

*Industrial*TM *PLANKTON*

PBR 100L 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** connect LED panels when the lights are powered. This damages the LEDs.
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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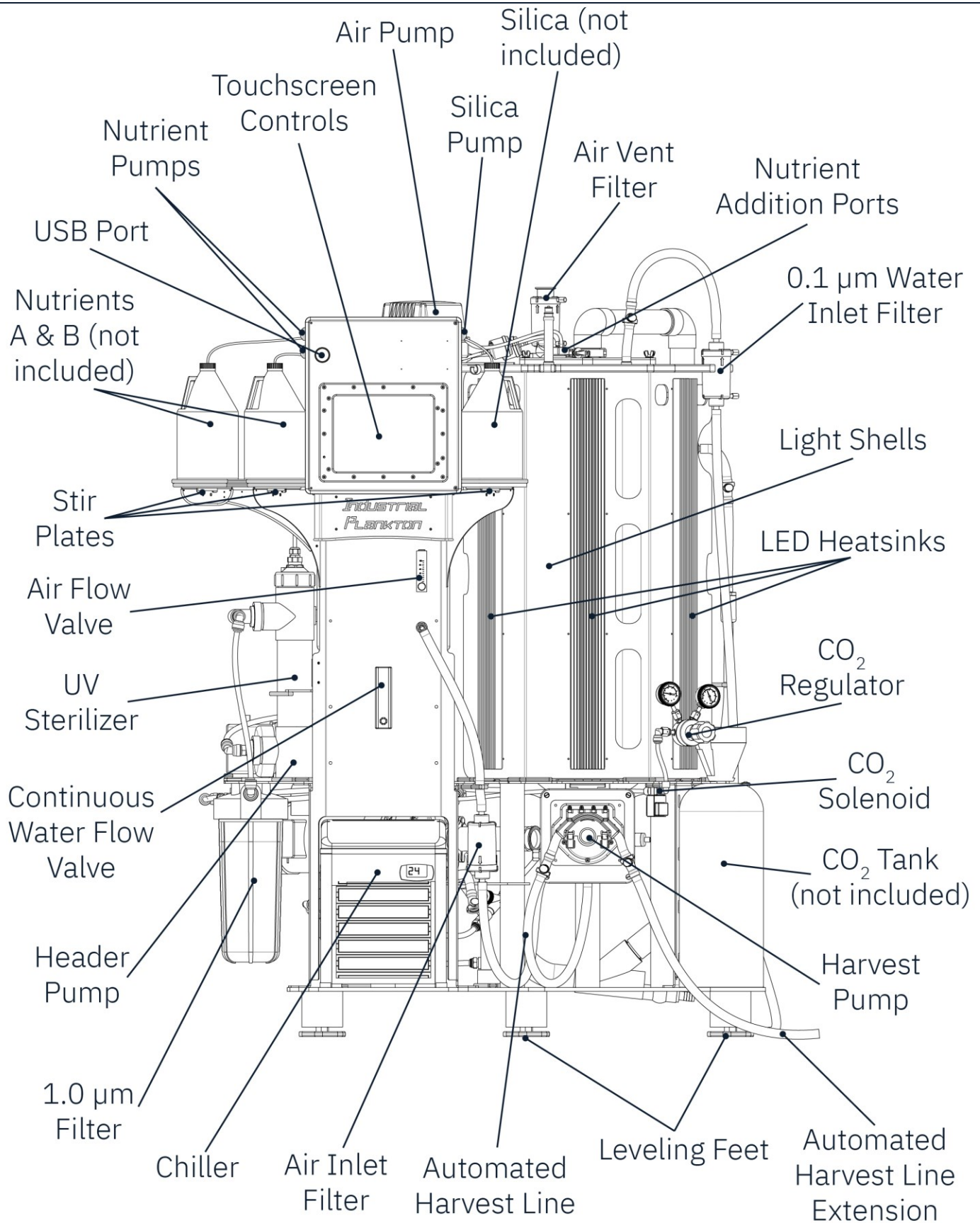
Abbreviations Used

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	Ground F ault I nterrupter
mQDC	Male autoclavable Q uick D isconnect fitting
NPT	National P ipe T hread
PBR	Phot b ioreactor
PLC	Programming L ogic C ontroller
QDC	Autoclavable Q uick D isconnect fitting
thio	Sodium t hiosulphate

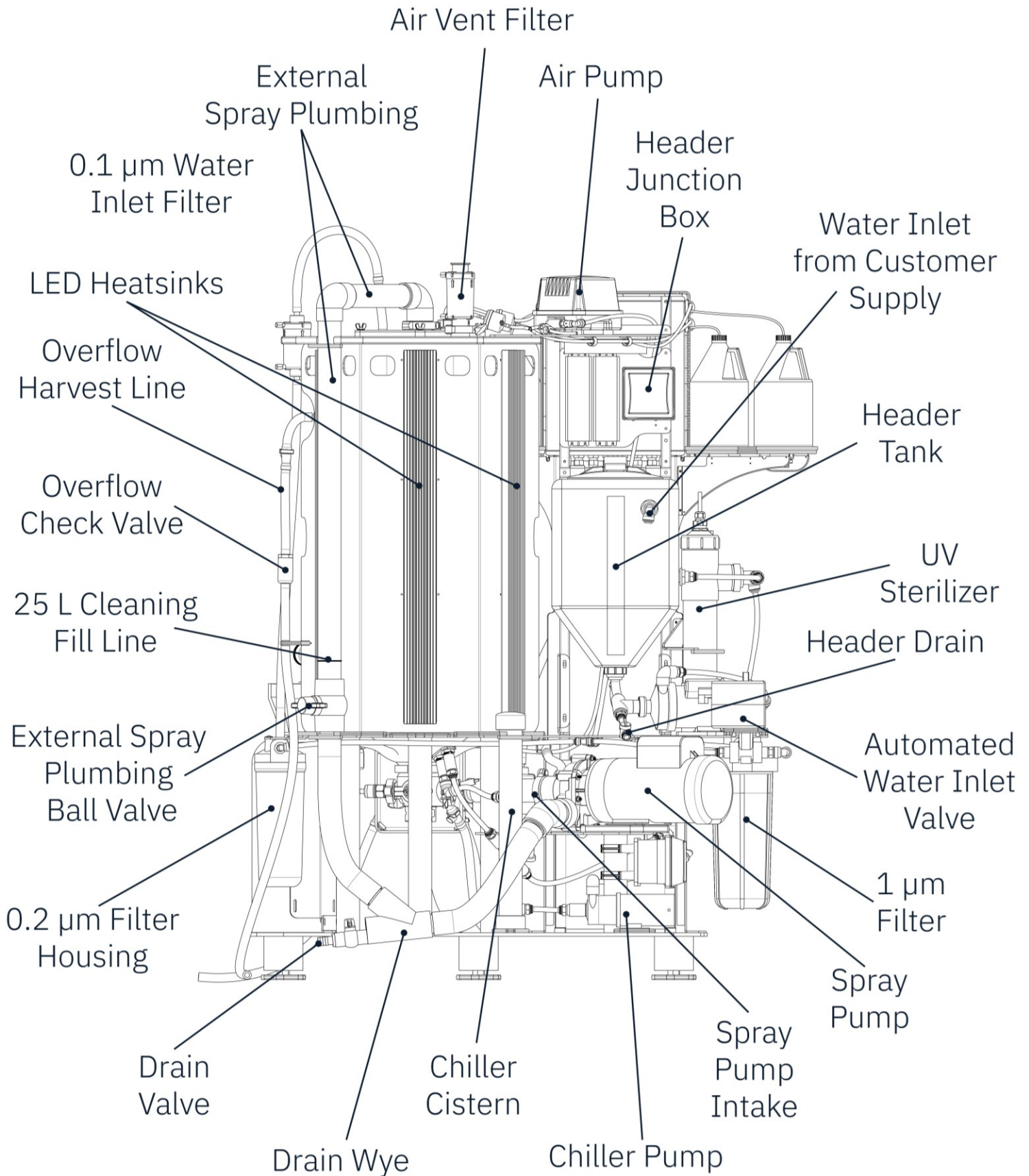
Standard Solutions Used

- 7.0 & 10.0 pH buffer / calibration solutions (4.0 optional)
- Alcohol (rubbing, ethyl, or isopropyl alcohol are all acceptable), do not exceed 30% on acrylic faces, but higher concentrations may be used for sterilizing QDCs.
- Biofilm Removal Agent (Steris CIP 100, Muriatic Acid, sodium hydroxide, EDTA)
- Bleach (4-12% sodium hypochlorite)
- Deionized water
- Sodium thiosulphate
- Compressed CO₂ gas

PBR 100L Components (Front)



PBR 100L Components (Back)



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

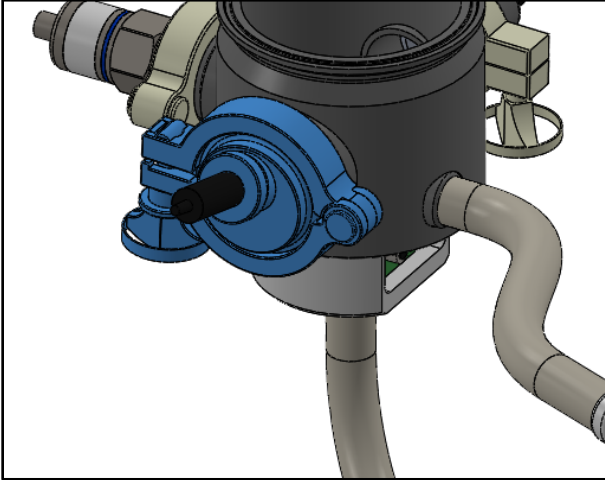
Cleaning Agent	Purpose	Recommended Concentration*	Maximum concentration*	Water
Steris CIP 100	Caustic biofilm removal	27 mL/L	35 mL/L	Fresh water
Sodium hydroxide (10% NaOH w/v)	Caustic biofilm removal	200 mL/L	250 mL/L	Fresh water
Hydrogen peroxide (34% H ₂ O ₂)	Enhanced biofilm removal	7.81 mL/L	8.00 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. Ensure PBR is filled to the Cleaning Fill Line for cleaning. For cleaning agents that require higher volumes per liter, ensure to account for the volume of cleaning agent added, for max efficacy (i.e. 7.5 L of Muriatic acid @ 33% HCl + 17.5 L of fresh water is the max concentration for a total volume of 25 L).

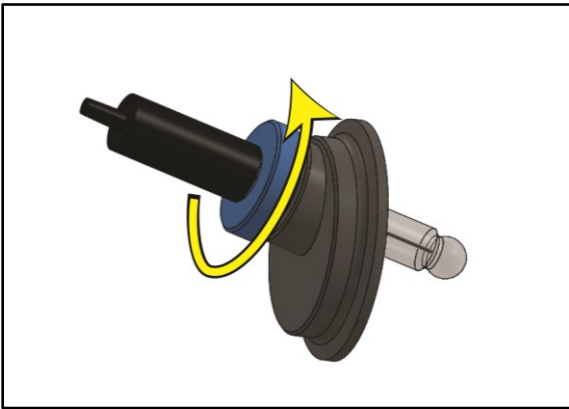
Preparation

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. Remove pH triclamp from manifold.

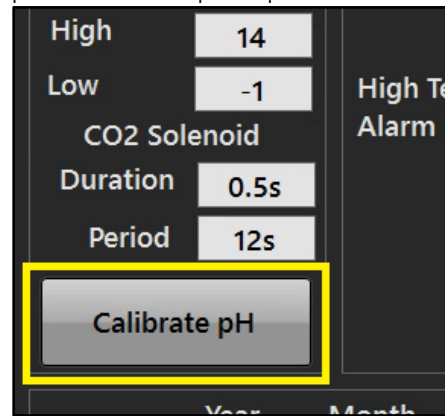


2. Loosen compression screw on pH triclamp.

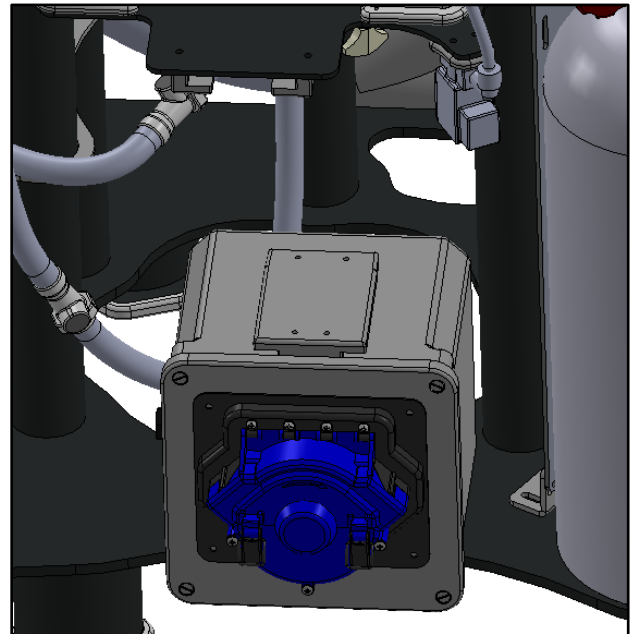


3. Remove pH probe from pH triclamp fitting.
4. Ensure pH probe BNC connection is well connected to the control box's BNC connector, Located on the right behind the Industrial Plankton logo cowling under the touchscreen.
5. Prepare 7.0 & 10.0 calibration solutions in small containers and deionized water in a spray bottle.

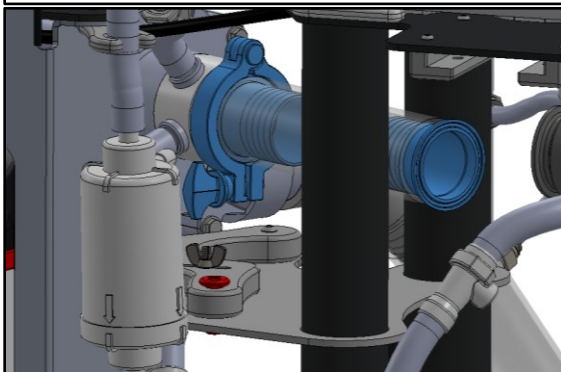
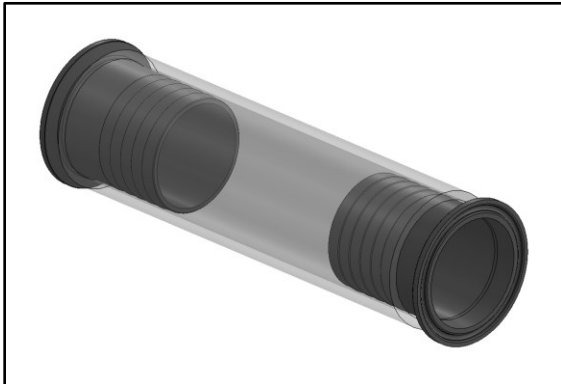
6. On the Advanced Settings screen, press Calibrate pH and follow prompts.



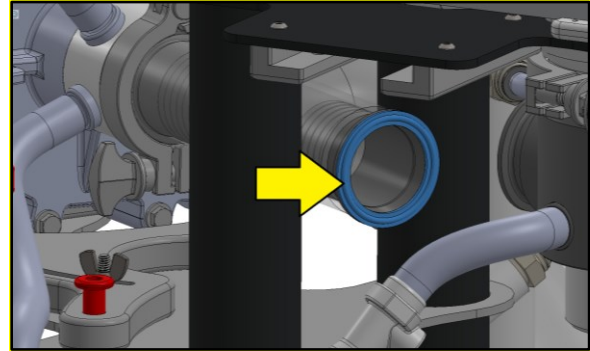
7. To make room slide the Harvest Pump forward to release it from its bracket and place it on the base.



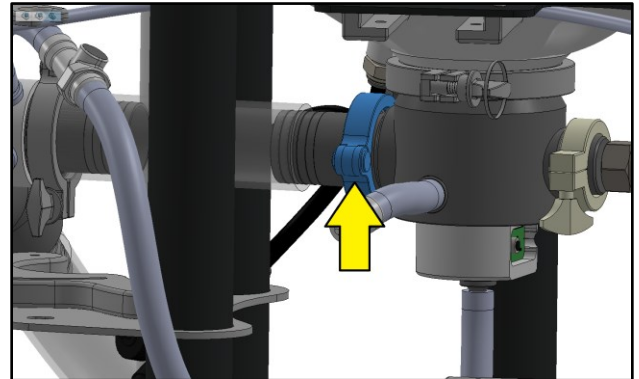
8. Attach the Spray Pump Intake Tube to the Spray Pump Intake Triclamp using triclamp gasket and clamp.



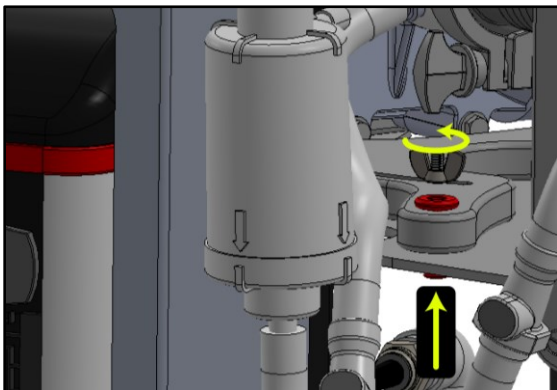
triclamp on the Manifold.



11. Tighten 2" triclamp around the mating faces. Do **not** force this connection. Too much force may damage the acrylic tank.

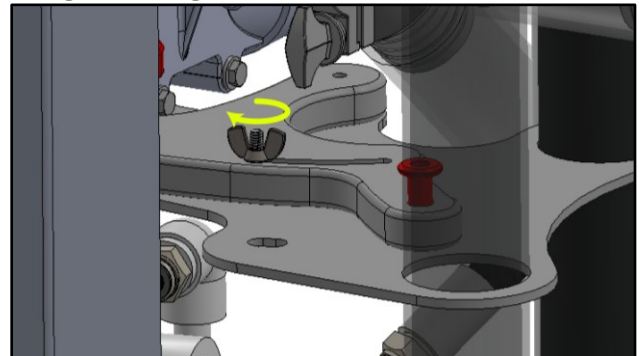


9. Loosen Spray Pump Plate wingnut and lift the red pin to allow the Spray Pump to rotate and connect to the Manifold.

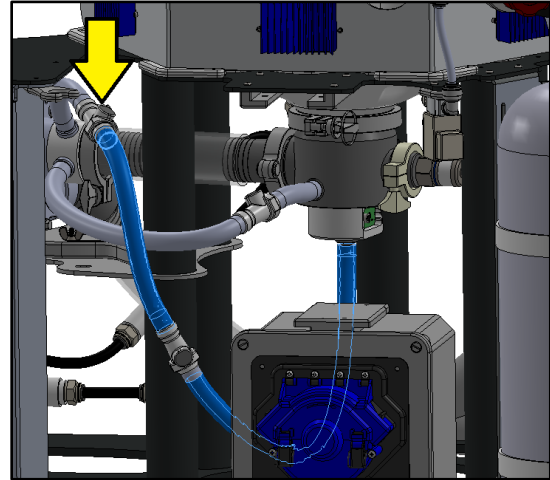
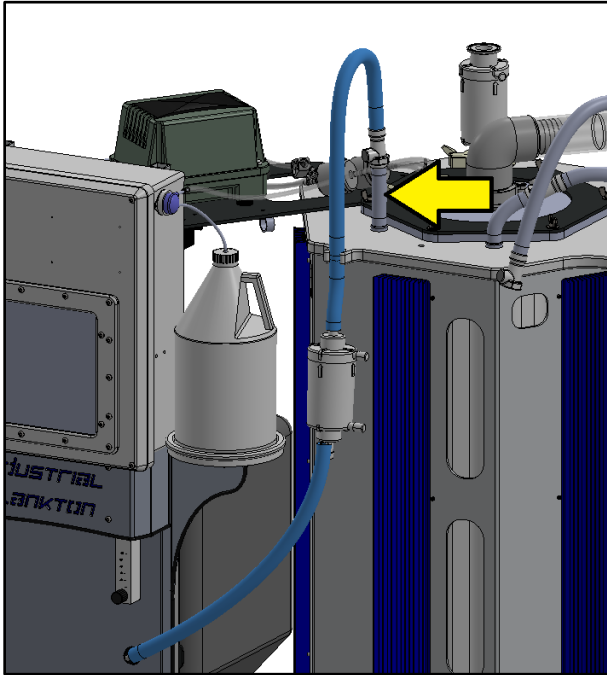


10. Place triclamp gasket onto Spray Pump Intake Tube and slowly swivel the pump to align with 2"

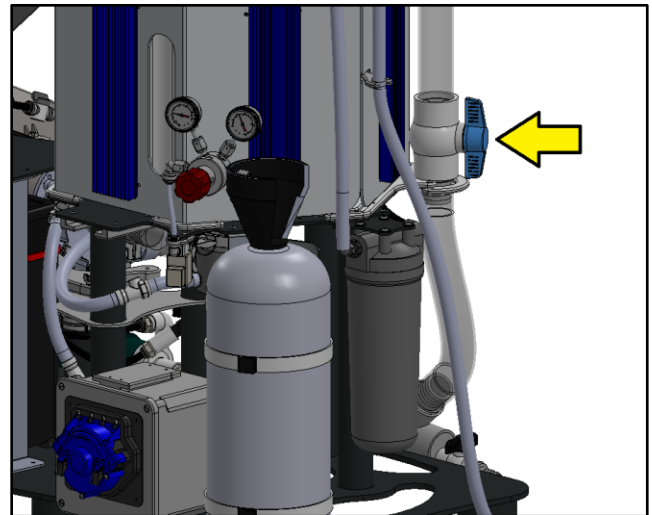
12. Retighten wingnut to secure Spray Pump.



13. Ensure air supply is connected to the Positive Pressure Port on the lid.

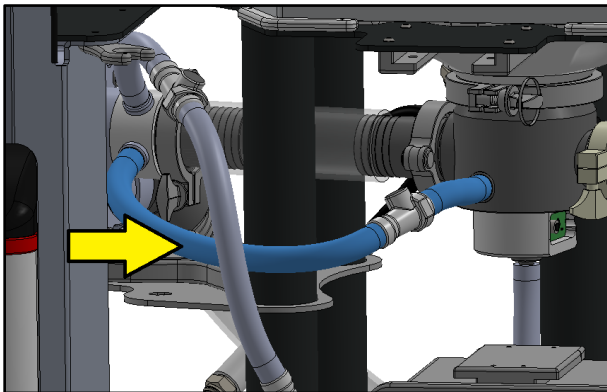


16. Open the External Spray Plumbing Ball Valve at the back of the PBR.

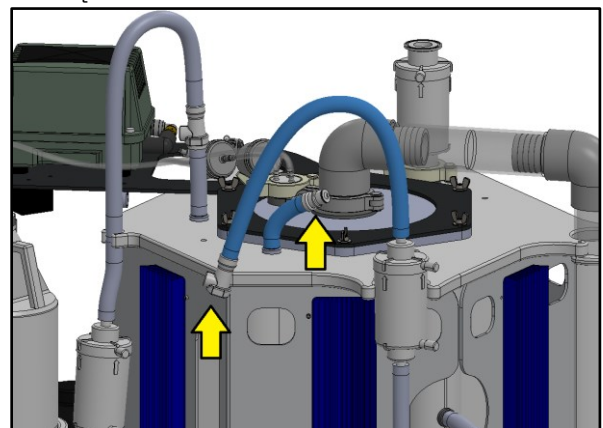


17. Disconnect the 0.1 µm Water Filter's fQDC from its mQDC

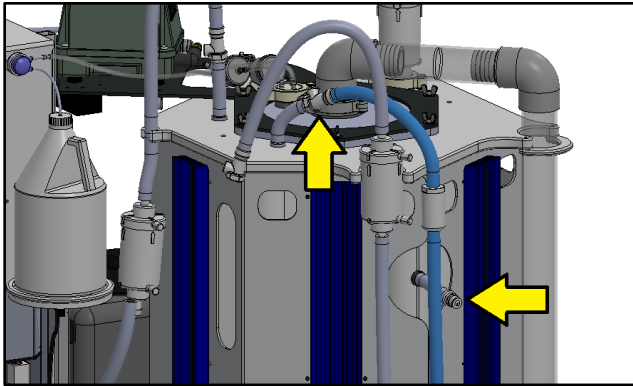
14. Connect manifold airline to Spray Pump Intake as shown.



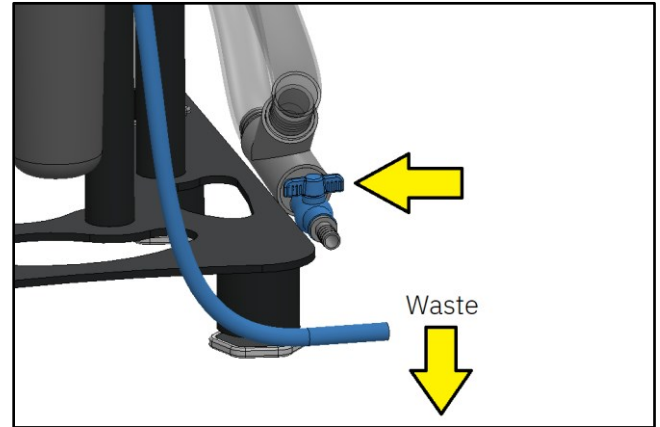
15. Unclamp Automated Harvest Line from the Harvest Pump and connect to lower tube on the Spray Pump Intake.



18. Disconnect the Overflow Harvest Line from the Overflow Port in the sidewall and connect it to the 0.1 µm filter's mQDC in the lid.



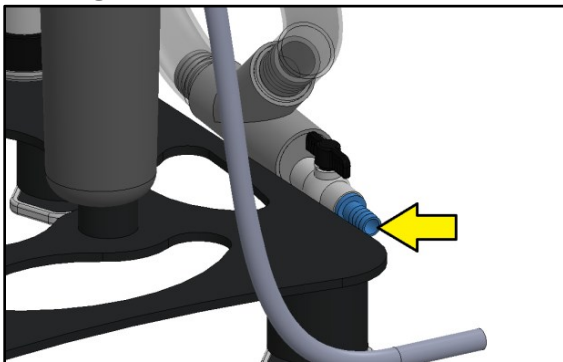
19. Direct the other end of the Overflow Harvest Line to **waste** (Do not submerge or route tube uphill), and ensure drain is closed.



Fresh Water Addition

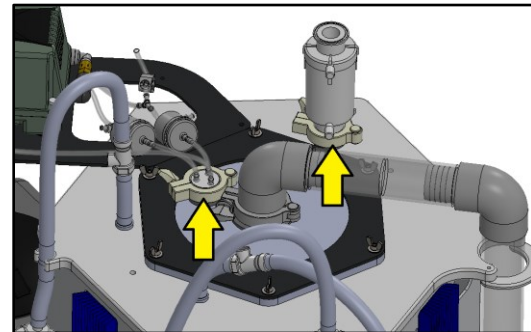
Freshwater can be added to the PBR by directing a hose into the PBR and bypassing the filter chain. This saves filter life. Ensure your freshwater supply is free of particulate. Use one of the following options to fill the PBR with Fresh Water.

1. Add water by connecting a faucet to the drain valve. The Drain Line can serve a dual purpose for this. Ensure the drain valve is open prior to opening the faucet.

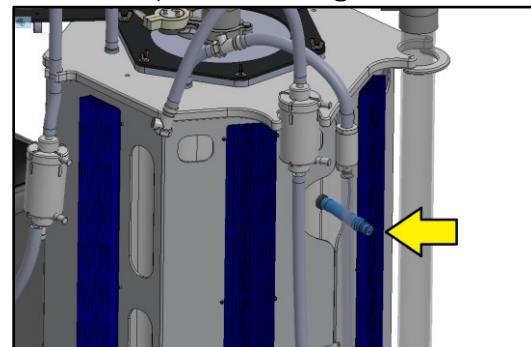


2. Disconnect a one of the top's triclamps fittings and place a hose through it. Ensure the end of the hose doesn't scratch the inside of the PBR and

will not fall out while filling.



3. Equip a freshwater hose with a fQDC and connect it to the mQDC indicated below. QDCs are only rated to 35 psi, so ensure the QDC pair is connected prior to turning on water.



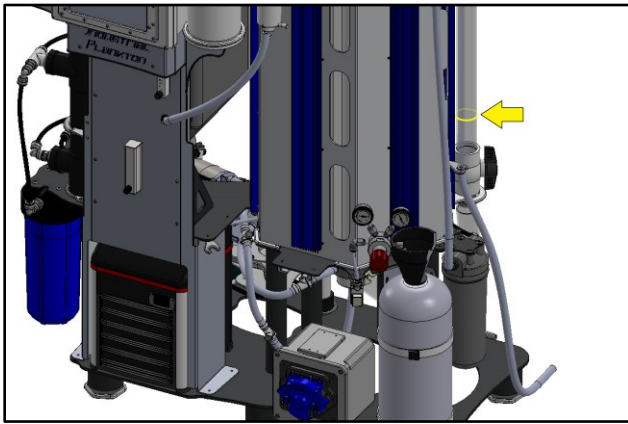
Rinse

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

The Overflow 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 Cancel and add more water.

1. [Add fresh water](#) to the fill line located on the back plumbing of the reactor (25 L).



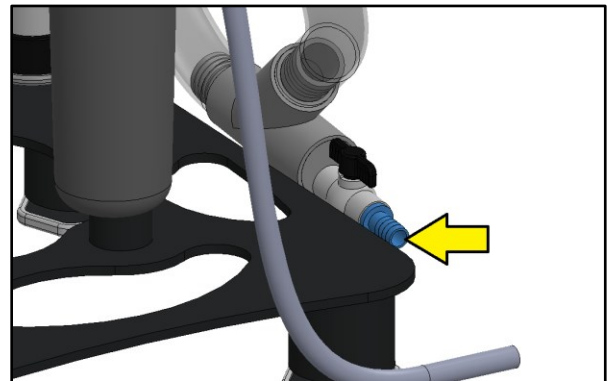
4. Spray Pump will stop when timer has elapsed, or press Cancel to stop Spray Pump at any time.



2. Spray Pump Check List:

- Water in PBR is up to Fill Line
- Spray Pump is connected to the manifold
- Spray Pump wingnut is tight
- External Spray Plumbing Ball Valve (behind PBR) is open
- Air line is connected to the lid (not the manifold)
- Drain Valve is closed
- Overflow Harvest Line is connected, directed to waste, and can vent freely
- Lid is sealed (wingnuts tight, tubing and triclamp ports connected)
- External Spray Plumbing triclamp is connected securely to lid
- Air Inlet Line on manifold is connected to Spray Pump Intake QDC
- Automated Harvest Line is connected to Spray Pump Intake QDC

5. Open Drain Valve.



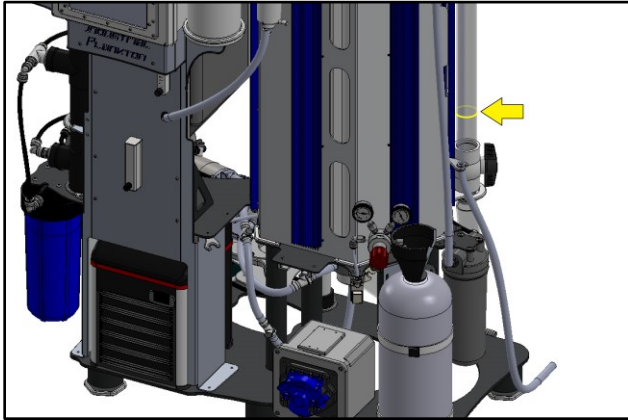
6. Close Drain Valve once the PBR has drained.
7. Continue to [Biofilm Removal](#) or [Autoclaving](#)

3. Set spray pump timer for 10-60 minutes and press Spray Pump to start rinsing.

Biofilm Removal

Rinse tank between using different cleaning chemicals as combining cleaning agents is dangerous. **Never** combine Bleach and acid.

1. [Add fresh water](#) to the fill line located on the External Spray Plumbing of the reactor (25 L).



2. [Add Cleaning Agent](#) for Biofilm removal. Use concentration indicated in table: [Cleaning and Sterilizing overview](#).
3. Spray Pump Check List:
 - Water in PBR is up to Fill Line
 - Spray Pump is connected to the manifold
 - Spray Pump wingnut is tight
 - External Spray Plumbing Ball Valve (behind PBR) is open
 - Air line is connected to the lid (not the manifold)
 - Drain Valve is closed
 - Overflow Harvest Line is connected, directed to waste, and can vent freely
 - Lid is sealed (wingnuts tight, tubing and triclamp ports connected)
 - External Spray Plumbing triclamp is connected securely to lid
 - Air Inlet Line on manifold is connected to Spray Pump Intake QDC
 - Automated Harvest Line is connected to Spray Pump Intake QDC
 - Automated Harvest Line is connected to Spray Pump Intake QDC.

4. Set Spray pump timer to desired time and press Spray Pump. Two to four (2-4) hours should be enough time to remove biofilm at proper concentration.



5. In the manual controls, press Spray Pump to start Spray cycle. Do not allow water temperature to increase above 40°C. The pump will automatically stop if the water temperature exceeds 50°C.
6. Spray Pump will stop when timer has elapsed, or press Cancel to stop Spray Pump at any time.



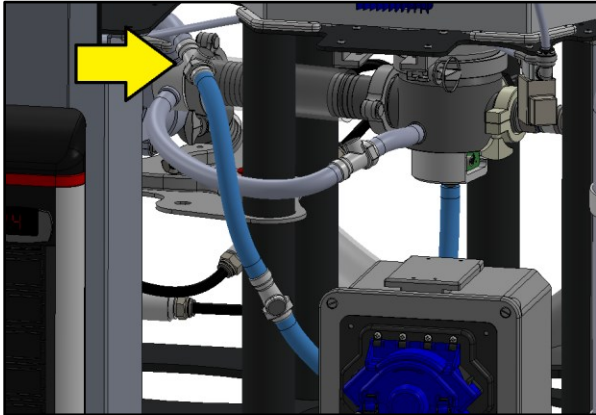
7. Inspect tank for any residual biofilm. If any biofilm remains, increase concentration of removal agent to max concentration, or complete the following steps and start Biofilm Removal with a different cleaning agent. Chlorine will not penetrate biofilm, so it is important to remove all biofilm prior to moving to autoclaving.
8. Open Drain Valve.
9. Close Drain Valve once the PBR has drained.
10. [Rinse](#) the PBR following previous directions.

Add Cleaning Agent

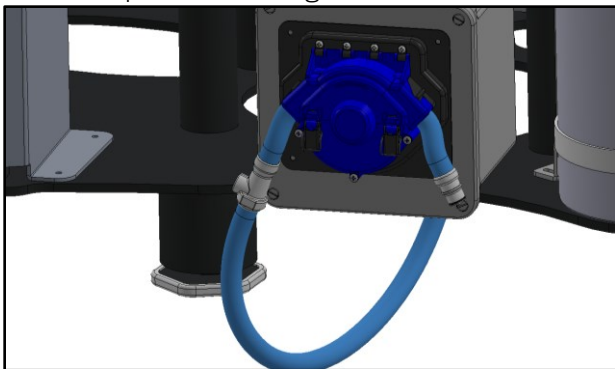
To add cleaning agents, pour them through the lid's triclamp ports, or use the following steps to draw them into the reactor by running the harvest pump in reverse using the Inoculation function. **Wear personal protective equipment when handling chemicals.**

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

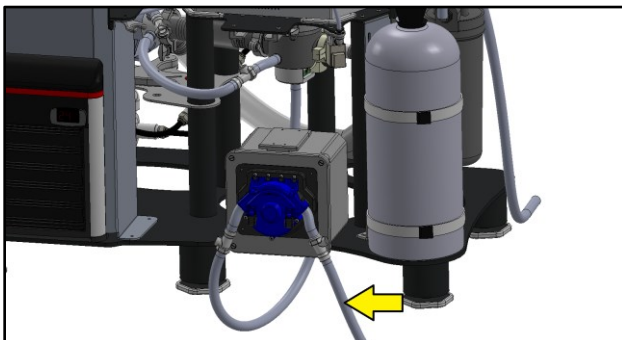
1. Disconnect Automated Harvest Pump Line's mQDC from Spray Pump Intake.



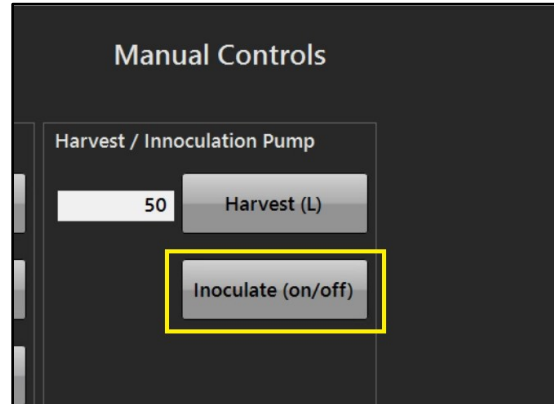
2. Place Automated Harvest Line through Harvest Pump. Ensure tube is completely pushed into rollers to prevent damage.



3. Connect Automated Harvest Line Extension to Automated Harvest Line and

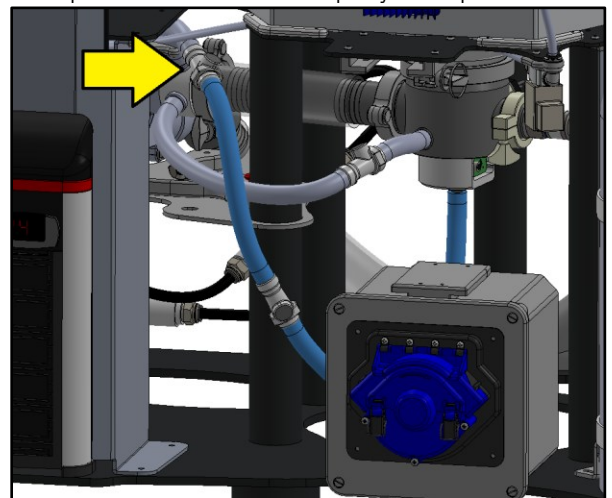


4. Draw in a measured volume of cleaning agent by pressing Inoculate (in Manual Controls).



5. After cleaning agents have been added, press Cancel to stop pump.

6. Disconnect the Automated Harvest Line Extension fQDC, remove tubing from Harvest Pump and reconnect to Spray Pump Intake.

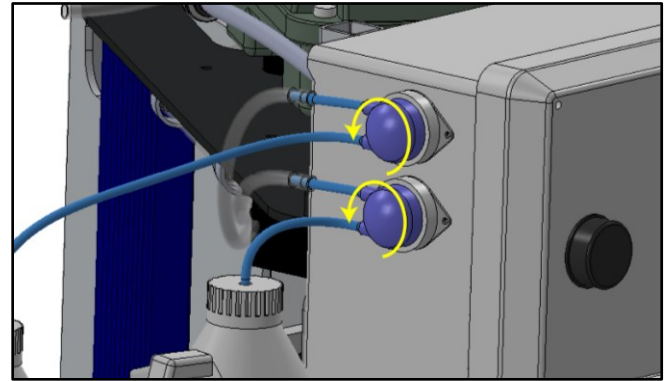
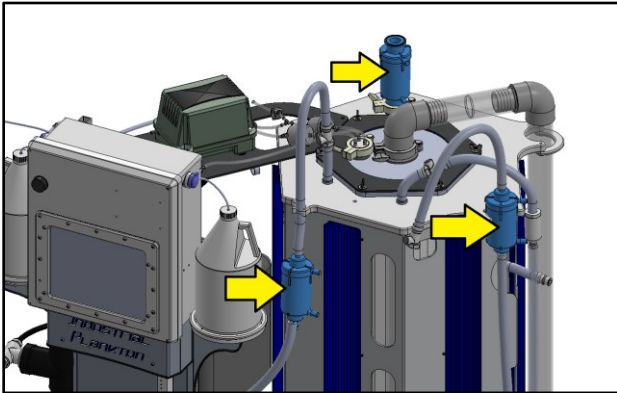


7. Return to [Biofilm Removal](#) or [Chlorine Sterilization](#).

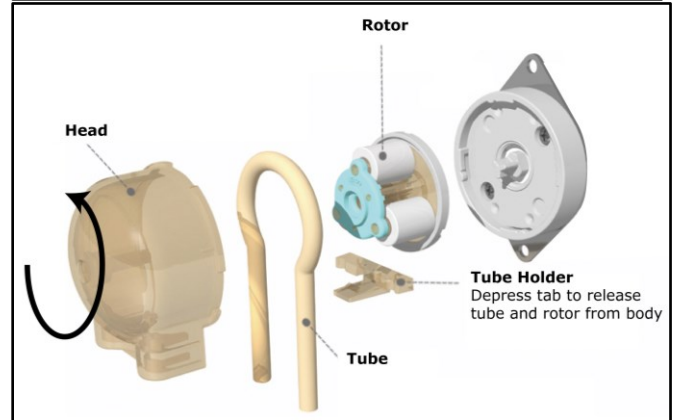
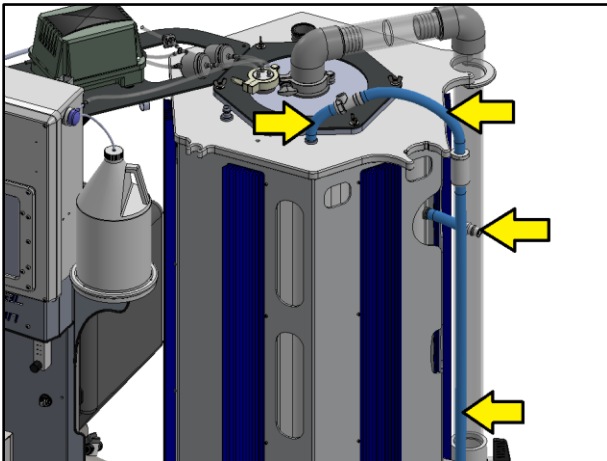
Autoclave

Ensure no biofilm remains 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 three micron filter capsules (air inlet, air vent, water inlet) and associated 1/2" tubing & QDCs from the tank's barbs. The air vent gasket is autoclavable.

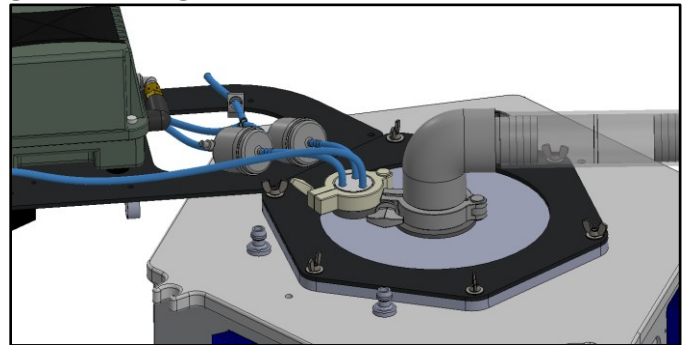


2. Remove the Overflow Harvest Line including all silicone tube, the QDC pair, and the Overflow Check Valve.

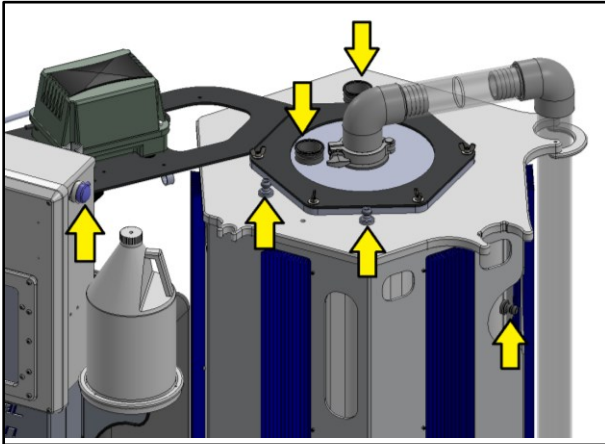


3. Rotate Nutrient Pumps counterclockwise to separate from their motors. Depress Tube Holder Tab gently and slide back away from Head (do not lose tube holder). Remove tubing by gently pulling away from Head while keeping rotor loosely in place. Only tubing is autoclavable. Do not autoclave the other parts.

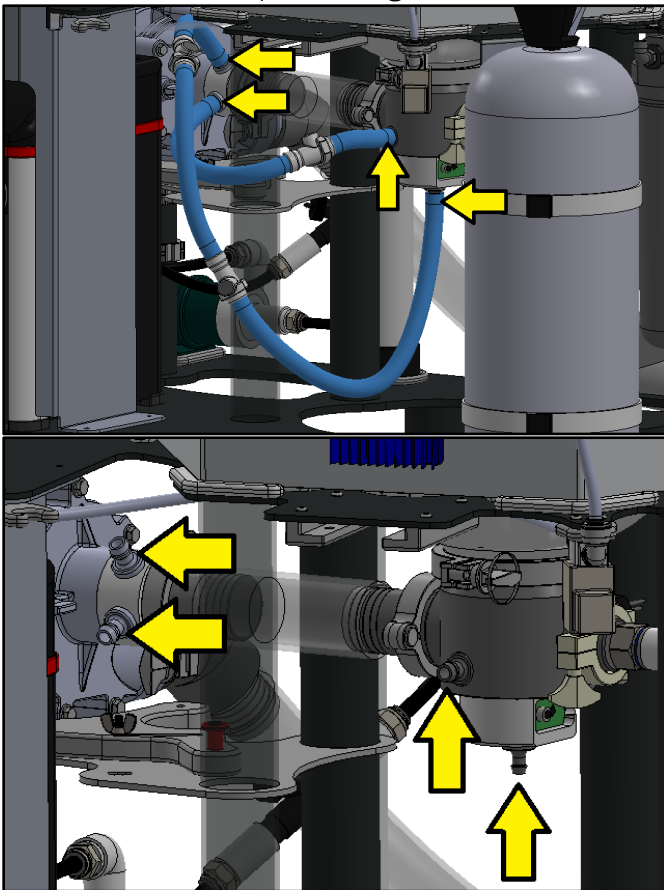
4. Remove nutrient addition triclamp, associated gasket, tubing and filters.



5. The top should look like this when everything has been removed properly.

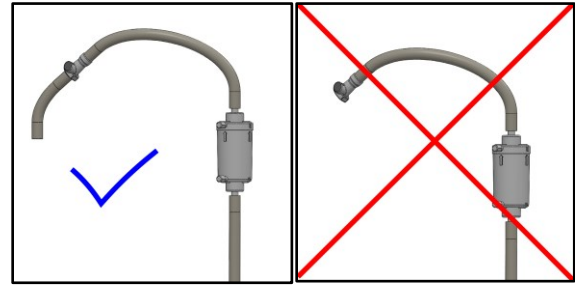


6. Completely remove the Automated Harvest Line and Air Inlet Line from Spray Pump Intake and Manifold barbs. Keep QDCs together.

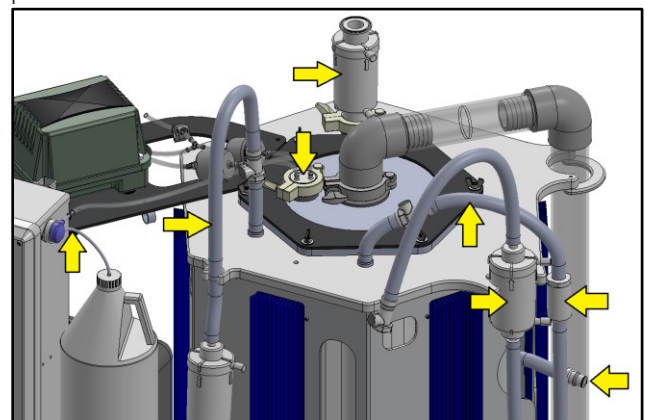


7. Ensure steam can flow freely through all tubing and to both sides of filters to avoid damaging filter membranes. Ensure to connect the 0.1 µm water filter's fQDC to the stub of tube with a mQDC from the Overflow Harvest Line. All QDC pairs need be

connected for autoclaving. Pour out any residual water in filters or tubes.



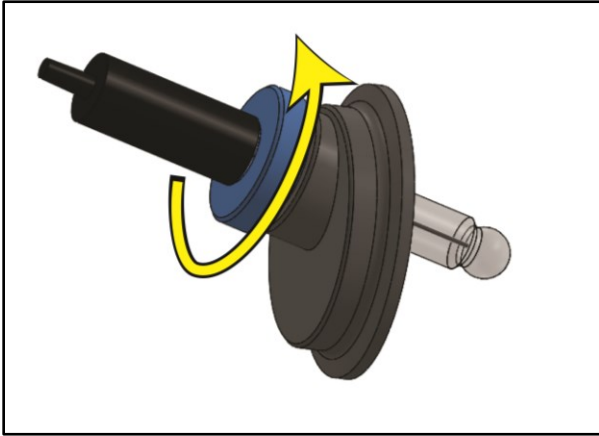
8. Place all parts in an autoclavable bag and autoclave in a plastics cycle (20-30 min, 121°C, 15 psi / 103 kPa). Exceeding this time or temperature decreases filter and tubing life. [Read filter documents \(https://drive.google.com/open?id=0ByGBhpbgn-DxQk1lR2c0enpQeIE\)](https://drive.google.com/open?id=0ByGBhpbgn-DxQk1lR2c0enpQeIE) before autoclaving.
9. After autoclaving, seal autoclavable bag to avoid contamination when transporting to PBR. Disconnecting QDC pairs seals off the individual QDCs, ensuring sterility between them and filters.
10. When reassembling components onto the PBR, spray mating faces, barbs and QDCs with 70% alcohol. Pay careful attention to follow sterile procedure.



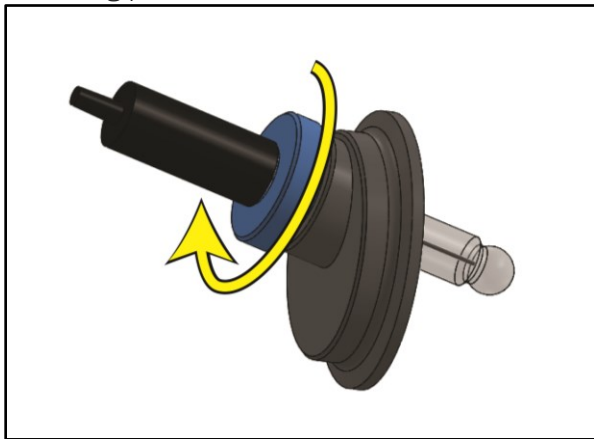
11. Place tubes onto barbs first, then adjust clamps around all barbs to secure tubing.
12. Reconnect QDCs, sterilizing mating faces with alcohol.

Chlorine Sterilization

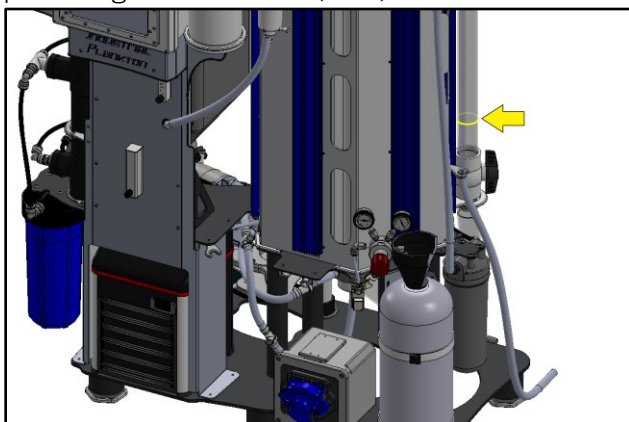
1. Disassemble pH Triclamp Assembly and remove any visible biofilm. Do not use biofilm removal agents on pH probe; it can be damaged.



2. Reassemble pH Triclamp Assembly and leave to soak in a 2 mL/L bleach solution during the following process.



3. [Add fresh water](#) to the fill line located on the back plumbing of the reactor (25 L).



4. [Add](#) 50 mL of 12% sodium hypochlorite liquid chlorine bleach to 25 L of water in the tank. If using different percentage of sodium hypochlorite adjust volume accordingly. (i.e., 6% requires 100 mL total, or 4 mL/L). It is very important to get the right concentration to ensure proper sterilization.

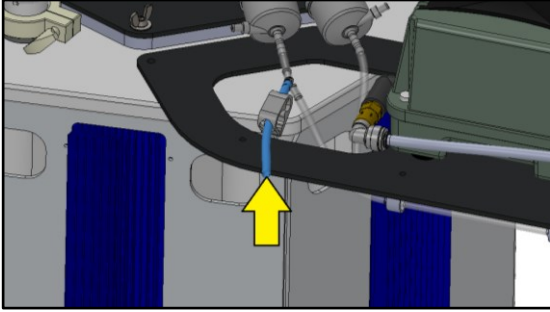
5. Spray Pump Check List:

- Water in PBR is up to Fill Line
- Spray Pump is connected to the manifold
- Spray Pump wingnut is tight
- External Spray Plumbing Ball Valve (behind PBR) is open
- Air line is connected to the lid (not the manifold)
- Drain Valve is closed
- Overflow Harvest Line is connected, directed to waste, and can vent freely
- Lid is sealed (wingnuts tight, tubing and triclamp ports connected)
- External Spray Plumbing triclamp is connected securely to lid
- Air Inlet Line on manifold is connected to Spray Pump Intake QDC
- Automated Harvest Line is connected to Spray Pump Intake QDC
- Automated Harvest Line is connected to Spray Pump Intake QDC.

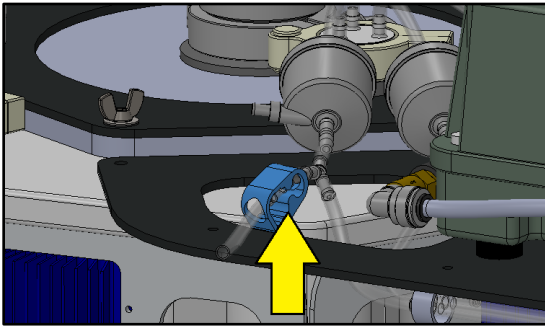
6. Run Spray Pump for 1-2 hours. Do not allow water temperature to increase above 40°C. The pump will automatically stop if the water temperature exceeds 50°C.

7. After spraying, add sodium thiosulphate to neutralize bleach in the PBR.
 - a. Ensure thio is fully dissolved in stock solution.
 - b. Using syringe to add 1 mL of thio per mL of 12% bleach used (i.e., 50 mL of thio for 50 mL of 12% bleach used previously).

- c. Connect syringe to tubing with barbed "Y" attached to its nutrient filter.



- d. Release tube clamp and add thio with syringe.



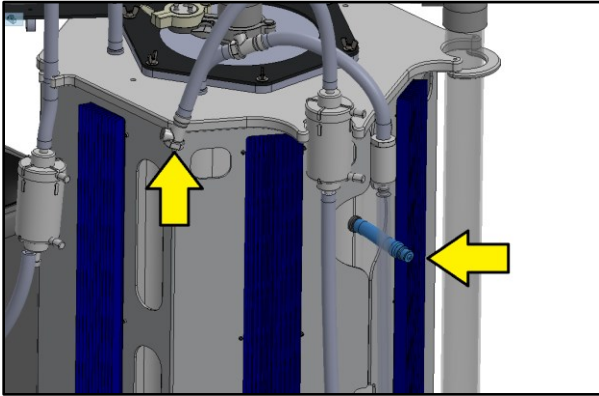
- e. Flush 100 mL of DI Water through the nutrient filter with the syringe (to push thio into the PBR). Do not mix thio with nutrients: it may precipitate and clog the filter.

8. Run Spray Pump for 15 minutes to ensure chlorine neutralization.
9. Once Spray Pump stops, open Drain Valve and drain tank.
10. Close Drain Valve once lower plumbing drains.

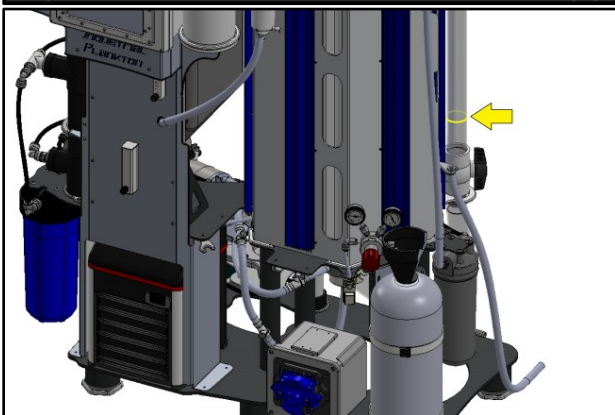
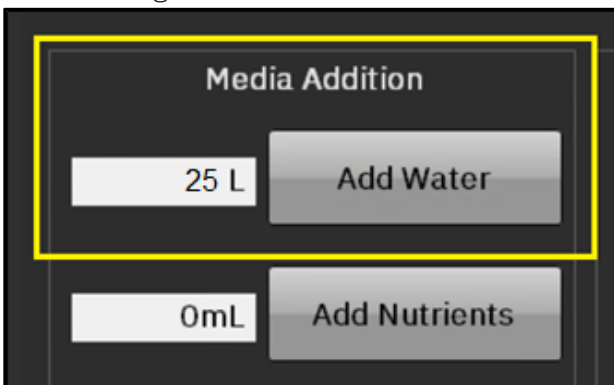
Final Rinse and Reassembly

We recommend a rinse with filtered seawater to ensure bleach and thio are washed free of the PBR.

1. Connect the 0.1 μm Water Inlet fQDC to the sidewall mQDC for the Overflow Harvest Line.



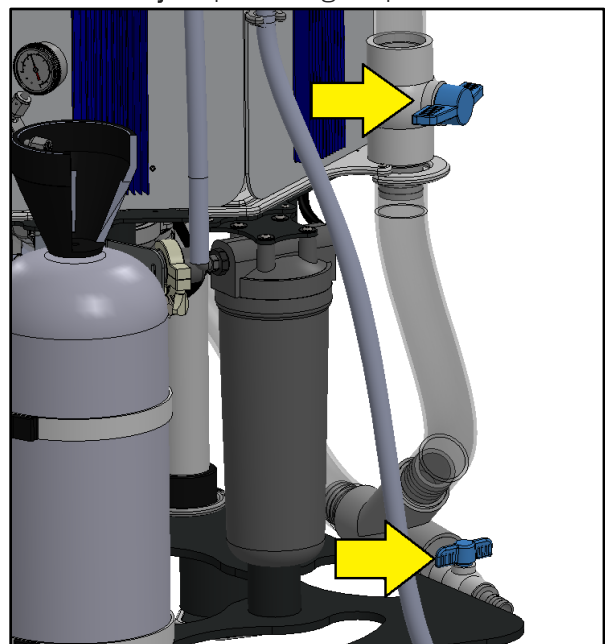
2. Set volume and press Add Water (L) to add 25 L of water through PBR's filters.



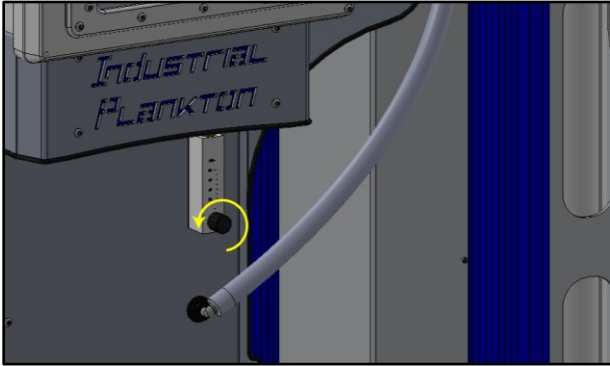
3. Spray Pump Check List:
 - Water in PBR is up to Fill Line
 - Spray Pump is connected to the manifold
 - Spray Pump wingnut is tight

- External Spray Plumbing Ball Valve (behind PBR) is open
- Air line is connected to the lid (not the manifold)
- Drain Valve is closed
- Overflow Harvest Line is connected, directed to waste, and can vent freely
- Lid is sealed (wingnuts tight, tubing and triclamp ports connected)
- External Spray Plumbing triclamp is connected securely to lid
- Air Inlet Line on manifold is connected to Spray Pump Intake QDC
- Automated Harvest Line is connected to Spray Pump Intake QDC
- Automated Harvest Line is connected to Spray Pump Intake QDC

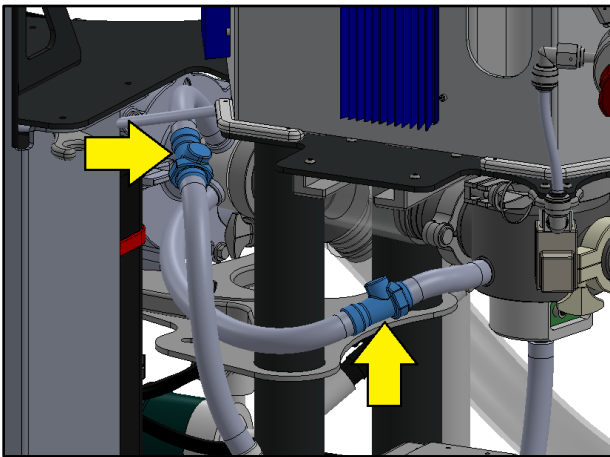
4. Run Spray Pump for 15 minutes.
5. Once Spray Pump stops, Open Drain Valve.
6. Close drain valve and external spray post ball valve **immediately** as plumbing empties.



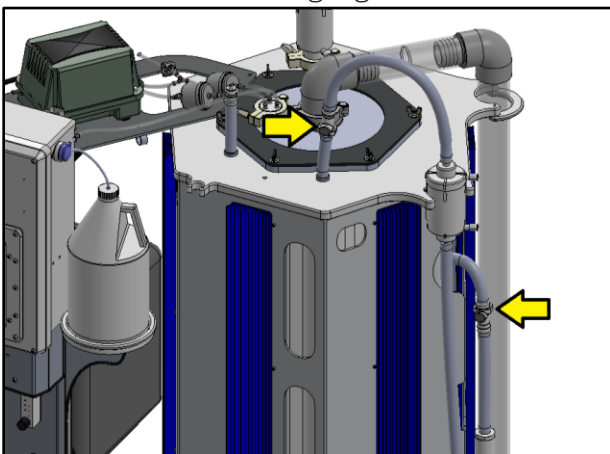
7. Increase airflow into PBR to establish positive pressure (for inserting the pH Probe Triclamp).



8. Disconnect Spray Pump Intake's QDCs.

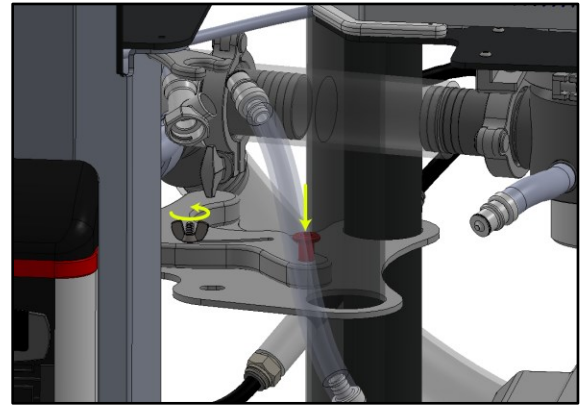


9. Spraying alcohol on the QDCs rearrange the Overflow Harvest Line and the Water Inlet Filter connections for culturing algae as shown.



10. Loosen Spray Pump Plate wingnut and ensure red stopper is in place, so it can drop down when Spray Pump is rotated back. This prevents it swinging

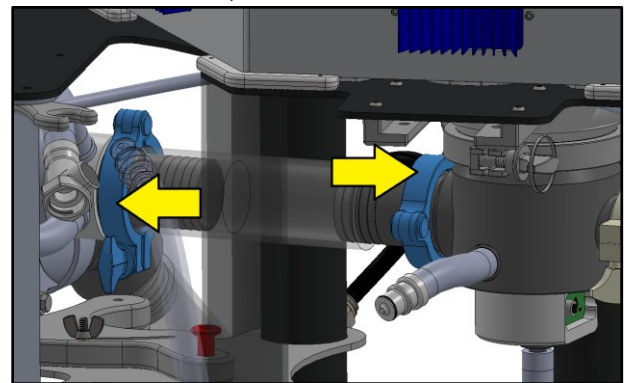
back and breaking the pH Probe.



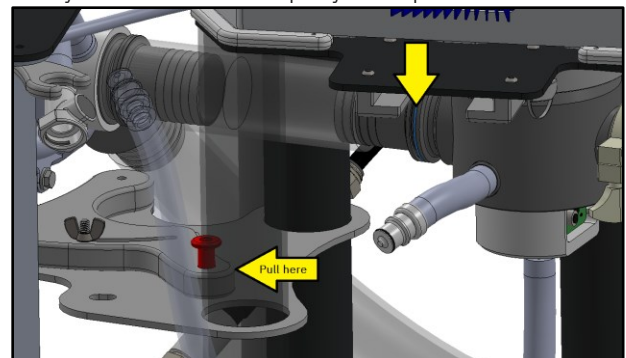
11. Use thio (1 mL / mL of 12% sodium hypochlorite) to neutralize chlorine soaking pH Triclamp and pH Probe.

12. Remove pH Triclamp and pH Probe assembly from solution and thoroughly spray pH triclamp with 70% alcohol.

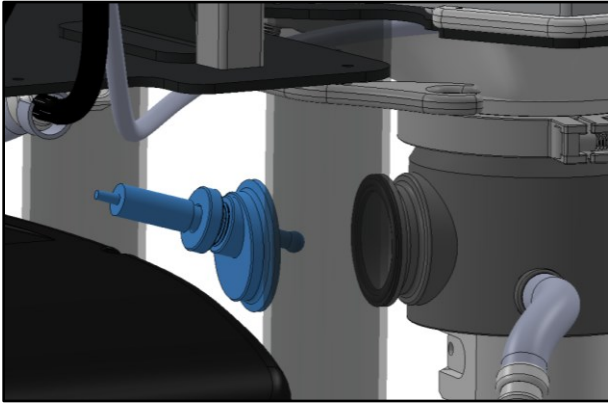
13. With lots of 70% alcohol spray, keep light pressure compressing the Spray Pump Intake Tube and remove the clamps.



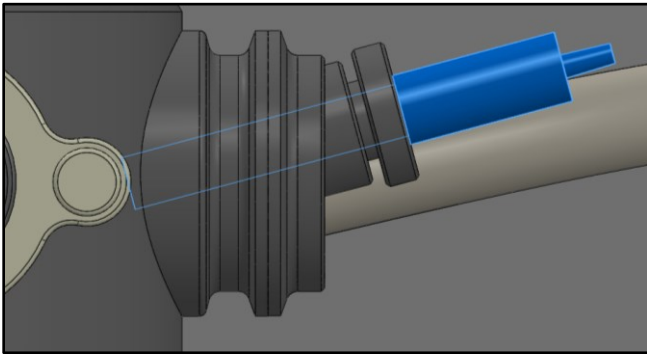
14. Spray alcohol and keep the triclamp gasket in contact with the Manifold while rotating the pump away to remove the Spray Pump Intake Tube.



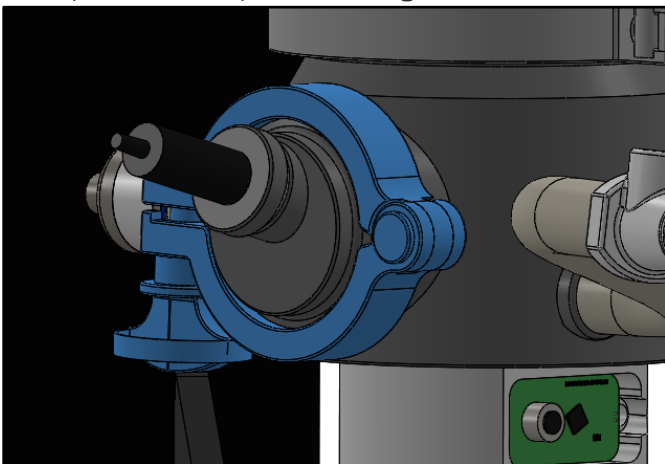
15. Spray alcohol on the Manifold Triclamp Face, Triclamp Gasket, and pH Triclamp then **swiftly** place both the pH triclamp **and** gasket onto manifold to seal PBR.



16. Ensure pH probe tip points **down** or it will not read consistently (pH Triclamp can be rotated before clamping)

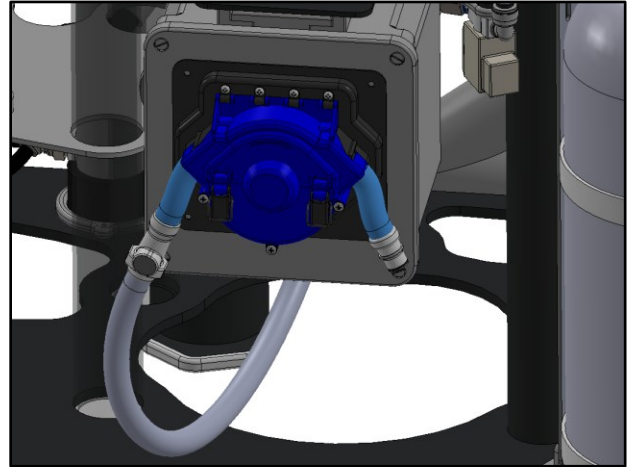


17. Holding pH triclamp against manifold to seal the PBR, place triclamp over and tighten.

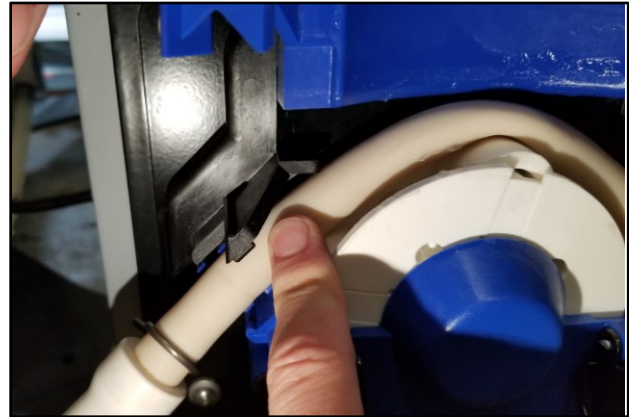


18. Replace Harvest pump onto bracket and route Automated Harvest Line through. Ensure the tubing is inserted fully into the rollers to avoid damage to

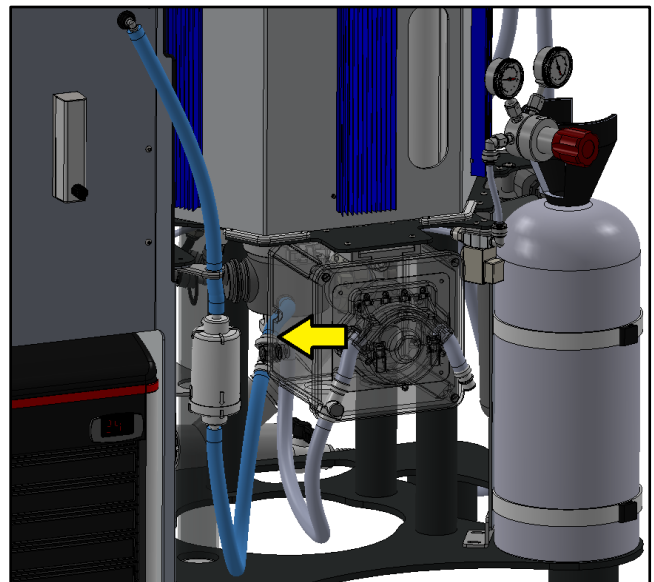
tubing and pump.



19. The tubing must be behind the tabs that protrude to avoid damage.

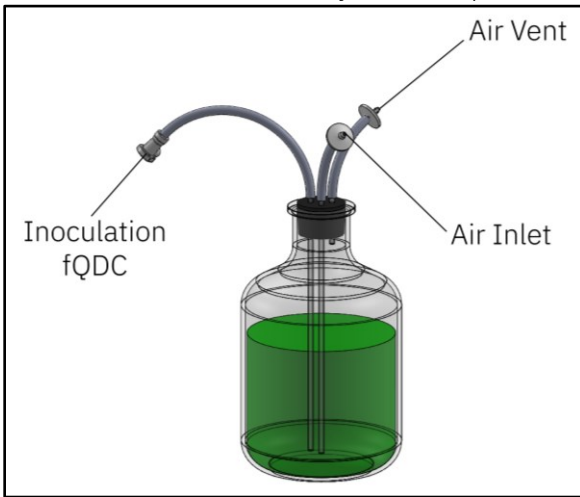


20. Disconnect Air Inlet Line from the Positive Pressure Port in the lid and connect to Manifold Air Inlet.

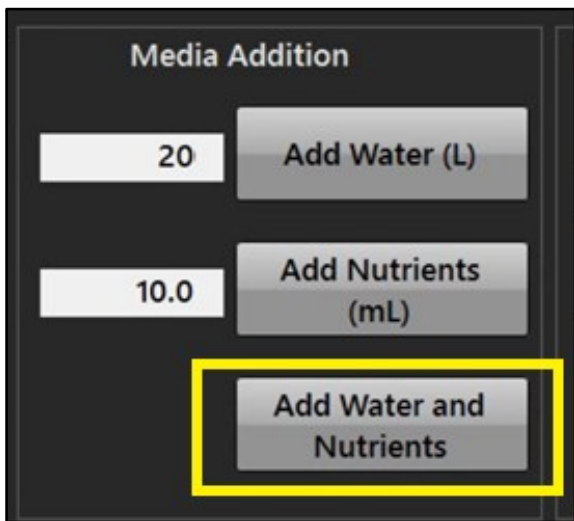


Inoculation

- 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.

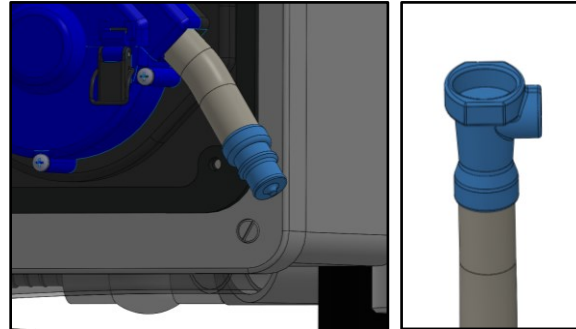


- Set Add Water and Add Nutrients values on the on manual controls screen and press Add Water and Nutrients to add media to the PBR. For a 2 L inoculum we recommend 20 L of water and 10 mL of nutrients.

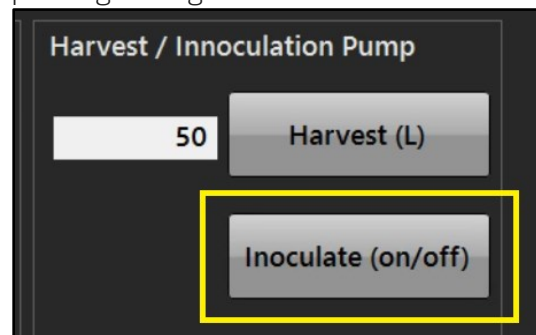


- Ensure pH and temperature are acceptable for the inoculum prior to proceeding, to avoid shocking the algae.

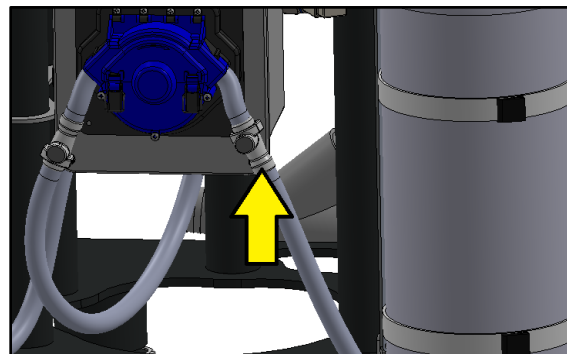
- Spray inoculant and Automated Harvest Line QDCs with alcohol and connect.



- Ensure tubes are not kinked.
- On the manual control screen, press Inoculate. 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.



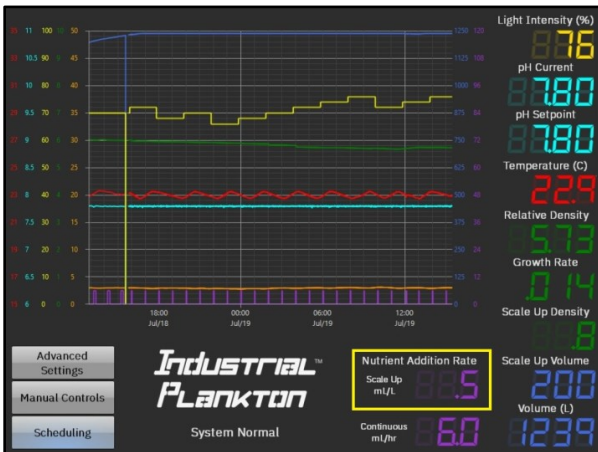
- Press Cancel to stop Harvest Pump once inoculum is in PBR. **Do not** draw debris from inoculum into PBR.
- Disconnect QDCs between inoculum carboy and Harvest Pump
- Connect Automated Harvest Line Extension.



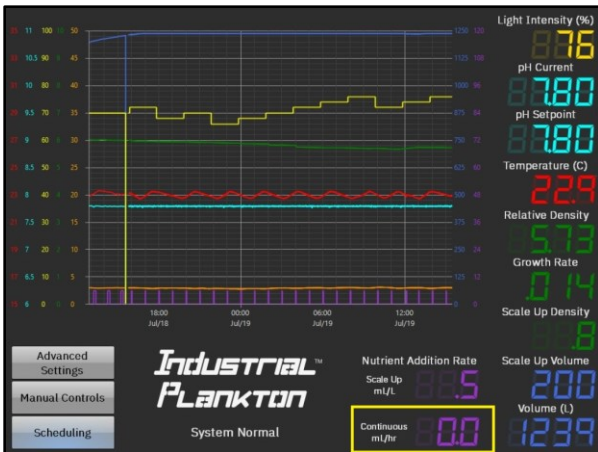
Scale-Up: Semi-Continuous

With these settings, the PBR will 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 more than 10 L of water to start with in the PBR.

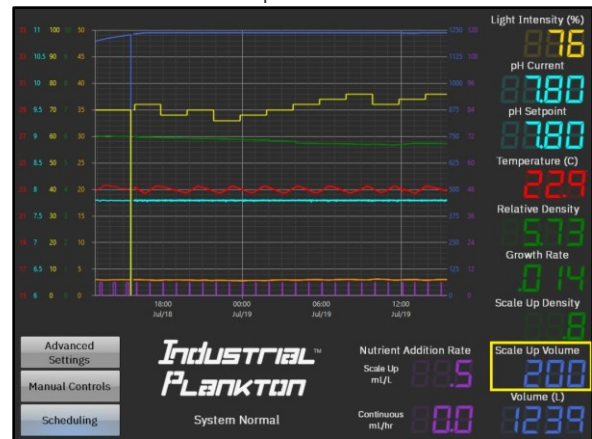
1. Set the desired Scale Up Nutrient Addition Rate.
This many mL's of **each** nutrient will be added for each liter of water added.



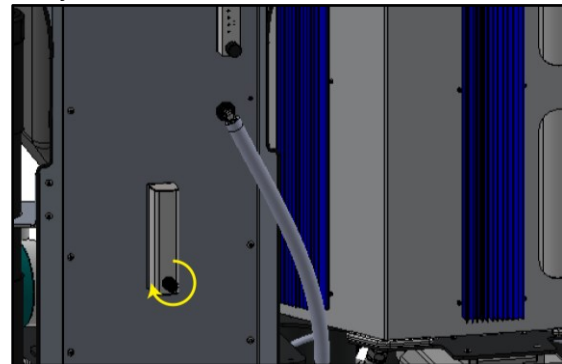
2. Set the Continuous Nutrient Addition Rate to 0.0.



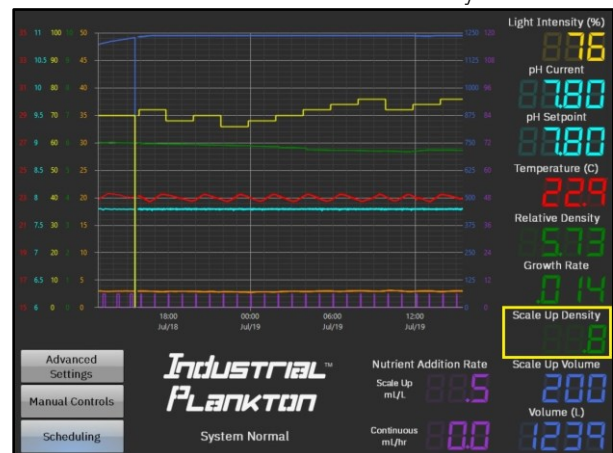
3. Set desired Scale Up Volume.



4. Fully close the Continuous Water Flow Valve.



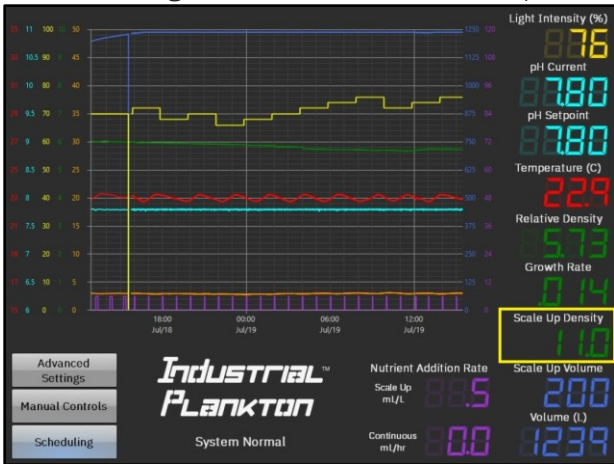
5. Set desired Scale Up Density. The PBR will add the Scale Up Volume and the Scale Up (mL/L) Nutrient Addition Rate each time this density is reached.



Scale Up: Continuous

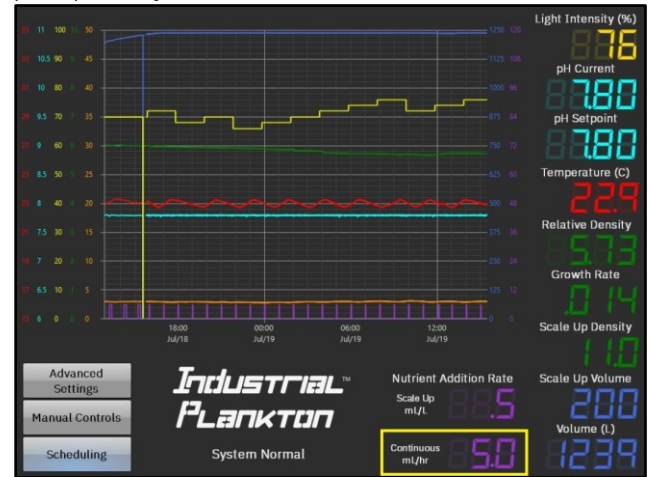
With these settings, the PBR will automatically add nutrients every hour, regardless of incoming water. Flow rate is manually controlled from the Continuous Water Flow Valve. The PBR will start overflow-harvesting once it is full.

1. Set Scale Up Density to 11. This prevents the PBR from initiating Semi-Continuous Scale-Up.

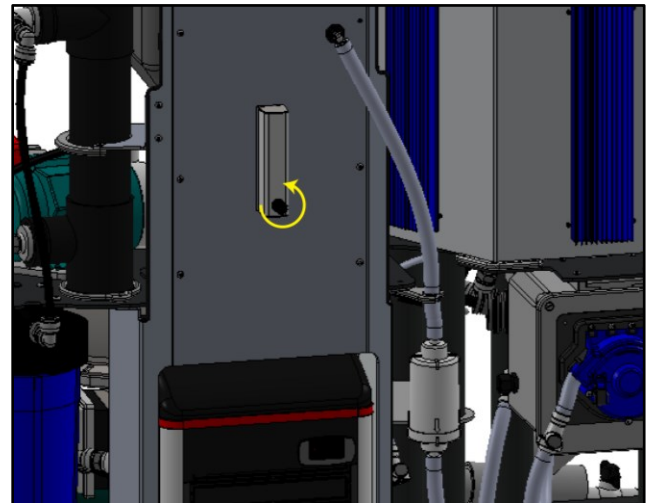


2. Set the desired Continuous Nutrient Addition Rate. This many mL of nutrients will be added from each

pump every hour.



3. Open the Continuous Water Flow Valve to desired flow rate.



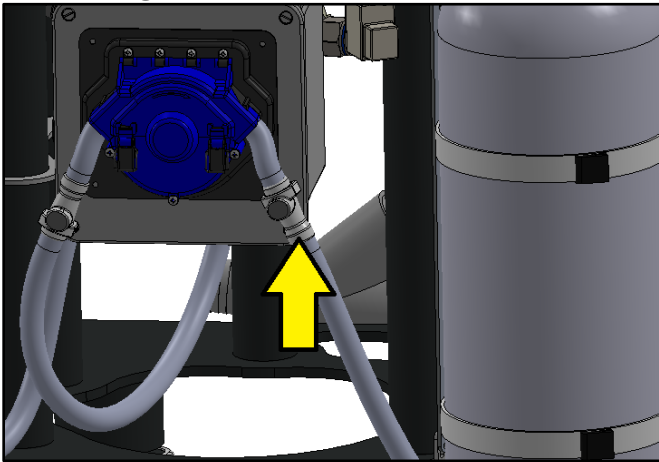
Harvest: Semi-Continuous

The PBR can be scheduled to automatically harvest and refill preset volumes up to 12 times per day from the Automated Harvest Line. The PBR will automatically add the missing volume of water, up to the Max Tank Volume with the corresponding Scale Up (mL/L) value. If the total harvest volume per day is too high it will overdilute the culture and density will drop. Ensure to set the Scale Up Density low enough that it will automatically refill after harvesting.

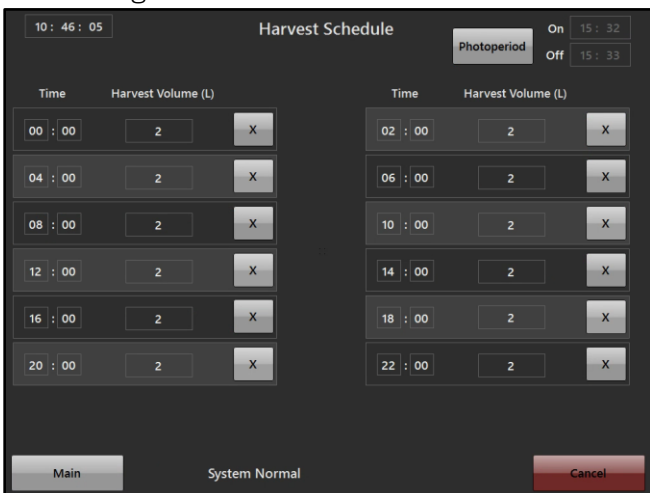
To initiate automatic refilling:

- The water level must be lower than 4 L below the Max Volume to automatically add water.
- The current Relative Density must exceed Scale Up Density.

1. Ensure Automated Harvest Line Extension is attached to Automated Harvest Line. Flow will not pass through disconnected QDCs.

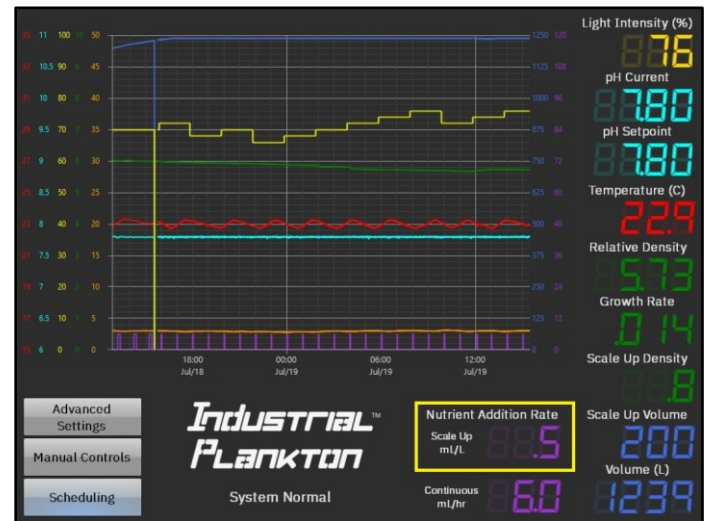


2. Add Harvest Times and Harvest Volumes in the Scheduling screen.

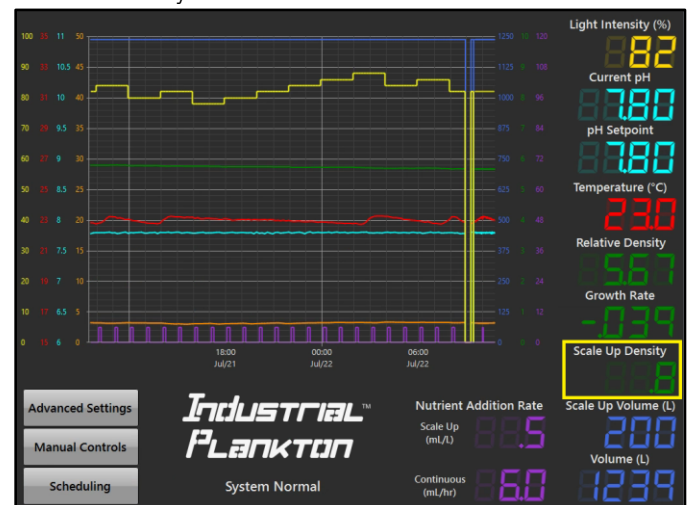


3. Set the desired Scale Up (mL/L) Nutrient Addition Rate (to be added with the water topping up the

PBR).



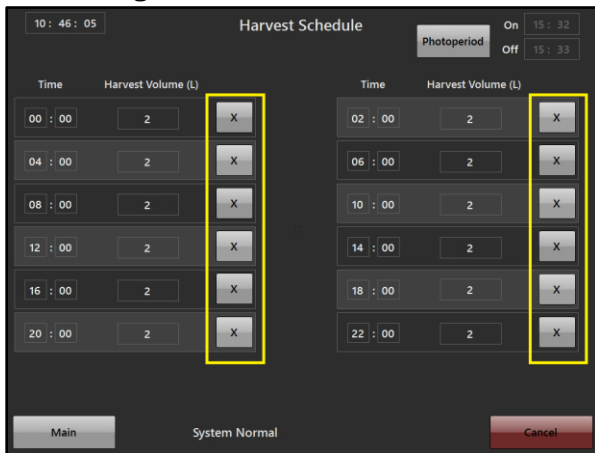
4. Set desired Scale Up Density. Setting it to 11 will prevent the PBR from refilling with media automatically.



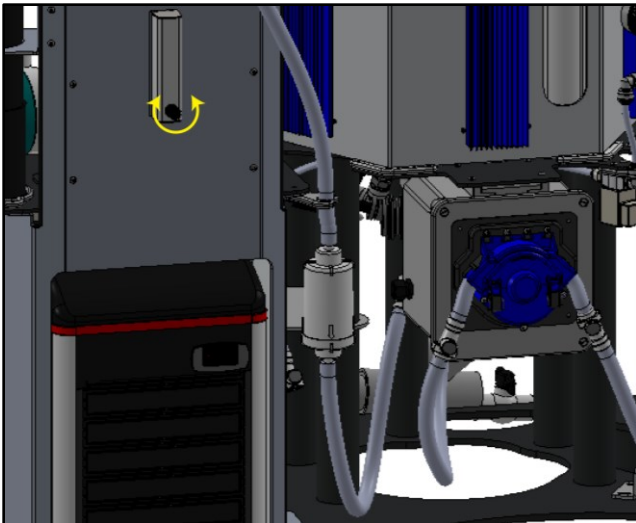
Harvest: Continuous (Flow-Through)

The PBR can be set to continuously add media, and overflow algae from the Overflow Harvest Line. The rate of water addition is the rate of harvest. The PBR must be full (Overflow).

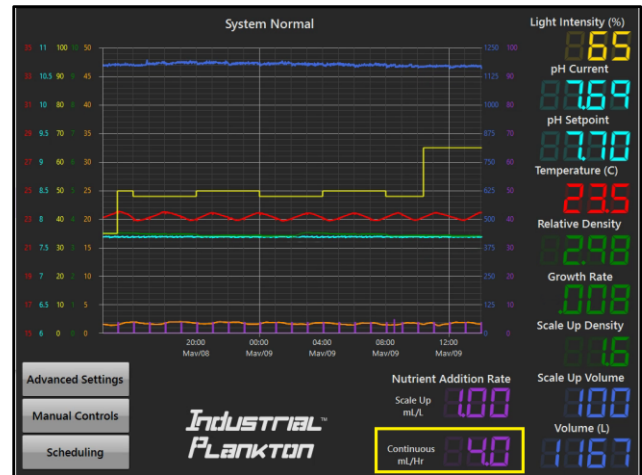
1. Remove all undesired scheduled Harvests by pressing X next to each scheduled harvest in the Scheduling screen.



2. Set desired harvest by setting the Manual Water Flow Valve to the desired flowrate. The incoming water increase the water level, forcing algae rich water out the overflow.



3. Set the Continuous Nutrient Addition Rate as desired. Calculate this based on the flow through the Manual Water Flow Valve.

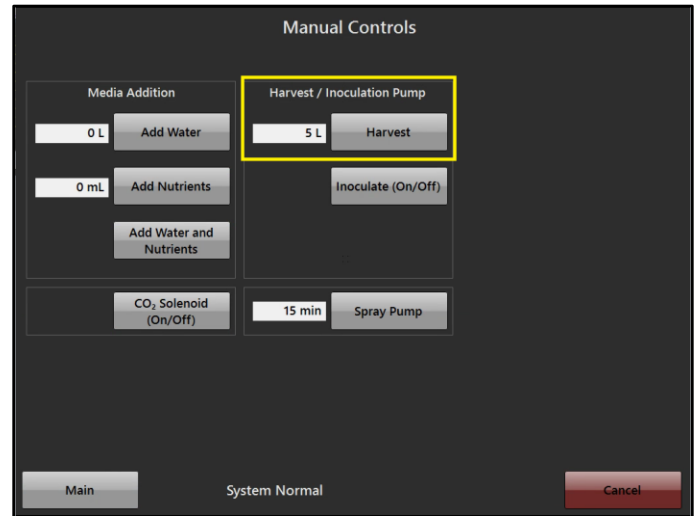


4. Check Manual Water Flow Valve **daily** (or more frequently) to ensure flow rate is correct.
5. Set PBR to harvest small volumes (1-2 L) frequently (every 2 hours) in the Scheduling screen to keep the Automated Harvest Line from stagnating and to keep the OD Sensor more reliable over time.

Harvest: Manual

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

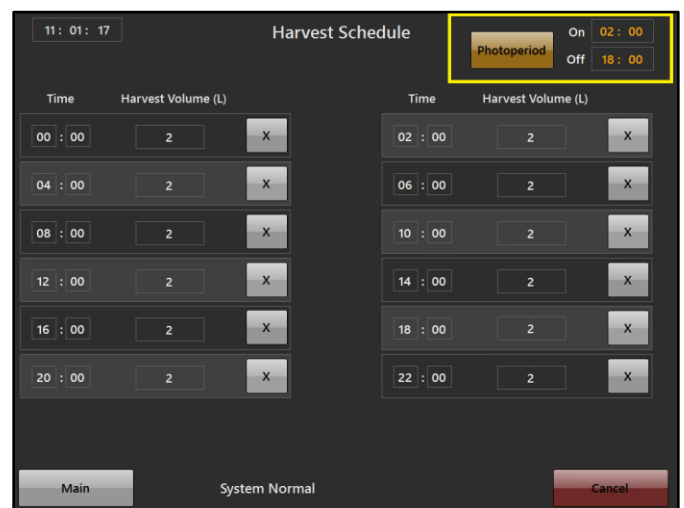
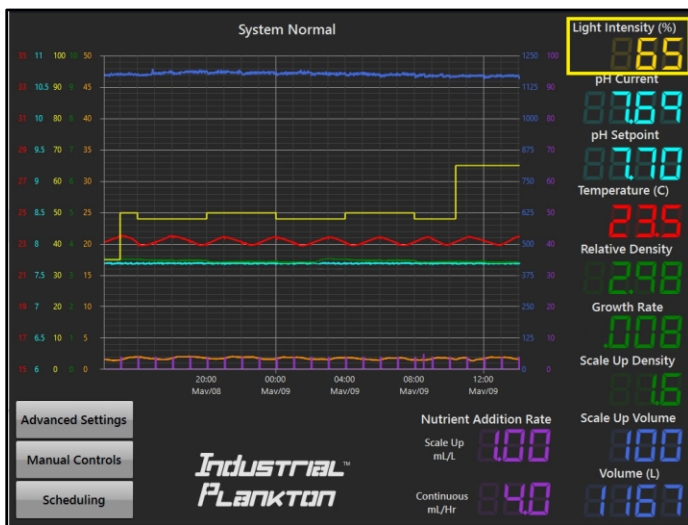
The PBR will refill automatically if it is set to semi-continuously Scale Up or Harvest, or continuously Scale Up or Harvest.



Light

The intensity of the LEDs can be set between 10-100% (values below 10% turn off lights). 100% is $\sim 1200 \mu\text{Em}^{-2}\text{s}^{-1}$

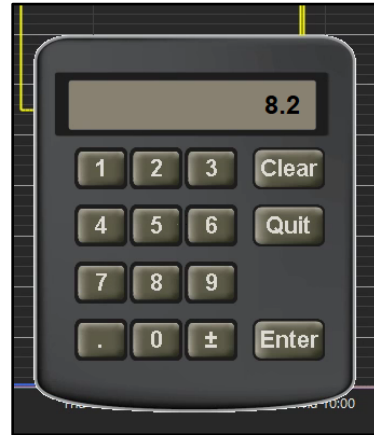
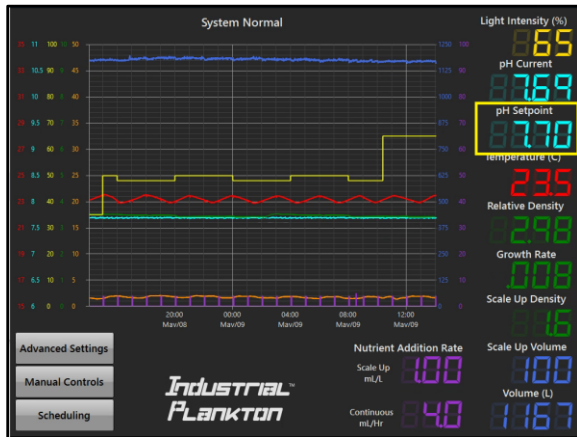
A Photoperiod can be selected with the Photoperiod button on the Scheduling screen. This is used to schedule the time lights should turn on and off over 24 hours. Values entered are for time of day in the 24-hour clock, not number of hours on and off (i.e., this will turn on at 2 AM and off at 6 PM). When it is highlighted yellow it is on.



pH Control

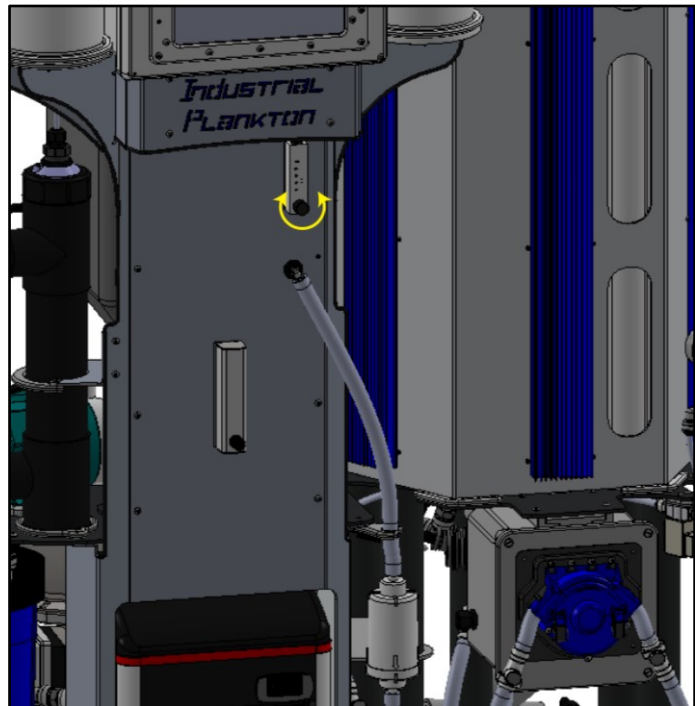
The PBR will automatically add CO₂ to the incoming air through the Air Inlet Filter to maintain a stable pH.

1. Press pH Setpoint number.
2. Enter desired pH Setpoint and press enter.



Air & Circulation

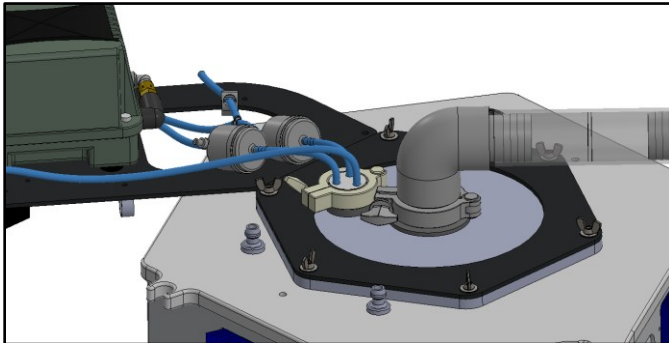
Set the desired air flow using the Air Flow Valve. Too much aeration can cause shear stress on cells, while not enough can promote settling. Do not shut off air flow completely with Air Flow Valve, or by disconnecting QDCs for long periods of time. It will damage the air pump and culture.



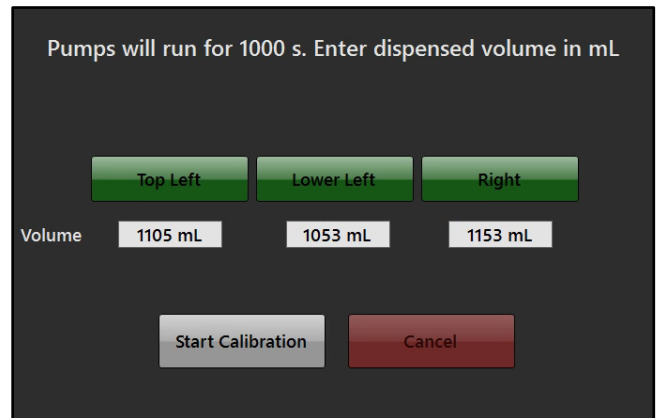
Nutrient Pump Calibration

The peristaltic pumps can be calibrated in the Advanced Settings. Three (3) empty 1.5 L containers and 4 L of water are required to calibrate all pumps at once.

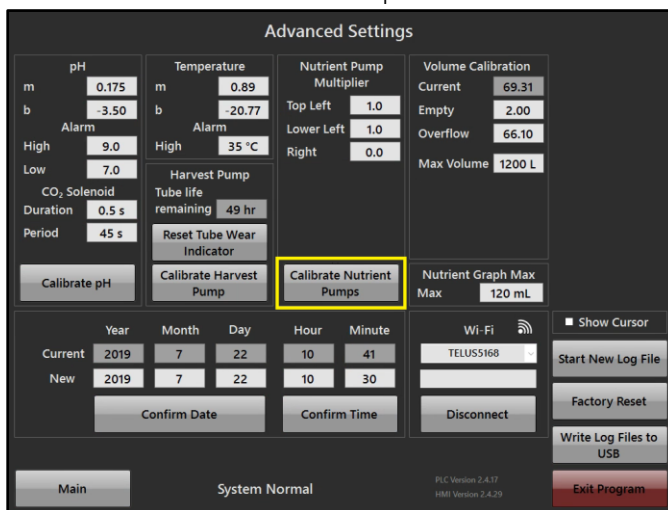
1. Disconnect the nutrient tubing from the triclamp adapters on the lid and direct tubes to each empty vessel.



3. Select the nutrient pumps you'd like to calibrate. Each pump selected will run for 1000 seconds.



2. Press Calibrate Nutrient Pumps.



4. Measure volume each pump dispensed and input into respective fields.

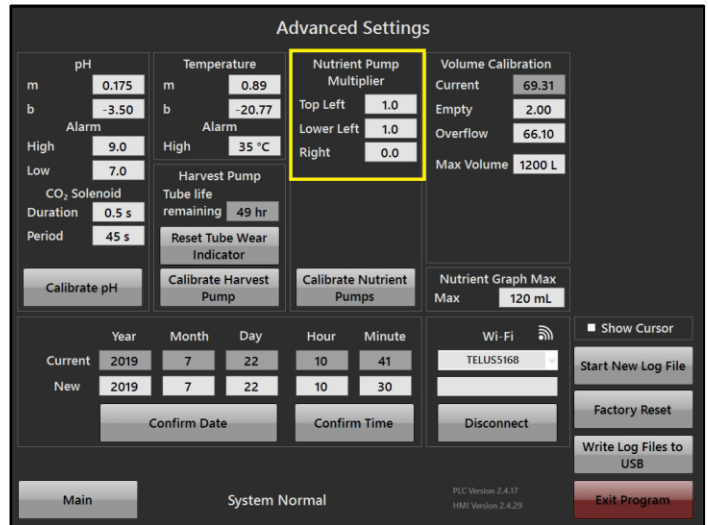
Nutrient Pump Multipliers

The nutrient pump multipliers will adjust the proportion of nutrients dosed automatically and manually.

To turn off an individual pump set the multiplier to zero.

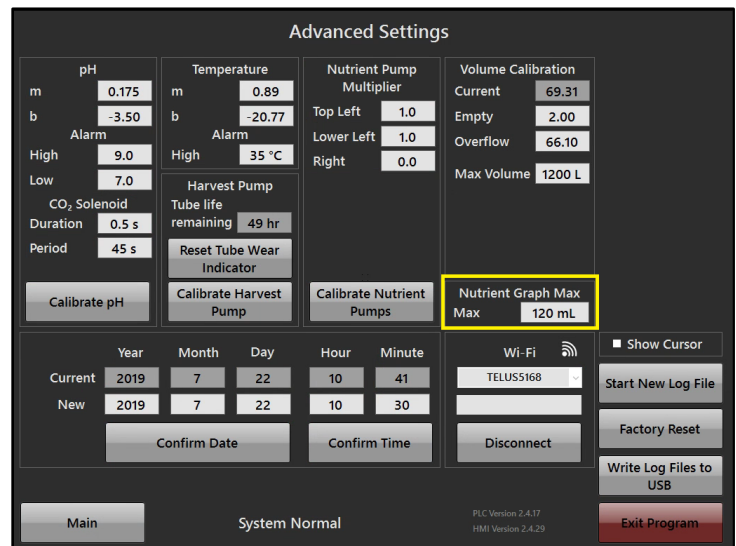
To dose different proportions of nutrients from each pump adjust the numbers as desired.

The volume of nutrients logged will be the base value (1X). The multipliers for each pump are logged individually and must be multiplied with the logged Nutrient Addition to get the total volume of nutrients added (i.e., if the Top Left Nutrient Pump Multiplier is set to 2.0, and 10 mL are manually added, the log file will show 10 mL added with a nutrient multiplier of 2.0, actually adding 20 mL of nutrient from the Top Left Pump).



Nutrient Graph Max

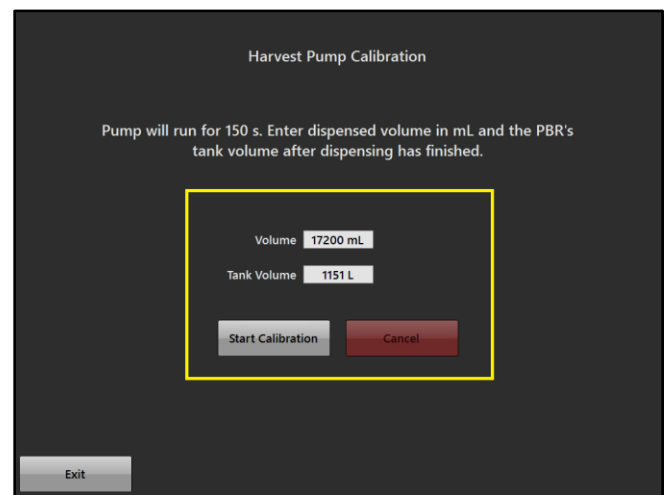
The scale for nutrients on the graphing screen is adjustable by changing the Nutrient Graph Max variable in the Advanced Settings page. This accommodates for the difference between continuous and semi-continuous nutrient additions (i.e., 10 mL/hr for continuous vs 400 mL at once for semi-continuous).



Harvest Pump Calibration

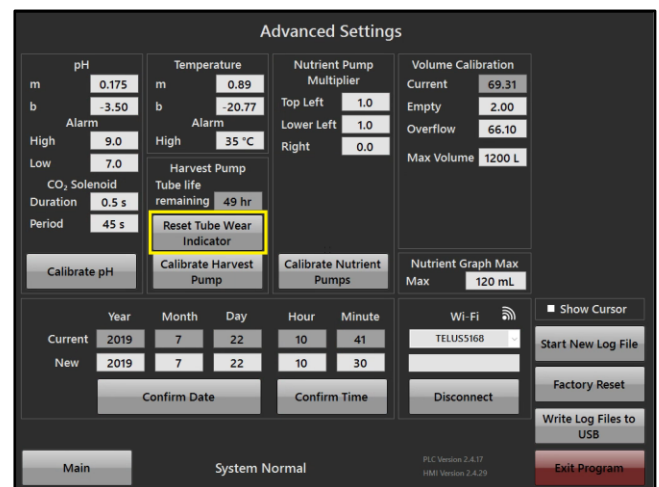
The Harvest Pump can be calibrated through the Advanced Settings screen. A 20 L bucket is needed to collect the volume dispensed and a graduated cylinder is required to measure it.

1. With at least 20 L of water in the PBR and the Automated Harvest Line and Extension installed, go to the Advanced Settings screen and press Calibrate Harvest Pump to open the calibration screen.
2. Press Start Calibration. The pump will dispense water from the tank.
3. Measure the volume dispensed and enter that value into the Volume cell on the calibration page. Enter the volume reading in the tank in the Tank Volume cell.
4. Ensure that the tubing is not filled with air prior to calibration, as it will decrease the volume dispensed.



Tube Wear Reset

All peristaltic tubing has a designated lifetime. The PBR automatically tracks the time each tube is used to provide recommendations on when to replace them. At minimum tubing should be replaced annually regardless of wear. When tubing is replaced, go into the tube Wear Reset Options to reset the countdown timer. Upon expiry of a countdown timer, an alarm will display on the home screen.



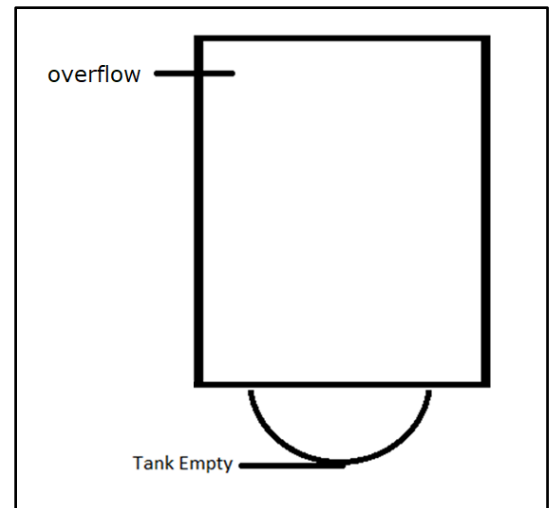
Tank Volume Calibration

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 overflow harvest tube). The PBR's volume is accurate within 5 L.

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.

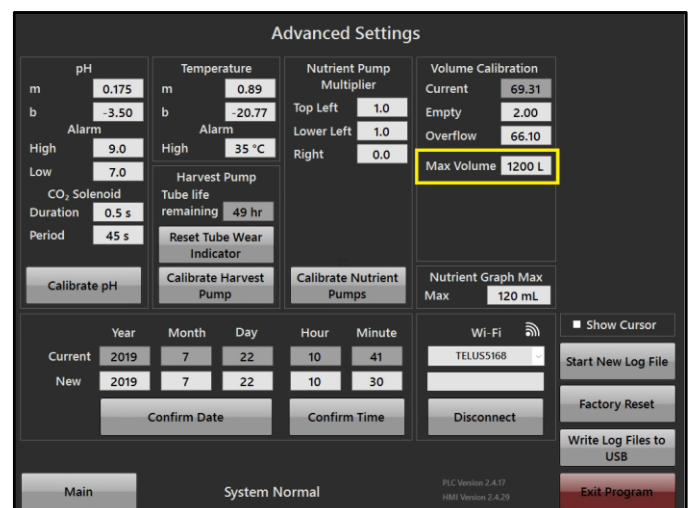


1. Ensure air is going into the PBR (factory calibrated at 20 scfh - standard cubic feet per hour) and all filters and triclamps are in place.
2. Add water to each volume calibration level.
3. At each water level, enter the Current reading into the respective Volume Calibration table slot once it has stabilized (Overflow factory calibration point is set with 30 L/day continuous water flow, so calibration point is above the bottom of the Overflow Barb).



Max Tank Volume

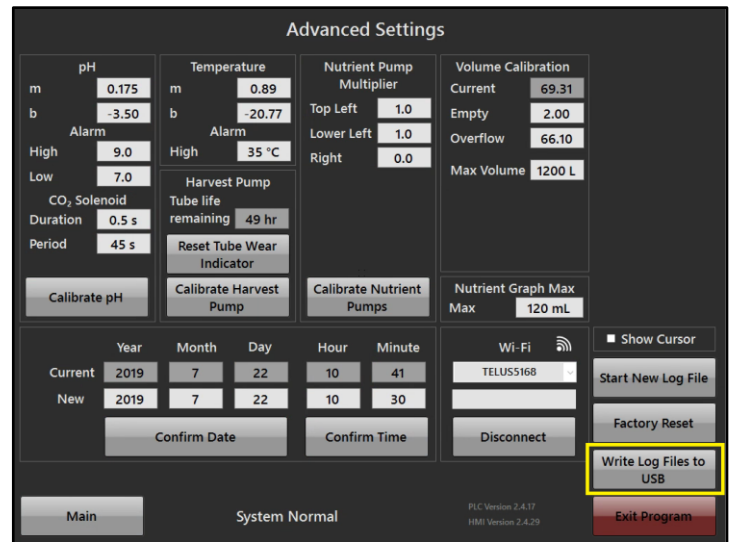
This parameter can be changed to operate the PBR at a lower volume than the harvest overflow line. The PBR must be run either in batch or semi-continuously to use a lower water volume.



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 a CSV file to the USB drive with headers. Events are logged separately from standard data in their own row.



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.



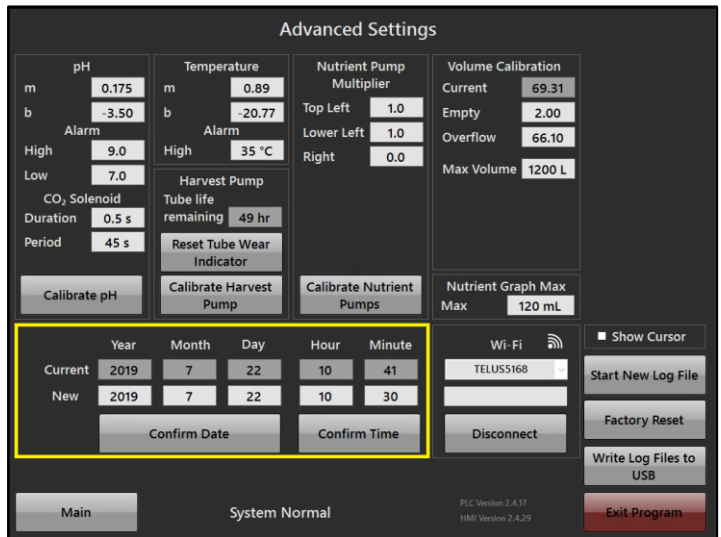
Set Date and Time

Date

- 1) Go to Advanced Settings
- 2) Enter date (YYYY MM DD)
- 3) Press Confirm Date

Time

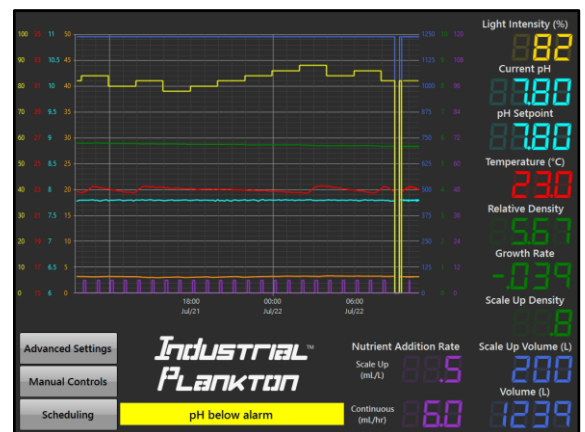
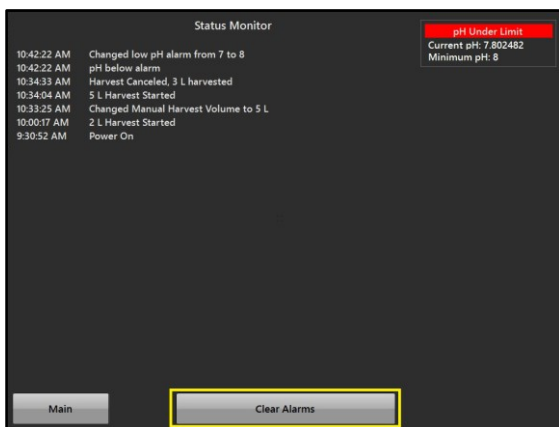
- 1) Go to Advanced Settings
- 2) Enter Time (24-hour clock)
- 3) Press Confirm Time



Note - Daylight savings time is not done automatically. Change the time manually to account for this. when the time is changed, one hour of data in the log file may be overwritten.

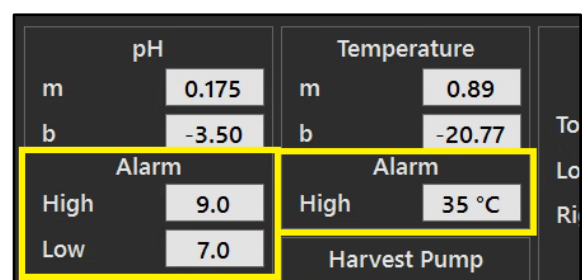
Alarms

The PBR has alarms that tell you when something is wrong with it. A red and yellow flashing banner will appear displaying the problem.



To clear an alarm, press the flashing alarms banner to go to the status monitor page, then press clear alarm. The alarm will automatically reappear if the condition has not been resolved.

The settable pH and high temperature alarms are found on the Advanced Settings page.



Code Version

There are two code numbers that describe the code operating the PBR:

- PLC version
- HMI version



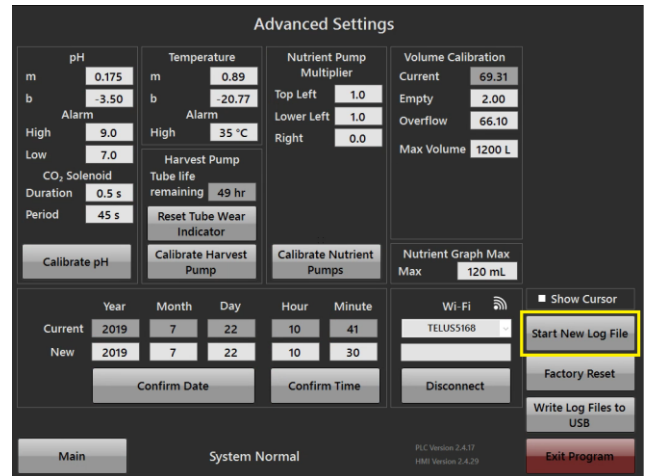
Factory Reset

If changes have been made to the variables in the Advanced Settings and the PBR is not functioning properly, press Factory Reset to restore the Advanced Settings to the original values. **Note** – all variables in the Advanced Setting will be reset except, Date, Time, Wi-Fi and Nutrient Graph Max.



Start New Log File

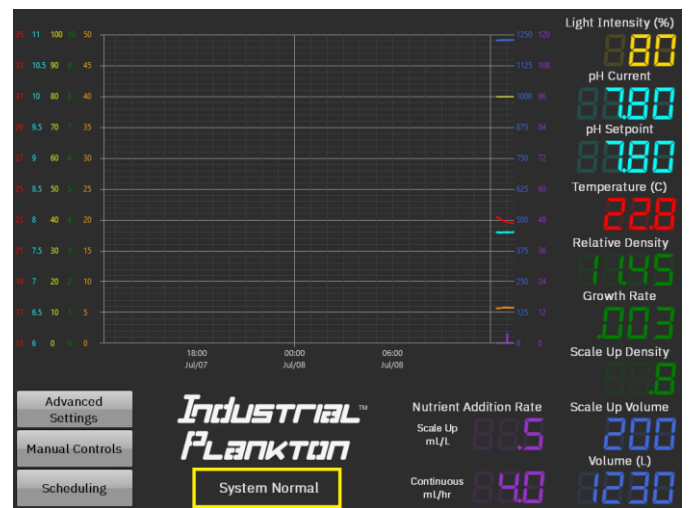
The log file is saved as one continuous file until the CSV file reaches capacity or Start New Log File is pressed. To create a new Log File before you inoculate a new algal strain, press Start New Log File. The log file number will be incremented, and the old data saved. **Note** - The graphing screen only displays the current log.



Status Monitor

If a change is made to the PBR, an event describing what has happened is logged.

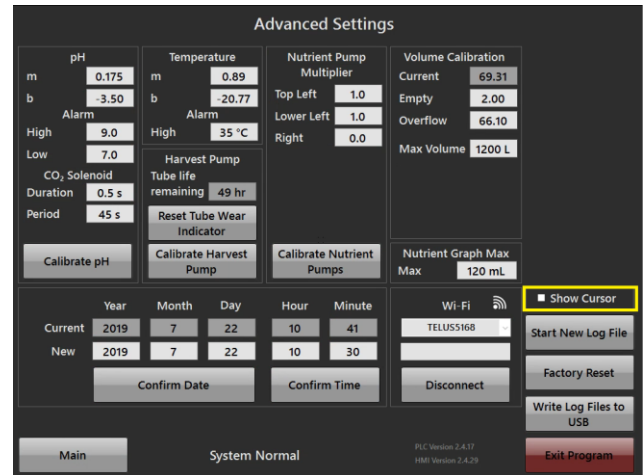
To view the events in the Status Monitor's, press the System Normal text visible on the home screen.



To close the Status Monitor, press Main.

Show Cursor

If you're using a mouse with the PBR, you can check this box to show the cursor.

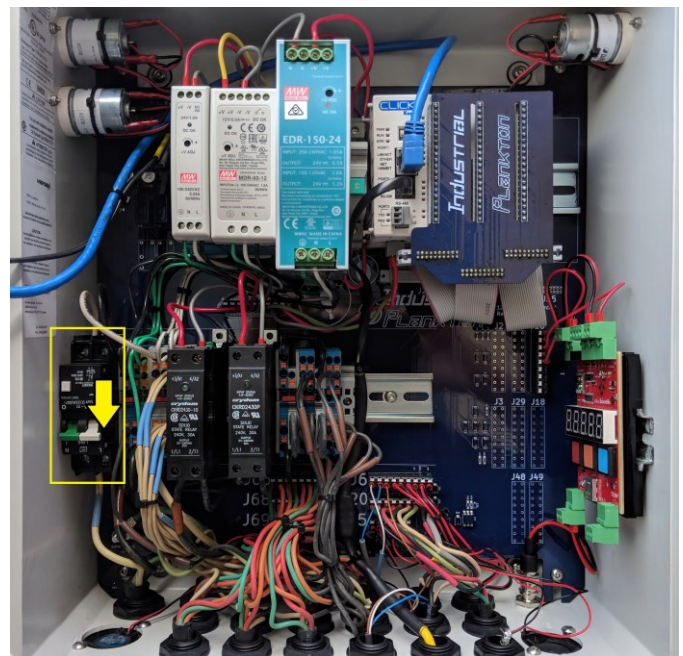


Power Loss

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 (HMI and PLC), the log files and the PBR serial number (found on the right hand side of the control box, on the name plate).