Arsenic Removal, Bangladesh and the BioSand Water Filter

By

Dr. David H. Manz, P. Eng., P. Ag.

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The BioSand Water Filter forms the basis for a very effective and inexpensive technology for removing arsenic from water – surface or groundwater. The methodology is effective, simple and inexpensive. The same treatment approach can be used with appropriately designed community-scale BSF systems. Household plastic BioSand Water Filters are manufactured in Dhaka, Bangladesh, in Calgary, Alberta, Canada and in Grand Rapids, Michigan, USA and they can be shipped, inexpensively, anywhere in the world. Household concrete BSF's can be produced in most corners of the world; but, may not be practical when attempting to reach several million consumers.

The BSF based arsenic removal technology was developed eight years ago for use in Bangladesh but due to unsettled political circumstances (domestic and international), uncertain funding and confusing international aid programs the technology has been unavailable until now. (It is estimated that between 40 and 60 million people in Bangladesh are subject to acute arsenic poisoning as a result of drinking arsenic contaminated well water.) The BSF based arsenic removal technology differs from all other coagulation-filtration approaches in that it also includes a distinct pre-oxidation step.

The arsenic removal process described has been proven to remove 98% or more of the arsenic present in all waters. This process has been laboratory and field tested in Canada, without using the oxidation step, before any of the field trials in Bangladesh were attempted. Arsenic removal challenges in Bangladesh using the BSF arsenic removal technology were very successful. The BSF based approach was capable of efficiently removing arsenic from rural well water in circumstances where **all** other arsenic removal technologies have failed (recent report on testing performed by the Bangladesh Government with funding from the Government of Canada).

The BSF is the only filtration technology that can efficiently remove both dissolved arsenic and pathogenic organisms from water. Use of the BSF promises to improve the health of hundreds of millions of people in Bangladesh, India, Nepal, Pakistan, Mexico and other arsenic affected communities throughout the world.

Methodology

To be effective the BioSand Water Filter (BSF) MUST be of correct manufacture in terms of its basic design and in terms of the media selection, preparation and installation. The operation is similar to 'ordinary' BSF operation but the water containing the arsenic needs to be pretreated with two inexpensive and commonly available substances, sodium

hypochlorite (household bleaching solution) and ferric sulphate (a very common chemical coagulant used in municipal water treatment plants worldwide).

Pumping water from a well that produces water with high levels of arsenic.

The first step is to add the sodium hypochlorite to the bucket of water (20 litres) until the 'stirred' water has the smell of chlorine. This process insures that all 'organically complexed arsenic' or other 'dissolved organic' substances are transformed to a condition where they will be available to attach to the chemicals formed by the addition of the ferric sulphate; and, equally important, will not interfere with the process of collecting the arsenic on the chemicals formed by the addition of the ferric sulphate.

Demonstrating addition of sodium hypochlorite to untreated well water.

The second step is to add 600 mg of ferric sulphate using a simple measuring spoon to the same bucket (20 litres of water) and stirring the water very thoroughly. Care needs to taken to purchase reasonably pure material that has been well taken care of (not adulterated or exposed to moist air). When used in a powder form the ferric sulphate immediately reacts when added to the water and turns the water a reddish (rust) colour. The water is allowed to stand for at least an hour and then it is stirred again. This process is repeated one more time after which the reddish coloured substances formed are allowed to settle to the bottom of the bucket. The periodic mixing insures that the arsenic is captured and will be removed by the BSF.

Demonstrating the addition of ferric sulphate and production of pure water.

The water is then carefully poured into the filter. The BSF will remove any remaining reddish coloured particles together with 98% of the arsenic and any disease causing pathogens (parasites, worms, etc.) that cannot be killed by the chlorine.

The performance of the BSF for arsenic removal is not affected by dissolved organic substances in the water – very common in Bangladesh for example. Most other technologies used to remove arsenic from water **are** adversely affected by the presence of excessive quantities of dissolved organic substances and may not work very well.

BSF's do not exhibit breakthrough phenomena. Most other technologies used for arsenic removal do exhibit breakthrough and can produce unsafe water without the consumer being the least aware of the problem.

The BSF can be operated twenty-four hours a day. It can be cleaned as often as required without incurring additional expense since the media is never replaced. There are cases in Bangladesh where up to ten families (50 people) share a small twenty litre per hour capacity filter.

The BSF is commonly used to treat water for non-consumptive purposes such as washing food, washing utensils for eating and cooking, cleaning tables and counters used for preparing and serving food, and water used to bathe. The water used for these purposes can have elevated concentrations of arsenic (unless taken with food); but, this water MUST be free of pathogens.

The BSF is also used to remove iron from water supplies. The presence of iron in water causes a bitter taste and will stain laundry. The BSF will remove both iron and pathogens from the water.

The waste water produced when cleaning a BSF used for removing arsenic is safe to handle and easily disposed of (United States Environmental Protection Agency reports). The arsenic is held very strongly by the chemicals that captured it and can only be released to the environment in exceptional circumstances (typical of industrial pollutants not domestic conditions).

Cost

The cost of chemicals used to produce the pathogen and arsenic free drinking water is approximately $3.00 to $4.00 per family of five for one year.

The cost of the BSF itself will vary depending on location and method of manufacture. In many parts of Asia, Bangladesh in particular, the delivered cost will be less than $50.00. (These filters are manufactured in Bangladesh and distributed by Bangladesh businesses and NGO's.) The BSF has a life of at least ten years. There are no replacement parts or materials.

If **both initial cost of the BSF and the cost of chemicals** used in treatment are considered the **yearly cost** of producing **safe drinking water for a family of five**, (approximately 20 litres per day and assuming the BSF will have a **minimum ten years of useful life**) is **$8.00**.

Comment

Considerable effort was expended in the research and development of the very effective arsenic removal technology described. Details will be published in subsequent papers, which will include performance comparisons with other arsenic removal techniques.

At this time the BSF based arsenic removal technology is the only water treatment technology that can practically and cost effectively produce water, at the household or community level that meets World Health Organization guidelines for arsenic, iron and pathogens.