A SOLAR-POWERED SOLUTION to the WATER CRISIS

by Deepika Kurup

OVER 70 PERCENT OF OUR BLUE PLANET IS COVERED IN WATER, SO IT SEEMS THAT WATER IS EVERYWHERE. WE USE WATER FOR DRINKING, COOKING, CLEANING, AND EVEN RECREATION, AND TO MANY OF US THE WORLD'S SUPPLY OF CLEAN WATER SEEMS ENDLESS. IN REALITY, IT IS ANYTHING BUT. TODAY THERE ARE 750 MILLION PEOPLE IN THE WORLD WHO LACK ACCESS TO CLEAN, SAFE WATER. WE ARE FACING A GLOBAL WATER CRISIS.

I saw this crisis for myself when visiting relatives in India. I saw people standing in long lines under the hot sun to fill buckets with tap water. I saw children filling plastic bottles with polluted water from nearby streams, and I watched them drink water that I felt was too dirty to touch. When I was in eighth grade, I decided to do something about it.

Clean, Green, and Fast

Currently in many developing countries, water is purified for drinking through solar disinfection (SODIS). In the SODIS method, water is poured into a colorless transparent bottle made of PET (polyethylene terephthalate) and left in the sun for at least six hours. The powerful UV radiation in sunlight inactivates disease-causing pathogens, making the water safe to drink. SODIS is simple and inexpensive, but it is very slow. In cloudy weather, it can take up to two days to purify a 2-liter bottle of water.

In the last decade, the SODIS process has been accelerated by photocatalysis. When UV radiation strikes a photocatalyst, such as titanium dioxide, highly reactive oxygen species (ROS) are created. These ROS both kill bacteria and degrade organic chemical compounds, such as benzene and toluene, pollutants that cause severe health problems. However, because the photocatalysts are usually applied as coatings inside the PET bottles, they often wash off into the water, which means people end up drinking the photocatalyst. In addition, the photocatalysts currently in use actually block some UV radiation, diminishing the efficiency of the SODIS process.

Three years ago, after researching ways to use the sun to purify water, I set out to overcome these drawbacks. I spent hundreds of hours reading scientific papers, building prototypes, and testing contaminated water samples in a makeshift lab in my garage. Eventually I submitted a video describing my idea for harnessing solar energy to purify water to the 2012 Discovery Education 3M Young Scientist Challenge. When I was named a finalist, I was assigned a mentor from 3M. Over the course of several weeks, my mentor, Dr. James Jonza, provided valuable guidance as I developed a pervious photocatalytic composite, which I integrated into a water purification panel. When exposed to sunlight, this device removes both bacteria and organic chemical compounds from water.

I continued working independently on my project the next year. While researching ways to harness not just UV light but visible light, I found several journal articles that described the use of semiconductors, such as silver, as doping agents. I decided to add silver nitrate to my composite, which extended the photocatalytic activity of my composite from the ultraviolet (which makes up just 3% of solar radiation) into the visible light spectrum (44% of solar radiation). In order to further enhance the efficiency of water purification, in 2014 I devised a process that combines filtration with photocatalysis: First, water percolates through a filter created with novel pervious composites, which destroys 98% of coliform bacteria and degrades organics. This filtered water is then transferred to a container with a disc made of the photocatalytic composite. Exposing the container to sunlight results in 100% inactivation of coliform bacteria—in just 15 minutes.

Research, Rewarded

Excited by these results, I submitted my project to the 2014 Stockholm Junior Water Prize (SJWP), the world's most prestigious youth science competition for water-related research. After winning the

New Hampshire contest, I went on to compete against U.S. SJWP state winners from 48 states. I was thrilled to win the national competition, $10,000, and an all-expenses-paid trip to Stockholm, Sweden, to represent the United States at the international competition during World Water Week in September.

After arriving in Stockholm with my chemistry teacher and the U.S. SJWP national coordinator, I immediately set up my display in the Stockholmsmässan, the conference center where, over the next week, all the SJWP finalists would present their work. My exhibit included two six-foot posters, pamphlets that displayed my published patent, an article I wrote for *Imagine* in 2012, and my 20-page paper.

The diversity of the 31 projects on display was truly remarkable. For example, the project from Germany focused on the biodegradation of polyethylene in sea water, the project from Cyprus created a novel process to remove xenobiotics from water, and the project from the Republic of Korea developed a novel water purification system using forward osmosis. Some students brought prototypes of their inventions, such as the student from Ukraine who brought a model of his wave-powered water desalination plant.

The next day, I got to meet the students who created these projects when all the finalists rode the *Tunnelbana* (Stockholm's metro system) to *Gamla Stan*, or "Old Town." We learned about the rich history of Stockholm from our tour guide before exploring the city on our own and having lunch with our newly made friends from across the globe. It was a perfect way to unwind, and it fostered a sense of camaraderie within the competition.

The day after our tour, we returned to the Stockholmsmässan to present our projects to the judges, who were all leaders in the water industry. They asked very specific questions, such as how much it cost to create my composite and how exactly it could be deployed in the real world. After working for so long on this project, it was exciting to speak in detail to people who were so curious about it and interested in it.

That night, we hopped on a double decker bus to the Grand Hôtel, where we met H.R.H. Crown Princess Victoria of Sweden, took plenty of pictures, and explained our projects to invited guests. During the awards ceremony, each finalist walked across the stage, waving their country's flag—a powerful reminder that clean water is an international concern. At the end of the night, we all cheered the announcement that Canada's Hayley Todesco, who devised a method of using sand filters to treat oil-contaminated water and recover water for reuse, was named the winner of the International SJWP.

My experience with the Stockholm Junior Water Prize was unforgettable—and it reinforced my belief that it is only when many minds are set on achieving a shared goal that we can tackle global challenges. We all need water to survive, so we all share the responsibility of making clean water accessible. I plan to do my part by continuing my research and eventually, I hope, deploying my water purification system. ■

Deepika Kurup is a junior at Nashua High School South in New Hampshire. For her work on harnessing sunlight to purify water, Deepika was named "America's Top Young Scientist" in the 2012 Discovery 3M Young Scientists Challenge, participated in the 2013 White House Science Fair, and was named one of the 2015 *Forbes* 30 Under 30: Energy. An ardent fan of martial arts, Deepika has black belts in karate and taekwondo. She will graduate high school early and attend Harvard in the fall.