QuickStart Guide
BioGill® Tower

Version 1.0

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1. INTRODUCTION

BioGill is a biotechnology company manufacturing above ground, attached growth bioreactors, known as the BioGill Tower. Our technology brings together the power of science and nature to treat and improve water quality.

This QuickStart Guide is designed to explain the technology behind the BioGill Tower and give you step by step instructions to successfully operate your unit. Also covered in this Guide are details on how best to transport, install, commission and run your BioGill Tower, as well as suggested maintenance routines. Using this Guide will ensure your BioGill Tower is up and running in the shortest time possible, achieving the best treatment performance.

If you have any further questions, please contact your authorized BioGill Distributor, visit www.biogill.com or email info@biogill.com

2. SAFETY OVEVRIEW

The personnel responsible for the installation, operation and maintenance of the BioGill Tower must be appropriately qualified. The operator must ensure that they have completely understood the instructions contained within this Guide.

All warranties and guarantees with respect to the function and durability of the BioGill Tower, shall be void should the operator fail to adhere to these safety instructions or any other instructions within this Guide. The associated risks due to failure to adhere to these safety instructions include, but are not limited to:

- Endangering people due to electrical, mechanical and/or chemical/biochemical hazards.
- Endangering the environment due to leakage of hazardous material (where chemicals are involved).
- Failure of important equipment and process functions leading to inferior performance.
- Biological hazard protocols should be followed as per type of wastewater being treated and standard industry guidelines.

Operator Safety

Do not operate the equipment without the proper instructions as given inside this QuickStart Guide.

When in doubt ask

Remember that the equipment may operate automatically and can start at any time. Isolate any equipment before working on it or asking others to work on it. When opening the BioGill Tower or handling chemicals **do wear** full Personal Protection Equipment (PPE) including but limited to protective clothing, chemical proof long gloves and face shield.

Make it safe first

Always make the unit safe by flushing out any chemical residues from the pumps and pipelines and isolating the equipment. If using chemicals, test the safety shower regularly and immediately before any chemical delivery. If the shower does not work, have it repaired **before** you handle chemicals.

Always electrically isolate the equipment and switch off the local isolator **before** you dismantle any electrical equipment. Remember that equipment can be turned on by accident. Do not undertake any works unless the consequences are carefully thought through. Many pipelines contain chemicals or effluent under pressure even when the equipment has been shut down for some time.

The personnel responsible for the installation, operation and maintenance of the BioGill Tower must be appropriately qualified for relevant activities which may include; electricals, plumbing, working at heights, working in confined spaces, etc.

3. LOADING & LIFTING

PLEASE NOTE: The BioGill Tower has been designed for use with a forklift, lifted from the base only. Under no circumstances should the load be lifted from any other point, slung or lifted in any other manner.

Receiving & Inspecting

Depending on the product, the equipment may be delivered fully assembled or in flat-pack form for local insitu assembly. Upon delivery, immediately inspect the goods and report any visible damage. Notify BioGill of any defect or damage and include photographic evidence. Note: Separate transport instruction will be provided for flat-pack units requiring assembly onsite.

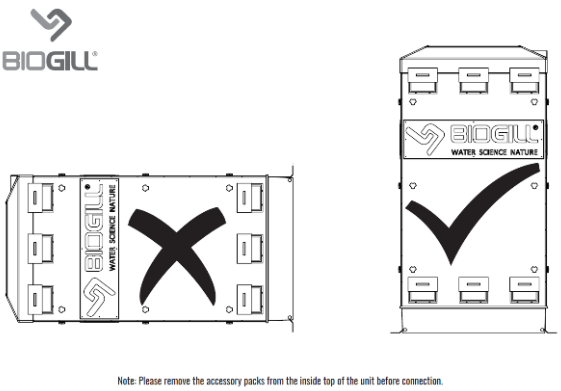
Typical Loading / Unloading

Before doing any work, an appropriate lift study needs to be undertaken by a qualified person before commencing the lift. The lifting procedures specified in this Guide are only generic guidelines and should be reviewed for suitability depending on actual site conditions.

Transporting Guidelines

When transporting a BioGill Tower, the following procedure must be followed.

1. The unit should always be kept upright.
2. Lift the unit with a forklift, appropriately rated, by the base using the design tine points.
3. Strap securely over the top in two directions minimum.



Note: Please remove the accessory packs from the inside top of the unit before connection.

Installing Guidelines

Installation of the unit must be performed in compliance with any national and local regulations. The following procedure is a generic guide to installing the BioGill Tower.

Prior to Installation

- Ensure that there is clear access to the equipment and to the site of installation.
- During lifting and placing, safety shoes with steel caps, hard hats and eye protection must be worn to prevent injuries.
- Always stand clear of a suspended load.
- The unit and any vessels should be installed on a level surface.
- This is critical in ensuring that the hydraulic equipment is loaded evenly, as well as in preventing load imbalance during operation.
- As a general rule, the unit must be put on top of an evenly casted concrete plinth/ platform of sufficient rating to support live load conditions.
- Remove any packaging and dispose of appropriately.

Lifting & Positioning

Planning, selection, and operation of the crane must be done in accordance with local regulations. Check the empty equipment weight and select appropriately rated and sized lifting equipment.

- Lift the BioGill Tower in a vertical/upright position on top of the plinth / platform.
- Lift the unit from the base (use the forklift channels provided).
- The unit dry weight is approximately 240kg (529lbs) and therefore using a mechanical lifting device is recommended. Do not attempt to lift the unit by hand.

Mechanical Installation

- Secure the BioGill Tower to the plinth / platform at the latch points provided on the base. The standard fittings provided are suitable for fixing the Tower to concrete using M12 dynabolts.
- Install the recirculation pump (provided by others) in the treatment tank below and connect the pipe to the inlet port at the top with the provided coupling.
- Install the return line (minimum DN100 | 4" flexible coupling) with a minimum gravity fall of 1:50. It is recommended to have an inspection point at the discharge of the base, such as a screwed capped tee.

Electrical Installation

- Electrical installation must be carried out by qualified electricians only. Make sure that the power supply is disconnected and locked out!
- Connect the earth connection to the plant prior to beginning any other work.
- All electrical installation work associated with the BioGill Tower and any ancillary equipment must be connected in accordance with the manufacturer's guidelines. For example, please refer to the pump supplier's drawings.

4. GENERAL INSTALLATION GUIDELINES

Preparation for Installations

Load bearing stable base: A BioGill Tower when fully loaded with water and operational biomass, may weigh up to 1,000kg | 2,200lbs. Please ensure the unit is positioned on a stable load bearing base. As a rule, the equipment must be put on top of a concrete base of sufficient rating to support live load conditions.

Level base: In addition, please ensure the base is level to allow an even fall of water through the BioGill Tower. The treatment unit should be installed on a level surface. This is critical in ensuring that the hydraulic equipment is loaded evenly, as well as in preventing load imbalance during operation.

Ventilation: The pathway of air to the treatment unit vents must be clear and unobstructed. It is recommended that at a minimum, there is a 150mm | 5.9" clearance around each vent.

Top clearance: To remove the lid and inspection hatch will generally require access from two sides to position a ladder and the remove lid. As such, it is recommended that at a minimum, there is a 600mm | 23.6" clearance from the top of unit to the ceiling.

Side clearance: To allow air flow and access, at a minimum the side clearance should be no less than 150mm on vented sides and a minimum of 600mm | 23.6" on at least one side for access. Other considerations are the required access for feed and discharge piping, including;

- **Inlet:** Orientation can be positioned on either side by rotation of the lid. Install the recirculation pump (provided by others) by connecting to the inlet port at the top of unit. This can be via a removable fitting should the unit be required to be moved in the future. Connection of a reducing valve is ideal for fine tuning the flow rate to the unit.

- **Outlet:** Although each Tower has provision for two outlet pipe connections, only one is open. The second outlet is blanketed off and is designed for applications requiring a large recirculation flow (>20m^3/h). Connect the discharge pipe (minimum DN100) via the flexible coupling fitting supplied. Ensure the fall of the discharge pipe of a minimum 1:50 gradient to the gravity feed water out of the treatment unit. With the water flows generally used and a small gradient it is unlikely that the base of the unit will overflow. However, excessive distance between the outlet and the receiving tank/pond, too many elbows and other fittings on the discharge line, or using reducing fittings on the discharge line may reduce the drainage flow. This may cause an overflow into the collection tray. If this occurs, it may be necessary to reduce the inflow, connect a secondary outlet or increase the fall gradient. The maximum backpressure on the outlet is 90mm | 3.5" head.

  It is recommended to have an inspection point at the discharge of the base, such as a screwed capped tee that will also help will sampling should it be required. Further to this, a variety of cheap and easy to install 3-way valves are available that can be installed to direct the waste from the cleaning procedure to a separate line.

Installation in a confined room: Please ensure that the ventilation to the room is sufficient for a safe working environment. This will also ensure suitable air quality for operation of the BioGill Tower. Forced ventilation may be required to achieve these conditions via a small low wattage fan. Please consult your authorized BioGill Distributor in this instance.

Spare parts

- For all spare parts please contact your authorized BioGill Distributor.

Accessories Pack

TIP: *The accessories pack is inside the top of the BioGill Tower for shipping. Please remove the accessories pack, prior to installing onsite. Accessories are supplied in two separated cardboard boxes.*	
Components	4 x Base hold down plates, 12 x Vent lids.
Materials	4 x M16 washers, 4 x M16 spring washers, 4 x M16 Hexagonal nuts, 4 x M16x200 Hex Screw, 1 x DN100 Flexi coupling, 24 X thumbscrews.

5. COMMISSIONING

Objective

The overall objective of commissioning is to ensure that the components of the treatment plant are complete, operational and meet the specified requirements. Typical commissioning requirements include:

- Checking that installation of all required items is complete.
- Completion of testing of all individual items of equipment and instrumentation for correct operation.
- Checks on the operating control systems to ensure they function as per design intent or contract requirements.
- Establishment of the treatment process to operate in automatic and manual modes as required by contract documents and specifications.
- Confirmation that all relevant acceptance test criteria have been met.
- Confirmation that alarms work as intended.
- Placement of the plant into operating mode for process establishment and evaluation.

OH&S Considerations

1	All personnel involved in commissioning and performance testing must have undertaken site induction as required by the site owner.
2	The commissioning activities for the day must be evaluated for their risks and work method statements are to be developed and documented.
3	Correct PPE, & tools-of-trade are used and working correctly. All personnel are to be adequately experienced and trained for all assigned tasks.
4	All personnel are fully acquainted with supplier's manuals and this commissioning plan.
5	Material Safety Data Sheets for substances are available

Commissioning Plan

A Commissioning Plan is to be read in conjunction with the following documents:

- Plant drawings - General Assembly (GA), Process and Instrumentation Diagram (P&ID).
- Installation instructions.
- Operation and Maintenance manual (O&M).
- Equipment manuals.
- Spare parts register.
- Materials safety data sheets.
- Dangerous goods licence for chemicals.

Commissioning Phases

The Commissioning Plan is divided into five (5) phases:

1	Pre-Commissioning	▪ All equipment available onsite installed as per GA, P&ID documentation. ▪ Electrical connections and tests completed.
2	Dry Commissioning	▪ Reliable power supply. ▪ Pre-Commissioning punch list closed out. ▪ Electrical & Mechanical trades support available.
3	Wet Commissioning	▪ Suitable supply of raw water.
4	Process Establishment	▪ First fill chemicals available. ▪ Minimum feed water per day. ▪ Appropriate PPE.
5	Training & Handover	▪ Plant operators/maintenance personnel available – 2 days. ▪ System is running and treating water.

Pre-Commissioning

Pre-commissioning starts after completion of the erection and installation of the BioGill Tower and includes all activities that need to take place to confirm the correct installation of each individual component. This is done by checking against a checklist which is generated for each component separately before water is put through the system. At the start of this phase the power has been connected to both the MCC with the main isolator locked by the Commissioning Manager in the off position. Activities to be undertaken as part of pre-commissioning are:

1) Clear site of any rubbish
2) Check the services are connected and isolated
3) Undertake pre-commissioning checklist's
4) Close out priority punch list items
5) Mark up P&ID as "As Built"
6) Mark up Electrical Drawings as "As built"
7) Check that all isolators in the MCC are in the off position
8) Unlock the main power isolator to the MCC and place it in the ON position

Dry Commissioning

Dry commissioning starts at the close out of the pre-commissioning checklist for all the individual components of a system in the plant. The dry commissioning will be a system wide procedure, meaning this stage of commissioning will be completed for each plant system separately.

An industrial plant can be categorized into the below sub-systems:

- Feed pumping station
- Balance tank
- Recirculation tank
- BioGill Towers
- BioGill housing with associated services like ventilation and solar heating
- Filtration system
- Sludge handling system
- Chemical dosing system

Wet (Clean Water) Commissioning

Wet commissioning involves introduction of clean service water to primary equipment to prepare filters, and chemical dosing systems. Wet commissioning will be a system wide procedure, meaning this stage of commissioning will be completed for each plant system separately. The main actions that will be performed for each sub-system during wet commissioning are:

1) Fill the tanks with water and check the relevant Instruments functionality for each tank.
2) Open air bleed on pumps until the pumps are flooded.
3) Run the pumps with water and the check the pumps functionality.
4) Run each system separately on manual mode to make sure each system is installed and commissioned properly.
5) Run each system in automatic mode to ensure correct operation.

Hydraulic Leak Testing

The period when the system is being filled with water is the best time to perform leak testing. Check all pipe work for leaks while the system is being filled with water, and rectify as necessary. As a guideline:

- Check for leaks around valves and flanges and rectify if required.
- Check for leaks around the flexible couplings and tighten clamps as necessary.
- Open the inspection hatch on the top of the bioreactor and check the spray system coverage. There should be even distribution and wide coverage from each HydroSwirl™ dispersal nozzle.

Process Commissioning

Process commissioning is operating the full system to produce treated water. BioGill Towers rely on a biological process to achieve effluent output quality standards. This biology will establish itself over a period of time. It is contingent on variables such as temperature, influent quality and influent quantity. Process commissioning consists of:

Process Commissioning Procedure	
Function	**Procedure**
Wastewater	Check wastewater quality/quantity.
Chemical Dosing	Fill chemical dosing containers with chemicals if required.
System Start	Start-up BioGill Plant in AUTO mode.
Monitor Plant	Monitor plant and if you have any questions, contact your authorized BioGill Distributor.
Electrical	Ensure all level switches, emergency stops, etc. work with the plant in normal operation.
Performance Trial/ Adjustments	Lab analysis of effluent samples to verify effluent quality against targets. The fine-tuning process is iterative with adjustments made on daily measurements and effluent quality sampling.
Process Validation/ Site Acceptance	Sample and test for relevant analysis to demonstrate compliance with contract requirements.

Unit Dispersal Adjustment

The HydroSwirl™ dispersal system has a recommended operating flow range of 7,500 to 10,000 litres per hour (2000 to 2600 gallons per hour). To ensure the correct flow to the HydroSwirl™, it is recommended that a ball valve is installed on the recirculation line. This allows for the flow to be throttled if required.

Biomass Seeding

Food & Beverage wastewater: The best bacteria inoculum or seed is the one naturally growing on the food source and generally obtained from sources around the wastewater source. BioGill also provides Bacteria Sachets if local culturing is not possible. The sachets are proprietary packets containing the spores of up to 60 bacteria species and are customized to the waste stream. Check with your authorized BioGill Distributor regarding the availability of sachets for your waste stream.

Sewage: A good source for bacteria seed is the local sewage treatment plant. Check with the operator to ensure an aerobic process is used, and that you can obtain sewage sludge. Mixed Liquor Suspended Solids or MLSS (the term used for Activated sludge) can be collected from the bottom of the clarifier (preferred), from the aeration tank or humus Tank (in a trickling filter plant). A seed volume of 10% of the recirculation tank volume is recommended. MLSS is heavier than water and mixing will be required or the MLSS will settle to the bottom of the tank.

Once seeded, the tank can be topped up with the wastewater source. Supplement nutrients are then dosed as per BioGill recommendations. The system will then run in batch mode. Nitrogen or Phosphorus depletion can be used to measure the rate of biomass growth. The system is run until all the nutrients are near depleted. Once depleted, the recirculation flow should stop and the biomass in the recirculation tank allowed to settle for at least 2 hours. After settling, decant ½ the tank volume and refill with waste water. Top up nutrients as required and start recirculation.

Repeat this process until reasonable biomass growth is observed on the BioGill. Please note that stabilisation is not part of seeding but is a part of process proofing after commission when the plant is fed the intended raw water. Maintaining good pH, nutrients, temperature and uninterrupted recirculation is important in keeping the natural selection pressure in favour of the most optimum bacteria. It is recommended that site specific commissioning procedures be developed by liaising with your authorized BioGill Distributor.

Shutdown and Decommissioning

Should the BioGill Tower need to be shut down for an extended period of time (greater than one week) or decommissioned, then please follow these steps:

1. Contact your authorized BioGill Distributor for technical advice and support.
2. Switch off the recirculation pump and allow water to drain freely from the BioGill Tower base.
3. Manually isolate and tag out each hand valve and electric isolators.
4. Remove the top lid cover and hose down the top of the gills and the spray nozzles making sure they are clean and free of debris. Re install the lid.
5. Clean the air vents.
6. Slowly drain and flush base of the bioreactor.

Even when dry, BioGill systems are considered dormant, biologically. Many bacteria form spores which can survive for a long time under extreme environmental conditions. Please consult your authorized BioGill Distributor if disinfection of the BioGill Tower is required.

6. TRAINING & HANDOVER

Nominated operators must be available and attend the wet commissioning period to develop an in depth understanding of the BioGill Tower. Training will consist of:

1) Presence during commissioning
2) Onsite operations
3) Test of competency

All handovers will be appropriately documented. A suggested format of "Handover Acceptance Agreement" is below.

HANDOVER ACCEPTANCE AGREEMENT Authorized BioGill Distributor and Client hereby agree that all commissioning activities have been completed. Responsibility for day to day running of the treatment plant (including operations, personnel, chemical supply, monitoring, completion of daily logs, and all associated OH&S requirements) is now the responsibility of the Client.	
Authorized BioGill Distributor Representative *Name:* ..... *Date:* ..... *Position/Title:*	Authorized Client Representative *Name:* ..... *Date:* ..... *Position/Title:* .....

7. GENERAL OPERATIONAL PARAMETERS

Operating Guidelines

OPERATING & DESIGN INFORMATION*	**Temperature range (water)**	18-37 ℃ | 65-100°F
	Biological pH range	6.5 – 8.5
	Chemical Resistance pH Range	4 - 10
	Nutrient Quality	Preferred C:N:P ratio of 100:10:1
	Required pre-treatment	3mm | 1/8" Screen** Maximum FOG 100 ppm
	Flowrate per module	7.5 -10 m^3/hr | 33 – 44gpm***

*Consult your authorized BioGill Distributor for information about specific applications.
**General recommendation - can vary depending on influent composition. For sewage, hair removal is required.
***Optimal operating flowrate.

NOMINAL DIMENSIONS & WEIGHT	**Media Area**	230m^2 | 2475ft^2
	Depth	1,171mm |46.10"
	Width	1,171mm |46.10"
	Height	2252mm |88.7"
	Minimum Height Clearance	600mm | 23.6"
	Dry Weight	240kg | 529lbs
	Wet weight (high load approx.)	1,000kg | 2,200lbs (approx.)

CONNECTIONS	**Inlet Connection**	DN50 | 2" pressure pipe fitting
	Outlet Connection	DN100 |4" flexible coupling

Please note: As use conditions and applicable laws may differ from one location to another and may change with time, the Customer is responsible for determining whether products and the information in this document are appropriate for Customer's use and for ensuring the Customer's workplace and disposal practices are in compliance with applicable laws and other government enactments. BioGill assumes no obligation or liability for the information in this document.

Basic Process Parameters and Requirements

The following table presents the basic process requirements of a BioGill Tower bioreactor.

Parameter	Requirements
Solids Removal and Screening	The core function of the BioGill technology is to oxidise soluble nutrients such as BOD. As such, solids and particles should be reduced in primary treatment as much as possible. Although FOG will be broken down in the BioGill treatment process through enzyme release from the biomass, FOG (Fat, Oil and Grease) should be reduced as much as possible in primary treatment. Particles over 3mm must be removed to ensure performance in any application. BioGill recommends screening to at least 3mm. In sewage applications, screening must effectively remove hair, as this can cause clogging of the dispersal system. Pumps fitted with integral self-cleaning intake filters are useful for sewage applications.
pH Balancing	Wastewater streams that are below pH value of 6.0 will require adjustments prior to the BioGill treatment. This is particularly important during the establishment phase of the biomass. At acidic pH levels, the treating biomass grown on the gills will lead to acid fermentation of the waste stream and treatment rates will be lower. Waste streams that are above pH value of 8.5 will also require adjustments prior to the BioGill treatment. High alkaline wastewater will damage the treating biomass and the patented nano ceramic coating on the media. Small fluctuations in BOD will be balanced by the biomass once it is established. Large fluctuations will cause cell die-back and reduce treatment effectiveness.
Feeding to Balance C:N:P Ratio	To enable effective biological treatment of the wastewater, an appropriate quantity of nitrogen and phosphorous is required. This is not an issue for sewage and general wastewater, however it is critical for the treatment of industrial wastewater. The carbon/nitrogen ratio should ideally be greater than 10:1. The carbon/phosphorous ratio should ideally be greater than 100:1. Please note: Results show that in a high nitrogen waste stream, up to 80% of the nitrogen is removed where available carbon is present. Some phosphorous is removed during the building of new cells. However, this may only be a small percentage for waste streams with a high level of phosphorous.
Pumps & Energy Consumption	The energy requirements of BioGill treatment will depend on the detailed system design, however in comparison to other technologies it is comparatively low. Energy usage is primarily through the recirculation pump which lifts the wastewater to the head of the BioGill unit for gravity dispersal.

Parameter	Requirements
	To calculate energy use, refer to the absorbed power of your required pump and multiply this power by treatment time.
Recirculation Rate and Number of Stages	Increasing the recirculation rate over the Tower will increase the treatment performance, however there is a diminishing return with each additional recirculation pass. A single stage BioGill system may be capable of delivering up to 90% removal for high strength influents (+1,000 mg/L) and for lower strength (<500 mg/L BOD) influents, removal in excess of 95%. However, it is generally advised that for systems targeting >80% removal, a multi-stage (or more) may be a preferred option. BioGill Towers can be configured for batch treatment or in a continuous flow design. Continuous processes are more able to accommodate multiple stages. Whilst batch operation affords more process flexibility.
Sludge Generation & Removal	Sludge produced from the BioGill Tower will be in the form of cellular sludge. Carbon conversion by the biomass will generally be converted to 40-70% CO_2 and 30-60% cell mass. This cell mass is seen as sludge. In low strength wastewater, which is being treated to a high level discharge, cannibalisation of some sludge will occur internally inside the biofilm, leading to lower sludge yields. Typical BioGill sludge yield for high strength wastewater >1,000 mg/l BOD is around 0.3 kgVSS/kgVSS.day For high strength wastewater that is being treated to a lower level, less cannibalisation will occur due to the higher nutrient load remaining in the wastewater. Sludge needs to be removed from the treatment system. This may take place through the discharge with the treated waste. Please note: 1. The sludge will impact the nutrient levels of the treated wastewater. 2. If the sludge is not intended to be discharged with the wastewater, settlement and or other removal will be required. 3. Old sludge left in the treatment system will decay and reduce the treatment efficiency.
Disinfectants and Sterilisation	BioGill Towers are significantly more resilient than suspended growth biological treatment technologies. This is because the BioGill treating biomass contains multiple layers which offer high resistance to the “killing” agent. Furthermore, the BioGill structure is not as susceptible to low detergents, ammonia, chlorine, sulphur dioxide, etc. However, sterilisation agents such as Quaternary Ammonium compounds, above 10 ppm that are designed to specifically “kill” microorganisms, will kill the biomass. These long-lasting compounds may take time to work through the treatment system. Some food preservatives may slow the biological process. Pre-treatment holding of the wastewater for up to 24 hours and dilution with general wastewater will largely resolve this problem.

8. GENERAL MAINTENANCE

Periodic Inspection and Maintenance Routine

The intervals specified below are a general guideline. Actual requirements will be dependent on the wastewater type and site specific treatment parameters,

TIP: *Ongoing monitoring of the plant will indicate if maintenance is required.*
If wastewater effluent quality is being maintained, a reduced cleaning routine may suffice.

Maintenance Item	Maintenance Routine
DAILY	
Pipework	Inspect pipework and valves for leakages.
Pumps	Check if liquid is pumped. Inspect pumps for unusual noises and/or vibrations.
WEEKLY	
Observe wastewater flow through visual inspection	Partially open the top inspection hatch and observe wastewater flow and distribution through the dispersal manifold. If blockages are apparent, cleaning will be required. High pressure flushing, to within the recommended pipeline operating pressure, can be used to flush any sludge build-up inside the HydroSwirl™ nozzles. If excessive build up of material has occurred, the water dispersal manifold should be removed and manually cleaned. If manual cleaning is required, please go to the step below.
HydroSwirl™ cleaning	Open the top inspection hatch and the dispersal manifold must be removed. Stop the flow of wastewater to the BioGill Tower and remove the top inspection hatch using a 6mm Allen key. Disconnect the dispersal manifold at the barrel union. Use light to medium hose pressure and a soft brush to clean each HydroSwirl™ nozzle, inspect pipes and remove any blockages.
Vents	For housed units only, inspect and clean the vents on the BioGill Tower. Clean blockages by applying light to medium hose pressure to remove any sludge build up.
Flow rates	Check and review pressure and flow rates across the entire system. Any reduction in flow rate will most likely be an issue with the pump/s.
MONTHLY	
Nano ceramic media	Stop the flow of wastewater to the BioGill Tower. Remove the top inspection hatch using a 6mm Allen key and clean thoroughly the dispersal manifold and the water side of the gills with light hosing. Sludge build up inside the gills will increase suspended solids content in the treated effluent and reduce plant performance. Cleaning frequency depends on the strength of wastewater being treated, required effluent quality and level of pre-treatment. Monitor system performance to establish the optimal cleaning cycle.
Inlet	Check inlet for blockages and check all seals. Clean blockages by applying light to medium hose pressure to remove any sludge build up.
Outlet	Inspect outlet for blockages and check seals and rubber joints. Clean blockages by applying light to medium hose pressure to remove any sludge build up.

Resources	Minimum one person, platform, hose & water supply.
Safety Requirements	Any person performing maintenance on a wastewater treatment system should wear neoprene gloves, safety goggles and covered rubber soled shoes. After work is complete the service technician(s) should completely decontaminate by washing their hands with soap and water and then with a disinfectant hand wash. Where more extensive services are performed, the technician should shower. Any cuts contaminated with wastewater or solids should be washed as described above and then an antiseptic or antibiotic should be applied. For systems treating sewage or animal waste we recommend the wearing of a protective breathing mask. General caution should be followed with work on platform and water, as surfaces can become wet and slippery.

9. ROUTINE PROCESS MONITORING

Process monitoring is used as a technique to qualitatively and quantitatively record and measure process performance. Sampling and analysis, process data, plant settings and data recording are most important monitoring requirements. The object of sampling is to measurement key criteria at an appropriate accuracy. This is often determined by regulation. All sampling should be in accordance with the local standard and guidelines.

10. FAQs

Biology

Q: How long does the biology take to establish on the media?
A: Cells can take from 5 to 60 days to reach optimum level of growth. In the case of sterile wastewater from industrial processes the process may take longer for inoculated cells to establish.

Q: What does active biology look like?
A: This will depend on the nature of the growth. Normally well-established growth will be homogenous in colour and surface layer. BioGill Towers with established biology will generate heat which may be evident by a warm air outflow from the top vents. Aerobic biomass growing in the air side should have an earthy smell.

Q: What can I do to help the biology grow faster and establish on the media?
A: Follow the seeding procedure. It may take longer but will be beneficial in achieving better treatment results.

Q: What can I do if the biology looks weak and cells are dying off?
A: Investigate the reason the biomass is dying. It could be due to unbalanced pH, inhibitor or disinfector products in the wastewater, inadequate recirculation flow rate or recirculation pump failure.

Q: Are there any considerations with chemical use?
A: Yes, be careful with the use of disinfection and sterilization agents as these will harm the biological system and reduce treatment capacity.

Q: Fungi is growing in the system instead of bacteria. What can we do to stop its growth and encourage bacteria growth instead?

A: Fungi can maintain optimum growth at pH as low as 2.2. If the BioGill Tower is constantly seeing low pH, then the operator is inadvertently giving fungi a selective advantage over bacteria. Fungi has a typical doubling time of 3.5-6 hrs, compared to 0.35 hrs for bacteria and will outgrow bacteria if its growth is not limited.

Nutrients

Q: If the carbon load fluctuates significantly, how will this effect performance?
A: A well developed biomass has the ability to significantly attenuate and absorb shock loads. If a system is experiencing big flow fluctuations, a balance tank may be required. This should not affect well developed and established biology on the BioGill treatment units.

Q: What is the nitrogen requirement for a BioGill system?
A: Theoretical nitrogen for optimal biomass growth is around 24% of carbon load. In general, aim for a minimum of 10% by mass.

Q: What is the phosphorous requirement for a BioGill system?
A: Theoretical phosphorous for optimal biomass growth is around 4% of incoming carbon load. In general, aim for a minimum of 1%.

Q: Is there any advantage in adding trace element to the wastewater stream?
A: Yes. However, most wastewater treatment streams will contain sufficient trace elements.

Q: If yes, what elements and in what quantities for optimal performance?
A:

Element	Relative to carbon
Sulphur	2%
Potassium	2%
Sodium	2%
Calcium	1%
Magnesium	1%
Chlorine	1%
Iron	0.4%

pH

pH has a direct influence on wastewater treatability. When the pH drops below 6.0 or rises above 8.5, treatment activity drops. To optimize performance, wastewater entering the BioGill Tower requires pH of between 6.5-8.5. Measured on a scale of 0-14, wastewater with a pH of less than 7 is considered acidic while greater than 7 is more alkaline. The midpoint of the scale is 7. Wastewater with a pH of 7 is neutral.

Q: Why is pH important in establishing the biology in the BioGill system?
A: Optimum pH will give maximum growth, thereby reducing the time frame in establishing the biology on the gills.

Q: Once established, is the BioGill more tolerant to pH variations?
A: Yes

Q: What is the likely outcome of a very acidic waste stream on the biology?
A: Below 6 -- biomass will suffer die back – avoid long exposure.
A: Below 6.5 -- most of the cells established at higher pH will cease to grow.

Q: What is the likely outcome of high pH?
A: Above 8 -- growth rate and COD/BOD removal might be adversely affected.
A: Above 9 -- biomass will suffer die back – avoid long exposure.
A: Above 10 -- media may be affected from long term exposure– Avoid.

Q: Should I install a pH monitoring and dosing system?
A: Monitor the waste stream using pH strips or a probe to gauge pH levels. If the levels are below 6 or above 8, you will need to dose the water with acid or caustic to balance the pH.

11. FURTHER INFORMATION

For further information on designing, installing, commissioning and all other aspects of the BioGill Tower and technology, please contact your authorized BioGill Distributor. Further information can also be found at: **www.biogill.com**

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