WATER & WASTEWATER TREATMENT

WASTEWATER TREATMENT

- Advanced Oxidation Processes
- Biosolids/Sludge Management
- Clarification/Separation
- Disinfection
- Engineering & Design Upgrade & Integration Services
- Headworks (Primary Treatment)
- Instrumentation & Controls
- Neutralization/Precipitation/Chemical Feed Systems
- Odour & Gas Control
- Resource Recovery
- Secondary/Biological Treatment
- Tertiary/Filtration

Ultra Filtration Skid

PROCESS WATER TREATMENT

- Pretreatment Products
- Primary & Polishing
- Membrane Systems
- Repair & Upgrade Services

Reverse Osmosis System

POTABLE WATER TREATMENT

- Chemical Pretreatment
- Clarification/Lime Softening
- Disinfection/Chemical Conditioning
- Filtration
- Instrumentation & Controls
- Pretreatment
- Repair & Upgrade Services
- Solids Handling/Dewatering

JOHN BROOKS COMPANY LIMITED

YOUR CLEAR CHOICE FOR SEPARATION TECHNOLOGIES

INDEX

REVERSE OSMOSIS SYSTEMS 3-5

ULTRAFILTRATION EQUIPMENT 6-8

MEMBRANE BIOREACTORS 9-16

REVERSE OSMOSIS SYSTEMS

Reverse Osmosis Systems

John Brooks Reverse Osmosis Systems are engineered to provide purified water that is up to 99.5% free of total dissolved solids (TDS) when configured in a double pass system. These highly reliable and economical units are available in pre-engineered sizes producing from up to 1,440 to 320,000 gallons per day of purified water. They are designed to meet the high performance demands of a variety of industrial applications.

Standard components on our RO systems include 5-micron prefiltration at the inlet to protect the downstream components from resin fines and minor turbidity. Stainless steel centrifugal booster pumps provide the correct raw water pressure and flowrate to the Thin Film Composite (TFC) membrane(s). Process parameters such as flow, pressure and treated water quality are measured and displayed on the integral instrumentation display rack and fully customizable control panel.

All of our Reverse Osmosis components are prepiped, prewired, tested and shipped as a complete skid mounted package ready for installation with minimum floor space requirements. Our network of technically trained field personnel ensures that you receive immediate and reliable support and service 24 hours per day, 7 days per week.

Optional components are added to the units to allow for modifications to comply with virtually any engineering specification. Only high quality, industry recognized components are utilized to ensure many years of maintenance free operation.

Standard Features

- Low Energy Thin Film Composite Membranes FRP Reinforced Housings Available Up to 1,000 PSI for Sea Water Applications
- Polyurethane Coated or SS Frames
- Low Pressure Protection for no Flow Situations
- Automatic Feed, Reject, Permeate and Flush Valves
- 5 Micron Prefiltration
- Water Quality Monitoring of Feed and Permeate Critical Parameters
- Feed, Concentrate and Recycle Control Valves
- Product, Concentrate and Recycle Flow Meters
- Glycerin Filled Pressure Gauges
- Multi-Stage Centrifugal Pump with TEFC Motor
- NEMA 4, UL Listed Control Panel includes Fully Programmable Process Controller, Control Switches, Lights and Relays
- Power Supply: 208-230/1/60, 208-230/3/60, 575/3/60
- In Situ Cleaning Connections

REVERSE OSMOSIS SYSTEMS

Typical Applications

- Laboratory Reagent Water and Glassware Rinse Water
- Microelectronics Parts Manufacturing Rinse Water
- Food and Beverage Product Ingredient Water
- Cosmetics Product Formulation and Rinse Water
- Boiler Feedwater / Turbine Rinse Water
- Pharmaceutical Product Ingredient Water
- Drinking Water Purification
- General Industry Process and Rinsing Water

Options

- Auxiliary Pump / Ancillary Device Controllers
- Product Pressure Relief Valve
- Optional Power Supply Configurations
- Automatic Product Flushing System
- Storage Tanks and Repressurization Systems
- Automatic Concentrate Flushing System
- Stainless Steel Sanitary High Purity Product Piping
- Fully Integrated DCS / BMS Control System
- Product Water Quality Divert to Ensure Consistent Product Quality in Direct Feed Mode
- Touch Screen Graphic Display Panels

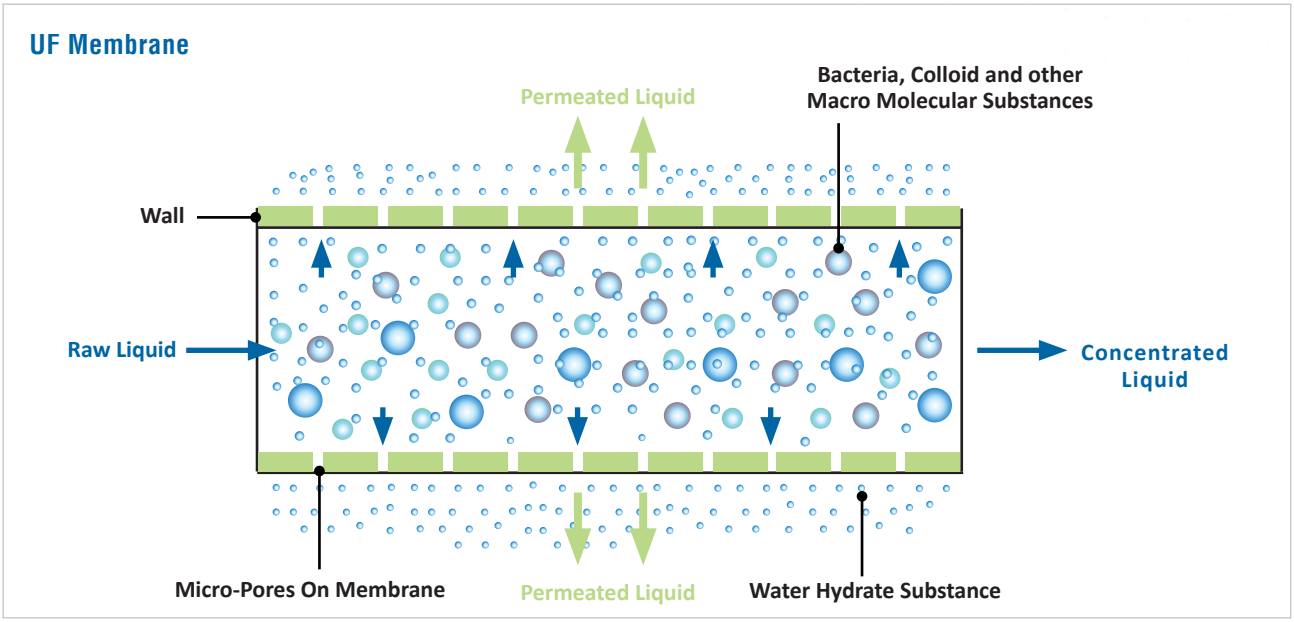
Typical Operating Parameters

- Feed Water Pressure 30 - 85 PSI
- Oil Tolerance 0 PPM
- pH Range 6.0-9.0
- Feed Water Temperature 38° - 100° F
- Max. Feed Water Hardness <1 GPG (Pretreatment may be required)
- Max. Feed Water Turbidity 1 NTU
- Max. Feed Water Iron <0.1 PPM (Pretreatment may be required)
- Max. Feed Silt Density Index <5
- Max. Feed Water Hydrogen Sulfide 0 PPM
- Max. Total Dissolved Solids (TDS) 3000 PPM (50,000 for Sea Water Applications)
- Chlorine Tolerance 0 PPM

UF Working Principle and Features

The core processing element of this unit is JBABE-160-I internal compressive UF membrane module. Raw water, after pressurization, enters the UF membrane cavity of capillary UF membrane (molecular weight cutoff: 50,000 Dalton, cutoff pore size: 0.01UM). Within the UF modules, bacteria, algae, suspended solids, colloid and other macromolecular organic substances in raw water are withheld by the module membranes, while the purified water permeates from membrane wall and gathers together to yield ultrafiltrated water.

In order to prolong membrane life and extend cycles between cleanings a prefilter is used as required.



Membrane Module

LITREE LH3 series is a hollow fiber, internal pressure UF membrane module. The material used on UF membrane is improved PVC which is hydrophilicity, pollution proof, acid and alcohol resistant. LITREE UF membranes have high productivity at low pressures.

LITREE UF membranes can be used to remove aerosols, colloids and animalcule in water. Under minimal pressure, the water molecules and dissolved solids permeate the UF membrane while aerosols, colloids, suspended solids and animalcule are blocked on the inner surface of the UF membrane. The tiny aperture in UF membrane fiber is so small that various organisms, such as suspended particle, colloid, bacteria and macromolecule organic are compound in water. These blocked substances accumulate on the inner surface of the membrane, so it is necessary to perform regular back washing and purge with chemical to these UF membrane module.

LITREE UF module's stable and outstanding performance makes it ideal for use in:

- Separating Bacteria and Virus
- Rejecting Colloid and Suspended Particulate in Surface Water, Well Water and Seawater
- Pretreatment of a RO System
- Industrial Cycling use of Water or Sewage Water Treatment in any Industrial Water System

ULTRAFILTRATION EQUIPMENT

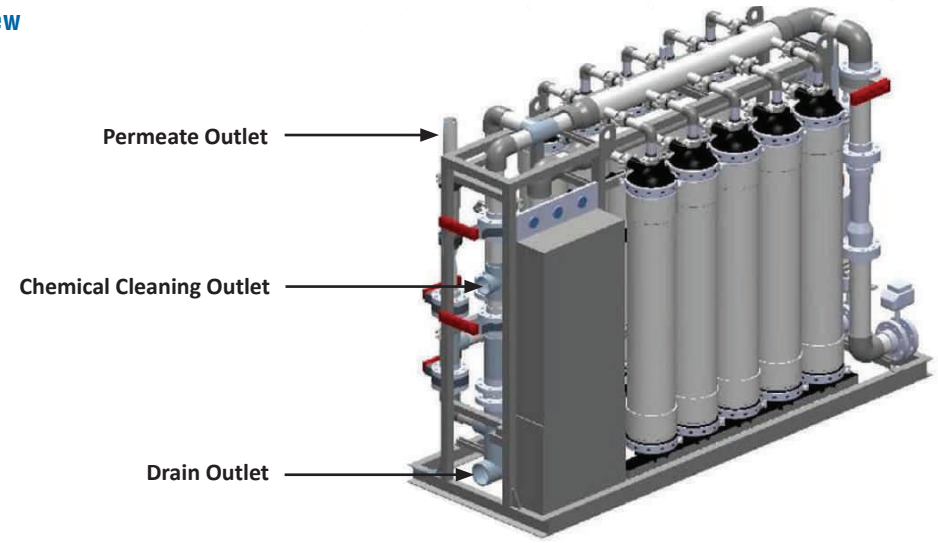
Product Model & Technical Parameters

MODEL NO.	WATER PROCESSING CAPACITY (M^3/H)*1	OPERATING PRESSURE (MPA)	MAX WATER TEMPERATURE (^0C)	POWER SUPPLY	DIMENSIONS (MM) L x W x H*2
JBABE16-4	8-12	<0.15	38	600V 60Hz	1850 × 1000 × 2180
JBABE16-6	12-18	<0.15	38	600V 60Hz	2160 × 1000 × 2200
JBABE16-8	16-24	<0.15	38	600V 60Hz	2575 × 1000 × 2230
JBABE16-10	20-30	<0.15	38	600V 60Hz	2895 × 1000 × 2225
JBABE16-12	24-36	<0.15	38	600V 60Hz	3395 × 1000 × 2355
JBABE16-14	28-42	<0.15	38	600V 60Hz	3705 × 1350 × 2355
JBABE16-16-6	32-48	<0.15	38	600V 60Hz	4115 × 1350 × 2400
JBABE16-18-D	36-54	<0.15	38	600V 60Hz	4365 × 1350 × 2400
JBABE16-20	40-60	<0.15	38	600V 60Hz	4675 × 1350 × 2400
JBABE16-24	48-72	<0.15	38	600V 60Hz	5895 × 1350 × 2440
JBABE16-26	52-78	<0.15	38	600V 60Hz	6205 × 1350 × 2440
JBABE16-28	56-84	<0.15	38	600V 60Hz	6515 × 1350 × 2440
JBABE16-30	60-90	<0.15	38	600V 60Hz	6825 × 1350 × 2440
JBABE16-34	68-102	<0.15	38	600V 60Hz	6515 × 1350 × 2440
JBABE16-38	76-114	<0.15	38	600V 60Hz	7135 × 1350 × 2440
JBABE16-42	84-132	<0.15	38	600V 60Hz	7755 × 1350 × 2440
JBABE16-46	92-138	<0.15	38	600V 60Hz	8375 × 1350 × 2440

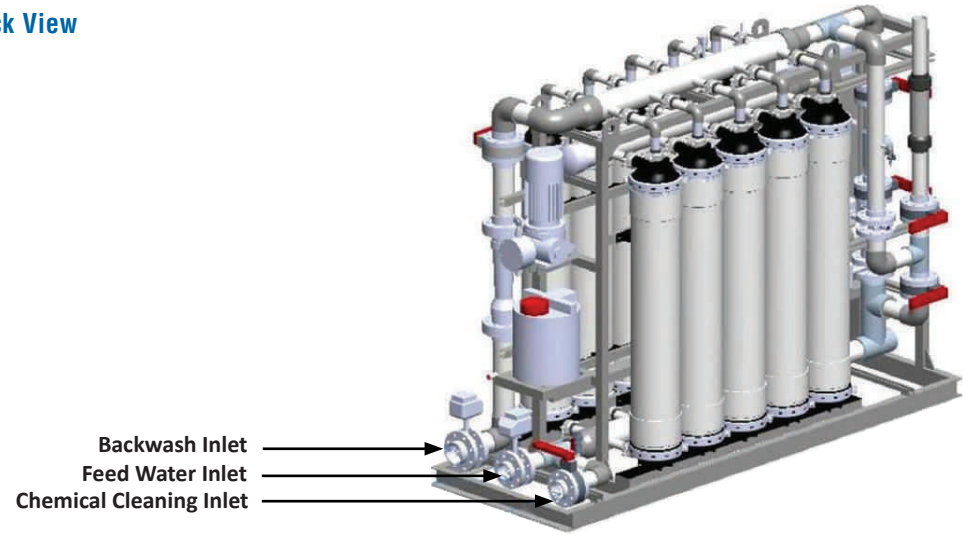
**1 Water Processing capacity is associated with quantity and temperature of the feed water*
**2 Equipment dimension is for reference only, the correct size as per the equipment*

Ultrafiltration

Front View



Back View



Ultrafiltration Package Includes:

- Feed Pump
- Permeate Storage Tank
- Backwash Pump
- Chemical Cleaning and Disinfection Pump
- Full Control Package for Automatic or Manual Operation

MEMBRANE BIOREACTORS

MBR-Membrane Bioreactors

The following paper provides some general information based on John Brooks - A.B.E.'s experience with Membrane Bioreactors (MBRs). It focuses on three types of MBRs: John Brooks - A.B.E's hollow fiber cassette or plug flow membranes compared to Zenon's hollow fiber membranes. These are the membranes that we are currently using in our small plant designs. It is not the intent of this paper to suggest that our clients exclude other manufacturers from participating in their projects. Rather, it is our intent to provide a synopsis of our experiences with these systems, provide some explanation of the advantages of using MBRs and to explain some of the differences in the construction and operation of these systems.

After reading this synopsis, it is our hope that you will better understand membrane bioreactors and will allow John Brooks - A.B.E. the privilege of working with you on your next wastewater treatment plant, be it an MBR or a more conventional technology.

Membrane Bioreactors combine conventional biological treatment processes with membrane filtration to provide an advanced level of organic and suspended solids removal. When designed accordingly, these systems can also provide an advanced level of nutrient removal. In an MBR system, the membranes are submerged in an aerated biological reactor. The membranes have porosities ranging from 0.02 microns to 0.4 microns (depending on the membrane selected), which is considered between micro and ultra filtration.

This level of filtration allows high quality effluent to be drawn through the membranes and eliminates the sedimentation and filtration processes typically used for wastewater treatment. Because the need for sedimentation is eliminated, the biological process can operate at a much higher mixed liquor concentration. This dramatically reduces the process tankage required and allows many existing plants to be upgraded without adding new tanks. To provide optimal aeration and scour around the membranes, the mixed liquor is typically kept in the 1.0-1.2% solids range, which is 4 times that of a conventional plant.

The membrane bioreactor has several distinct advantages over the Extended Aeration (EA) and Sequencing Batch Reactor (SBR) systems that make most regulatory agencies look favorably on MBRs, especially for small plants in environmentally sensitive areas. However, since the equipment is more costly than conventional plants, it is not the appropriate technology for every application. The key advantages of MBRs are that they provide a higher level of treatment and are much more resistant to upsets due to fluctuating influent flows. In addition, if land is at a premium, the MBR system can be designed to have a much smaller footprint.

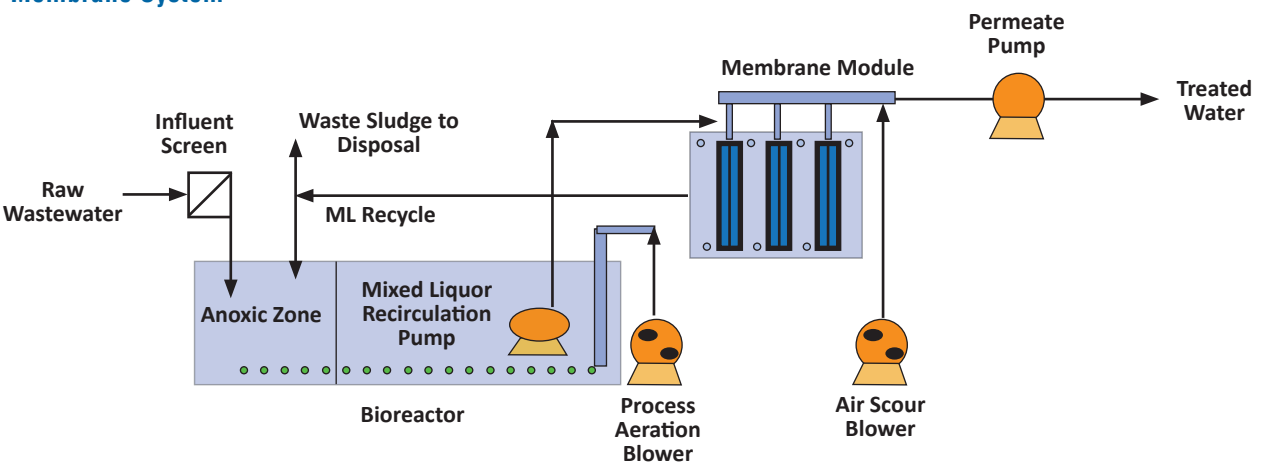
Proprietary Notice

Benefits of MBRs

- Hydraulic Retention Time (HRT) of 4-8 Hours vs 16-24 Hours
- Solids Retention Time (SRT) of 15-365 Days, Can Vary Based on Flow without Negative Process Impact
- MLSS of 10-15,000 MG/L
- Sludge Yield of 20-40% less than Conventional
- Footprint of 25% Conventional Plant
- Modular Expandability
- Highest Quality Effluent
- Capable of Meeting AWT Standards for Nutrient Removal
- Barrier to Giardia/Crypto
- Less Susceptible to Upsets Due to Flow Variations
- Less Odor
- Simple, yet Sophisticated

To better explain the process, a Schematic of a Membrane System is provided below.

Membrane System



Simplified MBR Schematic

MEMBRANE BIOREACTORS

Cassette or Plug Flow UF Membranes

As noted, we work with our own AIDEN line of cassette or plug flow UF membranes, with our cassette style membranes being most similar to the Zenon membrane. Process-wise, the Zenon and John Brooks - A.B.E. systems are very similar and both will provide high quality effluent. However, there are several differences in how the membranes themselves are configured and in turn how the ancillary equipment (pumps, cleaning systems, valves) is configured to support each type of membrane.

Zenon
Cassette Style Hollow Fiber Membrane

John Brooks - A.B.E.
Aiden M4 Cassette Style Hollow Fiber Membrane

The Zenon's ZeeWeed® and John Brooks - A.B.E. Model Aiden 4 are cassette style hollow fiber membranes. The Zenon membrane is a slightly looser membrane. ZeeWeed®'s pore size is 0.1 micron. The Aiden 4 pore size is 0.02 micron. As such, in theory, the Aiden 4 removal efficiency will be superior to the Zenon hollow fiber system. Both types of cassette membranes are NSF approved and can meet all standards for public access reuse, and both types of cassette membranes operate at an order of magnitude better than a conventional sand or fabric filter.

The John Brooks - A.B.E. Model 1 is a plug flow UF membrane filter that offers distinct advantages over immersion style cassette membranes. The UF skid assemblies can be external to the primary reactor tank thereby simplifying the installation and operation process.

A.B.E. Industrial Plug Flow UF Membranes

A1-45PF

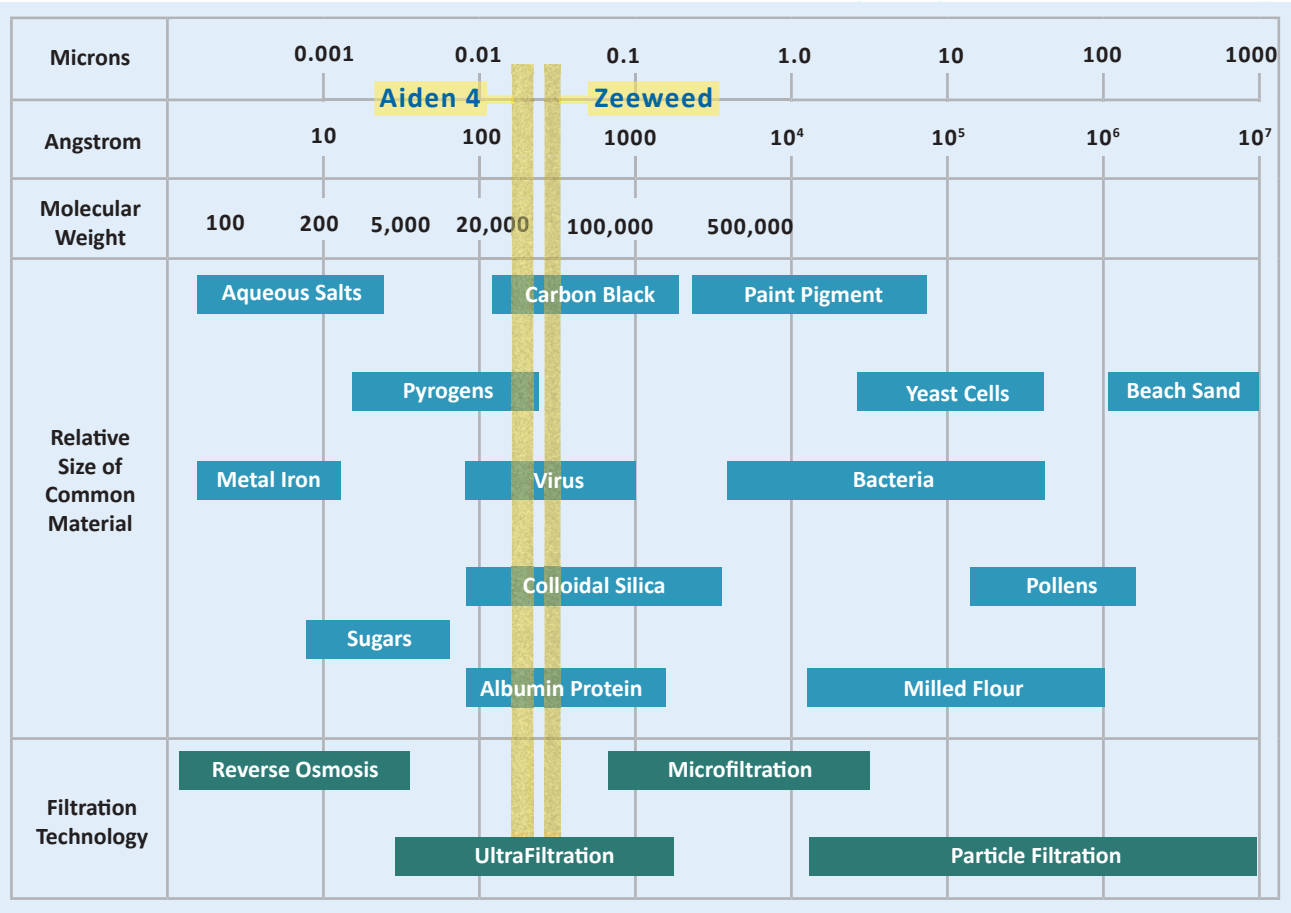
A1-65PF

A1-85PF

The Filtration Spectrum

These membranes will also provide bacterial level removal, as illustrated in the Filtration Spectrum graphic.

The Filtration Spectrum Graphic

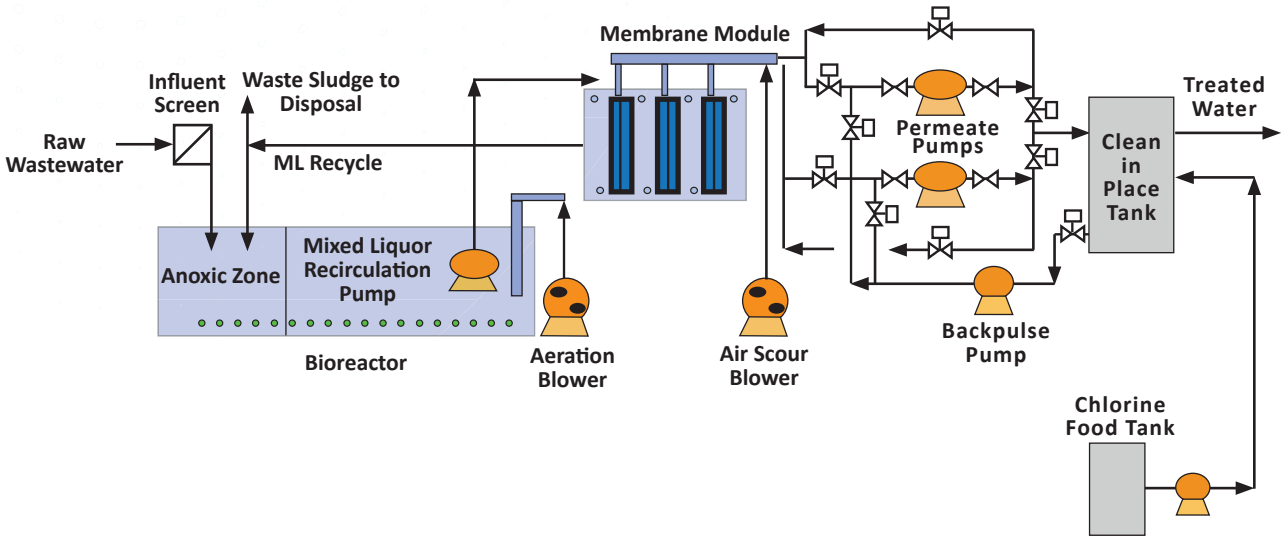


In addition, as a hollow fiber, the John Brooks - A.B.E. Aiden 4 system can operate at a higher suction pressure than the Zenon system. This differential does allow operators to “push” the Aiden 4 system harder than the Zenon system when it is fouled. However, the looser Zenon membrane does allow for a slightly higher “flux rate”, or gallons per day per square foot of membrane.

Both the Aiden 4 and the Zenon UF membranes require an automatic back pulse (or back wash) system. A back pulse system is used to force flow back through the fibers every 10-15 minutes to prevent plugging. This system is integrated into the permeate pump skid and requires additional automatic valves.

Zenon Zeeweed and Aiden 4 Cassette Style UF Membranes

Simplified MBR Schematic



Both cassette style membrane systems occasionally require an intense cleaning to remove excessive biogrowth and grease that can foul the membranes. The frequency of cleaning is a site-specific factor but for most plants, cleaning is required every three to six months. For this type of cleaning, the membranes soak in a dilute solution of sodium hypochlorite for a period of time before being returned to service. In certain cases, a mild acid or caustic solution may also be required.

With the Zenon system designs, individual membrane chambers are provided to allow for in situ cleaning of the membrane banks. Zenon membranes are taken out of service, the chambers drained and the membranes are soaked for 24-48 hours in 200 to 1000 MG/L of bleach. In addition to cleaning the membranes themselves, rags and stringy material can catch on the membranes fibers and casing and interfere with proper air scour. The Zenon membrane fibers are in cassettes and the entire cassette must be lifted out of the tank. Our experience is that this de-ragging is needed at least as frequently as the chlorine cleaning and therefore recommend installing a hoist and monorail or bridge crane with the Zenon systems.

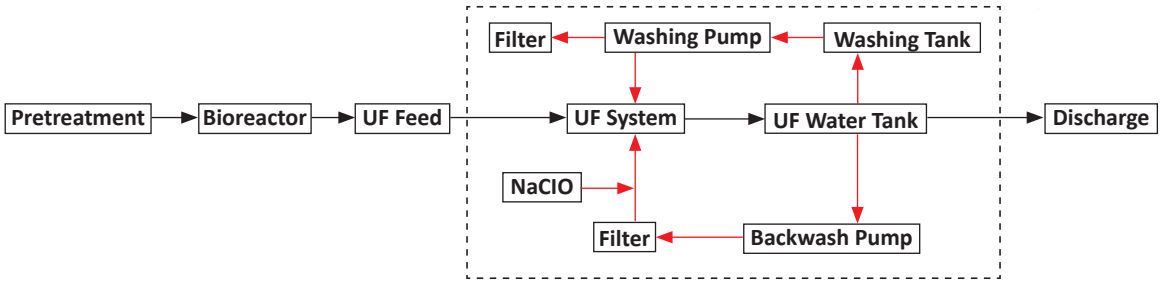
The Aiden 4 membranes are also cleaned in an external tank, however, these membranes can be cleaned within a time period of 2-6 hours. Once clean, the chlorine remaining in the chamber can be readily deactivated by the addition of a dechlorination chemical such as dry sodium sulfite.

John Brooks - A.B.E. Model 1 UF Cleaning Cycle

Unlike the Zenon and Aiden 4 membrane systems, the John Brooks - A.B.E. Model 1 UF cleaning cycle can be done WITHOUT draining the primary reactor tank or removing the cassette style membranes.

Because the UF plug flow membrane system is external to the bioreactor, operational and maintenance requirements related to inspection, replacement and offline cleaning are simplified:

John Brooks - A.B.E. Model 1 UF Cleaning Cycle



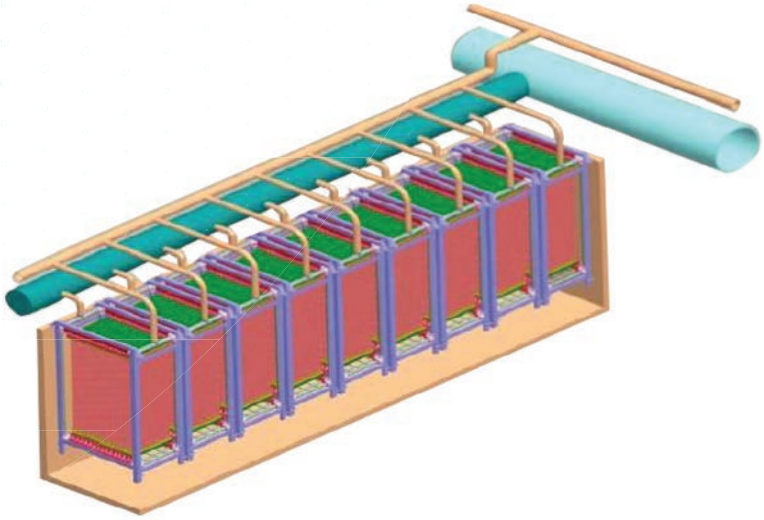
A dilute solution of bleach is pumped through the permeate lines. The solution soaks in the membranes for 1-2 hours, and then the plant is brought back on-line. As a result, you still have an active biomass in the bioreactor upon startup after cleaning, resulting in a simplified cleaning process that minimizes downtime.

When comparing MBRs to other processes, the issue of energy efficiency is often brought up. MBRs utilize aeration for membrane scour and require permeate pumping systems. At full design flow, MBRs typically use more power. However, few plants operate at full design flow, especially those in seasonal resorts. By properly designing the MBRs, portions of an MBR plant can be taken out of service and the cassettes can be cycled during low flow periods to provide a lower net energy cost.

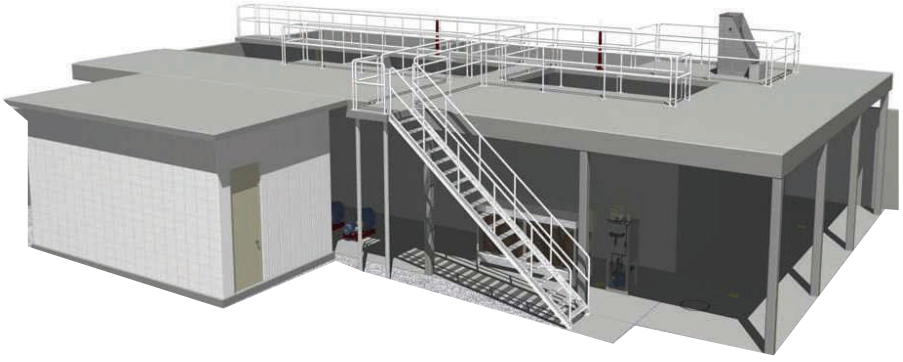
In addition, the Aiden 1 cassette style UF membranes can be arranged in the final aeration chamber and the scour aeration can also provide process aeration. This can virtually eliminate the extra power due to scour aeration for this style of MBR.

MEMBRANE BIOREACTORS

Membrane Models

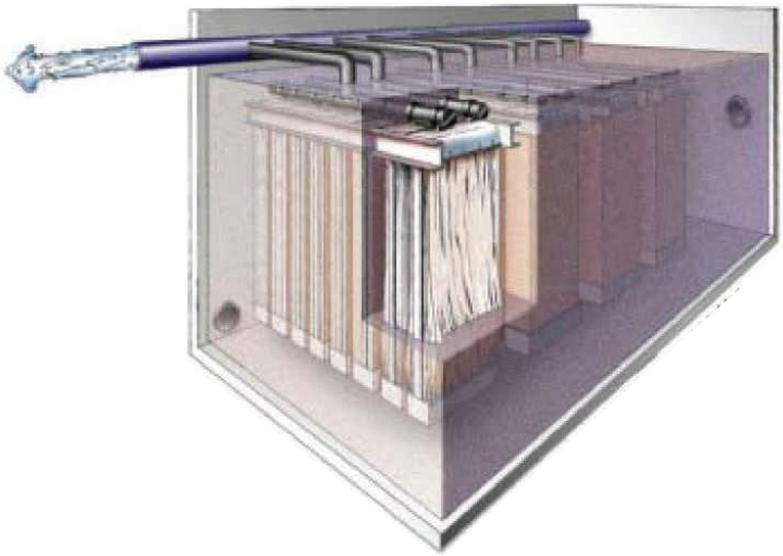


Aiden 4 Membrane

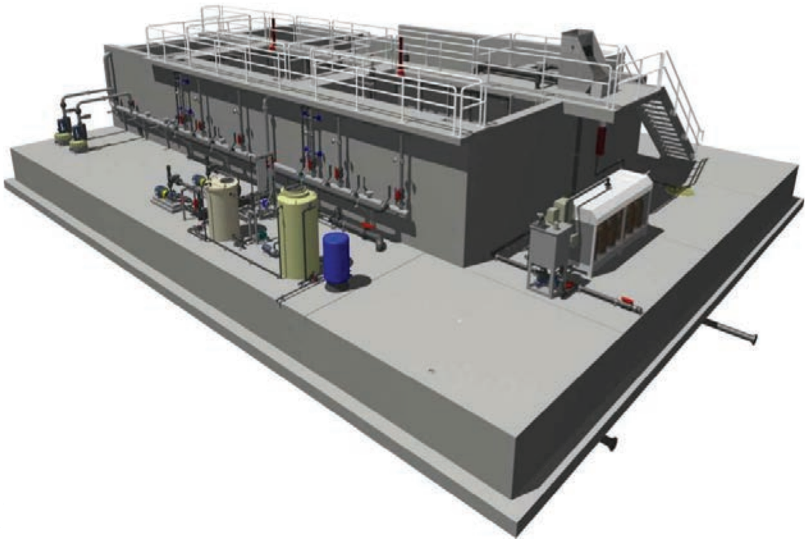


Zenon Membrane

Membrane Bioreactor Models



Aiden 4 Membrane Bioreactor



Zenon Membrane Bioreactor