KOONAC Goat Farm

Slow-flowing Bio-Sandfilter

Introduction

The food safety regulations in Australia only allow water that is free of *E. coli* to be used in any commercial food production process. For most food businesses this is not an issue, because they are connected to the communal mains water supply, which delivers potable water. In contrast, our farm is not connected to mains water supply, and we, therefore, need to have our own supply of potable water to be used for our food production processes (e.g. milking, cheese making). This text describes the filter system we have installed to purify the water from our dam to meet the requirements for potable water.

The filter system is a slow-flowing bio-sandfilter. It is suitable to purify water that is only mildly polluted, for example, surface and sub-surface run-off from bush and extensively used agricultural surfaces, or dam water containing small organic particles (e.g. plankton). It is low-tech, very reliable, and requires almost no maintenance.

How the filter is built

The system basically consists of two PE water tanks, as they are commonly used in rural areas (Picture 1).

Picture 1: 4500 L filter tank (left) and 3500 L reservoir tank (right).

One tank contains the filter body, and the other tank is the reservoir tank, where the purified water is stored and pumped from. On our farm, both tanks are buried approximately 1 m in the ground (Figure 1). The tank that is used for the filter has a volume of 4500 litres (1000 Gallons). Its diameter and overall height are 180 cm and 212 cm, respectively. The volume of the reservoir tank is 3500 litres (750 Gallons), its diameter and overall height are 160 cm and 210 cm, respectively.

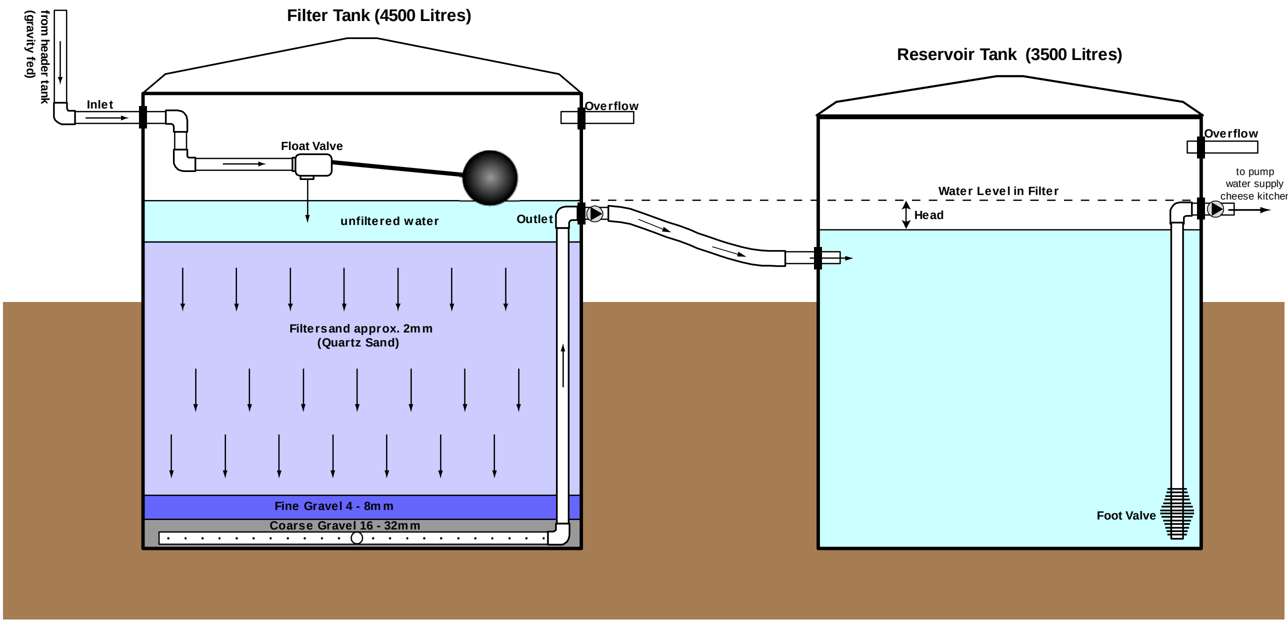
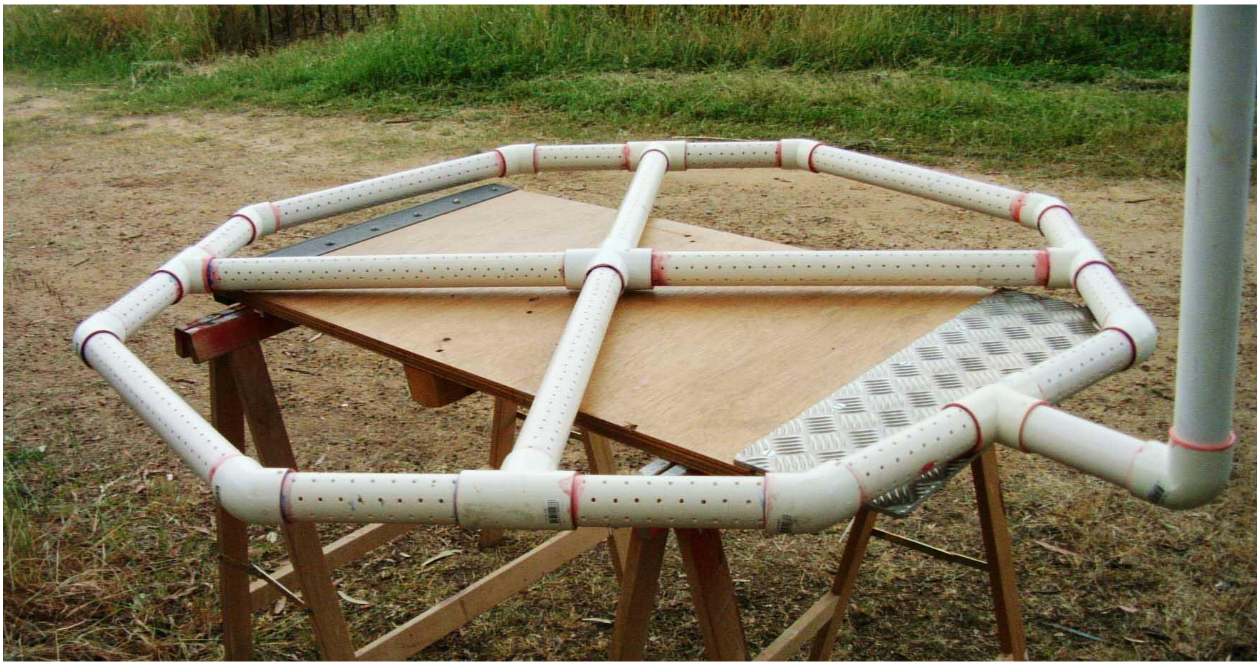


Figure 1: Schematic drawing of the Water Filtration System (see text for explanations)

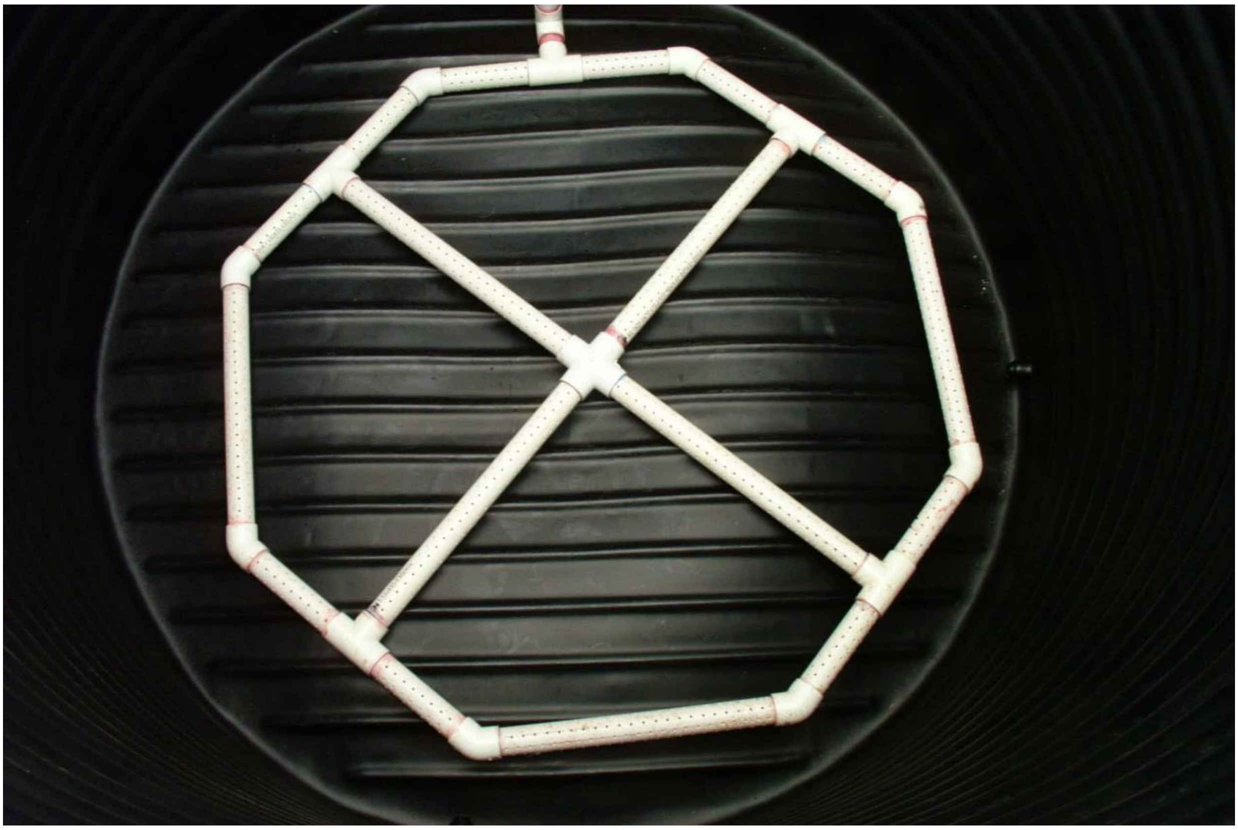
These types of PE water tanks are normally fitted with a man-hole of approx. 40 cm diameter, which allows only limited access to the inside of the tank, for example to instal the fittings (flanges etc.) of the reservoir tank. However, the access is not sufficient for the installation and maintenance of the filter tank. To install the pipework, and also to fill the tank with sand and to maintain the filter, the entire top of the tank needs to be removable[1]. Hence, if the tank is not sold with a removable top, it will be required to cut the top off (the technical service of the tank manufacturer might assist with some advice how this is best done without weakening the tank too much).

At the bottom of the filter tank lies an assembly of perforated PVC pipes, which collects the filtered water (Picture 2 and Picture 3). It is made from 40 mm PVC pressure pipe (Class 18) and joiners (e.g. T-pieces, 45°elbows, etc.), as they are widely used for domestic plumbing. 5mm holes are drilled into the pipes in regular distances.

[1] In this respect we were lucky: At the time when we purchased our tanks, a tank manufacturer (Team Poly) from South Australia sold tanks in Western Australia, where the entire top could be removed. Team Poly cut the top of the tanks off in order to stack smaller tanks into larger ones, to make the transport from South Australia to Western Australia more economic.



Picture 2: Assembly of perforated 40mm PVC pipes and joiners, which collects the filtered water at the bottom of the filter tank



Picture 3: The collecting pipe assembly in place at the bottom of the filter tank, before it is covered with a layer of gravel (see text for details)

One side of the pipe assembly is connected to a rising pipe, which carries the collected water to the hose that connects the filter tank with the reservoir tank (see Figure 1). The two tanks could also be connected at bottom level. However, to avoid a potential contamination of the filter, we did not drill a hole through the wall of the filter tank at the bottom. Furthermore, this way the connection between the two tanks remains accessible for maintenance, and can be fitted with a gate valve to regulate the flow from the filter to the reservoir tank.

The pipe assembly at the bottom of the filter tank is embedded in a 20cm layer of coarse gravel (grain size 16-32 mm, Picture 4). The purpose of this coarse gravel layer is to allow the water to flow into the collecting pipe, but to prevent the filter sand from being washed into the pipe.

Picture 4: The bottom layer of coarse gravel is in place, covering the pipe assembly. On the right site is the rising pipe that transports the collected water up and over into the reservoir tank.

The second layer is also approximately 20cm high and consists of fine gravel of 4-8 mm grain size. It acts as a barrier between the layer of coarse gravel and the filter sand.

The third layer, which is approximately 100 cm high, consists of quartz sand. This layer represents the actual filter body.

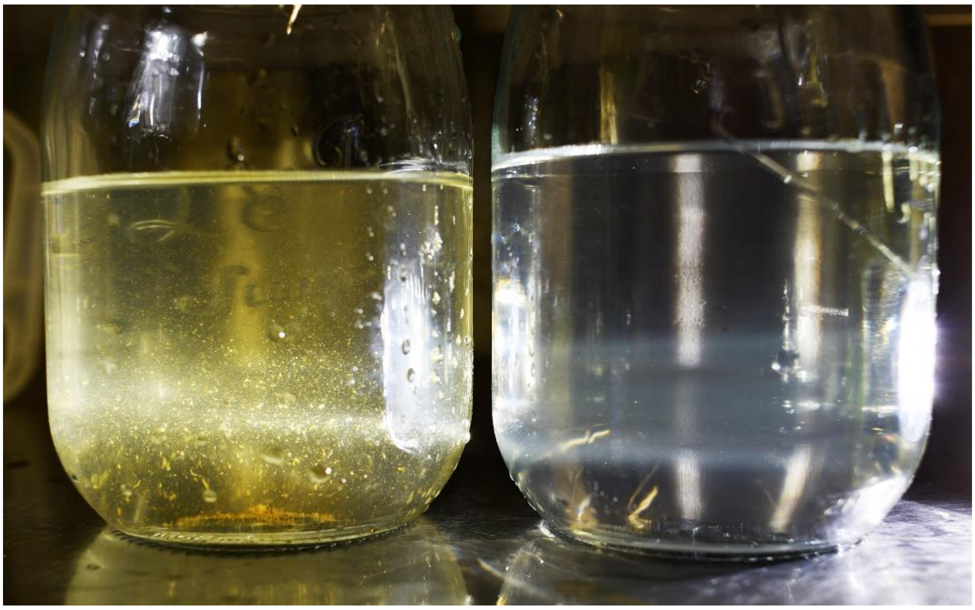
How the filter works

Hydrology

Because the two tanks are hydraulically connected, the difference between the water level in the filter tank and reservoir tank is the “head” (pressure) which forces the water through the filter sand (see Figure 1). If the water level in both tanks is equal, no water is flowing. As soon as water is pumped from the reservoir tank, the water level in this tank drops, and the resulting head pushes water through the filter. Hence it is possible to control the inflow (replacement) of fresh water to the filter tank with a simple float valve at the inlet to the filter tank (Picture 5).

Picture 5: Filter tank (with lid removed; front) and reservoir tank (back). The inflow of fresh, unfiltered water to the filter tank is controlled by a float valve. The top of the raising pipe that carries the filtered water to the reservoir tank is visible below the inlet pipe at the back of the filter tank.

Filtration/Purification



Picture 6: Raw dam water (left), and the same water after it has gone through the sand-filtered (right)

The purification process (Picture 6) is the result of a physical filtration and a biochemical breakdown of organic matter: Particles in the raw water (e.g. plankton, protozoa, bacteria) are trapped and retained between the sand particles. These particles are then digested (metabolised) by the biofilm, which covers the surface of the sand grains. This biofilm is a complex community of different micro-organisms.

The biochemical purification is highly effective, because the total surface of all sand grains in the filter body is enormous. The system works best at a constant, but low thru-flow rate (our filter runs at approximately $0.5m^3$/day). Furthermore, if the filter is filled with fresh (clean) sand, it will take several months for the biofilm to develop. In our case it took about five months until the filter was able to remove all E. coli bacteria from the raw water.