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Evaluation of MS-2 Reduction by UV Water Box Water Disinfection

Report

October 18, 2021

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Project Summary

The Water Box device for disinfection of potable water by UV light was tested for anti-viral efficacy using MS-2 *Escherichia coli* (*E. coli*) bacteriophage. Performance was tested with a reservoir filled with distilled water that was inoculated with approximately $1x10^7$ MS-2 viral particles and contaminated with 1.2 ppm 4-hydroxybenzoic acid (PHBA) to reduce UV transmission to 80 %. A 100 mL sample of contaminated water was collected prior to UV processing, and a second sample was collected after 90 seconds irradiation. The Water Box hand generator was used to power the UV lamp. Samples were diluted and plated on Tryptic Soy Agar (TSA) plates with *E. coli* inoculum for MS-2 enumeration.

Procedures and Data

UV Transmission Adjustment

The test protocol specified that the challenge water be modified with the addition of PHBA to reduce UV254 transmission to 80%. An Ultrospec 1000 spectrophotometer was used to measure the transmission of 254 nm light over a 1 cm path length. Previous testing established that 1.2 ppm PHBA would reduce transmission to approximately 80 %. Several solutions from 1.0 to 2.0 ppm PHBA were used to confirm the concentration needed to reduce the transmission to 80 %. As in previous tests, 1.2 ppm provided 80 % transmission of 254 nm light.

Challenge Water Preparation:

The MS-2 inoculum was prepared as in the previous evaluation. Plaque counts of the filtrate determined the viral density was $2.5x10^9$ PFU/mL. This culture was used to inoculate 5.0 L of challenge water. Sufficient PHBA concentrate was added to bring the concentration to 1.2 ppm. The resulting solution had a UV254 transmission rate of 78 %, slightly below the 80 % target.

Anti-Viral Challenge:

To begin, The Water Box was filled to the overflow holes with challenge water. Next, a 100 mL "Influent" sample was collected in a sterile bottle via the Water Box outlet. The water was then treated by UV light generated by the hand crank generator for 90 seconds. The crank was rotated 123 cranks during the 90 second treatment interval. This does not include cranks required to fully illuminate the UV bulb. Following the treatment phase, a 100 mL "Effluent" sample was collected at the outlet. The two samples were then diluted and plated on TSA plates with soft agar and an *E. coli* inoculum.

Results:

Results are presented in Table 1.

Water Box Test Results

Test #	Duration (s)	Power Source	Test Volume (L)	Initial Viral Load	Post Treatment Viral Load	Log Reduction
1	90	Hand Generator	4.1	$3.7x10^7$	$3.2x10^6$	1.1