Low-cost technology to better provide drinking water in developing countries

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Maji Safi founder John Maiyo, and company adviser John Howarter, pour water into a slow sand filter that the company is developing to provide clean and safe drinking water to schools and communities in developing countries. The technology, which can be used in plastic pails or 55-gallon drums, utilizes sand and water to better disinfect the contaminated water. At the bottom of the container is a porous plastic water collection plate, designed at Purdue. Credit: Purdue Research Foundation

A Purdue-affiliated startup has developed a low-cost, low-maintenance slow sand water filter technology to better provide clean and safe drinking water to schools and communities in developing countries around the world.

Maji Safi International LLC, which means clean water in Swahili, was founded by John Maiyo, a doctoral student in Purdue's College of Engineering. Chad Jafvert, a professor of civil engineering and environmental and ecological engineering; and John Howarter, assistant professor of materials engineering and environmental and ecological engineering, are company advisers. The company installs groundwater wells, and provides ceramic filters and slow sand filters, in western Kenya where safe water is not readily accessible.

"Access to clean water is a huge problem that many countries and communities face around the world, especially developing countries," Maiyo said. "Around the globe, twice the population of the United States lives without access to safe drinking water, and globally one-third of all schools lack access to safe water and adequate sanitation."

The unique Purdue technology used by Maji Safi is a slow sand filter that utilizes containers filled with sand and water. At the bottom of the

container is a water collection plate, designed at Purdue. The sand provides a large surface area on which microbial growth occurs that metabolizes the dissolved and particulate organic material in the water. The point-of-use slow sand filters are made from readily available five-gallon plastic pails or 55-gallon drums.

"Typical slow sand filters use gravel layers at the bottom of the filter as the water collection zone, however, our filters do not use gravel. Instead we use a porous plastic plate enclosed within a mesh bag," Jafvert said. "We've found this method to be much simpler to use and maintain. There is only the sand to sieve and rinse, instead of sand and different gravel sizes. It provides easier maintenance and makes for easier filter transportation and final assembly."

Once water is treated by a filter, a small amount of chlorine is added to the water for final disinfection, producing clear, colorless, drinkable water.

Maiyo said that after 30 minutes of contact with the chlorine, the water is ready to drink. "People and children in schools come up to the filter systems with a cup to get a drink, and the schools are able to use the water in their kitchens or for cleaning," he said. "Because the filters are operated in 'batch' mode, water is generally added three times each day, providing for an eight-hour contact time between the water and microorganisms in the filter. Each 55-gallon drum filter can process 200 liters of water each day. With five filters installed at one school, this meets the needs of over 400 children and teachers at the school every day."

Howarter said the filters are ideal for rural communities.

"The materials needed for these filters are very basic and can be found in the countries we aim to serve. The idea is that the microorganisms do

the work to remove organic materials from the water so the only energy demand is pouring water into the filter," he said. "Our particular design allows for the filters to be easily transported, and does not require any particular expertise for final construction at the point-of-use. As a disinfectant, chlorine is very inexpensive in the countries where we have installed filters, so there is no huge investment required by the communities to use the technology."

Maji Safi has installed 10 large slow sand filters in rural schools in Kenya, and Jafvert and Howarter have installed similar filters in Colombia, Tanzania and China.

"Our team, as well as many of our undergraduate and graduate students, have traveled to these countries to install the filters, and we've been able to see that the children and teachers use the filters every day," Jafvert said. "The first filters we installed in Columbia in 2011 are still being used today, so that's a good sign."

Maji Safi International was born out of Purdue's involvement in AMPATH, a consortium of North American academic health centers led by Indiana University, working in partnership with the government of Kenya, to provide access to health care. Technology used by Maji Safi International LLC has been licensed through the Purdue Research Foundation Office of Technology Commercialization. The company is a member of the Purdue Startup Class of 2016. Purdue has 27 startups based on Purdue intellectual property that were launched in the 2016 fiscal year.

Jafvert said the initial work on the technology was done through a $40,000 gift from the Kimberly-Clark Corp. The group also received $10,000 from Purdue's Department of Earth, Atmospheric, and Planetary Sciences through an H20 grant written by undergraduate students who participated in the research, $10,000 from the Purdue

Burton D. Morgan Center for Entrepreneurship, and additional support from AMPATH.

Maji Safi plans to improve the filters based on feedback from the communities.

"We're working to improve water delivery, water chlorination and chlorine detection, as well as automating the filters so that water can be pumped directly from local streams to the filters," Howarter said. "We're also working on a device that connects to a smartphone to tell users what filters aren't working properly so adjustments can be made remotely instead of having to visit the schools in person."

Maiyo said the company's next steps involve marketing the filters to other schools.

"Everything we've done, so far, has been through funding, but now that we've installed the filters in a few schools and the schools have seen the filters' potential, we're hoping other schools will be willing to purchase them," he said. "It would be great if a private organization or government agency would fund this project to allow us to install water filters in many schools. We've heard from multiple community leaders and the feedback is always 'how can we get more?' So now it's just a matter of finding funding to be able to do that."

Maji Safi aims to implement filters in 1,000 schools over the next five to 10 years.

"We started out with a goal of providing filters to just four schools as demonstration projects, and now that that's done and has been successful, we're working on scaling up," Maiyo said. "A filter in Kenya costs about $50 in materials, with labor and transportation as additional costs, but that filter will last five to 10 years, so the overall cost is very

low. We're open to partnering with a local manufacturer in Kenya or elsewhere who would be willing to do a trial run of parts manufacturing for 1,000 filters, which would be a huge step forward."

The company also is seeking support from people who would like to sponsor one or more schools, which would enable Maji Safi to install filters and provide clean drinking water to the students, teachers and community members.

Provided by Purdue University