FilterPure Employs New Standards for Fabricating and Distributing CWF

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ABSTRACT

FilterPure is a new non-profit organization working primarily on facilitating the manufacture and distribution of effective and long lasting ceramic water filters in the developing world. FilterPure's priority is distributing high quality point of use ceramic water filters to people with the greatest need. FilterPure is identifying and addressing the problems of manufacturing and distribution in third world countries. FilterPure is working toward a standard for filter fabrication, thus making it possible to produce consistent quality filters across all projects. Several changes in processing have been integrated into the FilterPure manufacturing process, but one major change is in silver application. Rather than using the "paint on" or "submersion" methods of applying colloidal silver after the filter is fired, FilterPure is adding colloidal silver to the filter mix before it is formed and fired. This "fired in" method shows promising results for extending the life of the filter and minimizing post-filtration contamination.

FilterPure's commitment to quality is driving standards for filter fabrication and distribution. Standardization of raw materials, fabrication processes, and distribution methods can produce consistently high quality filters and successful community acceptance.

KEYWORDS Sustainability, sustainable enterprise, ceramic water filtration, FilterPure, AguaPure, silver application, follow up, monitoring, standardization

WHO IS FILTERPURE?

Around the world 1.2 billion people have no access to clean (purified) drinking water, most of whom are poor, and the result is an unacceptable level of water-borne disease, malnourishment and the resultant poverty. Given all of this as the ultimate challenge, FilterPure's goal is to develop and deliver a water purification solution that is specifically tailored to this large, economically-challenged population.


Figure 1 –FilterPure works where there is the most need and fewest resources.

To truly succeed on a global basis, economics must be kept central to our technology development, our strategy and ultimately our mission. An expensive solution deployed for a few thousand people is not FilterPure's ambition. Our solution, referred to as Point-of-Use Filtration (POU), involves a very flat, decentralized purification strategy capable of bringing modern sanitary standards to large numbers of impoverished people.

FilterPure is targeting a "low-cost" ($1/person/year), "high-quality" (meets WHO sanitary standards), "reliable" solution that can be deployed for billions of people throughout the world. We also aspire to make this effort "sustainable" by using local labor and indigenous materials thus generating self-fulfilling enterprise and employment. These are FilterPure's goals. FilterPure is a US 501(c)3 tax exempt organization.

FILTERPURE'S BACKGROUND

FilterPure began in the Dominican Republic in August 2006. Dominican Republic is a country with many needs and poorly guarded resources. Water-borne diseases are common and a serious problem. Between 2000 and 5000 cases of diarrheal disease in children under 5 years old are registered with doctors every week.

AguaPure, the Dominican Republic brand for FilterPure, was located at an existing pottery owned by a local man who had been working in the ceramics industry for more than 30 years. The project started with a well-known and commonly used ceramic filter design. However, within months after distribution AguaPure noticed a decline in the performance of the filters they were producing. Production and filter distribution were suspended, distributed filters were monitored, and AguaPure began evaluating the problem.

Working with David Webb, agent and consultant to Fairey Industrial Ceramics whose brand names "Doulton and British Berkefeld" are known for high quality drinking water in over 144 countries, AguaPure was able to incorporate scientifically proven methods of filter fabrication into the AguaPure design - a familiar, sustainable, third-world application. The result is an economical water filter that has a 99.9% effective microbe removal rate and has a recommended useful life of at least five years.

Table 1 – AguaPure filter performance - “paint on” silver application method

Water test	**AguaPure “paint on” Initial Test**	***AguaPure “paint on” after one month of use***
Total Coliforms <1.1 nmp/100 ml.	<1.1	**>2420**
Fecal Coliforms <1.1 nmp/100 ml.	<1.1	**2.0**
Identification of E.coli: Negativa/100 ml.	Negative	**Positive**
Identification of Pseudomona spp: Neg/100ml.	Negative	**Positive**
Clasification	**A**	**D**

FILTERPURE’S TECHNOLOGY

The technology of the FilterPure ceramic water filter is simple, effective, and, sustainable. A round-bottom ceramic pot is made from a mixture of clay, a combustible material, and colloidal silver. Any agricultural waste such as sawdust, rice husks, and/or coffee husks can serve as a combustible additive. After the clay and combustible have both been sieved through a fine mesh, they are mixed together with a measured amount of silver and water until a homogeneous mixture is formed. The mixture is then made into a filter using a filter press, and is kiln fired. During the firing process, the combustible material is burned out leaving micro pores coated with the silver to clean the water. During the firing process, about ½ inch of charcoal is produced within the filter which further improves the water.

When contaminated water is poured through the FilterPure ceramic water filter, it is purified in three ways:

1) A pore size of less than or equal to 1.3 microns filters out main contaminating particles: turbidity, parasites and bacteria.

2) Colloidal silver creates a hostile environment for bacteria, rendering it ineffective as it passes through.

3) One half inch of charcoal integrated into the core of the filter improves taste, odor, and color.

Figure 2 – Cutaway of filter showing charcoal integrated into the core

Figure 3 – AguaPure Filter and Ceramic Filter Inserts

DISCUSSION OF APPLYING SILVER BEFORE FIRING

"Firing in" the colloidal silver into the ceramic pot filter rather than using the "paint on" or "submersion" methods commonly used today, was the main change to the FilterPure filter. Silver is added during the mixing phase. It is mixed into the water before it is added to the clay to insure a more even distribution. More silver is needed per filter when applying the silver before firing. However, the small incremental cost appears to outweigh the benefits of extended life and improved sustainability. There are four main benefits to producing filters this way:

1) The silver does not wash out of the filter extending the filter's life indefinitely. Because silver melts at a lower temperature than the filters are fired, it binds or unites with the clay body preventing wash out. The current recommended life of the FilterPure filter is five years.

2) The silver in the filter will not oxidize. Using the "paint on" or "submersion" methods leaves the silver in the filter vulnerable to oxidization and significant reductions in filter effectiveness. When silver is applied prior to the firing process, it binds to the clay and becomes immune to oxidization from normal use.

3) The silver in the filter will not chemically react with chlorine present in treated water. Again, the silver binds to the clay preventing the chemical reaction and enabling the filter to be used with treated or untreated water.

4) A precise formula is used to determine the amount of silver to add to the clay. Once the correct amount of silver is added, the antibacterial effect activates. This seems to eliminate risks associated with improper application of the silver and lends itself to the idea of standardization. Precise amounts processed a specific way can be duplicated and can create the same high quality filter every time, and in any situation.

OTHER FINDINGS

Materials Processing

Meticulous processing of clay and sawdust to remove particles damaging to the filter's integrity is necessary. Clay processing begins in a hammer mill to pulverize the clay and release any large particles and impurities. It is then sifted through a fine mesh screen to filter out any remaining particles that can damage the structure of the filter. Making the clay particles homogenous and impurity-free allows the clay to bind into a single unit with a consistent pore structure and without any gaps or spaces that will allow for bacterial contamination. Any foreign material left in the clay, whether small rocks or leaf material, will cause a breach in the filter's structure because the clay will not bind to the foreign object and will leave a passage for microbes to pass through.

The sawdust is handled in a similar manner but using a different size mesh screen that corresponds to the less than 1.3 micron ceramic pore size needed for effective microbe removal. The sawdust is processed through the hammer mill and then sifted so that no larger particles of sawdust or foreign materials remain that can breach the integrity of the filter.

Figure 4 – Sifting materials through a fine mesh screen

Thorough Mixing

Thorough mixing of all the ingredients further insures a consistent pore structure for effective filtering. FilterPure uses a cement mixer for this process and discourages hand mixing of the ingredients. If complete mixing of the ingredients is not achieved, the sawdust and silver will not be evenly distributed throughout the filter leaving "pockets" of ineffective filtering in the filter itself. The pore sizes and spacing will vary throughout the filter and silver dispersion will be uneven. Taking time to insure a homogeneous mixture is used for filter fabrication is critical to the performance of the filter.

Figure 5 – Silver is mixed into the water to insure a homogenous mixture is attained

Final Silver Application before Transport

A final step to insure a fully functioning filter is delivered to the end user is to paint the filter with a colloidal silver solution before transporting. This protects the filter from contamination by impurities in the air during transport. This has become an issue in countries where the environment is often contaminated with agricultural and livestock by-products.

RESEARCH COMPLETED IN THE DOMINICAN REPUBLIC

FilterPure is committed to quality and has sought ways to improve and standardize the filter. Consistent and thorough testing by local and certified laboratories in the country is necessary. Choosing a laboratory or test facility is a top priority. In the Dominican Republic, the laboratory chosen has a proven record of consistently maintaining high standards. FilterPure has completed two years of testing: regular testing of the life of a filter under constant use and performing random testing in communities where filter programs exist.

Table 2 - FilterPure filter performance – "fire in" silver application method*

FilterPure Filter Performance Water Quality Results (4 filter sample size)					
	Week 1	Week 2	Week 3	Week 4	Week 5
Pre Filtration (Total Coliforms)	535.7	5140	4291.7	820	11567
Post Filtration (Total Coliforms)	0	0.3	1.0	10.6	7.8
% Reduction TC	**100**	**100**	**99.98**	**98.71**	**99.93**

Tests completed by Molly Klarman, Emory University student, who spent the summer of 2008 testing the efficacy of different filter variables.

Table 3 – FilterPure filter performance for 16 months.

		Jarabacoa water with FilterPure filtration after			
	Jarabacoa Water no fitration	**9** months	**11** months	**13** months	**16** months
E. Coli presence	present	absent	absent	absent	Absent
Fecal Coliforms	20.1	<1.1	<1.1	<1.1	0
Total Coliforms	222.4	<1.1	<1.1	<1.1	0

Tests initiated by Filter Pure and completed by Instituiciones Pecuarias Dominicanas S.A. and confirmed by government certified laboratories (DIGENOR)

FILTERPURE'S PROGRAM

FilterPure does not only facilitate the local and sustainable manufacturing of quality ceramic filters, it also invests in user acceptance by distributing the filters coupled with education and follow up. Education programs are offered either directly to the user or to participating NGOs with filter distribution programs. Education workshops teach about the water and how it affects health; basic hygiene and sanitation; and, the use and care of the filter. Follow up takes place a short time after the education session and allows users to ask questions, insures proper use and maintenance, and develops community relationships. Monitoring the users for about 8 weeks is ample time to achieve improved health which ultimately motivates continuous use of the filter. FilterPure has noticed that users educated in filter management and sanitation begin to educate their neighbors, who will adopt the filter and the hygiene and sanitation lessons for themselves.

Figure 6- Education and follow up are key components to successful user acceptance.

FILTERPURE'S SUCCESSES

Applying silver prior to firing the filter prevents silver wash out and oxidization, the risks associated with it, and extends the recommended life of the filter to 5 years.

Fabrication processes can be well-defined and, hence, standardized resulting in consistently high quality ceramic filters across FilterPure projects.

More than 10,000 filters have been distributed in the Dominican Republic positively affecting more than 70,000 lives.

In a study performed by Pontifica Universidad Catolica Madre Maestra (PUCMM) in Santiago, Dominican Republic, 100% of families using the filter noticed an improvement in their health.

Follow up visits show approximately 90% of distributed filters are still full and in use after one year.

Working in partnership with NGOs makes distribution, education and follow up more sustainable in the communities they work in.

Because of the user acceptance, interest from NGOs is increasing. Word of mouth is the primary impetus for adoption and wide-spread use.

Figure 7 – Tens of thousands of Dominicans are benefiting from using the FilterPure filter

FILTERPURE'S CHALLENGES

Quality Assurance- Product Standardization

Providing a high quality product and service is noble, but it does come at a cost. More effort, more materials, more accountability must be engineered into the FilterPure product and services. The extra time and effort to produce a higher quality product is one of the biggest debates within appropriate technology. FilterPure tries to balance standards of excellence with cost and sustainability for the developing world. FilterPure continually seeks out collaborative efforts to improve the quality of all aspects of ceramic water

filtration. Additional study in the area of length of life and reliability would help determine which efforts are clearly providing an advantage and help to further define a more reliable and economical standard for filters.

Distinguishing FilterPure filters from other filters on the market. One of the problems with lack of quality control standards in ceramics is that it is unknown whether different models are effective - and in developing country societies where quality is unknown of different filters, it is difficult to determine which to use or promote. It is important that customers can differentiate FilterPure filters copy cat versions that may not meet the quality standards necessary to ensure adequate filtration. Some copy cat versions may not even contain silver, a substance invisible to the end user. Those who are relying on our product to insure the health of their families should feel confident about purchasing FilterPure products.

Figure 8 – One approach to distinguish FiterPure filters from others filters on the market

Ongoing studies and testing by reputable institutions

Continue to partner with respected institutions to gain scientific knowledge of our products and objective information about our programs for the purpose of continuously improving the FilterPure technology and methods.

Resources to realize the FilterPure concept

FilterPure needs sponsorship and expertise to evolve the FilterPure concept into a working organization facilitating the wide-spread dissemination of effective and long lasting point of use ceramic water filters for home use. While we feel that the studies and investigation that we have achieved in these past years has produced a filter that shows amazing promise for the developing world in regards to appropriate technology, implementation will depend on collaboration.

FilterPure plans to produce comprehensive documentation that will explain “how to” create manufacturing and distribution projects. The factory installation manual will include topics like: what you need to know before you get started; examples of successful business

models; sample factory layouts; equipment schematics; how to make a FilterPure filter; testing and quality control procedures; and more. The distribution manual will include strategies for partnering with NGO's and organizations; how to educate the local population on use and care of the filter, water and its effect on health, and basic hygiene and sanitation; how to follow up with and monitor communities using the filter; and, alternative turn-key solutions for communities that might need water collection and/or other forms of filtration.

FilterPure also plans to provide access to quality on-site consultation and training, hard to find materials such as the colloidal silver and mesh screen used in the manufacturing process, and professionally developed sales and educational materials. We will continue to partner with institutions and organizations to complete research to improve the filter, as well as troubleshoot problems that may present themselves, and disseminate new knowledge to all FilterPure projects. FilterPure will act as an agent to raise awareness globally and to join potential supporters with potential projects.

PROPOSED FUTURE RESEARCH

Studies already conducted have shown that the FilterPure filters are a viable option to the technology commonly produced presently in projects around the world. However, only short term studies have been conducted and one of the major advantages of adding the silver before firing is the effect it has on the life of the filter. We believe the filter life can be extended to 5 years and maybe longer since the silver does not wash out of the clay body nor oxidize. Furthermore, we believe the health of the filter itself will be improved since bacteria will not grow where silver is present.

Another area for future testing is recontamination. Water passed through the filter and into the receptacle container is susceptible to recontamination if the container is not properly washed. Our studies have shown that, through the ongoing ionic effect of the silver present in the filter, keeping the filter in contact with the water has the potential to continue purifying the water, thereby reducing risk of recontamination.

FilterPure would like to participate in research to determine the effective useful life of the FilterPure filter and how it performs against other like filters.

PLANS FOR FILTER DISTRIBUTION

FilterPure has started a program in Tanzania, and is soon to release the filter there. A Tanzanian NGO has been established and their filter is in the test phase. Once the WHO targets are consistently achieved during filter production, the filter will be released and the programs of education and follow up implemented.

The FilterPure strategy is to facilitate the wide-spread implementation of local and sustainable enterprises that manufacture and distribute effective and long lasting point of

use ceramic water filters for home use. FilterPure plans to document programs based upon strategies of affordable water filtration, sustainable enterprise, and local education - a solution designed to be replicated worldwide. These programs are designed to allow others, whether individuals or organizations, to more easily install filter factories and distribution programs.

Figure 9 – Filter Distribution in the DR

CONCLUSION

FilterPure has a vision that addresses quality water filtration, sustainability, ease of implementation, and affordability for communities with a need for clean drinking water. Our emerging quality standards address consistency in manufacturing and can be put into place in future projects, and even improve the quality of existing projects. Our focus on education and follow up create successful programs that significantly improve the health and well being of those who lack access to clean water. Individuals and organizations who work with FilterPure to install clean water projects will have a more effective filter and a greater chance for successful sustainability.

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Kelsey (2008) averages.xls: Kelsey is a Lehigh student who looked at efficacy of the PFP filter (flat bottomed, silver before and after) with the FilterPure filter (round bottom, silver before) for five weeks.

M Klarman (2008) DR-project.xls : Molly Klarman is an Emory student who spent the summer of 2008 in the DR looking at the efficacy of different filter variables (bacterial reduction of different flow rates, burnables, etc.)