EVALUATING HOUSEHOLD WATER TREATMENT OPTIONS:

Health-based targets and microbiological performance specifications

World Health Organization

A2.5.5.2 Special considerations

Adenoviruses are more resistant to UV disinfection than any known non-pathogenic surrogate virus. However, the virus surrogate coliphage MS2 is relatively resistant to UV radiation and can be used to evaluate the performance of UV disinfection HWT technologies (Thurston-Enriquez et al., 2003). If the UV treatment process is operated as a flow-though or continuous flow reactor and flow rate can vary within a specified range, triplicate spiked water challenge tests should be performed at the average, maximum and minimum flow rates to document the range of microbiocidal effectiveness across the flow rate range.

Thermal Technologies: Include boiling and heating to pasteurization Temperatures (typically 63 degrees Celsius for 30 minutes).

A2.5.6 Thermal (heat-based) technologies

Thermal technologies are those whose primary mechanism for the destruction of microbes in water is heat produced by burning fuel. This includes boiling and heating to pasteurization temperatures (typically > 63 °C for 30 minutes). For example, pasteurization (Iijima et al., 2001) was found to improve household drinking-water quality in a trial in Kenya. Another field trial from Bangladesh demonstrated inactivation of thermotolerant coliforms using a pasteurization process (Islam & Johnston, 2006). Relatively low heat (55 °C) for several hours may inactivate key protozoan pathogens in water, such as *Cryptosporidium parvum*, *Giardia intestinalis* and *Entamoeba histolytica* (Feachem et al., 1983; Sobsey & Leland, 2001; Sobsey, 2002; Spinks et al., 2006). Boiling remains the most common form of household-scale water treatment worldwide, having been used to treat drinking-water since antiquity.

Because boiling of drinking-water is the most widespread practice for treating drinking-water in the world and, in theory, the most effective for reducing pathogens, it should, like other existing methods of water treatment, not be discouraged when alternative technologies are not as effective or are less likely to be used correctly, consistently and continuously. In practice, however, boiling may not be as effective as other strategies, for various reasons. Disadvantages to boiling include the following: boiling does not reduce sediment or turbidity; boiling may negatively affect taste; boiling heats up water so that it cannot be drunk immediately; the temperature achieved may not be easily measured; and the method may use large amounts of fuel. Boiling may not be a cost-effective or practical option in many places. Boiled water still must be safely stored to avoid contamination in the household, as well.

Technologies that use thermal energy for heat inactivation as the main mechanism for microbial reductions in water should be tested according to the manufacturer's or implementer's recommendations for use. The specifics of the temperature required and the length of time at this temperature that must be maintained for proper treatment should be included in the testing conditions. At a minimum, test waters 1 and 2 (Table A2.2) should be used to establish effectiveness over a range of water quality characteristics.

A2.5.6.1 Experimental time period and sampling schedule

Spiked challenge waters should be treated according to the manufacturer's or implementer's instructions as a batch process. If the process is a flow-through reactor, the manufacturer's instructions for operating conditions in challenge tests should be followed. Samples of untreated (raw challenge) and treated water should be taken for analysis according to the microbiological methods outlined below. A minimum of three such challenge tests should be performed, each with triplicate microbiological analysis.

Heat pasteurization is another example of a thermal technology.

Table A2.4. (continued)

Treatment process	Enteric pathogen group	Baseline removal (LRV)[b]	Maximum removal (LRV)[c]	Notes
UV light technologies using lamps				
UV irradiation	Bacteria	3	5+	Excessive turbidity and certain dissolved species inhibit process; effectiveness depends on fluence (dose), which varies with intensity, exposure time, UV wavelength
	Viruses	2	5+	
	Protozoa	3	5+	
Thermal (heat) technologies				
Thermal (e.g. boiling)[d]	Bacteria	6	9+	Values are based on vegetative cells; spores are more resistant to thermal inactivation than are vegetative cells; treatment to reduce spores by boiling must ensure sufficient temperature and time
	Viruses	6	9+	
	Protozoa	6	9+	
Sedimentation				
Simple sedimentation	Bacteria	0	0.5	Effective due to settling of particle-associated and large (sedimentable) microbes; varies with storage time and particulates in the water
	Viruses	0	0.5	
	Protozoa	0	1	
Combination treatment approaches				
Flocculation plus disinfection systems (e.g. commercial powder sachets or tablets)	Bacteria	7	9	Some removal of *Cryptosporidium* possible by coagulation
	Viruses	4.5	6	
	Protozoa	3	5	

LRV, $\log_{10}$ reduction value; MF, microfiltration; NF, nanofiltration; RO, reverse osmosis; UF, ultrafiltration

[a] $\log_{10}$ reduction value, a commonly used measure of microbial reduction, computed as $\log_{10}$ (pretreatment concentration) – $\log_{10}$ (post-treatment concentration).

[b] Baseline reductions are those typically expected in actual field practice when done by relatively unskilled persons who apply the treatment to raw waters of average and varying quality in developing countries and where there are minimum facilities or supporting instruments to optimize treatment conditions and practices.

[c] Maximum reductions are those possible when treatment is optimized by skilled operators who are supported with instrumentation and other tools to maintain the highest level of performance in waters of predictable and unchanging quality.

[d] Heat pasteurization is another example of a thermal technology. For further explanation of the process and references, refer to section A2.5.6.

Source: WHO (2011)