MBBRd 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 Moving Bed Bioreactor – Denitrifying (MBBRd) 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 at www.orenco.com.

Before You Begin

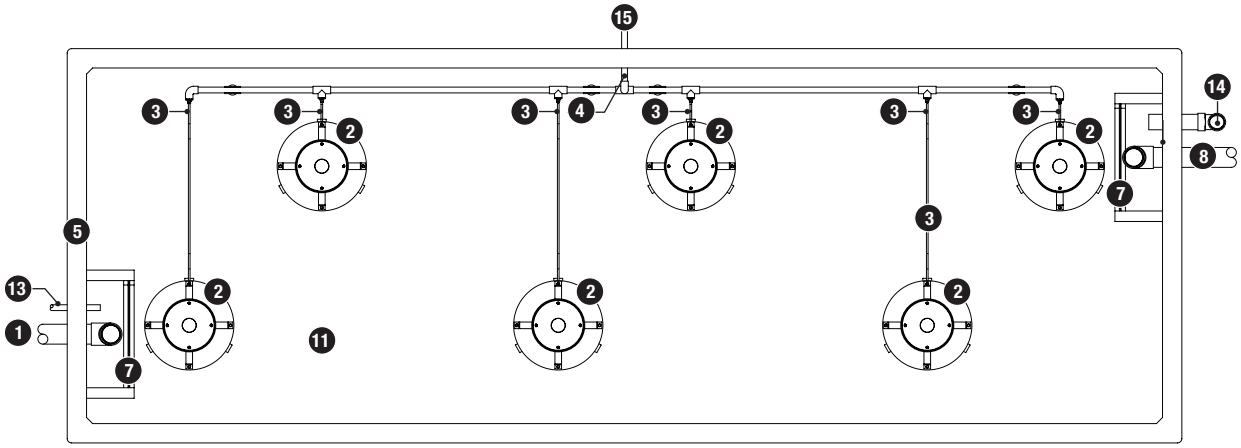
This instruction set provides information on starting the MBBRd unit along with regular operation and maintenance activities once the unit is in operation and troubleshooting assistance if the unit is not operating correctly. Maintain a written record describing all activities relating to the MBBRd.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

Before beginning, read these instructions and any documents referenced in them, and confirm the instructions for all components are the most current available. Check the Orenco Document Library at www.orenco.com to be sure your documents are current.

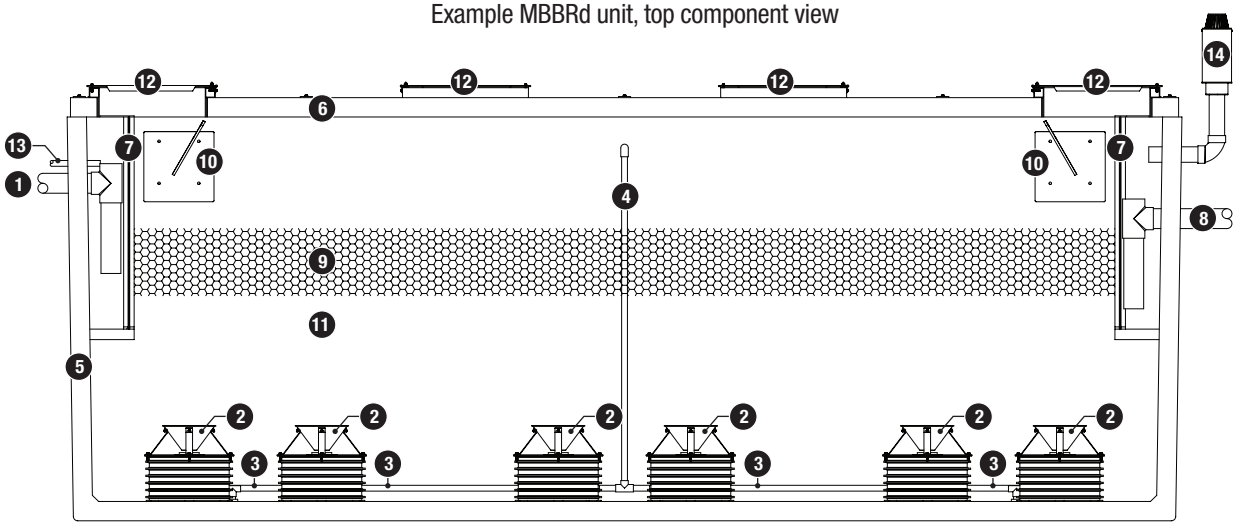
If you are not a trained wastewater system operator, or if you have questions about this MBBRd system, contact your dealer for training. The dealer can provide technical support, training, and replacement components. To find the nearest dealer, check the Distributor Locator page at www.orenco.com. If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

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



Example MBBRd unit, top component view



Example MBBRd unit, side cutaway view

MBBRd Components

1. Inlet
2. Pneumatic mixer
3. Pneumatic mixer line
4. Pneumatic feed line
5. Tank wall
6. Tank top
7. Media retention plate
8. Gravity outlet
9. Biofilm carrier
10. Lifting bracket
11. Denitrifying chamber
12. Access lid
13. Carbon feed line
14. Air vent
15. Air line from blower assembly (blower assembly not shown)

Safety Precautions

IMPORTANT

- **The biofilm carrier CANNOT support any individual or equipment that falls into, 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 personal protection equipment (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 MBBRd unit is complete.

Tools and Supplies

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

- Ammeter, loop style
- Calculator
- Camera
- Cleaning brush
- Cordless drill/driver
- Flashlight
- Hex wrench, 3/16in
- Multimeter (voltage and amperage) and probes
- Orenco Field Test Kit or wastewater test kit
- Sampling tube for measuring settleable solids (sludge)
- Slip-joint pliers, 6in and 12in
- Socket with ratchet, 1/2in
- Sprayer nozzle
- Water hose

Start-up

Step 1. Prep MBBRd Unit

Note — *MBBRd 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 system's specifics.*

Step 1a. Place the MBBRd blower circuit breaker(s) in the OFF position.

Step 1b. Check the function of the MBBRd high-level alarm float switch, if a high-level alarm is installed.

- Turn on the circuit breaker for the high-level alarm float switch.
- 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 1c. Fill the unit with clean water to the invert of the unit outlet.

- Make sure the pneumatic mixers are submerged.
- Do not fill the unit past the invert of the unit's outlet.

Step 1d. Make sure that the air line is connected from the blowers to the pneumatic mixers.

Step 1e. Place the blower circuit breakers in the ON position.

Step 1f. Check the static voltage to the blowers from the blower breakers in the control panel.

1. Set the blower MOA switches to the OFF position.
2. Use a multimeter and standard electrical probes to measure incoming voltage to each blower by touching one probe to the top wire of the blower circuit breaker and the other probe to a neutral terminal.
3. Record the static voltage to the blowers.

Step 1g. Check the operation of each of the unit's blowers.

1. Set the blower MOA switches to the manual (MAN) position.
2. Ensure that the blowers are running. During the mixing cycle, the movement of water and media within the tank is obvious.
   – Refer to the plans to see how many mixers are in the tank.
3. Observe that the pneumatic mixers are cycling and mixing.
   – Over the course of a few minutes, confirm each mixer has at least one bubble-generating event.
4. Time how long it takes for all the mixers to release bubbles, then multiply that number by 2 to determine the unit's ON time.
   – There should be two or more large bubbles per mixer, per cycle.

Step 1h. Check the amperages and dynamic voltages of the blowers.

1. Set the blower MOA switches to the manual (MAN) position.
2. Use a multimeter and standard electrical probes to measure the dynamic voltage of each blower by touching one probe to the top wire of the blower circuit breaker and the other to a neutral terminal.
3. Measure the amperage of each blower by placing the ammeter loop around the power cable of each blower, in turn.
4. Read the amperage values for each blower.
   – The amperage should be within plus or minus 10% of the blower's full load amperage.
5. Record amperage values on the label inside of the control panel.

Step 1i. Set the blower MOA switches to the automatic (AUTO) position.

Step 1j. Set the blower timer for initial "Off" and "On" time settings based on Step 1g and Table 1.

Table 1. Initial Blower Timer Settings

Percent Media Fill	Off Time	On Time
10	4hr	3min to 5min
20	3hr	3min to 5min
30	2hr	3min to 5min
40	1hr	3min to 5min

Step 2. Prep Carbon Feed System

Notes

- *The peristaltic pump has to be primed for the carbon feed system to operate correctly.*
- *See the section on constituent monitoring and feed adjustment for more carbon feed information.*

Step 2a. Turn on the circuit breakers for the carbon feed system and carbon feed pump.

Step 2b. Verify that the carbon feed pump is on and running.

Step 2c. Verify carbon flows through the tubing into the MBBRd tank.

Step 2d. Turn off the circuit breaker for the carbon feed pump.

Step 3. Secure Access Hatches

Secure the access hatches on the unit when the start-up is completed.

- If hatch bolts are lost or damaged, immediately contact your dealer for replacements.

Constituent Monitoring and Feed Adjustment

Note — *For new systems, begin at Step 1. For existing systems, begin at Step 2.*

Step 1. Activate Carbon Feed System

Step 1a. After four weeks of MBBRd operation, test for influent nitrate concentrations to the MBBRd to determine the carbon ratio (C:N).

Step 1b. Log the initial nitrate concentration values.

Step 1c. Activate the carbon feed to help balance the carbon to nitrogen ratio (C:N) in the wastewater for effective denitrification.

- C:N ratios of 4:1 to 6:1 are preferred to ensure near-complete denitrification.

1. Turn on the circuit breakers for the carbon feed system and carbon feed pump in the control panel.
2. Verify that the carbon feed pump is on and running.
3. Verify carbon flows through the tubing into the MBBRd tank.

Step 2. Total Nitrogen Testing Cycle

Note — *Typically, nitrification is occurring 2 to 4 weeks after system start-up. In cold weather, this may take longer.*

Once the carbon feed system is active, begin testing for total nitrogen at the discharge end of the final polishing treatment stage.

- Follow regulatory testing requirements or test once per quarter, whichever is the shorter duration.

Step 3. Adjust Carbon Feed

Review test results for TKN (total Kjeldahl nitrogen) and for TN (total nitrogen); enable and adjust the carbon feed rate for best effect.

Note — *Perform wastewater constituent tests based on regulatory requirements. If there are no regulatory requirements, take samples quarterly for the first year to establish a baseline. Testing after the first year may be reduced based on the established baseline. Regular sampling provides valuable information for ongoing maintenance and troubleshooting. Report all results obtained to the appropriate organizations, including Orenco's Systems Engineering Department.*

- Higher TKN results indicate the prior process stage is not properly nitrifying. Possible causes are:
  - Insufficient oxygen in the nitrification stage,
  - Lack of appropriate alkalinity, and/or
  - Low temperature.
- High TN with low TKN results indicate insufficient carbon feed.
  - Adjust the feed rate up; begin a weekly test regimen to assess results.
- Higher $cBOD_5$ coupled with low TN and low TKN results indicate too much carbon being fed into the flow.
  - Recalculate the feed rate and adjust the feed pump accordingly.

Regular Maintenance

Note — *Check the system plans for the system's maintenance schedule, or contact the design engineer or Orenco.*

Step 1. Check System Function

Check the following items while the MBBRd unit is operating.

Step 1a. Open the access hatches on the MBBRd unit and verify that the pneumatic mixers are operating during programmed blower ON times.

- See the start-up section for pneumatic mixer testing.

Step 1b. Verify that the biofilm carrier is circulating throughout the unit.

Step 2. Clean Media Retention Plates

Step 2a. Visually inspect the media retention plates on the MBBRd discharge for solids buildup.

Step 2b. Clean the media retention plates, if necessary.

1. Remove any buildup on the plate by spraying it with clean water.
2. If buildup on the plate is inhibiting flow, drain the tank to below the plate level and spray the plate with clean water.

Step 2c. If buildup continues to block the media retention plate, contact Orenco before removing the plate from the inlet or outlet box and scrubbing it clean with a brush.

Step 3. Check Float Switch Function

For units equipped with a high-level alarm, test the high-level alarm float switch in the MBBRd unit.

Step 3a. Raise the high-level alarm float switch.

- After a brief delay, a visual alarm on the front of the panel should illuminate.
- If the alarm doesn't illuminate, check the lamp for possible damage.

Step 3b. Check for the automatic reset of the alarm by lowering and again lifting the float and checking for reactivation of the visual alarm.

Step 4. Inspect Biological Growth

Check the biological growth on the biofilm carriers in the MBBRD unit.

Note — *Biological growth is necessary to the treatment process. It normally appears light brown to dark brown and is gelatinous in texture.*

Step 4a. For the record, take a photo and comment on the growth and characteristics of the biological growth.

Step 4b. If the growth appears yellowish with the texture of lard or margarine, check the grease and oil concentrations and clean if necessary.

Step 4c. If excess biological growth is occurring or appears to be occurring, measure the sludge level in the MBBRd unit and pump the unit as necessary (see Step 5).

Step 5. Check Sludge Accumulation

During each regular maintenance activity, measure the sludge layer in the MBBRd unit.

Step 5a. Turn off the blower MOA switches.

Step 5b. Use a sampling tube to measure the thickness of the sludge layer in the unit.

Step 5c. If the sludge thickness is 16in (406mm) or more, pump the sludge out of the tank.

Key Point — Turn off all pneumatic mixers during a pump-out to avoid removing biofilm carriers!

Step 5d. Check for excessive biological growth on the biofilm carriers 24 hours after any sludge removal.

- If excessive growth is observed, increase the blower output for 12 to 24 hours to shear any excess material from the biofilm carriers.

Step 5e. Turn on the blower MOA switches after measuring (and pumping, if necessary) is complete.

Step 6. Secure Access Hatches

Secure the access hatches on the MBBRd unit when the maintenance is completed.

- If hatch bolts are lost or damaged, immediately contact your dealer for replacements.

Troubleshooting

Table 2. MBBRd Troubleshooting Chart*

Issue	Possible Causes	Actions
$cBOD_5$ values acceptable; NO_3-N values higher than expected	The carbon feed system is not providing enough carbon to complete denitrification.	• Ensure that the pneumatic mixing system is operating shortly after carbon addition to promote mixing. • Compare flows and influent values to historical values and adjust the feed system as necessary.
NO_3-N values acceptable; $cBOD_5$ much higher than expected	The carbon feed system is providing significantly more carbon to complete denitrification than is necessary.	• Compare flows and influent values to historical values and adjust the feed system as necessary.
NO_3-N, $cBOD_5$ values acceptable; NH_3-N higher than expected	Nitrification is not occurring prior to the MBBRd unit. (The MBBRd does not treat ammonia.)	• Check the nitrification system prior to the anoxic MBBRd. • Make adjustments to the nitrification system.
NO_3-N and $cBOD_5$ values slowly trending up over several months	The system may be undersized.	• Check historical values to determine if the parameters are within the design parameters of the project.
	If historical values are within design parameters:	• Check the carriers for excessive biological growth and insufficient mixing shear. • Check and test the mixing air blower and repair or replace if it is not functioning correctly.
	If the mixing air blower functions correctly, but the biofilm carriers show signs of excessive growth:	• Temporarily reduce the off timer setting to increase mixing and promote shearing.

** Contact Orenco for assistance with these issues or any other issues not addressed here.*