

# PureMadi

The intersection of water, societal, & human health disciplines

## Our Mission:

To prevent waterborne diseases through educating, training, and empowering resource-limited communities to produce and distribute innovative point-of-use water treatment technology.

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*Clean Water is a Right for Everyone*  
and our passionate team is working to make that a reality.

### PureMadi Filters: What are they? Why do we need them?

In developed nations, high-quality drinking water is provided through centralized water-treatment/distribution systems. In less developed areas, centralized systems are often unreliable, or simply do not exist, resulting in 2 to 3 billion people not receiving reliable, high-quality water delivered to their households. In these instances, water is typically collected and stored within the household, often in open containers without any residual disinfectant. To address this, PureMadi teaches people in rural South Africa how to manufacture silver-ceramic water filters with local resources that provide safe drinking water.

*(Continued on page 4).*

### Filter Distribution Program Expands!

For the past few years, PureMadi has been distributing filters to primary and secondary school classrooms in relatively poor, rural communities. Without this effort, school children typically consume untreated water during the school day, which often results in repeated gastrointestinal infections. *(Continued on page 5).*



### PureMadi Faces a Pandemic

In March, PureMadi closed its doors and sent all workers home in response to the COVID-19 pandemic. Our thought at the time was that we would close down production for a few weeks and open back up once the risk subsided. Our reality was much different, and we have yet to welcome all workers back to the facility. *(Continued on page 6).*



## PureMadi Receives \$30,000 Donation



Susan Wells Sargeant, a long-time supporter of PureMadi, has donated \$30,000 to our organization. Ms. Sargeant has been aware of sustainable ceramic filtration technologies for almost 15 years, supporting early efforts by the Charlottesville-based Ixtatan Foundation and the University of Virginia to promote ceramic filter distribution in the Guatemalan Highlands. As a former nurse, she has consistently supported technologies and programs that improve human health, particularly for marginalized members of our society. Ms. Sargeant, along with her daughter, Holly, and family friend, Mary, visited our Dertig Facility in 2017, where they were warmly welcomed in song by PureMadi staff. Funds from her donation will be used to move PureMadi closer to financial sustainability by increasing commercial sales and expanding our programs to deliver filters to regional primary and secondary school classroom and old-age homes. We cannot thank her enough for her most recent donation and all her past support of our programs.



## Collaboration with the SEED Program

Student Entrepreneurs for Economic Development (SEED) is a student club at the University of Virginia that provides pro-bono consulting services. Essentially, we are helpers-for-hire. Every semester around ten project groups are formed. Past projects have included study abroad programs, refugee charities, and education-focused nonprofits.

A project group opens the semester with a call to their designated client to set up project goals and scope. At this stage, team members are able to ask the client about current events regarding their organization, and persisting or new challenges that have come up. Afterwards, the group creates a scoping document that outlines preliminary information on the client as well as the goals for the project. The second stage of a project is brainstorming and research. The team comes together to brainstorm potential solutions for a problem, and then sections off research areas to different team members. At the end of the semester, everyone comes back together and compiles everything into a final deliverable.

This fall, I had the pleasure of being the student team leader for the PureMadi group. The team consisted of Jake Hilbarger, Coleman Wise, Roshni Puli, Cynthia Song, and Bobby Yazdi. Together, we met with PureMadi President, Rebecca Kelly, back in October to learn about PureMadi's current ongoings and future plans.

The scope that we derived from the meeting was a focus on alternative fundraising strategies and educational outreach. Together as a team, we brainstormed various solutions and conducted research. Several of the areas that we pursued were partnerships with other Africa-focused nonprofits based in Virginia, international grants, educational outreach within the U.S., and social media marketing.

Overall, it was an invaluable experience getting work with PureMadi this semester. As someone who has been with SEED for several semesters now and have worked with PureMadi before in the past, I can honestly say that they are one of the most understanding and supportive organizations to work with.

Victoria Li (UVa Class 2023)  
SEED PureMadi Fall 2020 Project Team Leader



## Abiot Madiba: Night and Day Dedication

Meet Abiot Madiba, a filter maker and night watchman at the PureMadi Dertig Facility. Abiot started working for PureMadi in 2016 and is an invaluable member of our staff. He first served as our night watchman, spending each night at the facility to insure our equipment and filter inventory was secure. After some time, he gravitated to the filter-making process, and is now an expert in all aspects of the filter production process. Abiot is gregarious and loves to entertain the staff with his jokes. During his spare time, Abiot plays soccer and is part of a community team called Masters Football Club. He has two beautiful children whom he loves dearly. He is proud to be part of PureMadi and hopes the organization will continue assisting communities to have access to clean drinking water.

## Nkosi Ndebele Attains Her Master's Degree

Nkosi Ndebele, our Dertig Facility Manager, has attained her Master's degree and graduated with a distinction from the University of Venda for her research to evaluate a new silver application method for ceramic filters. Nkosi performed this work while continuing to work full-time for PureMadi and oversee all 10 filter workers and operations in Dertig. Nkosi's research is being reviewed for publication in the prestigious open access journal *Water*.

Silver is a powerful disinfectant for waterborne pathogens; however, there are a number of limitations to our current approach in its utilization. First, silver nanoparticles are not locally available in South Africa. As a result, they are difficult to obtain and require significant shipping and tariff costs. Second, silver nanoparticles are 3 to 10 times as expensive as silver in the form of silver nitrate. Third, silver nanoparticles often wash out of the filter, reducing their effectiveness and shortening filter lifespan. Finally, silver nanoparticles are potentially hazardous for filter workers to use, as they risk exposure to silver inhalation during the manufacturing process. Nkosi's research is the final step in evaluating a new silver application method for filters that avoids the above-mentioned problems while maintaining effective disinfection performance. Nkosi's method applies an aqueous solution of silver nitrate during the clay-sawdust mixing process (e.g. before firing versus the current application of painting silver nanoparticles post firing, see pg. 4 for manufacturing process of PureMadi filters).

With this new method, during the firing process, the ionic silver is reduced to metallic silver patches throughout the porous ceramic filter. The nitrate ions are converted to nitrogen gas and water vapor. Dr. Kathryn Nunnelley, from the University of Virginia, demonstrated this approach was effective in a laboratory setting. Nkosi demonstrated that filters produced in Dertig with this new method and used in real-world households also performed as well or better than the previous silver nanoparticle method. Silver levels in the effluent water were also significantly reduced, which likely increases a filter's lifespan. In the next year, PureMadi will decide if it will switch to this new method for all its filter manufacturing.

*PureMadi continues to be grateful for all the wonderful work by Nkosi!*



*It was an amazing two-year journey and I am grateful for the invaluable and generous counsel given by my supervisors Prof John Odiyo, Prof Jim Smith and Dr Joshua Edokpayi. I would like to express my thankfulness to PureMadi for awarding me an opportunity to be part of the organization, which enabled me to have a greater passion for point-of-use water treatment. I am also humbled by the kind assistance given by PureMadi Dertig staff and UVA students during filter production, sample collection and sample analysis. I appreciate the Dertig community members for their maximum cooperation throughout the study. My deepest appreciation goes to my family and friends for their love and encouragement. I believe that all goals are achievable and I am looking forward to enrolling for a PhD in the near future!*

- Nkosinobubelo  
Ndebele

## ...continued from page 1. **PureMadi Filters: What they are? Why we need them?**

The consumption of unsafe water leads to high rates of morbidity and mortality from water-related diseases. The WHO has indicated that one possible solution to this problem is to decentralize water treatment so that people treat their water right before they consume it in their homes (e.g. point-of-use water treatment). However, designing point-of-use water treatment technologies is a challenging design problem that requires the product to be technologically effective, simple to use, inexpensive, and socially acceptable. In response to this challenge, PureMadi designed an inexpensive point-of-use water filter with the potential to help billions of people throughout the world purify their drinking water, and thus prevent water-quality related disease and death. The infographic below provides details on how the PureMadi filters are manufactured and the mechanism by which they disinfect water.

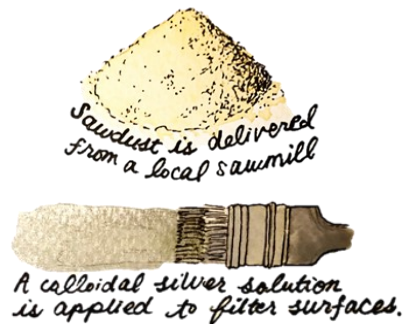
In addition to providing a household with safe water, PureMadi filters also provide a local economic stimulus. Workers who manufacture the filters are paid for their work in a community where unemployment exceeds 50%. In this regard, our PureMadi facility has the potential to be financially sustainable where revenue from filter sales will support the manufacturing and operational expenses.

### PureMadi Silver-Ceramic Water Filters

PureMadi uses a simple, yet effective method to manufacture ceramic water filters. Each filter effectively provides safe drinking water for a family of five for 2-3 years, and can remove up to 99.99% of bacteria from untreated water. Our methods use low-cost materials that are readily available and a manufacturing process that can be performed with local labor. This empowers local communities and helps minimize filter production costs and pricing.



### How are the PureMadi filters made?

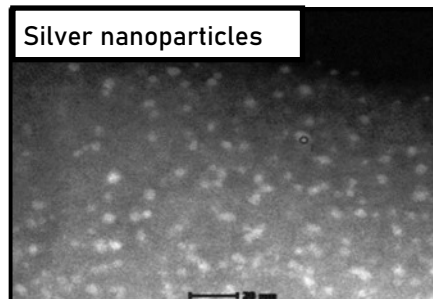


1. Clay from a local deposit is collected, dried, and grounded into a fine powder using a hammer mill.
2. Sawdust is delivered from a local sawmill. Like the clay, the sawdust is free and we only pay a modest delivery charge.
3. Clay, sawdust, and water are mixed together in a precise ratio. The mixture is pressed into the shape of a pot using a filter press. The press does not require electricity.

### How do the PureMadi filters work?



The air-dried filters are placed in a kiln and fired at 870 °C. The clay particles harden into ceramic and the sawdust combusts, leaving behind a pore space that will allow slow water percolation through the filter.



The filters are subjected to a pressure test and flow rate test to ensure quality. Filters that pass both tests are painted with a colloidal silver solution. Silver nanoparticles lodge into the filter pore space.

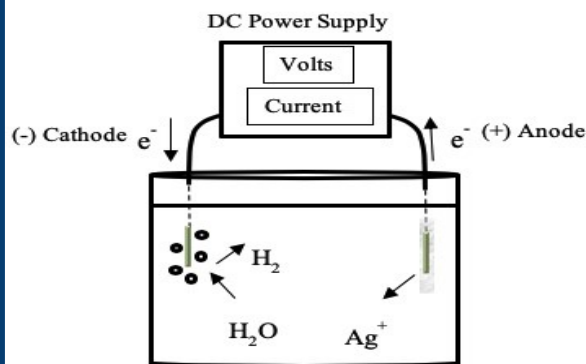


Turbidity and microbial pathogens are removed by physical filtration and chemical disinfection. Silver is a highly effective disinfectant for waterborne pathogens via 1) disruption of the membrane/cell wall, 2) inhibition of bacterial DNA replication, and 3) disruption of bacterial respiration.



## Latest Field Study in South Africa Testing New Water Treatment Device

Three Civil Engineering doctoral students (Courtney Hill, Sydney Turner, and Jamie Harris) traveled to South Africa in February and early March of 2020 to conduct a field investigation of an innovative new technology for point-of-use water treatment. With the help from Univen masters student Khuliso, the team conducted a field evaluation of an electrolytic water purifier in 30 households in rural South Africa. The purifier design, which was aided by work from a team of undergraduate students in Electrical Engineering at UVA (Kathryn Wason, Isaac Roberts, and J. You), is based on passing an electric current across silver wires, resulting in the release of silver ions into water. The results were encouraging, resulting in effective disinfection of household water with silver levels consistently below the 100- $\mu\text{g}/\text{L}$  drinking water standard. The student team has recently submitted a publication on this work to Environmental Science and Technology.



The figure on the left depicts the prototype electrolytic water purifier. The device floats in a water storage container and has silver-wire electrodes on the bottom that disinfect the water. The figure on the right is a schematic diagram of the electrolytic water purifier illustrating the electrochemical reaction that delivers silver ions to the water.



Field team members from left to right: Khuliso, Sydney, Jamie, and Courtney.



Membrane filtration is used to evaluate water quality samples taken from the field.



Delivery of filter donations at Are-Aganeng Old Age Home in Makapanstad, North West Province of South Africa.

...continued from page 1.

## Filter Distribution Program Expands!

During the Covid-19 pandemic, we had to suspend this program because most schools were not in session. However as restrictions in South Africa were lifted in late 2020, PureMadi was identified problem areas North West and Gauteng provinces of South Africa. In an effort to promote accessibility to clean drinking water, PureMadi has begun distributing ceramic water filters to disadvantaged residents of these communities. Old-age homes and orphanages in Hammanskraal and surrounding areas have received filter donations for water purification. These initial activities were highly successful and PureMadi plans to continue its effort in providing clean drinking water for communities in South Africa and beyond, as well as resuming our school programs in 2021.



...continued from page 1. **PureMadi Faces a Pandemic**



PureMadi remained dedicated to worker safety and decided early to consider employee comfort level in the decision-making process. In June, Nkosi Ndebele, PureMadi Dertig's Manager, created a Response Plan based on guidance from the South African government and the World Health Organization. PureMadi welcomed workers under age 60 back to the facility in July with revised operating guidelines. Since the filter production process is not conducive to social distancing, we took the opportunity to work on some quality audits and find other donation opportunities to continue our work in the local community safely.

This trying time has shown us how many things about which PureMadi has to be thankful. Our PureMadi team in the Dertig facility has remained healthy. All workers have been compliant with new policies and continue to communicate their needs and suggestions openly. Our donors have allowed us to continue paying all our workers their full salaries and extend filter donations to vulnerable populations. We look forward to the time in 2021 when we can safely welcome back the rest of our workers and get back to producing filters.



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[www.puremadi.org](http://www.puremadi.org)

*Your generous donation can help families and schools in South Africa have access to clean water.*