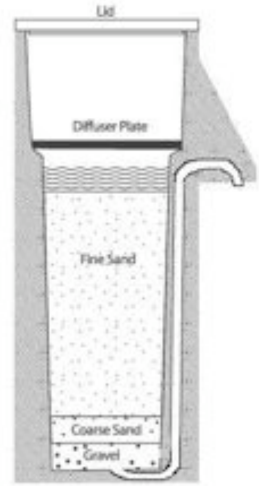
Household Water Treatment Options in Developing Countries: Slow Sand Filtration

Five household water treatment and safe storage (HWTS) intervention options – chlorination, solar disinfection, ceramic filtration, slow sand filtration, and flocculation/disinfection – are proven to improve microbiological quality of stored household water and reduce diarrheal disease in developing countries. Organizations that wish to develop HWTS programs are often faced with the difficult decision of selecting which option or options are appropriate for their particular circumstances, and how to choose between proven and unproven options. The most appropriate HWTS option for a location depends on existing water and sanitation conditions, water quality, cultural acceptability, implementation feasibility, availability of HWTS technologies, and other local conditions. This series of fact sheets is designed to assist organizations in comparing, and ultimately selecting, the appropriate HWTS option or options. For more information on household water treatment, please visit www.who.int/household_water. For more information on BioSand Filtration, please visit www.manzwaterinfo.ca, www.cawst.org, or www.bushproof.org.

Slow Sand Filtration

The Slow Sand Filter (SSF) is a sand filter adapted for household use. Please note that although commonly referred to as the BioSand Filter (BSF), the BSF terminology is trademarked to one particular design, and this fact sheet encompasses all SSFs. The version of the SSF most widely implemented consists of layers of sand and gravel in a concrete or plastic container approximately 0.9 meters tall, and 0.3 meters square. The water level is maintained to 5-6 cm above the sand layer by setting the height of the outlet pipe. This shallow water layer allows a bioactive layer ("schmutzdecke") to grow on top of the sand, which contributes to the reduction of disease-causing organisms. A diffuser plate is used to prevent disruption of the biolayer when water is added. To use the SSF, users simply pour water into the SSF, and collect finished water out of the outlet pipe into a bucket. Over time, especially if source water is turbid, the flow rate can decrease. Users can maintain flow rate by cleaning the filter by agitating the top level of sand, or by pre-treating turbid water before filtration.



Slow Sand Filter Schematic (CAWST, www.cawst.org)

Lab Effectiveness, Field Effectiveness, and Health Impact

SSF lab effectiveness studies with a mature biolayer have shown 99.98% protozoal, 90-99% bacterial, and variable viral reduction. Field effectiveness studies have documented *E. coli* removal rates of 80-98%. Two health impact studies report 44-47% reduction of diarrheal disease incidence in users. Experience has shown proper filter maintenance is necessary for optimal performance so proper user training and follow-up is critical to filter success. Since the SSF is typically used without subsequent chlorination, training users to properly care for and maintain the safe storage container is necessary.

Benefits, Drawbacks, and Appropriateness

The benefits of Slow Sand Filtration are:

- Proven removal of protozoa and the majority of bacteria;
- Acceptability to users because of high flow rate (up to 0.6 Liters/min), ease-of-use, and visual improvement (turbidity reduction) in the water;
- Production of sufficient quantities of water for all household uses;
- Local production (if cleaned, appropriate sand is available);
- One-time installation with low maintenance requirements; and,
- Long life (estimated >10 years) with no recurrent expenses.

The drawbacks of Slow Sand Filtration are:

- Low removal of viruses;
- Recontamination of water can occur if treated water is stored unsafely due to lack of residual protection;
- Routine cleaning requires agitating the top level of sand, which harms the schmutzdecke and decreases filter effectiveness; and,
- The difficulty in transporting a 100-350 pound item and the high initial cost make large scale implementation more challenging.

SSF is most appropriate in areas where there is external funding to subsidize the initial filter cost, education for users to correctly use and maintain the filter, locally-available sand, and a transportation network able to move the filter.

The locally-made Pure Water for the World concrete SSF design (Pure Water for the World)

The locally-made Pure Water for the World plastic SSF design (Pure Water for the World)

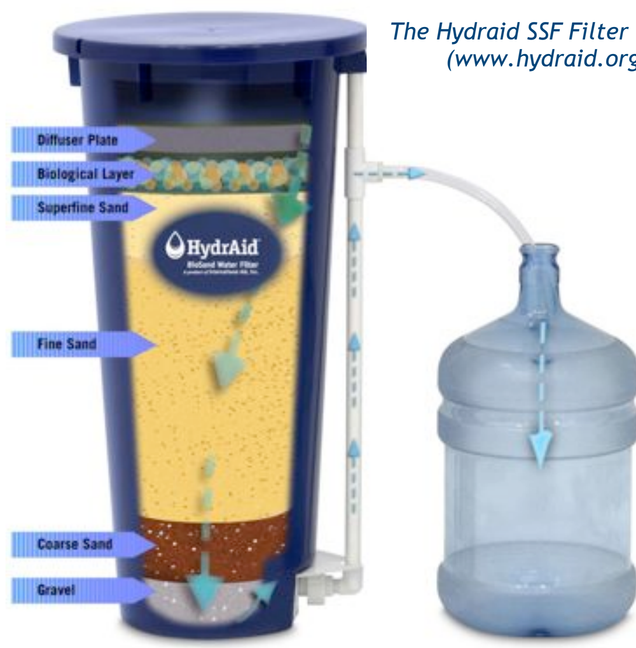
Implementation Examples

Initially, the BSF was designed by Dr. David Manz and his students at the University of Calgary (www.manzwaterinfo.ca). This and related versions of the SSF have been implemented using a variety of different strategies, including:

- Samaritan's Purse (SP) is a non-governmental organization (NGO) that implements the BSF through their Household Water Program (HWP). SP implements the BSF through providing managerial and technical assistance as well as project funding to field partners. Since 1998, SP has assisted in establishing BSF projects in 24 countries. As of April 2010, over 116,000 BSFs have been installed worldwide. SPs largest partner, Hagar International, is operating in rural Cambodia installing 15,000 BSFs per year. Hagar holds informational meetings for potential BSF users, and attendees interested in receiving a BSF are invited to a second training meeting, where they: sign up to receive a BSF; are asked to contribute a small amount to their ownership of the BSF (about $4); attend group trainings on use of the BSF and hygiene; and, send one family member to assist with the construction and transportation of the BSF. Samaritan's Purse has developed an implementation manual and has technical support staff to assist BSF projects across the world. www.samaritanspurse.ca/ourwork/water
- Recently, Dr. Manz has licensed the plastic version of the BSF to the NGO Hydraid. They manufacture the plastic containers in Michigan and Honduras, and work with local implementing organizations to import the plastic containers, create the sand filter, and educate users. Pure Water for the World (PWW) is another NGO working with a different plastic container SSF model, made locally using rotational molding in Haiti and Honduras. PWW works with local implementing organizations as well. www.hydraid.org, www.purewaterfortheworld.com
- There are several training centers that promote the SSF. The NGOs Centre for Affordable Water and Sanitation Technology (CAWST) and BushProof both offer training, implementation manuals, and assistance to organizations interested in starting SSF programs. www.cawst.org, www.bushproof.org

Economics and Scalability

The average SSF construction cost ranges from 15-60 USD, depending on whether local or imported materials are used. SSF programs are either fully subsidized or operated at partial cost recovery (with users paying 2-10 USD) using donor funds. Community motivation, distribution, education, and follow-up can add significantly to program costs. For Samaritan's Purse (SP), the average overall cost is about 100 USD per BSF. Assuming the SP BSF lasts 10 years and families filter 40 liters per day, the cost per liter of treated water is 0.068 US cents. Some NGOs have worked to train local entrepreneurs to manufacturer, promote, and sell the SSF within their communities, although this has met with limited success due to high initial filter expense and difficulty in identifying appropriate local entrepreneurs. Commercial implementation models are currently being explored.



The Hydraid SSF Filter Design (www.hydraid.org)