Technical Service Bulletin

Assembly, Installation and Servicing Guidelines for HYDRAsub®-Energy Saving (ES) MBR Modules

This Technical Service Bulletin provides information on how to assemble, install and service a HYDRAsub®-Energy Saving (ES) MBR module. Assembly may be required when the module is first shipped. Installation of the modules into the membrane tank is also discussed to ensure proper precautions are taken and that the module is secured and stable in the tank. Finally, guidelines are given for servicing a HYDRAsub®-ES MBR module if maintenance or removal is required.
TABLE OF CONTENTS

1 Bill of Materials (BOM) ................................ 4
  1.1 HYDRAsub®-ES MBR Module (HSM) .................. 4
  1.2 HYDRAsub®-ES MBR Cage (HSC-ES) .................. 4
  1.3 HYDRAsub®-ES MBR Element (HSE) .................. 7
  1.4 HYDRAsub®-ES MBR Filtrate Adapters (HSA) ....... 8
  1.5 HYDRAsub®-ES MBR Air Diffusers (HSD) ............ 9
2 Materials and Tools ..................................... 10
3 Module Assembly ......................................... 11
  3.1 Assembly Site Conditions ............................. 11
  3.2 Assembly Procedure .................................... 11
    3.2.1 Air Diffuser Installation ....................... 11
    3.2.2 Filtrate Header Installation ..................... 12
    3.2.3 Installation Guide Installation .................. 12
    3.2.4 Air Supply Line Support Installation ............ 13
    3.2.5 Element Installation ............................. 14
    3.2.6 Filtrate Adapter Installation .................... 14
    3.2.7 Filtrate Adapter Retainer Installation .......... 15
4 Guide rail Installation ................................... 17
  4.1 Guide rail Selection .................................. 17
  4.2 Guide rail Placement .................................. 17
  4.3 Guide rail Anchoring .................................. 18
5 Module Installation ....................................... 21
  5.1 Lifting the Module .................................... 21
  5.2 Module Placement ..................................... 22
  5.3 Air and Filtrate Hose Connections .................... 22
6 Module Maintenance and Service .......................... 24
  6.1 Troubleshooting Guide ............................... 24
  6.2 Module or Train Isolation ............................ 28
  6.3 Module Removal ...................................... 28
    6.3.1 Air and Filtrate Connections .................... 28
    6.3.2 Module Removal from Tank ....................... 29
    6.3.3 Module Conditions Outside of Tank ............. 29
  6.4 Module Inspection .................................... 30
    6.4.1 Module Disassembly ............................... 30
    6.4.2 Filtrate Connection ................................ 30
    6.4.3 Air Connection .................................... 30
    6.4.4 Filtrate Adapters ................................ 30
    6.4.5 Elements ......................................... 31
    6.4.6 Air Diffusers .................................... 32

LIST OF FIGURES
Figure 1: Partially assembled membrane cage (installation guides and filtrate adapter retainers not shown) .......... 5
Figure 2: Filtrate header (left) and air diffuser (right) .......... 6
Figure 3: Filtrate Adapter Retainer and Installation Guides
......................................................................................... 7
Figure 6. Filtrate adapters, assembled and as separated elbows ........... 9
Figure 7. Top view of air diffuser (left) and bottom view (right) ............... 9
Figure 8. Air Diffuser Installation ........................................... 11
Figure 11: Air Supply Line Supports ........................................ 13
Figure 13. Filtrate adapters in place .......................................... 15
Figure 14. Assembled HYDRAsub-ES MBR module ......................... 16
Figure 16. (a) Guide rails are welded to the top anchor which is bolted to the top of a concrete basin, (b) guide rails are welded to the top anchor which is welded to a steel frame around the hatch lid of tank, and (c) guide rails are welded to a steel beam that runs across the top of the tank ......................... 19
Figure 17. Guide rail welded to an anchor which can be bolted to the bottom of the tank ......................................................... 20
Figure 18. Lifting the module with chains (left) and a hydraulic truck crane (right) ................................................................. 21
Figure 19. Securing lifting chains to guide rails (left) and chains tied to rail on outside of tank (right) .............................. 22
Figure 20: Filtrate and Air Hose Connections ............................... 23
Figure 21. Removing connection from module to air header ............... 28
Figure 22. Example of a chain getting caught on the guide rail support .... 29
Figure 24. Removing element during module inspection ........................ 32

LIST OF TABLES

Table 1: Tools required for assembly, installation, and servicing ........... 10
Table 2. Troubleshooting Guide ................................................. 24
Safety Notices:
All safety precautions must be adhered to when operating equipment, working in enclosed spaces, at elevated levels, on or near ladders, floor or exposed openings, etc. in accordance with standards, local rules and regulations. The assembly, installation and servicing of HYDRAsub®-ES MBR modules may entail the use of a crane or hoist, working 8 ft (2.4 m) or higher above the ground, and working near an exposed opening, such as an open tank, where proper harnessing may be needed for operators. Safety boots and hardhats are also recommended. Personal protective equipment (PPE) should be used properly when working with or near chemicals, hazardous waste or corrosive materials. The use of PPE and good hygiene (washing hands with soap and water frequently, keeping equipment clean, etc.) will help prevent contamination and disease. Additionally, required immunizations, per local regulations, should be administered for operators working around sewage or wastewater.

1 Bill of Materials (BOM)

1.1 HYDRAsub®-ES MBR Module (HSM)
The HSM consists of the entire membrane unit, including the HYDRAsub®-ES MBR cage (HSC), HYDRAsub®-ES MBR elements (HSE), HYDRAsub®-ES MBR filtrate adapters (HSA) and HYDRAsub®-ES MBR air diffusers (HSD). Each module will have one cage to hold the elements, adapters, and diffusers. The number of these enclosed parts will depend on the module class (HSM500-ES, HSM1000-ES, or HSM1500-ES). The detailed BOM for each module is included in its respective drawing. For the sake of explanation, drawings for the HSM500-ES (refer to Appendix A) will be used throughout this document as an example.

Upon receipt of the module and/or its parts, immediately check for damage during shipment, including dents, cracks or loose parts. If there is any evidence of damage or the possibility of the membranes being wet or exposed to moisture, do not remove the module from the packing. Contact Hydranautics Customer Service immediately.

1.2 HYDRAsub®-ES MBR Cage (HSC-ES)
The cage consists of multiple pieces, including a frame, nuts and bolts, and connection points. It is constructed of SS304 or SS316 (upon special request) and can weigh up to 635 kg (~1400 lbs), without any other components installed, depending on the module type. The cage can be divided into six parts- the membrane frame, two filtrate collection headers, one air diffusers (two air diffusers for HSC1500-ES), two filtrate adapter retainers, two installation guides and two air supply line supports. (The HSC1500-ES has 4 air supply line
A partially assembled cage is shown in Figure 1.
The membrane frame is a rectangular frame which holds the elements, the filtrate headers, the air diffuser, and the installation guides. Each filtrate header, shown on the left side of Figure 2, is bolted to the top of the frame. Each has openings to receive the filtrate adapters and one (or two for the headers on the HSC1500-ES) connection point to connect each module to its respective train filtrate header. The air diffuser, shown on the right side of Figure 2, is bolted to the bottom of the frame. The air is supplied to the diffuser via two connections on either side of the diffuser. (The HSC1500-ES has 2 air diffusers.)

Two filtrate adapter retainers, which are bolted to the frame, keep the filtrate adapters installed in the filtrate headers and elements, and the elements from sliding out of the frame. One filtrate adapter retainer is indicated in Figure 3 (with elements and filtrate adapters installed) by an arrow. They are removed during installation or removal of the elements. Four installation guides are bolted to the frame, two on either end at the top and bottom, to ease installation of the modules in the membrane tank. Two installation guides are circled in Figure 3. The longer installation guide is installed on the same side the module as the air diffuser connections. Note that for HSC1500-ES, both installation guides are the same length.
1.3 **HYDRAsub®-ES MBR Element (HSE)**

The elements contain the membrane fibers which are potted into the element frame at the top and the bottom. The filtrate carrier transports filtrate to the top of the element where it is fed into the main filtrate header of the module as shown in Figure 4. One module will hold multiple elements. For example, the HSM500 contains 20 HSE25, that is 20 elements with 25 m$^2$ of membrane surface area in each.
1.4 HYDRAsub®-ES MBR Filtrate Adapters (HSA)

The filtrate adapters fit into the upper ends of each element after the element is installed into the cage. The adapters consist of two plastic elbows and multiple o-rings and back-up rings to seal the filtrate path from each element into the main filtrate header of the module. The top end of the adapter is the shorter elbow (horizontally), which inserts into the main filtrate header of the module. The part of the adapter that is inserted into the filtrate header has a lip as well. The bottom portion inserts into the top of the element on both sides.
1.5 **HYDRAsub®-ES MBR Air Diffusers (HSD)**

The air diffuser used in the module is a unique Hydranautics’ patent pending design. It is a sheet of metal cut and bent to a specific shape which results in uniform aeration and does not clog.
2 Materials and Tools

The tools listed are required for assembly, installation, and servicing of the HSM500:

Table 1: Tools required for assembly, installation, and servicing

<table>
<thead>
<tr>
<th>No.</th>
<th>Tool</th>
<th>Size</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Wrench (angle or box end)</td>
<td>1/2&quot; and 3/8&quot;</td>
<td>Attaching filtrate header to membrane frame.</td>
</tr>
<tr>
<td>2</td>
<td>Wrench (angle or box end)</td>
<td>1/2&quot; and 3/8&quot;</td>
<td>Attaching diffuser to membrane frame</td>
</tr>
<tr>
<td>2</td>
<td>Wrench (angle or box end)</td>
<td>1/2&quot; and 3/8&quot;</td>
<td>Filtrate Adapter retainer plate installation/removal</td>
</tr>
<tr>
<td>1</td>
<td>Lifting mechanism (crane, hoist, hydraulic truck, etc.)</td>
<td>Rated to handle the module wet weight plus 50% safety factor</td>
<td>Module installation/removal</td>
</tr>
<tr>
<td>4</td>
<td>Lifting chains, cables, or straps</td>
<td>Each rated to handle ¼ of the module wet weight plus 50% safety factor</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Anchor shackles, (Angle or box end) eyebolts, etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3 Module Assembly

3.1 Assembly Site Conditions
The membranes must be stored in a sheltered area, protected from freezing (greater than 5° C), moisture, direct sunlight and extreme heat (less than 40° C). The membranes must not come in contact with any water until the module is placed into operation. The area selected to assemble a module shall be free of debris and sharp edges. There should be enough room on either side of the module to insert the elements. There also must be clearance to lift the module into the tank and room for a crane, hoist or other lifting mechanism.

3.2 Assembly Procedure
Typically, the membrane frame, air diffuser, filtrate headers, filtrate adapter retainers, installation guides, and air supply line supports are disconnected for shipping. The elements and adapters are shipped in a separate package. The membrane cage may be shipped on its side and may require a forklift or crane to put it upright.

3.2.1 Air Diffuser Installation
The air diffuser has four mounting tabs with slots for level adjustment which match up with holes a few inches from the bottom of the vertical channels of the membrane frame. The air diffuser is bolted to the frame. The easiest method to bolt the air diffuser to the bottom of the frame is to tip the frame onto its back, as shown in Figure 7.

IN ORDER FOR THE DIFFUSER TO EVENLY DISTRIBUTE AIR TO THE ELEMENTS, IT MUST BE LEVEL. THIS IS ONE OF THE MOST CRITICAL STEPS OF THE MODULE ASSEMBLY AND INSTALLATION. If the membrane tank floor is level, then the diffuser will be level if square with the membrane frame. However, if the floor of the membrane tank is not level, the diffuser should
be adjusted in place to ensure it is level.

3.2.2 Filtrate Header Installation
After installing the air diffusers, the filtrate headers are bolted to the top of the frame, as shown in Figure 8.

![Figure 8: Filtrate Header Installation](image)

After installation of the filtrate headers, the frame can be set upright.

3.2.3 Installation Guide Installation
The installation guides are bolted to center of either side of the membrane frame at both the top and the bottom of the frame, as previously shown in Figure 3.
3.2.4 Air Supply Line Support Installation

Finally, the air supply line supports are bolted near the top of frame on the side that the diffuser connections are located, as shown in Figure 10.
3.2.5 Element Installation
Next, the elements are loaded into the membrane frame. The element installation procedure may require more than one operator as the elements weigh approximately 16 kg (35 lbs) dry and are 2 m (6.6 ft) in height. The elements must be placed into the slotted sections of the cage and pushed in horizontally as shown in Figure 11. Hold the elements by the filtrate carriers or top and bottom frame. Be careful not to pull on the membrane fibers or allow them to get caught on anything as they are pushed into the cage. Another operator should guide the element into the correct slot on the opposite side of the module, as shown in Figure 11.

3.2.6 Filtrate Adapter Installation
Ensure two elbows are properly connected and that all o-rings are present. Replace any deformed or torn o-rings. Carefully slide the top portion of the adapter into the opening in the main filtrate header. At the same time, insert the bottom portion of the adapter into the corresponding opening on each element. The longer elbow (horizontally) should be inserted into the element. If the adapter will not easily go into the element, use a small amount of glycerin or silicone.
grease. Be careful not to use too much and wipe off any excess grease after inserting the adapter. Do not use any mineral oil as it can damage the membrane. The element must be held in place from the opposite side or by the top and bottom frame when inserting the adapter so that the element is not pushed out of place. The adapter does not need to be pushed all the way into the element, but the o-rings should not be visible when the adapter is pushed in. Check around the entire adapter to ensure that all o-rings are completely inside the openings and that they have not been rolled or pinched in any place.

Take extra caution during the filtrate adapter installation to ensure that no damage occurs to the O-rings and to ensure that a proper seal is made between the O-rings and the elements and filtrate header. Failure to properly install the filtrate adapters may result in an integrity problem.

**Figure 12. Filtrate adapters in place**

### 3.2.7 Filtrate Adapter Retainer Installation

To complete the module assembly, secure the filtrate adapter retainers onto the frame by bolting them to the top, as shown in Figure 3.

Upon completion, the assembled module will look like the one shown in
Figure 13. Assembled HYDRAsub-ES MBR module
4  Guide rail Installation

Guide rails are pipes or beams that guide each module into and out of the membrane tank during installation and removal. During installation, they help lower the module straight into the correct position as suggested in the module layout diagram given in the technical proposal. During removal, the guide rails provide a path to raise the modules straight out of the tank without damaging surrounding modules or other equipment. The guide rails are typically secured to the tank floor and to a supporting beam above the tank or to the top of the tank.

4.1  Guide rail Selection

The guide rail size will depend on the module class and is specified in the respective module drawings and specification sheets. For example, the HSM500 requires a 50A (2") pipe (round or square). The height of the rail should extend vertically from the tank bottom to the top support structure. For the HSM500, where the minimum water level is 2.7 m (8.7 ft), the guide rails must be at least this tall in order to be visible above the water line. The guide rail material should be non-corrosive and able to handle the stress caused during installation, for example stainless steel (SS304 or SS316). Ensure that the guide rails are even along their entire length and do not bow during installation or operation of the system. This will prevent obstruction of the modules during installation or removal. The guide rails should also be leveled with shims so that they are vertically mounted in case the tank floor is uneven.

4.2  Guide rail Placement

The guide rails should be lined up so that they fit inside the guide rail supports on the module such that the module is in agreement with the module layout recommendations. The guide rail supports on the module are shown in Figure 3. They are located on each side of the module at the top of the membrane and diffuser cage.

Refer to DWG. HSM500-ES for exact location of the guide rail supports on a HSM500 for the guide rail support dimensions. These dimensions will vary for each module and can be found on the respective detailed drawings. The guide rail and module placement should be marked inside the tank before installation. First, the module boundaries should be marked for all modules in the tank. The module layout diagram recommended by Hydranautics, as shown in Figure 14, can be used as a guide. The X and A dimensions represent the extremities of the module.
Next, the position of the guide rail bottom anchor should be marked such that the guide rail will fit (within tolerances) into the guide rail supports for each module. Once the tank floor is marked with the bottom anchor position, the top anchor position should be measured by using a plumb bob. The position at which the guide rail will be secured to the top anchor should be marked on the top support structure at the point where the plumb bob is completely vertical. This will ensure the guide rails are at a 90° angle with the tank floor so as not to obstruct the installation or removal process.

4.3 Guide rail Anchoring
The guide rails must be anchored at the top and bottom of the tank. The top support structure should be chosen based on the OEM’s preference and experience. See Figure 15 for examples of anchoring guide rails to the top of the tank. The top anchor may also be bolted instead of welded as shown in the examples.
Figure 15. (a) Guide rails are welded to the top anchor which is bolted to the top of a concrete basin, (b) guide rails are welded to the top anchor which is welded to a steel frame around the hatch lid of tank, and (c) guide rails are welded to a steel beam that runs across the top of the tank
The bottom anchoring method will depend on the type of tank used and is up to the OEM to determine the best way to accomplish this. The bottom of the guide rail may be bolted or welded to the bottom of the tank. The OEM must ensure that the guide rail is secured such that the weight of the module can be supported by each guide rail. Figure 16 shows how the bottom of the guide rail may be anchored to the tank floor.

![Figure 16. Guide rail welded to an anchor which can be bolted to the bottom of the tank](image)

After the guide rails are installed, but before it is permanently anchored, check the level of the beam to ensure it is not creating an angle that will prevent the proper insertion or removal of the modules.
5  Module Installation

Once the modules are assembled and guide rails are installed, the modules are ready to be installed into the membrane tank. Ensure the tank is free of debris such as PVC or metal pipe shavings, spare parts (nuts, bolts, washers, etc.) and sharp objects before installing the membrane modules. Preferably, the system integrity should be tested prior to installation of the modules. The module isolation valves should be closed and all piping and fittings up to that point should be subjected to a pressure decay test to detect any leaks, cracks, or loose fittings, if present. Any changes or repairs after installation will cause the membranes to be exposed to the ambient conditions if not in an enclosed area.

5.1  Lifting the Module

To lift the module, attach shackles, eyebolts or loop cable through each of the four eyelets on top of the membrane cage. Attach a chain or cable rated to hold the specified dry weight (for new, unused modules) to each shackle or eyebolt. For a used, wet module, choose a chain or cable rated to hold the specified wet weight. The specified dry and wet weights for each module class can be found on the respective module drawing or specification sheet. A safety factor of at least 1.5 (relative to the wet weight) should be used to ensure the chain or cable does not break. Attach the other end of each chain or cable to the lifting device. The lifting device can be a crane (hydraulic truck, gantry, jib, monorail), hoist or other suitable piece of equipment. The lifting device should be rated to support the wet weight of the module plus a safety factor of at least 1.5. Make sure that there is enough height clearance for the entire module to be lifted into the tank. Total module heights for each module class are given in their respective specification sheets and drawings.

Slowly lift the module a few inches off the ground and ensure that the module is securely attached to the lifting points and that the membrane cage is securely attached to the diffuser cage before lifting any higher. If the module is secure,
continue lifting the module. Do not allow the module to sway and do not stand underneath the module as it is being lifted or lowered.

5.2 Module Placement
Move the module into the tank and onto the guide rails. This may require operator assistance. Gently lower the module down onto the tank floor with the guide rails in each support bracket. Check that the modules are level so that air scour is uniform during operation. Detach the chains or cables either directly from the lifting points on the module or from the lifting device. If possible, leave the cable or chain connected to the module lifting points and secure the other end to an easily accessible area outside of the tank and above the water level (see Figure 18). This will allow the modules to be removed later, if needed, without having to drain the tank down and re-connect at the lifting points. Make sure that the cable is tight and cannot move loosely inside the tank where it can damage the membrane or any other equipment and instrumentation.

Figure 18. Securing lifting chains to guide rails (left) and chains tied to rail on outside of tank (right)

5.3 Air and Filtrate Hose Connections
The air and filtrate hose connections should be accessible above the water line in the tank so that connections can be made or removed while the tank is full. The air connection on the diffuser cage should be made prior to the module being lowered into the tank. If possible, the end of the hose or pipe should be easily accessible along the walkway or side of the tank so that the connection to the air header can be made without going inside the tank, as shown in Figure 19. Air connections are circled. Consider tying a rope to the loose end of the hose so that it can be secured to the side of the tank while the module is being lowered in order to prevent sludge from entering the hose.
The filtrate connection on the membrane cage should also be made prior to lowering the module into the tank. Similarly, the end of the filtrate hose should be secured near the side of the tank or where it can be easily reached, as shown in Figure 19. The filtrate connections are indicated by rectangles.

Figure 19: Filtrate and Air Hose Connections
6 Module Maintenance and Service

After the modules have been assembled and installed, system integrity has been confirmed according to TSB410, and the system has been started up according to TSB400, operational issues may need to be resolved. This section addresses how to resolve those issues.

6.1 Troubleshooting Guide

To determine if there is a problem with the membrane system, use the troubleshooting guide in Table 2. Before assuming there is an issue with one process parameter, first check that all other process parameters, such as air flows, feed flows, etc., are within the recommended range. It is recommended that actions in each category are performed in succession for time efficiency purposes.

Table 2. Troubleshooting Guide

<table>
<thead>
<tr>
<th>Item</th>
<th>Problem</th>
<th>Possible Cause</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtrate Pumps, Backwash Pumps</td>
<td>1. Pump not reaching design flow rate</td>
<td>a. Insufficient suction head. (Noise may or may not be present)</td>
<td>• Ensure that suction line module isolation and pump isolation valves are fully open and line is unobstructed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Entrained air. Air leak from atmosphere on suction side.</td>
<td>• Check suction line gaskets • Check pipe and hose connections • Check air removal system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Direction of rotation wrong</td>
<td>• Adjust the electrical leads on the motor to ensure that the rotation direction is correct</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Impeller clearance too large</td>
<td>• Adjust impeller clearance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Valve on discharge is throttled</td>
<td>• Adjust degree of valve throttle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f. Module isolation valve(s) are closed</td>
<td>• Open module isolation valve(s)</td>
</tr>
<tr>
<td></td>
<td>2. No discharge or flow with pump running</td>
<td>a. Not properly primed</td>
<td>• Repeat priming operations, recheck instructions • If pump has been running dry, disassemble and inspect pump before operation. Refer to pump vendor manual.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Direction of rotation wrong</td>
<td>• Adjust the electrical leads on the motor to ensure that the rotation direction is correct</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Discharge valve is closed</td>
<td>• Open valve</td>
</tr>
<tr>
<td></td>
<td>3. Excessive noise from motor</td>
<td>a. Bearing damage due to improper lubrication identified by one or more of the following: • Abnormal bearing temperature rise • A stiff cracked grease appearance • A brown or bluish discoloration of the bearing races</td>
<td>• Ensure lubricant is clean • Ensure proper amount of lubricant is used • Ensure the proper grade of lubricant is used • Refer to pump vendor manual</td>
</tr>
<tr>
<td>4. Excessive noise from pump</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>a. Cavitation- insufficient suction head</td>
<td>• Ensure that pump suction isolation valve is fully open and line is unobstructed • Refer to pump vendor manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Impeller rubbing</td>
<td>• Check and adjust impeller clearance • Check outboard bearing assembly for axial end play • Refer to pump vendor manual</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trans-membrane Pressure (TMP)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. High TMP/high set point reached</td>
<td>a. Air is trapped in filtrate lines (visually check in rotameter, if possible)</td>
<td>• Ensure air removal system is functioning properly • Check filtrate connections on suction side of filtrate pump for leaks • Do integrity test on system according to TSB410</td>
</tr>
<tr>
<td></td>
<td>b. Poor sludge quality</td>
<td>• Check MLSS concentration in membrane tank and ensure it is in the proper range • Check viscosity of sludge in membrane tank and ensure it is in the proper range • Perform filterability test (TSB404) and ensure it is within recommended range • Ensure feed water limitations are being adhered to (i.e. oil and grease concentrations, DO and sBOD concentrations in the membrane tank, other chemicals from pre-treatment being overdosed, etc.).</td>
</tr>
<tr>
<td></td>
<td>c. Membrane is fouled</td>
<td>• Perform weekly CEB • Check pressure indicators on each module to determine if one module is operating at higher TMP than others • Ensure membrane aeration rate is in specified range to all modules. • Aerate affected modules for 1-3 hours at maximum recommended flow rate without filtration • Perform CIP, if needed (refer to Instruction Manual for cleaning procedures) • Contact Hydranautics Customer Service</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Filtrate Quality</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. High turbidity reading (Abnormal for system or &gt;0.3 NTU on a consistent basis)</td>
<td>a. Turbidity meter needs to be calibrated</td>
<td>• Check online readings against handheld meter readings • Perform turbidity instrument calibration according to vendor manual</td>
</tr>
<tr>
<td></td>
<td>b. Filtrate lines (around turbidimeter sampling point) are dirty</td>
<td>• Check rotameters or any clear section of piping or hosing, if used • Ensure that the flowrate to the Turbidimeter is in the manufacturer’s specified range. • Flush filtrate lines with a chlorine solution</td>
</tr>
<tr>
<td>Membrane Air Flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1. Low or non-uniform air flow</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Valve(s) on discharge side of blower is throttled</td>
<td>• Open valve(s) on discharge side of blower and check air flow</td>
<td></td>
</tr>
<tr>
<td>b. Flow control valve is throttled</td>
<td>• Open valve manually and check maximum flow</td>
<td></td>
</tr>
<tr>
<td>c. Blower is not producing enough air flow</td>
<td>• Ensure there is power to blower</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ensure blower inlet is not obstructed and clean. Replace filter if necessary.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ensure outlet piping is not obstructed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ensure there are no leaks in the piping or air connections</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Refer to blower vendor manual</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Contact blower vendor for assistance</td>
<td></td>
</tr>
<tr>
<td>d. Sludge build up on air diffusers</td>
<td>• Increase air flow to maximum value to try and flush out sludge deposition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Employ air diffuser backwash, if applicable (only for pipe style diffusers)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Remove module and inspect and clean air diffusers per TSB412</td>
<td></td>
</tr>
<tr>
<td>e. Blower damaged</td>
<td>• Refer to blower vendor manual</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Contact blower vendor for assistance</td>
<td></td>
</tr>
<tr>
<td><strong>2. High air pressure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Air flow restricted</td>
<td>• Open valve(s) on discharge side of blower and check air pressure</td>
<td></td>
</tr>
<tr>
<td>b. Air pressure regulators not functioning</td>
<td>• Check, reset and replace if necessary</td>
<td></td>
</tr>
<tr>
<td>c. Sludge build up on air diffusers</td>
<td>• Increase air flow to maximum value to try and flush out sludge deposition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Employ air diffuser backwash, if applicable</td>
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<td></td>
<td>• Remove module and inspect and clean air diffusers per TSB412</td>
<td></td>
</tr>
<tr>
<td>c. Blower damaged</td>
<td>• Refer to blower vendor manual</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Contact blower vendor for assistance</td>
<td></td>
</tr>
</tbody>
</table>

- c. Air bubbles present in filtrate lines
  - Visually check for air bubbles, if possible
  - Ensure air removal system is functioning properly
  - Check filtrate connections on suction side of filtrate pump for leaks
  - Do integrity test on system according to TSB410

- d. Leaks in piping or connections (below water level)
  - Perform integrity test according to TSB410
  - Repair any leaks

- e. Broken fiber(s)
  - Identify train and module responsible for high turbidity according to TSB410.
  - Remove affected modules from system (refer to TSB411 section 6.3)
  - Repair damaged fibers according to TSB402
<table>
<thead>
<tr>
<th>Backwash Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. High backwash pressure (above 2 psig)</strong></td>
</tr>
</tbody>
</table>
| a. Backwash flow too high | • Check that total flow to membranes does not exceed recommended flow given by Hydranautics  
• Adjust pump speed or flow control valve, if necessary |
| b. Membrane is fouled | • Check pressure indicators on each module to determine if one module is operating at higher TMP than others  
• Aerate affected modules for 1-3 hours at maximum recommended flow rate without filtration  
• Attempt CEB again or repeat above procedures as needed |

<table>
<thead>
<tr>
<th>Vacuum Pumps</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Pump will not turn on start-up</strong></td>
</tr>
</tbody>
</table>
| a. Alarm setting has turned off pump | • Ensure cause of alarm is corrected.  
• Clear alarm |
| b. No power to pump | • Ensure pump is turned on |
| c. Overload/breaker tripped | • Reset overload/breaker |
| d. Rotor is obstructed | • Remove pump cover and check if rotor turns freely |
| e. If the motor fails to turn, ensure that it isn’t a motor problem | • Check wiring- if motor is three phase and wired as single phase, motor can burn out |

| 2. No discharge or flow with pump running |
| a. Valves on inlet or outlet closed | • Open valves |
| b. Direction of rotation wrong | • Adjust the electrical leads on the motor to ensure that the rotation direction is correct |
| c. Insufficient water seal | • Check water seal; water must be fed continuously into the pump  
• Fill pump cavity with enough water to create the seal |

| 3. Poor pump performance, low vacuum |
| a. Pump may not be getting enough water | • Check vacuum pump while running by sealing off inlet piping and reading vacuum at the pump suction. If high vacuum is achieved, look for leaks in vacuum piping |
| b. Internal parts may be worn or damaged | • If high vacuum is not achieved upon closing inlet valve, the problem lies in the vacuum pump (assuming piping between isolation valve and pump suction is free of leaks)  
• Adjust water supply and observe performance  
• Remove pump cover and check for wear |
| c. Pump suction open to atmosphere | • Find leak and seal |

| 4. Pump unusually noisy |
| a. Motor bearings are worn or damaged | • Remove cover and rotate rotor by hand. If noise is detected, replace bearings. |

| 5. High amperage draw |
| a. Internal rubbing of rotor with stationary parts | • Shut off pump and rotate by hand to see if rotor turns freely. Ensure pump is locked out |
## Chemical Metering Pumps

<table>
<thead>
<tr>
<th>1. Pump does not prime in spite of full stroke movement and bleeding</th>
<th>a. Crystalline deposits formed in piping/check valves due to drying out of chemicals</th>
<th>• Remove suction hose from supply tank and rinse thoroughly with clean water. May also need to disassemble and clean valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>b. Valve closed on discharge or suction side of pump</td>
<td>• Open valves</td>
<td></td>
</tr>
<tr>
<td>c. Check valve is installed in the wrong direction</td>
<td>• Reverse direction of check valve</td>
<td></td>
</tr>
</tbody>
</table>

| 2. Float switch in supply tank does not switch off pump at minimum tank level | a. Float is blocked | • Remove deposits and clean float |

<table>
<thead>
<tr>
<th>3. Pump does not meter although display shows pump is metering</th>
<th>a. The stroke length is set to zero or no value is set</th>
<th>• Adjust the stroke length on pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>b. The pump is in &quot;STOP&quot; mode</td>
<td>• Press Start/Stop button until display indicates pump is in &quot;ON&quot; mode</td>
<td></td>
</tr>
</tbody>
</table>

| 4. Fluid is seeping from top/back plate | a. Screws are loose | • Tighten screws on the wet end • If needed, replace diaphragm |

### 6.2 Module or Train Isolation

Please refer to TSB410 for module and train isolation procedure.

### 6.3 Module Removal

#### 6.3.1 Air and Filtrate Connections

Disconnect the air and filtrate lines at the main headers above the water level. If hoses are used, care should be taken to keep the end of the hose out of the water when it is removed so that the line does not get contaminated. Secure the ends of the hoses so that they do not interfere with lifting the module or swing during removal, creating a safety hazard.

![Figure 20. Removing connection from module to air header](image)
6.3.2 Module Removal from Tank

If the chains or cables used to install the module were secured to the outside or top of the tank, then detach them and connect them to the lifting device. The module can then be brought up out of the water along the guide rails. Take care to prevent the chains or cables from catching any other part of the tank, module, or on other equipment while removing.

![Figure 21. Example of a chain getting caught on the guide rail support](image)

If there are no cables attached to the lifting points, the tank must be drained down enough to reach the eyelets and the connection must be made. Refer to section 5.1 for connection and lifting instructions.

As the module is being lifted out of the tank, excess sludge may be rinsed off the outside of the module. To minimize the impact on the biological system, use MBR filtrate to rinse off the module.

6.3.3 Module Conditions Outside of Tank

The module should be placed on a stable, level floor that is strong enough to support the wet weight of the module and put in a contained area. The membranes should be kept wet and, if possible, in the shade, spraying or dousing with water every 20-30 minutes. Increase the spraying frequency to every 10-15 minutes if the membranes are directly in the sun or ambient temperatures are high (above 30 deg C). Do not allow the membranes to sit outside for longer than 24 hours without wetting them. Keep the membranes away from sharp edges or debris. Do not expose the membranes to freezing conditions. Disposal of waste should be handled according to local regulations.
6.4 **Module Inspection**

If there is a problem that requires a visual inspection of the module and/or its parts, the module must be disassembled and analyzed. Refer to the detailed module drawings for the following disassembly instructions.

6.4.1 **Module Disassembly**

Remove the filtrate adapter retainers on both sides of the module by unscrewing the nuts and bolts along the top and bottom of each retainer. Keep all nuts, bolts, and washers together in a small container.

After visual inspection is complete, assemble module in accordance with section 3.2. Install module into tank as described in chapter 5.

6.4.2 **Filtrate Connection**

Remove the connection on each filtrate outlet of the module. Check the connection condition. For example, if a flange has been mounted to the cage, check the condition of the gasket. Look inside the outlets and lines to check if any sludge has leaked into the filtrate lines. If sludge has leaked into filtrate lines, rinse it out before reconnecting the filtrate hoses to the module.

6.4.3 **Air Connection**

Remove the connections on the diffuser. Check the connection condition. For example, if a flange has been mounted to the cage, check the condition of the gasket.

6.4.4 **Filtrate Adapters**

Before removing the adapters, note if any of the o-rings are sticking out of the elements or filtrate header that may cause a break in the seal. Also, note any stretching or deformities in the o-rings. Remove the filtrate adapters by gently pulling out the entire piece from the filtrate adapter receptacle. Replace any o-rings that are deformed or do not fit firmly around the adapter. Check inside the adapters for sludge residue. Rinse off adapters after visually inspecting and keep in a separate, clean container so that sludge or debris does not get inside the adapters.
6.4.5 Elements

The element removal procedure may require more than one operator as the elements may weigh more than 32 kg (70 lbs) when wet and are 2 m (6.6 ft) in height. The elements must be removed from the slotted sections of the cage and pulled out horizontally as shown in Figure 23. Hold the elements by the filtrate carriers or top and bottom frame. Be careful not to pull on the membrane fibers or allow them to get caught on anything as they are removed from the cage. The elements may need to be rinsed with water and any hair or fibrous materials that have accumulated on the membrane may need to be removed. This can be done by very carefully cutting or pulling the hair out while taking care not to damage the membrane fibers.

Remove the elements one by one, looking for membrane fiber breaks or other damage to the element. There may be loose fibers that have been cut short and repaired prior to shipment. Check the ends of any previously repaired fibers to ensure the epoxy plug is intact. If any damaged fibers are found, repair them according to TSB402. If any other damage to the element is found, such as a crack in the frame or damage to the potting, please contact Hydranautics Technical Support immediately. The frame may be fixed by applying epoxy to the plastic part of the frame. If spare elements are available, it is recommended to replace the damaged element.
6.4.6 Air Diffusers

After separating the membrane cage from the diffuser cage, remove the air diffusers from the saddle and look inside the diffuser pipe to determine if any sludge has entered through the inlet side of the diffuser. Check the o-rings on the diffuser pipe and ensure a good seal is formed with the air header. Check the rubber membrane on the outside of the diffuser pipe and note any deposits or damage to the membrane. Consult TSB412 for cleaning of the diffusers.

For answers to any questions about this document please contact Hydranautics Customer Service. For assistance with other issues that have not been covered in this document, please contact Hydranautics Customer Service before taking action to resolve the issue.
Appendix A- HYDRAsub®-ES MBR Module Drawing