Removal of Arsenic from Contaminated Ground Water using a Nicaraguan Ceramic Filter

Michelle M. Saltis and Robert N. Phalen, California State University San Bernardino

Introduction

Several communities in Mecca, California obtain their water from shallow wells (RCAC, 2010). These wells are contaminated with arsenic levels above the U.S. EPA threshold (EPA, 2013) and can also be contaminated with pathogenic microbes from local septic tanks. The objective of this study is to test a ceramic water filter used in developing nations for removal of arsenic using a time-tested removal media, manganese greensand (Hanson, 1999 and Spoljaric, 1979).

Materials and Methods

An Econo II Quick rapid arsenic test kit (Industrial Test Systems, Rock Hill, SC) was used to test water samples for arsenic, down to <2 ppb. About 40 L of water was run through the filters to remove residual arsenic from the clay; however, about 3-5 ppb was detectable with each 5 L run.

Laboratory water filtration treatments were performed using different test conditions:
1) a control;
2) filtration of 10 ppb arsenic with no treatment and
3) filtration of 10ppb arsenic with greensand media treatment.

The control was tested weekly to determine the amount of arsenic present in the water over time. Two ceramic filters were used. At least three runs were performed for each condition. Each filtration run consisted of 5 L of distilled water with 10 ppb arsenic added to match the EPA standard for drinking water of 10 ppb (EPA, 2013). This research project is ongoing and the final stage will be to test the system out in the field in Mecca, CA.

Future

The next step is to test the two ceramic filters with a greensand media. The best media configuration (e.g., post-treatment and active versus passive) is being investigated.

Results

No change in arsenic concentration over time (Condition 1) was observed with the control (Table 1). The test kit reliably read 9 ppb for each of the analyses. The test kit readings were 90% of the stock solution. On average, the results for arsenic filtration without treatment (Condition 2) resulted in an increase in the arsenic concentration of 14 ± 4 ppb arsenic. These results are presented in Tables 2 and 3. The filters added about 4 ppb arsenic to the water, on average.

Preliminary results for a small scale treatment of 10 ppb arsenic water with greensand at the bottom of the container were conducted. The results are presented in Figure 1.

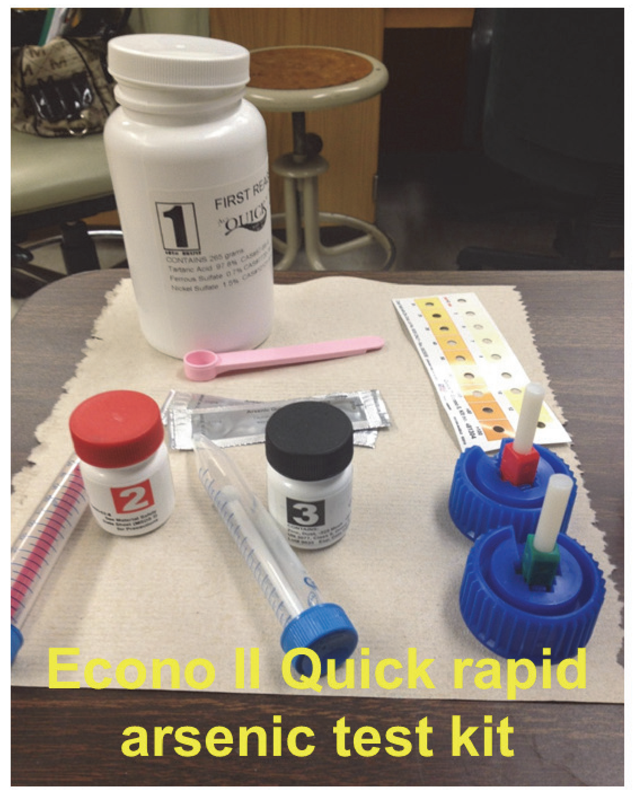

Figure 1: Preliminary test of Passive removal of Arsenic Using Greensand

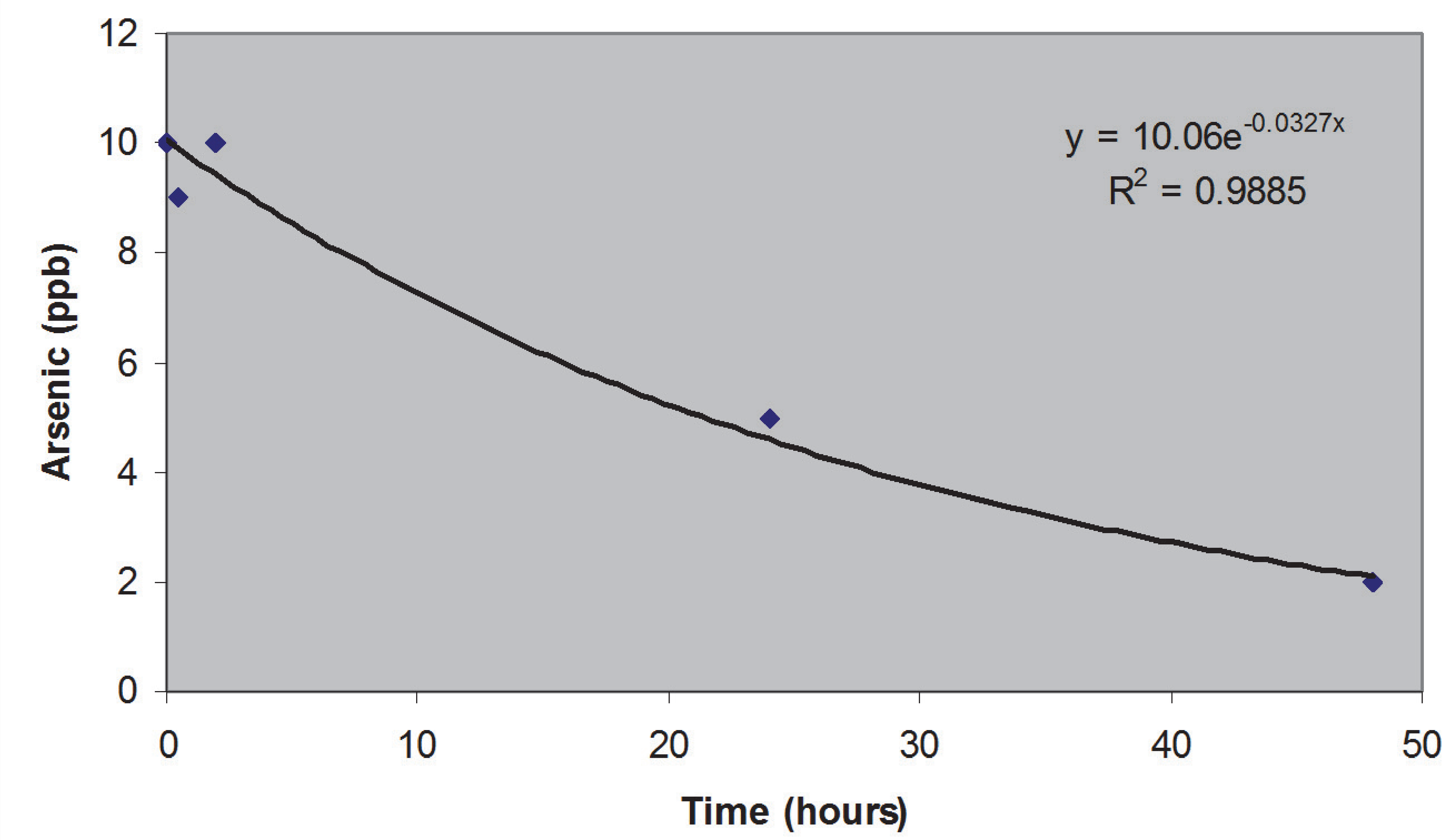

Table 2. Filter #1 Filtration of 10 ppb Arsenic without Media (Condition 2)

Arsenic	Filter One Pre (ppb)	Filter One Post (ppb)
Run 1	10	8
Run 2	10	12
Run 3	10	12
Run 4	10	12
Mean ± SD	10 ± 0	11 ± 2

Table 3. Filter #2 Filtration of 10 ppb Arsenic without Media (Condition 2)

Arsenic	Filter Two Pre (ppb)	Filter Two Post (ppb)
Run 1	10	16
Run 2	10	20
Run 3	10	16
Run 4	10	16
Mean ± SD	10 ± 0	17 ± 2

Table 1. Arsenic Control (Condition 1)

Control	Starting ppb	Tested ppb
Week1	10	9
Week2	10	9
Week3	10	9
Week4	10	9

Conclusions

The results for the control (Condition 1) show that the arsenic concentration in water stays consistent over time and that the analysis method is reliable at around 10 ppb. The results for filtration without treatment (Condition 2) showed a slight increase in the arsenic concentration, on average. This concludes that the ceramic filter alone adds arsenic to the water.

The preliminary results for treatment with media (Condition 3) indicate that additional steps are needed to actively remove arsenic from the water. This is likely to include post-filtration through a bead of media, followed by secondary filtration to remove insoluble arsenic.

References

Hanson, A., Bates, J., Heil, D. and Bristol A. (1999) Arsenic Removal from Water Using Manganese Greensand: Laboratory Scale Batch and Column Studies. Water Treatment Technology Program Report No. 41 for U.S. Department of the Interior. Available athttp://www.usbr.gov/pmts/water/publications/reportpdfs/report041.pdf

Rural Community Assistance Corporation (RCAC) 2010 Report on a Drinking Water Assessment for a Trailer Park in Mecca, California. Available at:http://www.water.ca.gov/irwm/docs/ResourcesLinks/Submitted_Applications/P84_Round1_Implementation/Coachella%20Valley%20Water%20District/Short%20Term%20Arsenic%20Treatment/St%20Anthony%20Final.pdf

Spoljaric, N. and Crawford, W. (1979) Removal of Metals from Laboratory Solutions and Landfill Leachate by Greensand Filters.Delaware Geological Survey Report of Investigations No. 32. Available athttp://www.dgs.udel.edu/sites/dgs.udel.edu/files/publications/RI32e.pdf

United States Environmental Protection Agency (E.P.A.), 03 June 2013. Drinking Water contaminants: National Primary Drinking Water Regulations. http://water.epa.gov/drink/contaminants/index.cfm

Acknowledgments

The research activities were supported by The Water Resources Institute (WRI) at California State University San Bernardino. USDA NIFA AWARD No. 2011-38422-31204