



Hydraid Biosand Water Filter – Proven Technology to Address the Global Water Crisis

According to United Nations reports, 4 billion cases of diarrhea occur each year in addition to millions of other cases of illness associated with lack of access to water that is safe for human consumption¹. In 2008, the World Health Organization (WHO) estimated that more than 2.2 million deaths of children per year could be prevented by reducing the diarrheal and malnutrition impacts related to unsafe water, inadequate sanitation or insufficient hygiene. For children under 15, this burden is greater than the combined impact of HIV/AIDS, malaria and tuberculosis. The UN report estimates there are nearly 900 million people receiving their water from an unimproved drinking water source. Where there is no improved water or infrastructure for sustainable water sanitization in homes or villages, there are few choices for people living in those conditions but to get their water from the same sources in which animals drink and defecate leading to water related diseases such as diarrhea, dysentery and cholera.

BioSand Technology

One of the world's most effective, sustainable and proven water purification methods, BioSand filtration technology significantly reduces the leading causes of disease and death in the developing world including diarrhea, skin and urinary tract infections. Through a combination of biological and mechanical processes, BioSand filtration makes unsafe water safe for family use. Users reduce contaminations using gravity alone by simply pouring surface or ground water through the filter to obtain water that is safe for drinking, food preparation, personal hygiene and sanitation. A typical system can treat up to 20 liters of water in about 30 minutes.

The technology is based on centuries old slow sand filtration technology and grew out of work conducted in Nicaragua in the early 1990's by Dr. David Manz of the University Of Calgary, Alberta, Canada² and a leading water expert. It is estimated there are more than 400,000 BioSand filters in more than 70 countries in Africa, Europe, Asia, North, Central and South America, the Caribbean and the South Pacific.³ Many of these BioSand filters are constructed of concrete requiring a mold and are generally constructed on site using local labor. Concrete filters are prone to breakage and production consistency issues. Capacity for cement production is generally one to two filters per day per mold, whereas plastic production is upwards of 980 filters per day per mold. The BioSand water filter technology has been extensively tested in laboratories at the University of North Carolina, University of Calgary, and elsewhere. The filters have consistently proven to be effective, reliable, and affordable. Health impact studies show improved quality with a 95% reduction of E. coli and 44% reduction in diarrheal disease.⁴

Based on several factors such as: sustainability, water quantity produced, ability to treat a range of water qualities, ease of operation, time to treat, cost per liter, and supply chain requirements Hydraid® BioSand Filter technology

¹ UN Progress on Sanitation and Drinking-Water: 2010 Update

² <http://www.manzwaterinfo.ca/fieldrpt.htm> (1/6/2011)

³ <http://www.manzwaterinfo.ca/> (1/6/2011)

⁴ Health Impact Study in Cambodia, 2007, Liang, K, Sosey, MD University of North Carolina

ranked best overall technology for the developing world by industry expert, Mark Sobsey of University of North Carolina.⁵

TABLE 3. Scoring of POU Treatment Technologies Based on Sustainability Criteria

technology	quantity	quality	ease of use	cost	supply chain	overall score
free chlorine	3	1	3	3 (liquid) 2(tablets)	1	11
coagulation/chlorination	2	3	1	1	1	8
SODIS	1	1	1	3	3	9
ceramic filters	2	3	2	3	2	12
biosand filters	3	3	2	2	3	13

Hydraid® BioSand Water Filter

The Triple Quest Hydraid® BioSand Water Filter is the same BioSand filtration technology developed by Dr. David Manz with a plastic vessel instead of a concrete one. This technology is dramatically more portable, scalable and low-cost compared to traditional concrete filters — a critical factor in scaling a project for rural and remote areas of the world. The Hydraid® filter incorporates the BioSand filter technology into a specially engineered plastic filter, making the unit easier to transport and distribute in the difficult terrain of the world’s most remote locations. The medical-grade plastic is FDA approved for drinking water, UV resistant and estimated to last beyond 10 years. There are estimated to be more than 50,000 plastic Hydraid® BioSand water filters in the field in a large variety of countries.⁶

- Height - .77m (30.5”), diameter - .42m (16.5”)
- Weight: Empty - 3.6kg (8 lbs.), Filled – 63.5kg (140 lbs.)
- No moving parts or parts to replace
- Intended Use: Point-of-use in homes
- Easy Installation: about 30 minutes (level and fill with sand)
- Power Source: Gravity (no electricity or plumbing required)
- Convenient: Operates on demand
- Filtering Capacity: 47 liters/hour
- Serves the needs of 8-10 people daily.
- Prep Time: Surface biological layer forms naturally in about 2 weeks
- Low Maintenance: cleaned in place by user, instructions provided

Alternative Technologies

Household water treatment options for rural villages without electricity and piped water range from boiling, sedimentation, combined coagulant-chlorine disinfection systems, SODIS-transparent polyethylene terephthalene (PET or PETE) bottles exposed to solar UV and heat, ceramic filters and BioSand filters. Other manufactures have introduced hollow fiber membrane filters, i.e. Sawyer filters, i.e. Tatas Swatch. Competitive BioSand filters assembled from local plastic vessels, PVC pipe, sand and gravel may have inconsistent performance. Furthermore, many of these products lack independent scientifically sound lab and field studies documenting their ability to

⁵ Environ. Sci. Tehcnol. 2008, 42, 4261-4267

⁶ Jim Gingrich, Business Unit Leader for Commercial Operations, Cascade Engineering, Inc.

improve water quality and reduce waterborne infectious disease in real world conditions. Accurate independent studies are available for the following technologies.

TABLE 2. Diarrheal Disease Reduction by POU Technologies in Controlled Studies⁷

Technology	Diarrheal disease reduction estimate (95% CI)*	Compliance (estimates of self-reported and/or measured % user compliance)
SODIS (solar UV radiation + thermal effects)	31% (26%-37%) (5)a	78% compliance during study (24); however, post study compliance rates may drop as low as 9% (25)
Free chlorine and safe storage	37% (25%-48%) (5)	60-73% of households were self-reported users, but only approximately 30-40% of those who reported use had detectable free chlorine levels (27-29)
Coagulation/chlorination, i.e. Water Maker, PuR	31% (18%-42%) (5)	usage rates may drop to as low as 10% after intervention ends (30)
Ceramic filtration through candle filters	63% (51%-72%) (50)	High until filter breaks; in a trial in Bolivia, compliance was 88% over 6 months (3)
Ceramic filtration through ceramic water purifiers	46% (29%-59%) (9)	dependent on filter breakage rates, (,10)
BioSand filtration	47% (21%-64%) (32)	85% post-implementation (33, 34)

* * Summary estimates stratified by type of intervention (from a meta-analysis of drinking water quality interventions and diarrheal disease reductions. Summary estimate from meta-analysis on POU chlorination (includes both free chlorine disinfection and combined coagulation-disinfection).

Multiple Health Impact Studies

Health impact studies have long been used to judge the health impact of various technologies and investments in water, sanitation and hygiene interventions. Independent and scientifically sound studies generally are accepted as an evaluation tool in the context of understanding the interconnected necessity of water, sanitation and hygiene for health and development. Two health impact studies have been performed and published on the BioSand Filter technology in concrete. In 2008, 3 health impact studies were performed specifically on the plastic HydrAid[®] BioSand Water Filter with 81 filters installed in Cambodian households, 89 in Honduran households and 115 in

⁷ Environ. Sci. Technol. 2008, 42, 4261-4267

Ghanaian households showed the following results for E coli reduction.⁸ Results have been published in abstracts and all three health impact studies are currently in the peer review process.

Location	# of plastic BSFs installed	Date of installation	Geometric mean reduction <i>E. coli</i> direct from BSF outlet (N)*	Geometric mean reduction <i>E. coli</i> from BSF stored and treated (N)+
Cambodia	81	7/2008	92% (533)	89% (503)
Ghana	115	9/2008	97% (401)	85% (398)
Honduras	89	8/2008	62% (738)	46% (729)

Health impact studies in and of themselves and especially when presented outside the context of the necessity of sanitation and hygiene are not universally accepted. This may be the case when the studies are commissioned by the product founders or when the studies measure only diarrhea illness and not other water related measurable outcomes. Other contributing factors are individuals have different infectious dose thresholds, water related pathogens have different infectious doses and there are multiple contamination pathways for pathogens other than water.

Conclusion

The World Health Organization recommends household water treatment as an effective and affordable solution to waterborne disease. The Hydraid® BioSand Water Filter is founded on proven technology, is simple, lightweight household point of use filter powered by gravity. The Hydraid® filter is extremely durable, has no parts to replace and last beyond 10 years making it the most sustainable filter available today that reduces parasites, bacteria and viruses found in contaminated water. The filter is improving the health and lives of families using it, as a part of an overall program of hygiene and sanitation. Working together with many different organizations, each with their own approach and sphere of influence can bring filters to families, save lives and lift people out of poverty.

Triple Quest

Triple Quest is one of the Cascade Engineering Family of Companies. Cascade Engineering is a multi-business manufacturer and marketer with over 30 years experience and expertise in large part injection molding to the automotive, solid waste & recycling, furniture, material handling and renewable energy markets. Cascade Engineering focuses on making a positive impact on society, the environment and being financially successful. Triple Quest is a social enterprise business unit focused on sustainable development and enterprise. Triple Quest holds the only U.S. license to manufacture and market the commercial version of the patented Hydraid® BioSand Water Filter technology. Additional information is available at our website www.hydraid.org or by calling 616.254.4114.

⁸ Field performance of the plastic biosand filter in Cambodia, Ghana and Honduras. C.E. Stauber, E. Printy, A.m. Fabiszewski, C.C. Kominek, A.R. Walters, K.R. Liang, and M.D. Sobsey, Georgia State University, Institute of Public Health, Atlanta, GA 30302, University of North Carolina, Dept. of Environmental Sciences and Engineering, Chapel Hill, NC

Other Studies

See Appendix A for a listing of additional studies that have been performed on the BioSand filter technology.

Appendix A

1. Sobsey, Mark D., Christine E. Stauber, Lisa M. Casanova, Joseph M. Brown and Mark A. Elliott. "Point of Use Household Drinking Water Filtration: A Practical, Effective Solution for Providing Sustained Access to Safe Drinking Water in the Developing World." Environmental Science & Technology 2008, 4262-4267
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3. Stauber, Christine E., Gloria M. Ortiz, Dana P. Loomis and Mark D. Sobsey. "A Randomized Controlled Trial of the Concrete Biosand Filter and Its Impact on Diarrheal Disease in Bonao, Dominican Republic." American Journal of Tropical Medicine Hygiene 80(2), 2009, pp 286-293
4. Elliott, Mark A., C.E. Stauber, F. Koksai, F.A. DiGiano, M. D. Sobsey. "Reductions of E. coli, echovirus type 12 and bacteriophages in an intermittently operated household-scale slow sand filter." Water Research 42 2008, 2662-2670
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8. Pokhrel, Damodar, Thiruvengkatachari Viraraghaven, F.ASCE² and Larry Braul. "Evaluation of Treatment Systems for the Removal of Arsenic from Groundwater." Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management July 2005

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10. Fabiszewski, Anna M., Christine E. Stauber, Adam R. Walters, Rony E. Meza Sanchez and Mark D. Sobsey. "A Randomized Controlled Trial of the Plastic-Housing BioSand Filter and its Impact on Diarrheal Disease in Copan, Honduras." 2011 DRAFT
11. Stauber, C.E., E.R. Printy, K.R. Liang and M.D. Sobsey. "A Randomized Controlled Trial of the Plastic-Housing BioSand Filter in Cambodia in 2008." 2011 DRAFT
12. Elliott, Dr. Mark. "The HydrAid® BioSand Drinking Water Filter." Gillings School of Global Public Health, The University of North Carolina at Chapel Hill
13. MacDonald, Laura, Bill Ball, Erica Schoenberger. "Aid Efficacy for Point-of Use Water Treatment: Following Interventions from Origin through Implementation to Evaluation." Johns Hopkins University
14. Stauber, C.E. Stauber, E. Printy, A.M. Fabiszewski, B.C. Kominek, A.R. Walters, K.R. Liang and M.D. Sobsey. "Field performance of the plastic biosand filter in Cambodia, Ghana and Honduras." 2011 Abstract 2009

15. Conrad, Kenneth, Roy Keunnen and Anne Hoyt. "Evaluation of Enhanced Pre and Post Treatment Technologies for BioSand Water Filters" Access Business Group Health Impact Studies
 16. Stauber, Christine, Anna Fabiszewski, Erin Printy, Byron Kominek, Adam Walters, Kaida-may Liang, Mark Sobsey. "Randomized Controlled Trials of a Plastic Housing Biosand Filter in Cambodia, Ghana and Honduras" Georgia State University and University of North Carolina. Submission to American Society of Tropical Medicine and Hygiene November 21, 2009.
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 18. Chuang, Patty, Mark Elliott, O.D. Simmons III and Mark D. Sobsey. "Bench-scale investigation of Biosand Filter Performance against a Surrogate for Protozoan Parasites." 2011 Abstract, Department of Environmental Science and Engineering, Gillings School of Global Public Health, The University of North Carolina at Chapel Hill
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 22. Manz, P. Eng., Dr. David H. "BSF Community Scale Drinking Water Supply Station V 1.0 Using Concrete Ring and Base Construction." July 22, 2005
 23. Manz, P. Eng., Dr. David H. "Guidelines Preparation of Media for the BioSand Water Filter, 'When there is no crushed rock!'" April 30, 2007
 24. BioSand Water Filter Removal, Treatment Capabilities and Specific Accreditation and Regulatory Approvals
 25. Manz, David H., Byron Buzunis and Carlos Morales. "Final Report Nicaragua Household Water Supply and Testing Project." December 1993
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International Certified Lab Results

32. Certified Lab Results commissioned by Fundación Hondureña de Investigación Agrícola: "Laboratorio Químico Agrícola, INFORME DE RESULTADOS DE ENSAYO." San Pedro Sula, Honduras. May 27, 2010.
33. Certified Lab Results commissioned by Mr. Vinod Ready. "Care Labs - AP Government Registered No. 2461/05" Erramanjil, Hyderabad, India. October 29, 2010.

World Health Organization

34. Clasen, JD, PhD, Thomas F., "Scaling Up Household Water Treatment Among Low-Income Populations." Public Health and Environment-Water, Sanitation, Hygiene and Health-World Health Organization Geneva 2009