Making Porous Concrete Bottle Filters

A Tool for Turbid Water Treatment and Safer Drinking Water.

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You are free to use this information at your own risk. Porous concrete filters are still in development and may be hazardous to your health. The author takes no responsibility for any personal injury or property damage caused by any information gleaned from this document.

Please note, the porous concrete filter described here is useful in treating **turbidity** - making dirty, cloudy water clear. No claim is made about its ability to remove all pathogens and toxins in contaminated water. Although according to the US EPA (1), where pathogens and turbidity occur in the source water, pathogen removal correlates well with turbidity/particle removal. Nonetheless, treated water needs further testing and may require disinfecting using SODIS, boiling or chlorine. Active granulated carbon can remove many metals and chemicals - but not all such impurities. My (unproven) hypothesis as to how the porous concrete filter works to treat contaminated water is discussed near the end of this paper. The filter clearly treats turbidity and low turbidity is needed for SODIS and effective chlorination. However, more biological testing is needed to prove its effectiveness at removing waterborne bacteria and virus.

Below, are five steps for making porous concrete (1-liter) bottle filters. These filters may be fitted inside 5-gallon (no.2 plastic) buckets for turbid water treatment as shown in Figure 1, below. To connect the bottle filter to a 5-gallon bucket, see the directions at the bottom of this paper.

Figure 1. Porous concrete bottle filter used with a 5-gallon bucket for turbid water treatment.

First, a list of materials and tools you will need to make a 1-liter bottle filter:

Materials

- 1000ml (1-liter) of clean, dry, fine sand.
- 70ml of ordinary Portland cement (Type I)
- 30ml of food grade diatomaceous earth (fine)
- 100ml of water
- 1-liter (PET) bottle (c.f., Dasani®) with cap
- Liquid bleach (sodium hypochlorite, 5%)
- Toy (helium grade) balloons (for watertight seals)
- One or two 5-gallon (no.2 plastic) buckets with lids
- 12-inches of 1/2-inch vinyl tubing

Tools

- 1-liter measuring cup
- Scissor and cutting blade
- 2-gallon plastic bucket (for mixing)
- Tablespoon (mixing and spooning)
- 10" nail spike (for ramming)
- Power drill with 1/2-inch and 1-1/8-inch hole cutting bits
- Duct tape (clear plastic)

1. Prepare the Cement Mixture

Begin by making a mixture of 70ml of ordinary Portland cement (OPC) and 30ml of (food grade) diatomaceous earth (DE). Use a tablespoon to thoroughly mix the ingredients in a measuring cup or small bowl. I call this mixture diatomaceous earth cement or simply– ***decement***. Generally, the recipe is 2-parts OPC and 1-part DE. Label and store the decement powder in a secure container.

Parenthetically, I found straight Portland cement too caustic - raising the ph and alkalines in filtered water to unpalatable levels. In my research, I learned to use natural admixtures like (food grade) diatomaceous earth (DE) as a method for making concrete with ***less cement***. Using DE is the safest way I found to reduce the alkalinity of concrete (by using less cement) while keeping strength and porosity. People eat DE as a nutritional supplement and dewormer. Food-grade DE can to purchased online ($16 for 10lbs).

2. Prepare the Sand

Try to use clean fine sand made from crushed rock. Otherwise, use whatever fine sand is available. I found that Quikrete® play sand and pool filter sand work well. Wash the sand in a bucket with water and decant until clean. Pick out any impurities and large pieces. To conserve energy, dry the sand in the sun using large flat pans or plates. Label and store the clean sand in a secure container.

3. Prepare the Filter Body

Use recycled PET bottles for the filter body. Select a bottle(s) with handgrip ribs as shown in Figure 2. I found the 1-liter Dasani® water bottle ideal. The ribs prevent the concrete from slipping away when force is applied. Cut the base completely off the bottom as shown in the figure. Save the base for later (Step 5).

Figure 2. Recycled 1-liter Dasani® water bottle used to make the filter body.

4. Mix the Concrete

Add 10-parts of clean fine (dry) sand and 1-part decement in a bucket, mix thoroughly. Next, add 1-part water, mix thoroughly. A typical mix would include 1000-ml (one liter) of fine sand, 100-ml of decement, and 100-ml of water. I recommend adding a couple of drops of liquid bleach to the water to help ensure the concrete is sanitized.

5. Make the Filter

There are four basic types of filters that can be made with a 1-liter recycled bottle. First, is a bottle filled with porous cement (about 90% filled.) This is good for heavy-duty use inside a 5-gallon bucket. Second, a half-filled bottle that is good for light-duty inside a 5-gallon bucket, and for bottle-to-bottle transfers. Third, is a binary concrete-carbon filter composed of (2/3) concrete (1/3) and granulated active carbon. Fourth, is a self-contained personal filter that is based on the binary design. The general way to make heavy-duty and light-duty filters is described, below.

Begin by replacing the cap on the plastic bottle and turn the bottle upside down. (I often glue poker clips to bottle caps to expand the base for support.) Add a few pebbles to fill the cap area. This prevents concrete from fouling the opening. Next, spoon and press the uncured concrete into a plastic bottle that you prepared in Step 2. I use a tablespoon to scoop in the concrete and the flat head of a large 10" nail spike to ram the concrete down the bottle, press out voids and smooth out the top. You want to pack the uncured concrete tightly to form as solid a filter block as possible. Cover with the plastic base and allow the concrete to cure for at least 5-days. Later, you can use the plastic base as a permanent splash shield by punching a dozen or more nail holes through it and replacing it on top of the concrete filter. This protects and keeps the top concrete layer moist and aerated - allowing the formation of a healthy biofilm layer. In time, the biofilm will help to disinfect untreated water. When available, a 1/4-inch layer of rockwool or cotton sandwiched between the concrete and splash shield improves the moisture/aeration and protects the biofilm when the filter is at rest.

Because of residual alkalines in the concrete, all new filters need to get a thorough water flushing - about 2-3 gallons before treated water is somewhat palatable. To flush the filter, connect it to a 5-gallon plastic bucket (see instructions, below.) As the filter is used and the concrete continues to cure, alkalines will be reduced and treated water will taste more like bottled water. The addition of carbon in the binary filter improves the removal of residual alkalines and other impurities from the water and makes for a better tasting drink. Steps for making a binary concrete-carbon filter are described, below.

Figure 3 shows how the concrete-carbon filter needs to be built in stages. Stage 1 is made by filling the cap and the cone area (about 1/3 bottle) with pea gravel. Then, add your uncured concrete on top of the gravel. Cure the bottle for at least five days, then drain the gravel. Stage 2, begins with a water flush of the new concrete (see above). Finally, fill the front end on the bottle with carbon. Squeeze a wad of clean cloth on top of the carbon at the opening.

Figure 3. Making a binary concrete-carbon filter in stages.

How the Porous Concrete Filter Works

The filter removes turbidity and pathogens from contaminated water in a number of ways including - biologically, mechanically and chemically. First, the filter typically lays 90° inside a 5-gallon bucket. Larger sediments and particles fall to the bottom of the bucket and do not enter the filter. Finer suspended particles are trapped and adsorbed by the concrete all along the filter. Pathogens will first encounter the biofilm layer. Many of the pathogens will be killed or injured by the biofilm. Remaining pathogens will be mechanically trapped inside the concrete and starved. Other pathogens will be adsorbed by the concrete; while still others will be killed or injured by the chemical alkalines in the concrete. When activated carbon is used, additional metal and chemical impurities are removed that concrete cannot affect. Finally, I have experimented with adding silver metal to the filter. Silver has disinfecting properties and may add a final germ killing barrier. One method is to a lay a dime sized .999% silver coin on the top opening of the bottle just beneath the cap/spigot. This way, any remaining (weakened) pathogens come in contact with the silver and are killed or injured to the point where they cannot reproduce. The coin is re-useable and so the added $4 cost may be justified.

How to Connect the Bottle Filter to a 5-Gallon Plastic Bucket

1. Lay the bottle sideways at the bottom of the bucket.

2. Mark the center of the bottle opening on the side of the bucket.

3. Remove the bottle.

4. Drill a 1-1/8-inch hole through your mark.

5. Figure 4 shows how to improvise a seal/gasket by using toy (helium grade) balloons that you roll inside out (with your finger) to form a latex O-ring. Fit the O-ring over the bottle opening to form a watertight seal. Cut away excess balloon with a scissor. You may need two balloons.

6. For a spigot, use pull-top bottle caps or drill a 1/2-inch hole through the center of a regular bottle cap and insert a 12-inch long piece of 1/2-inch vinyl tubing with a wrap of plastic duct tape to secure the fitting. Always use the caps that come with the bottles.

Figure 4. Preparing the bottle and spigot for connection to a 5-gallon turbid water treatment setup. A hygiene setup includes closed lids with vinyl tubing connection.

References

USEPA. April, 1999. Guidance Manual for Compliance with the Interim Enhanced Surface Water Treatment Rule: Turbidity Provisions. Office of Water, Washington, D.C.

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