Evaluation of Addition of Copper to Micron-sized Sand Filter

Student Researcher: Shiny Samuel

Faculty Mentor: David Wunder

Desert Rose PLC, a foreign social enterprise based in Addis Ababa, Ethiopia have developed a point-of-use filter known as the MINCH filter which uses micron particles for their media. This study focused on improving the efficiency of the MINCH filter with the addition of copper to its media. In the past, Copper has been a useful element in water purification due to it being one of the most toxic metals to heterotrophic bacteria in water. Copper is safe to humans as it is an essential trace element necessary for many physiological and metabolic processes. Although many studies have been done on the effect of copper as a biocidal in water purification systems, there is little known about the effect of copper included in sand filtration systems. The focus of the study was to observe the effects of copper on the removal efficiency of bacteria and viruses in the MINCH filter. Six bench-scale sand filters, based on the MINCH filter, were built. The media was modified through the addition of copper powder in different amounts.

One major challenge we faced was with the selection of the media. We were given a size specification of 25-50 microns, but it was hard to find products with particles only in this size range. First, we tried using silica, but since it had particles finer than 25 microns we had several problems, such as fines coming through with the filtered water or no flow of water through the filter. After multiple attempts, we finally settled on processing the media ourselves. Gravel was collected from the local gravel company and sieved in the civil engineering lab. A 53-micron and 25-micron sieve was used to collect media within this size range. The flowrate of the filters was much slower than the target flowrate of 50 to 250 mL per hour, but due to the lack of time, this could not be adjusted.

Out of the six filter columns, two columns were the control filters with no copper added to the media, two had copper amounting to 0.1% of the media by weight, and two had copper that amounted to 0.01% of the media by weight. The testing for bacteria and virus removal took place over a period of 8 days. Influent water was inoculated with bacteria and viruses and filtered through the columns. Daily 1.5 liters of water was fed into the columns and 200 mL samples were collected for analysis. Influent and effluent samples are monitored for bacteria and viruses such as *E. coli* and giardia cysts to calculate removal. Filter performance for virus and cysts showed above a required 3-log removal for cysts and 4-log removal for viruses (EPA). However, there was an increase in bacteria from the influent water to the effluent which could have been due to an internal contamination of the filters or due to short-circuiting in the media.

Working with the MINCH filter this summer was an eye-opening experience to the opportunities still available to provide and improve drinking water conditions. The MINCH filter is the only filter available in Ethiopia that costs less than 20 euros. It is cheap, and it uses material that is found locally, which makes it easily available to those who need it the most. This has shown me the importance of engineering to the needs and the culture of the people. Practically, I learned a lot about problem solving and creative thinking to maneuver through unexpected bumps in setting up the experimental process. In regard to this study, going forward, further research can be done regarding the effect of media bed length on removal efficiency.