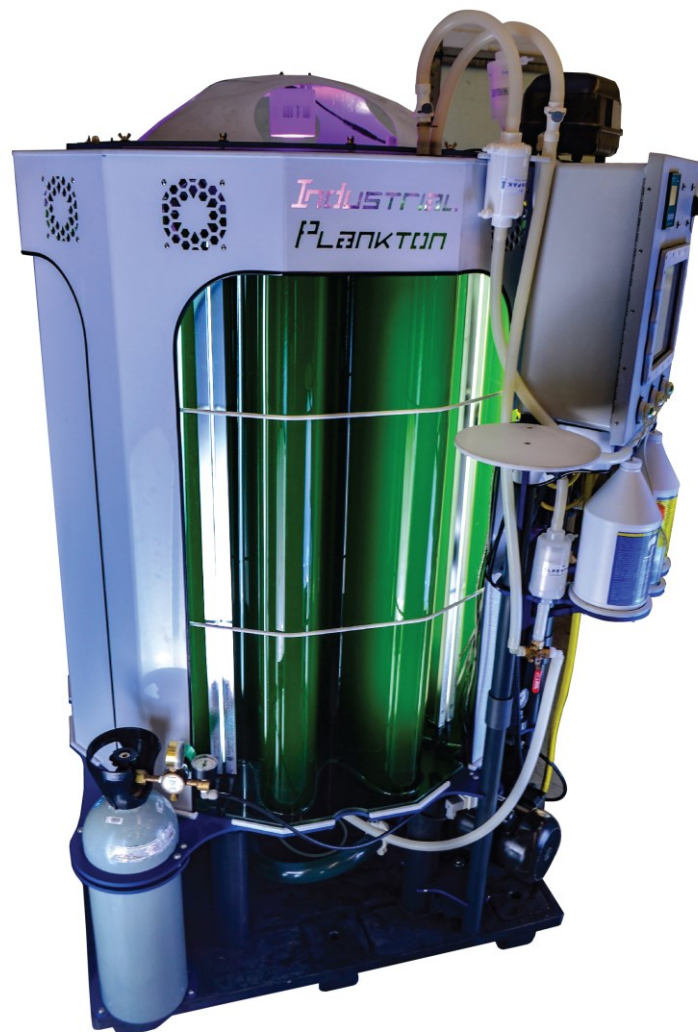


*INDUSTRIAL*TM *PLANKTON*

PBR 1000L User Manual



Warnings

1. **Never** use **Windex, acetone, ammonia,** or other solvent based cleaners on or near the PBR. The chemicals will weaken the acrylic and can cause catastrophic failure.
2. **Never** run Spray Pump without water in the PBR.
3. **Never** install T5 lights when the lights are powered. This damages them.
4. **Never** run Harvest Pump in reverse after inoculation.
5. **Never** mix cleaning fluids; it can result in serious injury or death.
6. **Never** drain the PBR without allowing air to replace draining fluid.
7. **Never** run the Chiller without water motion.
8. **Do not** drop the PBR when transporting it with a pallet jack or forklift.
9. **Do not** use sponges or paper towels to clean the tank. Only use soft cotton cloths to avoid scratching the acrylic.
10. **Do not** install PBR on soft ground or with uneven support.
11. **Do not** use the top port to add dangerous chemicals without appropriate personal protection.



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Abbreviations Used

Abbreviation	Description
CIP	Clean-in-place
DI Water	Deionized w ater
fQDC	Female autoclavable Q uick D isconnect fitting
F/2	Guillard's F/2 algae growth media
GFI	G round F ault I nterrupter
mQDC	Male autoclavable Q uick D isconnect fitting
NPT	N ational P ipe T hread
PBR	P hoto b ioreactor
PLC	P rogramming L ogic C ontroller
QDC	Autoclavable Q uick D isconnect fitting
thio	Sodium t hio s ulphate

Standard Solutions Used

- 7.01 & 10.01 pH buffer
- Alcohol (rubbing, ethyl, or isopropyl alcohol are all acceptable), do not exceed 30% on acrylic surfaces, but higher concentrations may be used for sterilizing QDCs and grey plastic components.
- Biofilm Removal Agent ([See Approved Cleaning Agents](#))
- Bleach (4-12% sodium hypochlorite)
- Deionized water
- Sodium thiosulphate
- Compressed CO₂ gas
- Nutrient media for algae
- Silica nutrient media (for diatoms only)

Cleaning and Sterilizing

Using a non-approved cleaning agent can damage the PBR **irreparably** and will **void warranty**. Consult Industrial Plankton before using different cleaning agents or higher dosages of approved agents.

Mixing cleaning agents is **extremely dangerous**. **Never** mix concentrates of any cleaner. Perform a freshwater rinse between different cleaning agents. **Never** mix bleach and acid.

Ensure cleaning fluid from PBR is sent to waste. Read local regulations to find out how to safely dispose of cleaning agents.

Mishandling cleaning agents can cause severe harm or death. Personal protection is necessary. Read safety data sheet (SDS) for any cleaning agent before it is used.

Steps

1. [Preparation](#)
2. [Rinse](#)
3. [Biofilm Removal](#)
4. [Rinse](#)
5. [Autoclave](#)
6. [Chlorine Sterilization](#)
7. [Final Rinse and Reassembly](#)

Do not allow biofilms to dry inside PBR.

Use a fresh water source to clean the PBR as many cleaning agents precipitate in saltwater. Refer to the [Fresh Water Addition](#) section for details.

Approved Cleaning Agents

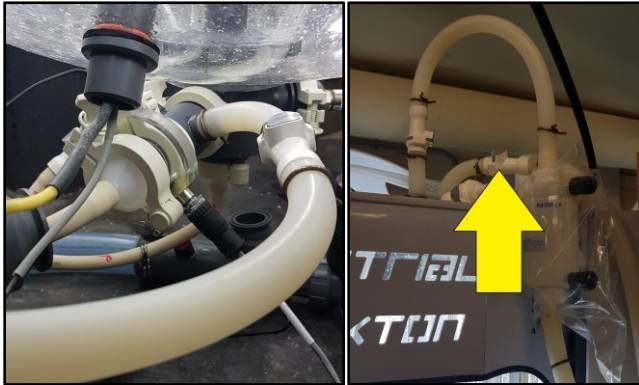
Cleaning Agent	Purpose	Recommended Concentration*	Maximum concentration*	Water
Steris CIP 100	Caustic biofilm removal	27 mL/L	35 mL/L	Fresh water
Sodium hydroxide (10% NaOH w/v)	Caustic biofilm removal	200 mL/L	250 mL/L	Fresh water
Hydrogen peroxide (34% H ₂ O ₂)	Enhanced biofilm removal	7.81 mL/L	8.00 mL/L	Use with pre-diluted Sodium hydroxide
Muriatic acid (33% HCl v/v)	Acid biofilm removal	40 mL/L	300 mL/L	Fresh water
Ethylenediaminetetraacetic acid (Tetrasodium EDTA)	Acid biofilm removal	8 g/L	12 g/L	Fresh water
Bleach (NaClO 12%)	Sterilization	2 mL/L	5 mL/L	Fresh or Saltwater
Sodium thiosulphate (anhydrous 158 g/L or pentahydrate 248 g/L)	Bleach neutralization	1 mL thio / 1 mL of 12% Bleach	-	Bleach water

*Concentrations listed are amounts of cleaning agent used per liter of volume in PBR for spray cleaning. There should be a total of 75L in the PBR for running the Spray Pump. For cleaning agents that require higher volumes per liter, ensure to account for the volume of cleaning agent added for max efficacy (i.e. 22.5 L of Muriatic acid @ 33% HCl + 52.5 L of fresh water is the max concentration for a total volume of 75 L).

Preparation

Check pH probe's calibration between every culture run and recalibrate if required. Never leave probe dry. If left dry, soaking in pH 4.01 buffer or storage solution may restore some functionality. Buffers 7.01 and 10.01 are required for testing and calibration.

1. Drain PBR by harvesting full volume in tank. You can unclamp the harvest pump to allow the PBR to gravity drain.
2. Connect the Air Inlet line to the top of the PBR.



3. Loosen compression screw on pH triclamp and remove pH probe from pH triclamp fitting.



4. Ensure pH probe BNC connection is well connected to the control box's BNC connector, Located behind the cowling under the touchscreen to prepare for calibration.
 - a. Prepare 7 & 10 buffer solutions in small containers and deionized water in a spray bottle.
 - b. A complete 2-point CAL is required for this Transmitter. If Calibration is aborted after 1st calibration point, transmitter reverts to previous Calibration data. Rinse probe

thoroughly with de-ionized water or a rinse solution. Blot excess liquid.

- c. Dip probe into calibration buffer. End of probe must be completely immersed into buffer. Stir probe gently to create a homogeneous sample.
- d. Press CAL to enter pH calibration mode. CAL indicator will be shown. Primary display will show measured reading while secondary display will indicate the pH standard buffer solution.



- e. Press ▲ or ▼ keys to select either pH 7.00 (USA) or pH 6.86 (NIST) standard buffers. This is the first point, Offset calibration.
- f. Wait for measured pH value to stabilize. Press **ENT[ER]** to confirm calibration. Transmitter is now calibrated to current buffer.
- g. Rinse probe with de-ionized water or rinse solution, and place in next pH buffer pH 10.01).
- h. Repeat steps 5 and 6.

- i. Upon successful Calibration, transmitter displays Slope (primary display, in mV) and Offset (secondary display, in pH) of electrode.
- j. Press ENTER to return to MEAS mode (standard measurement). Transmitter has been calibrated. Rinse electrode and place back in liquid.

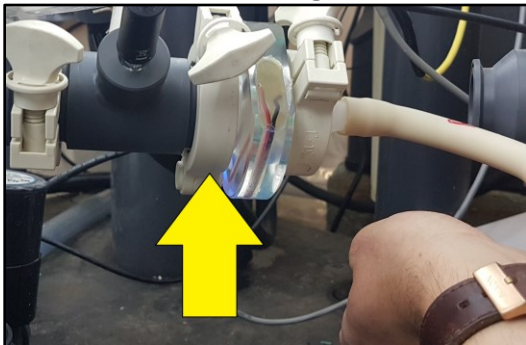
k. **NOTES** on pH Calibration

- i. To exit from pH calibration mode without confirming calibration, press ▲ and ▼ keys together.
- ii. If selected buffer value is not within ± 1.0 pH from measured pH value: electrode and buffer icon blink and ERR annunciator appears in lower left corner of display.

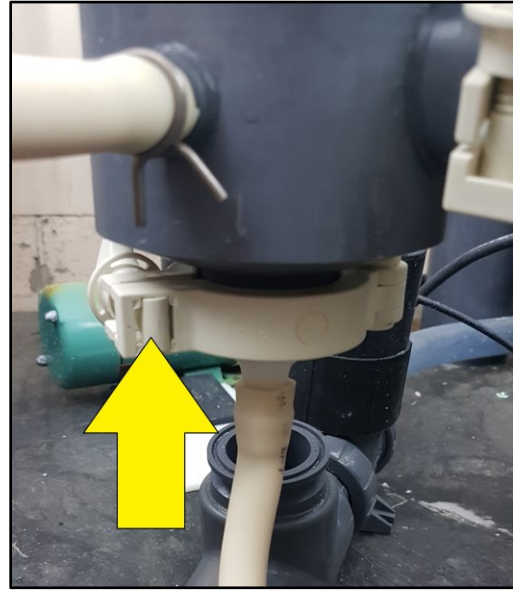
5. Remove side barb to triclamp adapter. (silicone gasket must be next to OD sensor).



6. Remove the OD sensor from the pH probe triclamps (silicone o-ring).



7. Remove bottom barb to triclamp adapter.



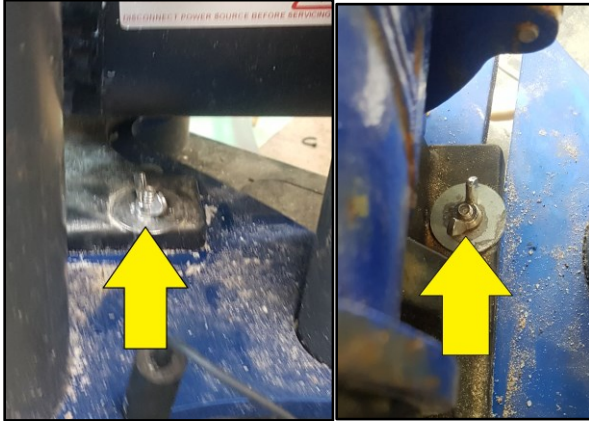
8. Remove pH probe triclamp assembly from manifold



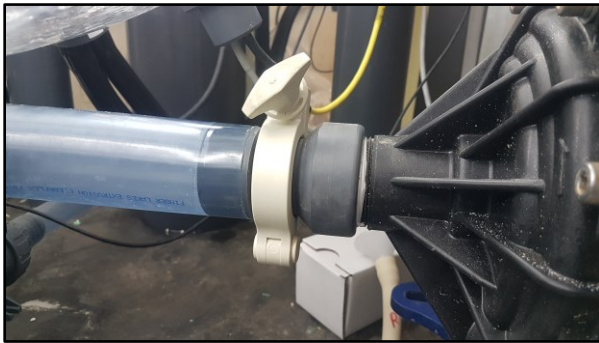
9. Disconnect Harvest "Harness" QDC from manifold.



10. Position Spray Pump to connect to PBR Manifold and loosely tighten wingnuts.



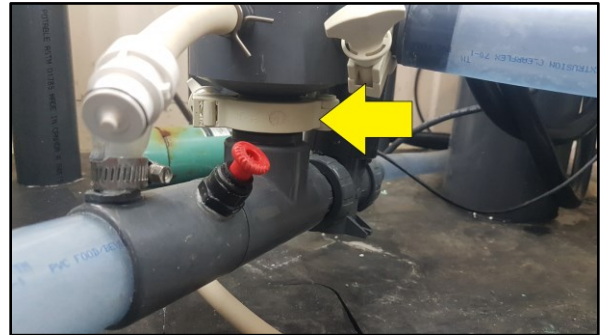
11. Place **black EPDM** triclamp gasket onto Spray Pump Intake Tube and connect to Pump intake.



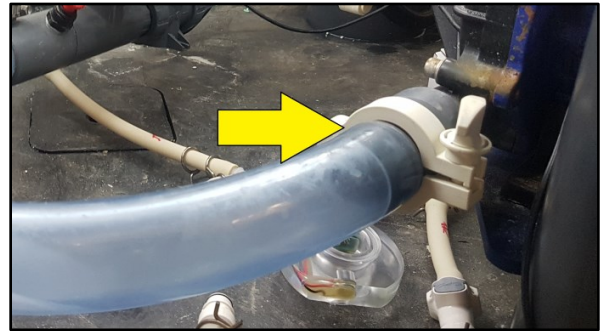
12. Place **black EPDM** Gasket between the pump intake and the manifold and connect intake to Manifold. Tighten triclamp around the mating faces. **Do not** force this connection. Too much force can damage the PBR.



13. Place translucent **Silicone** triclamp gasket between Drain Tee Manifold to the bottom of the PBR Manifold and clamp.



14. Connect Spray Pump Outlet with **silicone** triclamp gasket to Drain Tee Manifold and tighten Spray Pump Wingnuts.



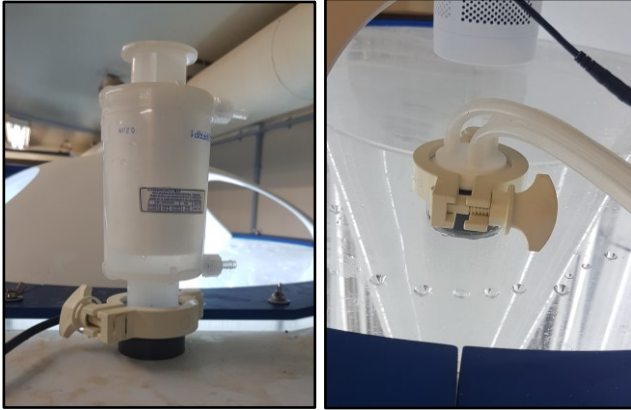
15. Ensure Air Bleed Line is directed to the drain. Do not submerge or route tube uphill (on the right of the PBR)

16. Ensure the drain valve is closed and secured to its unions to the spray pump tubing and the drain tubing.

Fresh Water Addition

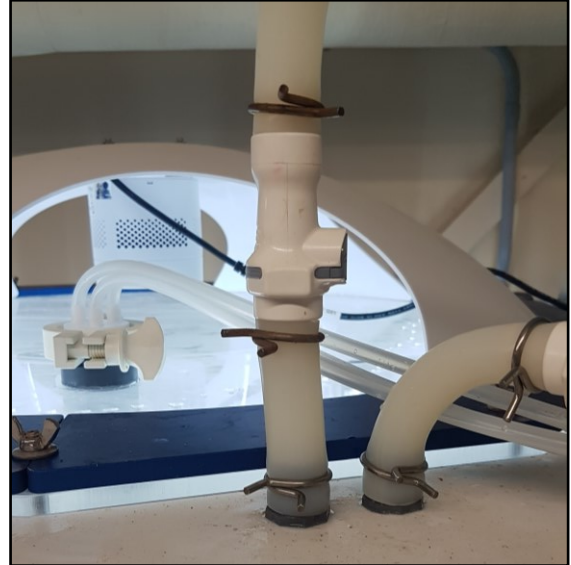
Freshwater can be added to the PBR by directing a hose into the PBR and bypassing the filter chain. This saves filter lifetime. Ensure your freshwater supply is free of particulate. Use **one** of the following **options** to fill the PBR with Fresh Water.

- Disconnect one of the top triclamps fittings and place a hose through it. Ensure the end of the hose doesn't scratch the inside of the PBR and will not fall out when filling.



- Equip a freshwater hose with a fQDC and attach the hose to the mQDC of the water inlet QDC. QDCs are only rated to 35 psi, so ensure the male and female are connected prior to turning on

water.



- Or attach 1/2" freshwater hose to the water inlet's 1/2" barb.



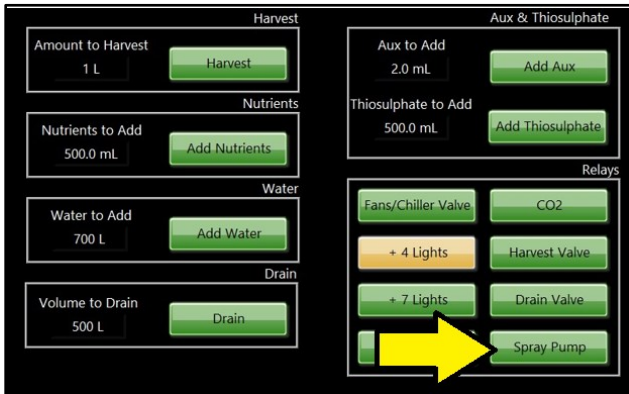
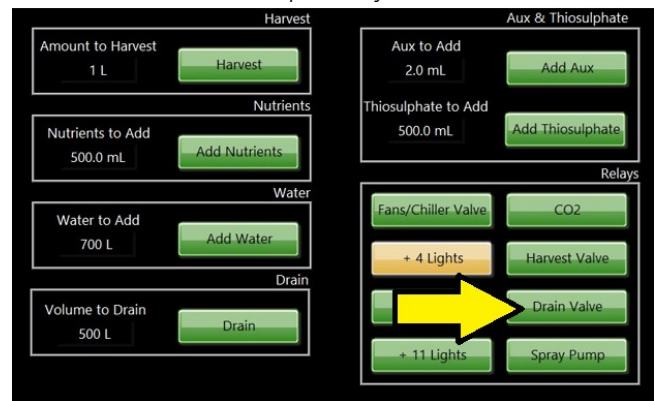
Rinse

Never run Spray Pump with Drain Valve open. It can create a vacuum and **implode** the tank.

The Air Bleed Check Valve **must** be in place to allow excess air to exit the PBR or the lid will **leak**.

When spraying, if the Spray Pump loses pressure intermittently (developing beats) it is probably sucking air, press Stop and add more water.

1. [Add fresh water](#) midway on the PBR's Heat Exchanger (35 L).
2. Spray Pump Check List:
 - Water in PBR
 - Spray Pump Inlet is connected to manifold
 - Drain Tee Manifold is secured to PBR Manifold and Spray Pump
 - Spray Pump is secure
 - Air line is connected to the Top (not the manifold)
 - Drain Valve is closed
 - Air Bleed is connected, directed to waste, and can vent freely
 - Lid is sealed (wingnuts tight, tubing and triclamp ports connected)
 - QDC on Harvest Line is disconnected
3. Spray Pump for 10-30 minutes on Manual controls
4. Press STOP or Spray Pump to stop.
5. Drain water in PBR using Drain Valve button. **NOTE: do not leave drain valve open for longer than necessary.** The solenoid will overheat and cease to function *temporarily*.
6. Close Drain Valve once the PBR has fully drained.
7. Proceed to [Biofilm Removal](#) or [Autoclaving](#)

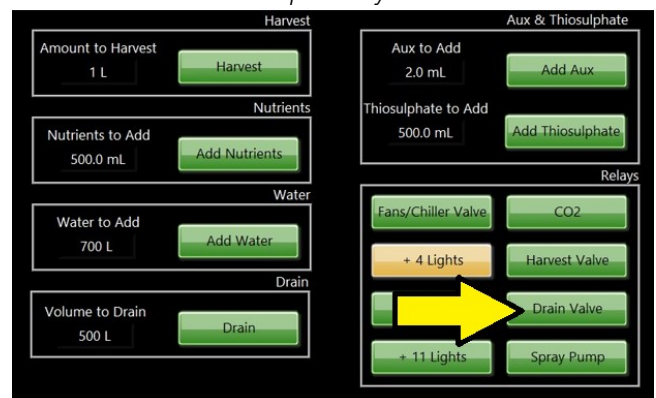


Biofilm Removal

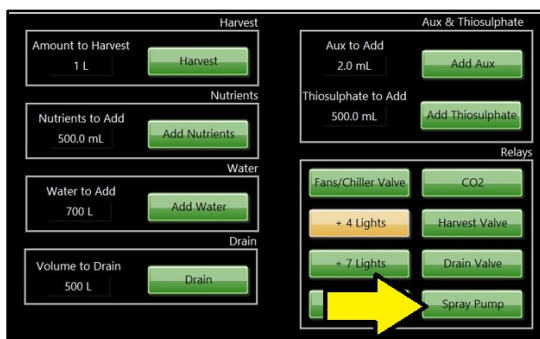
Biofilm removal is critical as chlorine doesn't penetrate biofilms. For stubborn biofilm residue, we recommend a 2-step biofilm removal: a caustic cleaner cycle followed by a rinse, then an acid cycle.

Rinse tank between different cleaning chemicals as combining cleaning agents is dangerous. **Never** combine chemicals, **especially** chlorine and acid.

1. [Add 35 L of fresh water](#) to midway through the Heat Exchanger.
2. [Add Cleaning Agent](#) for Biofilm removal. Use concentration indicated in table: [Cleaning and Sterilizing overview](#). **Note:** If using pure NaOH with H₂O₂, dilute the NaOH into the PBR water **prior** to adding the concentrated H₂O₂ to the PBR. H₂O₂ is only active for 1 hour from introduction, so ensure it is added directly before running the Spray Pump.
3. Spray Pump Check List:
 - Water in PBR
 - Spray Pump Inlet is connected to manifold
 - Drain Tee Manifold is secured to PBR Manifold and Spray Pump
 - Spray Pump is secure
 - Air line is connected to the Top (not the manifold)
 - Drain Valve is closed
 - Air Bleed is connected, directed to waste, and can vent freely
 - Lid is sealed (wingnuts tight, tubing and triclamp ports connected)
 - QDC on Harvest Line is disconnected
5. Press Stop or Spray Pump to stop.
6. Inspect tank for any residual biofilm. If any biofilm remains, increase concentration of removal agent to max concentration, or complete the following steps and start Biofilm Removal with another cleaning agent.
7. Drain water in PBR using Drain Valve button. **NOTE: do not leave drain valve open for longer than necessary.** The solenoid will overheat and cease to function *temporarily*.



3. Spray Pump Check List:
 - Water in PBR
 - Spray Pump Inlet is connected to manifold
 - Drain Tee Manifold is secured to PBR Manifold and Spray Pump
 - Spray Pump is secure
 - Air line is connected to the Top (not the manifold)
 - Drain Valve is closed
 - Air Bleed is connected, directed to waste, and can vent freely
 - Lid is sealed (wingnuts tight, tubing and triclamp ports connected)
 - QDC on Harvest Line is disconnected
4. Spray Pump for 60-240 minutes on Manual controls



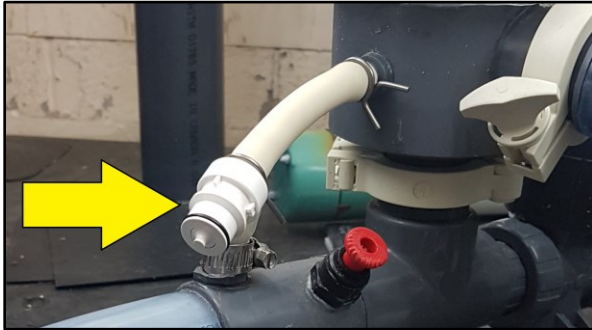
8. Close Drain Valve once the PBR has fully drained.
9. [Rinse](#) the PBR following previous directions to prevent chemical mixing of cleaners.
10. Manually remove biofilm on pH Assembly and OD sensor. Do not use biofilm removal agents on pH probe; it can be damaged. A soft (non-cellulose) cloth is recommended.

Add Cleaning Agent

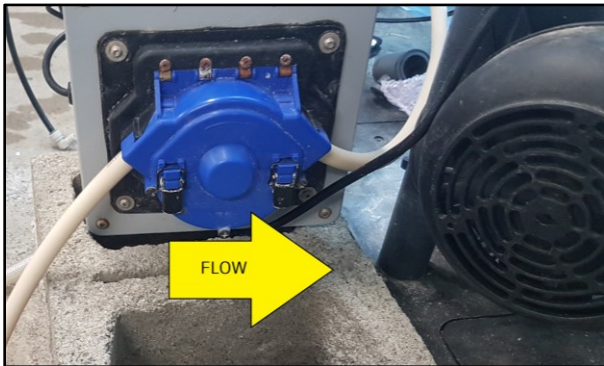
To add cleaning agents, pour them through one of the lid's triclamp ports, or pull them into the reactor by running the harvest pump in reverse using the Inoculation function as shown below. **Wear personal protective equipment when handling chemicals.**

Ensure chemicals are added to water in PBR, **never** to a dry PBR.

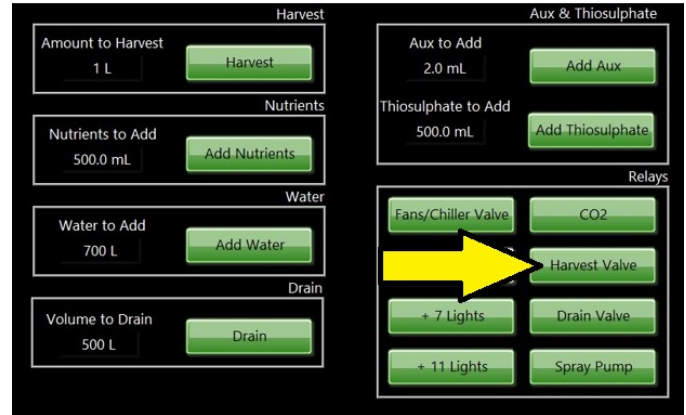
1. Connect Harvest Pump Tubing's fQDC directly to the manifold's mQDC.



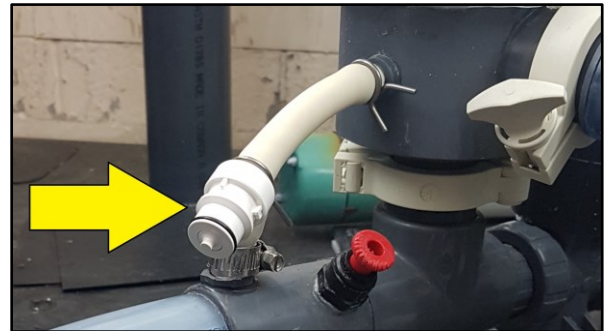
2. Place Automated Harvest Line Tubing backwards through Harvest Pump (pumping towards PBR). Ensure tube is completely pushed into rollers to prevent damage (behind black tabs).



3. Draw in a measured volume of cleaning agent by pressing Harvest Valve (in Manual Controls).



4. After cleaning agents have been added, press STOP or Harvest Valve to stop.
5. Disconnect manifold mQDC from Harvest pump.

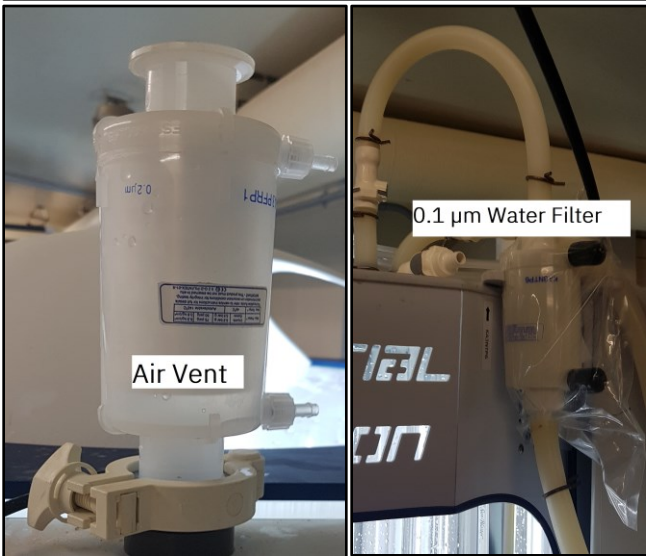


6. Return to [Biofilm Removal](#) or [Chlorine Sterilization](#).

Autoclave

Ensure no biofilms remain before proceeding to autoclaving parts. If tubes or filters have visible deposits or residues, disassemble and flush with fresh water. If biofilm persists, scrub, or soak tubes with a biofilm removal agent until clean. Do not soak filters in biofilm removal agents or chlorine.

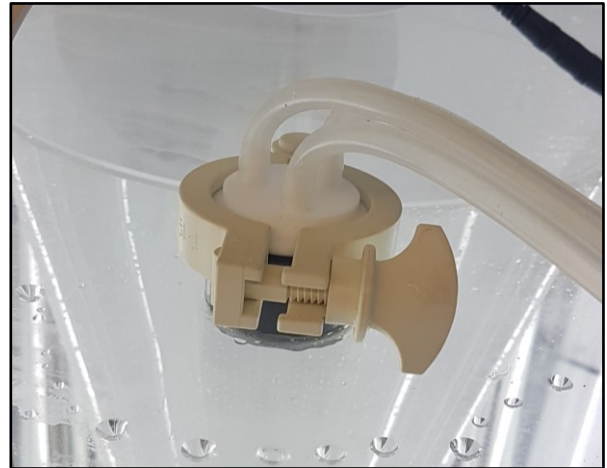
1. Remove the 3 capsule micron filters (air inlet, air vent, water inlet) and associated tubing & QDCs from the tank's barbs. The air vent triclamp gasket is autoclavable.



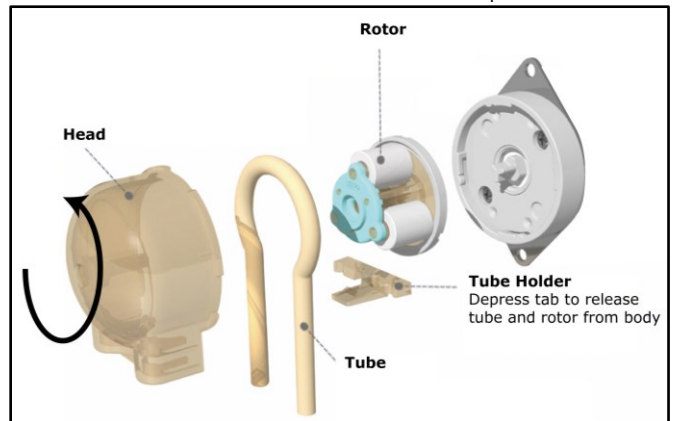
2. Remove the Air Bleed Line including silicone tube, and Check Valve.



3. Remove nutrient addition triclamp, and associated gaskets, tubing and filters.

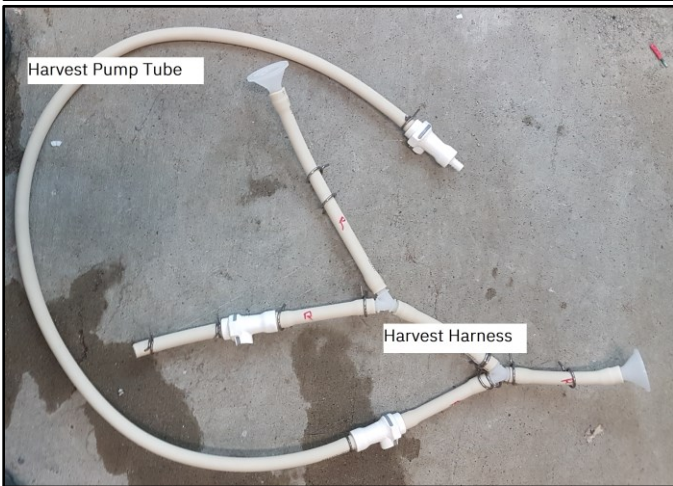
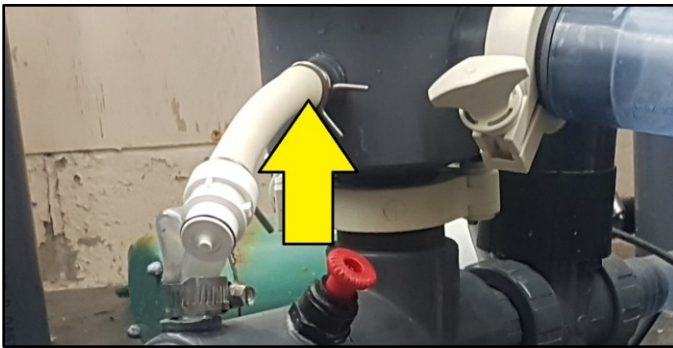


4. Rotate nutrient pump assembly counterclockwise to separate from Motor. Depress Tube Holder Tab gently and slide back away from Head (do not lose tube holder). Remove tubing by gently pulling away from Head while keeping rotor roughly in place. nutrient tubing from nutrient pumps. Only tubing is autoclavable. Do not autoclave other parts.



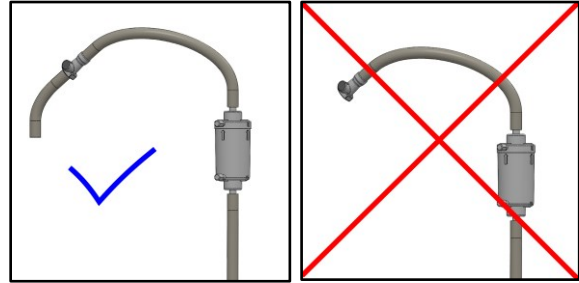


- Remove the Manifold Harvest QDC and Connect it to the Harvest Harness.



- Ensure steam can flow freely through all tubing and to both sides of filters to avoid damaging filter membranes. All QDCs should be connected for

autoclaving. Pour out any residual water.



- Place tinfoil over the ends of all tubing to maintain sterility post autoclaving upon transport and reassembly onto the PBR. The tubing does **not** need to be disassembled for autoclaving. Triclamps gaskets **are** autoclavable if desired. Positioning the spring clamps where they would be around the barbs makes for simpler reassembly and gives the tinfoil something to hold onto.
- Place all parts in an autoclavable bag and autoclave on a plastics cycle (20-30 min, 121°C, 15 psi / 103 kPa). Exceeding this time or temperature decreases filter and tubing life. [Read filter documents \(https://drive.google.com/open?id=0ByGBhpbgn-DxQk1IR2c0enpQeIE\)](https://drive.google.com/open?id=0ByGBhpbgn-DxQk1IR2c0enpQeIE) before autoclaving. **NEVER** autoclave pH triclamp or OD sensor.
- After autoclaving, seal autoclavable bag to avoid contamination when transporting to PBR. Keep tinfoil covering tube ends until **directly** before reassembling PBR.
- When reassembling components onto the PBR, spray mating faces, barbs and QDCs with 70% alcohol. Pay careful attention to follow sterile procedure.
- Place tubes onto barbs first, then adjust clamps around all barbs after to secure tubing. It is recommended to start from the top with the air inlet and work down reconnecting components to develop positive pressure inside the PBR.

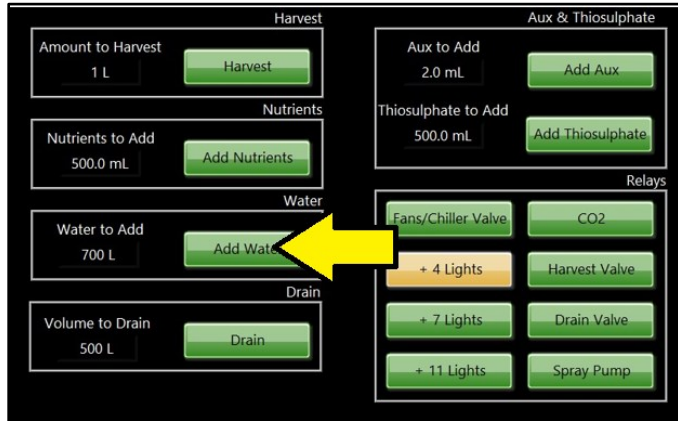
Chlorine Sterilization

1. [Add fresh water](#) up to heat exchanger (35 L).
2. [Add](#) 70 mL of 12% sodium hypochlorite liquid chlorine bleach to 35 L of water in the tank. If using different percentage of sodium hypochlorite adjust volume accordingly. (i.e., 6% requires 140 mL total, or 4 mL/L). It is very important to get the right concentration to ensure proper sterilization.
3. Spray Pump Check List:
 - Water in PBR
 - Spray Pump Inlet is connected to manifold
 - Drain Tee Manifold is secured to PBR Manifold and Spray Pump
 - Spray Pump is secure
 - Air line is connected to the Top (not the manifold)
 - Drain Valve is closed
 - Air Bleed is connected, directed to waste, and can vent freely
 - Lid is sealed (wingnuts tight, tubing and triclamp ports connected)
 - QDC on Harvest Line is disconnected
4. Run Spray Pump for 1-2 hours. Do not allow water temperature to increase above 40°C.
5. After spraying, add thio to neutralize bleach in the PBR without breaking sterility (thio can contaminate cultures – either use filtration or sterile thio).
 - a. Ensure thio is fully dissolved in stock solution.
 - b. Use one of the nutrient pumps to draw thio into PBR through nutrient filter.
 - c. Flush 200 mL of DI water through the nutrient filter. Do not mix thio with nutrients; it may precipitate and clog filter.
6. Run Spray Pump for 15 minutes to ensure neutralization.
7. Once Spray Pump stops, open Drain Valve.
8. Close Drain Valve once lower plumbing drains.
9. Clean pH probe assembly, pH probe and OD sensor with alcohol.

Final Rinse and Reassembly

It is recommended to rinse the PBR with filtered seawater to ensure bleach and thio are washed clean.

1. Set volume to 35 and press Add Water (L) to add 35 L of water through PBR's filters.

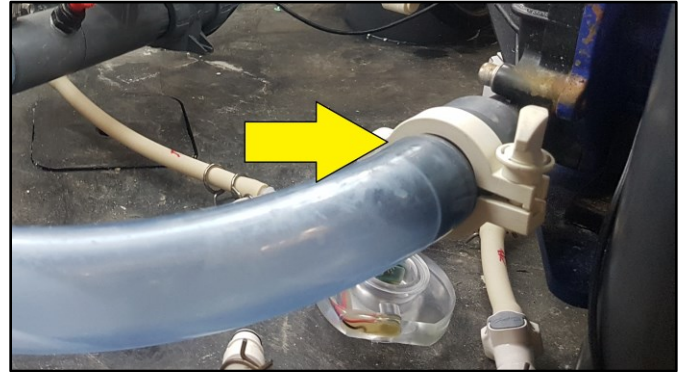


2. Spray Pump Check List:

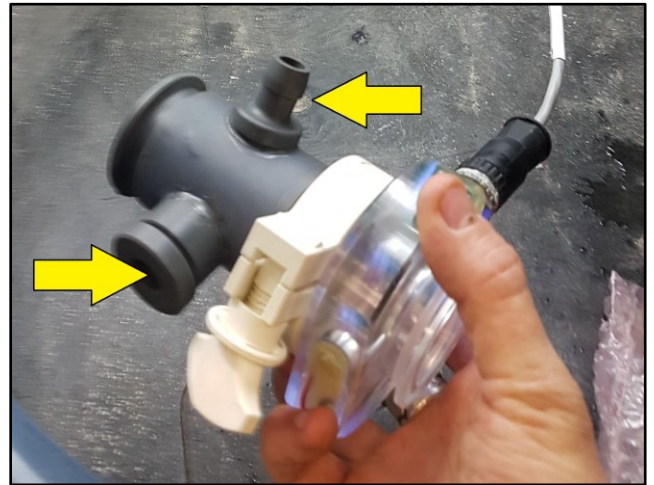
- Water in PBR
- Spray Pump Inlet is connected to manifold
- Drain Tee Manifold is secured to PBR Manifold and Spray Pump
- Spray Pump is secure
- Air line is connected to the Top (not the manifold)
- Drain Valve is closed
- Air Bleed is connected, directed to waste, and can vent freely
- Lid is sealed (wingnuts tight, tubing and triclamp ports connected)
- QDC on Harvest Line is disconnected

3. Run Spray Pump for 15 minutes.
4. Close drain valve **immediately** as plumbing empties.
5. Increase airflow into PBR to establish positive pressure (for inserting the pH Probe Triclamp).
6. Loosen Spray Pump wingnuts so it can disconnect from Manifold.

7. Disconnect Spray Pump Outlet triclamp with silicone gasket in it.



8. Use the **silicone** gasket to connect OD sensor to pH triclamp. Ensure pH probe will be pointed forward for easier assembly.

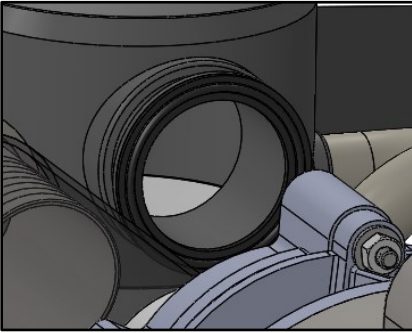


9. Disconnect Drain tee Triclamp from bottom of manifold (connected to drain tee) and use that **silicone** gasket to connect the autoclaved barb adapter to the OD sensor.



Industrial™ Plankton

10. Use thio (1 mL / mL of 12% sodium hypochlorite) to neutralize chlorine soaking pH probe and spray with alcohol to sterilize internal surfaces of pH Triclamp and OD assembly prior to reassembly.
11. With lots of 70% alcohol spray, unclamp Spray Pump Intake tube from Manifold and pump and pull it away. Keep O-ring on manifold.



12. Spray more alcohol on the incoming pH/OD sensor Triclamp assembly, Triclamp Gasket, **swiftly** place both the pH triclamp **and** gasket onto manifold to seal PBR.

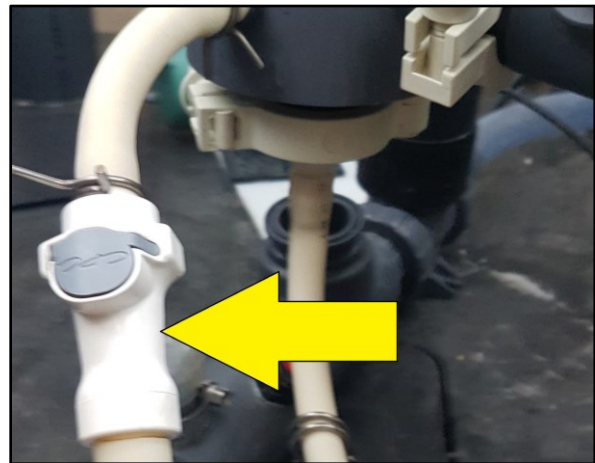


13. Ensure pH probe tip points **down** or it will not read consistently (pH Triclamp can be rotated before clamping)
14. Holding pH triclamp against manifold, to seal the PBR, place triclamp over and tighten to secure above assembly to manifold for culturing.

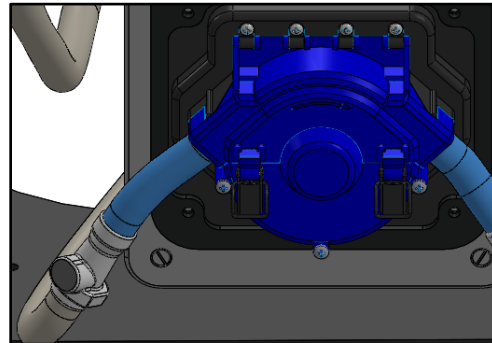
15. In the same manner, connect the barbed adapter to the manifold.



16. Connect the Harvest Harness's fQDC to the Manifold's mQDC.



17. Connect Automated Harvest Line to Harvest Harness and route through Harvest Pump. Ensure the tubing is firmly inserted into the rollers (behind black tabs) to avoid damage to tubing and pump.

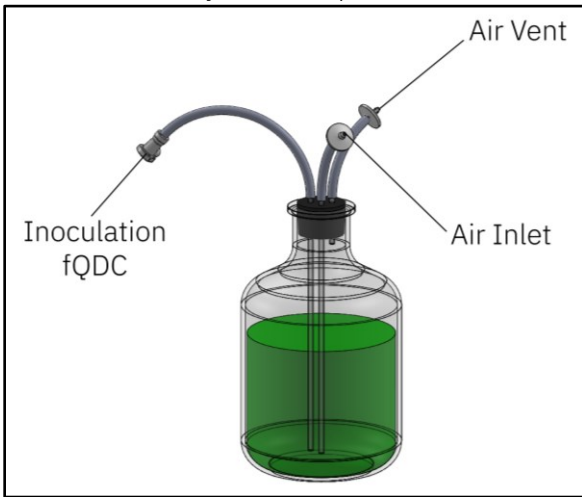


**Install this tubing backwards if using the Harvest pump for inoculation.

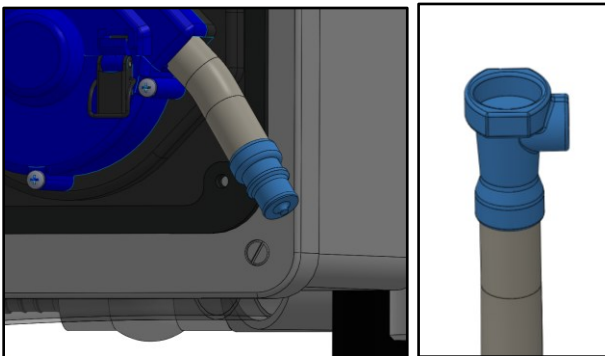
18. Disconnect Air Inlet Line from the Positive Pressure Port in the lid and connect to pH triclamp's Air Inlet.

Inoculation

- For biosecure inoculation, carboys should be equipped with fQDCs and 0.2 µm air filters. Prepare carboy(s) in advance with supplied 3/8" barbed fQDCs. Air replacing inoculum in the carboy, as it is pumped into the PBR should be filtered to maintain sterility with 0.2 µm filters.



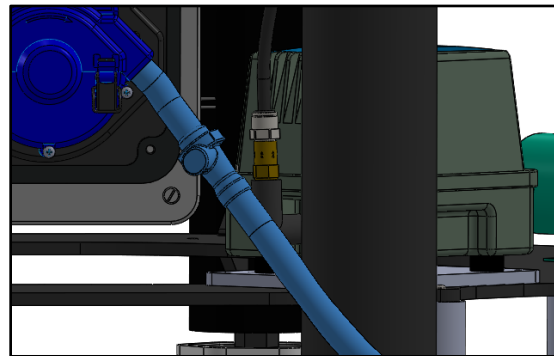
- Set Add Water and Add Nutrients values on the on manual controls screen and add them to the PBR. For a 20 L inoculum we recommend 200 L of water and 100 mL of nutrients (using Proline / Kent ect concentrated f/2 formulation).
- Ensure pH and temperature are acceptable for the inoculum prior to proceeding.
- With Harvest Tubing **backward** through Harvest Pump clean inoculant line's QDCs and Automated Harvest Line QDCs with alcohol, then connect.



- Ensure tubes are not kinked.
- On manual control screen, press Harvest Valve. Ensure inoculant carboy does not develop a vacuum. If necessary, stop Harvest Pump intermittently to allow air to pass through 0.2 µm filters. Do not allow air to enter carboy without passing through the filter.



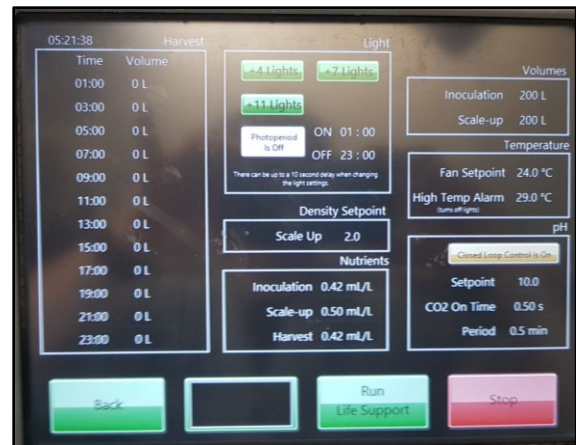
- Press Stop or Harvest Valve to stop Harvest Pump once inoculum is in PBR. **Do not** draw debris from inoculum into PBR.
- Disconnect QDCs between inoculum carboy and Harvest Pump
- Re-route Automated Harvest Line the harvesting direction through the Harvest Pump and connect harvest line extension.



Scale-Up

The PBR can automatically add the Scale Up Volume of water and the proportional Scale Up (mL/L) Nutrient Addition Rate when the Relative Density **exceeds** the Scale Up Density. This incrementally scales up the culture diluting it with media once it reaches the Scale Up Density until it reaches the Max Tank Volume. There must be at least 50 L of water in the PBR before it will scale up automatically and there must be a non-zero number in the scale up volume. These parameters are controlled on the culture setting page.

1. Set the desired Scale Up Nutrient Addition Rate.
This many mL's of **each** nutrient will be added for each liter of water added. (0.5 mL / L recommended)
2. Set desired Scale Up Volume (200 L recommended)
3. Set desired Scale Up Density. Suggested density depends on the species grown and desired results. The PBR will add the Scale Up Volume and the Scale Up (mL/L) Nutrient Addition Rate each time this density is reached.



Harvest: Semi-Continuous

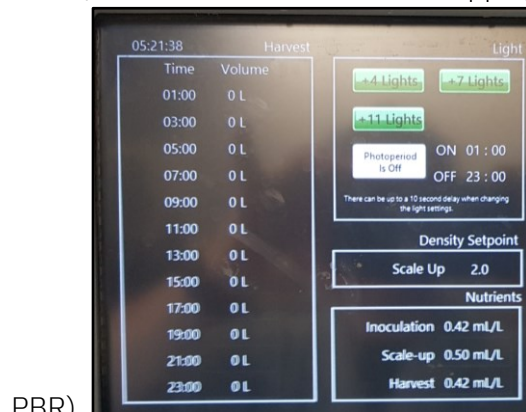
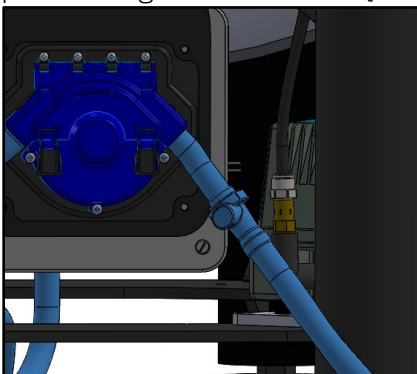
The PBR can be scheduled to automatically harvest 12 times per day from the Automated Harvest Line and refill. The PBR will automatically refill to the Max Tank Volume along with the corresponding Scale Up (mL/L) value.

To initiate automatic refilling:

- The water level must be lower than 50 L below the Max Volume to automatically add water.
- The current Relative Density must **exceed** Scale Up Density.

If the total harvest volume per day is too high it will overdilute the culture and **density will drop**.

1. Ensure Automated Harvest Line Extension is attached to Automated Harvest Line. Flow will not pass through disconnected QDCs.
2. Add Harvest Times and Harvest Volumes in the Culture Settings Page.
3. Set the desired harvest (mL/L) Nutrient Addition Rate (to be added with the water topping up the

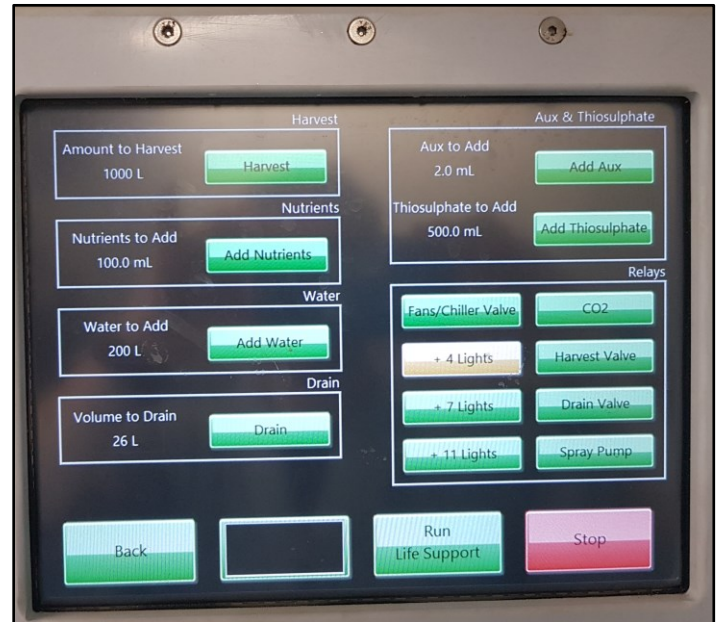


PBR).

Harvest: Manual

The Harvest Pump can be used to take samples, harvest discrete volumes, or empty the PBR.

The PBR will refill automatically if it is set to semi-continuously Scale Up or Harvest, or continuously Scale Up or Harvest.

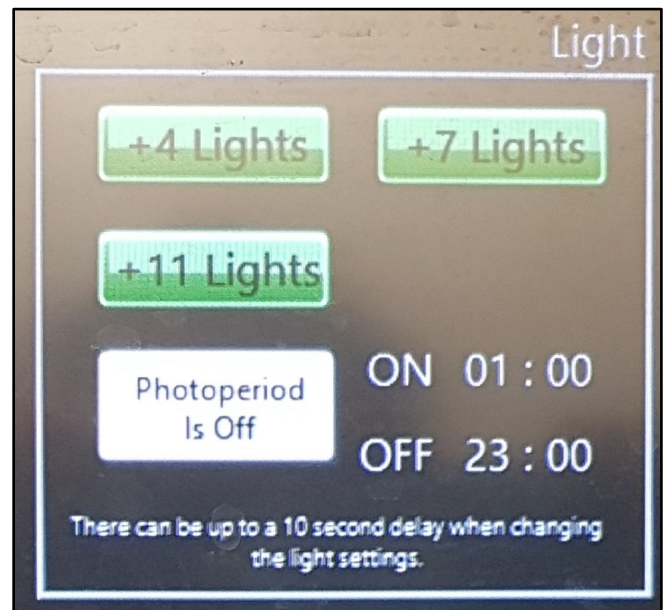


Light

There are 22 T5 High Output florescent lights and one LED on the PBR. These are tuned on in discrete packs:

- 4 T5 HO
- 7 T5 HO + LED
- 11 T5 HO

A Photoperiod can be selected with the Photoperiod button on the culture settings screen. This is used to schedule the time lights should turn on and off over 24 hours. Values entered are for time of day in the 24-hour clock, not number of hours on and off (i.e., this will turn on at 1 AM and off at 11 PM –on for 20 hr/day). It is highlighted yellow and says “Photoperiod is on” when it is on.

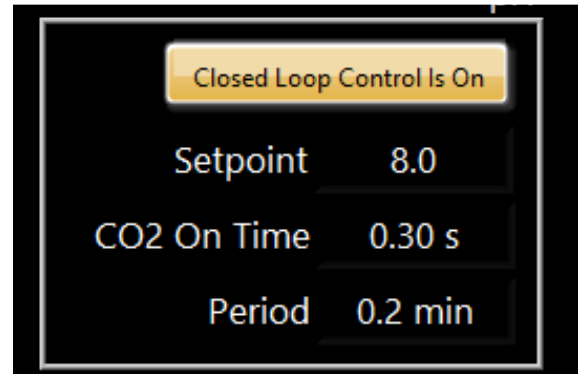


pH Control

To adjust the pH go to the culture settings page, change the pH setpoint to a desired pH Setpoint and press enter.

The PBR automatically adds CO₂ to the incoming air through the Air Inlet Filter to maintain a stable pH. CO₂ on time should be 0.50 s and period should be 0.75 minutes.

Ensure that Closed Loop Control is On



Air & Circulation

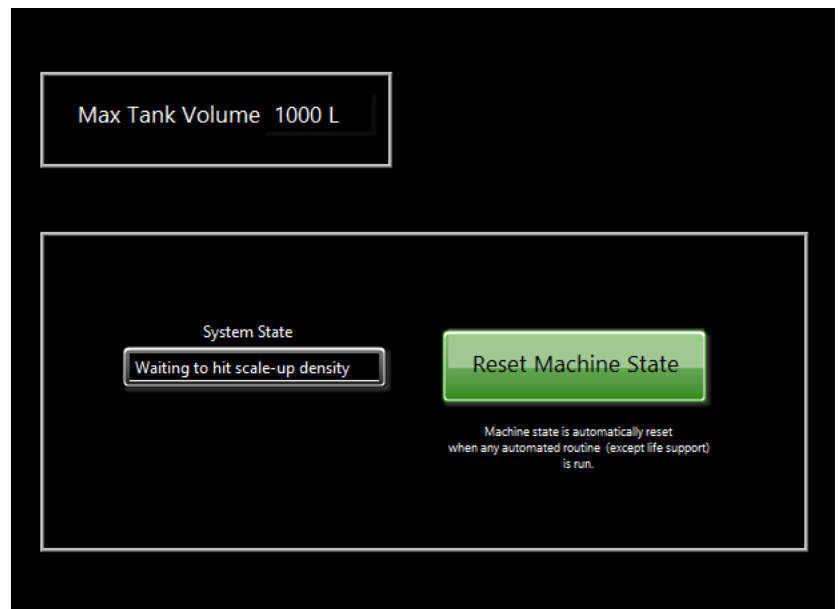
Set the desired air flow using the Air Flow Valve on the left of the control box above the air filter.

Too much aeration may cause shear stress on cells, while not enough can promote settling. Do not shut off air flow completely for long periods of time. It will damage the air pump and culture.

Reset the machine state

If the program runs into an error state or if the scale up mode is desired, press Reset Machine State button.

Investigate any error states, before resetting the program as if the state isn't corrected before resetting it will just reoccur. Consult Industrial Plankton if necessary.



Optical Density Sensor

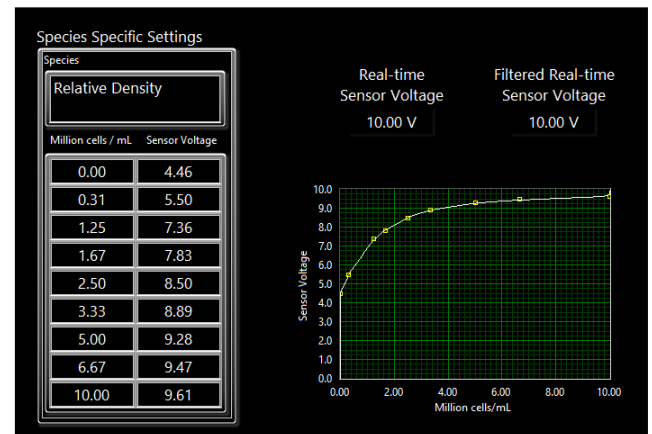
The optical density (OD) sensor is calibrated in relative density; however, multiple calibrations can be programmed in the drop-down menu for different strains of algae. The first time a new species is grown, leave the PBR in the relative density setting otherwise the PBR will be unpredictable without a calibration curve.

The Relative Density setting is used to allow the reactor to function on a 0-10 scale of density, where 0 is water and 10 is dense algae. Setting culture “set-points” in the culture settings page to 11 with a relative density calibration prevents any automated routine from happening (scale-up etc), because reading cannot exceed 10.

When calibrating the sensor If the OD sensor is reading 0.00 V with water in the sensor, it is worth trying to decrease the power to the OD sensor (lower the amperage) in the advanced settings. This will yield better resolution in the low densities of algae. Or, if water is reading above 5.5, try increasing the power to the sensor (increase the amperage). Reading for water should be between 0.01 and 5.5. By having multiple different calibration curves associated with different intensities, the OD sensor can read in a higher range.

There are two options for calibrating the OD sensor for different algae species: in-situ (while growing algae) or done ahead of time by taking the OD sensor off and using serial dilutions starting from dense algae.

1. Take 9 manual cell counts and record corresponding “Filtered Real-time Sensor Voltage” over a range of densities.
2. Once 9 pairs of data are recorded enter them, in order, into the calibration table. The program interpolates between points. A graph of the data is plotted beside the table. It should be a smooth curve and should look like the graph shown here.
3. Use data points that spans the range of densities you expect that span voltages from 0.01 - 9.99 Volts.

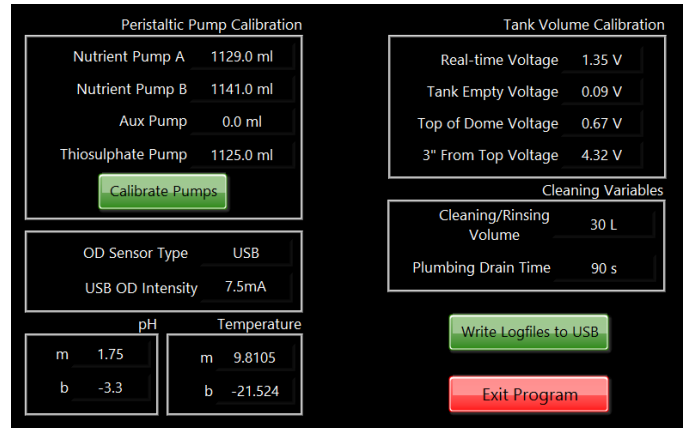


Nutrient Pump Calibration

The nutrient peristaltic (ONLY A and B) pumps can be calibrated by pressing Calibrate Pumps on this screen. They will run for 1000 seconds. Have at least a 3.5L vessel to draw from and 3 separate 1.5 L containers to dispense into. The tubing should be disconnected from the PBR and put into the bottles for this. After it runs, measure the volume dispensed by each and put these values into the respective boxes.

For the middle (silicate) pump, calibration is tied to the Nutrient A pump and will be proportional to that pump. Adjust the concentration of your silicate solution accordingly. For example, if the volume dispensed by A is 1129 mL and the middle pump (previously silicate) doses 1051 ml, the silicate pump will run at 1051/1129 proportion. This is approximately 93% as fast as Nutrient A, so the silicate solution should be made at a concentration higher than usual to stay equal to

nutrient A. In this example the concentration should be higher so 1/93% or 1.074 times more silicate / L. If the nutrient ratio should be 100 g/L anhydrous Sodium metasilicate, this solution should be made at 107.4 g/L.



Peristaltic Pump Tube Wear

All peristaltic tubing has a limited life. Nutrient tubing should be replaced annually, and Harvest Pump Tubing should be replaced every 2-3 months. If the tube wears through, it will rupture and leak into the harvest pump causing failure.

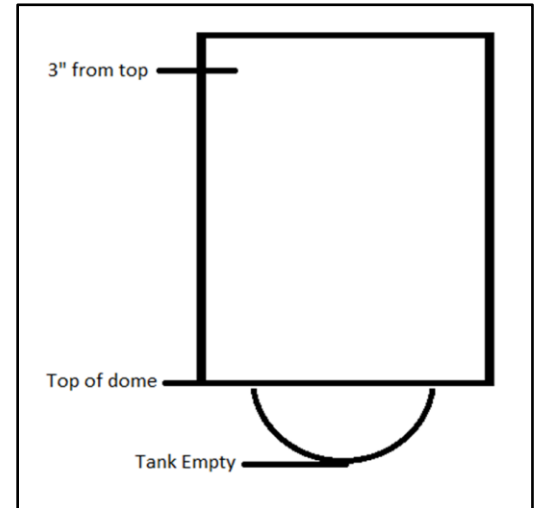
The Harvest Pump can dispense up to 7 L/min and the tubing is rated to 15 psi maximum. Backpressure on this tubing greatly decreases its viable lifetime, so replaced more frequently if backpressure is high.

Tank Volume Calibration

The volume is measured with a pressure sensor attached to the Manifold. For the volume reading to be accurate, all filters and air flow tubing must be in place on PBR (especially the Air Bleed Tube and check valve able to vent).

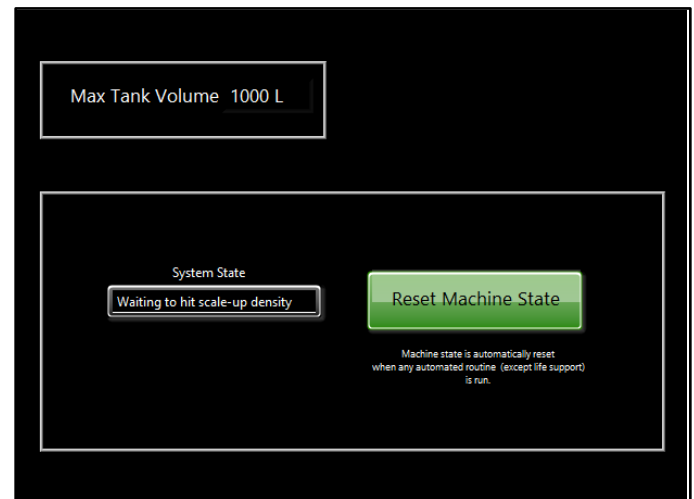
Ensure air is set at desired flow rate for culturing during calibration for accuracy. All filters and seals must be in place on the PBR. Calibrating at a different flow from what will be used to culture will result in an offset volume reading.

1. Add water to each volume calibration level
2. At each water level, enter the Current reading into the respective Volume Calibration table slot once it has stabilized.



Max Tank Volume

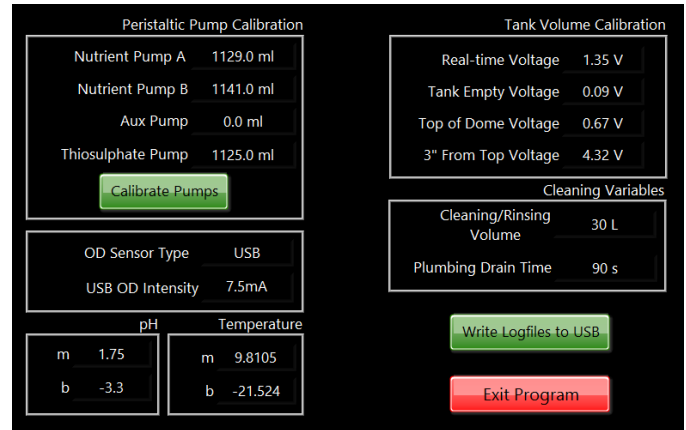
This parameter can be changed to operate the PBR at a lower volume.



Write Log Files to USB

Insert a USB drive to the USB bulkhead near the touchscreen and press Write Log Files to USB on the Advanced Settings page.

This will export all log files to the USB drive.

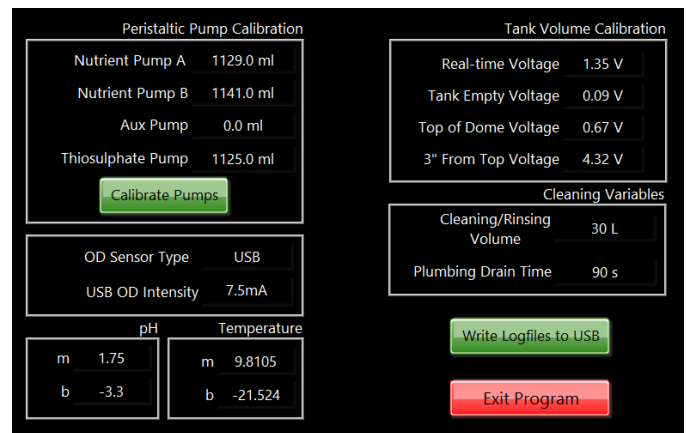


Exit Program

This button will exit the PBR Program to a Windows operating system. While in Windows, the PLC will continue to operate the PBR.

The PBR will stay at the Windows login until

- A user is selected
 - **Operator password: op**
 - This will start the PBR program.
 - **Admin password: dansarki**
 - This leads to the desktop layout of the PBR's computer
- Power is cycled (by restarting windows or unplugging the PBR).
 - This will start the PBR program upon restarting.



Set Date and Time - Windows

- 1) Exit program to Windows
- 2) Double click unlock computer (this restarts the computer into the PBR program)
- 3) Exit program again
- 4) Set the time and date using Windows interface
- 5) Enter date (YYYY MM DD)

Alarms

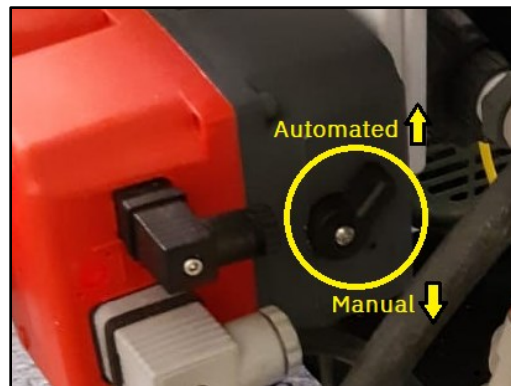
The PBR has alarms that tell you when something is wrong with it. The most common alarm is slow water addition rate. If this occurs the water inlet valve will automatically be closed, and it will display an error. To reset the system, go to the Machine Settings Page.

Code Version

Code version is found on the machine settings page.

Automated Water Inlet Valve Manual Override

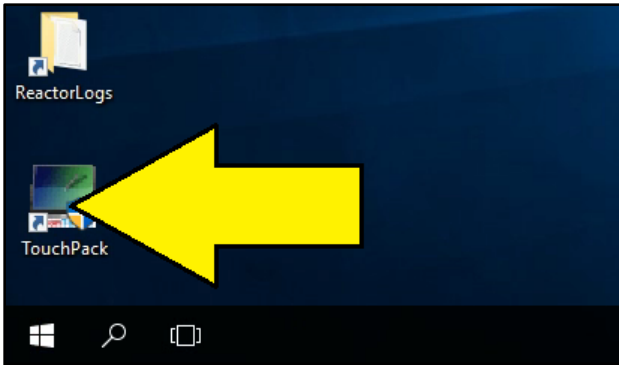
If power fails to the PBR, but not the header tank, during water addition, the Automated Water Inlet Valve will still be allowing water in. To close it, switch the valve to Manual and rotate the knob until the yellow indicator line is vertical.



Touchscreen Calibration

To reset the touchscreen calibration [Exit Program](#) to the Admin user. If the touchscreen is unresponsive use remote access or a USB mouse to get into the Admin user.

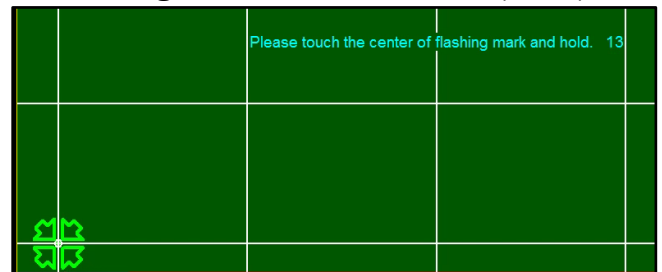
1. Open the touchscreen calibration tool from the desktop.



2. Choose 9 pts linearization.



3. Hold finger over crosshairs until prompted.



Power Loss

If the PBR loses power, the program automatically restarts when power is returned. Settings will be saved, but the graphs visibly change as data will be populated from the 10 min increments from the log file.

If a power outage caused the GFI breaker to flip, it will need to be reset.

1. With PBR unplugged, open the control box
2. Reset GFI (located in lower left side of control box, it has a white and green switch) by moving the switch toward 0 then to 1
3. Plug PBR in

Support Requests

If you'd like to submit a Support Request, please contact us (info@industrialplankton.com) and include pertinent details, your PBR code versions the log files and the PBR serial number (found on the right hand side of the control box, on the name plate).