Slow Sand Filters Tipsheet 50p

Safe drinking water is a high priority for people living without mains facilities. This tipsheet will help you construct a reliable filter for cleaning water without using chemicals or energy.

Centre for Alternative Technology Publications

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Slow sand filters provide a low maintenance, no energy system for purifying water. They remove bacteria and other small particles without the use of chemicals. A sand filter doesn't guarantee to be 100% effective in its removal of bacteria, all the time, but it is very good as a primary filter. At CAT we use a sand filtration system but we pass the water through a small ultraviolet filter as an extra precaution. This tipsheet provides a basic introduction to the subject and the sand filter described below is designed for private use only.

Water source

It is important to start off with a fairly clean source of water (i.e. not cloudy with suspended solids and away from possible animal and bacterial contamination). If in doubt, get a sample tested by contacting your Local Authority Environmental Health Officer. When you have found a source for your potential supply you must consult the Environment Agency and the Environment Health Department about your proposed abstraction and ensure the 'finished product' complies with the Private Water Supply Regulations (1991).

They will often offer to come and test the water for you to ensure it is clean and pure (although they will charge for subsequent 'check-up' visits).

Even spring water or very clean river water should be checked for undesirable contaminants. Sand filters do not remove heavy metals, chemicals or excessive organic pollutants. Their prime purpose is to remove bacteria and particles from the water. If your chosen water source does have a high level of contamination, ideally you should locate a new one. If this isn't possible other methods of filtration may be used, depending on the level of contamination, e.g. carbon filers or ion-exchange resin filters (see CAT's *Water Filters* tipsheet). If the water contains sediment, it should be passed through an initial settling tank before it gets to the sand filter.

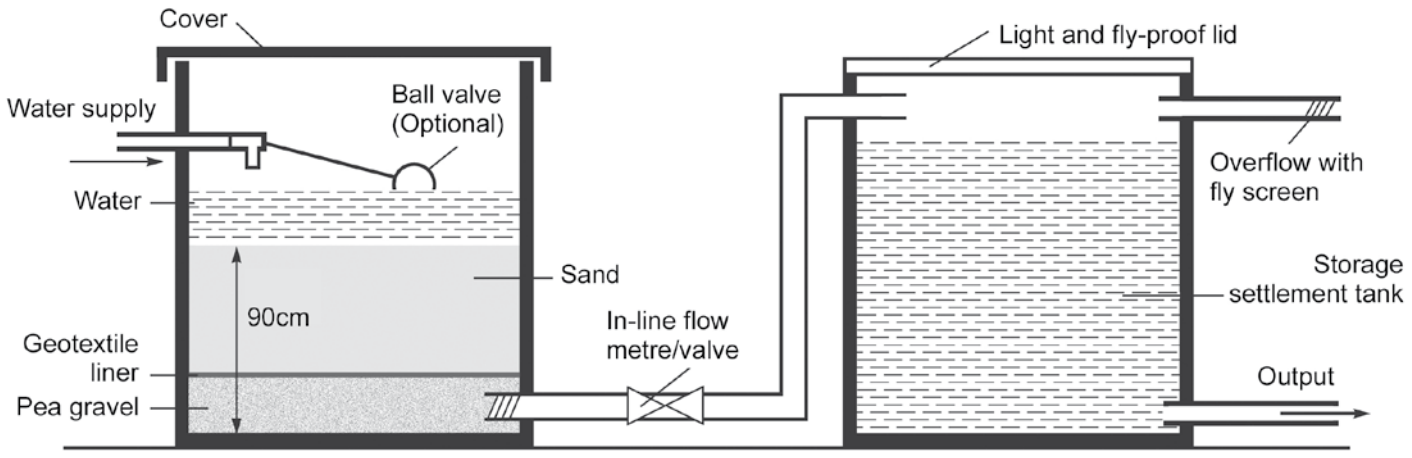
How the filter works

Water passes through the filter from top to bottom under pressure from the supernatant, the name given to the water above the sand. Algae growing on top of the sand forms a sticky mat which strains out passing particles. Smaller bits of organic material are deposited in the top few centimetres of the filter forming a slime around the sand grains which is eaten by grazing microscopic organisms including bacteria and protozoans. Provided that the grain size is around 0.1mm in diameter, a sand filter can remove faecal coliforms (bacteria that are an indication of faecal contamination) virtually all viruses and even discolouration.

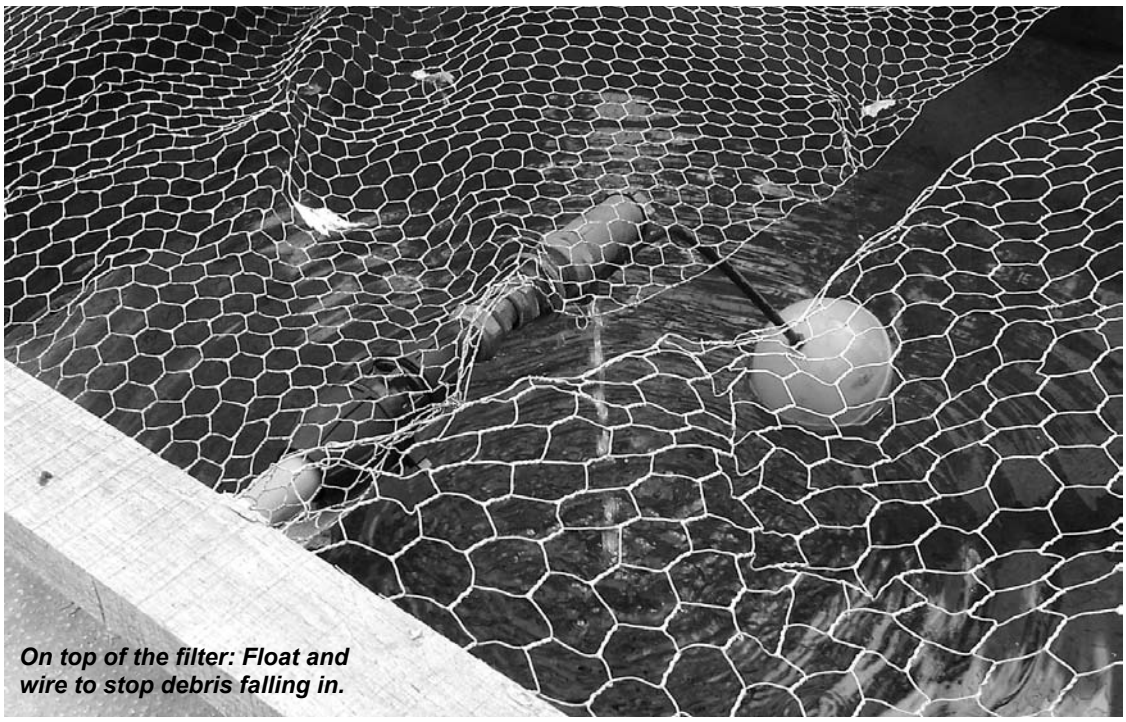
Construction

Sand filters can be constructed from rendered block, by setting a concrete ring onto a concrete slab or a polyethylene tank. The internal sides should be constructed with a rough finish. This stops the water taking the quickest route down the sides of the container and forces it to pass through the sand. A lid should be fitted to stop leaves and other debris entering the tank. In hot climates this should not allow any light in, as algal growth can be a problem. This is different in colder climates where sand filters benefit from the extra UV an open top brings.

10cm of washed pea gravel should be placed at the bottom of the container, covered by a layer of geotextile (any synthetic,



A simple slow sand filter. This simple filter works on the principle of slow sand filters in municipal waste treatment plants. The water is filtered by the sand itself, and by the layer of micro-organisms that develops on top of the sand. A nylon curtain makes a good geotextile liner.



On top of the filter: Float and wire to stop debris falling in.

Although the time spent is small, conscientious attention to detail is essential. Filters can be satisfactorily left while users are away, but must always be checked on return.

Controlling filtration

Controlling the rate of filtration is one important aspect of effective operation. If you fit an in-line flow meter and valve on the outlet pipe you can monitor the water flow. Ideally the flow should be 0.1-0.2m^3 (100-200 litres) of water per m^2 of sand per hour to ensure good treatment.

water permeable fabric with a tight weave, e.g. a nylon curtain) and 80cm of fine, non-silt sand. The sand must be washed prior to use to remove any remaining silt. Filters should not be smaller than 1m^2 (the minimal cross-sectional area), even if very few people are using it. This will serve between four and ten people. Allow at least 0.02-0.08m^2 per person. The depth of the supernatant should be no less than 0.3m, and no more than 1.2m

Maintenance

Sand filters cannot be backwashed to clean like other water filters and it is unwise to add chemical cleaners to a biological system. Instead the filter will need to be drained for cleaning every three or four months.

A 2cm depth of sand will need to be removed from the top of the sand filter. This will remove the biologically active layer which tends to clog over time. This sand can be rinsed clean and returned to the filter or removed. Eventually the depth of sand will drop to 0.5m. It should then be topped up to around 0.8m. During times of hard frost, a tap in the house should always be kept running to prevent the system freezing over, and water from the filter should be piped to a storage tank. It is essential that water flows continuously otherwise the filtrating bacteria will die and the filter will fail.

If an assured supply is required, two filters should be built in parallel, so one can be used while the other is being cleaned, or if any unforeseen problems arise.

It is preferable to avoid pumping the filtered water, since energy is required to run the pump. If the water source and filter are well above the storage tanks, pumping will not be necessary. However, as header tanks will sometimes need to be situated in the roof space of a dwelling, or at least upstairs, this will not always be possible.

It should be noted that, despite their apparent simplicity, the construction and operation of sand filters must be carried out with great care. When in use they must be checked regularly. Measurements will need to be made to determine average daily requirements for the household. You could set up a small experiment to work this out, either by deflecting the end of the waste pipes into a dustbin or similar store or by measuring at the source (i.e. at the tap or cistern). Either way, measure over one week and record your findings daily. At the end of the week work out a daily average.

Using these two pieces of information, the required size of water storage facility can be calculated. The flow into the filter can be adjusted using a valve. In addition, a ball valve can be used to maintain the water level.

The water flow through the filter must be maintained continuously. With a constant supply this can be achieved simply by fitting an overflow to the storage tanks. If the water source is limited or intermittent the filtered water can be pumped back to the top of the supernatant when necessary, but this does require pumping and control gear.

Further treatment

Although sand filters are an excellent way of upgrading 'raw' water they can never fully guarantee ultimate safety. If water is to be used for the public or if very young or old people use the supply, it would be sensible to install an ultraviolet filter in the house to kill off any remaining bacteria.

Further reading

- *The Water Book: find it, move it, store it, clean it… use it*, Judith Thornton, CAT Publications
- *Water Treatment and Sanitation*, Mann and Williamson, Intermediate Technology Publications
- *Water filters,* CAT tipsheet

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