HEIDI GOAT CHEESE naturally good

KOONAC Goat Farm

Slow-flowing Bio-Sandfilter

The food safety regulations in Australia only allow water that is free of pathogens 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. This text describes the filter system which is in place to produce the potable water for our food production processes (e.g. milking, cheese making).

It is a slow-flowing bio-sandfilter, which is suitable to purify water that is only mildly polluted (e.g. surface and sub-surface run-off from bush and extensively used agricultural surfaces). It is low-tech, hence very reliable, and requires almost no maintenance.

The system consists of two “normal” PE water tanks, as they are commonly used in regional Australia. One tank contains the filter; the other tank is the reservoir tank, where the purified water is stored and pumped from (see Figure 1).

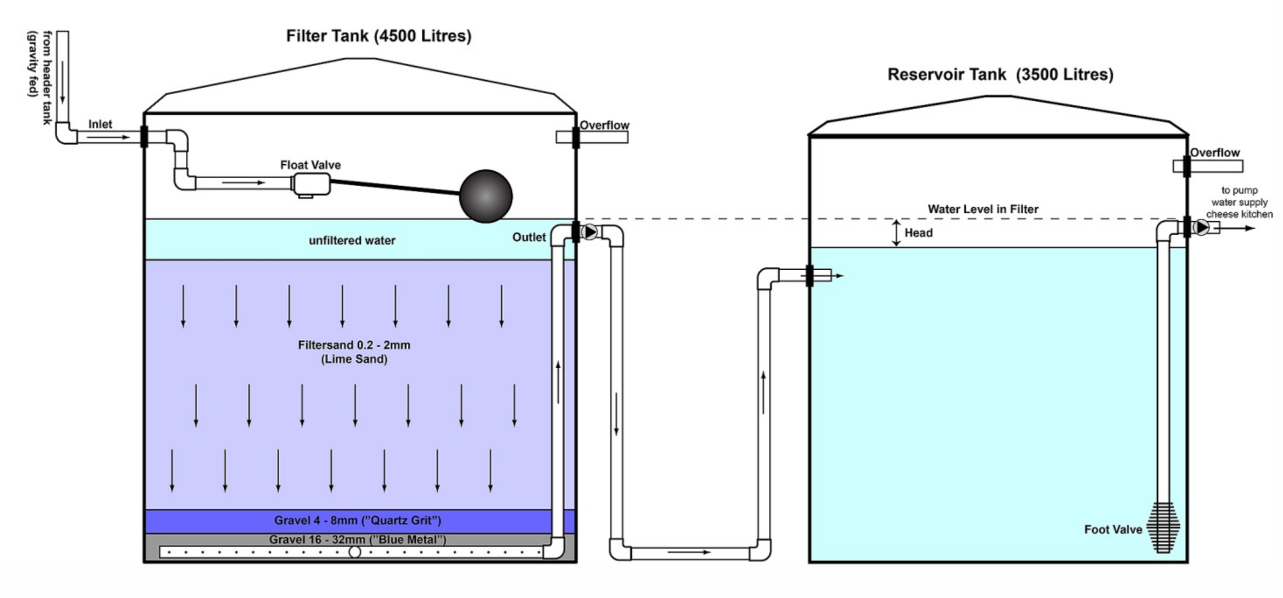

Figure 1: Schematic drawing of the Water Filtration System (see text for explanations)

The tank we use 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 of 160 cm and an overall height of are 160cm and 210 cm, respectively (see Figure 2).

Figure 2: 4500 L filter tank (left) and 3500 L reservoir tank (right)

These types of tanks are normally fitted with a man-hole of approx. 40 cm diameter, which only allows a limited access to the inside of the tank. We found that such a man hole allows installing the fittings (flanges etc.) of the reservoir tank, but that the access is not sufficient for the installation and maintenance of the filter tank. To install the pipework (see below), and also to fill the tank with sand and to maintain the filter, the entire top of the tank should be removable[1] (see Figure 7). Hence with most tanks 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 (Figure 3 and 4). It is made from 40mm 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.

One side of the pipe assembly is connected to a rising pipe, which carries the collected water to the pipe that connects the filter tank with the reservoir tank (see Figure 1). In regards to the hydraulics of the system, the two tanks could also be connected at bottom level. However, we decided to bring the collection pipe up to the top of the sand because we did not wanted to drill

[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.

a hole through the wall of the filter tank at the bottom level, to avoid contamination of the filter through a potential leakage of the flange.

Figure 3: Assembly of perforated 40mm PVC pipes and joiners, which collects the filtered water at the bottom of the filter tank

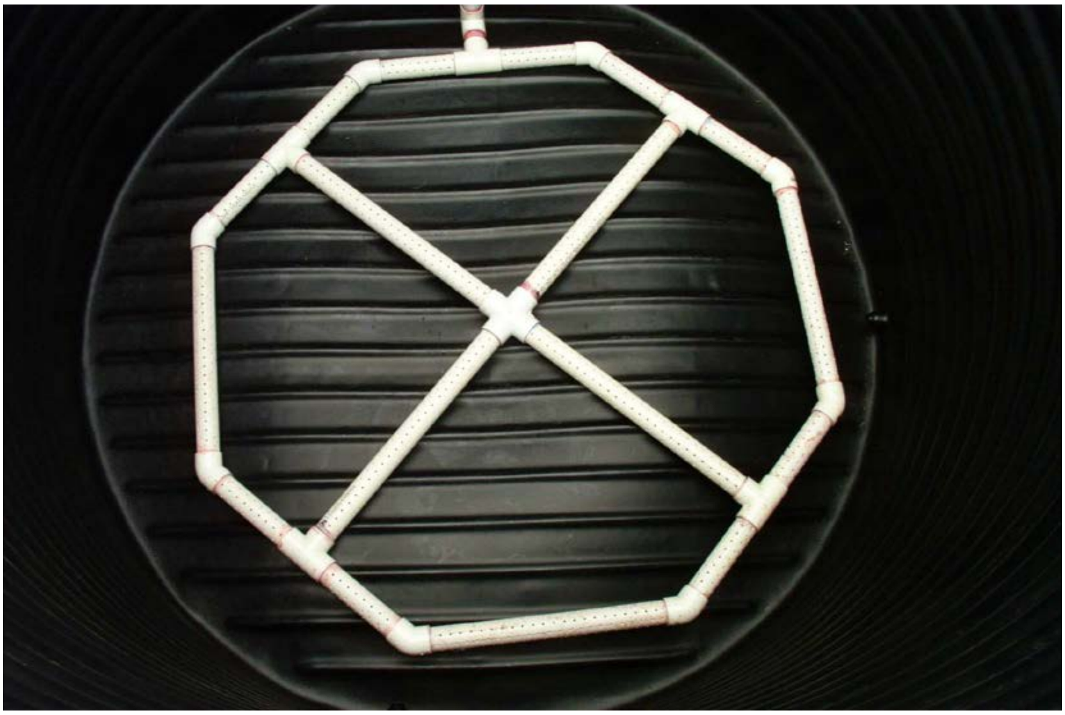

Figure 4: The collecting pipe assembly in place at the bottom of the filter tank, before it embedded in a layer of gravel (see text for details)

The pipe assembly is embedded in a layer of coarse gravel (crushed granite, so-called “blue metal”). The grain size of this material is approximately 16-32 mm. The purpose of the gravel layer, which is approximately 20 cm high, is to allow the water to flow into the collecting pipe, but to prevent the holes in the pipe to be clogged by fine mineral material. Figure 5 shows the tank after the pipe assembly has been embedded and covered with gravel.

Figure 5: The bottom layer of gravel is in place. The pipe assembly is embedded in it. 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 coarse sand (“Quartz Grit”), which has a grain size of 4-8 mm. It acts as a barrier between the gravel and the filter sand. It prevents fine filter sand from being washed into the coarse gravel at the bottom of the tank.

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

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. For this reason 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 (see Figure 7).

The layer of lime sand represents the actual filter body. It acts as a physical and biological filter. Inorganic particles (e.g. silt) and organic particles (e.g. algae from the dam, shreds of biofilm from the walls of the pipes) are trapped and retained between the sand particles (physical filtration).

Figure 6: Filling the filter tank with lime sand.

Figure 7: The reservoir tank (right) is equipped with a 40 cm man-hole, which only allows limited (but sufficient) access to the inside of the tank. In contrast, the entire top of the filter tank (left) needs to be removable to build the filter, and for maintenance purpose. The inlet of fresh, unfiltered water to the filter tank is controlled by a simple float valve (see text for explanation)

Additionally, the surface of every sand grain is covered with a so-called “biofilm”. This is a layer of different micro-organisms (e.g. bacteria, fungi, protozoa), which form as a complex biocoenosis. Dissolved organic compounds (e.g. sugars, proteins, etc.), which often are fairly big and complex molecules, are “eaten” by the biofilm, i.e. broken down to their basic components (e.g. minerals, water, carbon dioxide, nutrients). The biological filtration is highly effective, because the total surface of all sand grains in the filter body is enormous (in our filter it is probably around 1 ha).

However, one needs to keep in mind that the biological activity of the biofilm is low due to the low concentration of organic compounds available as “food” for the micro-organisms to grow, and that the system works best at a constant and low thru-flow rate. After we started to use our filter, for example, it took several months until the filter system was “run in” and fully effective. Furthermore, the water in our filter is only replaced approximately every 48 hours. If substantially more water is filtered, some of the biofilm will be washed out of the system, resulting in a reduced microbial activity. Also, if the incoming water contains a lot of particles (e.g. algae), they will accumulate on top of the sand layer. With time, they will clog the filter with an anaerobic film, which needs to be removed from time to time.