WHO International Scheme to Evaluate Household Water Treatment Technologies

AquaPak

Product evaluation report

WHO performance classification	Comprehensive protection Three-star (★★★)
Manufacturer	Solar Solutions LLC 10080 Willow Creek Road San Diego CA 92131 United States www.solarcleanwatersolution.com
Evaluation procedure	Full laboratory testing
WHO report issue date	Round II, 2018
WHO reference number	20/07/2015-R2-22

Summary of evaluation

This report summarizes the results of laboratory testing of a solar pasteurization bag known by the tradename 'AquaPak', under Round II of the World Health Organization (WHO) International Scheme to Evaluate Household Water Treatment Technologies (the Scheme). Testing followed the requirements of the WHO protocol for solar (ultraviolet and heat) disinfection technologies. Testing investigated the ability of the device to inactivate bacteria, viruses and protozoa. Based on the evaluation results, the AquaPak meets WHO performance criteria and is classified as providing three-star (★★★) *Comprehensive protection* against bacteria, viruses and protozoa.

Background

Evaluation under the Scheme is based on performance criteria set out in *Evaluating Household Water Treatment Options: Health-based targets and microbiological performance specifications* (WHO, 2011). The criteria were determined by applying quantitative microbial risk assessment (QMRA) methods outlined in the WHO *Guidelines for Drinking-water Quality* (2017) and set out $\log_{10}$ reduction targets against bacteria, viruses and protozoa, as shown in Table 1.

Table 1. WHO performance criteria for household water treatment technologies

Performance classification	Bacteria ($\log_{10}$ reduction required)	Viruses ($\log_{10}$ reduction required)	Protozoa ($\log_{10}$ reduction required)	Interpretation (with correct and consistent use)
★ ★ ★	≥ 4	≥ 5	≥ 4	Comprehensive protection
★ ★	≥ 2	≥ 3	≥ 2	Comprehensive protection
★	Meets at least 2-star (★ ★) criteria for two classes of pathogens			Targeted protection
—	Fails to meet criteria for 1-star (★)			Little or no protection

Product description

The AquaPak is a pasteurization device that uses solar and thermal energy. The device consists of a 5 L polyethylene bag with a bubble pack layer of clear plastic on the front and a black plastic layer on the back. When the device is exposed to sunlight, the black layer radiates heat, which pasteurizes water in the bag. The bubble pack layer insulates the bag. The AquaPak has a 'treatment complete' indicator, a glass cap filled with orange-coloured wax that melts to a clear colour at 65 °C when the water has been sufficiently treated. The full description, illustrations and use instructions can be found at: www.solarcleanwatersolution.com.

Test methods

Product-specific test plan: A product-specific test plan was developed based on the manufacturer's instructions for use; the Harmonized Testing Protocol: Technology Non-Specific V 2.0 (WHO, 2018a); and the Solar (UV and Heat) Disinfection Technology Protocol V 2.0 (WHO, 2018b). Testing was conducted at a WHO-designated laboratory, KWR Watercycle Research Institute, in the Netherlands.

Test organisms: Evaluation of the AquaPak investigated its performance in reducing bacteria, viruses and protozoa. The test organisms were *Escherichia coli* (*E. coli*); coliphages MS2 and phiX174; and *Cryptosporidium parvum (C. parvum)* infectious oocysts, respectively.

Test waters: The device was tested in two simulated natural waters: General Test Water (GTW), simulating high quality groundwater, and Challenge Test Water (CTW), simulating surface water. Details on the physicochemical characteristics of the test waters are provided in the Solar (UV and heat) Disinfection Technology Protocol (WHO, 2018b)

Test set up: Three production units were used in the test, with daily test volumes of 3–5 L. The units were operated according to the manufacturer's use instructions. Solar and UV irradiance were simulated using the Atlas SUNTEST XXL instrument. Pretreatment and posttreatment water grab samples were analysed using methods identified in the product-specific test plan. Testing was conducted over four days (GTW on days 1 and 2; CTW on Days 3 and 4), resulting in a total of 12 sample points for each organism (i.e. 2 days × 2 test waters × 3 test units).

Results

Fig. 1 presents the mean $\log_{10}$ reductions for the three units in GTW and CTW. All GTW and CTW characteristics were within specifications.

Fig. 1 Performance across test units[1]
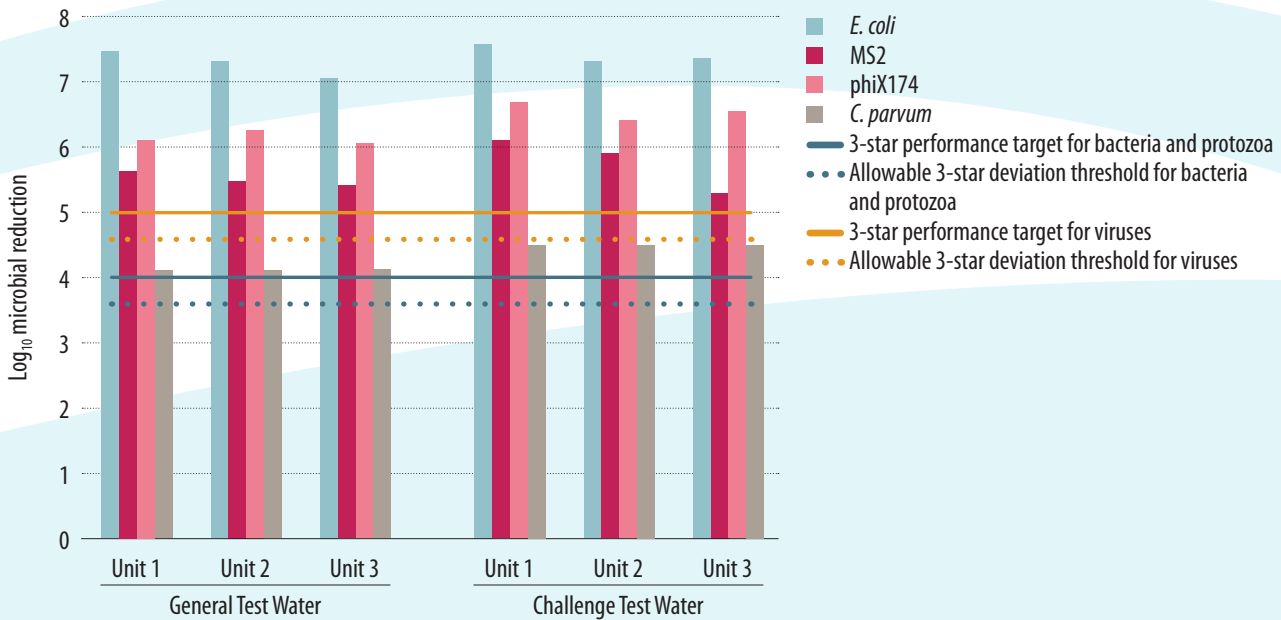
The AquaPak achieved mean $\log_{10}$ reductions of >7.3 for E. coli, >5.7 for MS2; >6.3 for phiX174; and >4.3 for *C. parvum*.

Interpretation and application of results

Performance is classified in three ascending tiers of performance: ★ (one-star); ★★ (two-star); and ★★★ (three-star), as shown in Table 1. Both three- and two-star products are classified as providing *Comprehensive protection* against all three microbial groups. One-star products are those that meet performance targets for only two of the three microbial groups, and are classified as providing *Targeted protection*.

Each production unit should consistently meet or exceed the performance target for each microbial group, and in both test waters (GTW and CTW). However, a maximum deviation of 0.2 $\log_{10}$ is acceptable for 25% of sample points at the two-star performance tier, and 0.4 $\log_{10}$ at the three-star performance tier[2]. This means that for classification as a two-star product, up to three of the twelve sample points can achieve a reduction of 1.8 $\log_{10}$ for bacteria or protozoan cysts (instead of 2 $\log_{10}$), or 2.8 $\log_{10}$ for viruses (instead of 3 $\log_{10}$). Each phage is treated separately for evaluating acceptable allowance, and the overall claim for viruses is based on the lower performing phage.

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[1]   The maximum microbial reduction that can be demonstrated is limited by the pretreatment challenge concentration delivered. For each organism tested, the pretreatment concentration must be sufficient to allow for the demonstration of the performance targets in the table showing the performance criteria. Due to the complexity of using viable organisms, there may be variation in these pretreatment concentrations above what is sufficient, which may lead to demonstrated reductions reported that far exceed the performance targets. However, the emphasis is on whether the performance target has been met and not the extent by which the target was exceeded.

[2]   These cut-off values were determined using QMRA modelling and selecting ranges that still resulted in appreciable health gains within a specific performance tier.

Performance classification

The AquaPak met the ★★★ (three-star) performance targets for bacteria, viruses and protozoa. It is classified as providing Comprehensive protection (★★★).

Considerations for product selection

Microbial conditions		Effective against bacteria, viruses and protozoa; can be used under all microbial water quality conditions
Physico-chemical water characteristics		Can be used in both turbid and non-turbid water; includes a pre-filter to help reduce turbidity
Environmental conditions		Relies on solar / thermal energy; most appropriate for sunny climates
Product information and labelling		Check that product is appropriately labelled and has clear instructions for use

References

WHO (2011). Evaluating household water treatment options: health-based targets and microbiological performance specifications. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/publications/household_water/en/).

WHO (2017). Guidelines for drinking-water quality, fourth edition. Incorporating the first addendum. Geneva: World Health Organization (https://www.who.int/water_sanitation_health/publications/dwq-guidelines-4/en/).

WHO (2018a). Harmonized Testing Protocol: Technology non-specific version 2.0. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/water-quality/household/household-water-treatment-scheme-resources/en/).

WHO (2018b). Solar (UV and heat) Disinfection Technology Protocol version 2.0. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/water-quality/household/household-water-treatment-scheme-resources/en/).

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