

## Welcome to a Special Edition of the Technical Bulletin!

This is a special edition of our technical bulletin to launch **biosand filter "Version 10"**. In March 2009, CAWST expressed its plan to field test Version 10 during the first half of the year. The results are in and CAWST is pleased to share with you the improved biosand filter design.

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### Current biosand filter Version 9

Version 9 of the biosand filter is effective. [Research studies<sup>1</sup>](#) have shown that the filter removes 87.9% - 98.5% of bacteria, 70 to 99% of viruses, >99.9% of protozoa and up to 100% of helminths. In addition, Version 9 of the biosand filter has been shown to reduce diarrheal disease by approximately 47% according to a [study<sup>2</sup>](#) conducted by the University of North Carolina (Stauber, 2009).

Version 9 of the biosand filter is working well; however, CAWST is recommending that clients should consider migrating to Version 10.

### Why CAWST reviewed the current design?

In laboratory studies by three independent [research<sup>3</sup>](#) teams, the portion of the water that remained in the filter during the pause period had much better bacteria and virus removal compared to the water that passed directly through the filter without a pause period. This variation in filtered water quality is because the fill volume (or 'reservoir' volume: the amount of water that can be poured into the filter at one time) is greater than the pore volume of the filtration sand (the volume in the void spaces between the sand grains).

In addition, CAWST has learned that reducing the depth of the reservoir and decreasing the flow rate in the filter will further improve the filter's effectiveness.

CAWST has concluded, based on these research learnings, that the biosand filter design should be reviewed.

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<sup>1</sup> [http://www.cawst.org/assets/File/BSF\\_Literature\\_Brief.pdf](http://www.cawst.org/assets/File/BSF_Literature_Brief.pdf)

<sup>2</sup> <http://www.ajtmh.org/cgi/content/abstract/80/2/286?ck=nck>

<sup>3</sup> [http://www.cawst.org/assets/File/BSF\\_Version\\_10\\_Research.pdf](http://www.cawst.org/assets/File/BSF_Version_10_Research.pdf)

## What changes were made in Version 10?

To address the key issues identified in the research, CAWST recommends that clients should migrate to Version 10 of the biosand filter. Version 10 includes the following modifications:

- The filter size (height and width) are the same as the previous design, but the height of the spout and the diffuser location has changed. The spout is higher, and therefore the nose of the filter is shaped differently.
- The filtration sand (the fine sand bed) depth is increased by 10 cm (4 inches) to 55 cm (21.6 inches) in Version 10. This means that there is about 22% more fine sand in the filter. The separating gravel (6 mm or ¼ inch) and underdrain gravel (12 mm or ½ inch) layers remain the same.
- The depth of the reservoir (which provides the gravity 'head' pressure) is reduced by 10 cm (4 inches) to 17 cm (6.7 inches). This will cause the initial flow rate (when the filter has been filled to the top) to be about 1/3 less.
- The recommended flow rate is 0.4 L/min (measured when the reservoir is full to the top). It will take a longer period of time to filter the same volume of water.
- The maximum fill volume is 12 litres in Version 10 compared with about 18 litres in the previous design. This means that the filter will need to be filled more often to treat the same amount of water.

**Table 1: Comparing Version 8/9 and 10**

	<b>Version 8/9</b>	<b>Version 10</b>
Depth of the reservoir	27 cm (10.6 inches)	17 cm (6.7 inches)
Maximum fill volume	18 litres	12 litres
Filtration sand depth (fine sand bed)	45 cm (17.7 inches)	55 cm (21.6 inches)
Separating gravel (6 mm or ¼ inch)	5 cm (2 inches)	5 cm (2 inches)
Underdrain gravel (12 mm or ½ inch)	5 cm (2 inches)	5 cm (2 inches)
Flow rate	0.6 L /min	0.4 L /min

For more information on the changes made for Version 10, see the following presentation: [http://www.cawst.org/assets/File/BSF\\_Version\\_10\\_Changes.pdf](http://www.cawst.org/assets/File/BSF_Version_10_Changes.pdf)

## Evaluation test results for Version 10

CAWST believed that the changes were significant enough that Version 10 should be field tested before recommending it to our clients. The main questions we set out to answer were:

1. Will the reduced 'head' (the height of the water above the outlet) and greater depth of filter sand lead to the flow rate becoming unacceptably slow or stopping prematurely?
2. What are the perceptions of the household users towards Version 10?

In India, the [DHAN Foundation](#)<sup>4</sup> tested 12 filters used in households for approximately 3 months where the source water was from both a river and boreholes. In Zambia, [Seeds of Hope International Partnerships \(SHIP\)](#)<sup>5</sup> monitored 10 filters for nearly 3 months as well. The two evaluations included visits to each household with a structured questionnaire as well as measurements of the filter flow rate and turbidity of both the source and filtered water.

The Zambia and India filters performed similarly. The [evaluation test results](#)<sup>6</sup> showed no serious flow problems with the new design, although, as expected, flow rates were generally 0.3 to 0.5 L/min. This is lower than the current design (0.6 L/min) because of the reduced 'head' and additional sand depth. All users (100%) in both evaluations stated that they liked the filter and would recommend it – perceptions in all other aspects were also good. The filters proved effective in reducing turbidity; however the highest source water turbidity was only 13 NTU, so frequent cleaning was not required during the field tests.

While these tests did not cover every situation that the biosand filter may encounter, the results were very positive. CAWST believes that the research is sufficiently compelling to recommend Version 10 to our clients at this time.

## Making the change to Version 10

CAWST believes that Version 10 is a significant improvement over Version 9 that will better protect the health of the people drinking the filtered water. For this reason, CAWST recommends that our clients change to Version 10. We recognize that the cost of fabricating new molds is a significant investment for an organization. Biosand filter Version 9 remains an effective filter, and CAWST will continue to support our clients regardless of the version used. You can choose to change to Version 10 immediately, or consider a phased approach to reduce the cost of fabricating new molds.

For clients wishing to implement Version 10 there are several options:

1. Fabricate new molds
2. Modify the exterior mold and build a new interior mold
3. Modify the exterior mold and use the existing interior mold with a diffuser basin instead of a diffuser plate

### **1. Fabricate new molds**

Option 1 is the preferred option, but given the cost of molds, may not be a good option for some clients. The Version 10 fabrication instructions are now available in the new [Biosand Filter Manual](#)<sup>7</sup>.

### **2. Modify the exterior mold and build a new interior mold**

Existing exterior molds can be modified by changing the 'nose panel'. The other three panels remain the same. To change the nose panel:

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<sup>4</sup> <http://www.dhan.org/>

<sup>5</sup> <http://www.sohip.org/>

<sup>6</sup> [http://www.cawst.org/assets/File/BSF\\_Version\\_10\\_Evaluation\\_Results.pdf](http://www.cawst.org/assets/File/BSF_Version_10_Evaluation_Results.pdf)

<sup>7</sup> [http://www.cawst.org/assets/File/Biosand\\_Filter\\_Manual\\_Version\\_10\\_Sep09.pdf](http://www.cawst.org/assets/File/Biosand_Filter_Manual_Version_10_Sep09.pdf)

- Remove the existing nose piece
- Weld a 6 mm plate to fill the original cut-out hole
- Cut a new hole in the panel for the new nose piece
- Cut the new nose pieces
- Assemble and weld the new nose pieces

Fabricate a new interior mold, with the ledge for the diffuser plate 10 cm higher. Complete instructions are provided in the [Biosand Filter Manual](#)<sup>8</sup>.

### **3. Modify the exterior mold and use the existing interior mold with a diffuser box instead of a diffuser plate**

Modify the exterior mold by changing the 'nose panel' (see Option 2 above for instructions). Use the existing interior mold and install filters with a diffuser box instead of a diffuser plate. If diffuser boxes are used, then the diffuser ledge is no longer needed, therefore it is not necessary to modify the existing interior mold.

A diffuser box is often preferred because diffuser plates often become bent, broken or do not fit properly. This allows fast moving water to go around the plate and disturb the biolayer at the top of the sand. This disturbance can allow the contaminated water to 'bypass' the biolayer potentially reducing the effectiveness of the filter. Diffuser boxes prevent this since the water can only flow through the small holes at the bottom.

The diffuser box is more costly than the diffuser plate since it uses about 4 times more galvanized sheet metal and often requires a local sheet metal worker (or equivalent trained worker) to fabricate the box.

Complete instructions for building a diffuser box are provided in the Biosand Filter Manual.

## **Key operating conditions for Version 10**

The following applies to any version of the biosand filter that is being used. Proper installation includes a high quality filter body, lid, diffuser, safe storage container and well prepared filtration sand. Our recommendation for preparing the filtration sand is to use 0.7 mm (0.028") opening size screen, also called #24 wire mesh. The detailed instructions for construction, installation and operation are in CAWST's Biosand Filter Manual.

If a filter is not installed properly or is not being operated properly, then we can expect that the filter is not working properly. It may not produce good water consistently.

The following eight operating conditions must be met for the Version 10 biosand filter to work properly and consistently:

1. Filter is used for at least one month since installation
2. Filter is used at least once each day
3. Source water is not too turbid (less than 50 NTU)
4. The concrete filter body is not leaking
5. Diffuser is in place and in good condition

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<sup>8</sup> [http://www.cawst.org/assets/File/Biosand\\_Filter\\_Manual\\_Version\\_10\\_Sep09.pdf](http://www.cawst.org/assets/File/Biosand_Filter_Manual_Version_10_Sep09.pdf)

6. Water level is 5 cm above the sand during the pause period
7. Top of sand is level
8. Flow rate is 0.4 litres per minute or slower (Note: The flow rate for Version 8 or Version 9 is 0.6 litres per minute or slower)

CAWST recommends checking these eight operating conditions and fixing any identified problems to ensure the best results.

### **New training resources for Version 10**

Download the [Biosand Filter Manual](#)<sup>9</sup> for more information on Version 10. See also the [frequently asked questions](#)<sup>10</sup> about Version 10 for additional information.

### **Questions for CAWST**

If you have any problems or questions, please contact the International Technical Advisor for your region or e-mail Ron Lentz at [rlentz@cawst.org](mailto:rlentz@cawst.org).

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<sup>9</sup> [http://www.cawst.org/assets/File/Biosand\\_Filter\\_Manual\\_Version\\_10\\_Sep09.pdf](http://www.cawst.org/assets/File/Biosand_Filter_Manual_Version_10_Sep09.pdf)

<sup>10</sup> <http://www.cawst.org/index.php?id=325>