



Anaerobic Baffled Reactor (ABR)



13 October 2023

Organisation that implemented the case study

NGO Forum for Public Health

Geographic location

Camp 7
Cox's Bazar -
Bangladesh

Main treatment objectives

BOD / COD Reduction
Compost production
Nutrient reduction
Pathogen reduction
Solid/liquid separation
TSS and TDS reduction

Technologies employed

Settler

Unplanted drying beds
Sand filter
Polishing pond
Anaerobic baffled reactor
Gravel filter
Constructed wetland

Design population

4640 persons

Source of sludge

Pour flush toilet
Health facilities
Lined pit latrines
Pit latrines affected by groundwater infiltration
Public toilets

Final outputs

Compost
Effluent

Time construction and commissioning

TS Reduction

50.00 %

Required space

5.30 m²/m³ of design input flow

Design input flow

35.00 m³/day

Local constraints

Mountainous or hilly terrain
Only locally available materials
No permission to dig/install underground infrastructure.
No permission to build a permanent structure
No connection to the electricity network
Limited space
Limited road access, only for small vehicles
Landslide
High temperatures
Heavy Rain or monsoons
Flood prone area
Water scarce areas / Water scarcity

Skills level

Communitarian operation
Design and Engineering Specialist
FSM specialist for construction
FSM specialist for design

FSM specialist for operation and maintenance
Local contractor for construction
Local NGO for operation and maintenance

COD Reduction

70.00 %

Faecal coliforms reduction

90.00 Log reduction

Resources needed for operation

Chemicals

Engine

Capex / design input flow

324.00 USD/m³/day

Real input flow

35.00 m³/day

Description of the emergency context

Currently, there are 929,606 Rohingya refugees residing in 33 congested camps that have been officially designated by the Government of Bangladesh. This population surge occurred as a result of the extreme violence outbreak in Myanmar's Rakhine State on August 25, 2017, which led to an estimated 687,000 Rohingya refugees crossing the border into Cox's Bazar, Bangladesh. The Rohingya refugees have repeatedly sought refuge in Bangladesh due to ongoing persecution. Previous significant influxes occurred following acts of violence in Rakhine State in 1978, 1992, 2012, and once again in 2016. However, the largest and most rapid refugee influx from Myanmar into Bangladesh began in August 2017.

Operating within highly congested settings, such as the Rohingya camps, WASH actors face numerous challenges in implementing effective faecal sludge treatment processes that can

efficiently remove pathogens. These challenges primarily stem from space limitations, which impose constraints on the inclusion of appropriate, safe, and sustainable processes for treatment.

Description of the treatment process

Transfer station:

The sludge from toilets is emptied into the transfer points which are connected to the FSTP from different directions using motorized equipments like super sucker or centrifugal pump. The dumping chamber has a capacity of 300 litre. These points are situated in high elevation in order to transfer the sludge to settler tanks using gravity flow.

Settler Tank:

The majority of settleable solids are removed in a sedimentation chamber in front of the actual ABR. Two settler tanks and four baffled reactors are integrated in a single brick walled structure. Solid and liquid separation occurs at settler tanks and the liquid enters the baffled reactors for next level of treatment

Anaerobic Baffled Reactor:

ABR consists of a tank and alternating hanging and standing baffles that compartmentalise the reactors and force liquid to flow up and down from one compartment to the next, enabling an enhanced contact between the fresh wastewater entering the reactor and the residual sludge, containing the microorganisms responsible for anaerobic digestion of the organic pollutants. The compartmentalised design separates the solids retention time from the hydraulic retention time, making it possible to anaerobically treat wastewater at short retention times of only some hours (24 hrs)

Gravel filter bed:

It contains stone beds and *Canna indica* plants.

With a capacity of at least 6 m³, it allows effluent to pass through. Microbial content in the effluent forms gelatin, while plant roots reduce pathogenic organisms. At the end of the filtration waste water pass through a coarse sand (FM=3.5) layer and moves to polishing pond before final discharge to environment

Polishing Pond:

The stored water in the polishing pond comes direct contact with sunlight and some pathogens are removed. Pond water is taken for lab testing of indicators like BOD, COD, TSS, FC, TDS. Finally treated waste water disclosed to the environment if the results are satisfactory.

Sludge Drying Bed:

The drying bed is situated adjacent to the settler and ABR tanks. When solid portion of sludge occupies 50% of tank volume, it is transferred to the drying bed where it transforms to soil like substance and also helminths are removed.

Assessment & design (feasibility)

The total cost for implementing the ABR system is USD 11500 which covers all the necessary materials, such as Brick, cement, sand, steel, stone chips, coarse sand and fencing. It also includes the construction work, such as site preparation, digging infiltration trenches and sludge pits, and installing hardware materials for the tank. All the materials used in this system are locally sourced and readily available worldwide.

FS characteristics:

pH (6 to9), BOD (≤ 30 mg/L), COD (≤ 200 mg/L), Nitrate(≤ 250 mg/L), Phosphate (≤ 35 mg/L), Total Nitrogen (≤ 15 mg/L), TSS (≤ 100 mg/L), Temperature ($\leq 30^{\circ}\text{C}$), Coliform (≤ 1000 cfu/ 100ml)

Population: The design of the FSTP was prepared to treat the volume of sludge generated

by 4640 people resided at G- block, camp-7

Surface area: Approximately 2000 sft land area was required to meet the design provision

Soil infiltration rate: not tested

Groundwater levels: 25 meter

Flood-prone areas: the area is not flood-prone

Proximity to water sources: The area is beyond the proximity to water sources which is said to be 30 meters

Construction

The preferred site (appx 2000 sft) was made suitable to accommodate a series of tanks(2 settler and 4 ABRs), a planted gravel filter bed, polishing pond, sludge drying bed, store room and a cleaning cum changing room for workers. The chosen site was free from the threat of land sliding and flooding. The site was properly leveled and compacted before applying a RCC mat casting.

Construction work was done taking standard safety measures for workers. Wearing PPE in the construction site was mandatory. Entry of local people was restricted to the site by clear sign and preventive measures adapted to refugees (site fencing, guard, sign board writing in Burmese, etc.)

All waste produced by the construction are properly collected and disposed of by the contractor to mitigate any negative impact on the environment and public health.

All tools and work equipment were under continuous inspection by NGO supervisor.

Operation and maintenance

ABR Performance Summary:

Parameters tested between inlet and outlet show significant reduction, demonstrating the effectiveness of the treatment mechanism:

FC: 80-90%

TS: 70%

COD: 65-90%

BOD: 70-95%

TN: 75%

TP: 90%

Helminths: 99.6%

- Raw sludge quality varies, making it unsuitable for use in congested camps.
- Infiltration process depends on soil characteristics.
- Chlorine can be added in emergencies for disinfection (15mg/l in tank 5, 2000 liters).

Desludging and O&M (refer to SOP):

- 1 daily desludging team required (4:5 m3 per day).
- Use one desludging pumps run by octane
- Connected with 3 sludge transfer statios of capacity 5000 Liter each
- Regular monitoring by trained staff is essential for preventive maintenance.

Lessons learned

- Needs strategy for faecal sludge management (effluent quality rapidly deteriorates if sludge is not removed regularly)
- Sludge network or transfer stations integrated with ABR FSTP improves treatment performance and ensures durability of the system as well

Strengths

- Low operation and maintenance cost
- No skilled labour required
- No direct contact with faecal sludge, allows for safe operations
- Treated end products are reusable in landscaping, soil conditioning etc.
- The system is fully sealed, eliminating odors and minimizing exposure to wastewater.
- Long service life
- High reduction of BOD
- Low sludge production; the sludge is stabilized
- Moderate area requirement (can be built underground)

Weaknesses

- Low reduction of pathogens and nutrients
- Effluent and sludge require further treatment and/or appropriate discharge
- Sludge handling requires space

Image Gallery

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