Submerged Membrane Bioreactor (MBR) Systems
SINCE THE 1980’s, Membrane Bioreactors (MBR) have been successfully used to treat municipal, commercial and industrial wastewaters for discharge and reuse applications. Today, with thousands of installations operating worldwide, MBR technology is shaping the way we view wastewater treatment and water conservation in the US and around the world.

Submerged in each MBR are membranes that physically reject pathogens and other suspended solids. However, it is the biological process that removes contaminants such as biochemical oxygen demand (BOD), nitrogen and phosphorus. As such, MBRs are generally only one part of a system that is designed to biologically treat wastewater.

As a provider of complete wastewater treatment plants (WWTP) since 1966, Enviroquip, Inc. understands that systems, not just components, must be easy to operate and reliable. This is why we have partnered with the Kubota Corporation to offer the most robust and operator-friendly submerged membrane unit (SMU) available on the market today. It is also the reason why we provide complete MBR Systems and not just membrane equipment.

At Enviroquip, our multidisciplinary staff draws on over forty years of experience to integrate state-of-the-art technologies into custom plants or pre-engineered packages (MPAC™) to maximize energy efficiency, optimize process control and protect membrane equipment. Our goal is to provide our customers with comprehensive solutions to their wastewater problems.
THE HIGHEST QUALITY EFFLUENT

AT THE HEART OF AN ENVIROQUIP MBR System is a tailored biological process that virtually eliminates pollutants such as biochemical oxygen demand (BOD), nitrogen and phosphorus that can cause fish kills and algae growth (eutrophication).

Microorganisms that are created during biological uptake of dissolved pollutants are filtered through multiple protective barriers to levels that are generally not detectable by standard methods. In fact, fecal coliform concentrations are normally non-detectable in MBR permeate before post-disinfection, as compared to 100,000 cfu/100ml in traditional secondary effluent.

THE UNRTM PROCESS

Coupling state-of-the-art technologies together, Enviroquip has developed the Ultimate Nutrient Removal (UNRTM™) process, guaranteed to meet the most stringent nutrient limits. Different treatment levels are shown below along with typical effluent quality.

**PERMEATE QUALITY**

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>TYPICAL VALUES</th>
<th>ACHIEVABLE VALUES&lt;sup&gt;a,c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>&lt;2.0 mg/l</td>
<td>Non-Detect&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ammonia</td>
<td>&lt;1.0 mg/l</td>
<td>Non-Detect&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>&lt;10.0 mg/l</td>
<td>&lt;3.0 mg/l&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>&lt;1.0 mg/l</td>
<td>&lt;0.03 mg/l</td>
</tr>
<tr>
<td>TSS</td>
<td>&lt;2.0 mg/l</td>
<td>Non-Detect&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Turbidity</td>
<td>&lt;0.1 NTU</td>
<td>&lt;0.05 NTU</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>&lt;2.2 CFU/100ml</td>
<td>Non-Detect&lt;sup&gt;b,d&lt;/sup&gt;</td>
</tr>
<tr>
<td>SDI</td>
<td>&lt;3</td>
<td>&lt;2</td>
</tr>
</tbody>
</table>

<sup>a</sup> Contingent on plant design and operation.

<sup>b</sup> Assuming Standard Methods of detection.

<sup>c</sup> Requires UNRTM Process.

<sup>d</sup> Post-disinfection may be required.

**PARAMETERS               TYPICAL VALUES                ACHIEVABLE VALUES<sup>a,c</sup>**

<table>
<thead>
<tr>
<th>UNR LEVEL</th>
<th>BOD&lt;sub&gt;5&lt;/sub&gt;</th>
<th>AMMONIA</th>
<th>TOTAL NITROGEN</th>
<th>PHOSPHORUS&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;5.0 mg/l</td>
<td>&lt;1.0 mg/l</td>
<td>&lt;10.0 mg/l</td>
<td>&lt;1.0 mg/l</td>
</tr>
<tr>
<td>2</td>
<td>&lt;5.0 mg/l</td>
<td>&lt;1.0 mg/l</td>
<td>&lt;7.0 mg/l</td>
<td>&lt;0.5 mg/l</td>
</tr>
<tr>
<td>3</td>
<td>&lt;5.0 mg/l</td>
<td>&lt;1.0 mg/l</td>
<td>&lt;3.0 mg/l</td>
<td>&lt;0.1 mg/l</td>
</tr>
</tbody>
</table>

<sup>a</sup> Limits are a function of process design and are dependent on operating conditions.

<sup>b</sup> Assuming Standard Methods of detection and an average

<sup>c</sup> Assumes combination of enhanced biological phosphorus removal and chemical coagulation.

THE CLEAR ADVANTAGE

EASIER TO OPERATE

- Gravity Filtration
- Fine Screening of Feed Only
- True Clean-in-Place Membranes
- No Backpulsing Equipment
- Simple Piping Design
- Completely Automated (Optional)
- Optical Process Measurements

MORE FLEXIBLE

- Proven performance at MLSS concentrations from 8,000 mg/l -18,000 mg/l
- Superior performance at colder temperatures
- Industry leading hydraulic peaking capabilities to handle storm flows

MORE RELIABLE

- Over 1,000,000 membrane cartridges produced since 1989
- Over 40 years of experience in complete plant design and supply
- Single-Source Responsibility
- Comprehensive technical support
- Title 22 Approved

MORE COST EFFECTIVE

- Up to 75% more compact than conventional systems
- Up to 50% less automation than comparable MBR systems
- Overhead cranes or other lifting equipment (optional)
- Up to 40% less sludge production at long residence times
- Costly tank liners not required as for other MBR systems
- Pre-thickened or Class B solids production (optional)
THE ENVIROQUIP MBR SYSTEM

Each Enviroquip MBR System can include multiple technologies in proven designs that allow for flexible and adaptable operation. The ability of an Enviroquip MBR to operate over a range of conditions generally improves overall system performance as compared to conventional treatment processes and MBRs that utilize hollow fiber type membranes. Some of the advantages of an Enviroquip MBR System over other technologies are listed below.

VERSUS TYPICAL CONVENTIONAL PROCESS
- More robust biological process
- Easier to operate
- Less maintenance
- Smaller footprint
- Smaller UV dosage requirement
- Superior water quality

VERSUS TYPICAL HOLLOW FIBER MBR PROCESS
- Better process control
- Easier to operate
- Smaller footprint
- No side-stream screening
- Fewer recycle streams
- Less maintenance
- Higher peaking capabilities

ENVIROQUIP MBR SYSTEMS CAN INCLUDE:

HEADWORKS
Complete packages including roughing screens, fine screens and grit removal.

PROVEN MEMBRANE TECHNOLOGY
Kubota Submerged Membrane Units (SMU) are installed in more MBR plants around the world than any other MBR technology.

BIO-MONITORING TECHNOLOGY
Low maintenance optical process technology used to achieve the most stringent nutrient limits under extreme conditions.

DIGESTION/THICKENING
Membrane-based systems designed to digest and/or pre-thicken waste-activated sludge. Optional Class-B systems available.

ANCILLARY PROCESS EQUIPMENT
A full complement of proven components for a fully functional MBR System, including pumps, blowers, mixers, etc.

INTEGRATION & CONTROLS
Supervisory Control and Data Acquisition (SCADA) packages to reduce energy costs, maximize membrane performance and allow for remote plant control.

WASTEWATER

MBR Process Train (UNR1™)

MEMBRANE EQUIPMENT

ANCILLARY PROCESS EQUIPMENT

INTEGRATION AND CONTROLS

HEADWORKS

Membrane Equipment

ANCILLARY PROCESS EQUIPMENT

Integration and Controls
A MBR is an activated sludge process that uses membranes to filter out suspended solids, including harmful microorganisms such as viruses, bacteria and cysts.

THE MBR
In a MBR, one or more SMUs are connected via common permeate, air supply and diffuser cleaning pipes.

THE SUBMERGED MEMBRANE UNIT (SMU)
Each SMU is comprised of an integral air diffuser assembly and one or two membrane cassettes. The air diffuser provides air for scouring, mixing and cellular activity. A membrane cassette contains between 25 and 208 membrane cartridges that are connected to, or form, a common permeate manifold. Multiple SMUs are connected to a common header in each MBR.

THE MEMBRANE CARTRIDGE
Each membrane cartridge is constructed by ultrasonically welding a sheet of thin polymeric material to the back and front of a support panel. Between the panel and the membrane material is a porous spacer material that distributes water to a series of grooves that channel filtered water to the top of the cartridge.

MULTIPLE BARRIERS
In an Enviroquip MBR, flat-sheet membranes are used to filter a concentrated mixture of microorganisms commonly referred to as mixed liquor. The microorganisms consume BOD, nutrients and refractory organic compounds such as NDMA. In addition, they attach themselves to the membrane surface to form a thin film called a biofilm.

Within seconds, cells begin to form a biofilm that functions like a dynamic membrane. Properly maintained, the biofilm protects membrane material from fouling and creates a second densely packed barrier to pathogen breakthrough.

BIOHYDRAULICS
Irrespective of the type or shape of a membrane, biofilms do most of the filtering and create the most resistance to water flow. Maintaining biofilm thickness and porosity through effective air scouring and proper biological process control is the key to optimizing the hydraulic performance of any submerged membrane technology in MBR applications. The link between biological process conditions and membrane hydraulics is referred to as biohydraulics.

Kubota SMUs are engineered to maximize air-scouring efficiency and eliminate opportunities for hair and debris to accumulate. Efficient and equal air scouring dramatically reduces the pressure it takes to filter solids from treated wastewater, often referred to as transmembrane pressure (TMP). The ability to operate at low TMP reduces the propensity for membrane fouling and eliminates the need for weekly chemical cleanings and or backpulsing common to other technologies.

WHY DO KUBOTA FLAT-PLATE MEMBRANES LAST LONGER THAN OTHER TECHNOLOGIES?
- Equal and effective air scouring
- Low transmembrane pressure (TMP) operation
- No backpulsing or weekly chemical cleans
- Infrequent chemical cleaning
- No fiber buildup
THE ENVIROQUIP APPROACH

OUR SERVICES
Enviroquip realizes that our continued success depends on customer satisfaction and ultimately, plant performance. We take great pride in providing superior design support during the engineering and construction phases of a project, and most importantly, in maintaining reliable after-sale support. Using advanced remote monitoring technologies, Enviroquip stays in constant contact with our plant operators. Moreover, Enviroquip offers ongoing technical training through workshops and site visits to continuously update our customers and transfer new technical information. At Enviroquip, our reputation is built on providing quality service and innovative systems that last.

THE SYSTEM
Simple in design and easy to operate, an Enviroquip MBR System provides the benefits of membrane technology without the complexity. From point-of-use package plants (see MPAC™ Brochure) to custom municipal installations, Enviroquip has designed and/or commissioned over 100 MBR facilities. Our experienced staff of professionals is trained to help you customize your plant using several available options as shown in the diagram below.

STORM MASTER™
This configuration provides a cost-effective means of handling storm events and can significantly reduce solids handling costs. This option also incorporates features of the Energy Pro configuration.

ENERGY PRO
Using an automated system of slide gates and specific plant layouts, this configuration incrementally brings plant capacity online to match demand and optimize energy efficiency.

UNR™
Using award-winning bio-monitoring technology, UNR™ processes improve energy efficiency and biological performance while reducing system complexity.

STANDARD
Standard systems include few moving parts and are extremely easy to operate. In fact, automation is optional for smaller systems.
MISSION STATEMENT

Enviroquip understands that our customers and the environment depend on our systems for reliable treatment. That is exactly why we offer single source responsibility for all process equipment and comprehensive warranty packages that can include biological treatment. The quality and reliability of our equipment and after-sale support separate us from membrane manufacturers and are the main reasons why we are industry leaders. At Enviroquip, every project is a partnership, just ask our customers.

“There’s just not a lot of moving parts on an Enviroquip MBR System. It’s a lot more forgiving than my SBR and [conventional] activated sludge systems.”

Charlie Evans
Operator
Environmental Management Services

“It’s amazing how easy it is to start up and operate one of these [MBR] plants.”

Warren Felton
Superintendent
The Bandon Dunes WRF, OR

“During the snow melt, my MBR system handled higher than design flows at lower than expected temperatures for over a month. When it counted, the system performed.”

Kevin Maughan
Lead Operator/Assistant Fire Chief
The Hyrum WRF, UT

ENVIROQUIP MBR INSTALLATIONS

The Hyrum City WRF
Rated Capacity: 2.0 MGD
Operating Mode: Suction
SMU Type: Double Deck

The Hamptons WRF
Rated Capacity: 1.0 MGD
Operating Mode: Gravity
SMU Type: Double Deck

The Rolling Hills WRF
Rated Capacity: 0.2 MGD
Operating Mode: Gravity
SMU Type: Single Deck

The Skyline Ranch WWTP
Rated Capacity: 38K GPD
Operating Mode: Suction
SMU Type: Single Deck
MBR TECHNOLOGY DOESN’T HAVE TO BE COMPLICATED…

NO WEEKLY MAINTENANCE CLEANING
NO BACKPULSING
NO PERMEATE PUMPS
NO PROBLEM

Protected by USA patent #’s 5192456, 5482625, 5651888, 6277209, 6287467 and patents pending.