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Testing of Steri-Pen, a Hand-held Ultraviolet Water Treatment Device using MS2 Coliphage on Visibly Turbid Natural Water

Introduction

Hydro-Photon, Inc. of Blue Hill, ME contracted with the University of Maine Department of Microbiology and Biochemistry to test Steri-Pen, a hand-held ultraviolet water treatment device. Steri-Pen is designed for batch treatment of up to 16 oz. of water. The device uses a germicidal ultraviolet lamp with a peak output at 254 nanometers.

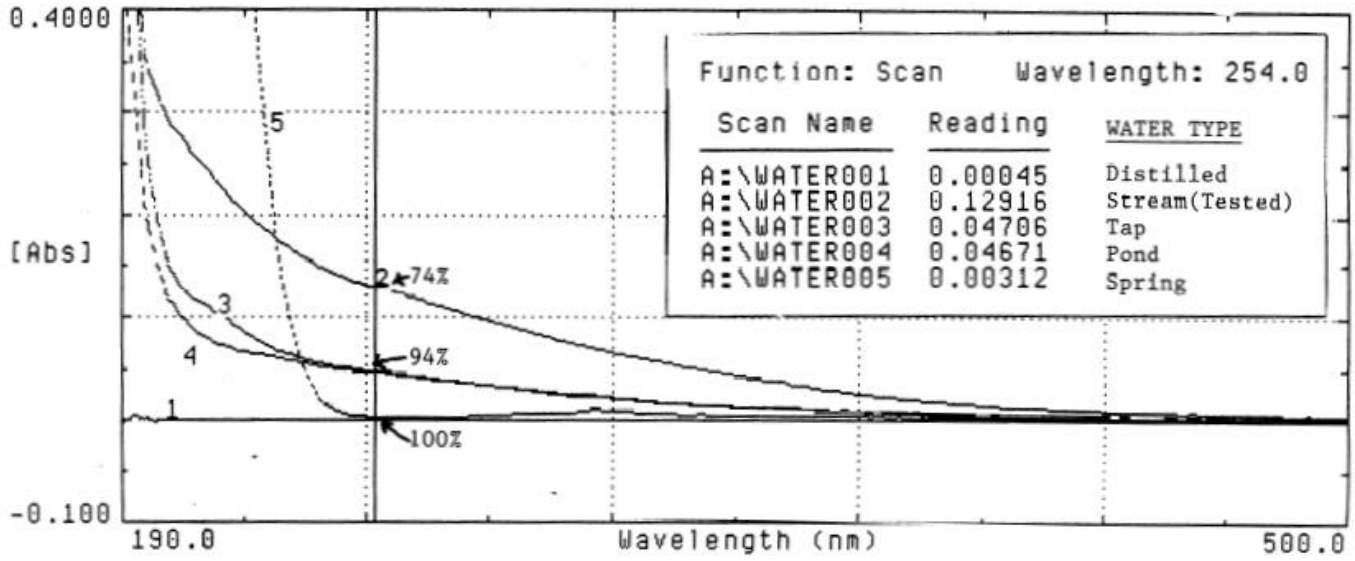
While it's size and mode of operation are novel, Hydro-Photon's device employs the same basic principles as large "flow through" ultraviolet water treatment systems. During UV exposure a microbe's DNA absorbs ultraviolet energy in the germicidal range - nominally between 245 and 270 nanometers. This energy absorption causes formation of dimers which disrupt the basic structure of the DNA which, in turn, inhibits the DNA's replication and function (1).

MS2 coliphage is a bacterial virus that infects *E.coli* ACTT 15597. The virus MS2 coliphage was chosen as the test organism. MS2 was selected because of its linear response and high resistance to UV disinfection (2). "A 99.5% (-2.3 log) reduction of coliphage MS2 was found to be equivalent or greater than a 99.9999% reduction of the bacterial and a 99.99% reduction in the viral pathogens." "For water purifiers, the U.S. E.P.A. Guide Standard and Protocol for Testing Microbiological Water Purifiers requires a 99.9999%, a 99.99% and a 99.9 removal/inactivation of bacteria, viruses, and protozoan cysts, respectively" (2,3). Steri- Pen has been shown to cause a greater than 99.9% reduction in MS2 coliphage in sterile tap water (7).

Test Procedure

Samples of “natural” local water sources were run through a Beckman DU 7500 spectrophotometer to determine the % transmittance of the sample in comparison to distilled water at 254nm(Figure 1). The sample with the greatest reduction in transmittance was chosen as the test water. This sample, collected from a local stream, was the most visibly turbid.

Figure 1. The absorbance of a set of naturally occurring waters measured over a range of wave lengths using a Beckman DU 7500 spectrophotometer. Percent transmissions compared to that of distilled water at 254 nm are indicated.



Samples of 450 ml stream water were spiked with stock MS2 coliphage to give a final concentration of approximately 4X10 6 PFU (plaque forming units)/ml. The stock MS2 was grown and assayed using the methods described by Johnson.(5)

To test, the Steri-Pen was activated and submerged in the challenge water and moved in a stirring motion for the duration of the preprogrammed time (designated as a cold start). The phage titer of the treated water was determined using the double agar overlay method (5). The host *E. coli* ATCC 15597 was prepared as described by Johnson. (5)

Test results Coliphage titers were determined on the untreated (control) and treated samples using the method described by Johnson (5). Logarithmic reductions in titer and % kill were calculated.

Table 1 The coliphage titer in PFU/ml for each of the three test trial before (control) and after treatment with the Steripen. Logarithmic reductions in titer and percent kill of coliphage after treatment with the Steripen

Results-Stream Water 7/01						
Trials	Control	treated	Log reduction	% Kill		
	MS2 titer	MS2 titer				
	PFU/ml	PFU/ml				
T1	4.40E+06	2.00E+04	2.34	99.55		
T2	4.00E+06	8.90E+03	2.65	99.78		
T3	4.70E+06	6.80E+03	2.84	99.86		
average			2.61	99.73		

Conclusion

Testing on naturally occurring turbid stream water samples indicates that Steri-Pen is a very effective anti microbial device. Even in the conditions presented by the turbidity and discoloration of the stream water, Steri-Pen treatments resulted in an average of -2.61 log reduction (99.7%) of MS2 coliphage. Testing at the University of Arizona demonstrates the "A 99.5% (-2.3 log) reduction of MS2 coliphage was found to be equivalent or greater than a 99.9999% reduction of the bacterial and a 99.99% reduction of the viral pathogens." According to the U.S. E.P.A., a -2.1 log reduction in MS2 is approximately equivalent to: -3.7 log (99.98%) reduction of Rotavirus SA-11, 4.6 log (99.997%) reduction of Hepatitis A, and -5.4 log (99.9996%) reduction of Poliovirus type 1 (6)

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