Protecting Health With POU

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POU systems meet global standards for microbial reduction

The global need for point-of-use (POU) drinking water treatment products with microbiological reduction or purification claims has grown in recent years. The proliferation of these products is evident in developing countries such as Brazil, China, India and Mexico, where water quality is of concern to the general population.

Because microbial reduction or purification is a significant health claim, the efficacy of these products' performance is paramount for consumer protection.

Waterborne microbial illnesses are often the result of acute exposure to microbes in drinking water. So, how effective do POU microbiological systems need to be to protect the consumer? Payment et al. showed that reverse osmosis (RO) systems can reduce the incidence of gastrointestinal illness by about one-third.[1] But is that good enough?

Worldwide Standards

The World Health Organization (WHO), in its treatise "Evaluating Household Water Treatment Options: Health-Based Targets and Microbiological Performance Specifications," concluded that systems that can reduce ≥2 logs of bacteria, ≥3 logs of viruses and ≥2 logs of protozoa (microbial cysts) are "protective" to human health.[2] WHO further stated that systems that reduce ≥4 logs of bacteria, ≥5 logs of viruses and ≥4 logs of protozoa are "highly protective" to human health.

These log reduction values are based on a conservatively targeted, tiered approach in which highly protective treatment represents a 10^{-6} disability-adjusted life year (DALY) that "allows for the tolerable loss of 365 healthy days in a population of one million people over the course of one year." In other terms, an individual using a highly protective system has a one in a million chance of contracting a drinking-water-related microbiological illness over the course of a year.

The risk of microbe-related drinking water illness increases for those that use protective systems to 10^{-4} DALY, or one in 10,000. In regions where waterborne illnesses are prevalent, these reductions in disease can significantly improve the health of the local population. The log reduction values expressed by WHO are based on a rigorous review of microbial risk and pathogen occurrence in the water supply.

In contrast with WHO recommendations, the U.S. Environmental Protection Agency (EPA) Guide Protocol states that microbial purifiers should meet ≥6 log reduction of bacteria, ≥4 log reduction of viruses and ≥3 log reduction of microbial cysts.[3]

Testing Protocols

WHO also suggests testing schemes for various water treatment technologies. The proposed test regimens last a minimum of 14 days, with testing and sampling on days zero, one, three, five and 14. If the product life is greater than 14 days, the systems should be challenged and sampled at 0%, 25%, 50%, 75% and 100% of system life. WHO recommends spiking systems with microbes at the proposed sampling intervals and gives other specifics on performing microbial challenge testing, including using two water types.

Continuous Challenge

After reviewing this document, we wanted to take microbial challenge testing to the next level—continuous challenging of a POU system with bacteria and viruses throughout the life of the product. We conducted the testing on a microbial purifier carbon block currently used in an off-the-shelf retail product, the Whirlpool Water Purifier Model WHEMB-40. The proprietary microbiological interception carbon block technology in this product uses a high-molecular-weight polycationic interception agent, cationic silver halide complex and pH-altering material to achieve microbial control.[4]

Testing was conducted using general test water one (GTW-1), as described in the EPA Guide Protocol, with the microbial purifier cycled 10% on, 90% off for eight hours per day with a 16-hour rest period.[3] The testing lasted three weeks, including multiple stagnation periods.

The GTW-1 was seeded with *E. coli* (ATCC strain 11229) and the MS-2 bacteriophage (ATCC 15597-B1). The microbial seed levels were 107 to 108 CFU/100 mL for *E. coli* and 106 to 107 PFU/mL for the MS-2 bacteriophage. The MS-2 bacteriophage host bacterium was *E. coli* ATCC 15597. We did not challenge for microbial cysts, but it can be presumed that any filter that effectively removes viruses and bacteria should remove larger protozoan cysts.

Testing Results

The results of duplicate testing are shown in Tables 1 and 2 (see page 18). The systems were tested for 25 days with three stagnation periods: two of 48 hours and one of 72 hours. The volume of water through the carbon block exceeded the system's stated capacity (350 gal). The microbial interceptor carbon block continually was challenged with bacteria and viruses.

The multiple stagnation periods used in this testing regimen challenged the ability of the microbiological interception carbon block to prevent microbial proliferation on the filter or "grow-through" of microbes during non-use periods. The results from the testing show that this technology exceeds the stated requirements for highly protective water treatment by reducing ≥4 logs of bacteria and ≥5 logs of viruses. Thus, this technology achieves the highly protective WHO classification.

Conclusions

This testing is significant in that this microbiological interception purification technology continually

The research team conducted the tests using an off-the-shelf water purifier.

was challenged with a high concentration of bacteria and viruses and met the rigorous requirements for microbial reduction as defined by WHO for a highly protective POU water treatment system.

Performance was based on 100% or more of filter life with three stagnation periods of significant duration. The microbial challenge levels in the test were significantly greater than those proposed by WHO and EPA in that our filter experienced a continual challenge of microbial contaminants versus periodic spiked samples at defined periods of the filter's life cycle.[2, 3]

Though this series of tests did not include water with high turbidity and organics loading, it is important to note that this technology did pass the equivalent of the EPA Guide Protocol in turbidity and organic challenges. That testing, conducted by an independent laboratory, also showed the log reduction of viruses and bacteria to meet the highly protective WHO classification.[3]

In summary, the microbiological interception carbon block technology used in the Whirlpool microbial water purifier model WHEMB-40 was shown to provide microbiologically safe drinking water under a variety of conditions and meets the highly protective POU water treatment classification as defined by WHO. *wqp*

References:

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2. *World Health Organization, "Evaluating Household Water Treatment Options: Health-based targets and microbiological performance specifications," 2011.*
3. *United States Environmental Protection Agency, "Guide Standard and Protocol for Testing Microbial Purifiers," 1987.*
4. *Brigano, F.A. and V.P. Nero. "Keeping Public Water Supplies Safe,"* Water Quality Products*, 2008.*

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Table 1. Constant Microbiological Challenge Results for Carbon Block No. One

Day	Influent pH	Flow (gpm)	Total Flow (gal)	Challenge Point (% life)	MS2 LRV*	*E. coli* 11229 LRV
1	6.7	0.65	10	3%	6.6	8
2	7.5	0.71	50	14%	6.7	8.7
3	7.4	0.67	101	29%	6	8
4	48-hour stagnation					
5						
6	8.0	0.69	145	41%		
7	7.4	0.66	150	43%	5.3	8.2
8	7.4	0.67	176	50%		
9	7.1	0.66	201	57%		
10	7.1	0.66	204	58%		
11	7.0	0.66	224	64%	6.5	7.7
12	7.0	0.66	234	67%		
13	7.2	0.64	263	75%		
14	48-hour stagnation					
15						
16	6.5	0.59	291	83%	3.8**	7.5
17	6.8	0.58	311	89%		
18	6.8	0.58	337	96%	5.3	8
19	7.0	0.57	363	104%		
20	6.9	0.57	389	111%	5.3	8.2
21	72-hour stagnation					
22						
23						
24	7.4	0.53	413	118%	6.3	8.2

**LRV = log reduction value*
***Due to low influent challenge*

Table 2. Constant Microbiological Challenge Results for Carbon Block No. Two

Day	Influent pH	Flow (gpm)	Total Flow (gal)	Challenge Point (% life)	MS2 LRV*	*E. coli* 11229 LRV
1	6.7	0.67	10	3%	6.6	8
2	7.5	0.66	51	14%	6.7	8.7
3	7.4	0.63	101	29%	6	8
4	48-hour stagnation					
5						
6	8.0	0.65	140	40%		
7	7.4	0.62	150	43%	5.3	8.2
8	7.4	0.62	168	48%		
9	7.1	0.61	196	56%		
10	7.0	0.62	201	57%		
11	7.0	0.64	221	63%	6.5	7.7
12	7.0	0.62	229	65%		
13	7.2	0.64	256	73%		
14	48-hour stagnation					
15						
16	6.5	0.57	282	81%	3.8**	7.5
17	6.79	0.52	301	86%		
18	6.83	0.52	324	93%	5.3	8
19	6.95	0.51	348	99%		
20	6.90	0.50	371	106%	5.3	8.2
21	72-hour stagnation					
22						
23						
24	7.36	0.47	393	112%		
25	5.76	0.49	410	117%	6.3	8.2

**LRV = log reduction value*
***Due to low influent challenge*