Slow Sand Filter

Introduction

The Slow Sand Filter is a very low technology method to improve the quality of water contaminated with micro-biologic pathogens. It can purify water to the point where it is safe for human consumption. With simple training, almost anyone can successfully build a functional Slow Sand Filter. Many of the materials used to build the filter can be obtained locally at low cost or even free. The three main raw materials that can often be obtained locally are gravel of varying sizes, sand and flat rocks. The external inputs are a container such as a 55 gallon plastic barrel and PVC pipes with associated connectors. The technology is simple enough that local people can build and maintain the filters with minimal training.

Basics of Filter Operation

The primary filtering action of the Slow Sand Filter occurs in the sand layer, however, it is not the sand itself that does the micron-level filtering. A complex colony of micro-organisms, primarily algae, forms in the wet sand layer. It is this slime layer, or Schmutzdecke as it is called, that removes the pathogens. The sand does remove larger particles from the water, but the sand's main purpose is to support the Schmutzdecke layer. As with most filters, the Slow Sand Filter cannot reliably remove viruses, but it can remove bacteria, parasites and parasite cysts and eggs.

Construction involves five main steps.

1. Build a simple 1/2” PVC pipe structure and install in the barrel.
2. Fill the bottom third of the barrel with small gravel.
3. Fill the barrel with fine, clean sand to within 6-8 inches of the top.
4. Place flat rocks on the top of the sand layer
5. Fill the filter with water.

The filter does not become fully functional for a few days or weeks until the Schmutzdecke layer forms. Because the Schmutzdecke layer is composed of microorganisms, bleach would kill the Schmutzdecke layer, reducing the effectiveness of the filter. Over time, the flow of water through the filter may slow. This usually results from silt blocking water flow through the sand layer. This problem can be rectified by removing the sand layer and either cleaning the sand or replacing the sand. The Schmutzdecke layer would need to be reformed after the sand layer is rebuilt. Areas that only have silty water will require more frequent cleaning/replacement of the sand layer than areas with clear water.

Another common cause of reduced water flow occurs almost immediately after construction. If the gravel layer is too thin or the gravel is not fine enough, sand from the sand layer will travel through the gravel layer and block the PVC pipe at the bottom of the barrel. If within 1-2 weeks of placing the filter into use, water no longer flows through the filter, blocking of the PVC pipe by sand is the most likely cause. If the water being filtered is extremely silty, this could be another cause. The Slow Sand Filter may not be an appropriate filtering solution in areas with extremely silty water, unless the silt/turbidity problem is first corrected by other means (see separate chapter).

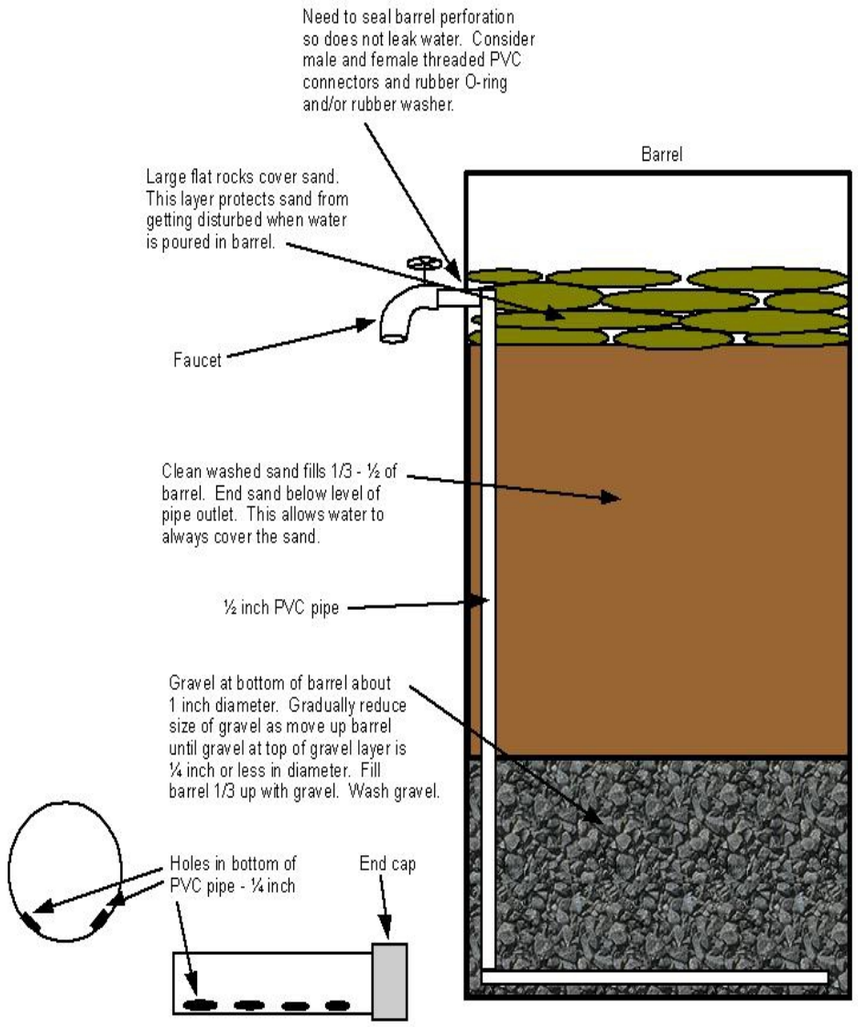
Parts List

Materials

- 1 @ 25 - 55 gallon plastic barrel (ensure prior contents not toxic)
- 6 feet @ 1/2 inch PVC pipe
- 1 @ 1/2 inch PVC end cap
- 2 @ 1/2 inch PVC 90 degree elbows
- 1 @ 1/2 inch PVC female thread to female slip
- 1 @ 1/2 inch PVC male thread to whatever faucet accepts
- (this may not be needed depending on adapter immediately above: 1 @ 1/2 inch PVC connector to attach faucet to PVC pipe)
- 1 @ 1/2 inch faucet – PVC fine, but brass/bronze lasts longer
- 2 @ rubber washers for 1/2 inch PVC adapter perforation of barrel side
- 1 @ small can PVC cement
- 1 @ roll of teflon tape
- Pea gravel – enough to fill about 8 inches of bottom of barrel
- Fine clean sand – enough to fill barrel from top of pea gravel layer to 6 inches from top
- Flat rocks – enough to completely cover top of sand layer – often 3-4 rocks deep

Tools

- Drill – power/battery drill makes work easier
- Drill bits – 3/16 inch and bit that just allows male 1/2 PVC male threaded adapter through.
- Sandpaper – 150-180 grit
- Clean cloth
- Hacksaw, or power hand-held jig saw (makes work much faster)


Need to seal barrel perforation so does not leak water. Consider male and female threaded PVC connectors and rubber O-ring and/or rubber washer.
Barrel
Large flat rocks cover sand. This layer protects sand from getting disturbed when water is poured in barrel.
Faucet
Clean washed sand fills 1/3 - ½ of barrel. End sand below level of pipe outlet. This allows water to always cover the sand.
½ inch PVC pipe
Gravel at bottom of barrel about 1 inch diameter. Gradually reduce size of gravel as move up barrel until gravel at top of gravel layer is ¼ inch or less in diameter. Fill barrel 1/3 up with gravel. Wash gravel.
Holes in bottom of PVC pipe - ¼ inch
End cap

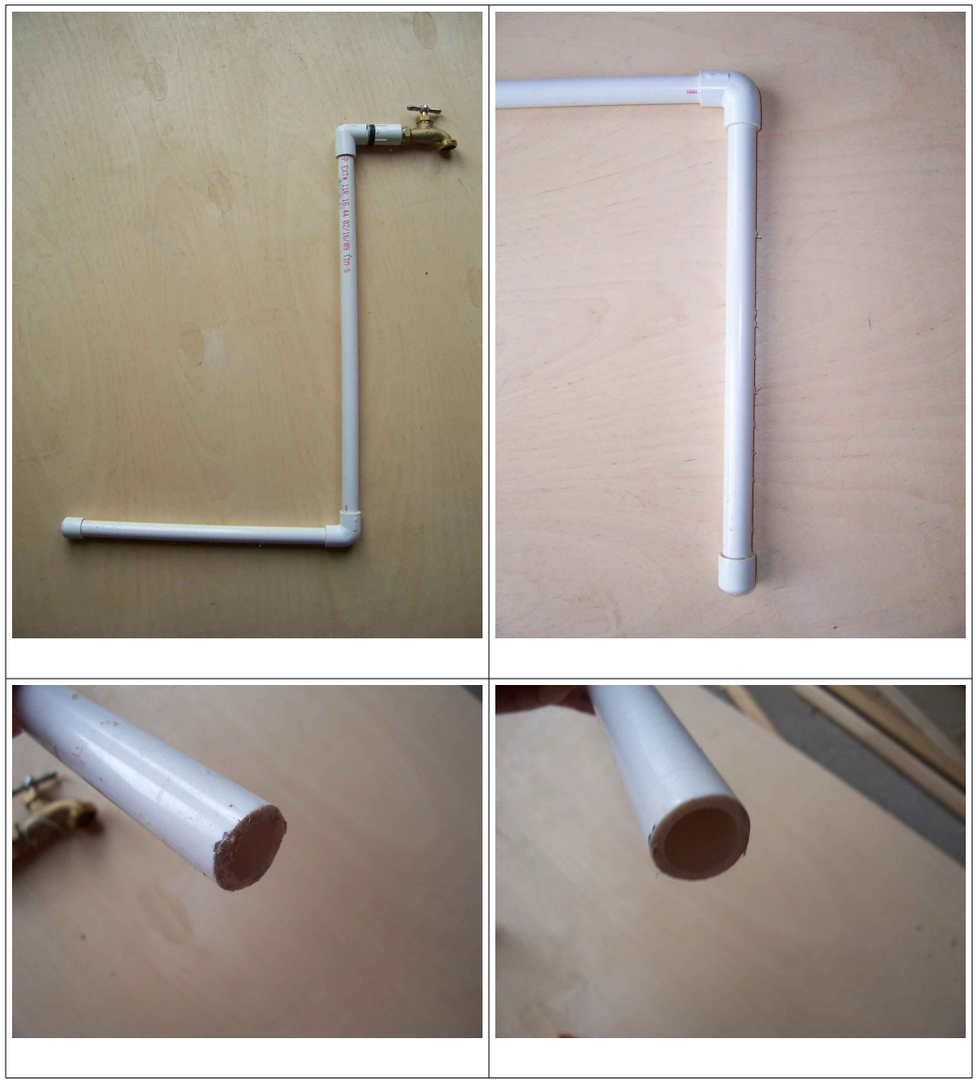
Topics in Appropriate Technology for Developing Countries

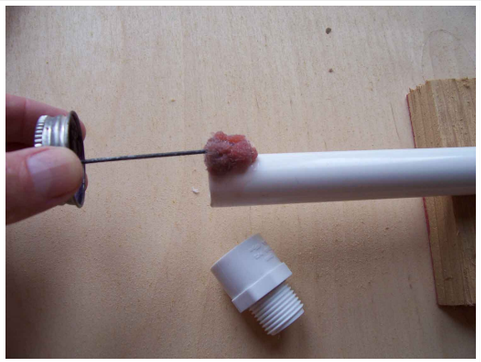
Gluing PVC

- Ensure end of cut PVC square, not angled
- Clean off the two joints to be glued together lightly with sand paper (180-400 grit). Do not take off too much material with the sand paper or the joints will not fit together well.
- Wipe both mating surfaces with a clean dry cloth. Ensure no moisture, dirt or dust is on the mating surfaces.
- If available, use PVC cleaner on both mating surfaces to ensure clean joint surfaces. Lightly rub the mating surfaces with the applicator until the surfaces are moistened. In many areas with limited resources, PVC cleaner will not be available so this step is skipped.
- Pre-fit surfaces to ensure fit is tight and that when assembled project will be correct dimensions. Once the two joints are glued, they cannot be taken apart.
- Apply PVC cement to **both** mating surfaces until entire mating surfaces are wet with cement.
- Insert the male end into the female end until fully inserted. Then promptly spin the male surface inside the female surface 90 degrees and hold the joint in place for at least one minute.

Creating leak-free screw-type fittings

Teflon tape or pipe dope must be used whenever threaded joints are screwed together. Not doing this will result in a slow leak. Teflon tape is low cost and very easy to use. When facing the end of the male joint (on end), wrap teflon tape clockwise onto the entire male threaded surface at least 3-4 revolutions. Then screw the teflon-tape covered male end into the female end.





Treating water with Chlorine/Bleach
Common bleach (sodium hypochloride) is a simple method to make water safe for drinking. Although it may not be available in rural areas, it can usually be purchased in larger cities at grocery stores. Bleach is easy to use and effective. The downsides include recurring cost, unavailable at times, chlorine taste of water, and the dangers to inexperienced persons and children in handling bleach.

The table below lists common amounts to use of beach to make water potable. Note that the higher quantity of bleach will provide a strong taste of chlorine. More chlorine is needed if there is organic matter in the water because the organic matter binds the free chlorine, making the amount available to kill microbes less. Leaving the water open to air can reduce the chlorine taste, but this takes time and then exposes the water to new contamination.

Treating Water with Bleach

Volume water	Volume bleach	
	Water clear	Water cloudy
1 liter	1 drop	2 drops
1 quart	1 drop	2 drops
1 gallon	0.25 ml	0.5 ml
5 gallons	1.25 ml	2.5 ml
55 gallons	12.5 ml	25 ml
500 gallons	125.5 ml	250 ml

Potters for Peace Ceramic Filter
The Potters for Peace filter is a small, household-level filter that works well at removing bacteria and parasites from water. It does not reliably kill viruses. The filter looks a bit like a clay flower pot that hangs inside a plastic bucket. Raw water is poured into the top of the pot. The water percolates slowly through the pot, collecting in the plastic bucket below. The inside surface of the ceramic pot is coated with a silver emulsion that kills microbes. The benefits of the Potters for Peace filters are they are small, can be made in-country, relatively low cost (~ $20 US), and easy to use. The downsides of the filter include easily breakable, the ceramic part loses efficacy over time (2 year estimated lifespan), cost, slow

filtration rate so that a single filter cannot keep up with the water consumption of a large family.

Purifying water with UltraViolet (UV) Light

Boiling Water