

Bio-Sand Filtration

Filter Construction Guidelines



Introduction

On the following pages, you will find an illustrated construction guide that will take you step-by-step through the process of building your own bio-sand filter. Please note that you will first need a metal mould of improved round design. If you don't have your own mould yet, you can easily build one using the illustrated mould construction guide that is available from www.biosandfilter.org.

The author collected much of the information in this document during a project that was financed and implemented by Medair in Kenya, in 2000. Check www.medair.org for more information on the humanitarian programmes implemented by this organization.

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Under ideal circumstances, the bio-sand filter can produce drinking water of excellent quality, which is safe to drink without further treatment. However, this cannot always be guaranteed. BioSandFilter.org and the author(s) shall not be liable to anyone whatsoever for any damage resulting from reliance on any information contained in this document.

This also applies to the consumption of water produced by a bio-sand filter. It should be noted that a bio-sand filter cannot be relied upon to remove chemical contamination.

List of Required Materials

To build a filter using an improved round mould, the following materials are necessary:

Filter material

- Portland cement
- River sand, clean without clay
- Gravel / aggregate 5 – 10 mm, clean
- PVC pipe with maximum outer diameter of 20 mm, cut to length of 84 cm
- PVC elbows (x 3) to fit PVC pipe (optional, only needed if you will not bend PVC pipe using heat)
- Cooking fat or margarine (NB: not engine oil)

Tools

- 1 metal mould
- 2 spanners (no.17) to open the bolts securing the mould parts
- 1 hacksaw to adjust PVC pipe length
- Sieve for gravel and sand
- Masonry tools (trowel, shovel, spirit level, etc)
- 1 piece of iron reinforcement bar (1 metre long)
- 1 rubber mallet to vibrate/compact the concrete

Casting procedure

Step 1 – Preparing the PVC pipe, greasing and assembling the mould

There are two ways to make the PVC pipe that is cast inside the concrete. The first way is to use PVC elbows, but the filter cost then increases, while the second way is to just bend the pipe using heat.



Take the PVC pipe and cut one section of 40 mm length and a second section of 560 mm length.



Clean the surfaces to be glued with pipe cleaner or turpentine, roughen them, apply glue and join.



The pipe then looks like this. A final piece of 20 mm PVC pipe then needs to be cut and glued to the last elbow which will go through the nose plate.



The second method uses heat to create the bends. Fill the PVC pipe with sand, knock it so that the sand is compacted, then block the openings (e.g. with bits of plastic bags, or wet clay).



Heat the pipe over a fire, turning continuously. When it becomes floppy, bend it to the desired shape and fix the shape by dousing with water.



Cut to 2 cm after heating to fit into filter when casting. It is 5cm here since it is easier to bend when longer.

The dimensions of the pipe will vary slightly according to your mould and will probably need adjustment, but use the dimensions above for an initial trial. The 5 cm dimension (left hand above) will need to be cut to lie flat against the mould's inner core.

To test the pipe, the mould needs to be assembled.



Assemble the two outer halves of the mould using the bolts.



Grease the inner core with cooking fat, paying attention especially to the diffuser plate ledge.



Also grease the inner sides of the outer shell.



Lower the inner core carefully into the outer shell.

Note: Do not apply used engine oil since the finished surfaces will be in contact with drinking water.



Secure the inner core to outer shell with bolts.



Insert the nose plate and lock it into place using the bolt.



Turn the mould upside down. Test the PVC pipe for size. The pipe should protrude comfortably through the hole in the nose plate.

The inner side of the hooked end of the pipe (the end near the nose plate) should sit as close as possible to the lip of the metal mould. This is so that the resting water level in the concrete filter will be below the ledge for the diffuser plate – if the pipe is set too high in the concrete, the final water level will submerge the diffuser plate.



Once the pipe dimensions are correct, you can use the pipe to create a mould from mortar (1 part cement, 4 parts sand) which can serve as a guide for all subsequent pipes.



Insert the PVC pipe with correct dimensions. Secure the pipe in place by lightly tightening the bolt protruding from the base of the front shell. This bolt presses the bend of the PVC pipe flush against the inner core.

Step 2 – Making and pouring concrete



Sieve the gravel using 2 sieves of 10 mm and 5 mm. This is to remove stones with too large a diameter. If the gravel is not clean, it should be washed after sieving.



Weigh the gravel, sand and cement to achieve correct mixture. More commonly, this can also be done by volume.



Mix concrete to the ratio of 1 : 2 : 2 (by weight or volume):

- Cement 1 part
- Sand 2 parts
- Gravel 2 parts

Mix evenly as a dry mixture first. Add just enough water to allow workability – adding too much water will result in weaker concrete and subsidence in the mould.



Add the concrete into the mould using small quantities at a time.



Remove any air pockets in the mixture by tamping the concrete in the mould with a rod or stick, but avoid hitting the PVC pipe. Also tap the outside of the mould with a rubber mallet. Ensure especially that the nose is filled with concrete.

Do this enough to get rid of the air, but not too vigorously so that the cement migrates upwards in your mixture.



Continue filling up to the top. Make a smooth, flat finish, since this will become the bottom of the filter. If not flat, the filter will not stand evenly.

Step 3 – Removing the filter



Allow for a setting time of 24 minimum before removing the mould. Turn the mould the right way up, remove the bolts securing the inner core, but leave the two outer shells locked together.



Install the puller in the bushes on the sides of the outer shells, and screw the threaded centre bolt into the inner core.



Turn the threaded centre bolt on the puller using a lever. Some force may be necessary. If it does not come out easily, it could be that the mould is dented or was not greased sufficiently.



Some gentle tapping on the outer shell with a rubber mallet may help to break the grip.



At a certain stage, you can remove the inner core by hand.



Unscrew the bolts from the sides of the outer shells.



Remove the nose plate, and unscrew the bolt near the base that secured the PVC pipe.



Carefully, pull the two halves apart. The shell with the nose can be more easily removed by tilting the filter backwards while first pulling the shell outwards from the base.



Repair any holes with cement mortar (1 part cement, 3 parts sand).



Do not forget to also fill the hole left by the bolt that originally secured the PVC pipe. Wait for a few hours after doing this, and then commence the curing process.

Curing:

The concrete filter should be cured for 7 days. Curing is where the concrete is kept wet in order to allow chemical hydration processes to occur, making the concrete stronger and more waterproof. To cure the filter, plug the PVC outlet pipe (e.g. with some bits of plastic bag), and fill the filter with water to the brim.

Do not be alarmed if the filter wall leaks at various places – these leaks should stop within some hours as the concrete cures.

Sometimes where a fissure has been created when the mould was removed, water will continue to flow. In such a case, empty the water out, scrape out the concrete along the line of the fissure and repair with mortar.

Note:

If the mould is to be used for intensive production then it is possible to use more outer shells with only one inner core. If handled carefully, the inner core can be removed after 8 - 12 hours.

Order information:

This mould is also available ready-made. For more information, email info@biosandfilter.org.

Credits:

This mould was designed by Jitu Jawahar Patani and Adriaan Mol in Nairobi, Kenya in 2000.