The results of local clay filters when used for the removal of arsenic from water

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Abstract

Clay filters have been used to help improve water quality in underprivileged parts of the world with success, however, they were not designed to remove arsenic and have never been tested in that regard. This experiment was designed to test the effectiveness of these filters at removing arsenic when they are made from local clays. Filters made from two local clays were tested against filters made from control clay from Texas A&M. An arsenic solution was passed through the filters and the post-filtration concentration was measured. During the experimentation several clay filters were coated with red iron oxide, which allowed them to be tested under different conditions. Experimental results suggest that the local clay from Lake Ray Hubbard had the highest arsenic removal rate though even this was incomplete. Some problems encountered were a lack of uniform thickness, a lack of a better mold, and clay cracking.

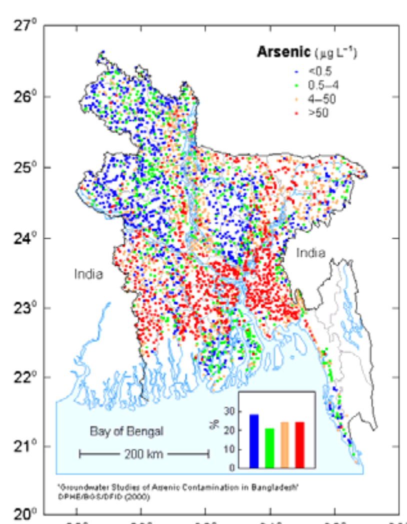
Introduction

Arsenic contaminated drinking water has become a problem in many underprivileged areas throughout the world, most noticeably the country of Bangladesh, with the drinking water of poor countries' exceeding 5 times the EPA maximum arsenic concentration [1]. Overdose of arsenic has been tied to skin disorders, cancer, and death [2].

One approach to this issue uses porous clay pots as arsenic filters. To make the filters, clay for the pot is mixed with a combustible material such as sawdust. During the firing process the entire combustible materiel is burnt leaving a porous clay filter behind. These filters have been used before in places with poor water quality, and they have been shown remove 98.7% to 99.97% of bacteria when dipped in silver [3].

This experiment is designed to test the effectiveness of three different clays used in the filtration process, Artists clay from Texas A&M University's art department, clay from the bank of Lake Ray Hubbard (a reservoir that services Dallas, Texas), and blackland clay from the Quinlan, Texas area.

A Picture of a full size filter from the potters for Peace web site [4]. The lip around the rim of this filter will fit perfectly on the top of the bucket. Impure water is poured into the top, and filtered water can then be accessed through the spicket.



A map showing the arsenic distribution in Bangladesh. The EPA maximum arsenic concentration is 10 μg/L while this map shows concentrations much higher than this [5]. This picture is from the Harvard Physics web site[6].

Materials and Methods

A clay sample was acquired from Lake Ray Hubbard from a bank on the west side of the reservoir next to a power plant. The clay was taken to the Eastfield College art department, dried to the appropriate workability, and mixed with fine sawdust. The mixed sample was further dried on plaster plates and molded into four pot shaped filters. One filter was left plain, while the other three had iron oxide added in different methods. After a final drying process, the filters were fired at 1500°F. A second clay sample was taken from, the Texas A&M art department. Because the sample was in powder form the first drying stage was skipped and the sawdust was added immediately. The last clay sample was blackland clay. Because of its density, it had to be dried overnight in the kiln before it could be brought to the right consistency. Outside of those steps, the samples were prepared as described above, except that only three filters were made from each of these two samples.

Two liters of distilled water were run through each filter to remove as much residual arsenic as possible (two artist's clay filters that ran slowly, so only 1.5 liters was run through them). Another half liter of distilled water was run through each filter and one 15ml sample was obtained to determine the background level of arsenic.

A stock solution prepared to run through the filters contained 86 ppb of arsenic. A liter of the solution was then passed through each filter in two half liter increments. A 15ml post filtration sample was collected from each filter from each 500 ml. The concentration of each sample was determined by the use of an atomic absorption spectrometer.

Results

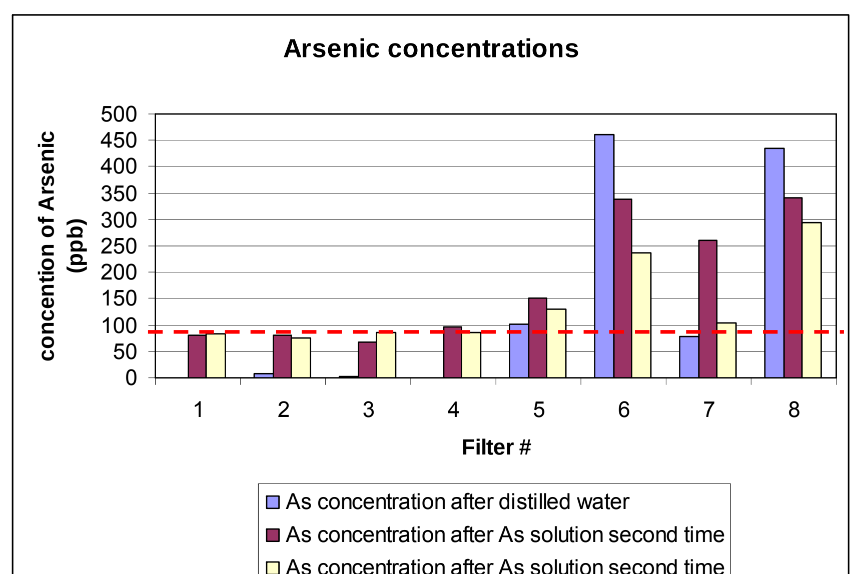


Figure 1. This graph indicates the concentration of arsenic present after filtration. The three tests are the test with distilled water to test for background arsenic, and two tests using an arsenic solution. The dashed line indicates the concentration of the applied arsenic solution. Filters 1, 2, 3 & 4 were made with Lake Ray Hubbard Clay. Filter 5 was made with blackland clay. Filters 6, 7, & 8 were made with artist's clay.

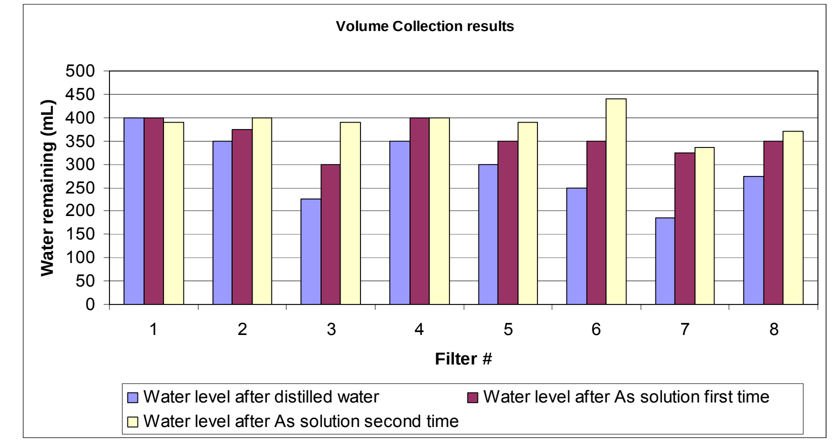


Figure 2. This graph indicates the volume of water present after filtration. The three tests are the test with distilled water to test for background arsenic, and two tests using an arsenic solution. 1, 2, 3 & 4 were made with Lake Ray Hubbard Clay. Filter 5 was made with blackland clay. Filters 6, 7, & 8 were made with artist's clay.

Discussion

Most of the filters were left overnight to fully filter the samples probably causing evaporation to affect the end concentration of many of the samples. Because the amount of water that remained in each filter is unknown, the precise effect of evaporation cannot be determined.

Filters #2 and #3 produced the most remarkable results. Assuming that between 50 and 100 mL of water was trapped inside the filter, filter #3 removed between 46% and 40% of all the arsenic in the first sample, while filter #2 removed between 19% and 9% of the total arsenic. During the second test, filter #3 removed between 12% and 1.3% of the total arsenic while filter #2 removed between 22% and 12% of the total arsenic.

The arsenic-contaminated sawdust, which noticeably affected the artist's clay, had little effect on the Lake Ray Hubbard (LRH) clay. One possible reason is that the LRH clay was formed into thinner filters which caused them to contain less sawdust. Anther possibility is that the LRH clay bonded to the arsenic in the sawdust less firmly.

Another point of interest is that filter #3, during the first test, had a much higher removal rate than it did during the second test, whereas filter #2 had more consistency. Because filter #3 had a layer of iron oxide on the outside of the filter in addition to the inside it is possible that some of the arsenic it removed was trapped between the two iron oxide layers, contaminating future samples.

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