STeP Sanitation Technology Platform

WASTEWATER TREATMENT TECHNOLOGIES

Illustrative technologies & features, urban India

DECEMBER 2015

The Sanitation Technology Platform

Please Note: This report is a good faith effort by RTI International to accurately represent information available via secondary and primary sources at the time of the information capture. Visit the Resource Center at http://stepsforsanitation.org/ for this and other STeP resources.

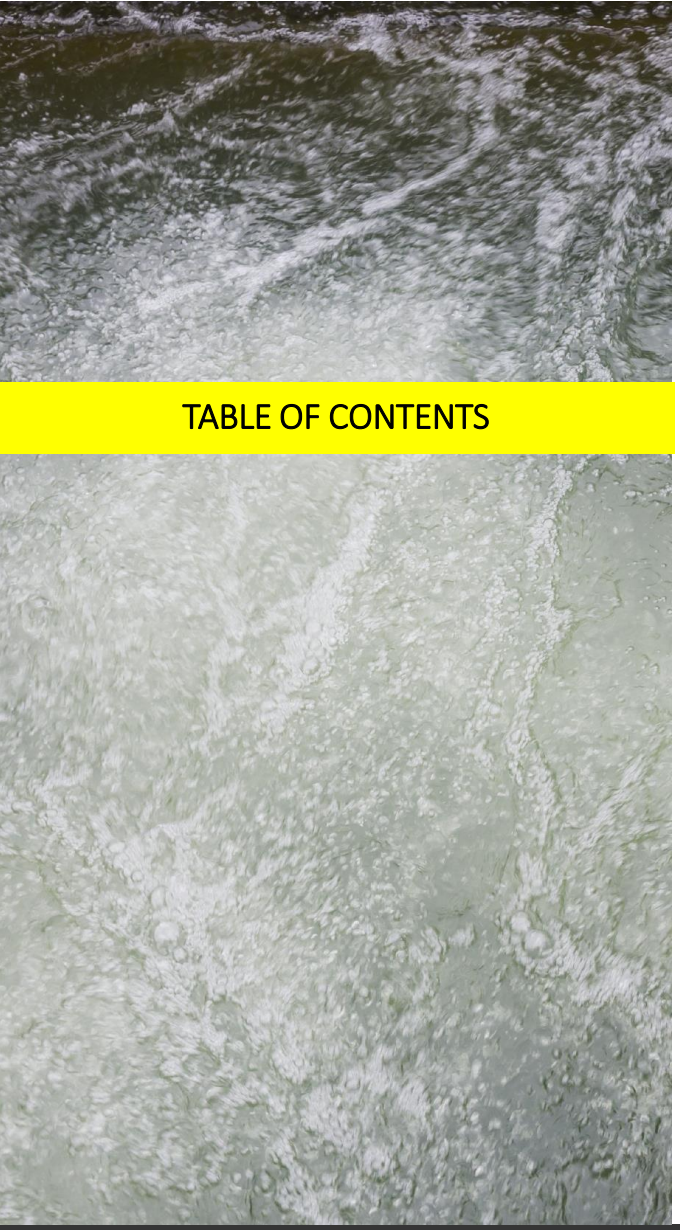


TABLE OF CONTENTS

STeP has developed an inventory of firms selling decentralized waste water treatment technologies.

STeP, with the support of the Gates Foundation, aims to support commercialization and market entry of novel sanitation technologies. In assessing the value proposition of technologies under development, the team recognizes the need to take inventory and assess currently available systems.

This task is designed to bring focus to the current state and provide a resource for the Gates Foundation and partners in the form of a living document that houses similar findings and analysis moving forward. Specific objectives were to:

- Develop an illustrative inventory of companies selling, installing, and manufacturing decentralized wastewater treatment technologies in urban India.
- Understand the key variables that influence the selection of sewage treatment technologies in urban India.
- Identify and profile the most common decentralized waste water treatment technologies.
- Collect data through primary and secondary research on key variables in order to inform pricing and operating expenses.
- Compare features of systems, including OPEX and CAPEX as well as energy requirements and footprint.
- Provide a baseline for additional market intelligence based on understanding of currently available technologies.

STeP followed a three step process to explore wastewater solutions in India.

1

Conducted secondary research to categorize and characterize various technologies.

- Definitions
- Volumes treated
- CAPEX, OPEX
- Footprints
- Energy use
- Manufacturers

2

Conducted limited primary research with company representatives.

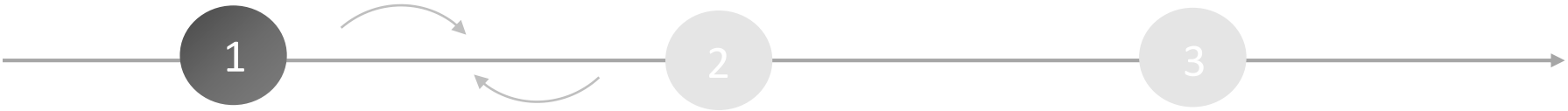
- Interview guide
- Telephone interviews with representatives from selected firms
- Selected site visits

3

Developed technology summaries & profiles.

- Sequential Batch Bioreactors
- Septic Systems
- Moving Bed Bioreactors
- Fluidized Bed Bioreactors
- Primary insights from selected firms

STeP informed the data needs through secondary and primary research.



Conducted secondary research to categorize and characterize various technologies.

Initial List

- Definitions
- Volumes treated
- CAPEX, OPEX
- Footprints
- Energy use
- Manufacturers

Research informed expanded list of factors to consider and assess

- Volume Treatment capacity
- Treatment efficiencies
- Total suspended Solids
- Biochemical Oxygen Demand Output
- Chemical Oxygen Demand Output
- Capital Expenses
- Operating Expenses
- Maintenance Expenses
- Skilled labor needed
- Energy Requirements
- Land use requirements
- Water volumes expelled

STeP developed use-case scenarios to support primary interviews.

1 — 2 — 3

Conducted limited primary research with company representatives.

STeP presented three scenarios to each point of contact to support discussion and analysis.

KLARO India

UNITED United Septic Tanks

Sintex

ENVICARE Technologies Pvt.Ltd. Recycle | Refuse | Reduce | Reuse

G.E.T. WATER SOLUTIONS PVT LTD

SCENARIOS FOR DISCUSSION

1. **Large Multi Apartment Building Complex**
   - Presumed to have 140 KL/day
   - 13 buildings
   - 4 stories each
   - 32 units per building
   - Each with 4 to 6 people per unit
   - 1,600-2,500 people total

2. **Single Building Apartment**
   - 4-5 floors
   - 16 units
   - 4-6 people per unit
   - 60-100 people total
   - 1 central system

3. **Extra Large Facility**
   - Campus or hospital
   - 6-8 floors
   - 30,000 people on the campus
   - One centralized system/solution

STeP followed a structured interview guide.

1 — 2 — 3

Conducted limited primary research with company representatives.

STeP presented three scenarios to each point of contact to support discussion and analysis.

QUESTIONS FOR CONSIDERATION

- Based on the varying scenarios, what type of system would you recommend?
- What is the capital expense of such system?
- What is the operating expense of such a system?
- What inputs are required, e.g., chemicals, energy, labor, maintenance?
- Is skilled labor required?
- What is the Biochemical Oxygen Demand output (BOD) of your system?
- What is the Chemical Oxygen Demand output (COD) of your system?
- What is the Total Suspended Solids output (TSS) of your system?
- What amount of water is being expelled?

Interviewees were responsive to some questions, but not all; they were particularly sensitive about pricing data

Primary insights revealed that firms weigh a limited set of factors in decision making.

Expanded list

- Volume Treatment capacity
- Treatment efficiencies
- Total suspended Solids
- Biochemical Oxygen Demand Output
- Chemical Oxygen Demand Output
- Capital Expenses
- Operating Expenses
- Maintenance Expenses
- Skilled labor needed
- Energy Requirements
- Land use requirements
- Water volumes expelled

Key decision factors were revealed to be:

- State level PCB standards
- Treatment efficiencies
- Capital Expense
- Land Use Requirements

State level standards and treatment efficiencies are both currently being met by the wastewater treatment technologies.

1 Treatment efficiencies must be high enough to meet PCB Standards

Increased efficiency of the wastewater treatment technology is necessary in order to meet more stringent state level PCB standards; however, current state controlled PCB standards are low enough that every technology researched is able to meet their obligated standards.

The current technologies are capable of meeting the state level PCB standards, therefore this variable is of little value to companies choosing wastewater treatment technologies.

2 State level PCB standards greatly influence the cost of technologies

As state level PCB standards increase, the need for more efficient treatment technologies increases as well, which in turn raises the capital cost of the technology.

The current technologies being offered are all capable of delivering the efficiencies necessary to meet the state level PCB standards, therefore this variable is of little value to companies choosing wastewater treatment technologies.

The two most relevant limitations that shape the choice in wastewater treatment technologies are CAPEX and land availability.

3 Capital expense is the largest limiting factor in deciding which technology to use

Due to variance in technology and size of plants, capital investment continues to be the most crucial element in deciding on what system. Many systems are capable of obtaining the minimum state PCB standards, thus the lowest CAPEX is often the deciding factor by developers.

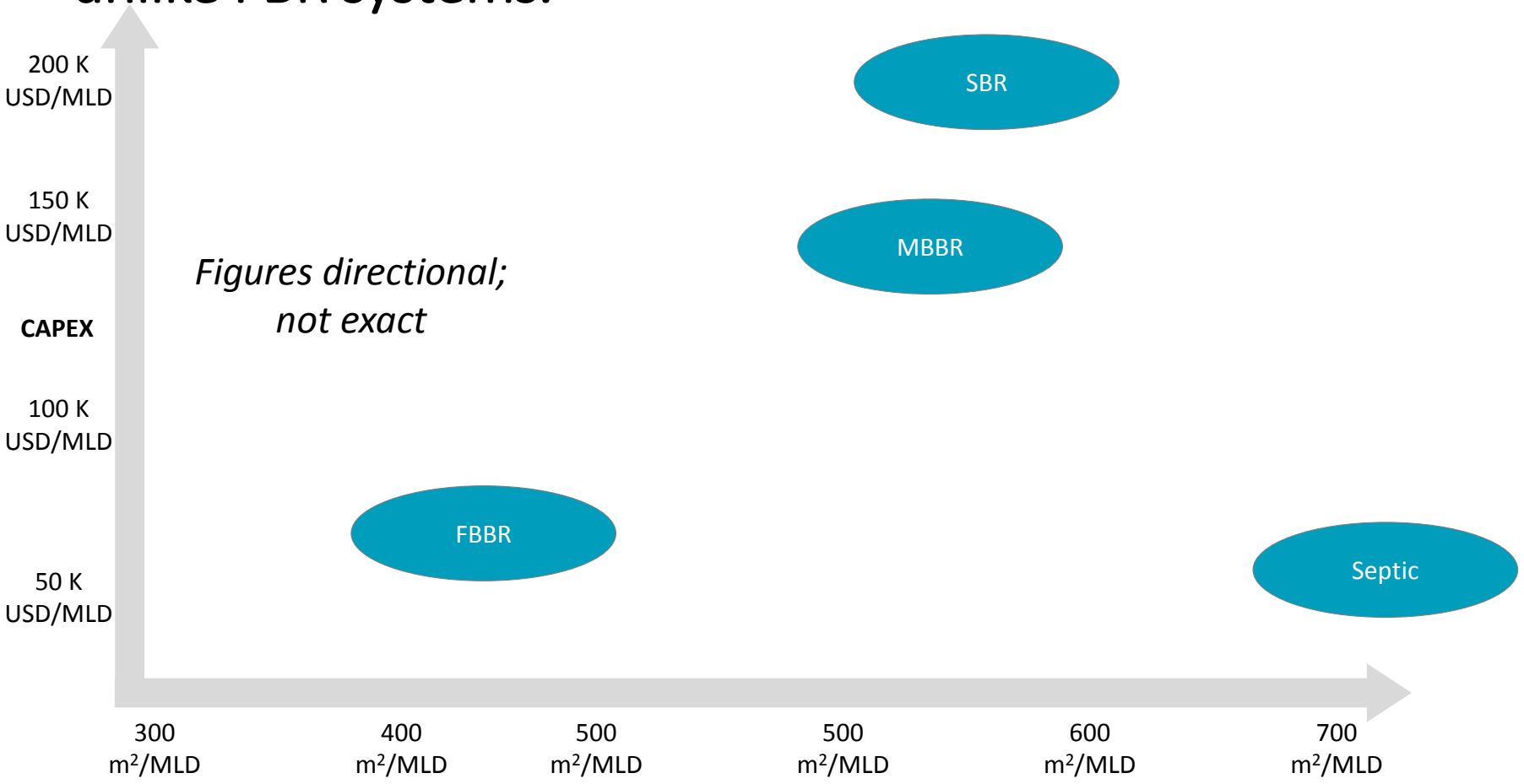
Although OPEX and maintenance are considered for deciding on the treatment technology, they are not as important as land area and capital cost. This is mainly due to developers not maintaining the facilities, generally they are just responsible for installation.

4 Land use requirements and footprint of technology influences CAPEX

Land availability and initial capital investment for a given size/capacity are two of the most important limitations. The land required generally relies upon the adopted technology, its treatment capacity and type of locality (rural vs urban).

Additionally, the footprint of the technology is dependent on the available area and a large influence in considering the appropriate technology. Limitation of land generally increases the capital cost of the technology.

Although pre-fabricated septic tanks tend to be inexpensive, they require a large underground footprint unlike FBR systems.



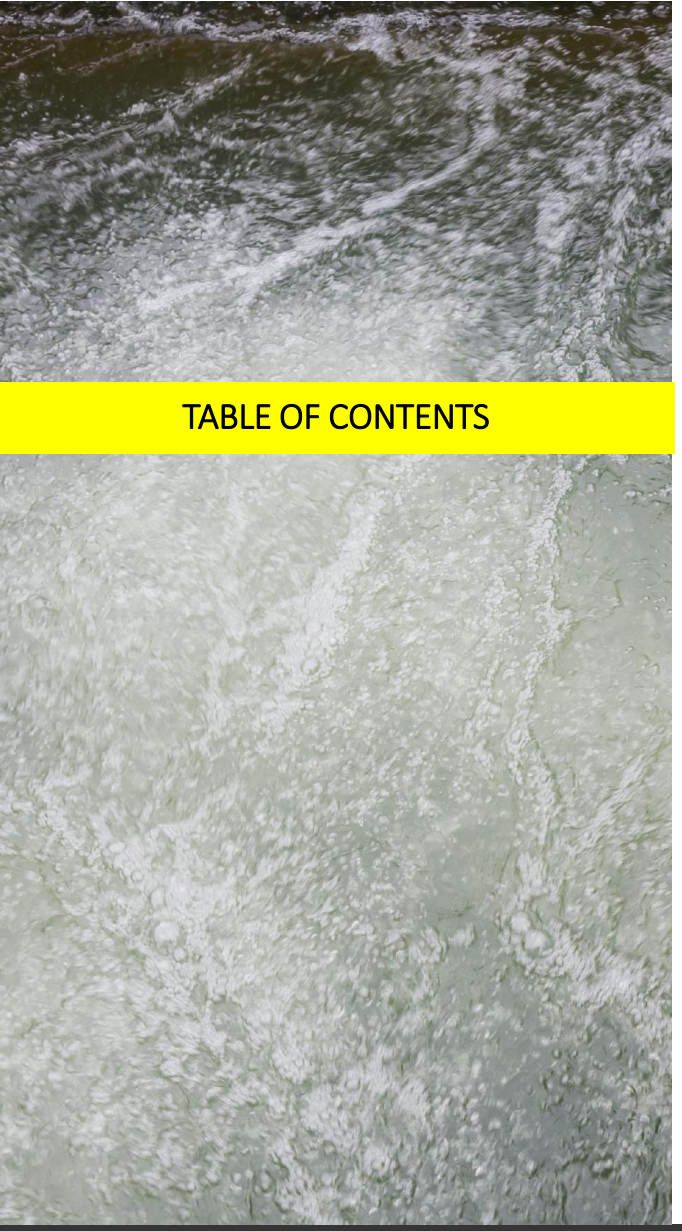


TABLE OF CONTENTS

SBRs allow for a continuous process that is easily monitored and maintained without large energy consumption.

Feature	What the Technologies Do
Definition	SBRs have two identically equipped tanks with a common inlet, which can be switched between them. The tanks allow raw wastewater (influent) to "flow through" the system, with treated water (effluent) flowing out the other end. While one tank is in settle/decant mode, the other is aerating and filling. In the final tank, the effluent is decanted, and clean water can be removed. The final effluent is pumped out and can be further refined or used as fertilizer.
Output materials	Decanted clean water and waste-activated sludge, which is moved to a holding facility where it can go back through the process.
Volume treated	2,000 LPD–760,000 GPD (liters/gallons per day)
Capex	177,000 USD/MLD
Opex	11,600 USD/MLD
Footprint	550 m^2/MLD
Energy use	8-10 kWh for entire operation of large facility
Manufacturers	Klaro, HydroTherm, Envirocare Technologies, G.E.T. Water, Xylem India, WABAG India, Engreen Global.

Advantages

- True-batch system allows react, settle, and decant phases to occur within the same reactor
- No secondary clarifiers and return activated sludge (RAS) lines
- Lower construction, installation, operation, and maintenance costs
- Low cost of ownership
- Several can run in unison to minimize maintenance outages

Disadvantages

- Higher level of control is required
- Batch reactor means it is not a constant flow
- Expense of aeration
- Large volume of sludge
- Requires multiple systems to treat large volumes of waste

Klaro India develops small, customizable wastewater treatment plants with environmentally friendly and extra safe features.

Company Profile

Klaro specializes in small wastewater treatment plants that range in size from 7 KLD to 225 KLD, largely due to its modular design. It focuses on safely handling wastewater, ensuring the absence of pumps and electrical parts at any stage of its products' processes. One of Klaro's key differentiators is its advanced remote monitoring system installed in all of its treatment plants. This drives down the operating costs of maintenance, as problems are only dealt with if they are detected by the preinstalled system.

Location: Chennai, India

Size: Operates in 34 countries, with 31,000 installations

Geographic Region: All of India

Proportion of business: 100%

Contact: +91 44 2747 2006

Web site: www.klaro.in/

Technologies

- SBRs

HYDROTHERM

HydroTherm is an engineering services company that offers expertise on large processing plants, including wastewater treatment technology.

Company Profile

HydroTherm Engineering Services specializes in large processing plants, including water treatment, storage tanks, wastewater treatment, and many others. Known for its durable products and timely service, HydroTherm's extensive client list includes MGF, Kapoor Industries Textile Unit, Frost Falcon Distribution, and Indo Gulf Sugar. Its Thermax brand sewage treatment plants offer flexible, customer-driven plants often designed for municipal corporations, housing societies, commercial complexes, special economic zones (SEZs), hotels, and hospitals. Location: New Delhi, India

Size: 11-25 employees

Geographic Region: Global, focus on urban India

Proportion of business: 25%, the rest focused on treatment plants

Contact: +91 83 7390 4273

Web site: http://www.hydrothermengineeringservices.com/

Technologies

- SBRs

Sainath Enviro-Tech is an environmental consulting agency that specializes in waste processing.

Company Profile

Sainath Enviro-Tech is a multidisciplinary environmental consultancy firm that also employs engineers and develops its own products, including waste treatment plants. Its process is based on field studies of the designated demography where its staff plan the ideal treatment scheme for the given effluent and overcome any issues with current treatment plans. The company's main focus is on how to improve the environment in India. Previous projects have included clients in the textile, sago, dyeing, chemical, power, and dairy industries of South India.

Location: Coimbatore, India

Size: < 50 employees

Geographic Region: Tamil Nadu and surrounding region

Proportion of business: <20%, they offer lots of environmental services

Contact: 0461 2310 644

Web site: http://www.sainathenvirotech.com/

Technologies

- SBRs

MBBRs are used on most large-scale sewage treatment systems, but they are highly susceptible to power outages and fluctuations.

Feature	What the Technologies Do
Definition	MBBRs biologically treat wastewater by circulating moving media in aerobic and anaerobic, activated sludge environments. Influent passes through a fine screen into a chamber where free-flowing bio carriers enter and remain in that chamber due to a sieve on the piping. The moving media is typically a floating plastic substrate colonized by a community of bacteria called a biofilm. Increased levels of biofilm enhance the biological treatment process by introducing a more robust microbial community to break down nutrients.
Output materials	Decanted clean water and waste-activated sludge, which is moved to a holding facility where it can go back through the process
Volume treated	80,000 LPD–2,000,000 LPD (liters per day)
Capex	166,000 USD/MLD
Opex	105,000 USD/MLD
Footprint	550 m^2/MLD
Energy use	300 kWh/d/MLD
Manufacturers	G.E.T. Water, Xylem India, WABAG India, Envircare Technologies

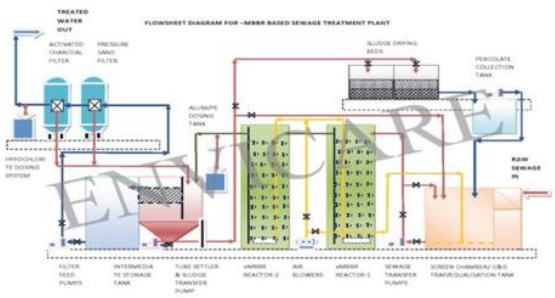
Advantages

- Self-regulating
- Responds to increased load in real-time
- Can greatly enhance biological nitrogen removal
- Ideal for siting applications requiring a compact physical footprint
- Scalable to a large degree

Disadvantages

- The use of biofilm media requires specific sizes and flow rates, limiting its scalability
- Biofilm media expense
- Surface area of microorganisms on media is not as large as it is for other technologies

ENViCARE
Technologies Pvt.Ltd.
Recycle | Refuse | Reduce | Reuse



Envicare's flow diagram for an MBBR-based sewage treatment plant pictured above.

Envicare Technologies specializes in MBBR and SBR sludge treatment methods with customizable features.

Company Profile

Envicare Technologies has over 13 years of experience handling industrial and sludge effluent using its numerous treatment technologies. With industrial, institutional, and municipal customers alike, Envicare offers effluent treatment plants, sewage treatment plants, industrial reverse osmosis plants, and many more. Envicare specializes in high-rate wastewater treatment processes using the MBBR method. Units can be preassembled for quick on-site installation.

Location: Mumbai, India

Size: <25 employees

Geographic Region: Global and India

Proportion of business: < 20%

Contact: +91 20 2724 1501

Web site: http://www.envicaresystems.com/index.html

Technologies

- SBRs
- MBBRs

WABAG India is a leader in not only wastewater treatment, but the entire plant operational management industry.

Company Profile

VA TECH WABAG Ltd. holds 14% of the market share in the Indian water technology market. It specializes in both wastewater and industrial water treatment. WABAG emphasizes innovation and has published several papers concerning the improvement of its MBBR processes, which has helped the company differentiate itself as a leader in not only water treatment, but the entire industry of plant operational management.

Location: Chennai, India

Size: Public company with $190 M in annual sales

Geographic Region: Global and India

Proportion of business: >50%

Contact: +91 44 3923 2323

Web site: http://www.wabag.com/

Technologies

- SBRs
- MBBRs

Xylem India is a large wastewater treatment company that specializes in MBBR systems.

Company Profile

Xylem is a multinational corporation that deeply understands water as a resource—its importance and uses, in particular. One of the company's main capabilities is in waste management, where it provides several technologies designed to biologically treat sewage with high efficiency and accuracy. Its MBBR system accepts high loads of suspended solids and other types of contaminants. Its technologies can also be customized for various reuse quality requirements. The company also specializes in building and selling individual parts such as pumps and mixers.

Location: Mumbai, India

Size: $29.3 million in annual sales

Geographic Region: Tamil Nadu, West Bengal, Rajasthan, Maharashtra, Andra Pradesh, Delhi

Proportion of business: < 20%

Contact: +91 44 3923 2323

Web site: http://xylemindia.in/

Technologies

- SBRs
- MBBRs

Fluidized Bed Biofilm Reactors, “FBBRs”, pass wastewater through a bed of particles, increasing fluid-solid contact and system efficiency.

Feature	What the Technologies Do
Definition	FBBRs biologically treat wastewater by passing it through a concentrated “bed” of particles at a velocity that will resultantly impart significant motion to them. Dense concentrations of aerobic, facultative, or anaerobic organisms that have colonized these media then consume any decomposable contaminants as the wastewater flows through. The influent is pumped upward, where the outflow is separated from the particles in a clear water zone.
Output materials	Decanted clean water and waste-activated sludge
Volume treated	80,000 L/day
Capex	46,000 USD/MLD
Opex	10,259 USD/MLD
Footprint	450 m^2/MLD
Energy use	223 kWh/d/MLD
Manufacturers	G.E.T. Water Solutions, MORF India Pvt Ltd

Advantages

- Ability to operate reactor in a continuous state
- The nature of fluidizing causes a uniform temperature gradient, reducing product degradation
- Uniform mixing of solids and liquids allows for better fluid-solid contact, increasing efficiency and quality
- Increased microorganism surface area enables a high flow rate
- FBBR plant size is small compared to similar reactor technologies

Disadvantages

- Conical shape of the reactor means it must be larger than most packed bed reactors
- Requires a higher fluid velocity in order to suspend the solids, which requires more pumping power and higher energy costs
- Quicker wear and tear of the vessel as a result of the fluidized bed
- Larger capital cost than most

MORF India is a leader in wastewater treatment technologies, particularly the FBBR technologies.

Company Profile

FBBR is MORF's primary technology for sewage treatment where the company performs a three-stage treatment process. The first is mechanical, where any large, nonbiological items are removed with a raked bar or coarse screen. Next, smaller, nonbiological items are removed with a filter. During the second stage, the biological material is aerated with oxygen in order to promote bacteria growth, leading to the consumption of biodegradable and soluble organic contaminants. The third stage effectively neutralizes the biological components of the sludge using the FBBR process.

Location: Chennai, India

Size: $1.51 Million in annual sales, 27 employees

Geographic Region: Tamil Nadu

Proportion of business: 25%

Contact: +91 44 4545 6666

Web site: http://www.morfindia.com/

Technologies

- FBBRs

G.E.T. WATER SOLUTIONS PVT LTD

G.E.T. Water Solutions is a growing water treatment company with capabilities in all three of the major sewage treatment processes.

Company Profile

G.E.T. Water Solutions Pvt Ltd is a water treatment company that serves many industries including irrigation, power, municipal, infrastructure, and textile. The company offers a wide range of products, efficient value-added service, and aesthetically pleasing design. Specialties include biological systems, filtration systems, membrane systems, and sludge dewatering systems.

Location: Chennai, India

Size: $1.99 Million in annual sales

Geographic Region: Tamil Nadu

Proportion of business: < 20%

Contact: +91 80 6564 9590

Web site: http://www.getwaters.com/

Technologies

- FBBRs
- SBRs
- MBBRs

Septic systems offer passive, primary treatment of blackwater; relatively slow rates of decomposition necessitate emptying or overflow.

Feature	What the Technologies Do
Definition	A septic system offers passive, primary treatment of blackwater from toilets and greywater from pipes in buildings. It typically consists of an airtight or watertight tank designed to allow solid material contained in wastewater to settle and be processed anaerobically. Because the rate of settling solids is quicker than the rate of decomposition, the effluent must be transported to a treatment plant for the remainder of its processing.
Output materials	Blackwater (settled, effluent), fecal sludge, and biogas
Volume treated	300-400 liters per user
Capex	
Opex	
Footprint	1280 m^2/MLD
Energy use	0 energy required
Manufacturers	United Septic Tanks

Advantages

- Built out of local, simple materials; simple design
- Flies cannot get in nor odor out
- No electrical energy needed
- Low operating costs and low depreciation rate
- Small footprint

Disadvantages

- Requires significant quantities of water as the transportation medium for waste
- Barely reduces pathogens, solids, and organic material
- Must be regularly cleared out of solid waste
- Vulnerable to floods
- Limited in size and throughput
- Manual cleaning is hazardous and mechanical cleaning requires high-tech equipment
- Requires further treatment

United Septic Tanks only supplies tanks to avoid the labor and maintenance issues associated with MBBR and SBR systems.

Company Profile

United Septic Tanks is a 25-year-old manufacturer for building materials such as cement pipes, RCC septic tanks, polyethylene septic tanks, and water tanks. Partnered with the Council of Scientific and Industrial Research (CSIR), United Septic Tanks developed a domestic sewage treatment plant. Included in its more traditional products is the vertical septic tank that serves the same function as typical products but reduces the buoyancy effect during monsoons. This means that if the tank happens to be empty during a flooding scenario, it will stay put in the soil. As this is a key disadvantage of septic tanks, this design adds tremendous value for customers in flood-prone areas.

Location: Thrissur, India

Size: < 50 employees

Geographic Region: India and Global

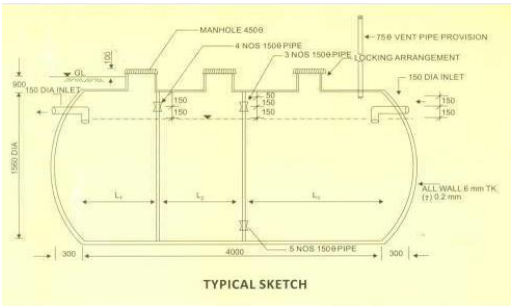
Proportion of business: 100%

Contact: +91 44 4545 6666

Web site: http://www.unitedseptictanks.com/

Technologies

- Septic tanks



A typical AMCON-designed septic tank

AMCON offers private septic systems of varying materials to comply with international standards around quality.

Company Profile

AMCON Fiberglass and Plastic Engineering Co. is a leading manufacturer of large, industrial products and, in particular, storage tanks. Its main focus is on the material of its products in order to comply with international standards. Some of the key industries it operates in are construction, government organization, and state-owned. Another key focus of AMCON is customization. Each product is tailor-made for the designated customer in order to best suit their needs. Among these products is the FRP Septic Tank, meant to consume 85% to 95% of toxic, polluting matter that enters using free oxygen and aerobic microorganisms.

Location: Kolkata, India

Size: < 50 employees

Geographic Region: India

Proportion of business: supplier of Sintex tanks

Contact: +91 84 4750 1394

Web site: http://www.amconfibreglass.co.in/

Technologies

- Septic tanks

Sintex is the worlds largest producer of water tanks and pre fabricated septic systems.

Company Profile

Sintex Industries is the worlds largest producer of plastic water tanks. It operates throughout Europe, America, Africa, and Asian markets. It provides septic systems for individual households all the way to industrial scale facilities. It also has a hybrid septic MBBR system that it is the exclusive seller of. Sintex tanks are considered the industry standard throughout India for water storage and septic tanks.

Location: Gujarat, India

Size: $638 Million in annual sales

Geographic Region: Global and India

Proportion of business: Worlds largest producer of plastic water tanks

Contact: +91-2764253000

Web site: http://www.sintex-plastics.com/

Technologies

- Septic tanks

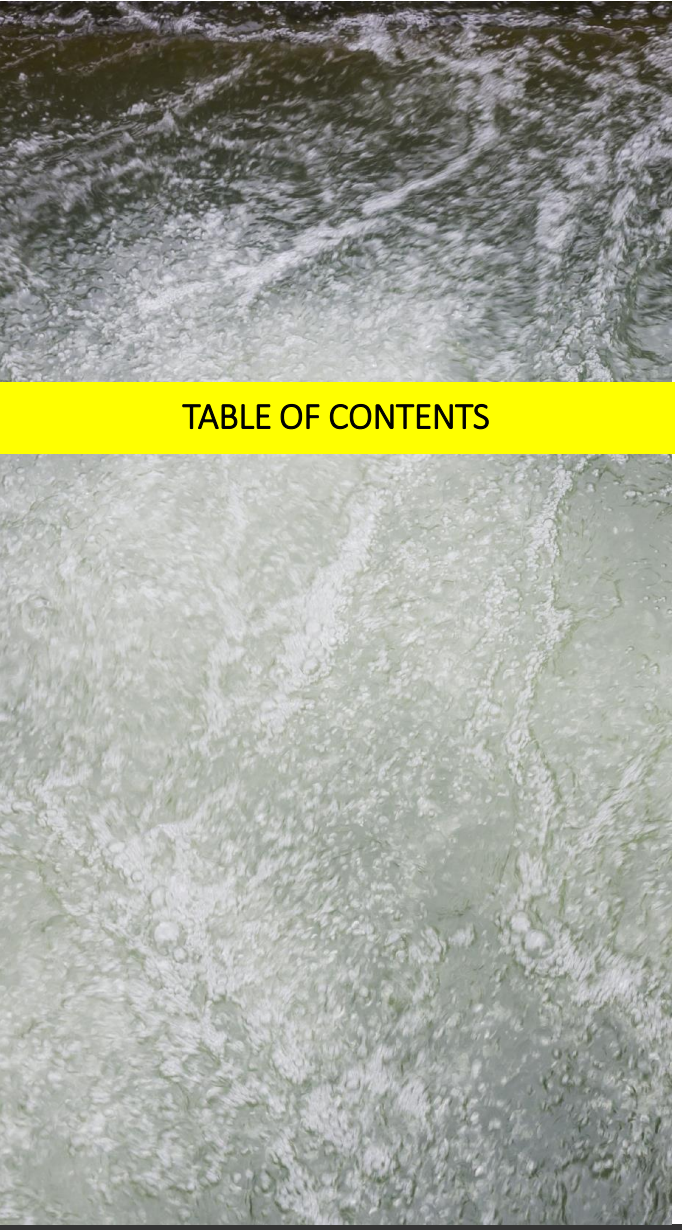
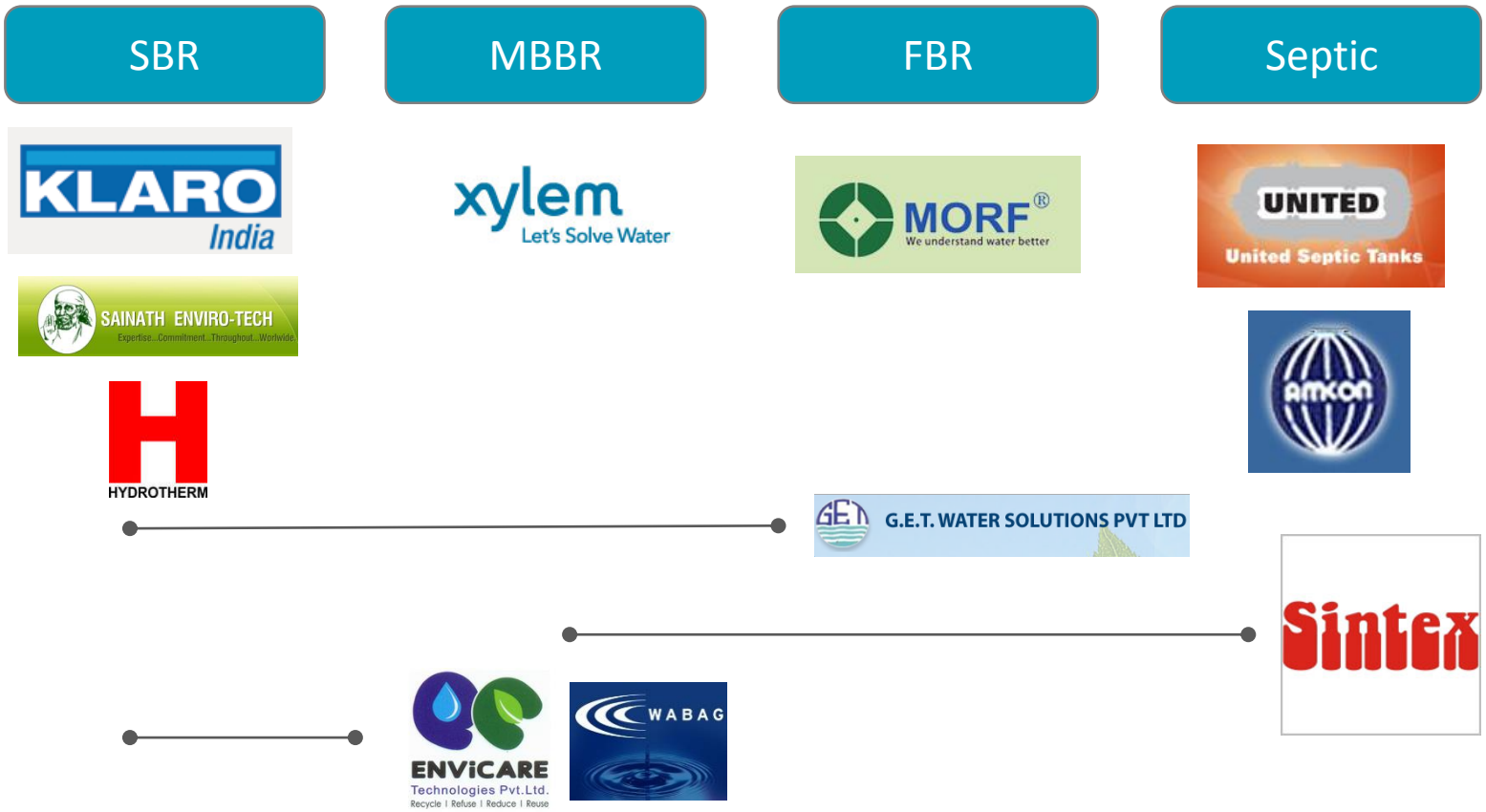


TABLE OF CONTENTS

Companies supply a range of sewage treatment system technologies, while some only specialize in SBR or Septic systems.



Suppliers commented that maintenance fees and power fluctuations are the main hindrance to use of FBBR and MBBR systems.

"When there is a power shut down for over 30 minutes, the microbes start to die in MBBR. They operate with a high level of mixed liquor suspended solids (MLSS). SBR works on the principle of batch processing with low MLSS, which reduced the extended aeration period and digestive process that MBBR requires. By design, SBR causes anaerobic digestion without the fear of microbes dyeing off."

—Kannan Pasupathiraj, Chief Engineer, Klaro India

"For large scale apartment buildings you will need the latest MBBR or Submerged Aerobic Fixed Film systems, so as to use the treated water for gardening purposes. You will also need to be able to recycle back the water for flushing by ozonation."

—Mangesh Surve, Director of Technologies, Envicare

"MBBR requires constant monitoring of the system and the feed has to constantly be coming in. Often there are blockages, issues with bacteria, and it requires lots of maintenance. Also, the power consumption is too much and labor is too much. So we decided to just build the tanks and that's it. Our contract ends at the tank.

—Raphy John, Engineer, United Septic

Depending on the state regulations, different wastewater technologies must be applied to meet certain standards.

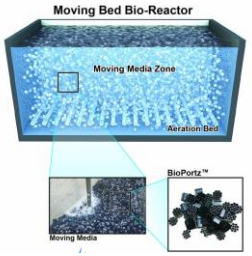
"Every state has different water reuse standards, which is the primary cost driver."

—Mr. R. Jayachandran, Head - Sales, G.E.T. Water Solutions Pvt. Ltd.

"Government laws and State Pollution Control Boards are becoming very strict. States like Tamil Nadu and cities like Bangalore and Pune have made it mandatory for households to treat the sewage before connecting their sewer pipelines to the main sewer pipeline of Municipal Corporation."

—Amit Shah, Product Head, Sintex Industries

G.E.T. WATER SOLUTIONS PVT LTD



Sintex