

MEMVEX – Molecular Oxygen Transfer Technology for Wastewater Treatment

Energy Efficient Biological Treatment Innovation

GREEN SOLUTECH CO., LTD.

ESG TECHNOLOGY

CLEAN WATER INNOVATION



The Global Wastewater Challenge

The Scale of the Problem

Global wastewater generation is rising rapidly due to urbanization, industrialization, and population growth. Conventional activated sludge (CAS) systems — the global standard — are reaching their limits in energy efficiency, treatment capacity, and operational sustainability.

Where the Energy Goes

Aeration systems alone consume **50–70% of total energy** in a typical wastewater treatment plant. Mechanical aerators and diffused air systems rely on generating billions of bubbles — a process inherently wasteful due to poor oxygen transfer rates and significant energy losses.

- The global water sector accounts for approximately 4% of all electricity consumption worldwide — and aeration is the single largest driver.

Rising Wastewater Volumes

Discharge volumes increasing 2–3% annually in developing economies

Low Oxygen Transfer Efficiency

Conventional fine-bubble diffusers achieve only 10–25% oxygen transfer efficiency

High Sludge Production

CAS systems produce large volumes of excess sludge requiring costly disposal

Operational Complexity

Continuous mechanical maintenance, clogging, and energy surges challenge plant operators

The Concept of MEMVEX

MEMVEX is a dual-function biological treatment technology that simultaneously delivers oxygen and supports microbial biofilm growth — all within a single compact membrane module.

Function 1: Molecular Oxygen Transfer

Pressurized air is fed through hollow fiber membrane tubes. Oxygen molecules diffuse directly through the microporous membrane walls into the surrounding water — **without forming a single bubble**. This eliminates the energy losses associated with bubble generation, rise, and surface escape.

Function 2: Biofilm Support Media

The fiber structure — resembling fine noodles bundled together — provides an extremely high specific surface area for microbial attachment. Dense, active biofilm communities establish naturally on the membrane surface, creating a highly efficient biological reactor within the module itself.

Three Biological Zones Within a Single Fiber



Aerobic Zone

Immediately adjacent to membrane surface — high dissolved oxygen, active BOD and nitrification

Anoxic Zone

Intermediate layer — oxygen depleted, denitrification proceeds using organic carbon

Anaerobic Zone

Outer biofilm layer — no oxygen, mineralization and phosphorus release occur

How MEMVEX Works: The Key Mechanism

Oxygen Diffusion Through Hollow Fibers

Low-pressure air is supplied to the interior lumen of each hollow fiber. Oxygen molecules — being small enough — diffuse passively through the microporous polymer membrane wall. This process delivers dissolved oxygen directly at the point of biological consumption, achieving near-100% transfer efficiency at the membrane interface.

- No bubble formation — zero energy wasted on bubble generation
- Oxygen delivered precisely where microorganisms consume it
- Supersaturated dissolved oxygen levels achievable near membrane surface
- Airflow requirements dramatically lower than conventional systems

Biofilm Establishes on Membrane Surface

Microorganisms colonize the outer surface of the fibers, forming a structured, multi-species biofilm. This living biological layer is the engine of treatment — degrading BOD, performing nitrification, denitrification, and nutrient removal simultaneously across the three biological zones embedded within the biofilm thickness.

- Unlike suspended growth systems (activated sludge), MEMVEX retains biomass on the membrane surface — eliminating the need for sludge recirculation or clarifier systems in many configurations.

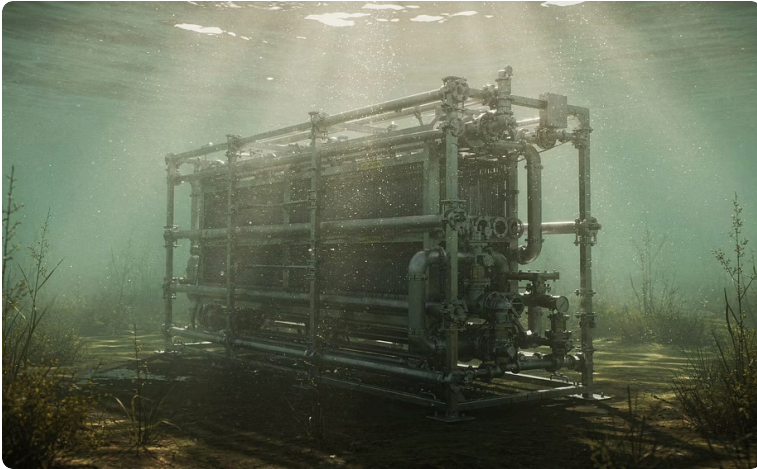
MEMVEX vs. Conventional Aeration: A Direct Comparison

The performance gap between MEMVEX membrane-aerated biofilm technology and traditional diffused aeration systems is substantial across every critical operational dimension.

Parameter	Traditional Diffused Aeration	MEMVEX Technology
Oxygen Transfer Efficiency	10–25% (bubble-based)	Near 100% at membrane surface
Energy Consumption	High — continuous blower operation required	Extremely low — minimal airflow, no blower surge
Airflow Required	Large volume, high pressure	Very low flow, low pressure
Sludge Production	High — large excess sludge volumes	Low — stable biofilm, minimal excess sludge
Nitrogen Removal	Limited without anoxic zones	Simultaneous in multi-layer biofilm
Maintenance	Frequent — diffuser clogging, mechanical wear	Simple — no moving parts in reactor
Operational Stability	Variable — sensitive to load fluctuations	Stable — biofilm buffers load variations
GHG Emissions	Higher — energy-intensive process	Lower — reduced energy and N ₂ O pathways

MEMVEX Installation Options

MEMVEX is engineered for flexibility. Two primary installation configurations allow the technology to be deployed in new-build projects, retrofit applications, and compact decentralized systems alike.



Type 1: Submerged Installation

MEMVEX modules are placed directly inside existing ponds, lagoons, or tanks. The membrane bundles are submerged and anchored, with air supply lines routed from a shore-mounted blower. This configuration is ideal for:

- Oxidation ponds and facultative lagoons
- Retrofitting underperforming ponds with no civil works
- Large-area, low-cost deployment
- Wetlands and polishing ponds



Type 2: On-Ground Reactor

A self-contained MEMVEX reactor vessel houses the membrane modules above ground. Wastewater is fed through the reactor continuously. This configuration suits:

- Compact treatment systems with limited land area
- Industrial wastewater polishing units
- Modular, scalable installations
- Locations requiring containerized or portable solutions

Typical Applications of MEMVEX

MEMVEX is a versatile platform technology applicable across a broad spectrum of wastewater sources and treatment objectives — from municipal lagoons to specialized industrial streams.



Lagoons & Oxidation Ponds

Retrofit existing ponds to dramatically improve BOD, TSS, and nutrient removal without excavation or new infrastructure.



Industrial Wastewater

Effective for food processing, beverage, pharmaceutical, and manufacturing effluents with high BOD and nitrogen loading.



Nitrogen Removal Systems

Simultaneously achieve nitrification and denitrification within the biofilm matrix — without the need for external carbon addition.



Municipal Wastewater

Upgrade or replace conventional activated sludge units in municipal treatment plants with a lower-energy, lower-sludge alternative.



Wetlands & Polishing Ponds

Enhance effluent polishing in constructed wetlands and final-stage ponds to meet stringent discharge standards.



Hospitals & Institutions

Treat complex institutional wastewater streams including pharmaceuticals, pathogens, and mixed organic loads safely and efficiently.

Key Advantages of MEMVEX Technology



Ultra-Low Energy

Power consumption as low as 0.1–0.4 kW for treating 20–90 m³/day — a fraction of conventional system requirements



Bubbleless Aeration

Near-100% oxygen transfer efficiency at membrane surface — no energy wasted on bubble formation or escape



Efficient Nitrogen Removal

Simultaneous nitrification and denitrification within the biofilm — no external carbon source required



Low Sludge Production

Stable attached biofilm produces significantly less excess sludge compared to suspended growth systems



Low GHG Emissions

Reduced energy demand and optimized nitrogen pathways translate directly into a lower carbon footprint



Simple Operation

No moving parts inside the reactor. Low maintenance burden with no diffuser clogging or mechanical failures



Flexible Installation

Submerged or on-ground configurations adapt to existing infrastructure with minimal civil works



Strong ESG Value

Directly supports environmental and sustainability goals — reduced energy, water quality improvement, and low operational emissions

Real-World Performance: Case Study Overview

The following slides present verified performance data from operational MEMVEX installations across diverse site types — including wastewater lagoons, dormitories, hospitals, temples, and industrial facilities. All data was collected from actual field measurements under real operating conditions.

Sites Evaluated

- Fancy World Lagoon
- Crystal Ratchapruek Community
- SCI Eco Industrial Site
- Animal Hospital
- Wat Thasung (Temple)
- University Dormitory

Parameters Evaluated Across All Sites

- **BOD** – Biochemical Oxygen Demand removal (%)
- **COD** – Chemical Oxygen Demand removal (%)
- **TKN** – Total Kjeldahl Nitrogen removal (%)
- **TSS** – Total Suspended Solids removal (%)
- **TP** – Total Phosphorus removal (%)
- **O&G** – Oil & Grease removal (%)
- **Power consumption** – actual kW measured on-site



Before & After: The Visible Difference

One of the most immediate and compelling demonstrations of MEMVEX performance is visible to the naked eye. Treated water exhibits a dramatic improvement in clarity, color, and odor compared to influent wastewater — a result of effective BOD removal, TSS reduction, and biological stabilization.



Raw Influent Water

Typical influent from oxidation ponds or lagoons: dark brown color, high turbidity, elevated BOD and suspended solids, strong odor from anaerobic activity.



MEMVEX Treated Effluent

Post-MEMVEX effluent: significantly clearer water, greatly reduced turbidity and color, minimal odor, and meeting or exceeding regulatory discharge standards for BOD, TSS, and nutrients.



Conventional Pond vs. MEMVEX Pond

A direct side-by-side comparison of conventional aeration pond effluent versus MEMVEX-treated effluent clearly shows the superior treatment quality achieved through membrane-aerated biofilm technology.

Fancy World Lagoon

System Specifications

60–90 m³/day

Design Flowrate

693 m²

MEMVEX Membrane Area

400 L/min

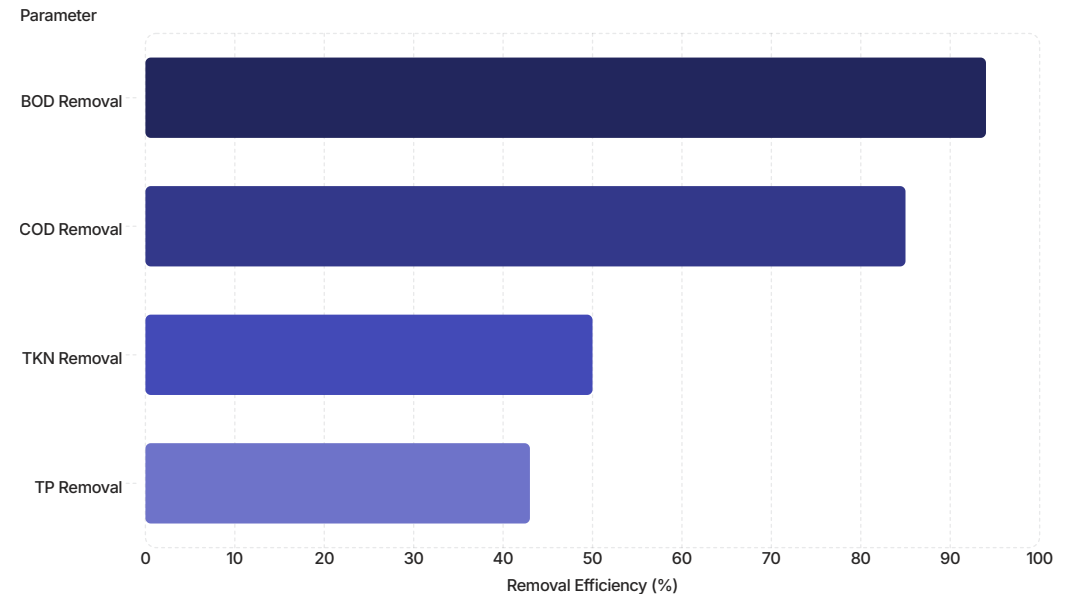
Air Pump Capacity

0.4 kW

Power Consumption

The Fancy World Lagoon installation is a submerged MEMVEX configuration treating combined wastewater from a commercial recreation facility. The system was designed to rehabilitate an underperforming facultative lagoon while minimizing energy cost and civil works.

Treatment Performance



Exceptional BOD and COD removal achieved at only 0.4 kW — demonstrating the remarkable energy efficiency of the MEMVEX platform at commercial scale.

Crystal Ratchapruerk Community

System Specifications

200 m³/day

Design Flowrate

200 m²

MEMVEX Membrane Area

100 L/min

Air Pump Capacity

Crystal Ratchapruerk is a residential community wastewater application where MEMVEX was deployed to treat domestic sewage from housing estates. The site demonstrates MEMVEX capability to handle high daily flowrates with a compact membrane area and minimal energy input — making it highly suitable for community-scale treatment.

- Key insight: A 200 m² MEMVEX module handling 200 m³/day shows that high hydraulic loading can be managed effectively with membrane-aerated biofilm technology at very low airflow rates.

Loading Rate Performance

200

m³/day Treated

High community-scale daily
flowrate

1 m³

Per m² Membrane

Hydraulic loading rate

100

L/min Airflow

Extremely low air supply for the
flowrate treated

The Crystal Ratchapruerk installation validates MEMVEX as a cost-effective solution for residential community wastewater treatment — delivering reliable performance with minimal operational complexity and very low energy requirements relative to the volume treated.

SCI Eco Industrial Site

System Specifications

20 m³/day

Design Flowrate

112 m²

MEMVEX Membrane Area

100 L/min

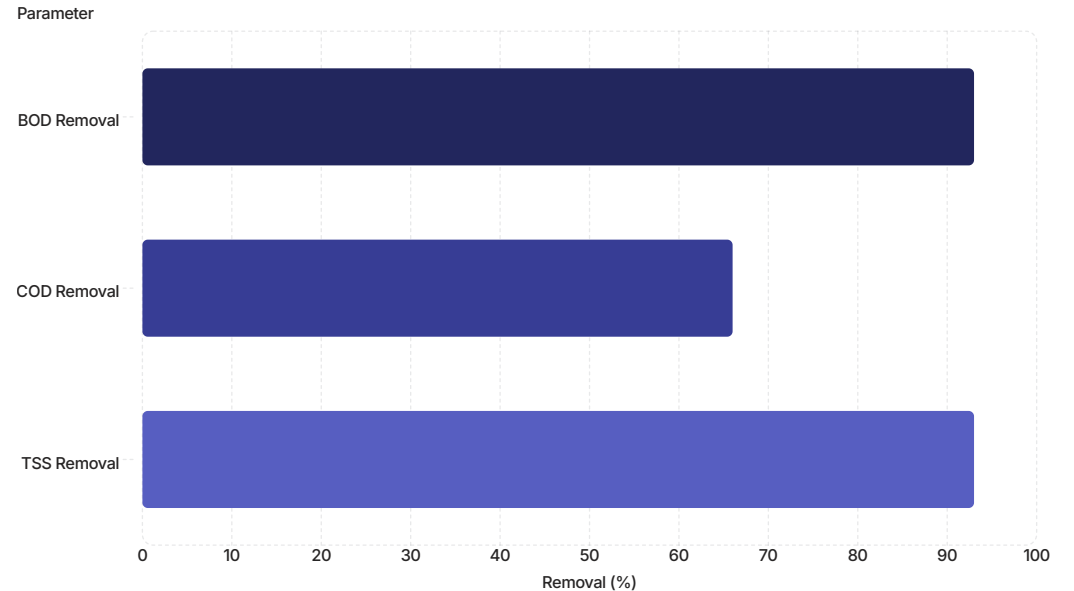
Air Pump Capacity

0.1 kW

Power Consumption

The SCI Eco installation represents a compact industrial wastewater scenario where stringent effluent quality must be maintained with minimal energy expenditure. The system treats process wastewater at one of the lowest recorded power consumptions of any MEMVEX installation — just 0.1 kW.

Removal Efficiency



- At just 0.1 kW, this installation achieves >90% BOD and TSS removal — a benchmark energy efficiency performance for small-scale industrial treatment.

Animal Hospital Wastewater Treatment

Hospital wastewater — including veterinary facilities — presents complex treatment challenges due to mixed organic loads, pharmaceuticals, pathogens, and elevated oil & grease content. MEMVEX was installed at an animal hospital facility treating 50 m³/day with a 112 m² membrane area and 200 L/min air supply.

System Specifications

50 m³/day

Flowrate

112 m²

Membrane Area

200 L/min

Air Pump

Contaminants Successfully Treated

→ **BOD & COD**

High organic load from surgical waste, animal excreta, and cleaning agents — effectively degraded by aerobic biofilm

→ **TKN (Total Kjeldahl Nitrogen)**

Nitrogen-rich streams from urine and biological waste treated through simultaneous nitrification/denitrification

→ **TSS & Oil/Grease**

Suspended solids and greasy waste from clinic operations removed to meet discharge standards without chemical dosing

Wat Thasung Temple Community

System Specifications

100 m³/day

Design Flowrate

896 m²

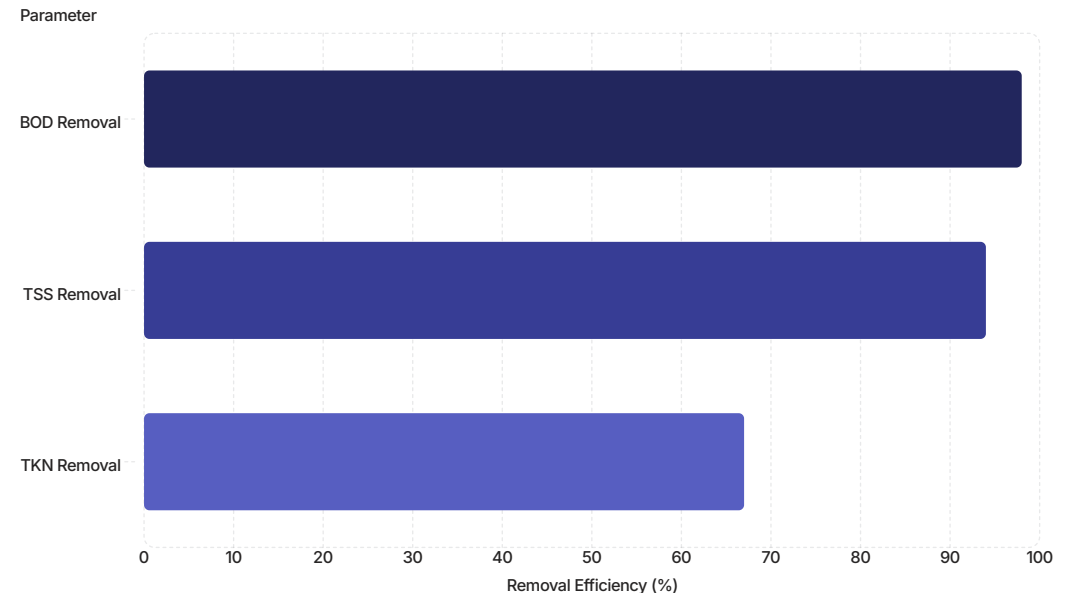
MEMVEX Membrane Area

800 L/min

Air Pump Capacity

Wat Thasung is the largest MEMVEX installation in this case study series, serving a temple community with significant wastewater generation from resident monks, visitors, and community activities. The large membrane area (896 m²) delivers outstanding treatment performance across all key parameters.

Treatment Performance — Highest Removal Efficiencies



- 98% BOD removal at Wat Thasung represents among the highest treatment efficiencies recorded across all MEMVEX field installations — confirming exceptional system performance at community scale.

University Dormitory

System Specifications

38 m³/day

Design Flowrate

200 m²

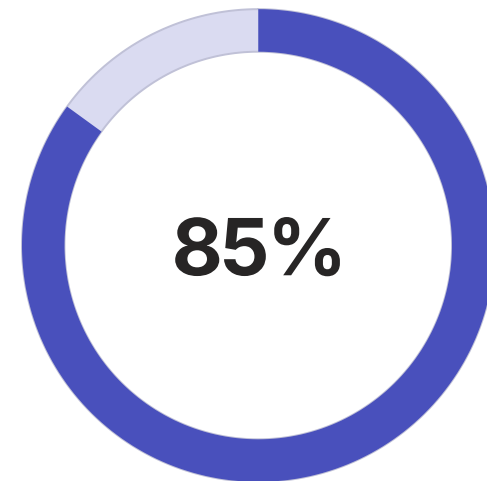
MEMVEX Membrane Area

100 L/min

Air Pump

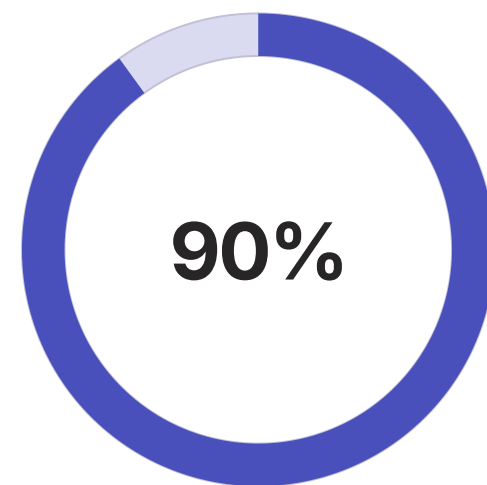
Dormitory wastewater is highly variable in flow pattern, with peak loads during morning and evening usage periods. MEMVEX's biofilm stability provides resilience against these hydraulic fluctuations — maintaining consistent effluent quality despite diurnal load variability.

Key Performance Metrics



BOD Removal

Effective organic load reduction from mixed domestic sewage



TSS Removal

High suspended solids removal ensuring clear, clean effluent

- ❑ Power consumption is extremely low — this installation is one of the most energy-efficient in the MEMVEX portfolio relative to the volume and population served, making it an ideal model for campus sustainability programs.

MEMVEX Design Loading Rates

MEMVEX systems are designed based on membrane surface area loading — a fundamentally different and more precise design approach than conventional volumetric loading. The following recommended loading values are derived from operational field data across all installed sites.

Recommended Surface Loading Rates

Parameter	Loading Rate	Unit
BOD	12	g/m ² /day
COD	24	g/m ² /day
TKN	2.5	g/m ² /day
TP	0.08	g/m ² /day
TSS	10	g/m ² /day
Oil & Grease	2	g/m ² /day

Power Efficiency Benchmark

20

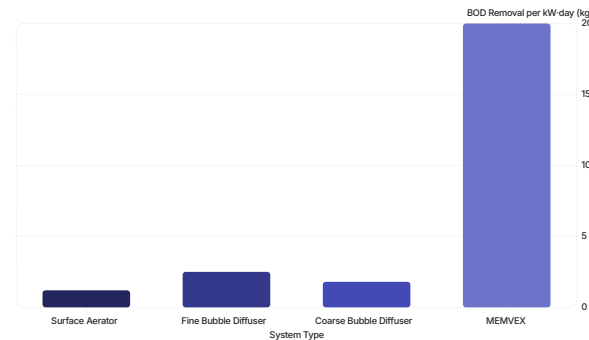
kg BOD / kW·day

Benchmark power efficiency — BOD removed per unit of electrical energy consumed

This power efficiency figure — approximately 20 kg BOD removed per kW·day — is **5 to 10× higher** than conventional diffused aeration systems, which typically achieve 1–4 kg BOD/kW·day. The loading table above enables engineers to accurately size MEMVEX modules based on influent quality and treatment targets.

Energy Efficiency: The Numbers That Matter

Conventional Aeration vs. MEMVEX



Real Installation Energy Data

SCI Eco: 0.1 kW

Treating 20 m³/day — achieving 93% BOD removal at the lowest recorded power draw in the MEMVEX portfolio

Fancy World: 0.4 kW

Treating 60–90 m³/day with 94% BOD removal — equivalent to a standard light bulb powering an entire treatment facility

University Dorm: Ultra-Low

38 m³/day treated with minimal power — ideal for campus ESG and sustainability targets

These figures represent actual, measured operational data — not theoretical projections — confirming MEMVEX as the most energy-efficient biological wastewater treatment technology available at these scales.



Environmental Impact & ESG Alignment

MEMVEX is not just a treatment technology — it is a sustainability platform that directly supports environmental, social, and governance (ESG) objectives for industries, municipalities, and institutions.



Reduced Carbon Footprint

Lower energy consumption directly translates to reduced CO₂ emissions from electricity generation. MEMVEX installations can cut wastewater-related energy emissions by 60–80% compared to conventional aeration.



Improved Nutrient Removal

Effective TKN removal reduces eutrophication risk in receiving water bodies — protecting aquatic ecosystems and biodiversity from nitrogen-driven algal blooms.



Lower N₂O Emissions

Optimized nitrification and denitrification pathways within the MEMVEX biofilm minimize the production of nitrous oxide (N₂O) — a greenhouse gas 265× more potent than CO₂.

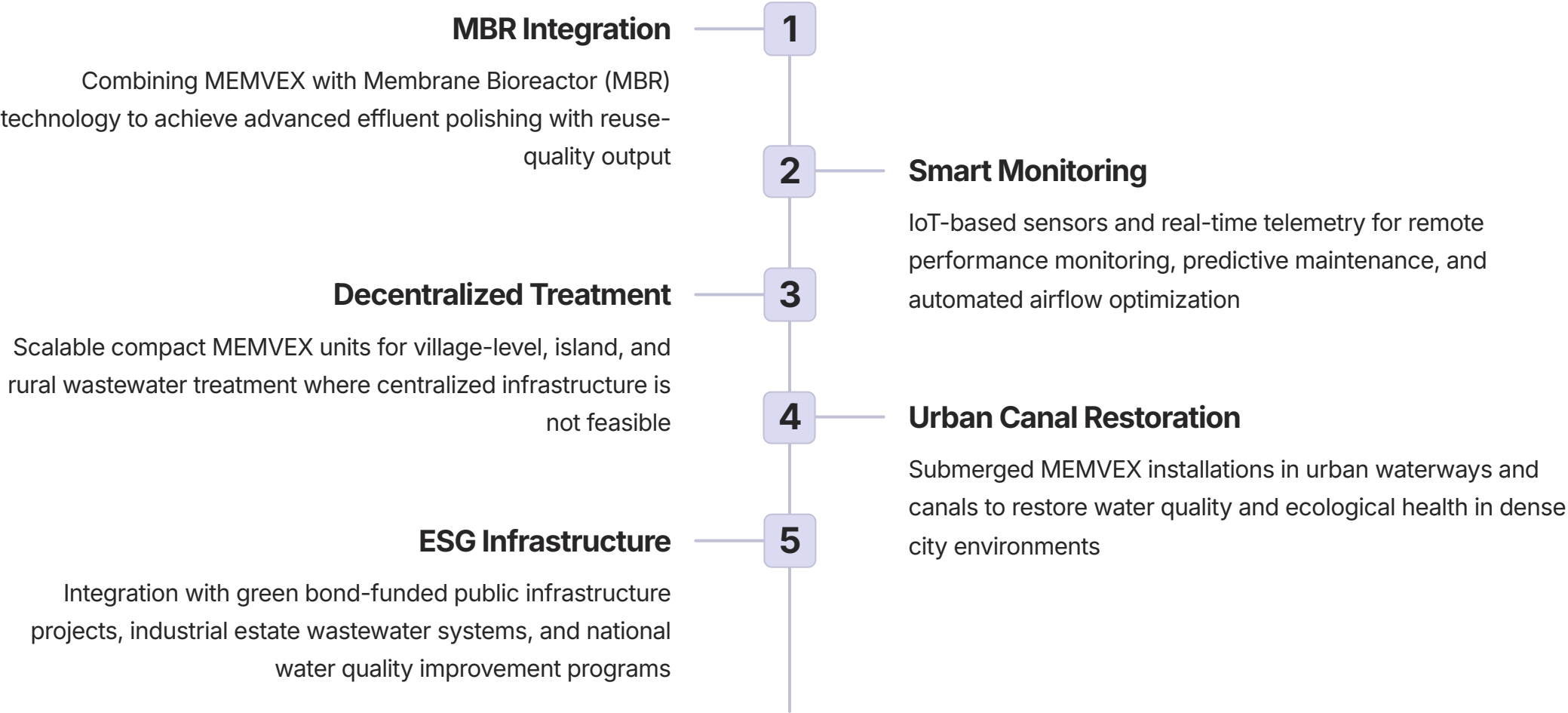


ESG Reporting Support

Quantifiable energy savings, emissions reductions, and effluent quality improvements provide measurable ESG metrics for corporate sustainability reporting and green financing eligibility.

Future Development Roadmap

MEMVEX technology is positioned for significant expansion across multiple dimensions — from smart digital integration to large-scale urban environmental restoration projects aligned with national ESG infrastructure goals.



Conclusion: A New Generation of Biological Treatment

MEMVEX represents a fundamental shift in how biological wastewater treatment is conceived, designed, and operated. By combining molecular oxygen transfer through membrane fibers with high-density biofilm growth, it achieves what conventional aeration cannot — outstanding treatment efficiency at a fraction of the energy cost.

High Treatment Efficiency

Up to 98% BOD removal, 94% TSS removal, and 67% TKN removal — validated across six diverse operational sites

Extremely Low Energy

Power consumption as low as 0.1 kW for full-scale treatment — up to 10× more efficient than conventional aeration per kg BOD removed

Flexible & Adaptable

Submerged or on-ground configurations suit new builds, retrofits, community systems, and industrial applications equally well

Strong ESG Value

Reduced carbon footprint, improved water quality, lower GHG emissions — directly measurable and reportable ESG benefits

MEMVEX is not an incremental improvement — it is a paradigm change in energy-efficient biological wastewater treatment, setting a new standard for sustainable water infrastructure globally.

MEMVEX – The Future of Energy Efficient Wastewater Treatment

Green Solutech Co., Ltd. is committed to delivering innovative, sustainable, and cost-effective wastewater treatment solutions for industries, municipalities, and communities.

Contact Green Solutech

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Full design, supply, installation, and commissioning services by environmental engineering specialists
- **ESG Partnership**
Supporting your sustainability goals with quantifiable environmental performance metrics

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