed, and these units were designed and connected to the mouths of the hand pumps. They were connected to 330 hand pumps in schools, with each serving the needs of at least 300 students.

"The potential of these in-the-line filtration units is immense," said Pradeep. "It is estimated that there are 2.53 million hand pumps installed in India. Around 5 per cent of them (more than 120,000) yield arsenic-contaminated water. In addition, these units can also be connected to home drinking water supply."

IIT-M has received an invitation from another West Bengal district administration — South 24 Parganas — with a grant support to install the nano-filters in the district.

Health impact

According to the World Health Organisation, [arsenicosis](#) is the effect of arsenic poisoning, usually over a long period such as five to 20 years. Drinking arsenic-rich water over a long period impacts health in various ways, including skin problems (such as colour changes, and hard patches on the palms and soles of the feet), skin cancer, cancers of the bladder, kidney and lung, and diseases of the blood vessels of the legs and feet, and possibly also diabetes, high blood pressure and reproductive disorders.

WHO's [prescribed limits](#) for arsenic in drinking water is 10 parts per billion (ppb). However, WHO felt that this may not be achievable in some countries, so it should be considered as a goal, and the value should be less than 50 ppb. According to the [Bureau of Indian Standards](#), the "requirement" (acceptable limit) is fixed at 10 ppb, whereas the "permissible limit in the absence of an alternate source" is fixed at 50 ppb.

The IIT-M technology removes arsenic so that the treated water has an arsenic concentration of 2 ppb, Pradeep said. This is at a cost of 4 paise (INR 0.04 or USD 0.0006) per litre of water. "With our technology we have managed to reach international standards at Indian costs," he observed.

How it works

The IIT-M arsenic filters use biopolymer-reinforced synthetic granular nanocomposite technology. In a paper published in the [Proceedings of the National Academy of Science of the United States of America](#), the IIT-M team states that combining the capacity of diverse nanocomposites to scavenge toxic species such as arsenic, lead, and other contaminants along with the above capability can result in affordable, all-inclusive drinking water purifiers that can function without electricity.

"The nanocomposite exhibits river sand-like properties, such as higher shear strength in loose and wet forms. These materials have been used to develop an affordable water purifier to deliver clean drinking water at USD 2.50 (INR 180) per year per family."

"The nanocomposite is like ordinary powder-like floating mass that can be made at room temperature without electricity," said Pradeep. "It is like the biological material that goes into the making of seashells in nature, and forms a labyrinth of nano-scale cages in the water. These cages can be used to filter microbes, arsenic, pesticides, mercury, lead and iron."

While chitosan (the material found in seashells and shells of shellfish) provides the structure to the cages in nature, the material in the nanocomposite used for dealing with the contaminant can be changed according to what needs to be eliminated from the drinking water.

Thus, while an aluminium oxyhydroxide-chitosan composite with silver nano-particles can be used to deal with microorganisms, manganese dioxide-chitosan can filter out lead. For filtering arsenic, an iron oxyhydroxide-chitosan is used.

The iron in the rocks gets oxidised to iron oxide or rust, which in turn mops up the arsenic from the water of the rivers flowing over it. These stones and pebbles later flow down the rivers and accumulate in the silt in the delta region. Arsenic from the stones leaches into the aquifer in the delta.

A [Stanford University](#) study found a certain group of bacteria responsible for breaking the arsenic and iron locked in the sediments into water-soluble form so that they sink into the aquifers.

Increasing use of groundwater in the deltas in recent decades has meant increasing risk due to exposure to arsenic. Though arsenic contamination in the delta regions of Bangladesh and West Bengal has been well reported, recent [reports](#) show an increasing incidence in the Indus river delta in Pakistan.

In Bangladesh, India and Pakistan, the communities that are most affected are the poor living in villages in the region where the rivers break into distributaries before reaching the sea.

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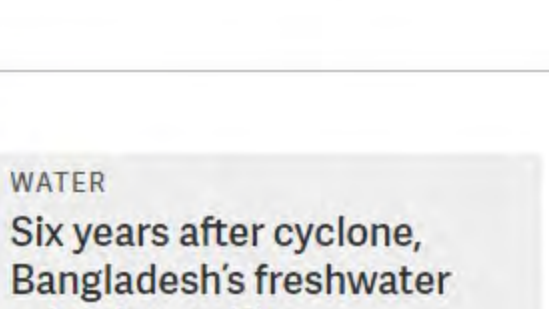
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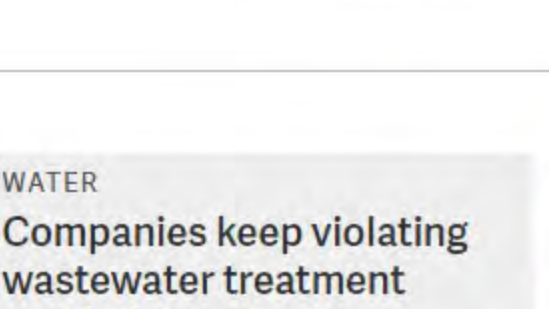
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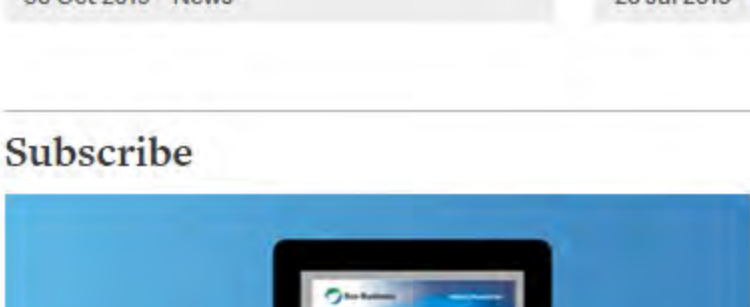
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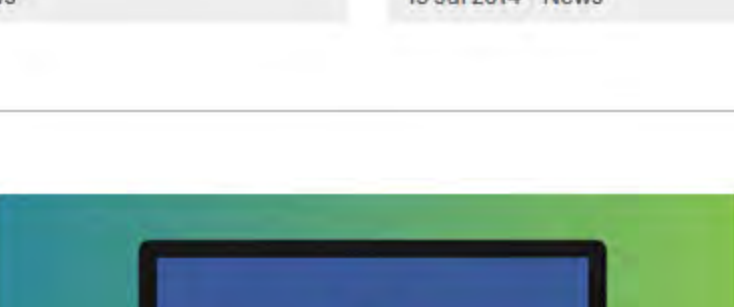
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