

Report: Ceramic Water Filters After 3.5 Years of Continuous Use in Community Homes Caminos de Agua

By Dylan Terrell, Executive Director
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Background

In August 2013, we in Caminos de Agua (then CATIS-Mexico) performed our first pilot projects with the Ceramic Water Filters. Funded by the Audubon Society, the pilot project provided a total of 68 filter systems to 64 families and several local schools in two rural communities - La Cienega and Juan Gonzalez.

More than 80% of the water used by families came from existing rainwater harvesting cisterns, while others utilized hand-dug artesian wells and/or river water as their main water source. All of the water sources — with the exception of one rainwater cistern — tested positive for total coliforms (general bacteria), and 95% of the water sources tested positive for E.coli (known harmful bacteria). E.coli is by far the most important indicator as it is:

- 1) A coliform bacteria of fecal origin known to cause harm in humans, and
- 2) Very small (less than 1 micron in size) and can easily pass through most physical filtration systems.

In several cases, E.coli levels were more than 2,400 times above allowable limits — even in rainwater harvesting cisterns (known to be “cleaner” water sources). Thus, it was very important for us to know that the Ceramic Water Filter systems worked efficiently in real community homes and under these realistic conditions, especially at removing the high levels of E.coli we were seeing in most of the community water sources.

During that initial pilot, the Ceramic Water Filters removed 100% of E.coli in all 54 tests, which took place at the beginning of the pilot and then again after 6 months of use with families under real-world conditions.

Returning to Pilot Communities

After three and a half years of continued use in community homes, we recently had the opportunity to return to these first pilot communities to change out some of the filter systems and see if they were still working at the same efficiency as they did when they were first installed. In total, 15 systems were taken back to the Caminos site for follow-up testing by Engineers Without Borders-UK placement, Sarah Mitchell.

Upon initial visual inspection, many of the filters did not look like they were in great shape. It was clear that some systems were maintained and cleaned often over the years. However, many systems were clearly not cleaned regularly as silicon connections were blackened or greened and many of the plastic containers were discolored. Further, some of the filters appeared discolored and in some cases to be physically degrading. If anything, it was obvious



Top Right: Kids come to change out used filter system in Juan Gonzalez; Top Left: Ceramic filter after 3.5 years of use. Discoloration and some physical degradation is visible.

that these systems have been hard at work filtering and disinfecting highly contaminated source water for years.

But, appearances aside, the question remained: *do the filter systems still work?*

Flow Tests

Before looking at water quality, Mitchell ran flow tests on all of the systems to make sure the water “quantity” would still be sufficient for a family. Two-thirds of the filter systems tested continued to perform well, producing between 1.8 and 4 liters/hour. Four of the five systems producing less than 1 liter/hour still produced sufficient drinking water for at least 6 adults if maintained full most of the time. One system, however, was only able to produce an abysmal 42 mL/hour, even after extensive cleaning.

For the most part, flow-rate appears to drop off over time; however, nearly all of the systems continued to produce sufficient drinking water with the majority still surpassing baseline standards for brand-new filter systems (figure 1). One filter system was completely clogged and unusable.

Biological Testing

For the biological testing, Mitchell mixed a consistent batch of several hundred liters of influent test water, which was a combination of well water and stagnant river water. All but one of

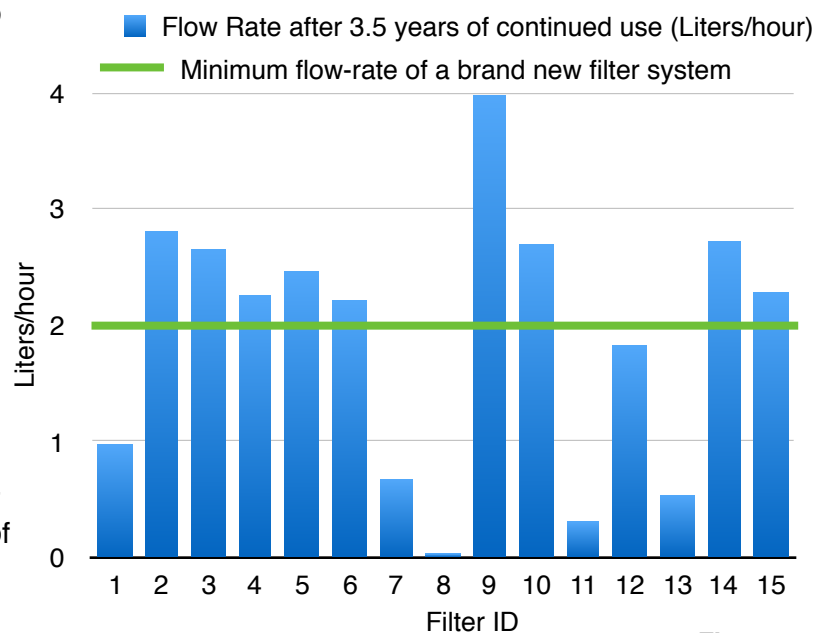


Figure 1

the 15 filter systems were tested. The flow-rate on system 8 was far too low to collect a useable sample. The systems were filled with the test water and samples were taken from each system, processed, and incubated for 24 hours at 35.5°C (+/- 0.5°C) per Mexican regulations.

The influent water tested at more than 2,400 times above the limit for total coliform (general) bacteria and roughly three times above the limit for E.coli. After more than three years of use, all of the systems continued to remove 100% of E.coli. The majority of the systems also removed 100% of total coliforms; however three systems did see some minimal breakthrough of total coliforms.

The three systems that did see some biological breakthrough still removed 99.8% - 99.9% of total coliforms as well as 100% of E.coli. This illustrates that the colloidal silver impregnated into the filters continues to function well. Flow-rate does not appear to be a factor. However, physical breakdown of the ceramic itself could be letting through some smaller bacteria through. Figure 2 below compares the original tests from 2013 with these more recent tests performed in 2017.



Used filter systems set-up for flow and biological testing.

Camino de Agua Ceramic Water Filters After 6 Months and 42 Months of Continued Use in Community Homes Under Various Influent Water Conditions

Filter ID	Source Water 2013			Filtered Water 2013				Source Water 2017			Filtered Water 2017			
	Type	Total Coliforms*	E.Coli*	Total Coliforms*	% Reduction	E.coli*	% Reduction	Type	Total Coliforms*	E.Coli*	Total Coliforms*	% Reduction	E.coli*	% Reduction
11	Artesian Well	2,419.60	2,419.60	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
2	River	93.8	4.1	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
12	Rainwater	1,011.20	25.4	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
9	Rainwater	> 2,419.6	> 2,419.6	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
3	Rainwater	816.4	164.8	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
10	Rainwater	24.5	8.6	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
7	Rainwater	829.7	No Detect	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
5	Rainwater	18.3	3.1	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
13	River	93.1	64.6	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
1	Rainwater	> 2,419.6	26.5	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
4	Rainwater	579.4	16.1	No Detect	100%	No Detect	100%	River	2419.6	3.1	1.0	99.9%	No Detect	100%
6	Rainwater	829.7	14.4	No Detect	100%	No Detect	100%	River	2419.6	3.1	No Detect	100%	No Detect	100%
14	Artesian Well	2,419.60	191.8	No Detect	100%	No Detect	100%	River	2419.6	3.1	5.2	99.8%	No Detect	100%
15	Rainwater	1986.3	NA	No Detect	100%	No Detect	100%	River	2419.6	3.1	2.0	99.9%	No Detect	100%
8**	Artesian Well	> 2,419.6	133.9	No Detect	100%	No Detect	100%	NA	NA	NA	NA	NA	NA	NA

* All Total Coliform and E.coli measurements are in MPN/100mL per the Idexx Quanti 2000 Testing method. All samples were processed within 12 hours of collection and incubated at 35.5°C for 24 hours.

** Flow-rate on system 8 was too low to collect a useable sample. However, data from 2013 is provided.

Figure 2

Both source water and filtered water samples from 2013 were taken directly from community homes and filter systems in use. The 2017 samples were taken from the Caminos de Agua site where filters all used the same source water as their influent.

Conclusions

Generally speaking, the filter systems continue to perform very well and exceed expectations. After more than three years of use under relatively intense conditions. The three systems which did see minimal detection of some coliform bacteria — systems 4, 14, and 15 — all still vastly reduce the original source water concentrations by more than 99 percent. System 4 saw almost no detection, indicating that it could be a processing error. System 15 is a filter mix that is no longer used, and System 14 was so badly degraded that a black ring formed on the top of the filter. Further, all systems continued to remove 100% of E.coli — the most important indicator.

Despite the minor breakthrough on three systems, all of the filters are still in-line with World Health Organization standards. Caminos de Agua is currently working on new filter designs, to make filter replacement significantly easier. Further, we will be modifying recommendations for filter maintenance and change-out based on what we have found with this latest round of testing. For instance, although many highly degraded filters still performed exceedingly well, to be conservative, simple recommendations on filter change-out due to ceramic degradation would be easy to implement and safeguard against potential breakthrough.