Reed Bed Operation Manual

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Introduction

During the week of 2 – 6 July, a team of National University of Singapore (NUS) students, assisted by the Hope Training Center (HTC) staff, constructed a pilot reed bed in the HTC compound, next to the main building as shown in Figure 1.

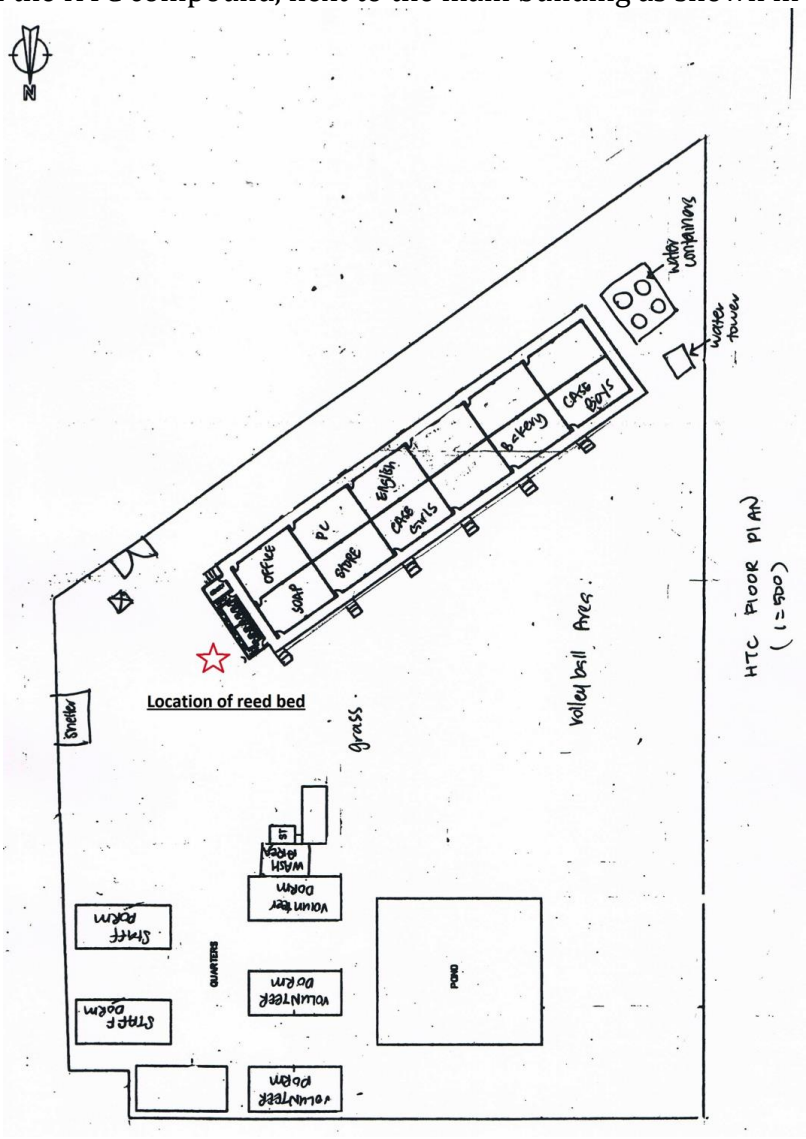


Figure 1: Location of Reed Bed

This manual will serve to document the basis of design and the operating instructions for the commissioning and operation of the pilot reed bed.

Basis of Design

During the feasibility studies in NUS, two primary filtration systems were considered for their low cost and effectiveness at clarifying soap water. These were the slow sand filter and the reed bed. The slow sand filter was found unsuitable due to fouling by coagulation of soap. The reed bed was thus chosen due reduction

The reed bed works by providing an oxygen rich environment in the reed roots. This promotes the growth of aerobic bacteria colonies that break down the organic components in soap water, clarifying the water in the process. The most suitable reed in Cambodia was the Phragmites Karka, due to availability within the region.

The reed bed's intended user is a village household. Based on an average bathing water requirement of 15 L per person per day, an average four person household will consume 60 L of water per day. A conservative design of 100 L per day was thus chosen.

Based on a small-scale in-vitro experiment in NUS, it was determined that a two day residence time was sufficient to clarify soap water to acceptable turbidity. As such, the total water volume within the bed was calculated to be 200 L, and assuming a void fraction of 0.4, the final bed size was 500 L (0.5 cubic meters). Thus a bed of 1x0.5x0.5 m was to be constructed.

Research has shown that the optimal density of reeds is approximately 4 reeds per square meter to avoid the overgrowth of reeds and the subsequent damage to the container. However, our design plants 8 reeds per square meter in order to speed up the startup time.

Optimal clarification is achieved if the system is run as close to steady state as possible. As such, both the flow rates in and out, and the level of water within the reed bed must be kept as constant as possible. The level of water within the bed is controlled via a toilet cistern float valve, while the flow rate out is controlled manually using a tap.

Due to the time needed for the roots to grow and the bacteria to form, an estimated one month start up time is required for the bed to reach full capacity. During this period, it is unlikely that the effluent will be of acceptable quality to be reused, and thus must be disposed of.

Construction

The purpose of the pilot reed bed is to determine if reed bed operation can be scaled to a continuous process and if the reeds found in Cambodia are suitable for soap water purification.

An above ground reed bed was built using bricks and mortar for the container and to elevate the feed drum. The feed drum is a vertical 200L plastic barrel. This drum is elevated to provide flow through gravitational force. The effluent from the bed is collected in a horizontal 300L plastic barrel at ground level. A mosquito net was secured on top of the feed barrel to avoid mosquitos from entering the barrel to lay eggs.

Soap water enters the bed through a toilet cistern valve into a distributer pipe that distributes the flow to the bottom of the bed. Effluent flows to the collection container via a ball valve located near the top of the bed. An additional ball valve is provided at a low point to facilitate draining of the bed. A hose fitting was also provided for the effluent valve to allow for a flexible linkage between the bed and the effluent collection drum.

During construction proper, there we modifications made of the spot. Due to the height of the collection tank, the internal dimensions of the reed bed was increased to allow the water level to lie above the collection tank to allow for gravitational flow.

The bed was packed with crushed rock of up to 20 mm in size. 21 mm PVC pipes were used for all fittings.

Structure

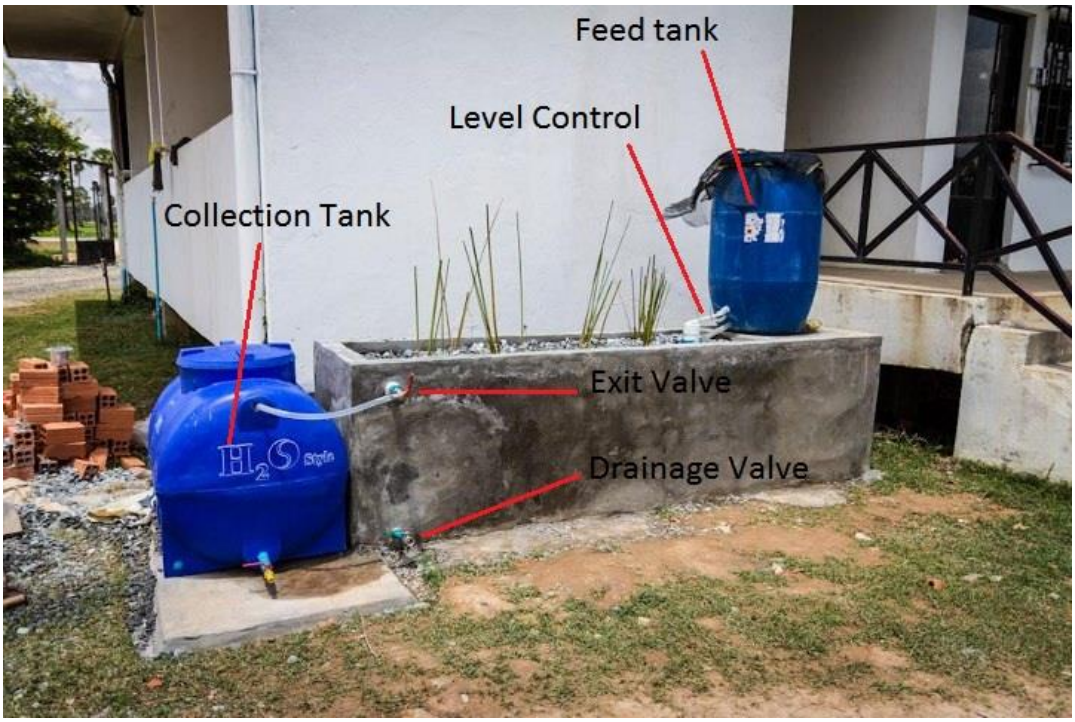


Figure 2: Labeled Diagram of the Reed Bed

Operation

Process Description

Water flows from the feed tank to the bottom of the bed using the distribution pipe. Here, it flows slowly through the bed until it reaches the exit valve at the top of the bed. This will take 2 days to occur. From the exit valve, the water will flow through the hose to the collection tank beside the bed.

Start-up

1. This set of instructions assumes that the reed bed has no water in it.
2. First, fill the bed with water either through the feed barrel or directly into the bed until the bed is full (when water begins to come out of the exit valve). Approximate water volume of the bed is 200L.
3. From then on, add water to feed tank and begin operation.
4. The flow rate is can be adjusted to be more than 100L/day to clear fine particles in the gravel. This should be maintained for 2-3 days.
5. After this, regular operation begins.

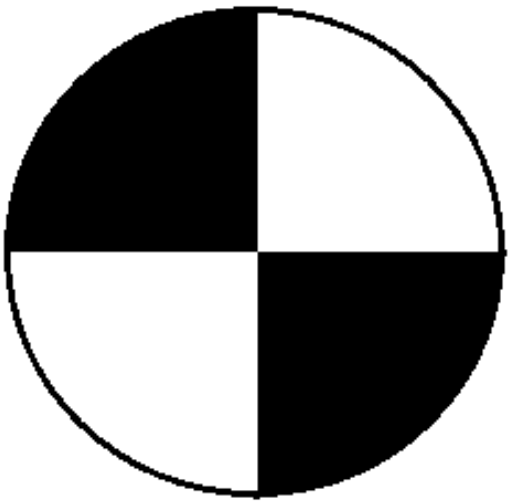
Operation (This covers day-to-day operation after start-up)

1. Water is added to the bed by filling up the feed barrel.

2. Adjust the outlet valve to target 100 L/day (35 ml per 30 seconds) by using the provided measuring cylinder and stopwatch.
3. Use the measuring cylinder and the disc to check for the turbidity of the water.
4. Record the turbidity down to allow for continued monitoring.

Turbidity Tests

1. A turbidity test is conducted using a measuring cylinder with a laminated circular disc placed at the bottom.
2. Turbidity tests are to be conducted fortnightly by OHF. These results are then sent monthly to NUS.
3. The circular disc looks like the following:



4. Fill the measuring cylinder with water from the collection valves (inlet and outlet) until the laminated circular disc at the bottom cannot be seen. Water from the inlet is collected from the feed tank.Water at the outlet is collected bydisconnecting the hose from the exit valve.
5. Record the volume of water in the measuring cylinder when this occurs. The record sheet is shown on Page 8.
6. Also note the color and smell of the water from the exit valve.

Date	Volume of Water at Inlet (ml)	Volume of Water at Outlet (ml)	Taken by

Shut Down

1. To empty the bed, close the exit valve at the top of the bed and open the drainage valve at the bottom of the bed.

Maintenance

Reeds

1. For a reed bed of the size built at HTC, only 4 reeds clusters are needed based on our literature review.
2. 8 clusters were planted instead to speed up the startup process and to serve as backups in the event that some of the plants died.
3. The growth of the reeds should be monitored to avoid the bed getting clogged.
4. Entire plants (with roots) should be removed if this occurs.
5. After a year of operation, the reeds are cut/trimmed to 20 cm above the ground.

Feed and Collection Tank

1. The collection tank should be emptied and cleaned when the water is deemed suitable for re-use.
2. The feed tank and mosquito net on top should be rinsed periodically (in the order of months).