TOT 2

Small-scale Water Treatment

2. Filtration Basics & Household Level Filtration

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Contents

- Filtration basics
- Rapid and slow sand filters
- Bio-sand filter
- Ceramic filter

Filtration - Introduction

- **Filtration process is widely used in water treatment mainly for the removal of "particulate materials".**
- **In this process, water passes through a filter medium, and particulate materials either accumulate on the surface of the medium (*surface filtration*) or are collected through its depth *(depth filtration*).**
- **A wide range of media is utilized in filtration systems.**
- **Filtration improves the clarity of surface waters by removing algae, sediment, clay, and other particulates.**
- **Filtration is often required in conjunction with disinfection of surface water to ensure that water is free of pathogens.**

Filtration in Water Treatment

- **Mechanical filters (bar screens; micro-strainers)**
- **Granular media filtration**
  - **Roughing filtration**
  - **Rapid sand filtration (RSF)**
  - **Slow sand filtration (SSF)**
- **Membrane Filtration**
  - **Microfiltration (MF)/Ultrafiltration (UF)**
  - **Nanofiltration (NF)**
  - **Reverse Osmosis (RO)**

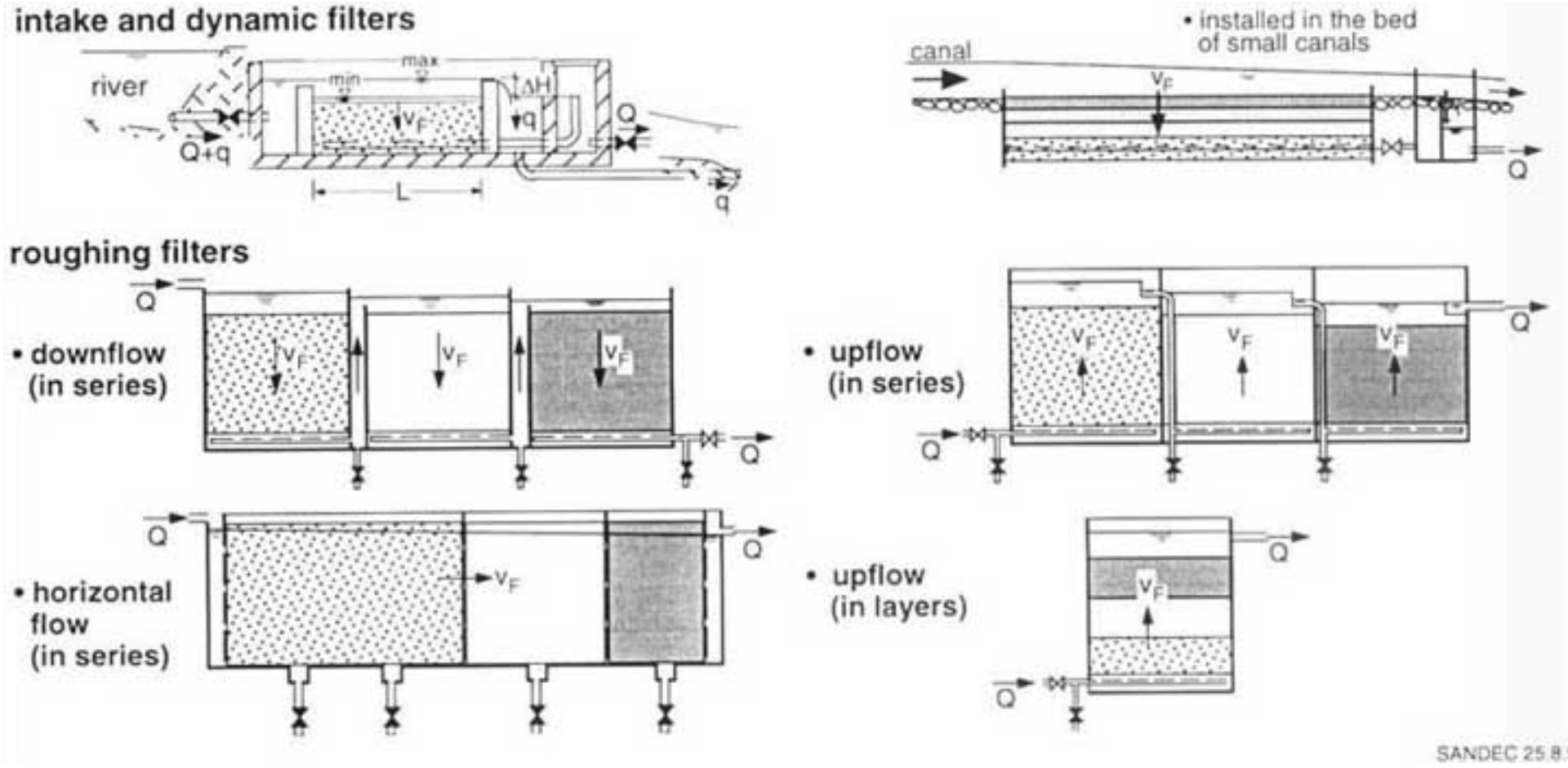
Granular media filters for small-scale water treatment

Filter type	Media size (mm)	Filtration rate (m/h)
Roughing filter	4 – 20	0.3 – 1.5
Rapid sand filter	0.5 – 2	5 – 15
Slow sand filter	0.15 – 0.35	0.1 – 0.3

Roughing Filter (1)

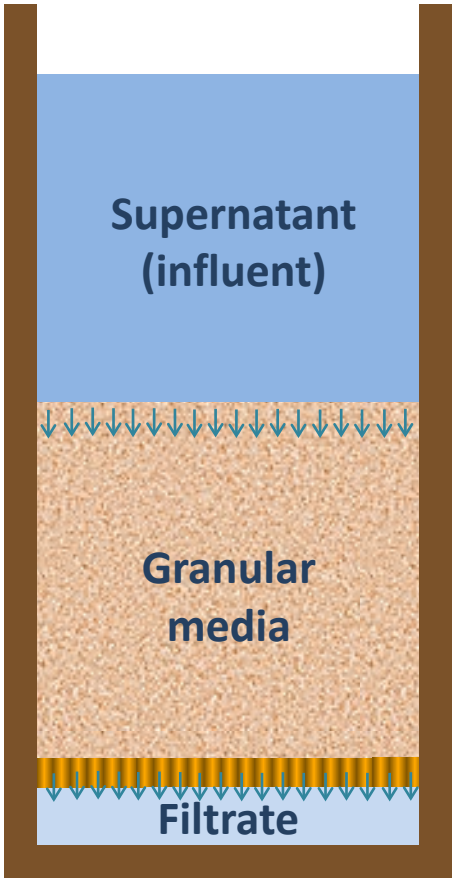
- Roughing Filter are used as pre-treatment of surface water containing high suspended solid loads.
- As different fractions of rough filter material are used in these prefilters, they are called roughing filters.
- Prefiltration is a simple and efficient treatment process applied for turbidity removal, which also improves the microbiological water quality to some extent.
- Slow sand filtration is effective in improving the microbiological water quality, but requires raw water of low turbidity.
  - Roughing filters are used as pre-treatment of SSF.

Classification of Roughing Filters



Source: Wegelin (1996)

Rapid Sand Filter



- Filtration of water through media e.g. sand (diameter 0.5 – 2.0 mm).
- Filter media placed in a vessel or tank (bed depth 0.5 to 2.0 m).
- Filtration rate: 5 to 15 m/h
- Depth of supernatant: 0.3 to 1.5 m
- Suspended and colloidal particles are (partly) removed.
- Filter will clog in the course of time due suspended and colloidal particles.
- After clogging, filter is cleaned/ backwashed (e.g. with water)

Types of Rapid (Deep Bed) Filters

- **Gravity or Pressure Filters**
- **Single media, dual media or multi-media filter**
- **Upflow and Downflow filters**
- **Constant rate and declining rate filters**

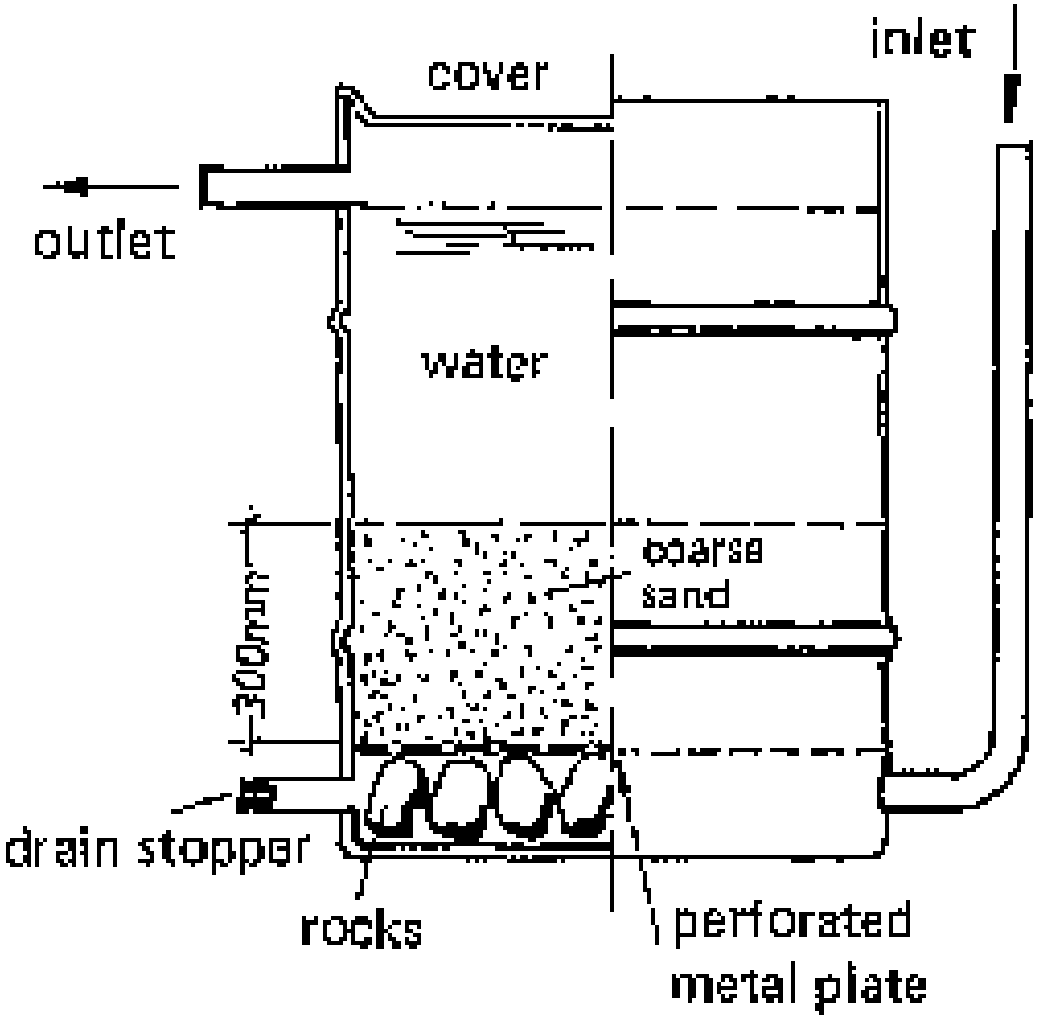
Slow Sand Filter (SSF)

- The filtration rate in SSFs are relatively "slow" (0.1 to 0.3 m/h), about 50 to 150 times lower than that of RSF.
- Removal of the majority of fine particles and bacteria takes place on the surface of the filter bed.
- The water treatment in SSF is the result of a combination of physico-chemical and biological mechanism.
- SSF is generally used as final treatment step or polishing step for removing micro-organisms.
- Main limitation of SSF when used a single treatment step is its inability to treat water with high turbidity.
  - (should be < 50 NTU)

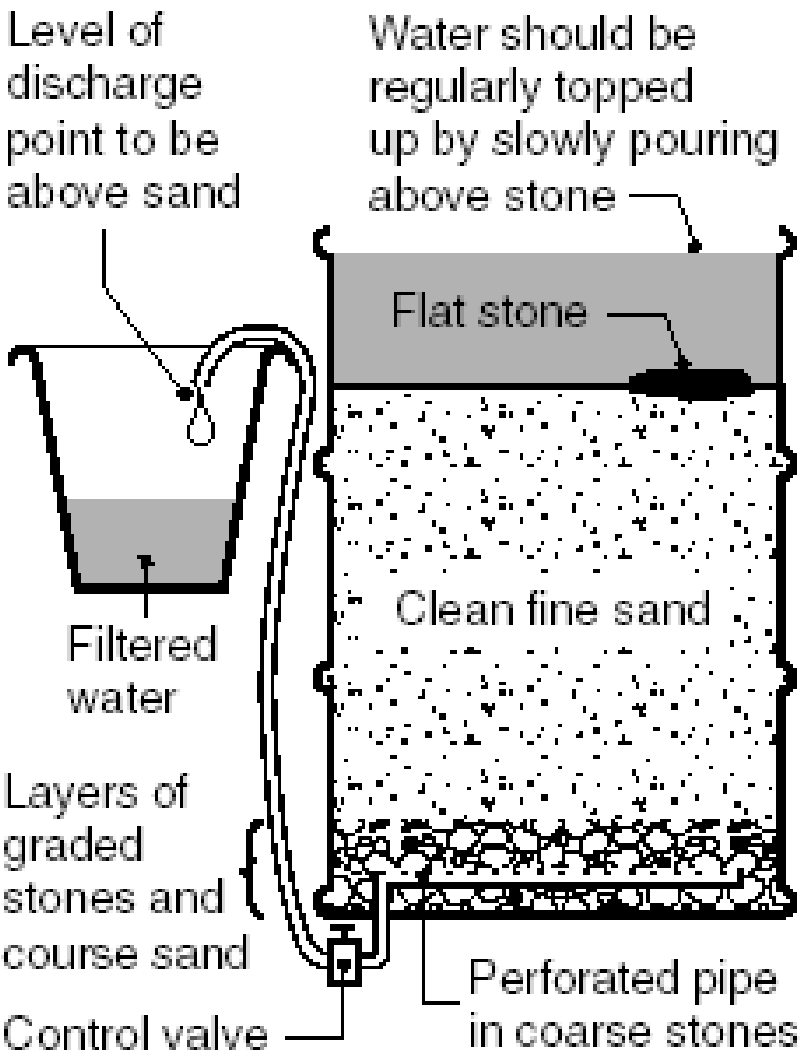
Comparison of RSF and SSF

	Rapid sand filtration	Slow sand filtration
Rate v (m/h)	5 – 15	0.1- 0.3
Grain size (mm)	0.5 – 2	0.15 – 0.35
Media depth L (m)	0.6 – 1.5	0.6 – 1.5
Run time t (days)	1- 3	20 – 100
Cleaning	Backwashing with water (+ air)	Skimming top layer
Removal mechanism	Physicochemical	Physicochemical and biological
Removes	Fine particles/Flocs	Fine particles and microorganisms

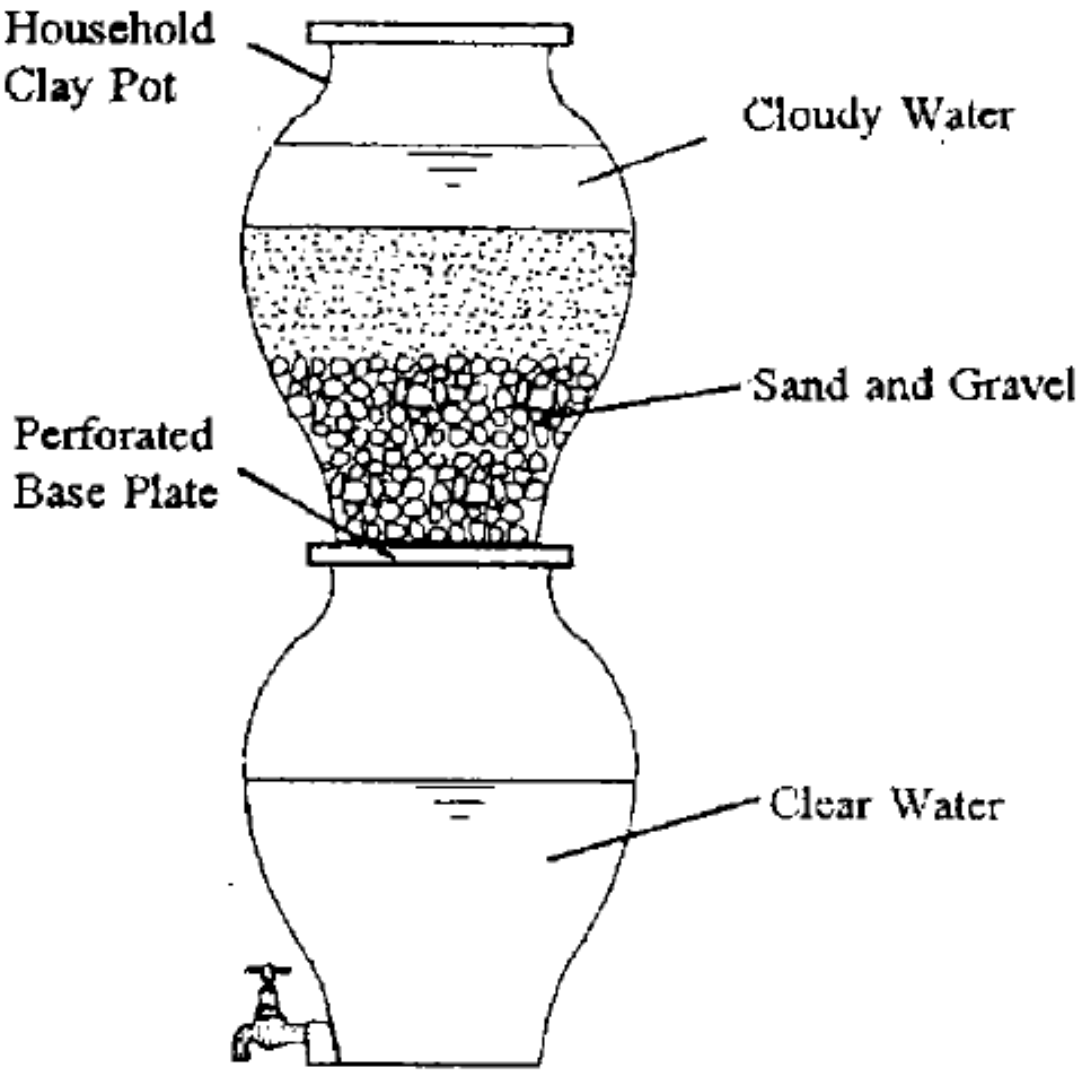
Upflow RSF for household or small community



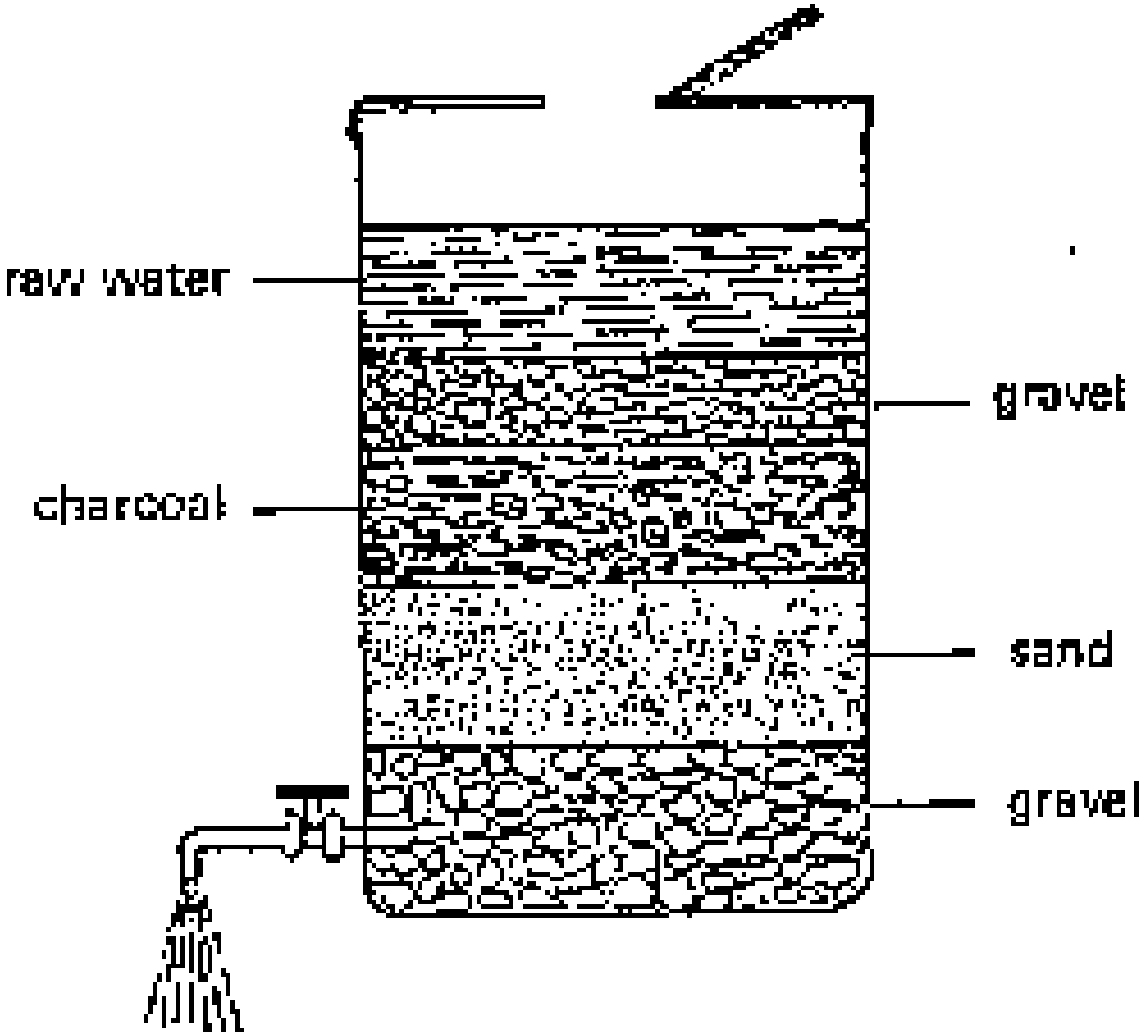
A Simple Sand Filter



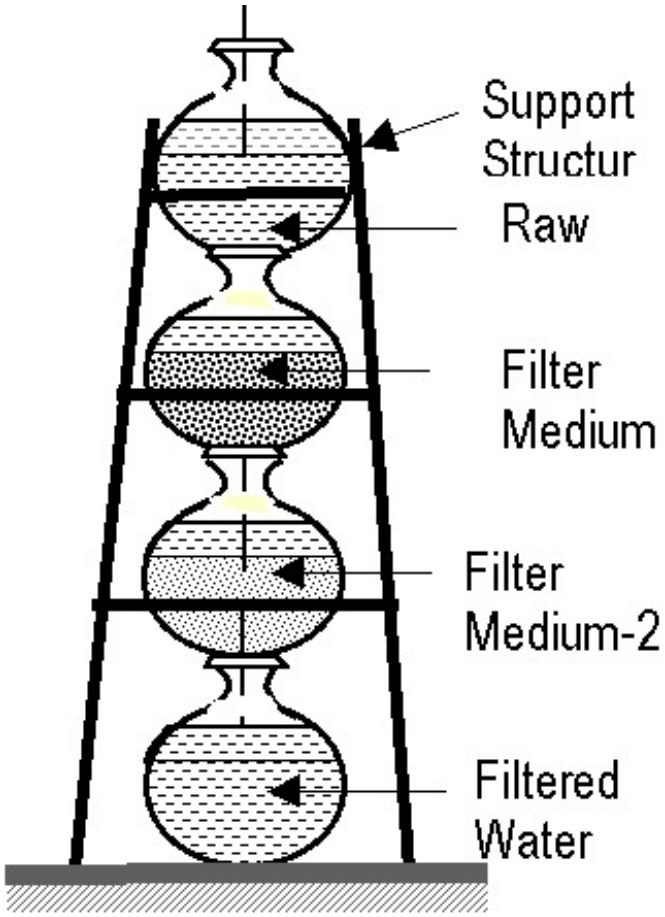
Household Water Filter

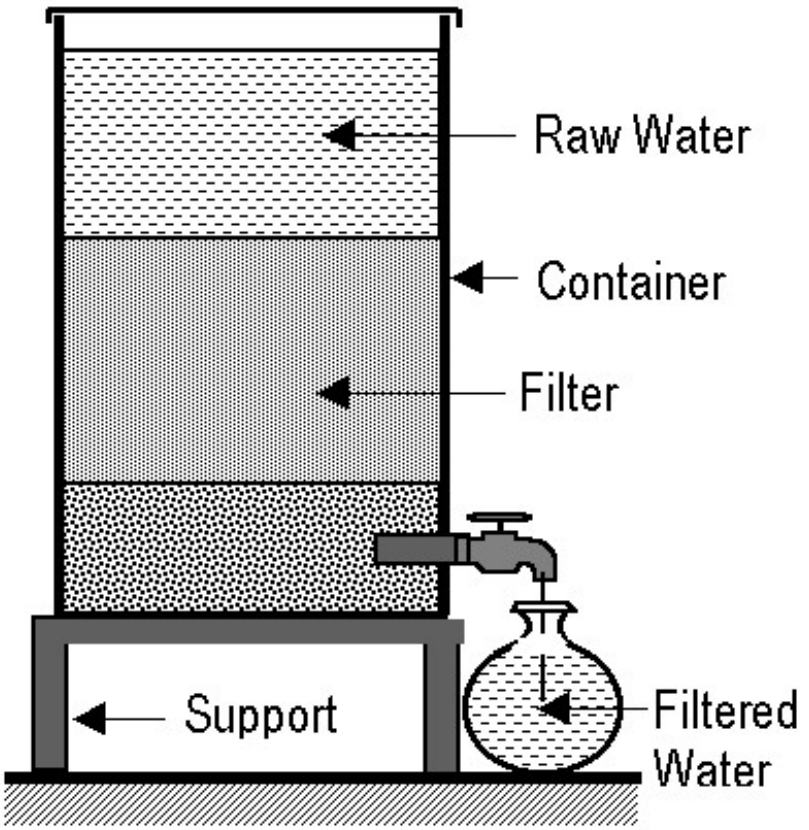


Multiple Layer Filter

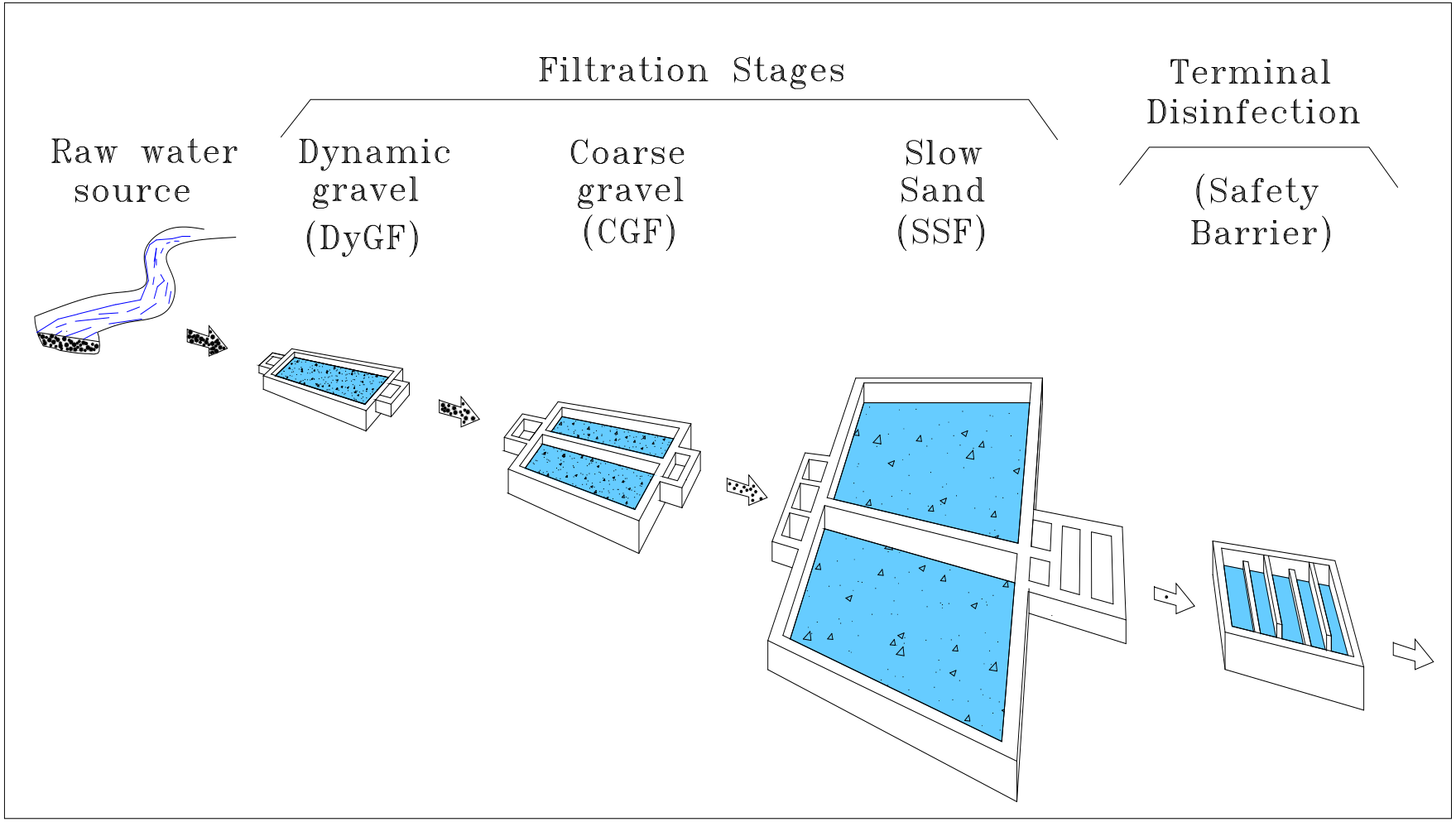


Household Water Filter





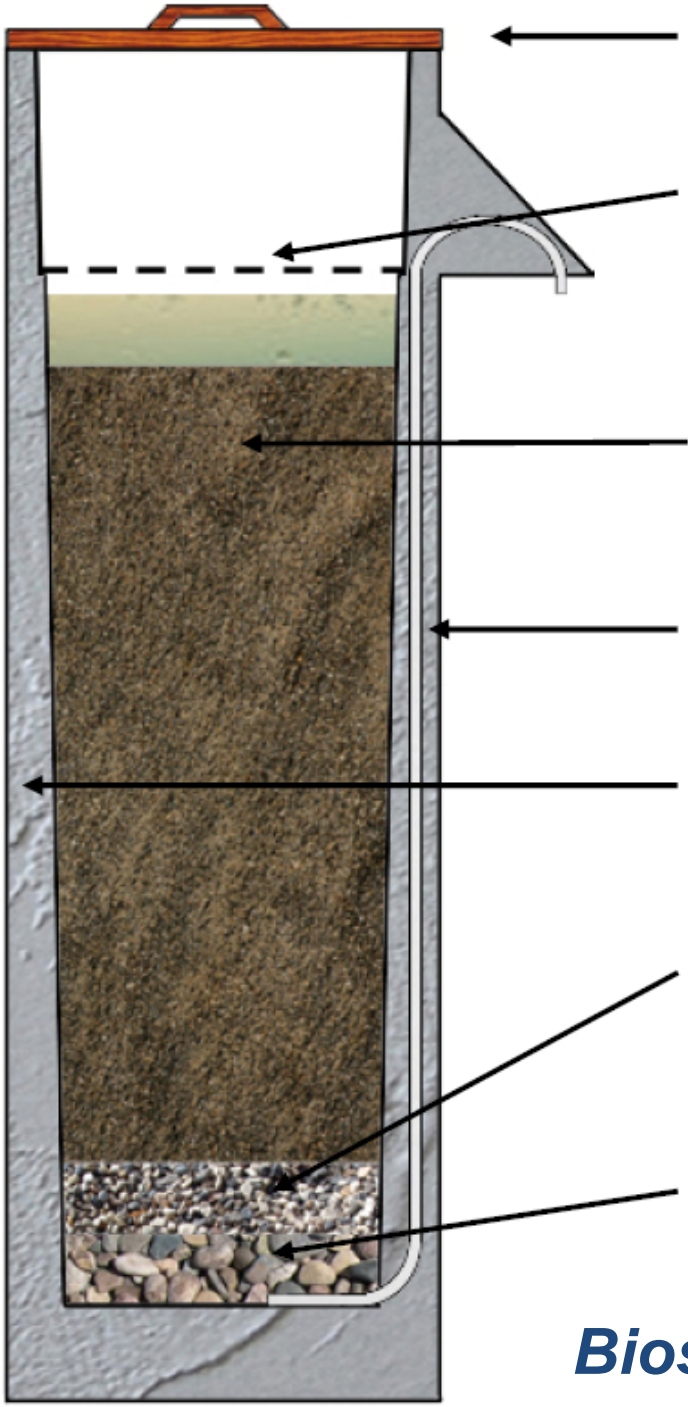
Multi-Stage Filtration – Community Level



Household Level Filtration: Bio-sand Filter and Ceramic Filter

Bio-Sand Filter

- a low cost slow sand water filter, specifically designed for intermittent use at household level
- essentially a rectangular box, filled with about 0.5 to 0.6 m of fine sand (0.15 – 0.35 mm) and supporting gravel layer
- simple in operation: *remove the lid, pour a bucket of water into the filter, and collect the treated water from the outlet in a clean container*
- A layer of water (up to 10 cms deep) is maintained above the sand at all times.
  - This design improvement to SSF technology has allowed individual households to access this old well proven treatment technology at very low costs.

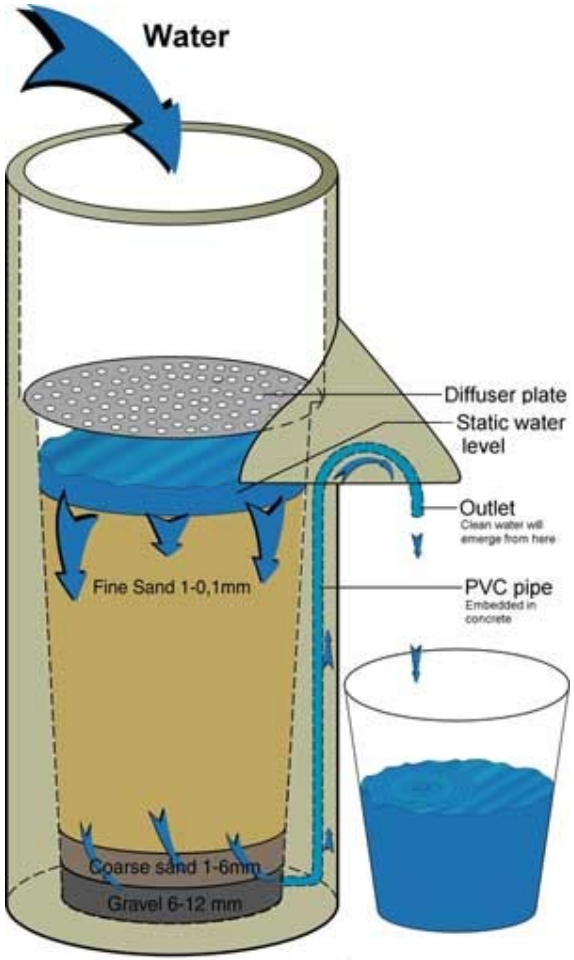


1. **Lid** – Tightly fitting lid prevents contamination and unwanted pests.
2. **Diffuser** – Prevents disturbing the filtration sand layer and protects the biolayer when water is poured into the filter.
3. **Filtration Sand Layer** – Removes pathogens and suspended solids.
4. **Outlet Tube** – Required to conduct water from the base to the outside of the filter.
5. **Filter Body** – Holds the sand and gravel layers.
6. **Separating Gravel Layer** – Supports the filtration sand and prevents it from going into the drainage layer and outlet tube.
7. **Drainage Gravel Layer** – Supports the separating gravel layer and helps water to flow into the outlet tube.

Biosand Filter Components

Source: (CAWST, 2009)

Bio-Sand Filter



www.medair.org/sandfilter/Index.htm

www.bushproof.com

Bio-Sand Filter

http://www.biosandfilter.org

Bio-sand filter removes:

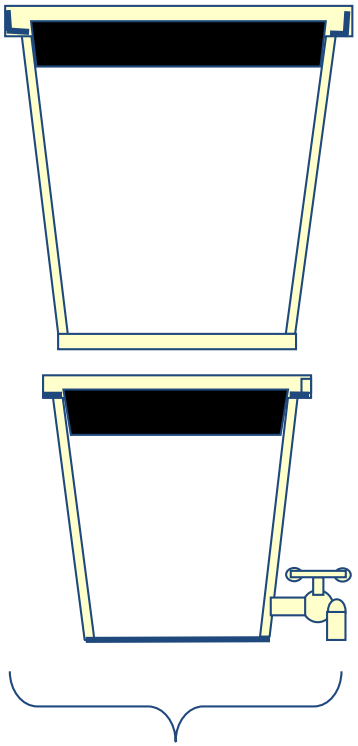
- More than 90% of faecal coliform
- 100% of protozoa and helminths
- 50-90% of organic and inorganic toxicants
- 95-99% of zinc, copper, cadmium and lead
- < 67% of iron and manganese
- <47% of arsenic
- all suspended sediments

Source: http://www.cawst.org

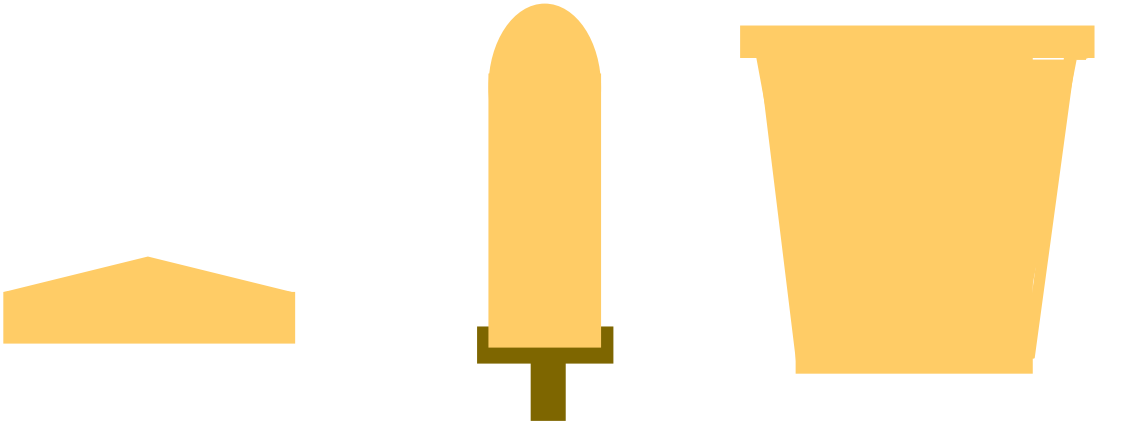
Ceramic Water Filters

- Clay and other materials are blended and shaped into vessels, disks or hollow cylindrical "candles".
- Combusted under controlled conditions to can produce micron and submicron (0.2 µm) size pores.
- Microbes and other suspended solids are mechanically reduced due to depth filtration (straining) and adsorption.

Ceramic Water Filters



Filter System



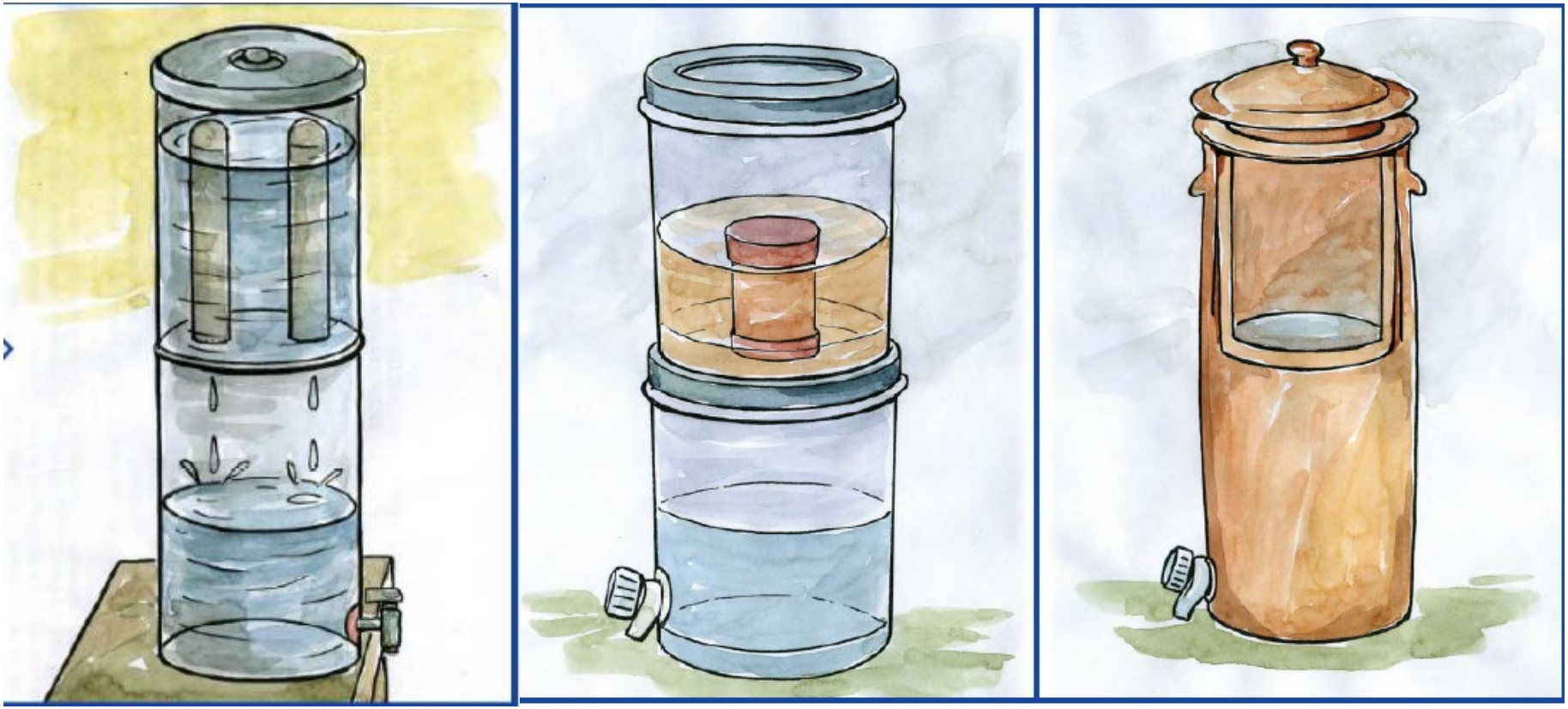
Disk Candle Pot

Filter Media/Element

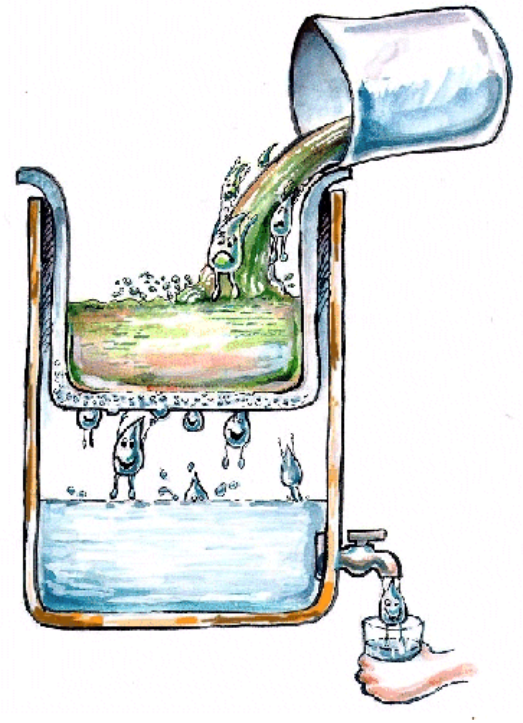
Ceramic Water Filters

- **The container with filter element is manually filled with water from a contaminated source, which seeps through the "ceramic/clay" element at a rate of 0.5 to 3 litres per hour.**
- **The typical ceramic filter holds approximately 8 - 10 litres, allowing a family to produce 20 to 30 litres of water per day with 2 to 3 fillings.**
- **Ceramic may be impregnated or coated with colloidal silver or other bacteriostatic substance to enhance efficacy and prevent microbial growth.**

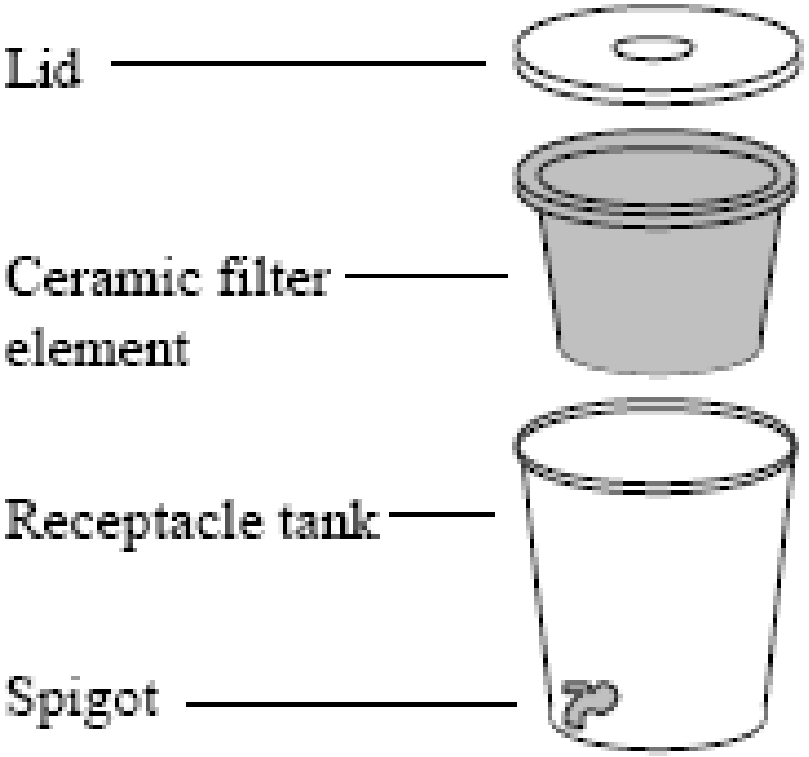
Ceramic Water Filters



Ceramic Filter/Ceramic Water Purifier



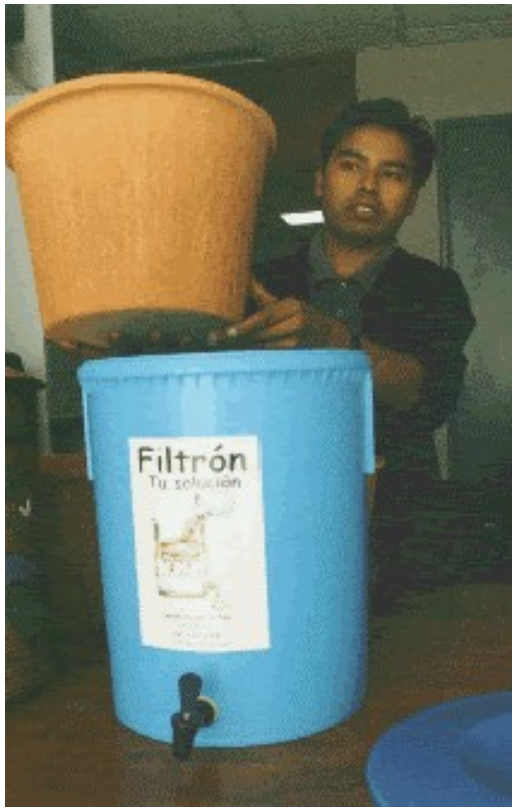
Parts of Ceramic Pot Filter



- **It consists of a porous, pot-shaped filter element made of kiln-fired clay and impregnated with colloidal silver.**
- **The ceramic filter element is set in a receptacle tank with a lid and a spigot.**

Ceramic Filter/Ceramic Water Purifier

ECOFILTER

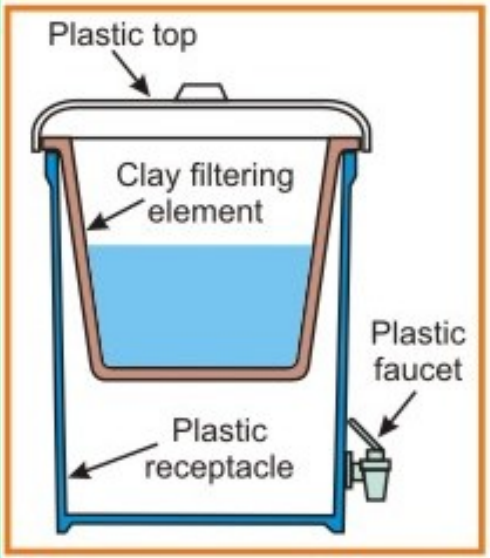


FILTRON

https://www.waterfiltersforthepoor.com

http://www.filtrao.org/

HOW TO USE YOUR FILTRON



1. Washing the RECEPTACLE

Wash your hands with soap .
Attach the spigot (faucet) to the plastic receptacle.
Fill the receptacle one quarter full with water and add two tablespoons of chlorine bleach.
Leave this for thirty minutes to disinfect the plastic receptacle.
Use this water to wash the entire inside of the plastic receptacle and the lid with a brush or cloth.
Drain the water out through the spigot to disinfect.
If you do not have bleach, wash the receptacle and lid with soap and water as described above.
You can use either filtered or boiled water to rinse.

2) Place the plastic receptacle in a location that is stable and out of the way of activity.

Using both hands on the edge of the clay filter, place it on the mouth of the receptacle.

3) To get rid of the clay taste of the new filter, fill it with water and drain through the spigot. Repeat until all taste is gone.

4) If your water is turbid, strain it through a clean piece of fine cloth. Tie the cloth in place around the outside of the plastic receptacle.

5) **Keep your filter filled and covered at all times.**

The filter will flow more rapidly (one to two liters per hour) if it is kept full.

Remember: Before serving water wash your hands and cups with soap.

Ceramic Pot Filter – Removal Efficiency

Parameter	Removal Efficiency
Bacteria	>90% - 99.99%
Viruses	66 – 99.6%
Protozoa	>99%)
Turbidity	83 – 99%
Iron	>90%
Colour	90% - 96%

TOT 2

Small-scale Water Treatment

2. Filtration Basics & Household Level Filtration

Thank you for your attention