



Fecal Sludge Management

Anaerobic Baffle Reactor

Standard Operating Procedure

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Introduction:

Anaerobic Baffle Reactor (ABR) is an important component of Fecal Sludge Management (FSM). An ABR is an improved septic tank with a series of baffles under which the wastewater is forced to flow. The increased contact time with the active biomass (sludge) results in improved treatment.

ABRs are robust and can treat a wide range of wastewater, but both remaining sludge and effluents still need further treatment in order to be reused or discharged properly. A drying bed can be constructed for further treatment of sludge. And for the safe disposal of effluents, maturation pond (also called polishing pond) is also included in the treatment facility.

The input of the Treatment Plant:

- Blackwater: wastewater and sewage from latrines.
- Greywater: relatively clean wastewater from baths, sinks, washing machines, and other kitchen appliances.
- Brown water: an inland or coastal waterway especially when murky or colored brown by silt, tannins, or pollutants.

The output of the Treatment Plant:

- Biogas
- Compost/bio solids
- Fertigation Water for irrigation

Components and operation of ABR

❖ **Storage Tank:** Generally, this is not the main component of ABR. Since the sludge has been transported from the pit by Vacutug having a volume of 2000 liter per trip and need to discharge at a time which cannot harm the treatment process. Thus, a storage tank is required to maintain a constant rate with respect to the capacity of the treatment before sludge going to the anaerobic reactor.

The sludge has been transferred from vacutug to the storage tank (10000L). A ball valve must be ensured to control the water flow at the rate of 8-10 liters per minute. This ABR will treat 10 m³ sludge per day.

❖ **Vertical baffles reactor:** From the storage tank, sludge comes to the inlet of baffles which initiate the treatment process. This reactor consists of several chambers called a baffle. This process allows the sludge to settle down the solid part in an anaerobic condition. The sludge comes to one chamber at the bottom and the liquid parts go to another chamber by settling down the solids partially without mixing any reagent. Higher the number of chamber means a higher the capacity of treatment. The cross-section of the baffles is shown as below. Scum and sludge levels need to be monitored to ensure that the tank is functioning well. Usually, these chambers need to dislodge once in a year.



Figure: Anaerobic Baffle Reactor

❖ **Planted gravel filter:** This filtration process consists of different layers of gravel-sand filter media of different thickness and size. Initially, higher sized gravel is used and gradually goes down to coarse sand. There are mainly three-chamber; the first one with 100-150mm gravel, the second one with 18-25mm and the last one with coarse sand. This gravel filter beds usually need to clean 2-3 times in a year. After the filtration process, the liquid part finally goes to the polishing pond for further treatment.

The drying process is enhanced by evaporation and solid-liquid separation by gravity percolation of leachate. *Canna indica* (locally known as *Kolaboty*) is the perennial plant used in the filtration unit to aid further leachate treatment.



Picture: Planted gravel filter

- ❖ **Drying bed:** The settled solid sludge from the baffles has been taken to the drying filter bed. This bed allows to evaporate naturally and filter media allows to soak down the liquid part from the sludge. The retention time of the solid sludge at the bed depends on the temperature, humidity of the environment. The retention time is less at a higher temperature and lower humidity, and vice-versa. A common section of drying bed shown below.



Picture: Drying Bed

- ❖ **Polishing pond:** Polishing is the tertiary and final effluent wastewater treatment stage before the wastewater can eventually be discharged into natural water bodies. Polishing process involves the removal of remaining suspended solids and biological oxygen demand (BOD) that may be left after filtration. They are very shallow (usually 0.9 – 1 m depth), to allow light penetration to the bottom and aerobic conditions throughout the whole depth. The loading on the maturation pond is calculated on the assumption that 80% of the BOD has been removed in the preceding treatment. Wastewater parameters should be tested in every 3 months in laboratory to ensure the system is functioning properly.



Picture: Polishing Pond

Working Procedure

STEP 1

Desludge into 10m³ Tank (attached with the baffle reactor). Do not desludge directly into baffle reactor.

STEP 2

Inlet Tank (10 m³): After desludging into the tank make sure solid doesn't settle in the bottom. For that stirring with a bamboo stick is essential. Send the raw sludge for lab testing in every 4-6 months.

STEP 3

Gate Valve at the inlet: Make sure the gate valve attached is functioning properly and controlling the discharge of 8 liters per minute.

STEP 4

Baffle Reactor: Check the baffle for solid accumulation in per 15 days. If accumulated solid is more than 2.5' in height, cut the solids and put them into drying bed. Test the liquid in the last baffle in every 4-6 months.

STEP 5

Planted Gravel Bed: Check if there is any water logging in any part of the bed. If so filter media might be clogged and need to change the filter media. Make sure plants are alive.

STEP 6

Maturation Pond: Make sure this maturation pond is getting direct sunlight and all the sides of the pond is protected. Test the liquids in every 4-6 months. **Do not discharge the liquid into environment without testing and getting approval to do so.**

STEP 7

Drying Bed: After putting the solids on drying bed check if the remaining liquid is being drained properly. If not check the filter media for clogging. If its clogged, replace the filter material.

Maintenance

- ❖ **Anaerobic Baffle Reactor:** Scum and sludge levels need to be monitored to ensure that the tank is functioning well. Process operation in general is not required, and maintenance is limited to the removal of accumulated sludge and scum every 1 to 3 years. This is best done using a motorized emptying and transport technology. ABR tanks should be checked from time to time to ensure that they are watertight.

- ❖ **Planted Gravel Filter:** Clogging is a common problem and, therefore, the influent should be well settled with primary treatment before flowing into the filter. With time, the gravel will become clogged with accumulated solids and bacterial film. The filter material at the inlet zone will require replacement every 10 or more years. Maintenance activities should focus on ensuring that primary treatment is effective at reducing the concentration of solids in the wastewater before it enters the wetland. Maintenance should also ensure that trees do not grow in the area as the roots can harm the liner.
- ❖ **Drying bed:** Drying of sludge is very simple, but trained staff for operation and maintenance is required to ensure proper functioning. The O & M also includes application of sludge, desludging, control of drainage system and the control of the secondary treatments for percolate or dried sludge. If the filter media in the drying bed gets clogged, it needs replacement.
- ❖ **Maturation pond/polishing pond:** Once the pond is full water can flow outside through the outlet pipe. Gate valve should be insured to control the flow. Site protection also be checked.

Final disposal

- ❖ **Dry Solids from drying bed:** The dry solid should be handled carefully. Gloves should be worn when handling sludge or handling crops which have been fertilized by sludge, and good hygiene practices must be observed. Several ways are available in this regard.
 - The dry sludge can be used in composting and used as fertilizer.
 - If suitable trees are not available for use of the fertilizer, or farmers are unwilling to use sludge as a fertilizer for reasons of social acceptability, the sludge must be buried. After burial, sludge should be covered with a 6-inch layer of soil.
 - The best option is to incinerate the dry solids.
- ❖ **Wastewater from Polishing pond:** Before final disposal of wastewater into nature, the following parameter as per Bangladesh Standard need to considered.

Table: Bangladesh standard for wastewater disposal

Parameter	Unit	Standard Limit
BOD	mg/l	40
Nitrate	mg/l	250
Phosphate	mg/l	35
Suspended solids	mg/l	100
Temperature	°C	30
Coliform	Number per 100 ml	1000

- ❖ Note-1: This limit shall be applicable to discharges into surface and inland waters bodies.
- ❖ Note-2: Sewage shall be chlorinated before final discharge.

Health, Hygiene and Safety

- Every person working on desludging should receive training on hygiene and standard operating procedures for desludging.
- Proper use of FSM bathing facility should be ensured. Water supply should be constantly available on site for cleaning and in case of emergency washing needs.
- Gloves will be issued to workers who are handling sludge and direct contact with sludge must be avoided unless the worker is wearing gloves.
- Protection will be issued to workers who are handling chemicals (lime or chlorine).
- After removing their clothing, workers must take a shower before putting on their home clothes.
- Workers should disinfect their hands with 0.05% chlorine solution / soap before eating or smoking.