

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

Report

August 13, 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 under three different conditions, no UV, 120VAC power, and hand power. Distilled water was inoculated with approximately 1×10^7 MS-2 viral particles and contaminated with 3 ppm 4-hydroxybenzoic acid (PHBA) to reduce UV transmission. A sample of contaminated water was collected prior to each test, and in both UV tests the UV was powered for 60 seconds prior to collecting the treated samples. Samples were diluted and plated on Tryptic Soy Agar (TSA) plates with *E. coli* inoculum for MS-2 enumeration.

Procedures and Data

Challenge Water Preparation:

The initial MS-2 culture density was determined by serial dilution and plating. The viral stock, obtained from ATCC, was used to inoculate 100 mL of *E. coli* culture. This culture was grown for 24 hours prior to filtration to remove bacteria. Plaque counts of the filtrate determined the viral density was 2.3×10^9 Plaque Forming Units/mL. This culture was used to inoculate the challenge water. The test protocol specified that the challenge water was to have only 65% transmission of UV at 254 nm. A series of PHBA solutions were prepared and the UV transmission was measured to establish a target PHBA concentration. This curve indicated that 2 ppm PHBA should provide the target transmission. The actual challenge water UV 254 transmission was measured in triplicate at 65.5, 66.0, and 66.3 %.

Test #1:

Test one evaluated how the Water Box materials affected MS-2. The Water Box was filled with contaminated water, an influent sample was taken immediately, and then a “treated” sample was taken after 10 minutes.

Test #2:

Test two evaluated MS-2 disinfection when the Water Box UV light was operated with 120VAC power. The Water Box was filled with contaminated water, an influent sample was taken immediately, and then a “treated” sample was taken after running the light for 60 s.

Test #3:

Test three evaluated MS-2 disinfection when the Water Box UV light was operated by hand power. The Water Box was filled with contaminated water, an influent sample was taken immediately, and then a “treated” sample was taken after running the light for 60 s. The 60 s did not start until the UV light was visible through the view port with steady illumination. This took approximately 4 s.

Results:

Viral plate counts from the three tests are presented in Table 1. It is apparent that the UV light does reduce viral load in the samples, but not to a degree expected. Typically, a 2 log reduction in virus concentration indicates a significant reduction, and 4 log is the minimum for

disinfection. In this case, the reduced efficacy is likely due to the reduced UV transmission and relatively long distance the light is transmitted. Standard residential UV disinfection devices have transmission distances of 1 or 2 inches, while the Water Box unit has a water depth of approximately 4 inches. Improvements that will significantly increase disinfection are to incorporate a reflector between the light and the box lid to increase the UV transmitted into the water and implementation of filtration while filling the box. Filtering the water to 1-5 micron should improve transmission significantly.

Table 1: Water Box Test Results

Test #	UV?	Initial Viral Load	Post Treatment Viral Load	Log Reduction
1	No	1.3×10^8	9.7×10^7	0.1
2	Yes	1.1×10^9	2.2×10^7	1.7
3	Yes	1.5×10^8	8.0×10^7	0.3