Portable freshwater harvester could draw up to 10 gallons per hour from the air

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For thousands of years, people in the Middle East and South America have extracted water from the air to help sustain their populations. Drawing inspiration from those examples, researchers are now developing a lightweight, battery-powered freshwater harvester that could someday take as much as 10 gallons per hour from the air, even in arid locations. They say their nanofiber-based method could help address modern water shortages due to climate change, industrial pollution, droughts and groundwater depletion.

The researchers will present their results today at the 256th National Meeting & Exposition of the American Chemical Society (ACS).

"I was visiting China, which has a freshwater scarcity problem. There's investment in wastewater treatment, but I thought that effort alone was inadequate," Shing-Chung (Josh) Wong, Ph.D., says. Instead of relying on treated wastewater, Wong thought it might be more prudent to develop a new type of water harvester that could take advantage of the abundant water particles in the atmosphere.

Harvesting water from the air has a long history. Thousands of years ago, the Incas of the Andean region collected dew and channeled it into cisterns. More recently, some research groups have been developing massive mist and fog catchers in the Andean mountains and in Africa.

To miniaturize water generation and improve the efficiency, Wong and his students at the University of Akron turned to electrospun polymers, a material they had already worked with for more than a decade. Electrospinning uses electrical forces to produce polymer fibers ranging from tens of nanometers up to 1 micrometer—an ideal size to condense and squeeze water droplets out of the air. These nanoscale fiber polymers offer an incredibly high surface-area-to-volume ratio, much larger than that provided by the typical structures and membranes used in water distillers.

By experimenting with different combinations of polymers that were hydrophilic—which attracts water—and hydrophobic—which discharges water, the group concluded that a water harvesting system could indeed be fabricated using nanofiber technology. Wong's group determined that their polymer membrane could harvest 744 $mg/cm^2/h$, which is 91 percent higher than similarly designed membranes without these nanofibers.

Unlike existing methods, Wong's harvester could work in arid desert environments because of the membrane's high surface-area-to-volume ratio. It also would have a minimal energy requirement. "We could confidently say that, with recent advances in lithium-ion batteries, we could eventually develop a smaller, backpack-sized device," he says.

What's more, Wong's nanofiber design simultaneously grabs water and filters it. The electrospun fiber network can act as an anti-fouling surface, sloughing off microbes that could collect on the harvester's surface. So the water would be "clear and free of pollutants" and immediately drinkable once it's collected, he says.

Next, Wong hopes to obtain additional funding to build a prototype of the freshwater harvester. He anticipates that, once his team is able to produce the prototype, it should be inexpensive to manufacture.

More information: Water harvesting from atmospheric airborne particles by electrospinning-enabled bio-inspired techniques, the 256th National Meeting & Exposition of the American Chemical Society (ACS).

Abstract
Driven by the scarcity of fresh water supply, climate change and ground watershed depletion, our research is directed towards the most abundant atmospheric water sources using ground-breaking nanotechnology. If successful, it will produce agile, light weight, portable, fresh water harvester powered by Li Ion battery with capabilities ranging from 1 to 10 gallons per hour. In the earth's water sources, only 2.5% is fresh. Three quarters of that is locked up in ice in the north and south poles. Most water sustainability research is directed towards water supply,

purification, waste water treatment and desalination. Little attention is directed towards water harvesting from atmospheric particles. Water has been extracted from air for at least 2,000 years using air wells in middle eastern desserts and subsequently in other parts for the world. The Incas were able to sustain their habitat for civilization above the rain line by collecting dew and channelling it to cisterns. For the first time, a portable harvester will be designed and made by electrospun polymer membranes that condensate moisture content in air into drinkable water. In this talk, we introduced a bio-inspired approach for a novel bead-on-string nanofiber with hydrophobicity/ hydrophilicity simultaneously by electrospinning-enabled technique, that can be used as a high-performance water harvester. Scanning electron microscopy (SEM) and water contact angle measurement showed the structures of novel water harvesters and a custom-made setup was used to evaluate its water harvesting ability. The water harvesting efficiency of our membrane was determined to be 744 mg/cm2/h, which was 91% higher than the virgin PAN membrane. The durability and efficiency of such a water harvester was also tested and will be reported.

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