This report summarizes the results of evaluating a three-stage ultrafiltration device known by the tradename ‘Nanofilter™’, under Round III of the World Health Organization (WHO) International Scheme to Evaluate Household Water Treatment Technologies (the Scheme). Evaluation of the Nanofilter™ followed the requirements of the WHO protocol for filtration technologies and investigated the ability of the device to reduce bacteria and viruses. Reduction of protozoa was assigned based on the mean bacterial reduction achieved.

Based on the evaluation results, the Nanofilter™ meets WHO performance criteria and is classified as providing one-star (★) targeted protection against bacteria and protozoa.
1. 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 the quantitative microbial risk assessment (QMRA) methods outlined in the *Guidelines for Drinking-water Quality* (WHO, 2017) and set log_{10} reduction targets against bacteria, viruses and protozoa, as shown in the table below.

**Table 1. WHO performance criteria for household water treatment technologies**

<table>
<thead>
<tr>
<th>Performance classification</th>
<th>Bacteria (log_{10} reduction required)</th>
<th>Viruses (log_{10} reduction required)</th>
<th>Protozoa (log_{10} reduction required)</th>
<th>Interpretation (with correct and consistent use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>★★★★</td>
<td>≥ 4</td>
<td>≥ 5</td>
<td>≥ 4</td>
<td>Comprehensive protection</td>
</tr>
<tr>
<td>★★</td>
<td>≥ 2</td>
<td>≥ 3</td>
<td>≥ 2</td>
<td>Meets at least 2-star (★★) criteria for two classes of pathogens</td>
</tr>
<tr>
<td>★</td>
<td></td>
<td></td>
<td></td>
<td>Targeted protection</td>
</tr>
<tr>
<td>−</td>
<td></td>
<td></td>
<td></td>
<td>Little or no protection</td>
</tr>
</tbody>
</table>

**Product description**

The Nanofilter™ is a gravity-fed three-stage filtration device that combines slow sand, bone char and membrane filtration. The assembled unit comprises a series of three stacked buckets. Untreated water is poured into the top bucket, which contains sand, to remove turbidity and other particulates. In the next bucket, the water filters through a layer of bone char and a 0.1-micrometre ultrafiltration cartridge attached to it. The filtered water then passes into the third bucket with a spigot attached to it, through which the treated water can be collected.

The device is also available in two other models: the Double-Nanofilter™ with two filtration cartridges, and the Tetra-Nanofilter™ with four filtration cartridges.

The full product description, illustrations and use instructions can be found at www.gongalimodel.com.

2. Evaluation approach

**Product-specific test plan:** A product-specific test plan was developed based on the manufacturer’s instructions for use; the *Scheme Harmonized Testing Protocol: Technology Non-Specific V 2.0* (WHO, 2019); and the *Testing Protocol for Filtration Technologies V 3.2* (WHO, 2020). Testing was conducted at a WHO-designated laboratory, NSF International, in the United States.

**Test organisms:** Evaluation of the ROAMfilter Plus investigated its performance in removing bacteria and viruses. The test organisms were *Escherichia coli* (E. coli), representing bacteria, and coliphages MS2 and phiX174, representing viruses. Based on the available evidence on removal of protozoan cysts by filtration media, testing against this microbial group was not conducted (WHO, 2019). The protozoan reduction is assigned based on the mean bacterial reduction observed.

**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. Refer to the technology test plan for Filtration Batch Technologies V 3.2 for details on physicochemical characteristics of the test waters.

**Test procedure:** The manufacturer provided three units of the Gongali Single-Nanofilter for testing. However, parts arrived damaged, so only two units were tested. These units were operated according to the manufacturer’s instructions. Pretreatment and posttreatment water grab samples were analysed using the methods identified in the product-specific test plan. Testing was conducted over four days, in GTW on Days 1 and 2 and in CTW on Days 3 and 4, with microbial sampling at three points in each test phase, resulting in a total of 12 sample points for each organism (i.e. 3 sampling points x 2 test waters x 2 test units).
3. Results

Fig. 1 presents the results of the bacterial and viral testing for the two units in GTW and CTW. Alkalinity and turbidity were slightly above the limit on Test Day 3. All other test water characteristics were within specifications.

Fig. 1. Performance across test units

![Graph showing log10 microbial reduction for E. coli, MS2, and phiX174 in GTW and CTW for Unit 1 and Unit 2, with targets and deviations indicated.]

CTW: challenge test water; E. coli: Escherichia coli; GTW: general test water.

The Nanofilter™ achieved a mean log10 reduction of 6.74 for E. coli; 1.04 for MS2; and 2.57 for phiX174. Unit 1 performed slightly better than Unit 2.

4. Interpretation and application of results

As shown in Table 1, performance is classified in three ascending tiers: ★ (one-star); ★★ (two-star); and ★★★ (three-star). Both three- and two-star products provide comprehensive protection against all three microbial groups. One-star products meet performance targets for only two of the three microbial groups, providing targeted protection.

Each production unit should consistently meet or exceed the performance target for each microbial group in both test waters (GTW and CTW). However, a maximum deviation of 0.2 log$_{10}$s acceptable for 25% of sample points at the two-star performance tier and 0.4 log$_{10}$ at the three-star performance tier. This means that for classification as a two-star product, up to three of the 12 sample points can achieve a minimum 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.

---

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 shown in Table 1. Due to the complexity of using viable organisms, these pretreatment concentrations may be above what is sufficient, which may lead to demonstrated reductions 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 Nanofilter™ met performance targets for bacteria. For the protozoan reduction, a value of 6.74 log_{10} is assigned, based on the mean bacterial reduction achieved. The minimum performance target for viruses was not fully met. As such, the Nanofilter™ is classified as providing one-star (★) targeted protection against bacteria and protozoa only.

**Considerations for product selection**

<table>
<thead>
<tr>
<th>Microbial conditions</th>
<th>Use where contaminant of concern is known to be bacterial / protozoan microbes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physico-chemical water</td>
<td>Can be used to treat turbid water</td>
</tr>
<tr>
<td>characteristics</td>
<td></td>
</tr>
<tr>
<td>Product information and labelling</td>
<td>Check that the product is appropriately labelled and has clear instructions for use</td>
</tr>
</tbody>
</table>

**References**


**Disclaimer**

Reference to any company or product in this report, particularly those listed in any of the figures and tables, does not constitute an endorsement, certification or warranty of fitness by WHO of such company or product for any purpose, and does not imply any preference over companies or products of a similar nature that are not mentioned.

WHO does not warrant that any products included in the figures and tables are of acceptable quality; have obtained regulatory approval in any country; or are used in accordance with the national laws and regulations of any country, including but not limited to patent laws. Evaluation under the Scheme is intended to guide United Nations Member States and procuring United Nations agencies in the selection of household water treatment (HWT) technologies. Furthermore, inclusion of any products in this report, particularly in any of the figures and tables listed in the report, does not imply any approval by WHO of these products (which is the sole prerogative of national authorities).

The results in this report reflect the performance level that the product was found to meet at the time of testing. WHO cannot represent that the products reported herein will continue to meet the stated performance levels. Furthermore, the results contained in this report may not be used by manufacturers, suppliers or any other parties for commercial or promotional purposes.