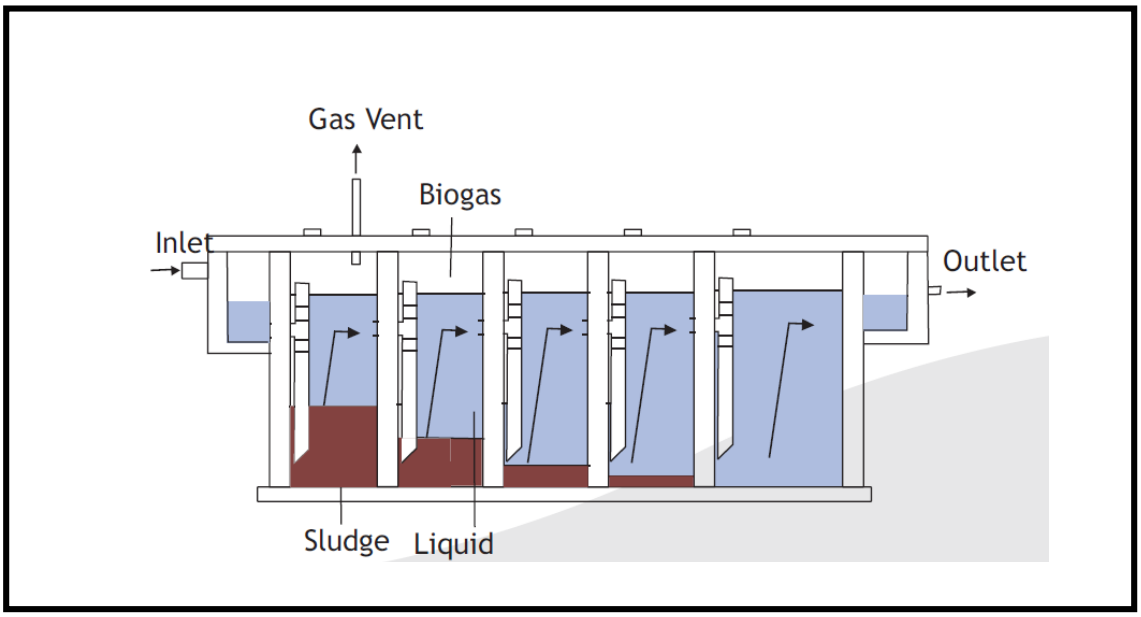
Anaerobic Baffle Reactor
Technical Note for urbanised Areas in India

Technology description

The anaerobic baffle reactor (ABR) consists of a series of chambers, in which the wastewater flows up-stream. Activated sludge is accumulated at the bottom of each chamber. The inflowing effluent is intensively mixed up with the sludge, wherein it is inoculated with bacterial mass that decomposes the contained organic load. ABR requires desludging at intervals ranging from 1-2 years, depending on the system design. The BOD reduction rate of the baffle reactor is up to 90 %. It is resistant to shock loads and variable inflow, and the operation and maintenance is simple.



Key design criteria: • Required area: 0.25 m²/p.e. • Up-flow velocity: 0.9-1.2 m/h • HRT: 18-24h • Allowed inflow: < 3000 mg BOD/L • Capacity range: 5-100 m^3 (suggested for urban India)	**This technology allows to provide:** • Secondary treatment **This technology needs to be combined with:** • Pre-treatments: Screen, Oil & Grease Trap • Primary treatments: Anaerobic Settler • Post treatments: Wetland • Sludge treatments: Sludge Drying
Implementation considerations: • Land requirement: medium • Capital cost: moderate • Maintenance burden: low	**Application and management level in the urban context:** • Neighbourhood • Peri-urban areas
Pollutant removal (%) TSS: up to 90% Organic: BOD_5 79-90% Ammonia: 50% Pathogens: 40%-75%	**Effluent suitable for:** • River discharge • Soil discharge

Design criteria for the Indian context

1. Suitability of the technology in urbanised areas in India

ABRs can be used for treating domestic wastewater. It can be set up in educational institutions, residential blocks, hostels, industrial set-ups with facilities for employees etc. ABRs are usually constructed as a part of a decentralised wastewater treatment system, where it acts as the secondary treatment module.

ABR is a gravity flow based system. This means that no energy input is required for its operation. It is also low in maintenance, as the major component of desludging is carried out only once in 1 or 2 years. These facts, that it consumes very low energy and is low in maintenance, make the ABR ideal for use in urban India. The system does have a larger area footprint than most conventional systems, but the unit is constructed underground, and with adequate structural design, the space can later be used for other purposes like parking lot, pathways, etc.

ABR is recommended for small to medium sized setups, i.e. 5-100m^3/day. This is because a smaller sized unit would make construction difficult and a larger unit would mean a very high area footprint and the construction would end up being very expensive.

2. Treatment performance expected under Indian conditions

ABR is a natural wastewater treatment system, so the performance of bacteria is key to the efficiency of the unit. India being a tropical country, serves as a suitable place for units such as ABRs as ambient conditions for the bacterial functioning are present at most times. The efficiency may decrease slightly during winter months, when bacterial metabolism is slower than in summer months.

During monsoon it should be taken care that the run-off water does not enter the chambers. For this purpose, the top slab is usually constructed in a way that the top surface is 30cm above the ground. This prevents flooding of the system.

For security, operation and maintenance reasons, it is advisable to construct ABRs where they are not susceptible to vandalism.

3. Pre-treatment and post-treatment required considering typical Indian domestic influents and effluents

ABR is a secondary treatment module and is most commonly used with primary and tertiary treatment modules.

Screening is usually done to prevent any non-biodegradable solids, like plastic bags, from entering the system. These materials may choke the pipelines at a later stage and hence need to be removed. This is typically followed by an oil and grease trap, subject to the quality of wastewater. In case the source of wastewater is a place where oil, grease and fats are expected, such as a canteens, then an oil and grease trap is highly recommended.

Treated water from the ABR is considerable low in BOD and solids. Though this water can be used for irrigation and surface disposal, it is not fit for use for purposes like flushing. For better reuse potential, it is suggested that ABR be followed by constructed wetlands. Tertiary treatment in the form of constructed wetlands can be given in case the water is intended for reuse. Disinfection, with methods like chlorination or UV, is necessary before water is reused to prevent contact of users with any residual pathogens.

In most cases, sludge accumulated in the treatment unit needs to be removed once in 1-2 years, depending on the design. This can also be treated off-site by expert agencies. Most commonly, the sludge is dehydrated/dewatered and can be used as manure.

4. Construction materials and equipment availability in Indian urban areas

Locally available construction materials can be used for construction. The outer walls and baffles can be made of RCC or bricks. This is also dependent on the volume of wastewater and the location of the plant. For example, it would be advisable to construct a unit with larger volumes with RCC, as it is more heavy-duty. Also if the plant is located in an area which is at a remote location in the premises and will not have much traffic/load on the surface, then brickwork can be used for construction. Water-proofing is essential for the outer walls as well as baffles. This is to avoid any leakage from the system and also seepage into the system.

PVC pipes are most commonly used for inlet, outlet and baffle pipes. These are durable and easily available in all shapes and sizes to suit the plant design. Levels for pipes are extremely crucial for the treatment system to function properly. ABR

is a gravity flow system and designed based on peak flow calculations to maintain the desired up-flow velocity in the chambers. It is designed in a way that only negligible amount of regulation devices are required. A bypass arrangement at the inlet can be done as an emergency provision to avoid flooding of the system. The inlet and outlet is simply based on level difference between the preceding and succeeding modules.

Sludge pumps are required for desludging activity. These need to be heavy duty pumps and screw pumps can also be used.

5. Sizing, site constrain and landscaping considerations

The unit has a large area footprint, as compared to most conventional technologies. But this constraint can be overcome as the system is built underground, and the surface can be later used for other purposes like parking and pathways.

To reduce the size of the system, it is suggested that grey and black water be separated at source. Greywater comprises 60-70% of the total domestic wastewater volume. It can be separated and sent directly for tertiary treatment owing to its low BOD and solid content. This way, the volume of water to be treated by the ABR becomes considerably less and as a result the size of the system is reduced to nearly 40% of the original size.

The soil profile of the site is an important consideration for both construction and budget considerations. For example, hard rock at a shallow depth would mean increased excavation costs.

It is important that the top slab has proper manholes for access during maintenance. Manholes should not be easily removable i.e. with tools like crowbar etc., especially if the unit is placed in public areas. Broken/stolen manhole covers should be immediately replaced.

It is possible that the stakeholders might not be welcoming for an unconventional technology like the ABR. To overcome this barrier it is important to create awareness among stakeholders about such systems. Presentations, interactive sessions and site visits can be useful for facilitating this process. It is important that the stakeholders are on board with the technology as this aids the operation and maintenance of the system in the long run.

6. Self-help compatibility for design and construction in Indian cities

In most domestic settings, it would be possible to replicate plants of the same size from previous implementations, if similar type of space is available. However, a trained consultant or designer needs to be involved if the plant needs to be up-scaled or downscaled or integrated into a different setting.

As per common practice, the contractor is informed about the system construction in detail. Technical and structural drawings are provided along with the BoQ. The consultant and contractor have a detailed discussion and all queries from the contractor are addressed. The construction of ABR is fairly simple though care needs to be taken at a few critical points. The installation of baffle pipes and inlet and outlet pipes is crucial. It is highly advised that the consultant be present for marking of these points. Alternately, if the contractor is competent he can be informed about the importance of these points. A supervisor can also be appointed for the purpose.

Costs and maintenance

Population equivalent (PE) finally received by the plant	1500-2000 PE
Expected life span (years)	20 years
Implementation costs (INR) related to Indian context (investment and construction costs)	3500 -5000 INR/p.e.
Maintenance and operation costs from Maharashtra experiences (INR/per year)	500-1500 INR/p.e. for operation and maintenance
Total treated water costs (INR/PE.year) related to Indian context (including operation costs)	4000-6000 INR /p.e.
Required construction staffs and skills	Designing of ABR requires basic understanding of wastewater treatment design. Construction can be conducted by local building company sufficiently skilled in excavation, earthmovings, simple hydraulic works and RCC or brickwork

Required operation and maintenance staffs and skills	After adequate training and on the basis of a simple O&M manual, operation and maintenance can be followed by unskilled workers
Energy requirements (kW/PE)	Energy is not required for operation and the treatment process. It is only required for desludging activity. Hence, we can say that no energy is required for the treatment process.

Credits

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