MBBRa Operation and Maintenance
Instructions

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DOCUMENT

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Table of Contents

About These Instructions

This manual contains steps for starting, operating, and maintaining an Orenco MBBRa unit. It is not intended to replace operator training. Many Orenco products and components come with installation instructions and other support documentation. All of these are available in hard copy from Orenco and available online in the Orenco Document Library.

Before You Begin

This instruction set provides information on starting the MBBRa unit, regular maintenance activities once the unit is in operation, and troubleshooting assistance if the unit is not operating correctly. Maintain a written record describing all activities relating to the MBBRa. This information will help you maintain consistent treatment and assist you if system troubleshooting becomes necessary.

Before beginning, read these instructions, the design plan set, any permit compliance requirements, the control panel operating instructions, and any documents referenced in these documents. Confirm the instructions for all components are the most current available. Check the Orenco Document Library to be sure your Orenco documents are current.

If you are not a trained wastewater system operator, or if you have questions about this MBBRa system, contact your dealer for training. The dealer can provide technical support, training, and replacement components. To find the nearest dealer, check the Orenco Distributor Locator. If there is no dealer in your area, contact Orenco.

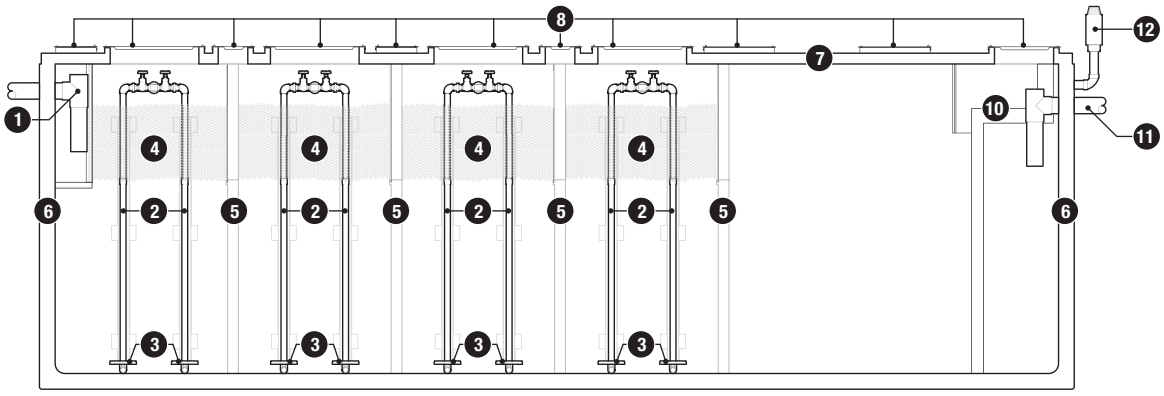
Key Point — Use anti-seize compound on all stainless steel threaded fittings.

Note — *All nominal plumbing and riser diameters provided are US nominal pipe sizes (NPS). If you're using metric pipe, you will need adapters to connect to the US fittings supplied.*

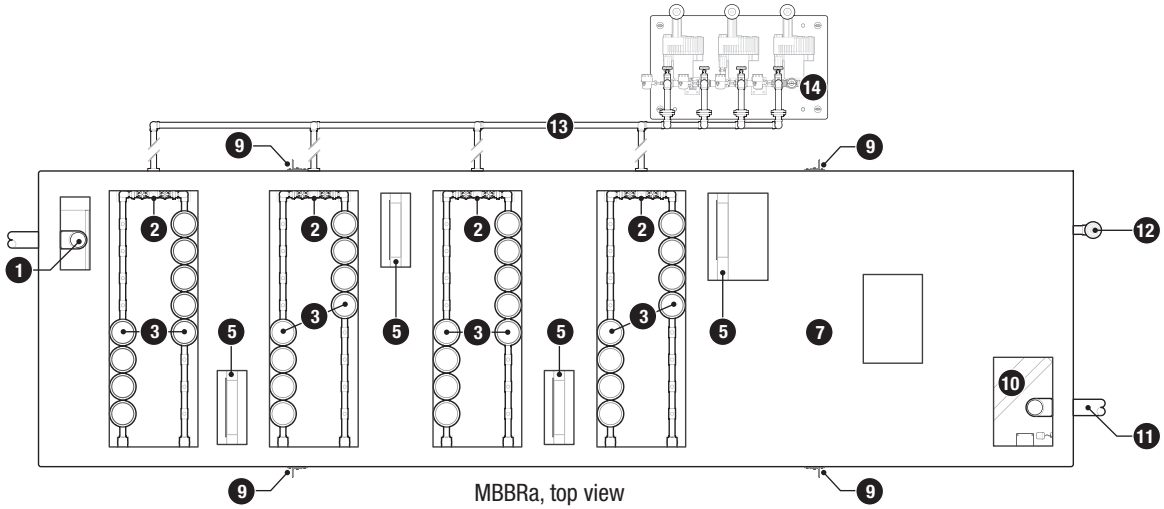
Standard Unit Components

Sample Moving Bed Biofilm Reactor - Aerating (MBBRa) Treatment Unit

Orenco's MBBRa units are highly customizable; multiple options and unit configurations are available. The configuration and components shown in this diagram are not intended to match the specific MBBRa unit(s) used in each installation.



MBBRa, side cutaway view



MBBRa, top view
(access lids removed)

MBBRa Components

1. Inlet with media retention plate
2. Air diffuser manifolds (duplex)
3. Air diffusers (quantity varies)
4. Biofilm carrier
5. Baffle
6. Tank wall
7. Tank top
8. Access lids
9. Lifting bracket
10. Corner weir
11. Outlet
12. Air vent
13. Air line
14. Air blower (3-blower configuration)

Safety Precautions

IMPORTANT

- **Use caution and wear appropriate personal protection equipment (PPE) whenever working with air lines and valving! Blowers and blower piping generate heat and can reach temperatures greater than 150°F (66°C)!**
- **The biofilm carrier CANNOT support any individual or equipment that falls, steps, or leans on it.**
- **Exercise extreme caution when opening hatches and working around open hatches.**
- **Avoid driving over any part of the wastewater treatment system unless it has been equipped with special traffic capability.**
- **If the system is subject to possible traffic, use barricades to protect the system.**

Additional safety precautions:

- Take necessary and appropriate precautions to avoid falling into open tanks.
- Wear PPE when handling or touching any equipment components that come in contact with wastewater or effluent.
- Wear proper clothing that covers all parts of the body that may be exposed to wastewater or effluent.
- Practice proper personal hygiene after start-up, maintenance, or service is complete.
- Switch off the power to the system at the service entrance panel and set the circuit breakers in the control panel to their "OFF" positions before removing or working on any system components.
- If the control panel or service entrance panel is not within eyesight of the pumping system, use lock-out/tag-out tags to ensure safety.
- Do not enter any tank access without proper equipment and training. Gases and depleted oxygen in the tank can be fatal.
- Any work to the tank should be done from the outside, if possible.
- Properly secure all tank access lids after any work on the MBBRa unit is complete.

Tools and Supplies

Key Point — Use anti-seize compound on all threaded stainless steel fittings.

Orenco recommends the following tools and supplies for start-up and performing O&M on the MBBRa:

- Alkalinity titration kit
- Ammeter, loop style
- Anti-seize compound
- Calculator
- Camera
- Channel-lock pliers, 6in and 12in
- Cleaning brush
- Cordless drill/driver
- Dissolved oxygen (DO) meter
- Electrical tester (voltage and amperage)
- Flashlight
- Hex wrench, 3/16in
- Orenco Field Test Kit
- pH tester
- Pressure gauge
- Rake or shovel
- Sampling tubes/sticks for measuring settleable solids (sludge)
- Socket with ratchet, 1/2in
- Sprayer nozzle
- Water hose

Start-up

Step 1. Prep MBBRa Unit

Key Points

- The biofilm carrier may not be fully submerged; this is normal.
- The biofilm carrier may take up to a week after start-up to reach neutral buoyancy which is a requirement for full calibration.
- It may take two or more visits to fully calibrate an MBBRa unit for start-up; plan accordingly. At minimum plan a second visit one week after the initial start-up activities.

Step 1a. Check the liquid levels in the MBBRa.

1. Open all of the hatches on the MBBRa.
2. Make sure the unit is filled with water up to the unit's operating level (the invert of the outlet or above the bottom of the retention plate).

Step 1b. Check that the control panel has power.

Step 1c. Check the function of the MBBRa high-level alarm float switch if a high-level alarm is installed.

- Turn on the control circuit breaker.
- Lift the high-level alarm switch until the high-level alarm activates.
- Lower the high-level alarm switch.
- Leave the circuit breaker in the ON position.

Step 1d. Check that all air piping has been installed properly.

Step 1e. Fully open all of the valves on the air diffuser manifold lines.

Step 2. Prep Blowers

Note — *MBBRa circuit breakers and Manual-Off-Auto (MOA) switches are in the control panel, which may be integrated with the treatment system or in a stand-alone panel. Check the design plans for the specifics of the system.*

Step 2a. Access the control building and control panel.

Step 2b. Turn all blower toggle switches to OFF.

Step 2c. Turn on circuit breakers to all blowers.

Step 2d. Inspect the blower plumbing; confirm it is properly installed.

Step 2e. Make sure each zone calibration (ZC) valve is marked with its corresponding aeration zone.

- There are two ZC valves (ORG1 & ORG2) in MBBRa systems with only organic (ORG) stages.
- There are four ZC valves (ORG1, ORG2, NIT1, NIT2) in systems with both organic and nitrification (NIT) stages.

Step 2f. Make sure the airflow meters have power.

Step 2g. Remove the ¼in plug from the stainless steel tee fitting next to the pressure relief valve (PRV).

- Don't discard the plug. Keep it in a known location for use later.

Step 2h. Install the pressure gauge in the tee fitting.

Step 3. Adjust Pressure Relief Valve (PRV)

Note — *The PRV releases excess pressure from the entire aeration system if pressure builds beyond 5psi (34.5kPa).*

Step 3a. Open all isolation ball valves in the blower manifolds.

Step 3b. Confirm the rotation of the blower motors.

- A directional arrow on the back of each blower motor indicates the correct spin direction of the blower shaft.

1. Have an assistant briefly set each blower MOA switch to the MAN position.
2. Confirm that all of the blower motors turn in the correct direction.
3. If necessary, contact a licensed electrician to change the 3-phase wiring to the blower.

Step 3c. Set the blower MOA switches to the AUTO position.

Step 3d. Close the ZC valves for each aeration zone in turn until the pressure gauge reads near 5psi (34.5kPa), +/- 0.5psi (3.4kPa).

Step 3e. Adjust the PRV so that it will release excessive pressure from the aeration system if pressure builds just beyond 5psi (34.5kPa).

- If air is escaping from the PRV at 5psi (34.5kPa), close the PRV just to the point at which air stops escaping.
- If air is not escaping from the PRV at 5psi (34.5kPa), open the PRV until air begins escaping, then tighten slightly just until air stops escaping.

Step 3f. Open the ZC valves for each aeration zone in turn.

Step 3g. Check for and address any leaks in the air feed plumbing and air diffuser manifold plumbing.

Key Points

- Soapy water works well to identify a potential leak.
- Use anti-seize compound on all threaded stainless steel fittings.

Step 3h. Set the blower MOA switch(es) to the OFF position.

Start-up

Step 4. Perform Initial Calibration

Determine the calibration requirement in cubic feet per minute (cfm) for each of the aeration zones in the MBBRa based on the parameters in the design plans and specifications.

Key Points

- There are two ZC valves (ORG1 & ORG2) in MBBRa systems with only organic (ORG) stages.
- There are four ZC valves (ORG1, ORG2, NIT1, NIT2) in systems with both organic and nitrification (NIT) stages.

Step 4a. Completely open all of the ZC valves.

Step 4b. Set the blower MOA switch(es) to the MAN position and adjust the variable frequency drives (VFDs) for the blower(s) to 60Hz.

- Duplex blower: turn on one blower; adjust its frequency
- Triplex blower: turn on two blowers; adjust their frequencies

Step 4c. Adjust the ZC valves until the airflow meters all show their specified cfm reading.

1. Start with the aeration zone requiring the highest cfm (see plan set).
2. Continue adjusting the ZC valves for the remaining aeration zones.
   - Each zone may require additional calibration and adjustment during the process, to balance cfm between aeration zones.
   - Record the pressure gauge reading after zone calibration.

Step 4d. Set the blower(s) MOA switches to the OFF position.

Step 4e. Allow the air lines to cool down before continuing.

IMPORTANT — Blowers and blower pipes can reach temperatures greater than 150°F (66°C)!

Step 4f. Remove the pressure gauge from the stainless steel tee fitting next to the PRV and reinstall the 1/4in plug.

Step 4g. Store the pressure gauge in a secure location for future use.

Step 5. Adjust Blower High-Low Amperage

Notes

- *Measure voltages and amperages at the circuit breaker.*
- *Do not measure voltage and amperage between VFDs and blowers. Doing so provides false measurements without specialized equipment.*
- *Under normal conditions, the blowers do not all run simultaneously.*
- *See the documents included with the control panel for instructions on inputting information into the panel's operating program.*

Step 5a. Set the MOA switch for the first blower in the normal run sequence to the MAN position.

Step 5b. Use a multimeter and standard electrical probes to measure the dynamic voltage of the blower by touching one probe to the top wire of the blower circuit breaker and the other to a neutral terminal.

Step 5c. Measure, compare, and adjust the blower's amperage.

1. Measure the amperage of the blower by placing the ammeter loop around the power cable of the blower.
2. Read the amperage value for the blower.
   - The amperage should be within plus or minus 10% of the blower's full load amperage.
3. Compare the blower amperage displayed by the control panel program to the measured amperage of the blower.
   - The panel amperage and meter amperage should be within 0.5A of each other.
4. Compare the blower amperage displayed by the control panel program to the measured amperage of the blower.
5. Calibrate as necessary to align the values.

Start-up

Step 5. Adjust Blower High-Low Amperage, cont.

Step 5d. Set the high and low amperage values for the blower.

1. Add 2A to the recorded amperage at 60Hz, and input this high amperage value into the controls program.
   – A high amperage alarm triggers if this value is exceeded during normal operation; the blower shuts off until the alarm is cleared.
2. Change the frequency of the blower's VFD to 50Hz, and record the amperage of the blower at 50Hz.
3. Subtract 2A from the recorded amperage, and input this low amperage value into the controls program.
   – A low amperage alarm triggers if amperage drops below this value during normal operation; the blower shuts off until the alarm is cleared.
4. Record the blower's operating, high, and low amperage values on the start-up paperwork.
5. Record the blower's amperage values on the label inside of the control panel.
6. Return the blower frequency to 60Hz.

Step 5e. Repeat the process in the normal run sequence for each blower in turn.

Step 5f. When all of the blowers have been adjusted, set all of the blower MOA switches to the AUTO position.

IMPORTANT — Close and secure all MBBRa hatches and secure the control panel and control building if it is necessary to leave the site.

Step 6. Set Initial Operating Parameters

Key Points

- Do not begin this step until the biofilm carrier is neutrally buoyant.
- Biological growth on the carrier accelerates neutral buoyancy.
- It may be necessary for the blower to run for several days under normal conditions as the carrier establishes neutral buoyancy.
- It may be necessary to allow the system to operate prior to receiving flow from the facility.
- If the biofilm carrier is not neutrally buoyant, use a rake or shovel to carefully push the carrier below the liquid's surface or resecure the system and let it run for a few more days before performing this test.

Step 6a. Set all of the blower MOA switches to the AUTO position.

- Only one blower is active at a time in a duplex blower configuration.
- Two blowers are active at a time in a triplex blower configuration.

Step 6b. Check that the blower VFDs are sending a 60Hz signal and adjust the VFDs as necessary.

Step 6c. Inspect the aeration and mixing in each aeration zone.

1. Open the hatches on the MBBRa unit.
2. Make sure every air diffuser manifold line valve is completely open.
3. Starting at zone ORG1, check for air bubbling in each of the unit's aeration zones.
4. Check for the carrier mixing in a rolling pattern (carrier moves up toward the surface in one chamber section then moves back down in an adjacent section).
   – Almost all of the carrier should be submerged during normal operation.

Step 6d. Determine the lowest mixing frequency.

1. Adjust all of the blower VFDs to 47Hz.
2. Use the airflow meters to determine when the airflow to each aeration zone stabilizes.
3. Inspect each aeration zone to see if it is still mixing.
   – If a zone is not mixing, adjust blower VFD frequencies up in increments of 1Hz to 2Hz until the zone begins mixing again.
   – If all zones are mixing, adjust blower VFD frequencies down in increments of 1Hz to 2Hz until a zone stops mixing, then adjust the VFD frequencies up until the zone begins mixing again.
   – Do not decrease the frequency below 40Hz or increase the frequency above 60Hz.
4. Record the lowest mixing frequency as the minimum for any adjustment to the system moving forward.

Step 6e. Adjust all of the blower VFDs to 60Hz.

Step 6f. Determine the operating cfm and blower frequency.

1. Evaluate the design parameters, including the system's design average flow.
2. Determine what cfm rate the processes need based on actual anticipated flow parameters.
   – This may or may not be in line with the design average flow, depending on system type, phase planning, etc.
3. Read the airflow meter for each aeration zone and note the cfm rate for each zone.
4. Adjust the blower VFDs until the cfm for each zone closely matches the anticipated demand.
   – 55Hz is a good starting point, pending additional sampling and testing to calibrate the system further once it's fully operational.
5. Make sure the aeration zones are all still mixing; adjust as needed to assure the carrier is mixing properly.
6. Record the cfm for each aeration zone on the start-up paperwork.

Start-up

Step 6. Set Initial Operating Parameters, cont.

Step 6g. Secure the hatches on the MBBRa unit.

Step 6h. Check that all blower MOA switches are in the AUTO position.

Step 6i. Secure the control panel and control building.

Step 7. Inspect Clarifier

If the MBBRa system includes an integral or separate clarifier, inspect it now.

Step 7a. Make sure the liquid level in the clarifier is even with the top of the weir plate all the way across the top.

Step 7b. If the clarifier is equipped with a sludge return pump, check the function of the pump.

1. Go to the control panel.
2. Turn on the circuit breaker or the sludge return pump.
3. Set the MOA switch for the sludge return pump to the MAN position.
4. Check the sludge pump for proper operation.
5. Calibrate amperage values (high/low).
6. Record the flow rate of the sludge return pump on the start-up paperwork.
7. Set the MOA switch for the sludge return pump to the AUTO position.
8. Access the sludge return pump settings in the control panel program panel and set the return pump timer based on the plan set.
9. Typically, the sludge return pump runs for a few minutes, once a day.

Step 7c. Secure all access to the clarifier.

Step 7d. Secure the control panel and control building.

Step 8. Confirm System Calibration

After 3-5 days of the MBBRa system receiving flow from the facility, check the DO levels in the system. Refer to the Regular Maintenance section of these instructions starting at Step 7. Check and Adjust DO Levels.

Regular Maintenance

The frequency of maintenance visits depends on the type of facility, permit requirements and limits, and any applicable regulations. Typically, systems with organic-only permit requirements are on a quarterly schedule, whereas systems with nitrogen permit requirements can require monthly visits. Very high waste strengths, upstream issues, chemical feed demand, and regulatory requirements can also increase service frequency.

Step 1. Record System Snapshot

Before performing any service work, document a snapshot of how the system is performing under current, typical conditions.

Step 1a. Consult the site plans or flow diagram to identify the sample points for the MBBRa unit.

Step 1b. Open the hatch at the first sample point.

Step 1c. Remove the lid.

Step 1d. Take a sample.

Step 1e. Replace and resecure the lid.

Step 1f. Close and secure the hatch.

Step 1g. Label the sample.

Step 1h. Repeat this step for the remaining points.

Key Point — For the sample point at the end of the clarifier, take the sample on the back side of the weir plate.

Step 1i. Analyze each sample for BOD_5, TSS, DO, and pH levels. Also measure TKN and NO_3 levels if applicable. Record all results.

Step 2. Check Blower Filters

Step 2a. Check the air inlet filter for each blower.

Step 2b. Clean or replace filters as necessary.

IMPORTANT — Clogged air inlet filters can result in cfm loss and high heat conditions for the blower.

Step 3. Check Media and Aeration

Step 3a. Open the hatch to the first chamber.

Step 3b. Verify that there is a rolling pattern of carrier mixing.

- There should be very little carrier that is not moving or mixing.

Step 3c. Check the media retention plate.

1. Make sure there is no buildup hindering the flow of effluent.
2. Verify that no carrier is exiting from one chamber to another.

Step 3d. Check several individual pieces of carrier in the chamber.

- There should be a thin biofilm film on the surface areas of the carrier, but the openings should not be clogged.

Step 3e. Close the hatch.

Step 3f. Repeat this step for the remaining chambers.

Step 4. Check and Service Clarifier

Step 4a. Access the clarifier.

Step 4b. Use sludge and scum measuring devices to measure the scum and sludge accumulation in the clarifier.

Step 4c. Record the measurements.

Step 4d. Resecure access to the clarifier.

Step 4e. Analyze the measurements.

- Scum depth should be ≤12in (305mm).
- Sludge depth should be less than 30% of the liquid depth of the clarifier.

Step 4f. Pump out the clarifier if either of these conditions are observed:

- Scum depth greater than 12in (305mm)
- Sludge depth 30% or more of the liquid depth of the clarifier

Step 5. Check Control Panel

Step 5a. In the controls program, verify that none of the blowers are in a fail state.

Step 5b. If possible, look at average daily flow logs to see if they are in line with expectations. Note any anomalies.

Step 5c. During annual or semiannual visits, check the current blower amperages against recorded start-up blower amperages.

Step 6. Check Aeration System

Step 6a. Listen and check for any air leaks in the blower manifold and associated plumbing. See Troubleshooting Air Leaks.

Step 6b. Measure and record the cfm readings on the flow meters.

Regular Maintenance

Step 7. Check and Adjust DO Levels

Step 7a. Check DO levels.

1. Open the hatch near the outlet of the organic process (ORG2).
2. Using a DO meter/test kit, probe or sample behind the midsection of the retention plate at least 6in (152mm) down.
3. Record this reading.
    - This is the ORG process DO.
4. Close the ORG2 hatch.
5. Open the hatch near the outlet of the nitrification process (NIT2), if present.
6. Probe or sample behind the midsection of the retention plate at least 6in (152mm) down
7. Record this reading.
    - This is the NIT process DO.
8. Close the NIT2 hatch.
9. Evaluate the DO levels based on performance expectations listed in Table 1. Expected DO Level Ranges, mg/L.

Table 1. Expected DO Level Ranges, mg/L

ORG process	3-4
NIT process	5-7

10. If prior test data is available, use it to weigh adjustments based on field findings.
    - If both DO levels are low, continue with Step 7b. Adjust to increase low DO levels.
    - If both DO levels are high, skip to Step 7c. Adjust to decrease high DO levels.

Step 7b. Adjust to increase low DO levels.

If both the ORG process DO and the NIT process DO (if applicable) are low, increase the frequency of the blowers incrementally as needed, to generate higher cfm to all process zones.

1. Increase the blowers by 1-2Hz.
2. Wait for 5 minutes.
3. Take another set of DO readings.
4. Evaluate the readings according to the values listed in Table 1. Expected DO Level Ranges, mg/L.
5. Repeat 1 through 4 until DO levels are within the appropriate ranges. If minor adjustments do not bring the DO levels up to the expected range, see Step 8. Confirm Need for Extensive Adjustments.

Step 7c. Adjust to decrease high DO levels.

If both the ORG process DO and the NIT process DO (if applicable) are high, decrease the frequency of the blowers incrementally as needed to generate lower cfm to all process zones.

1. Decrease the blowers by 1-2Hz.
2. Wait for 5 minutes.
3. Take another set of DO readings.
4. Evaluate the readings according to the values listed in Table 1. Expected DO Level Ranges, mg/L.
5. Repeat 1 through 4 until DO levels are within the appropriate ranges. If minor adjustments do not bring the DO levels down to the expected range, see Step 8. Confirm Need for Extensive Adjustments.

Step 8. Confirm Need for Extensive Adjustments

If a moderate number of small adjustments do not produce readings that are within the acceptable range, consider system characteristics that could result in a higher tolerance range.

- Testing results are leading indicators for system performance and adjustment.

Step 8a. Measure and record the mg/L of BOD_5 and mg/L of ammonia coming into the ORG process.

Step 8b. Measure and record the mg/L of BOD_5 and mg/L of ammonia coming out of the ORG process.

Step 8c. Measure and record the mg/L of BOD_5 and mg/L of ammonia coming into the NIT process (if applicable).

Step 8d. Measure and record the mg/L of BOD_5 and mg/L of ammonia coming out of the NIT process (if applicable).

Step 8e. Calculate the air requirements, and compare the total cfm demand to each process before making extensive adjustments to the system. See the *MBBR Design Guidelines*, NDA-TRT-MBB-1 for more information.

Step 9. Complete the Maintenance Activities

Step 9a. Document all adjustments made to the system.

Step 9b. Record the cfm to both ORG1 and ORG2.

Step 9c. Record the cfm to both NIT1 and NIT2, if present.

Step 9d. Secure all hatches, lids, the control panel, and the control building.

Air Diffuser Service

If at any point one or more large bubble(s), 9-12in (229-305mm) in diameter, appear in the MBBRa chamber above a diffuser manifold section, it is possible that a diffuser needs to be replaced. Follow the instructions in this section to remove the diffuser manifold, inspect diffusers, replace diffusers as necessary, and reinstall the diffuser manifold.

IMPORTANT — MBBRa diffusers have a 7-10 year life span. Orenco recommends scheduling replacement at the 10 year mark if this has not already been done.

Step 1. Remove Air Diffuser Manifold

IMPORTANT

- **Removing a diffuser manifold requires two people with the appropriate PPE!**
- **Leave only one hatch open at a time as necessary.**
- **Leave the aeration system ON during this procedure.**

Step 1a. Open the hatch to access the diffuser manifold to be removed.

Step 1b. Close the valve associated with the diffuser manifold line connected to the manifold to be removed.

- You should see the area above this line decrease in mixing and there will be fewer air bubbles; however, the carrier should still be moving.

Step 1c. Completely loosen the 2in union on the diffuser manifold line.

- You may need a wrench to get the union loose.

Step 1d. Remove the associated cap plate.

1. Locate the cap plate in the same chamber, opposite of the union.
2. Remove the two bolts.
3. Remove the cap.

- At this point, the diffuser manifold may feel buoyant.

Step 1e. Station one person on the union side, and the other on the cap side.

Step 1f. Working together, slowly lift the piping of the manifold, keeping it level, until the diffusers break the surface of the carrier.

Step 1g. Pull the diffuser manifold completely out of the chamber and lay it on top of the unit.

Step 2. Inspect Air Diffusers

If you are replacing diffusers due to age, skip this step.

Step 2a. Inspect the top of the diffusers on the manifold.

Step 2b. Look for tears or other damage in the membrane on the top of the diffuser.

Step 2c. Mark any damaged diffuser for replacement with a new one.

Step 3. Replace Air Diffuser(s)

IMPORTANT — It is easy to cross-thread diffusers onto the manifold. Be sure diffusers are aligned and true when installing them.

Note — *Some manifolds may have plugs in the manifold ports. These are to add diffusers to scale treatment as needed. Unless otherwise planned, do not remove these plugs or install diffusers in these ports.*

Step 3a. Remove the diffuser.

1. Support the manifold piping and grab the diffuser to be replaced.
2. Turn the diffuser disk counterclockwise until it unthreads from the manifold.
3. Discard the old diffuser.

Step 3b. Install the diffuser.

1. Carefully install the new diffuser into the threaded port in the manifold turning clockwise to tighten.
2. Only hand-tighten the diffuser; do not use a wrench or other tools.
3. Repeat Step 3a and Step 3b until all desired diffusers have been replaced.

Air Diffuser Service

Step 4. Reinstall Air Diffuser Manifold

Step 4a. With the aeration system still running, station a person on each side of the diffuser manifold.

Step 4b. Working together, carefully lift the diffuser manifold assembly and place the bottom 90-degree elbows into the 5in guide rails within the chamber to align the manifold.

Step 4c. Simultaneously lower the manifold down the guide rails until the union connection and cap line up.

- At this point, the diffuser manifold may feel buoyant.

Step 4d. Reinstall the cap plate.

1. Reinstall the cap.
2. Reinstall the two bolts.

Step 4e. Tighten the union by hand.

Step 4f. Open the valve to the manifold.

Step 4g. Listen and check for air leaking from the union and tighten with a wrench if necessary.

- After a short period of time, the carrier above the reinstalled aeration system should start its roll again and small air bubbles will be seen.

Step 4h. Secure the hatch when complete.

Step 4i. Repeat Step 1. Remove Air Diffuser Manifold through Step 4. Reinstall Air Diffuser Manifold for each air diffuser manifold until all air diffusers have been inspected and/or replaced.

Troubleshooting Air Leaks

If at any time an air leak is suspected, use soapy water on the piping in the area to determine if a leak is present (bubbles will form at the area of the leak with soapy water applied).

IMPORTANT — Remember, blower piping can get extremely hot! Always use caution when working with any of the aeration plumbing or blowers.