

Water treatment options

Slow sand filter (example Jal-tara)



The slow sand filter ensures a simultaneous bacteriological and physical improvement in water quality comparable to the natural percolation of water through underground strata. Jal-TARA is standardized in 1000 litres water tank with the output water supply of 2500 – 3000 litres per day. The filters contain pebbles and sand of different sizes. System is provided with a synthetic fabric filter designed with advanced technique of fabric protection. The system can be fed under gravity flow or through conventional pumps or operated by solar photo-voltaic.

Operation

The top 5 to 10 cm of wet sand must always be under oxygen rich water. Therefore, the system needs continuous water flow. Large and fine particles of suspended matter are deposited on the surface of the filter bed by the action of mechanical straining and sedimentation, respectively. The colloidal and dissolved impurities are removed by adsorption, whilst the organic matter is converted into organic salts by the purification mechanics. The filtered water is collected at the bottom via a pipe system. Most microbiological action takes place in the 'Schmutzdecke' (bio film) formed in the fabric filter at the top of the sand bed.

Maintenance

The system is designed to have very little maintenance. The filter does require regular cleaning, though the frequency depends on input water quality (turbidity and bacteria contamination) and filtration rate. Cleaning operation includes cleaning of fabric filter and top sand layer. Fabric filter requires cleaning twice in a year for turbidity 10 – 15 NTU input water. To simplify cleaning operation, backwashing facility is also provided..

Manufacturing

Filter can be easily assembled locally available material like sand, pebbles and water tank. However, fitting material can be easily transported, if not available locally.

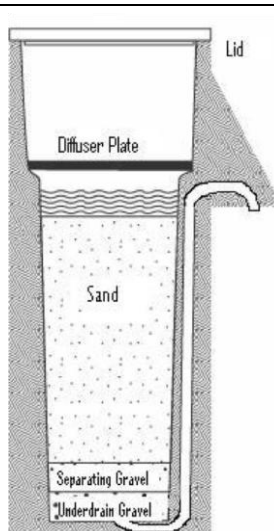
Considerations

Although the technology seems to be simple, many slow sand filters fail by inadequate operation and maintenance.

Cost (for treatment and storage only)

Investment for Jal Tara example is € 1.300. Unit price per m³ is about € 0,22.

Bio-sand filter (example CAWST)



The biosand filter (BSF) is an adaptation of the traditional slow sand filter, which has been used for community water treatment for hundreds of years. The BSF is smaller and adapted for intermittent use, making it suitable for households.

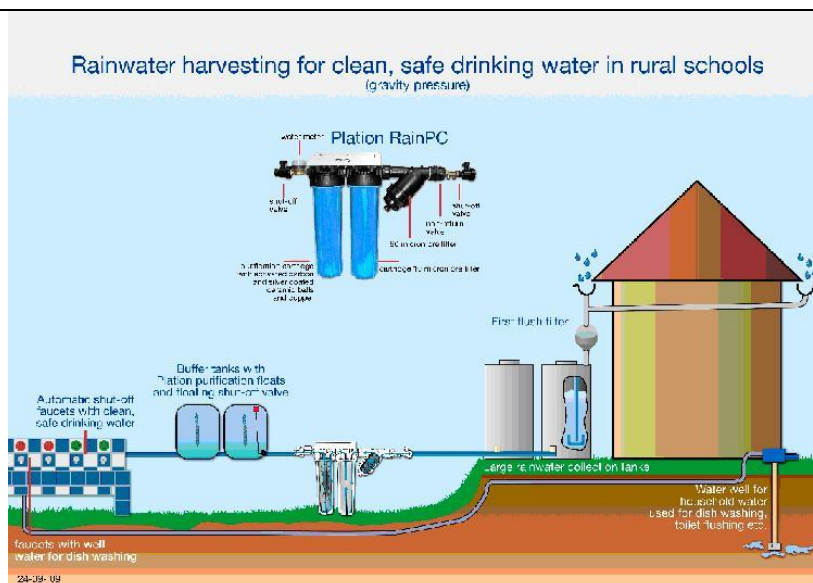
Water treatment is carried out by the sand inside the filter. The filter container can be made of concrete, plastic or any other water-proof, rust-proof and non-toxic material, though concrete has several advantages.

Pathogens and suspended material are removed from the water through a combination of biological and physical processes. These occur both in both the biolayer and within the sand bed. These processes include: mechanical trapping, adsorption/attraction, predation and natural death. It is not required that the bio-film remains under water, all the time.

Cost (treatment only)

Investment costs depend on the material applied. Pre-fab will cost between € 100 and € 200; but they can also be made from local materials or be locally manufactured. Sand and gravel can be re-used after cleaning.

Micro-filters in combination with other absorption filters (example Rain PC; Aqua Est)



AquaEst offers a wide range of water purification products which are applicable in various situations. In the Rain PC system, [rainwater](#) is purified by means of multi-stage and multi-media filtration. It's a three-stage filtration system using 80 micron and 10 micron pre-filters along with an activated carbon filter in which the colloidal silver-ceramic balls and metallic copper are embedded. The RainPC eliminates (pathogenic) bacteria and organic and inorganic pollutants/contaminants.

Operation

Operation of the Rain PC is very easy. It can be operated at low gravity pressure, as well as pump pressure up to 6 bar (in case of underground storage). The water flow is maximum 8 liters/minute, though this is depending on the level of pollution.

Maintenance

Practically no maintenance is required. For the RainPC system, the 80 micron filter has to be inspected and cleaned regularly. The 10 micron prefilter and filter cartridge with activated carbon, silver ceramic balls and metallic copper have, in adequate systems, a capacity of up to 150.000 liters without further maintenance.

Manufacturing

There is no possibility for local production of the purifying/conserving equipment. However other rain harvesting tools, such as gutters, taps or tanks can be produced locally.

Estimated Lifespan

The entire system has a service life of at least 15 years. The cartridges and 10 micron pre-filter can process a maximum of 150 000 litres, though the lifespan depends on the extent of pollution.

Cost (treatment and taps)

Investment costs about € 1.000 and relatively high replacement costs. The shown unit costs about € 2 per m³.

UV-filter (example Naiade, Clean Water Now)



The Naiade water disinfection unit is a spin-off from Nedap's and Trojan's know-how of large scale drinking water and industrial waste water treatment plants. The Naiade drinking water disinfection unit very effectively combines the potential offered by solar energy, UV light and battery back-up.

The Naiade has been designed to remove bacteria, protozoa, viruses and colloidal parts from raw fresh water. It operates without the use of fossil fuel or chemicals, but uses a battery.

The unit is made of tropical resistant poly ethylene. Its dimensions are 150 x 50 x 50 cm. The purification of the Naiade includes:

1. a sieve to remove larger parts such as leaves, stones etc.
2. a 25 micron filter bag
3. a 10 micron filter bag
4. a UV light, which kills any remaining bacteria and viruses

The Naiade has a LED warning indicator, informing about UV-lamp lifetime..

The normal flow rate is 5 – 6 liters per minute.

Operation

The Naiade can be installed in 30 minutes by local people without a technical background. A step-by step, pictured instruction leaflet and tools are provided. The unit is so easy to use that even small children can operate it.

After having filled the unit with raw water, one just pushes the button. Clean and disinfected water flows out from the tap. No waiting time is required. Water flow can be stopped/interrupted by pressing the button again. After 2 minutes, the tap closes automatically to avoid spillage of water. The flow rate is not influenced by the user, it is restricted by the design to guarantee a proper UV treatment of all passing water.

The capacity is about 3,500 liters per day, depending on the scale of organization.

The unit can function at night using a car battery of not less than 37 amp/hr capacity.

A supervision structure to guarantee optimal use is highly recommended.

Maintenance

Both filter bags can be removed from the unit for cleaning purposes. After careful flushing these bags can be replaced. The life span of the UV lamp is 10,000 operating hours, nearly 3 years. The UV lamp can be replaced within half an hour by the users themselves.

The cleaning procedure should be as follows:

- Daily cleaning the PV panel for optimal energy supply
- Regular rinsing or washing of the filter bags to avoid blockage by sediments or a micro biological layer
- Regular cleaning of the glass tube of the UV lamp to avoid sedimentation. This highly depends on the chemical consistency/content of the raw water.

The UV lamp is a standard industrial UV lamp.

Manufacturing

The unit does not contain any moving parts except for the electro-magnetic tap.

It is made of tropical resistant poly ethylene. All material as well as the applied technology is based on the intensive use in remote and tropical areas.

Estimated Lifespan

The estimated lifespan of the unit is over 10 years. Filter bags and UV lamps may need earlier replacement. The UV lamp has a life of 10.000hrs or 3 years at 9 h/day continuous service. The filter needs to be replaced approximately every 12 months depending on TSS of influent/washing frequency. The back up battery (12V-50Ah) lasts 36 hours. Built-in electronics will register the used time of lamp and a light in front of the unit will indicate when the lamp needs to be replaced.

Cost (treatment including storage)

The ex-factory costs are € 3.000 (excluding training). Unit costs are about € 0,59 per m³.

UV-light and other treatment (example Water Box, Aqua Aero systems)



Highly reliable and state of the art UV technology is used, power by solar panels and a battery. The radiation of a UV lamp is transmitted into the water and as result all bacteria, viruses and other pathogens are killed. The effectiveness of our UV system is 99,9 % dependant on the quality of the water intake. Systems are delivered in combination with proper filter techniques so that the sediment content is reduced and taste and odors are removed. Pre-filters for different chemical compounds can be added.

Dependant on the application 5.000 -20.000 litres (or multiple) of water volume are purified on a daily basis.

Cost (treatment only)

The investment cost will depend on the housing of the UV-unit. The water box is about € 1.500. Unit cost (without storage) will be about € 0,30.

Chlorination through electrolysis (example WaterPurifier, Bright Spark)



The WaterPurifier is a water treatment system that can be installed in rural areas. The unit removes all pathogens and produces clean and safe drinking water without external use of electricity or chemicals.

The contaminated water is first filtrated with a ceramic filter, then a second time using a disinfection unit using electrolysis, which is solar powered. The applied membrane is a 1 m² tubular ceramic ultrafiltration membrane with a pore size of 40 nm. The ceramic membrane has 120 tubular membranes inside with inside diameter of 2 mm.

The WaterPurifier is different from other water purification systems, because it only needs sunlight to operate and the unit creates disinfectant from the salt in the water that provides residual chlorine, thus preventing recontamination. It can be used everywhere. It is extremely robust, compact, and easy to transport.

Operation

The WaterPurifier is very easy to operate. One main switch will switch the unit in operation ready mode. If you tap the purified water the disinfection will start immediately. If you stop tapping water the disinfection is switched off. To generate enough pressure for the filtration process, water has to be kept in the barrel above the unit. Water pressure results in clean water. If the water barrel is empty a LED alarm light will warn you.

It is also possible to add kitchen salt (NaCl) if there the fresh water does not contain sufficient Cl⁻ for disinfection. About 50 gram per 1000 litres is recommended. For a production of 150 m³ water per year, this will cost 7,5 kg salt. The WaterPurifier can be scaled up to 5 times in the same configuration. In that case 3 to 6 m³ water/day can be treated.

The WaterPurifier is a self-contained, ready-to-use water purification unit. There are no moving parts

within the flight case as everything is build on a frame that does not move. The flight case is build so that it can be dropped on a luggage belt; normally the cases will be pitched on this. So it can survive in a lot of circumstances.

Quality can be checked with an indicator strip. If no free chlorine is present, the quality might be poor.

Maintenance

Maintenance is simple. The filter is cleaned with a hand-powered air pump or a bicycle pump which can pump up a small air container up to 6 bar pressure. This hand made pressure is used for backwashing the membrane filter with an air pulse driven clean water backwash.

Manufacturing

The membrane and electrolysis cell cannot be manufactured locally, as they are unique parts of Bright Spark. However, other parts can be locally produced.

It has a flexible raw water tank capacity of 300 or 600 L/day (10-hour operation) with connections. Accessories including are: hand pump 15 l/m in bucket, 220 Volt AC to 12 Volt DC adaptor; 12 Volt DC solar panel 15 pW (standard level), 12 Volt DC solar panel 150 pW (high level), oil drum 220 litres, mounting set for connecting tube/hose to a second hand oil drum, 2 m hose with GEKA connectors, tube connectors GEKA, clean water can (20 or 60 litres), water quality indicator sticks (365 units), stand for raw water tank (wood), and stand for raw water tank (aluminum).

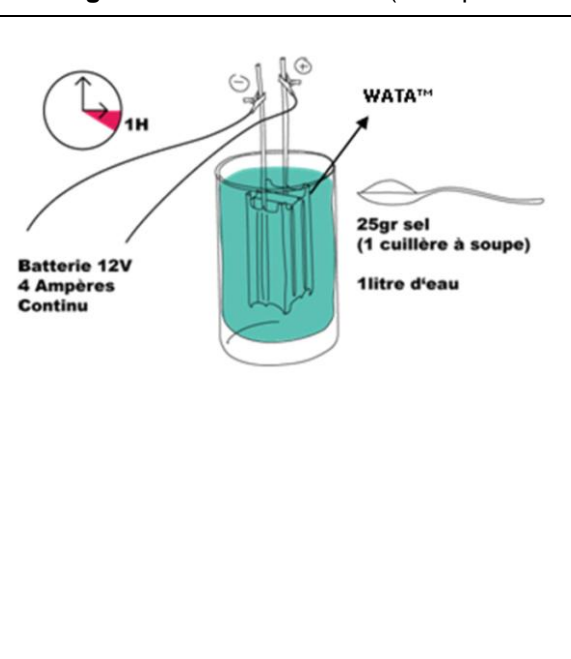
Estimated Lifespan

The estimated lifespan is 20 years if well maintained. The membranes and the electrodes have to be replaced after 5 years.

Cost

The investment cost of the WaterPurifier is € 1.800. Unit price is about € 1,21 per m³.

Adding chemical disinfectant (example mini-WATA for chlorine)



The Watasol is a simple a device which produces active chlorine from salt water using electrolysis. The device consists of two tungsten electrodes in a plastic container, and a transformer. The active chlorine forms hydrochloric acid when added to water. As the active chlorine has a very strong oxidizing power, is destroys almost all pathogenic germs The WATA device and its use was designed by [Antenna Technologies](#) based on the norms of the World Health organization on for example the accepted quality of water, amount of chlorine needed to disinfect 1L of water and the acceptable amount of free residual chlorine.

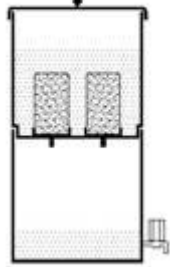
The mini-WATA is a variation of the WATAsol that fits into a regular water bottle. It produces active chlorine to treat up to 4800 litres of water per day, which is enough clean water for the daily needs of 240 people. It can run on 5V/1A but requires a minimum of 10W.

Cost

The smallest sized WATA-mini costs € 40, the standard one € 200 and the maxi € 1.700. The unit costs are around 1 or 2 cents only.

Instead of school wide solutions, one can also use units at the level of a class or a canteen. These might include products that are fit for households. Of the ones with a bit higher production, the following examples could be your choice.

Table top with candle filter (example Water4Life)



Water4Life makes use of the so called gravity purifier with ceramic filter candles, the heart of the system. Water4Life cooperates with two different manufacturers of filter candles. Both have the filtration of bacteria from the water at a level of more than 99% in common. Both models consist of porous ceramics with silver impregnation to prevent regrowth of pathogens. This combination assures a high reliability of the filtration of bacteria. One type of candles also contains granular activated carbon which can absorb some chemical and mineral contaminants, by which some improvement of taste can be achieved. This however is of secondary interest.

Cost

The Water for Life filter costs about € 16 if locally assembled. Unit price is about € 0,42 per m³.

Table top with candle filter (example Tulip)



The Tulip Table Top water filter is a fast flow candle-type water filter which uses gravity pressure to force water through a high-quality ceramic filter element filled with activated carbon. An innovative patent pending device makes it possible to double the average flow.

The filter element is impregnated with silver in order to increase the bacterial removal efficiency and to reduce the recontamination risk of stored filtered water.

The transparent housing enables frequent refilling without the risk of water overflow from the storage container.

Refilling once per hour, the unit delivers 3 liters per hour, without refilling an average flow of 2.5 liters per hour is realized.


Cleaning of the filter

The filter element is covered by a washable pre-filter to protect the filter element against premature clogging, when using dirty water. After some time, the flow rate will reduce because of clogging of the filter element. The filter element can be cleaned with a cloth or toothbrush. When this cleaning does not result in a sufficient flow, a small layer of the ceramic material of the filter element has to be removed by scrubbing the filter with a scrub pad, which is included.

Cost

The price of the table top model is around € 10- 15, depending the possible use of local buckets. The ceramic filter is to be imported from India.

Silver disinfectant (example Plation Float of Aqua Est)

 <p>JC-float for jerrycans</p> <p>PM-float in drinking water tank</p>	<p>All Plation® products are based on inactivation of (pathogenic) bacteria by silver ions. The use of silver as a water purification technique goes back millennia and is a proven method. The silver ions are released by a natural ionization process by using special ceramic balls with a coating of pure, high quality colloidal silver (microscopic small silver particles). For heavily contaminated drinking water as well as rooftop harvested rainwater, silver-ceramic balls are combined with metallic copper, as copper and silver ions together are even more effective against bacteria, algae and other microbiological contamination.</p> <p>AquaEst offers a wide range of products. Plation floats are primarily designed for preservation of drinking water in tanks and cisterns. Product range for tank sizes of 50 up to 6.000 litres. Plation PM is encased in rigid plastic tube. Plation PNS, PNK and JC are kept secured with open mesh food plastic. Plation floats are the only known non chemical, non toxic technique to preserve (drinking) water during storage to ensure fresh and safe drinking water quality. The Floats can also be used for purification/disinfection, either alone (with a proper exposure time) or complementary to other technologies such as activated carbon, UV and RO.</p>
<p>The price of the Plation floats is relatively high. A new device for sustainable application in water tanks for a 1 year operation is foreseen to enter the market in 2012. This would be fit for the purpose of school tanks.</p>	



Physical filtering: clock wise from top left: Tulip, Ceramic Pot Filter, Water for Life candle filter, slowsand filter, Kanchan filter and biosand filter

Physical inactivation: clock wise from top left: Aquapack (solar heat+UV), SODIS, Naiade (solar driven UV-lamp) and boiling



Chemical disinfection: clockwise from top left: AquaEst Platon (silver), AquaEst Rain (membranes, silver, coal), Aquatabs, WATASOL, chlorine and PUR (floc + chlorine)



Multi-process: clockwise from top left: Lifestraw Family, Pureit, Perfector, WaterPurifier

Figure 1: Sample of small scale disinfection products

Best/Cheap Buy	Product process, removal agent	Product name, brand	Capacity ltr/day	Unit price €/m ³	Overall AT-score *	Sub-score Performance	Sub-score Planet/People
	Limited virus and bacetria reduction						
	Plation floats (ceramic silver balls) **	<i>AquaEst</i>	(50)	€ 0,75	6,6	6,1	7,0
	Biosand filter	<i>CAWST; Hydraid</i>	100	€ 0,11	6,4	5,7	8,0
	Arsenic reducing biofilter	<i>Kanchan, ENPHO</i>	50-75	€ 0,11	6,1	5,3	7,0
	Limited virus reduction						
BB	Ceramic Silver Pot Filter	<i>Potters for Peace</i>	15-30	€ 0,57	7,9	7,9	8,0
CB	Ceramic/carbon candle	<i>Water4Life</i>	25-50	€ 0,42	6,3	5,7	5,5
CB	Siphon ceramic silver filter	<i>Tulip, Basic Water Needs</i>	50-80	€ 0,51	6,1	6,1	5,5
	Plation Rain Purification Centre	<i>AquaEst RainPC</i>	275	€ 2,00	5,4	5,7	5,0
	Slow Sand Filter	<i>e.g. Jal Tara</i>	(2.750)	€ 0,22	5,2	4,4	7,0
	Good virus reduction, individual-family size						
	Chlorine drops, hypochlorite	<i>e.g. Safe Water Storage</i>	NA	€ 0,24	7,0	8,3	4,6
BB	Solar UV - PET bottles	<i>SODIS</i>	1-mrt	€ 0,87	7,0	7,0	6,5
	Boiling (electrical; wood)		NA	€ 17,85	6,8	7,9	4,0
	Sodium dichloroisocyanurate tablets		NA	€ 3,25	6,5	7,9	4,6
	**	<i>NADCC aquatabs</i>	NA	€ 3,25	6,5	7,9	4,6
	Sachets flocculant/disinfectant	<i>PUR, Procter&Gamble</i>	NA	€ 7,14	6,5	7,9	4,6
	Solar UV/IR heat, plastic bag	<i>Aquapak</i>	5	€ 3,13	6,4	6,1	6,0
	Iodine & micro-filter in suction 'straw'	<i>Lifestraw, Vestergaard</i>	1 (max 10)	€ 4,08	6,4	6,1	6,3
	Iodine & ultrafilter, gravity	<i>Lifestraw, Vestergaard</i>	15 (max 150)	€ 0,79	5,3	4,9	5,2
	Carbon, filter, chlorine	<i>Pureit, Unilever</i>	20	€ 4,35	5,1	5,3	5,0
	Good virus reduction, group size						
CB	Multi-filter and UV	<i>Perceptor-E, Norit</i>	32.000	€ 0,69	6,2	6,6	6,0
CB	UV-(solar PV energy), macro filter	<i>Naiade, Clean Water Now</i>	2.000	€ 0,59	5,8	5,7	6,5
	Ultra-filter; hypochlorous (electrolyse)	<i>WaterPurifier</i>	600	€ 1,21	5,7	6,1	5,0
	Chlorine production (electrolysis)	<i>WATA (mini)</i>	(4800)	€ 0,02	4,9	5,3	5,8
	Quality distribution	good/green	green	6	7	7	7
		medium/orange	orange	9	9	9	6
		poor/red	red	6	5	5	8

* The overall AT score is using the weight of the criteria and is not by definition the average of the sub-scores

** Post treatment application only

Table 1: Summary of small scale treatment options and their validation (from: NWP (2010) Smart Disinfection Solutions)

BB = Best Buy (very good performance (all >6.5) and within price level of € 2/m³)

CB = Cheapest Buy (low price level at acceptable appropriateness level (all sub-scores >5.5))