# In-Tank Slow Sand Filtration

## Rainwater Harvesting

- Rainwater harvesting is a major water source in many water stressed areas, and could be used in many more.
- A rainwater harvesting system consists of a catchment (typically a roof), conveyance, and storage.
- Water quality is generally good, although it is affected by the condition of the system components.

## Rainwater Tanks

- There are many different types of rainwater storage.
- Typically above-ground tanks are used.
- Tanks are often made of ferro-cement, although plastic, bricks and galvanised iron are also used.
- Water quality depends on storage conditions – light, dirt, and vermin intrusion allow bacteria and algae to develop.
- Tanks can vary in size from 10 to 10,000 litres.

## History

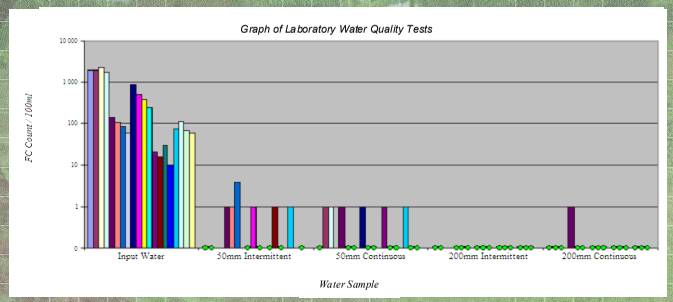
- Slow sand filtration has been in large scale use for 100 years and is a well established technique for reducing turbidity and bacteria in water
- It is known to work through two processes; physical sieving in the body of the sand, and biological predation in the active protozoal slime layer (schmutzdecke) that forms on the surface of the sand.
- In a conventional slow sand filter, a filter depth in the region of 1m is used and the vertical flowrate is around 200mm/hour.

## Explanation

This research examines the feasibility of using in-tank slow sand filtration in the context of a domestic rural rainwater tank in a developing country (although the application could be far more wide-ranging).

## Laboratory Work

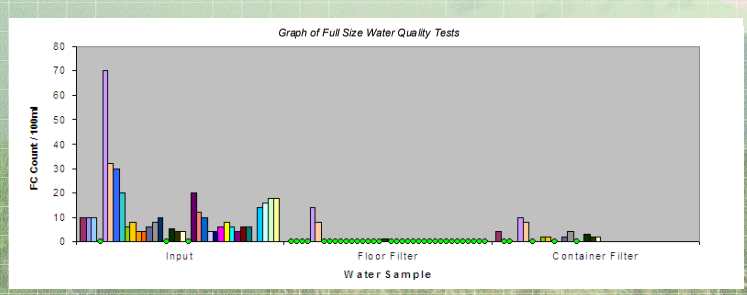
A real rainwater tank was simulated by scaling down the flowrate in proportion with the surface area of the filters. This led to areas and flowrates around 1% of those typically found in rainwater stores (0.0088m$^2$ and 0.44l/day respectively). The test rig was designed to compare the effectiveness of 50mm and 200mm deep filters, with two of each constructed alongside each other. It also contrasts continuous and intermittent flow, with each flow regime passing through each depth of filter. Three parameters were therefore varied; filter depth, intermittency of flow and dirtiness of input water, and the bacterial quality of the outlet was measured.



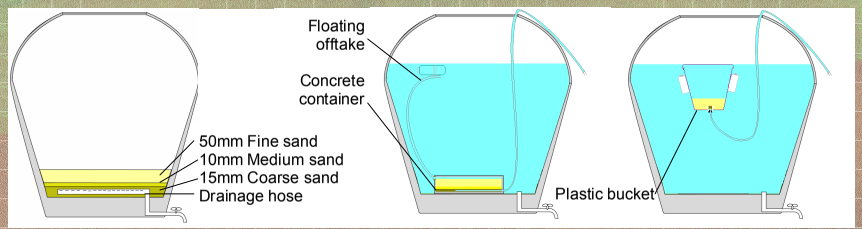

| | Input Water | 50mm Intermittent | 50mm Continuous | 200mm Intermittent | 200mm Continuous |
|---|---|---|---|---|---|
| Average FC/ 100ml | 545 | 0.6 | 0.4 | 0.0 | 0.1 |

The results clearly show a massive reduction in FC count across all filters, with little difference in performance between either 50mm and 200mm deep filters or intermittent and continuous flow regimes. The outlet quality is superior to water fetched from protected wells and springs, but not up to Euro/ US piped water standards.

## Field Work




Full size experiments were undertaken in tanks in Uganda with a view to confirming (or otherwise) the efficacy of the technique. Filters were placed in two positions, one at the bottom of a tank, covering the floor, and another at the top in a separate unit attached to floats so that it draws water from near the surface. Both filters were operated in deliberately unfavourable conditions to ascertain the robustness of the system. Very turbid pond water was used as the input water, and both filters were constructed out of generic, readily available materials.




## Conclusions

In-tank SSF is a feasible option with affordable (very shallow) filters, and has other attractive user properties. It is tolerant of the high intermittency inherent in the outflow of a domestic rainwater harvesting tank, and under some conditions gives excellent water quality. Laboratory work showed that with rainwater as the input water, excellent quality could be achieved. Field work showed that with very turbid pond water there are good improvements in water quality. This is particularly interesting when considering the use of rainwater tanks to improve the quality of water available in the dry season. In this context the tank can be used as a storage and quality improvement facility for any given water source.

The data shows that both filters reduced the outlet FC quality to less than 2 FC/100ml (WHO low risk) even under extreme conditions. The filter designs are vulnerable to high turbidity, and yet low-turbidity high-contamination water was not available in the rural Ugandan environment where testing was done.

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