



Global Water's Technology Push Program

Introduction

Generally, our water, sanitation and hygiene related projects utilize simple systems, which use local materials, require minimal servicing and therefore create more sustainable projects. These simple solutions often times makes it possible to work in rural areas and easier for the communities themselves to maintain the facilities, thereby extending the vitality of these systems.

However, there are technologies that Global Water works with in the Technology Push Program that makes effective use of state of the art technology to solve water quality issues. This program is focused on developing and providing filtration and disinfection equipment that's effective and maintainable in a remote, developing world environment. Through the success of this program, we wish is to expand our outreach to other countries we work in. This program has the potential to become a major resource that could support disinfection of water in rural villages around the world.

Background

Most water treatment technologies are not available routinely in developing countries, especially in rural areas. This is because there is not enough money available in rural communities of developing countries to purchase water technology and typically there is no one with the expertise to implement water equipment (either in the developing country itself, or in international aid organization staff working in developing countries). Even if water equipment could be purchased, rural inhabitants would not know how to install, operate and maintain that equipment. Global Water is fully aware of the fact that the international aid community has contributed to unsustainable practices, where equipment was brought to a developing country by some well-meaning group (who left soon after installation) only to have it break-down shortly after it was installed and sits inoperable thereafter. We are very sensitive to this reality, but plan to overcome this challenge. Global Water has the technical expertise and connections with local water-advocacy groups to provide water supply equipment to developing countries in order to "push" technology where it is needed and help people live more healthy and productive lives.

Disinfection

A complete water supply system consists of a water supply intake, treatment, storage and distribution. Water treatment stages used often in developing countries include sand filtration (such as the Biosand unit) and the SODIS system (a batch solar UV technology). These treatment technologies will reduce the number of disease-causing organisms in water, but will not leave it completely free of such organisms. Disinfection, when applied and controlled properly, is the most practical and effective means of removing and/or inactivating disease-causing organisms. It is disease-causing microorganisms (bacteria, virus and protozoa) that create life-threatening diarrhea diseases largely responsible for the death of children under the age of 5 years old throughout the developing world. Therefore, Global Water believes that

disinfection of drinking water holds the highest priority for any water supply technology to be implemented in a developing country.

Appropriate Technology

For many decades and continuing today, the level of technology that is thought usable by developing countries is technology readily maintained by the local population with logistic re- supply items procured locally, as well. That generally means using equipment made from locally available materials that can be repaired by local craftsmen. This is called appropriate technology and it works very well since it is fine-tuned to a local area, its people and its craftsmen's capabilities. It is a low-risk approach that increases the chance of a project to succeed in a remote location when the implementer (organization that installed the equipment) plans to leave the area after installation and does not plan to have contact with the equipment thereafter. Simply put, this approach reduces the risk of failure.

And there have been numerous cases of equipment failures in developing countries. Although most of the failures associated with using equipment-oriented technologies in developing countries were not in the water supply area per se, we must learn from these failures so as not to perpetuate the same mistakes. In each case, the reasons for failure were inherent in the project itself and include:

- Improper equipment;
- No local person or entity responsible for equipment;
- Personnel not properly trained to start;
- No follow-on training or training documents for new personnel;
- Inadequate logistical re-supply; or
- A combination of the above.

In the area of water supply and purification, appropriate technology can dig shallow wells and capture natural springs, provide filtration of turbidity and reduce levels of microorganisms with sand media filters, and can store water using ferro-cement and mason block tanks.

What it typically cannot do is effectively treat a severely microbiologically-contaminated or polluted water source to drinking water quality, or dig water wells beyond modest depths, or store and distribute water in a disinfected condition. However, the technology to do these tasks does exist outside of the appropriate technology arena and state-of-the-art technology can be harnessed to develop drinking water supplies that far exceed appropriate technology capabilities and expectations. What has been lacking in the past and what is needed to implement technologies above the basic "appropriate" level is for the implementing organization to maintain a relationship with the equipment being installed and those who are using/controlling the equipment. In other words, a long-term approach to equipment projects is necessary in developing countries and has been the missing link preventing success up until recently.

Objectives

Global Water has initiated a two-stage project to make selected water treatment technologies more readily available in developing countries. The objective of the first stage is to create a clearinghouse data base of disinfection technologies that is applicable to the developing world; this data base will describe the technology and its associated equipment in detail with its capabilities, limitations and cost. In order to create this data base, Global Water will evaluate technologies under semi-field conditions to ascertain their operational characteristics and capability to inactivate, kill or remove

microorganisms. The objective of the project's second stage is to implement those disinfection technologies that prove to be most useful for application in developing countries during the project's first stage. Technology implementation will be through water advocacy community-based organizations for implementation with support from Global Water.

This project has the potential to create a clearinghouse of disinfection technology data that will be useful for many NGOs all around the world. The database will include all the information needed by organizations wanting to implement water treatment technologies to prevent microorganism-related diseases. It is anticipated that the Global Water website will be the primary repository of this data, but other means of information dissemination will be implemented, as well.

Here is a description of the disinfection technologies to be evaluated during the first stage of this project. During the second stage, some of these technologies will be made available through Global Water to local, water advocacy organizations in developing countries:

Batch Disinfectant

This technology is designed to kill microorganisms in a container of water (commonly known as a "batch" mode since each container contents is disinfected separately). There are a variety of batch addition technologies available today for developing countries that include: Proctor & Gamble PUR sachets that allow a 10 Liter quantity (2.6 gallons) of high-turbidity water to be disinfected using a ferric sulfate coagulant and a chlorine-based disinfectant; Aquatabs, a chlorine-based disinfectant tablet that will disinfect several different quantities of low-turbidity water; and Silverdyne, a colloidal silver-based mineral additive that will disinfect several different quantities of high or low turbidity water. Water Production: This technology has been created usually for relatively small quantities of water in a container at the point of use, often in the 4-10 Liters size range. However, Aquatabs come in several different tablet sizes that will accommodate quantities up to 1,000 Liters of water; also, Silverdyne can be used with a wide range of water quantities with the ratio of 1-3 drops of Silverdyne per 2-liters of water. Water to be disinfected must be placed in a container or tank. Limitations: The PUR sachets and Silverdyne additive can accommodate high-turbidity water, but Aquatabs should only be used with a low-turbidity water source. The PUR and Aquatabs are packaged for one batch quantities; multiple packages are used for larger quantities of water; Silverdyne is a liquid and comes in a bottle so it can accommodate different quantities of water from its original packaging.

Photochemical - Enhanced Solar Bottle System (Optimized SODIS System)

This technology is designed to kill microorganisms (bacteria, virus and protozoa) by use of solar UV and solar heating inside 2-liter plastic "soda" bottles (or similar containers) available locally. The Solar Water Disinfection (SODIS) technology was developed by the Swiss Federal Institute for Environmental Science and Technology to provide small "batch" amounts of disinfected drinking water to individuals and families in developing countries. The original SODIS system uses 2-liter P.E.T. plastic soda bottles that are partially filled with water, shaken to entrain oxygen and placed in the sun for a period of approximately 6 hours. While sitting in the sun, water inside the bottle is treated by the ultraviolet (UV) rays that travel through the P.E.T. plastic containers and the water experiences heating, as well. This combination of UV and heating has proven to disinfect water to varying degrees in each bottle. However, testing of SODIS-treated water containing bacteria has shown that bacteria can reactivate and multiply after a period of time and continue to grow making the SODIS concept marginally effective if the treated water is not consumed within a certain period of time. It should be noted that this limitation is common for UV systems since UV light does not kill microorganisms, per se, but rather disrupts a microorganism's ability to reproduce quickly. If a treated water is not consumed, eventually, some microorganisms can mutate into new forms that can reproduce again. Since the concept is so simple, the SODIS has received a lot of notoriety and is being implemented by the Peace Corps and several international aid organizations. One

of these devices can disinfect 1.5 liters (0.4 Gallons) per bottle of water daily. Multiple bottles are used for higher quantities with a quantity of 4-6 bottles typical at an installation.

Bottles must be placed in sun without anything shading the location during the day; ideally, the device will be installed facing south at a 45 degree angle; if possible, on top of a roof or similar structure; no electricity necessary. Limitations: The sun; on cloudy days this device may not work effectively, as UV and solar heating will be reduced accordingly. However, a photochemical UV catalyst should allow disinfection to occur even on cloudy days more effectively than the original SODIS system; this capability must be determined during a first stage evaluation. Being a batch mode concept utilizing 2-Liter plastic "soda" bottles, water production is modest and only suitable for an individual or family.

Solar Pasteurization

This technology is designed to kill microorganisms (bacteria, virus and protozoa) by use of solar heating creating pasteurization temperatures inside a solar heating device. One example, the SunRay 1000 unit is marketed by Safe Water Systems to developing countries and other remote areas without electricity. It resembles a solar hot water heater that is placed on a roof of a house. When the assembly is placed in the sun, the heating chamber is designed to allow pasteurization temperatures (about 160 degrees F / 70 degrees C) to occur inside the device. Pasteurization is a very established disinfection technique that has potential to provide consistent disinfection results using only solar heating. One of these devices can disinfect 1,000 liters (264 Gallons) per sunny day. Multiple heating chambers could be used for higher quantities at an installation. The heating chamber must be placed in sun without anything shading the location during the day; ideally, the device will be installed facing south at a 45 degree angle; if possible, on top of a roof or similar structure; no electricity necessary. Limitations include the sun; on cloudy days this device may not work effectively, as solar heating will be reduced accordingly. However, disinfection may occur even on cloudy days; this capability must be determined during a first stage evaluation. This is a batch mode concept with the capability to produce enough drinking, cooking and bathing water for multiple families.

Disinfectant Resin

This unit is designed to kill microorganisms (bacteria and virus) in a flow of water inside a pipe. It uses a resin media that can be rejuvenated with liquid chlorine bleach available in developing countries. As an alternative, a similar resin is available that is rejuvenated with a liquid bromine solution. Chlorine is the chemical disinfectant of choice in the US and many other developed countries in the world. For large installations, chlorine is administered by means of a liquid or gas. In addition, devices exist that use solid tablets for small flows. This technology uses a new solid resin media that contains a chlorinated compound that kills microorganisms upon contact (as water flows through the media) and places a very small residual of free chlorine into the water, as well. When the media is spent, it can be rejuvenated on site by flowing liquid bleach (with a reduced pH) over the media. Liquid bleach is available in all developing countries because of its use in laundry applications so it is available virtually everywhere. This device must be used with a piped supply of water.

This device can accommodate virtually any flow rate depending upon the size of the resin housing used and consequently the quantity of resin installed. The rate of chlorine contact is automatically adjusted as flow varies through the housing. The true capability of this technology must be determined during a first stage evaluation. Water to be disinfected must flow in a pipe; no electricity is necessary. Limitations include the necessity for liquid bleach or tablets to be used to rejuvenate resin periodically (or continuously) and must be procured locally; this capability must be determined during a first stage evaluation. A simple chlorine testing device will be supplied with each dispenser; also, carbon cartridges are available to remove the taste of chlorine at the point of use, if necessary.

Liquid Chlorine Bleach Injection

This unit is designed to kill microorganisms (bacteria and virus) in a flow of water inside a pipe. It uses common liquid chlorine bleach available in developing countries as laundry bleach. With this device, chlorine is injected as a liquid directly into a piped flow of water. The device Global Water is interested in use no electricity as they use the flow of water through the device, itself, to inject a liquid solution into a pressurized flow of water. Also, these devices have a self-correcting capability in that they inject more solution as flow through the device increases (and less solution as flow decreases through the device). Liquid bleach is available in all developing countries because of its use in laundry applications so it is available virtually everywhere. This device must be used with a piped supply of water. This device can accommodate virtually any flow rate although each device is rated at a particular range of flows.

Water to be disinfected must flow in a pipe; no electricity is necessary. Limitations include the necessity for liquid bleach to be procured locally and mixed with water to create the disinfecting solution. A simple chlorine testing device will be supplied with each dispenser; also, carbon cartridges are available to remove the taste of chlorine at the point of use, if necessary.

Chlorine Tablet Dispenser

This unit is designed to kill microorganisms (bacteria and virus) by use of dissolving chlorine tablets in an un-pressurized flow of water through the device. These are chlorine dispensers that allow chlorine tablets to dissolve in a flow of water; this releases free chlorine to kill microorganisms as water flows through the dispenser. Most of these devices are designed to be used in a non-pressurized water flow, such as on the inlet of a water tank. However, there are some chlorine dispenser designs that allow tablets to be used in a pressurized pipe flow, as well. The device Global Water envisions utilizes a clear, plastic housing that can be used in an un-pressurized flow of water, especially useful as water cascades into the top of a tank. Clear plastic will allow operators to easily observe when tablets must be replaced. Tablets that are very slow dissolving will be tested for this device to maximize longevity of consumables. This device must be used with a piped supply of water. This type of device has historically been the most simple device available to disinfect a piped flow of water. This device can accommodate virtually any flow rate since more tablets can be placed inside the chlorine dispenser if need be; however there is a practical limit as the re-supply of tablets becomes a logistical challenge. Water to be disinfected must flow in a pipe; no electricity is necessary; typical installation is just before water cascades into a storage tank. Limitations include the necessity for tablets to be replaced routinely; therefore a periodic supply of chlorine tablets is necessary. A simple chlorine testing device will be supplied with each dispenser; also, carbon cartridges are available to remove the taste of chlorine at the point of use, if necessary.

Filter Systems

Filters are designed to physically remove microorganisms (bacteria, virus and/or protozoa). There are a wide variety of filters that can accomplish physical removal; the types that Global Water plans to investigate includes the following: 1) a small slow-sand filter (or Biosand filter), 2) a microfiltration (MF) or ultrafiltration (UF) membrane module, and 3) an electrostatic filter. These filters are all very different from one another and deserve individual testing and evaluation. The Biosand filter relies on a layer of biological activity to consume additional microorganisms as they penetrate the layer with contaminated water flowing through the filter. The MF or UF membrane has holes (or pores) small enough to restrict passage of microorganisms while allowing water to flow freely through the membrane structure. The electrostatic filter uses positively-charged media to “grab” microorganisms (negatively-charged) and hold them indefinitely in its media matrix. A UF membrane acts as a barrier to microorganisms and can effectively remove all microorganisms using only gravity-induced pressure. Membranes similar to the one that will be evaluated are now being commercially used for

municipal water and wastewater treatment specifically to remove microorganisms. This type of device has the potential to be a very simple device to disinfect water either in a pipe flow of water or in batch mode. A positively-charged filter also has the capability to filter microorganisms from a flow of water; these devices take the form of a 10-inch to 20-inch long cartridge filter. A Biosand filter is very small slow-sand filter (about 0.10 gallons per minute per square foot of filter surface area) that has media kept submerged at all times in order to develop a layer of biological activity; this active layer contains microorganisms that feed on other microorganisms that try to flow through as water is manually poured into the top of the filter. Filters can accommodate virtually any flow rate since more membranes or cartridge filters or square footage media tanks can be installed as needed. In particular, membranes and cartridge filters represent a modular type of treatment option that can be very simple to install and operate. Water can be pored through such a device into a container or the device can be installed into a pressurized distribution pipe. No electricity is necessary, but at least 2-psi (4- feet of head) pressure is usually necessary to force water through a membrane. Limitations include the necessity for membranes to be either cleaned in place or replaced as needed; cartridges would probably have to be replaced, rather than cleaned. The active layer in a Biosand filter can be partially removed when its pressure drop increases too much to pour water through it. Since this is a non-chemical method of disinfecting, there are no taste issues associated with a membrane or cartridge filter device; however, no residual disinfectant capability is available either. Global Water plans to only use membranes that can be cleaned with chlorine bleach, a cleaning solution readily available in developing countries.

Solution

Global Water has the technical expertise and connections with local water-advocacy groups to provide water supply equipment to developing countries in order to “push” technology where it is needed and help people live more healthy and productive lives. Due to the lack of clean water in remote rural parts of developing countries and Global Water’s ability to manage and finance technical projects, this proposed collaboration would have far reaching positive impacts.

The rural communities that we work with in developing countries have no political power, have no visibility and have no voice in the discussion of the human right to water. Together, we would give them a voice in the world to say: “yes, everyone deserves the right to safe water.”