

The background of the entire page is a close-up, high-speed photograph of water splashing, creating a dynamic and textured blue and white pattern. The water droplets are in various stages of motion, some sharp and some blurred, creating a sense of movement and freshness.

INTEGRATED
WATER
SERVICES, INC.

MBR SOLUTIONS
FOR MODERN INDUSTRIES



integratedwaterservices.com

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Efficient wastewater treatment is a high priority for many industries in the 21st century.

Why?

There are five economic and geopolitical trends prompting this issue:

1) Increasingly Stringent Environmental Regulations:

New laws are being passed at the state and local level across the U.S., mandating that industries reduce pollution and adhere to stricter effluent standards. (MBR) systems can meet the most stringent treatment goals and reuse requirements.

2) Sustainability Goals:

Industries of all stripes are seeing a new emphasis on sustainable business practices. Efficient wastewater treatment reduces ecological footprints and promotes corporate social responsibility. Materially, stakeholders may insist that businesses adhere to specific ESG goals—and tie those goals to financial investments.

3) Water Scarcity:

With the global concern of water scarcity, industries are focusing on wastewater treatment and reuse to conserve water resources. The wastewater treatment conversation is in part a discussion over our shared future.

INTRODUCTION



4) Public Health Concerns:

Proper wastewater treatment is crucial in preventing waterborne diseases and protecting public health. To date, [Integrated Water Services'](#) MBR systems have provided approximately 5,000,000 people with improved water and sanitation.

5) Economic Efficiency:

Efficient wastewater treatment can lead to cost savings in the long term, reducing fines for non-compliance and lowering operational costs through resource recovery and reuse.

You're reading our latest white paper, so we understand you're looking for solutions to this complex business landscape. You are not seeking simple compliance solutions, but rather you are interested in researching advanced, sustainable wastewater management systems that align with your business's growth trajectories and emergent needs, such as scalability and rapid deployment in crisis scenarios.

We're here to help.

HOW HAS MBR TECHNOLOGY REVOLUTIONIZED WASTEWATER TREATMENT?



Let's start with what's most important to understand:

MBR technology in wastewater treatment is an advanced integration of conventional biological treatment and membrane filtration.

Following traditional biological treatment, the wastewater undergoes filtration through membranes (either microfiltration or ultrafiltration, depending on the application). These membranes effectively remove suspended solids, bacteria, and viruses, resulting in high-quality effluent that can be reused or safely discharged. In these integrated systems, the membranes replace the secondary clarifier and sand filters in a typical activated sludge treatment system.

MBR is highly adaptable, efficiently handling diverse wastewater types and load variations (and taking up much less space than traditional solutions), which makes it suitable for various applications including municipal, industrial, and residential wastewater treatment. Its compact and modular design is beneficial in areas with space constraints, and the superior quality of the treated water often meets stringent environmental standards and can be suitable for reuse.

Integrated MBR systems first emerged in the broader wastewater treatment market in the late 1990s and early 2000s. In the interim, industrial applications became more clear, and MBR systems proliferated.

According to research firm IMARC Group, the global MBR market size reached \$3.6 billion in 2022. The firm expects the market to reach \$6.3 billion by 2028 (a 10% compound annual growth rate). Now more than ever before, industries like yours need to address the perils of unchecked wastewater treatment.

Due to its high efficiency in removing contaminants, MBR can play an important and even highly educational role in industries facing tighter regulatory rules around wastewater.

In the pharmaceutical industry, for instance, MBR systems have been used to remove certain active pharmaceutical ingredients from wastewater, ensuring compliance with strict effluent quality standards; they are superior pretreatment for technologies that remove recalcitrant organics. In the food and beverage sector, MBRs help in treating high-strength organic wastes, maintaining safety standards. Additionally, the technology is vital in the oil and gas industry for treating produced water, effectively managing hydrocarbons and other pollutants. For most applications, MBR solutions create the opportunity for reuse treated water onsite, reducing the demand for fresh water.

These examples demonstrate MBR's versatility and effectiveness in meeting the rigorous wastewater treatment demands of today's regulated industries. We'll get into specific industrial applications later in this white paper.

TECHNICAL FUNDAMENTALS



Whether pursuing a new installation or a modular upgrade, MBR systems allow for higher wastewater flow and improved treatment performance in a smaller space than conventional designs demand. MBR systems direct wastewater across a specialized membrane, which separates clean water from contaminants. As water passes through the membrane, it enters a separate channel for collection; this water is referred to as the permeate.



The cross-flow dynamic of the water against the membrane controls the buildup of material on the membrane surface. Air scouring is one way in which membranes in MBR applications are cleaner.

The construction of these membranes is a critical aspect of their function. Typically made from polymeric materials, pore sizes generally vary from 0.03m to 0.2m. However, in submerged, or immersed, applications the effective pore size is closer to 0.01m irrespective of the nominal membrane rating. Design is crucial to their efficacy, as it allows membranes to block particles as small as microorganisms (approximately 0.01 micron, or 0.001 millimeters, in size), effectively retaining them within the system. The alternative, more conventional forms of wastewater treatment involve multiple biological processes that are simply less compact less efficient—resulting in lower-quality effluent.



Membranes in immersed MBR systems are commonly configured in two ways: as hollow fibers grouped in bundles, or as flat sheets. Flat sheet products can be further divided into rigid plates and flexible flat sheet types. Other configurations and materials are available for niche applications such as multitube and ceramic products.

Flat plate membranes consist of sheets that are layered in a parallel arrangement, forming a compact stack. This design maximizes the surface area available for filtration within a relatively small footprint. The plates are often reinforced with a rigid frame to maintain structural integrity and to facilitate handling.

Application Tip: Membrane Selection

SPACE AND LAYOUT CONSIDERATIONS

- Hollow fiber membranes typically offer a higher surface area-to-volume ratio, making them ideal for applications where space is limited.
- Flat sheet membranes, while still space-efficient, might require more area compared to hollow fibers but are easier to access and maintain.

READ MORE: [Selecting the Right Membrane Configuration for Your MBR Application](#)

FOULING TENDENCIES AND CLEANING

- Hollow fiber membranes can be more prone to fouling due to their smaller pore size and intricate structure. They may require more frequent backwashing and air scouring.
- Flat sheet membranes are generally easier to clean due to their accessible design. They can be a better choice if the wastewater has high solids content or if ease of maintenance is a priority.

OPERATIONAL FLEXIBILITY AND ROBUSTNESS

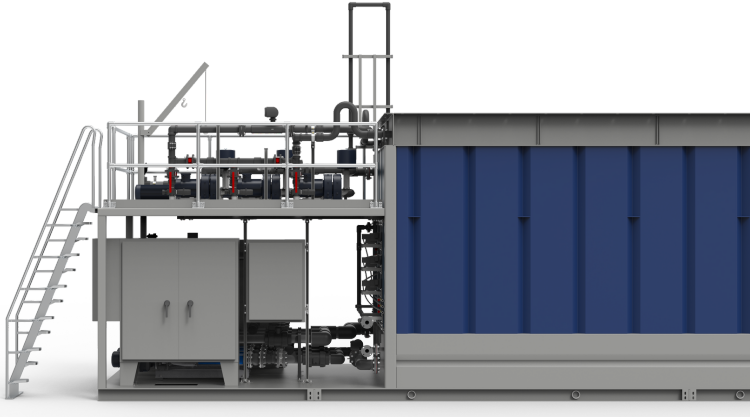
- Hollow fibers are often preferred for their operational efficiency and are suitable for applications with consistent wastewater quality.
- Flat sheets are considered more robust and can better withstand variations in wastewater quality, which is a common scenario in many industrial processes.

COST CONSIDERATIONS

- Initial investment and long-term operational costs can vary significantly between flat sheet and hollow fiber membranes. Hollow fibers might have a lower initial cost but potentially higher maintenance expenses.
- Flat sheets might require a higher initial investment but can offer savings in maintenance and cleaning costs over time.

WASTEWATER CHARACTERISTICS

- Assessing the specific characteristics of the wastewater, such as the presence of oils, fats, or certain chemicals, is crucial as these can impact the performance and longevity of the membranes.



Integrated Water Services' [BluBox](#) units are membrane-agnostic, so your team can use the exact media and filtration sizes to fit your needs.

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Operational Integrity

Controlling Flux Rates

Flux rate is the rate at which water permeates through the membrane. This metric is essential to balance treatment efficiency with membrane fouling prevention.

Engineers must consider the membrane's permeability, the characteristics of the wastewater, and operational conditions in order to optimize this metric. Flux rates are typically controlled by cleaning protocols and aeration rates, which can be optimized through computational fluid dynamics models or experimental pilot testing.

Determining Hydraulic Retention Time (HRT)

HRT, the time the wastewater spends in the bioreactor, is an important measurement for ensuring sufficient biological degradation of pollutants.

The optimal HRT is influenced by wastewater characteristics, temperature, and the specific biological processes desired (e.g., nitrification/denitrification). Modeling tools and kinetic studies of biological processes are used to accurately determine the HRT, ensuring efficient removal of contaminants while maintaining system stability.

Controlling Mixed Liquor Suspended Solids (MLSS) Concentration

MLSS concentration in the bioreactor impacts both treatment efficiency and membrane fouling.

High MLSS concentrations can enhance pollutant removal efficiency but may increase membrane fouling. Conversely, low MLSS levels reduce the risk of fouling but might compromise treatment efficiency.

Control strategies involve routine monitoring and adjustment of the waste sludge flow rate, often using automated control systems based on real-time MLSS data.

APPLICATIONS

THREE

Food and Beverage Industry

This industry typically deals with high-strength wastewater with significant organic content. An initial assessment of the organic

load, including peak load periods, is crucial. Design your MBR systems to handle the variability in waste composition and volume. Consideration of factors like fats, oils, and greases, which can affect membrane fouling, is essential.

Develop plans for treated water reuse in processes like cleaning or cooling, which can significantly reduce water footprint.



Pharmaceutical Industry

Conduct a detailed analysis of pharmaceutical compounds present in the wastewater, as these can be complex and varied.

Ensure the system meets all local and international environmental regulations, particularly for effluent discharge. Operational optimization, including the implementation of advanced monitoring systems and a stringent maintenance regime, is crucial for maintaining consistent effluent quality and system longevity.

Oil and Gas Industry

Plan for treatment of produced water, which may contain hydrocarbons, heavy metals, and high salinity, and work with your partner to design your MBR systems to be robust and resistant to chemical and physical stresses.

Implement modular and scalable MBR systems for quick deployment in case of spills or other emergencies.

Municipalities

Begin with a feasibility study and planning phase. This entails assessing the current and projected wastewater treatment requirements, ensuring the designed MBR system aligns with evolving environmental regulations and community needs. A thorough cost-benefit analysis is essential, considering both the immediate financial outlays and the long-term operational savings, such as those derived from the MBR system's compact footprint and reduced energy consumption.

Choosing the appropriate MBR configuration—hollow fiber or flat sheet—depends on specific factors like available space, wastewater composition, and ease of maintenance, each influencing the system's overall efficiency and integration with existing infrastructure.

Commercial and Residential Development

Plan for scalable and modular MBR systems to cater to growing populations and fluctuating wastewater volumes. This is especially true for more outlying rural areas that foresee significant commercial development in the years to come.

Design plans can be targeted for more compact systems, which are crucial in urban settings with limited space.

Be sure to engage the community for successful implementation, especially regarding water reuse strategies and conservation. Remember that even a simple MBR unit can present an opportunity for local education efforts, teaching students and families about the importance of clean water.

CONCLUSION



The ongoing adoption of MBR technology stands as a clear demonstration of progress in wastewater treatment across diverse industries. Your business can join this sustainable revolution now.

From the high organic loads of the food and beverage sector to the stringent purity demands of pharmaceuticals, MBR

technology promises compliance with environmental regulations and heralds a new era of efficiency and sustainability. The decision to invest in MBR technology has far-reaching, positive consequences for your community.

IMBR systems offer tailored solutions, balancing technological sophistication with the nuanced needs of each sector. The ability of MBR technology to adapt to varying scales, coupled with its modular design, makes it a versatile choice for future-focused wastewater management. The journey of integrating MBR technology, however, is not without its challenges.

This integration demands a proactive approach to planning, incorporating thorough assessments of wastewater characteristics, regulatory landscapes, and long-term sustainability goals.

The synergy of advanced engineering, strategic foresight, and a commitment to environmental stewardship is essential.

For industries grappling with the dual challenges of ecological responsibility and operational efficiency, MBR presents a pathway to exceed these expectations. But this requires diligence and corporate stewardship. MBR is an investment in a future where economic growth aligns with environmental conservation.

As this white paper draws to a close, it's clear that the potential of MBR technology in transforming wastewater management is vast and untapped.

For decision-makers in food and beverage, pharma, oil and gas, commercial and residential development, as well as commercial or industrial manufacturing, the message is clear: Embracing MBR technology is not just adapting to change – it's shaping the vanguard of your industrial marketplace. The time for action is now, to lay the groundwork for a world where clean water isn't just a resource but a well-managed legacy for generations to come.

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