BIO-CEL®-Modules
The Solution for state-of-the-art MBR-Technology
Backwashable - Self-Healing - Mechanically Cleanable
Tighter discharge regulations, urbanization and the increase in water recycling have made Membrane-Biological-Reactors (MBR) the leading innovation in wastewater treatment through conventional activated sludge. Traditionally, activated sludge treatment relies upon solids settling in a secondary clarifier to separate the biomass from the treated wastewater. This process has the disadvantage of running at a lower MLSS (Mixed Liquor Suspended Solids), thus requiring more space and producing lower quality effluent. With MBR technology, the clarifier is replaced by a physical barrier – our BIO-CEL ® membrane module. This physical barrier enables the MBR to operate at higher MLSS levels, thereby requiring a smaller overall footprint. The BIO-CEL ® membrane separates within the ultrafiltration spectrum, producing high quantities of quality effluent at consistent flows. Efficiency, reliability and cost effectiveness, as well as long term viability, are just some of the characteristics of the BIO-CEL ® module. The solids free effluent is suitable for recycling applications, such as irrigation or as feed for process water. BIO-CEL ® combines the benefits of traditional hollow fiber and plate and frame configurations without any of their inherent disadvantages. The self-supporting membrane sheet is just 2 mm thick, resulting in an extremely high packing density and very low specific energy consumption.

The BIO-CEL ® configuration is based on flat sheet technology, with crossflow eliminating clogging and reducing downtime. The module’s open top and bottom channels reliably prevent the deposition of sludge and fiber accumulation during the continuous crossflow process. The self-supporting structure of the membrane module enables frame-free installation, thus eliminating blockages around the external boundaries of each component.

The membrane module is configured to allow for consistent permeate flow and a highly effective backflush over the entire membrane surface. In summary, the BIO-CEL ® offers high packing density with optimal purification.

For large scale applications with a total inflow to the MBR plant of > 2,000 m³/d of wastewater to be treated, the BIO-CEL ® XL with a total membrane area of 1,920 m² has been developed.

**ADVANTAGES**

» physical barrier for the retention of solids and bacteria
» module design is unsusceptible to braiding/sludge deposits
» backwashable with filtrate or with chemicals if required
» high packing density
» low energy demand
» reliable performance
» self-healing membrane laminate
» fine bubble aeration
» mechanically cleanable
Especially when considering wastewater treatment using MBRs the integrity of the membrane plays a significant role. The actual cleaning of the wastewater in the MBR process is being performed by the biomass in the system. The membrane used must now ensure the safe separation of the biomass from the cleaned wastewater. Superficial damages to the membrane should therefore not compromise this.

If membranes are being installed in a wastewater treatment plant for many years possible damages to the membrane cannot be avoided – may they be caused by a screwdriver or any other debris falling into the filtration chamber. Indeed membranes are “vulnerable” but when using the appropriate module construction superficial damages to the membrane will not result in a serious problem.

In conventional plate and frame modules the membranes are mounted on a plastic plate and then glued or welded onto the frames. A hole in the membrane will then inevitably lead to a bypass of unfiltered wastewater from the plant.

With the laminate used in the BIO-CEL® module MICRODYN-NADIR has found a way to solve this problem. Instead of fixing the membrane on a mounting plate from both sides, the membrane is being laminated from two sides onto a special spacer material.

Subsequently, “laminate sheets” are being cut out of this laminate and welded on the sides. The suction of the clear filtrate is done through a permeate hole in the center of the sheet.

In case of damage caused to the membrane the spacer material allows for a sealing of the damage through the help of the biomass in the system. Even after the occurrence of a severe detraction of the membrane laminate, solids and bacteria can still be rejected by the membrane laminate.

Laboratory tests have proven that the membrane laminate “heals” itself in less than two minutes even under worst case conditions.
As a further process-integrated feature, the BIO-CEL® membrane module can also be cleaned mechanically, through the use of the patented BIO-CEL®-MCP 1) (Mechanical Cleaning Process), which helps to reduce operating costs as well as to minimize the energy demand. This innovative process reduces the formation of a fouling layer. The membrane cleaning process is being supported by the crossflow aeration and the use of the cleaning efficiency of inert, organic material (MCP granulate).

The MCP granulate is added directly into the activated sludge. The airflow induced by the module-integrated membrane aeration system draws the MCP granulate up between the membrane sheets. As the MCP granulate rises, the membrane area is continually cleaned through the direct contact of the granulate with the sludge on the membrane surface. The fouling layer formed during the filtration process is removed reliably without compromising the functionality of the membrane.

In the downstream area outside the membrane modules, the current draws the granulate back to the base of the module where it enters again into the upstream flow. The MCP granulate has been designed for permanent usage. It is retained in the filtration tank by suitable separation systems.

This mechanical cleaning can only be used in conjunction with BIO-CEL® modules, because other module types do not incorporate the required constructional and hydraulic characteristics to perform a mechanical cleaning.

Long-term testing shows that a chemical free operation is possible. The efficiency and reliability of the MCP technique could be proven by the continuous operation of a pilot plant for two years. Other large scale applications have been operating successfully for a number of years.

MAJOR ADVANTAGES OF THE BIO-CEL®-MCP:

» BIO-CEL®-MCP mechanically removes the cake layer from the membrane which significantly enhances the flux.

» Cost efficient process through a minimization of the installed membrane area and significantly lower energy demand as a result of reduced air sourcing requirements due to an enhancement of the specific flux

» Continuous membrane integrity – stable and reliable effluent quality

» No or low demand for chemical cleaning – thus, a continuous filtration process is possible

1) Note: The Mechanical Cleaning Process (MCP) for BIO-CEL® membrane bio reactors was developed by MICRODYN-NADIR (S. Krause), Darmstadt Technical University (Peter Cornel) and Osnabrueck University of Applied Sciences (Frank P. Helmus and Sandra Rosenberger).
BIO-CEL® Membrane Material

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Membrane Type</th>
<th>MWCO</th>
<th>Pore Size</th>
<th>Support Layer</th>
<th>Drainage</th>
<th>Chlorine Resistance</th>
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<tbody>
<tr>
<td>Polyethersulfone (PES)</td>
<td>Ultrafiltration</td>
<td>150 kDa</td>
<td>0.04 µm</td>
<td>Polyester</td>
<td>Polyester</td>
<td>500 000 ppmh</td>
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BIO-CEL® Module and Operating Data

<table>
<thead>
<tr>
<th>Parameters</th>
<th>BC XS-1 1)</th>
<th>BC50</th>
<th>BC100</th>
<th>BC416 2)</th>
<th>BC L-1 2)</th>
<th>BC XL-1 2)</th>
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</thead>
<tbody>
<tr>
<td>Membrane surface</td>
<td>10 m²</td>
<td>50 m²</td>
<td>100 m²</td>
<td>416 m²</td>
<td>480 m²</td>
<td>1920 m²</td>
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<tr>
<td>Frame material operation unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC</td>
<td>PE</td>
<td>PE</td>
<td>PE</td>
<td>Stainless Steel</td>
<td>Stainless Steel</td>
<td>Stainless Steel</td>
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<tr>
<td>Frame material membrane unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>PVC</td>
<td>PVC</td>
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<td>PVC</td>
<td>Stainless Steel</td>
<td>Stainless Steel</td>
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<tr>
<td>Dimensions [mm]</td>
<td>747 x 280 x 1515</td>
<td>702 x 694 x 1563</td>
<td>702 x 1270 x 1563</td>
<td>1152 x 1298 x 2763</td>
<td>1107 x 1514 x 2530</td>
<td>2106 x 2786 x 2450</td>
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<tr>
<td>Operating pressure</td>
<td>30 to -400 mbar</td>
<td>30 to -400 mbar</td>
<td>30 to -400 mbar</td>
<td>30 to -400 mbar</td>
<td>30 to -400 mbar</td>
<td>30 to -400 mbar</td>
</tr>
<tr>
<td>Max. Backwash pressure</td>
<td>150 mbar</td>
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<td>150 mbar</td>
<td>150 mbar</td>
<td>150 mbar</td>
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</tr>
<tr>
<td>Max. operating temperature</td>
<td>40 °C</td>
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<td>pH-range</td>
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<td>2 – 11</td>
<td>2 – 11</td>
<td>2 – 11</td>
<td>2 – 11</td>
<td>2 – 11</td>
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<tr>
<td>Max. air flow rate (Vn) 3)</td>
<td>6 m³/h</td>
<td>30 m³/h</td>
<td>60 m³/h</td>
<td>105 m³/h</td>
<td>115 m³/h</td>
<td>460 m³/h</td>
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<tr>
<td>Recommended content suspended solids (SS) 4)</td>
<td>12 g/L</td>
<td>12 g/L</td>
<td>12 g/L</td>
<td>12 g/L</td>
<td>12 g/L</td>
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</tr>
<tr>
<td>Size Cassette / Membrane Unit</td>
<td>10 m²</td>
<td>25 m²</td>
<td>25 m²</td>
<td>104 m²</td>
<td>480 m²</td>
<td>480 m²</td>
</tr>
</tbody>
</table>

Note: (1) Only for piloting purposes // (2) Excluding extra feet // (3) Vn is the volume flow rate at standard conditions according to DIN ISO 2533:1979-12 // (4) Other concentrations possible. Please consult your MICRODYN-NADIR representative.

Final sizing and selection has to be approved by an official MICRODYN-NADIR representative. Please contact phone + 49 611 962 6001 or www.microdyn-nadir.de

1 m³ = 10.764 ft³ | 1 ft³ = 0.26 us-gal | 1” = 2.54 cm
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