

CERAFILTEC

Ceramic Filtration Manual



Version 25.R0

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1 Introduction

Ceramic ultrafiltration (UF) is a cutting-edge filtration technology that utilizes ceramic membranes to separate and filter water. Ceramic membranes offer several advantages such as chemical and thermal stability, mechanical strength, less prone to fouling, superior performance, low power consumption, and long operational life span making the ceramic membrane process highly effective in a wide range of water applications.

This manual contains general guidelines for CERAFILTEC technology, assembly, installation, commissioning, operation, and maintenance. However, depending on the application and its projection, project-specific installation requirements might be needed, thus, before installation, ensure the location is ready as required by the project design and execution drawings.

It is vital that from the assembly personnel up to the user responsible for operation read this manual before installing and starting up the ceramic membrane filtration system. This manual must always be available at the location where the system is to be used.

It is necessary to observe not only the general safety information provided in this manual but also the pertinent safety laws as mandated by the country of location.

2 Technology & Product

Ultrafiltration technologies with a pore size of 0.1µm are commonly understood as filtration solutions to remove suspended solids such as clay and silt, pollen, algae, precipitated metal oxides, and a fraction of colloids. They are also a physical barrier for germs and bacteria and are classified as a disinfection solution with a typical log removal value (LRV) above 5.

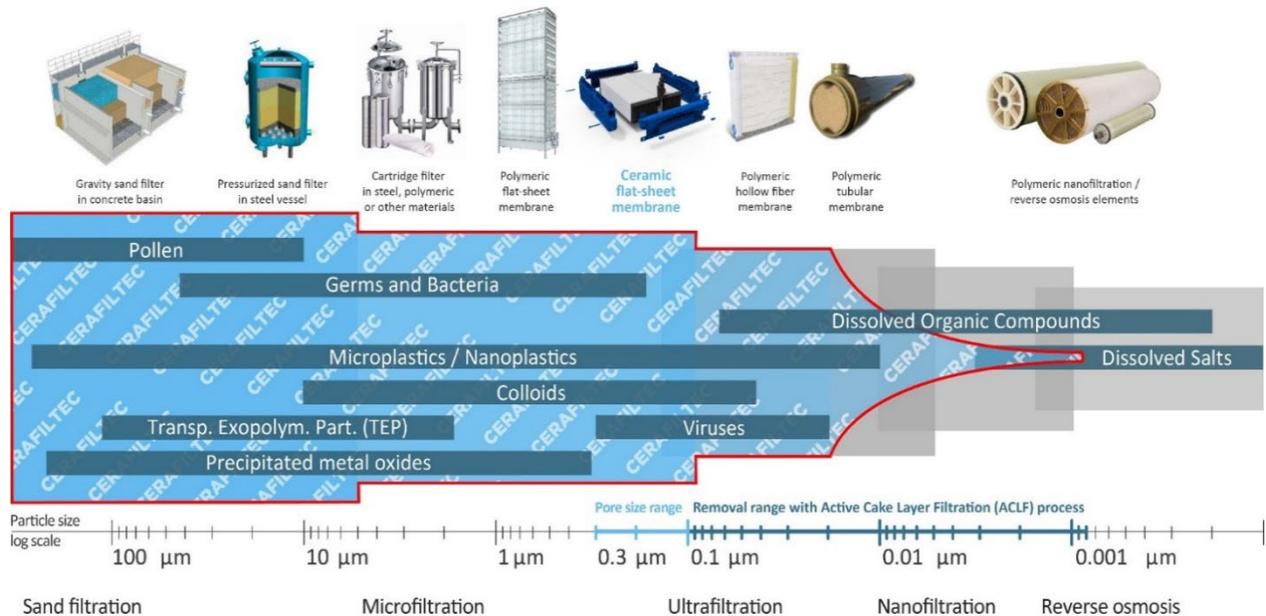


Figure 1: Filtration Spectrum with other filtration technologies

CERAFILTEC's ceramic flat sheet membrane solution is more than just a common ultrafiltration. The high resistance of ceramic materials and the resulting cleaning possibilities generate a unique high-performance system with a stable and low maintenance long-term operation.

In conjunction with developed pre-treatment processes, e.g. active cake layer filtration for a selective removal of dissolved ions, CERAFILTEC provides a superior filtration solution being the best pre-filtration solution for desalting technologies, like nanofiltration and reverse osmosis. CERAFILTEC's filtration module is highly seawater-resistant and corrosive-free.

2.1 CERAFILTEC Design Concept

One module is a single, modular, and expandable filtration unit consisting of the flat sheet ceramic membrane plate and a glass fiber-reinforced plastic housing. A module is equipped with up to 34 exchangeable ceramic plates and a total membrane surface area up to 6 m². The module housing was developed to tightly transport the liquid medium in internal channels, while at the same time withstanding high mechanical forces. All the housing, as well as all accessories, are free of any metals and therefore usable in the harshest applications, and at the same time achieving a very long lifespan. Additionally, no surrounding frames or hose connections between the modules are required. Up to 16 modules can be stacked up to a tower.

A module tower can be configured as a multi-tower. Several single towers can be simply connected through a common header pipe at the top. A fully modular configuration, no limitation in tower design as there is no surrounding steel frame.

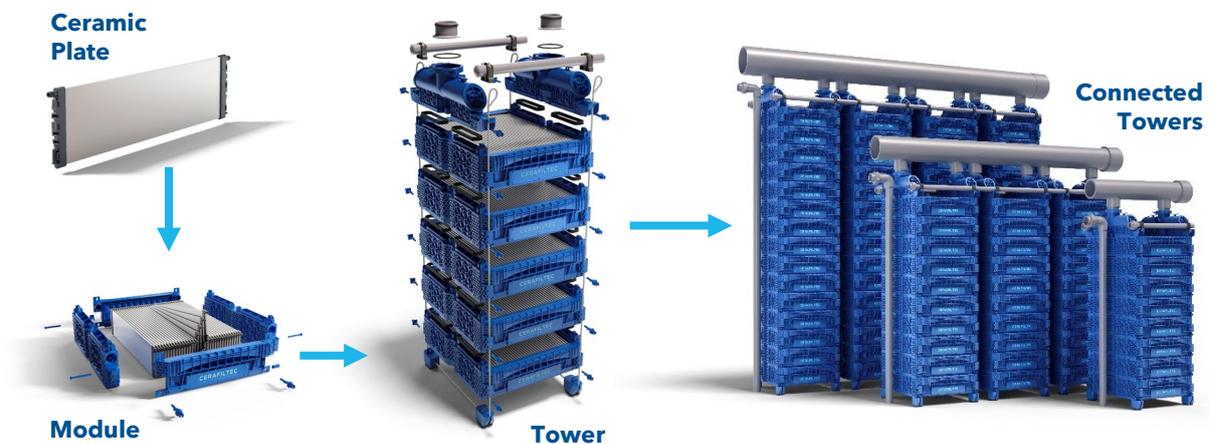


Figure 2: From a single membrane to a stack of modules (tower)

Benefits:

- Less filter area needed due to high flux operation - high CAPEX savings
- Suitable for challenging applications without any risks of corrosion problems
- Operation at high temperature
- Fully modular due to no surrounding frame - option to change the number of modules per tower at any time either to optimize project costs or to increase the plant capacity in the future
- Most compact design - towers can be installed in close distance to each other as no hoses are needed.

2.2 Module Specification

- Filtration module with ceramic flat sheet membranes suitable for submerged applications
- Multi-ceramic plate configuration with exchangeable single ceramic plates
- Internal filtered water piping
- Module housing fully made of glass fiber reinforced resin - free of any steel parts
- Out-to-in filtration and in-to-out backwash

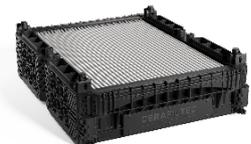
Table 1: Module Specifications



**Module 6.0 S
BLUE 61**



**Module 6.0 S
BLUE 419**



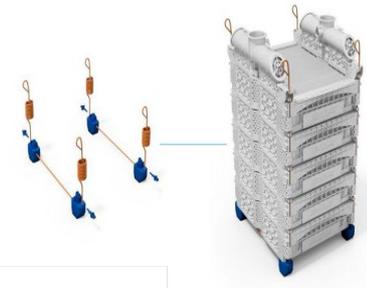
**Module 6.0 S
BLACK**

Certification			
Application	Drinking Water with NSF 61	Drinking Water with NSF 419 + 61	Wastewater Industrial & Municipal
Dimension L x W x H	710 x 576 x 160 mm / 28.0 x 22.7 x 6.3 in		
Dry weight	~37.7 kg / 81.6 lbs		
Material Ceramic Plate	Alumina		
Material Module housing	SABIC NORLYL™ resin 30% glass fiber reinforced blend of PPE/PS		
No. of plates per module	34		
Avg. spacing between plates	6.7 mm / 0.26 in		
Filter area per module	6.0 m ² / 64.6 ft ²		
Permeate pressure Max. suction	-0.7 bar / -10.2 psi		
Backwash pressure Max. delivery	1.2 bar / 17.4 psi		
Max. operating temperature	60 °C / 140 °F (D. HOT)		40 °C / 104 °F

2.3 Accessories and Tools

The accessories can be divided into essential accessories and optional accessories. Essential accessories must be supplied by CERAFILTEC, as shown below.

Essential accessories

Header Set	Base Set
 <ul style="list-style-type: none"> • Essential to connect the tower to the standard header piping • Contains 2 header collectors, 2 plastic tri-clamps, 2 plastic pipe adapters, 4 keys and all necessary gaskets • To be installed on the top module of each tower • Simply to be connected via key lock system • Plastic pipe adapter available in different sizes, metric as well as ASTM standard • Plastic pipe adapter to be glued to standard hose or pipe sizes 	 <ul style="list-style-type: none"> • Essential to install tower on the tank bottom • Contains 4 corner feet, lifting rope and 4 keys • To be installed below the bottom/base module of each tower • Simply to be connected via key lock system • Rope to be threaded through each module and to be connected on lifting device for installation of the tower inside the tank • Once tower is installed rope end to be fixed on header collector

Optional accessories:

Below accessories can be supplied by CERAFILTEC but the "optional" accessories are highly recommended to be arranged by the client according to CERAFILTEC's specifications. The details & drawings will be shared during project execution.

Lifting Device	Spare parts (Maintenance Set)	Sprinkler Set (Optional)	Aeration Set (Optional)
	 <p>https://www.cerafiltec.com/spare-parts/</p>		

3 Transportation, Storage & Handling

The following transportation, storage, and handling instructions describe how to handle the CERAFILTEC ceramic membrane modules correctly. It is important to read this instruction attentively to handle the product in a safe way.

3.1 Transportation

The modules from CERAFILTEC are packed on a euro pallet covered with wooden frames and a wooden lit or wrapped in foil. The packaging method is depending on customer preference or destination/freight method. Depending on the freight method the maximum height of a pallet regarding number of modules is individual. The maximum height regarding safety is a tower height of 11 modules, this means that 2x11 modules can be carried by one pallet.

The dimensions are roughly: 120cm x 80cm x 215 cm with a weight of ~ 900kg max.

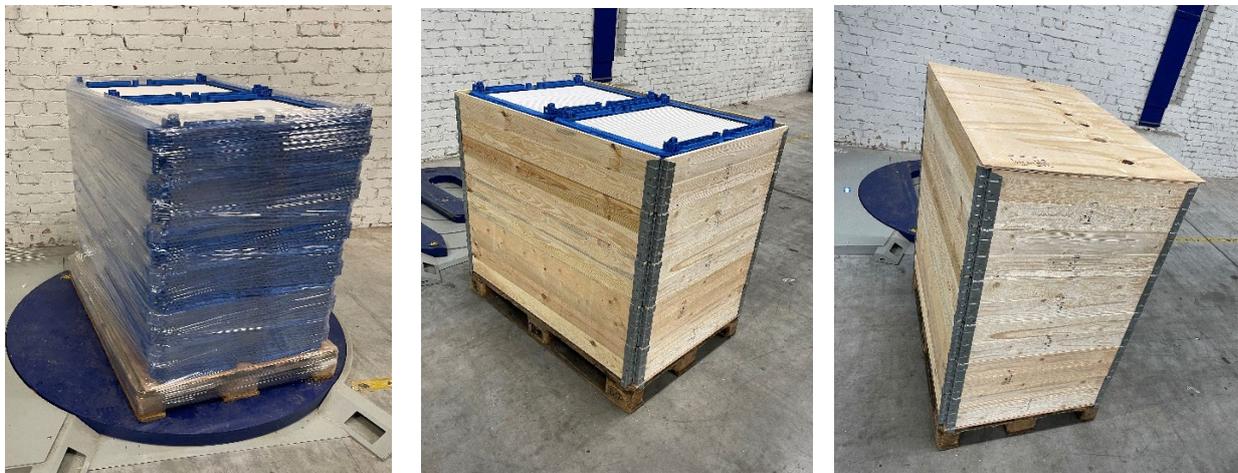


Figure 3: Packaging of Modules



Use only suitable means of transport and safety devices and secure CERAFILTEC's ceramic modules against shifting and tilting!



Shipment is only permitted in dry conditions at temperatures between minimum 1°C (34°F) and maximum 40°C (104°F).



To move the euro pallet a suitable forklift is necessary!

The offloading of the equipment and package must be done with an adequate forklift. Refer to the technical specifications for the exact weight of the units and always operate lifting equipment per manufacturer's recommendation.



Don't use a crane with rope-system due to damage to the membranes can occur!



Figure 4: Use adequate forklift for unloading



Figure 5: Wrong unloading of pallet box

If admissible deviations appear during the inspection of the packing units, modules and/ or other equipment shall be separately labeled and properly stored. The packing units shall not be installed under any circumstances until the quality assurance department of CERAFILTEC is consulted and has decided whether the parts can be used, returned, or need to be scrapped.



Pay attention to the weights when unloading and lifting the module towers!

The weights of the individual pallets can be found on the enclosed delivery notes.

3.2 Storage



If temporary storage of ceramic modules is necessary, it must take place on a suitable, level surface!



Storage is only permitted in dry conditions at temperatures between minimum 1°C (34°F) and maximum 40°C (104°F)!



Direct solar radiation must be avoided at any time to prevent damage caused by the tension of the material!



While in storage, possible damages to CERAFILTEC's ceramic modules through environmental influences or extraneous cause must be avoided!



Keep away from heat or flame!



Take extreme care to prevent membrane surface from damage, since membrane is exposed to surroundings. If possible, maintain membrane modules in the wooden crates/foil they arrive in, until time of installation!

Preferably, store the membranes dry. If stored wet, there is a risk for biological growth on and inside the membrane modules that will require expensive cleaning.

3.3 Handling

The components may be heavy. Always ensure that an adequate workforce is available.

After opening the transport boxes visually check the module for damage. External damage, e.g. due to shipment is obvious and shall be registered and communicated in writing immediately to CERAFILTEC with meaningful documentation (module numbers, complaint, images, etc.).



Cover the top module of assembled towers with a styrodur or plastic plate to prevent damage!

Normally, the modules are in ready-assembled towers when they come in a wooden box on a euro pallet. Due to shipment height limitations, some modules per tower will be delivered as complete, or more modules might be required to be added in the tower to complete the tower configuration.

If a tower must be assembled, ensure that all the necessary parts are on site with the right quantity and in good condition. We recommend for the handling of modules at least 2 persons and they wear safety shoes and safety gloves. The total weight of a dry module is approx. 37 kg. The modules shall be handled at the front sides only; never on or below the membranes. Any damage resulting from improper handling will result in the void the product warranty.

Lifting of modules can also be done when the header set is attached by lifting with a crane.



Figure 6: Handling of modules



Membrane discoloration may occur during transport and storage because the membrane is a hydrophilic material and attracts moisture. The membrane discoloration is not a quality feature and can be removed at the start-up by a membrane cleaning with a NaOCl solution (200 ppm free chlorine).

3.3.1 Lifting of a Module Tower

For lifting a tower, it is necessary to follow the local set of regulations and safety instructions for lifting heavy goods by crane.

The following things should be on site:

- Original CERAFILTEC lifting device (highly recommended)
- Shackle, grommet, and coil loop suitable as per the tower weight.
- A crane which can handle the given weight at the necessary cantilever.

Take care that all 4 ends of the rope are at the same height. If not, it is necessary to open one knot and put it on the right position to achieve the same height. Put a grommet inside of every knot.

The lifting tool should be hung up in the middle of the tool onto a crane hook by a suitable belt.

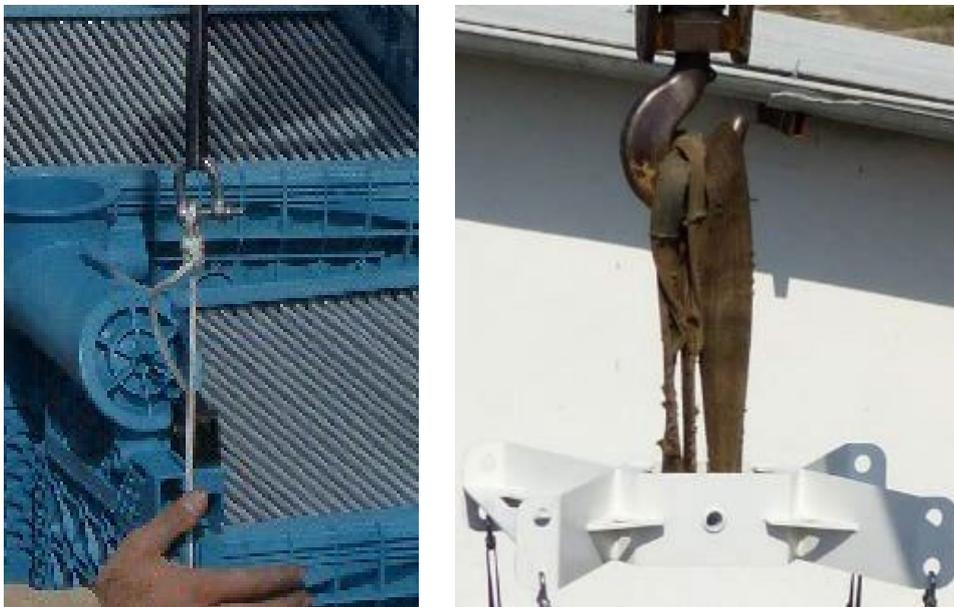


Figure 7: Fixing lifting arrangement

Connect 4 coil-loops with 4 shackles (best triangle shackles) with the lower holes of the lifting tool. The length of the coil-loop depends on the individual requirements of the location. The coil-loop should relate to the rope by shackle or with a carabiner.

When connecting the lifting tool with the filtration tower, take care of the right position. Because the module has a rectangular cross-section it is necessary to have the right position of the lifting tool. The coil-loops must be exact vertical. If this is not the case, the shackles must be opened, and the lifting tool must be turned by 90°.



Figure 8: Lifting a tower with the Lifting Tool



CERAFILTEC’s ceramic modules must be protected against shocks and strong vibrations at any time!



Direct solar radiation must be avoided at any time to prevent damage caused by tension of the material!

4 Safety Instructions

This section is intended to ensure the protection of the person and the system working during the plant operation.

4.1 Chemical Safety

Different chemicals are used for the cleaning of the filtration unit: Acid against deposit of inorganic salts and Sodium Hypochlorite against fouling caused by a bacterial growth on the membrane surface.

The re-filling of the chemical storage tanks needs to be done if the tanks are empty. Adhere to the following when handling chemicals:

- Wear adequate protection clothes (e.g. gloves & safety glasses) and follow the instructions in the MSDS.
- It should be carefully arranged to fill the chemicals in the correct storage tanks (compare with the safety labels on the storage tanks).
- The compound can form spontaneously gaseous chlorine. Not following the instructions might lead to severe injury or even death!!
-

4.2 Caution and Warnings

Hazard Symbol	Description	Safety Instructions
	<p>WARNING OF TILTING DANGER!</p> <p>Always ensure the stability of the Filtration Unit against tilting.</p> <p>Depending on the height of the Filtration Unit an anti-tilting device may be necessary!</p>	
	<p>WATCH FOR FALLING OBJECTS!</p> <p>Watch always for falling objects. We recommend wearing a safety helmet and safety shoes during assembly, replacement, maintenance or repair! Please follow the safety instructions in this document.</p>	 
	<p>WATCH FOR SHARP EDGES!</p> <p>Watch always for sharp edges. We recommend wearing gloves during assembly, replacement, maintenance or repair! Please follow the safety instructions in this document.</p>	
	<p>WARNING OF HEAVY COMPONENTS!</p> <p>Some components may be heavy. Always ensure that an adequate workforce is available. We recommend for the handling of the Filtration Modules at least 2 workers</p>	

Hazard Symbol	Description	Safety Instructions
	<p>CORROSIVE MATERIAL</p> <p>In the event of cleaning (ACEC) avoid any contact with irritant and/or corrosive chemicals. We recommend wearing protective goggles and gloves during the whole cleaning process! Please follow the safety instructions in this document and the material safety data sheet (MSDS) of the chemicals!</p>	
	<p>RISK OF BREAKAGE!</p> <p>Some components are fragile (in particular the ceramic membranes). Always handle all components with care. We recommend wearing gloves in case of any damage! Please follow the safety instructions in this document.</p>	
	<p>EXCESS PRESSURE</p> <p>In the event of backwashing (periodically during the normal operation) and cleaning (CCC, iCC) the permeate channels and the Filtration Modules are charged with an excess pressure up to 2 bar. Keep clear of these components during the described processes. We recommend wearing protective goggles at any time!</p>	
	<p>BIOHAZARD</p> <p>In the event of using CERAFILTEC® for the treatment of e.g. waste water or other water with possible biological contaminations ensure that all local regulations are observed. We recommend wearing protective goggles and gloves at any time!</p>	
	<p>GENERAL WARNING</p> <p>Please note that not all local regulations, hazard warning notices and safety instructions are covered by this document using CERAFILTEC modules. Please acquaint yourself with the local regulations in order to avoid any health risk! We recommend wearing protective clothing at any time!</p>	

5 Assembly, Installation, and Commissioning

The instruction for the assembly and installation is to have the correct set-up to ensure proper operation of the UF system.

5.1 Assembly

5.1.1 Preparation

A filtration tower consists mainly of stacked ceramic modules. The ceramic is a very robust material and can withstand for a long time in harsh conditions inside of the filtration tank but if a mechanical impulse comes on the ceramic, it can break and must be repaired or replaced. Also, dust and oily aerosols will not be helpful if the equipment should later be installed in drinking water application.

If a new delivery comes to the installation site, please open only the top of the wooden box to check all modules/towers and to check with the delivery note if all components are complete. Afterward, close the box, maintain storage at 40°C temp. max, and keep it closed until the start of tower assembly. For details, refer to section 5 for storage and handling instructions.

Normally, delivery will come as ready-assembled towers stacked in a wooden box on a euro pallet. Due to shipment height limitations, some modules per tower will be delivered as complete or more modules might be required to be added in the tower to complete the tower configuration.

If a tower must be assembled, ensure that all the necessary parts are on site with the right quantity and in good condition. The quantity can be checked by referring to the packing list. If admissible deviations appear during the inspection of the packing items, it shall be separately labeled and shall not be installed under any circumstances until the quality assurance department of CERAFILTEC is consulted and has decided whether the modules or accessories, can be used, returned or need to be scrapped.

The filtration tower can be assembled only with a few tools and with at least two people.



Figure 9: Sliding agent to be put with brush (e.g. Molykote compound 111)

The following items should be on site:

- Sliding agent for all profile gaskets at the permeate connections. As a standard, the gasket is made from EPDM. Because of this, the sliding agent must not contain mineral oils or other ingredients which degrade EPDM. Depending on the application, the agent must meet the local regulations for the application (e. g. drink water approval).
- Clean brush for putting the sliding agent.
- A flat stable floor of at least 1x1 m (3x3 ft) size.
- One or two ring spanners, size 17 or similar (e. g. which works very well is a spark plug spanner). This tool is used for the key lock. Do not use a screwdriver, the key lock can be damaged.

5.1.2 Tower Configuration

The tower size can be between 1 and 16 modules which is different in the height between 435 mm and 2675 mm. Please check which size is chosen for your project. A filtration tower always begins with a base module, the lowest module of a tower.

Table 2: Mounting Filtration Tower Basic Information

Tower Size <i>No. of Modules</i>	Height <i>mm</i>	Weight <i>kg</i>	Rope length <i>mm</i>
1	435	46	2 x 2520
2	595	82	2 x 2840
3	755	118	2 x 3160
4	915	154	2 x 3480
5	1075	190	2 x 3800
6	1235	226	2 x 4120
7	1395	262	2 x 4440
8	1555	298	2 x 4760
9	1715	334	2 x 5080
10	1875	370	2 x 5400
11	2035	406	2 x 5720
12	2195	442	2 x 6040
13	2355	478	2 x 6360
14	2515	514	2 x 6680
15	2675	550	2 x 7000
16	2835	586	2 X 7320

5.1.3 Assembly of Module Tower

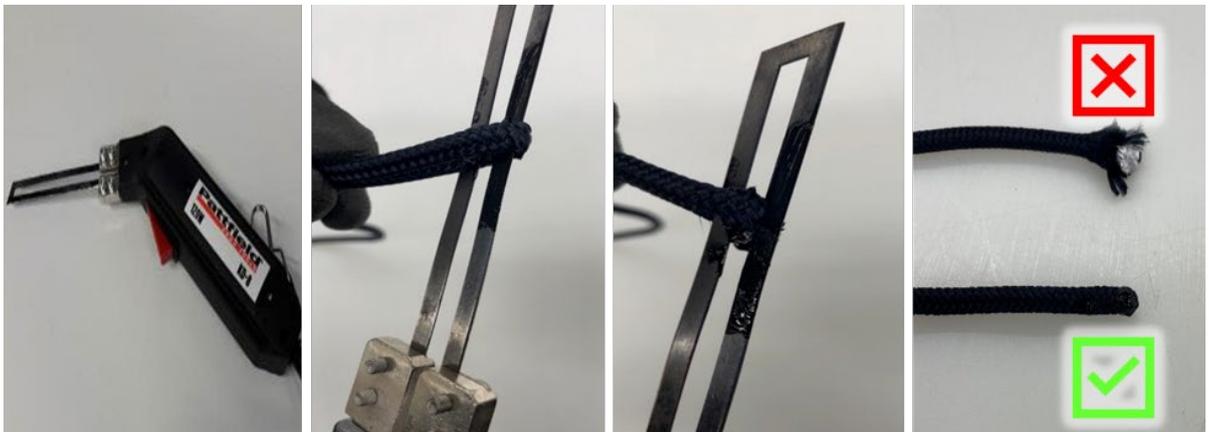
It takes at least two people to assemble a filtration tower. Refer to the following steps:

1. Put one base module on the floor. Put it on the front frame and lift one side. Put 2 corner feet in and fix it with 2 key locks. Lift the module in the same way on the other side and assemble the other both feet with the key locks.

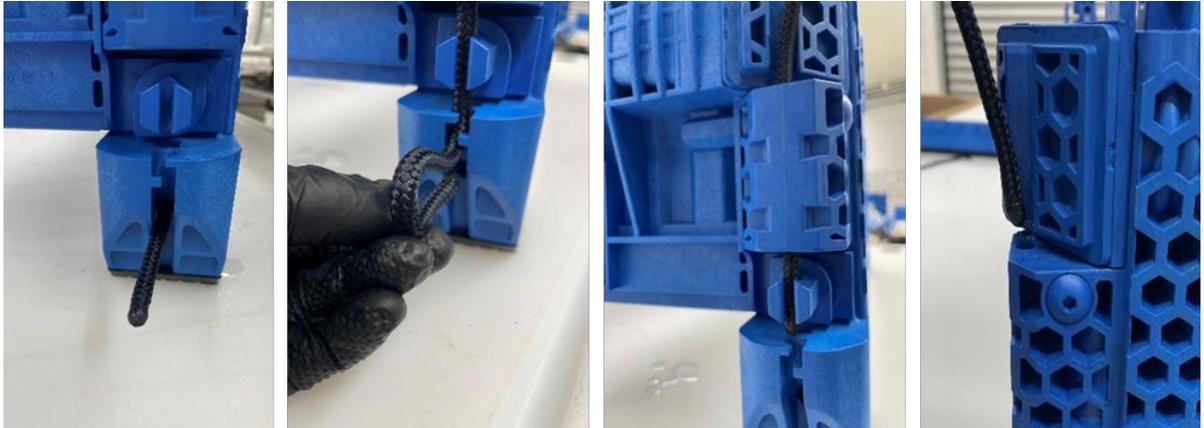


Caution! Ensure that the first module is a base module! All succeeding modules above it are standard modules.

2. For one tower, two ropes are necessary. The ropes must be the same and the right length. Both ends must be cut with a special hot rope cutter not with a knife or scissors. The diameter of the rope ends should not be wider than the rope itself, otherwise, it will cause problems during threading.



3. Thread one rope left and right into the holes on the lower side of the corner feet until it comes out on the top of the first module. If it is stuck, try to drill the rope with the fingers with a slight pressure. Do the same with the second rope on the other side. Finally, all 4 ends of the two ropes are on the top of the first module.



4. Put 4 asymmetric profile gaskets on the first module. Put the thicker side down. When all 4 gaskets are in the right position, coat only the outer side of the gasket with slide agent. Use a clean brush for this activity.



Caution: If gaskets are installed incorrectly (upside down), the module will pass pressure decay testing under pressure, but leaking under suction is possible. Please verify that the largest rib of the gasket is on the bottom side

- Put the second module on the top of the first, press it, and use the one-handed clamp from the CERAFILTEC toolbox.

Don't force the welded edges of the plastic frame!



- Press the one-handed clamp, put the key lock into the holes, and close it with the ring spanner.



Caution : Key lock's "line" should be positioned horizontally when inserting into the hole and ensure that it is fully inserted before turning clockwise until the "line" is in a vertical position. Never try to close the key with force!

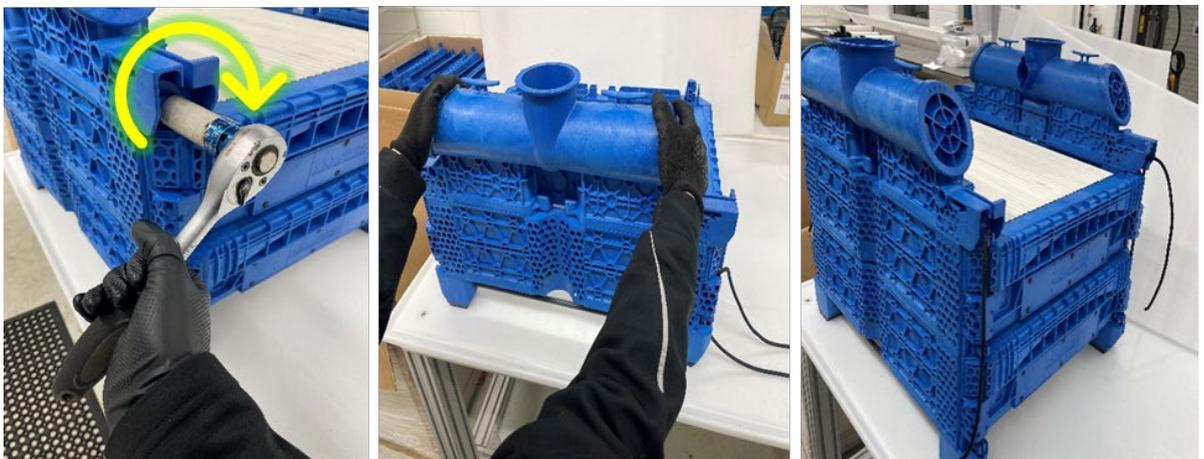


7. Thread the rope through each corner until the top module is finished.

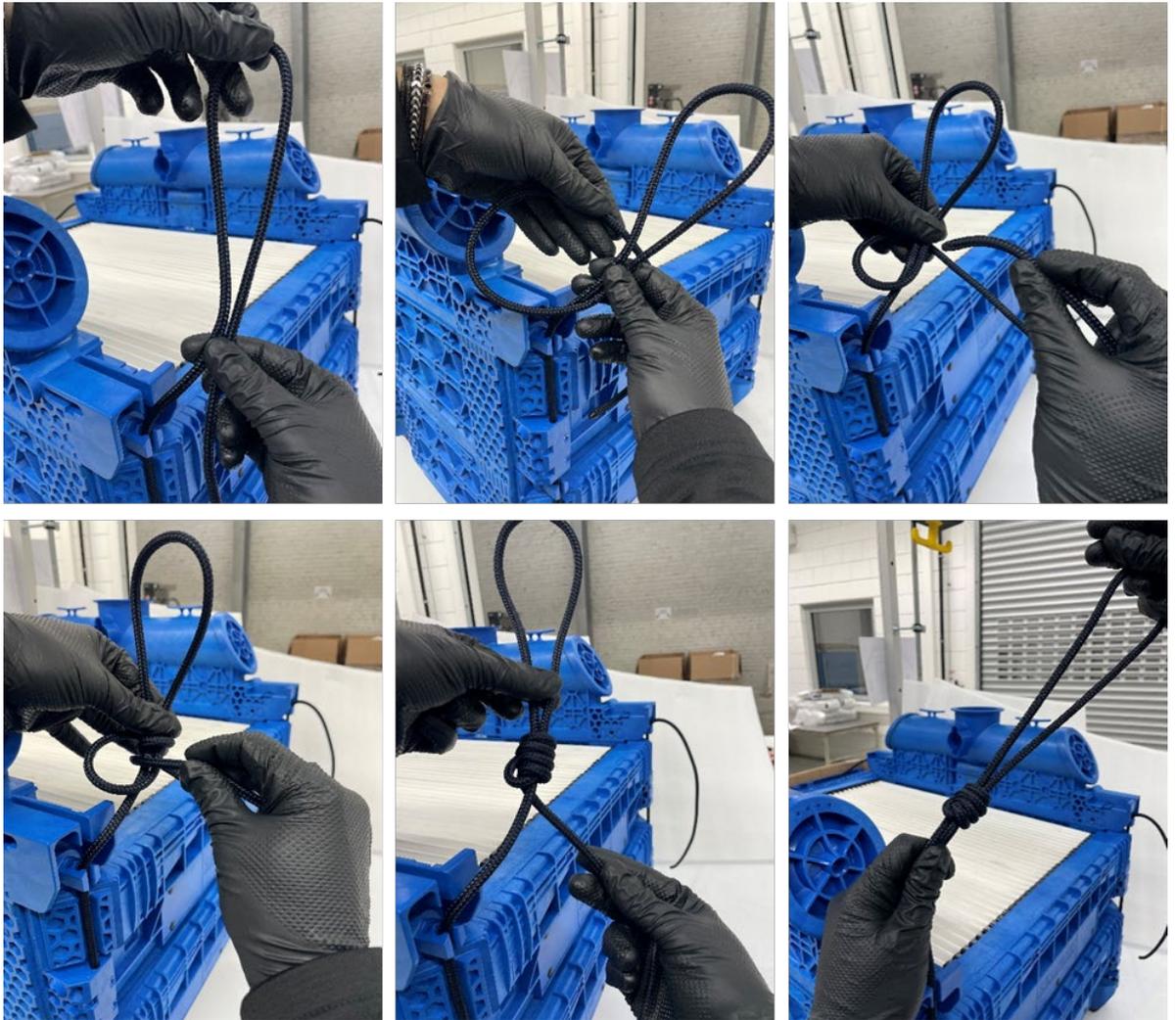


8. Repeat the instructions 4 to 7 until the correct size of the tower is reached.

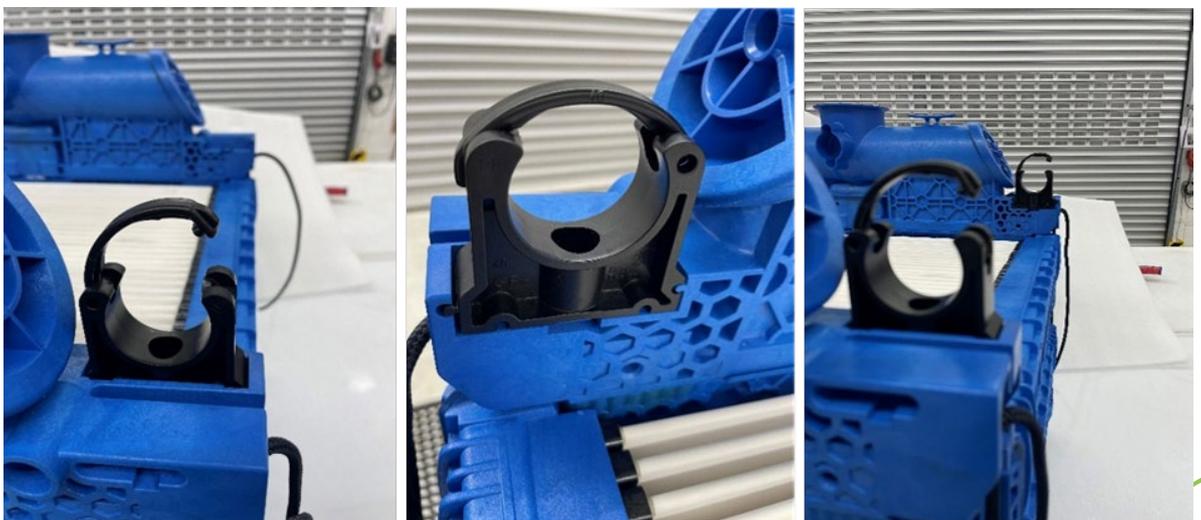
9. The completion of a tower is the header collector.
Installation is the same as for a module (step 4 to 7).



10. Prepare the lifting knots at every end of the ropes.



11. Install the pipe clips for the sprinkler system. Turn the pipe clip in the right direction and push it into the cutout until you can hear a "click". When both clips are installed and open do the same on the other side of the tower.



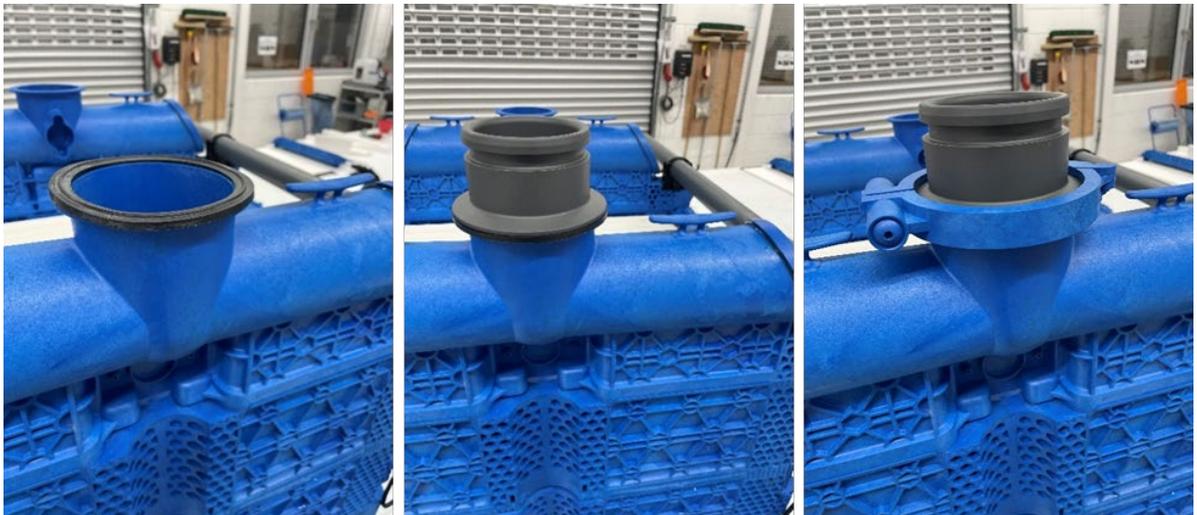
12. Put the sprinkler pipes and turn until the top holes are horizontal.

To install the pipes, they must be cut to the right length which is defined by the distance between the towers. Ideally, the connection will be done by a metric screw fitting. The fitting will be connected to the pipe by gluing it with a special glue for PVC-U pipes. The final closing of the threads of the PVC fitting must be done after the installation of the towers in the filtration tank.

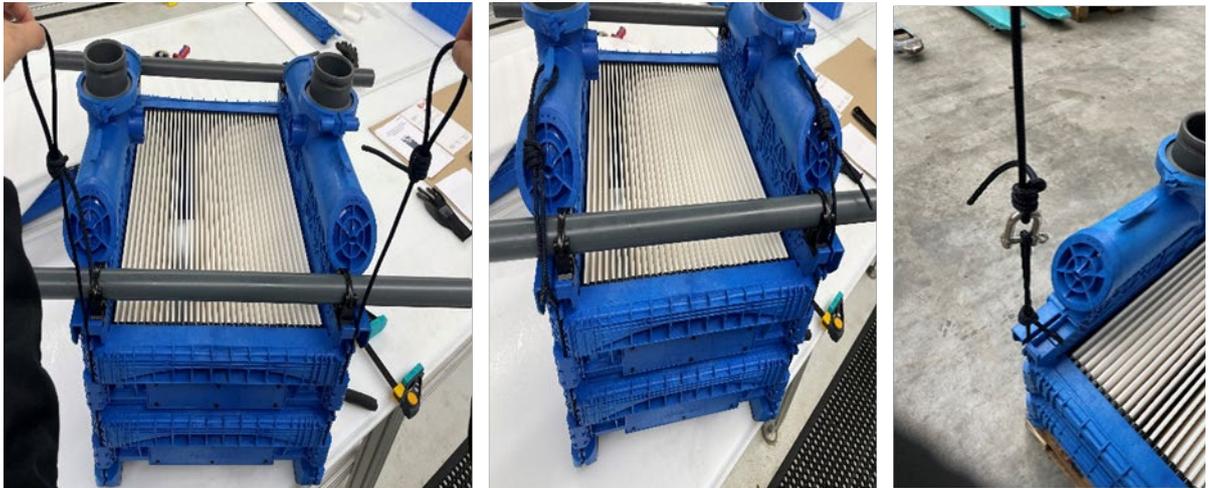


Note: Not all applications require sprinkler system. Refer to the specific projection if this is required.

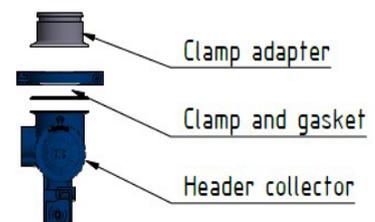
13. Assemble the header adapter to the header collector.



14. Assembly of the tower is now complete. Insert the shackles to lift the tower. Make sure the shackles are suitable based on the tower weight.



CERAFILTEC will provide up to clamp adapter only. Client to prepare o-rings, flexible PVC pipe, and collector pipe to complete the tower assembly



Step-by-step installation video guide:

<https://www.cerafiltec.com/how-to-assemble/>



5.1.4 Disassembly of Module Tower

Lift the tower and put it on a flat floor. Remove the header by opening the 4 keys and tire on the header parts. Put the header parts onto a clean floor.

For disassembling a tower, first all 4 knots of the ropes must be opened. Next, open all 4 keys of the top module with a ring spanner. Lift the top module with 2 people. Repeat this procedure for the next modules.

Take care with the handling of the modules. Put them on a flat floor. Don't put tools on the modules. If the modules should be stored for a longer time, cover them or put them into a box.

5.2 Installation

Tank sizes and the required filtration equipment are provided in CERAFILTEC projection. Tank design and all related standard drawings necessary for the installation will be shared upon project execution.

Due to the modular design concept of the towers, it is very easy to install our equipment.

5.2.1 Preparation of the Filtration Tank

Normally the filtration tank should be as tight as possible to reduce water loss during discharge and cleaning operations. If a cross-flow during filtration - produced by continuous aeration during the filtration process - is necessary, the area around each single tower should be at least the same as the cross-section from the top view of a module tower. This is required for the downstream.

Most important for every process is a good working sludge removal during a backwash by emptying the tank. For this, under every tower or tower row, a ditch is required (either with a defined slope of at least 5° or no slope depending on the application) and a width of the total inner width of the membrane tower is necessary (in general, 520 mm).

A smooth trowel finish is required, most importantly in the tank's bottom, to prevent the accumulation of sludge or deposits and to provide a thorough and effective tank drain. The smooth bottom surface should also be water-leveled to properly install the tower's position holders or frames. Also, the tank's surface to be chemical-resistant to protect the tank from harsh chemicals. Typically, tank coatings are applied with e.g. epoxy or polyurethane lining for chemical resistant additional protection. Concrete corrosion needs to be avoided in any case, debris of broken concrete can severely damage the membranes.

The train should be prepared for installation, which means that the civil work construction is completed and piping, valves, instrumentation, and related works are installed (scope of project partner).

5.2.2 Installation Steps in the Filtration Tank



CERAFILTEC's will provide its specific scope of material supply. All other components and accessories not explicitly mentioned will be end-user/installer scope. End-user/installer to fully understand the required materials and it and have them ready before installation of the tower modules inside the tank. CERAFILTEC will not be responsible for providing any missed components under the end-user scope.

Important Note: Adhere precisely to the general arrangement (GA) drawing to ensure all components are in the right position and properly aligned during installation.

The next steps are an example of a typical standard installation.

1. Installation of filtration Tank

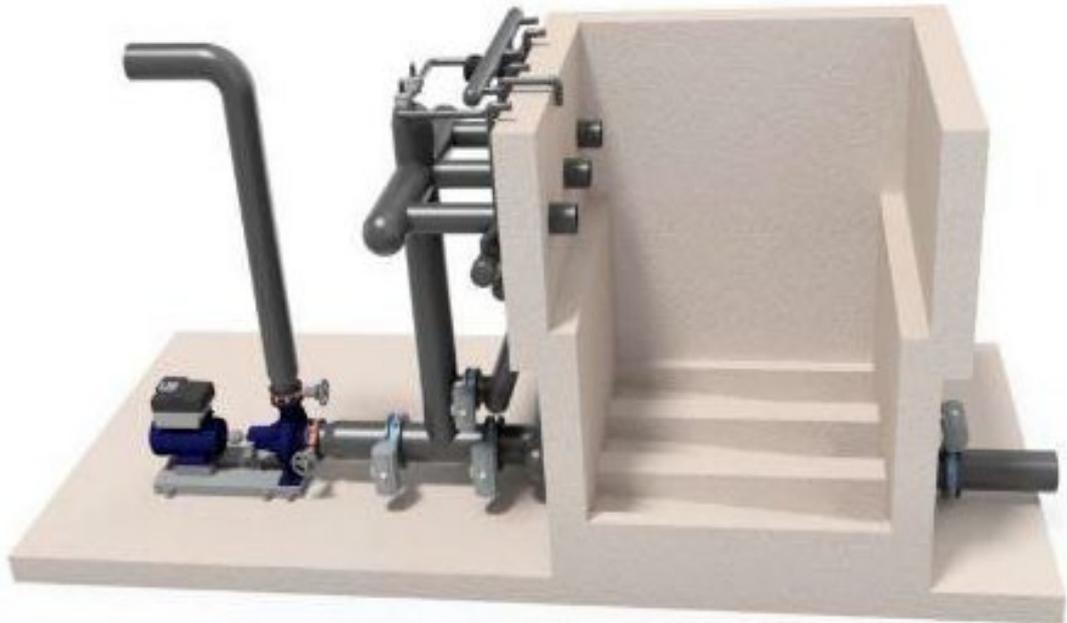
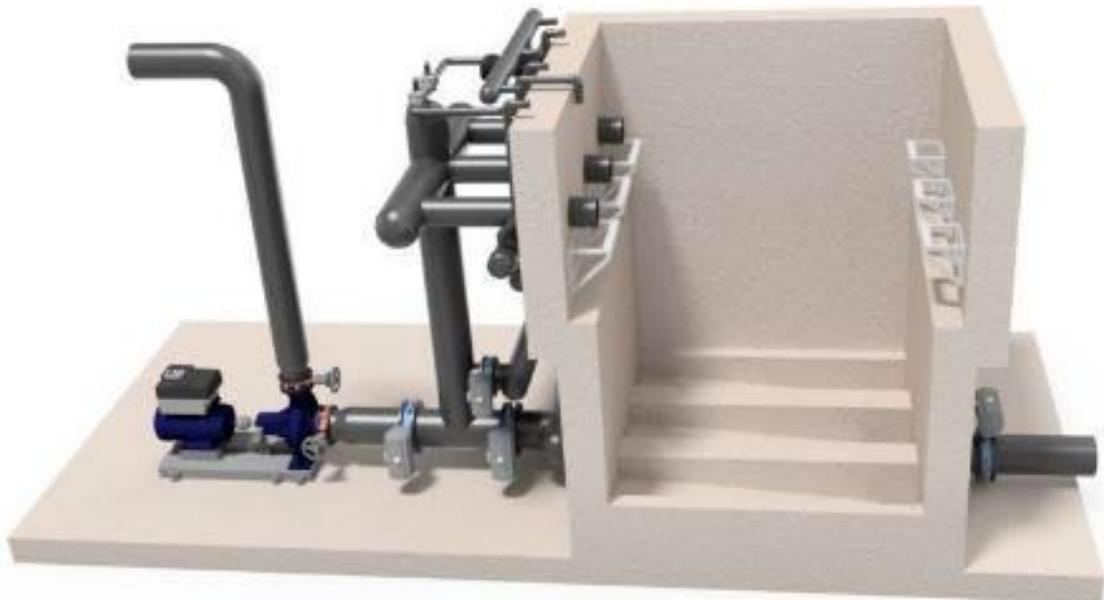


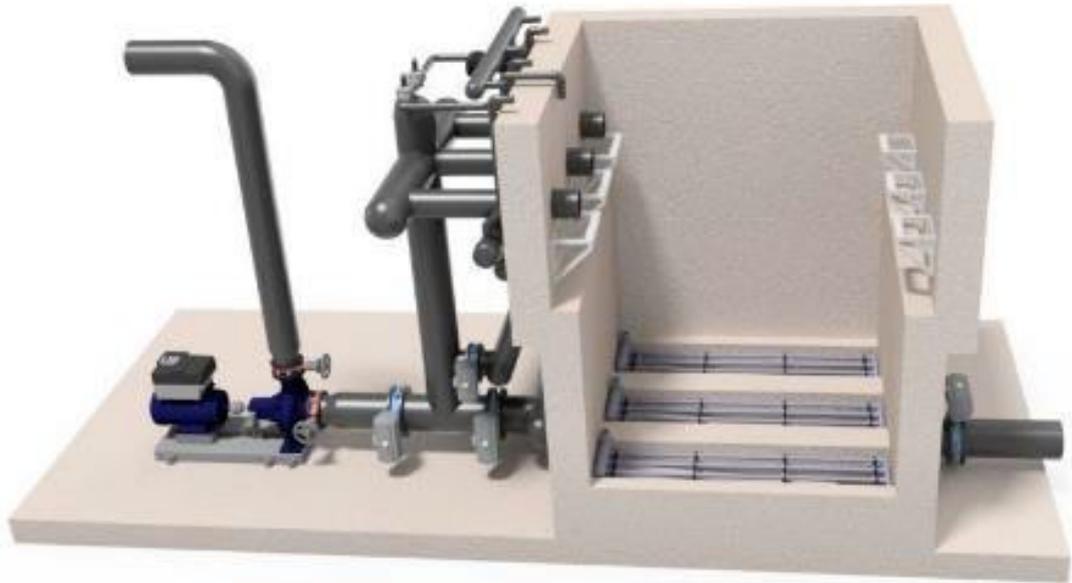
Figure 10: Tank design sample illustration

Ensure that the puddle pipes are fixed in the center of the channel and that the center of the puddle will be aligned with the center of the towers.

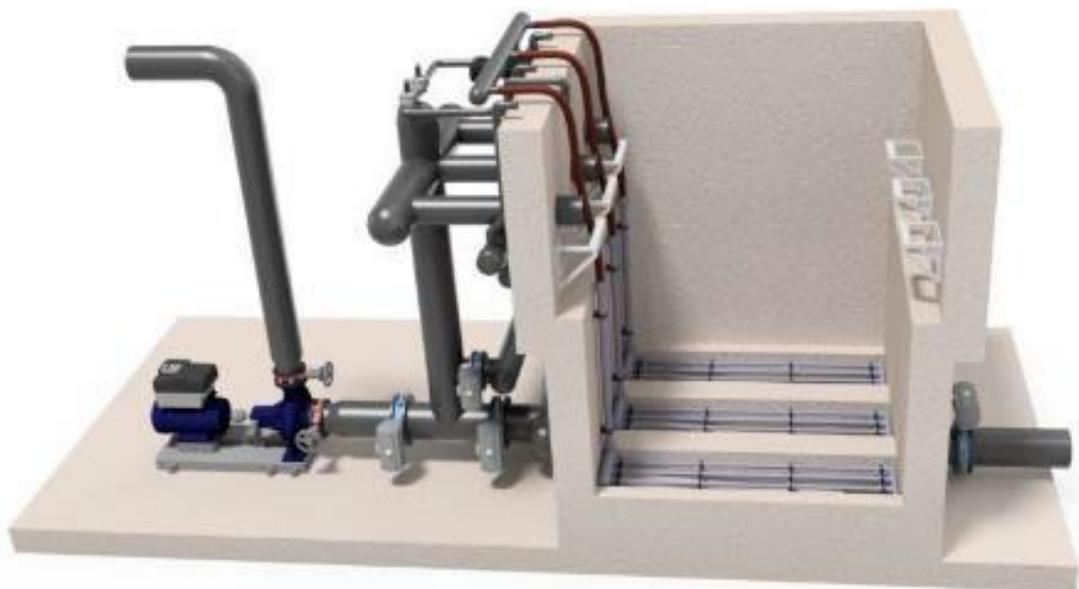
2. Installation of filtered water header **pipe holders** on the left and right sides of concrete walls.



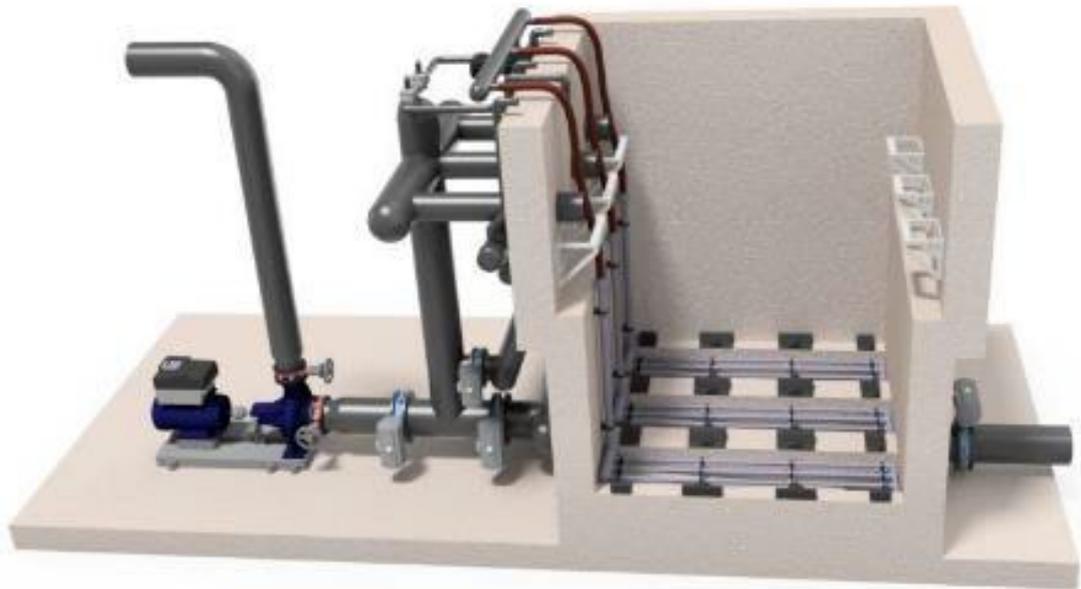
3. Installation of air scouring sets to be fixed by screws on concrete bottom.



-
4. Connection of installed **air-scouring sets** to common blower pipe.

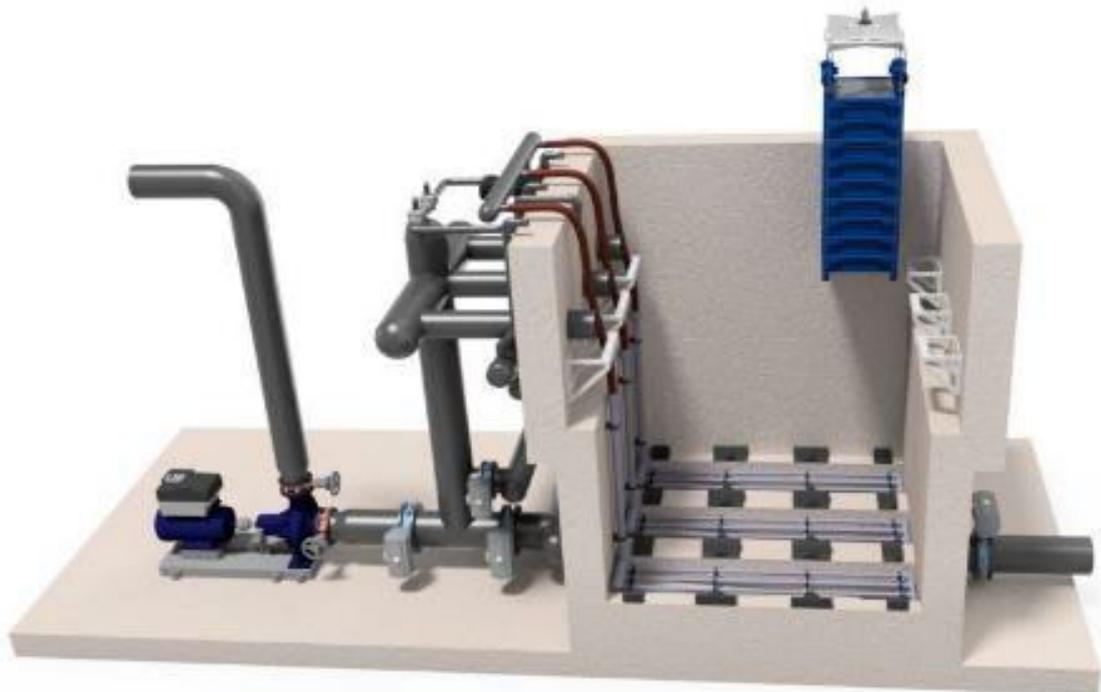


5. Installation of tower **holders** on the bottom of the tank. It can be a base frame or position holders as sample illustration below.



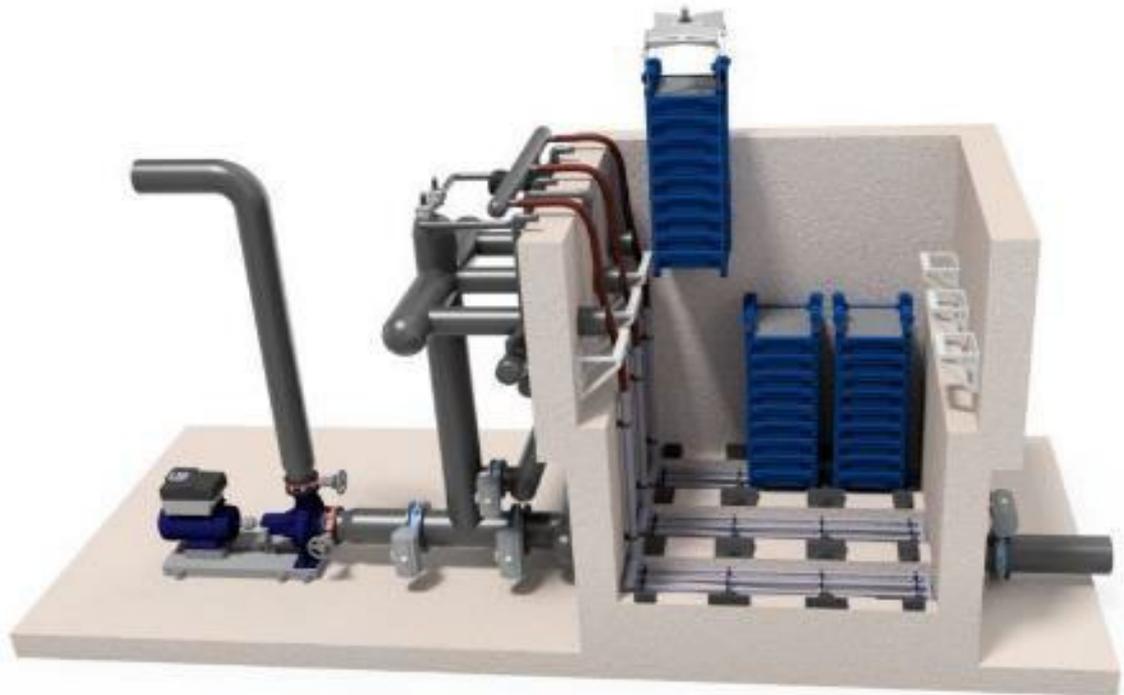
Ensure the position holders are aligned center on the channel beams and puddles. Position holders are to be fixed to a water-leveled surface.

6. Positioning of first module tower. (For tower lifting arrangement, refer to Sec. 3.3.1)

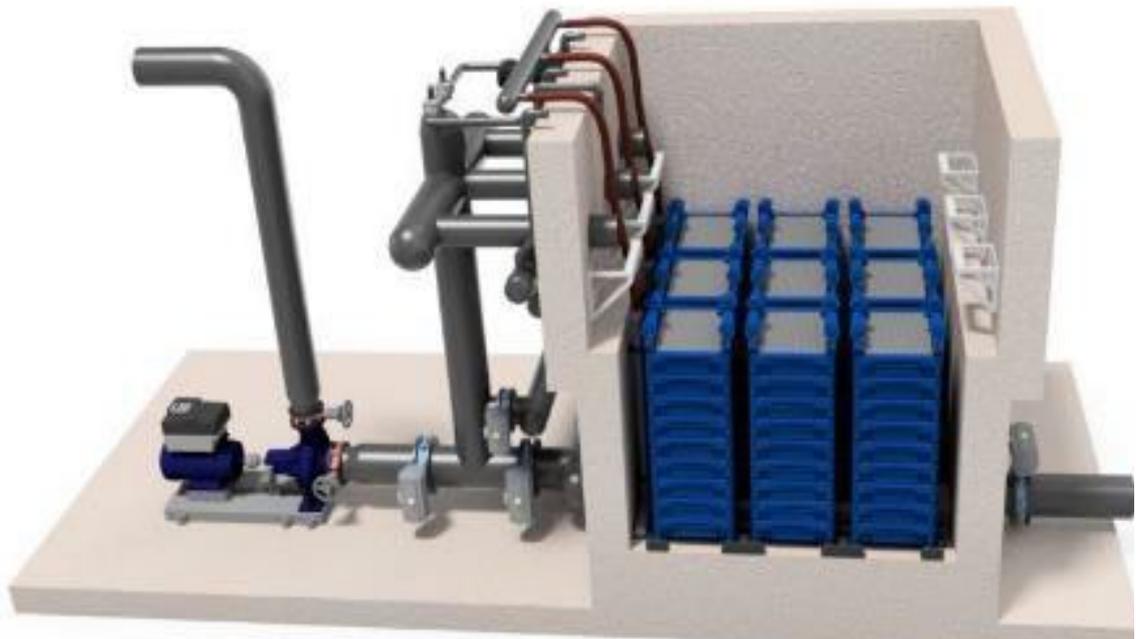


Consider the site conditions and safety protocols, when lifting and positioning the tower inside the tank. Ensure that no part of the tower hits any solid surface that may damage the tower or modules.

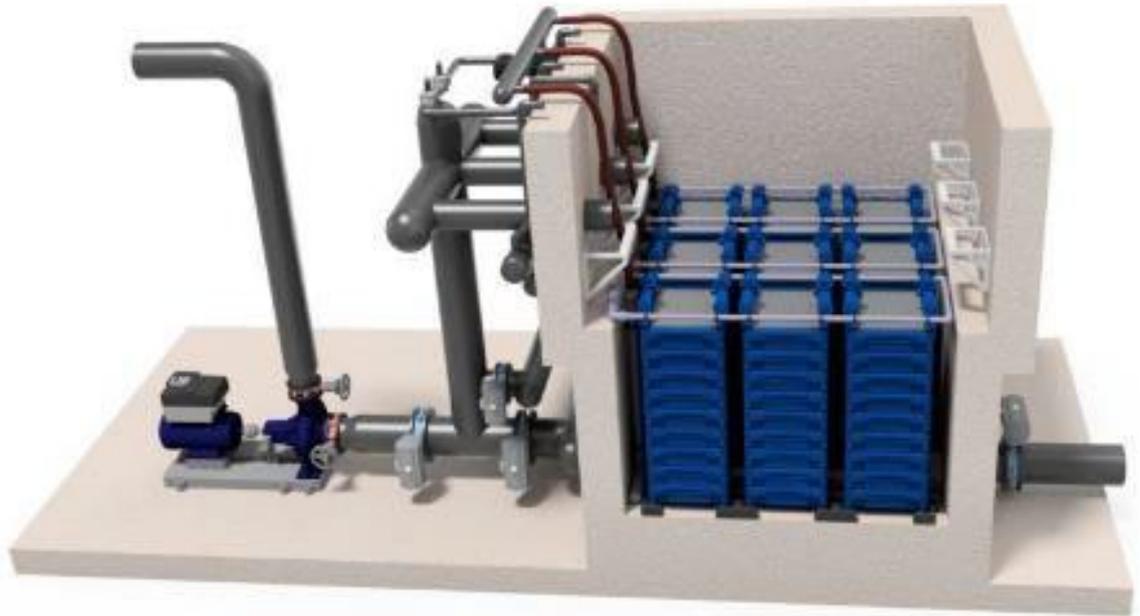
7. Completion of first tower line.



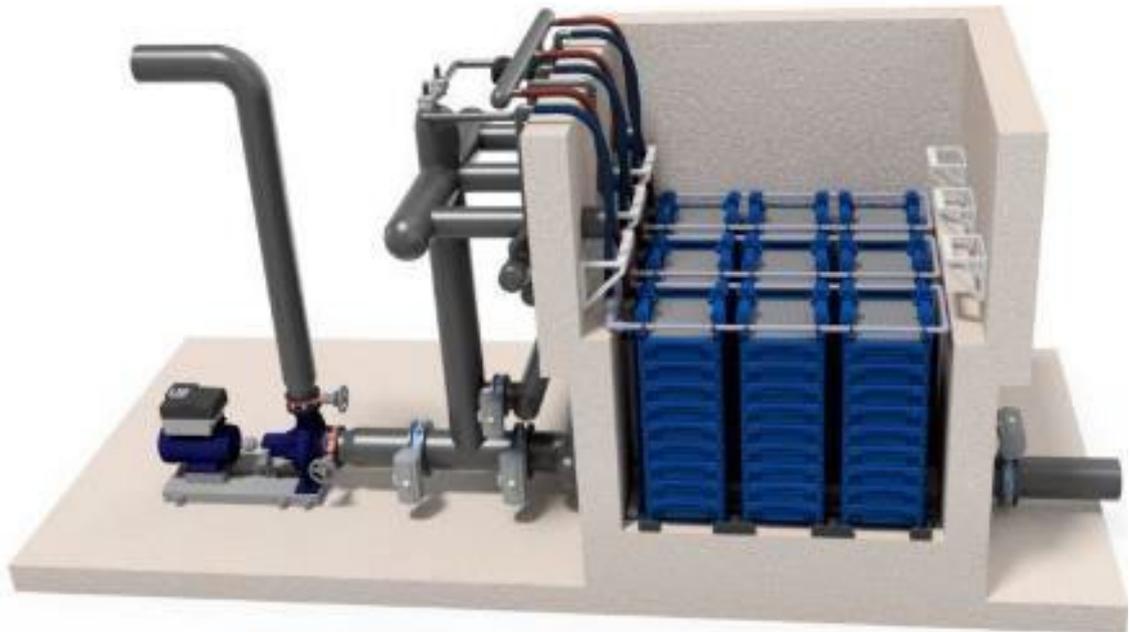
-
8. Repetition of tower positioning for all remaining tower lines.



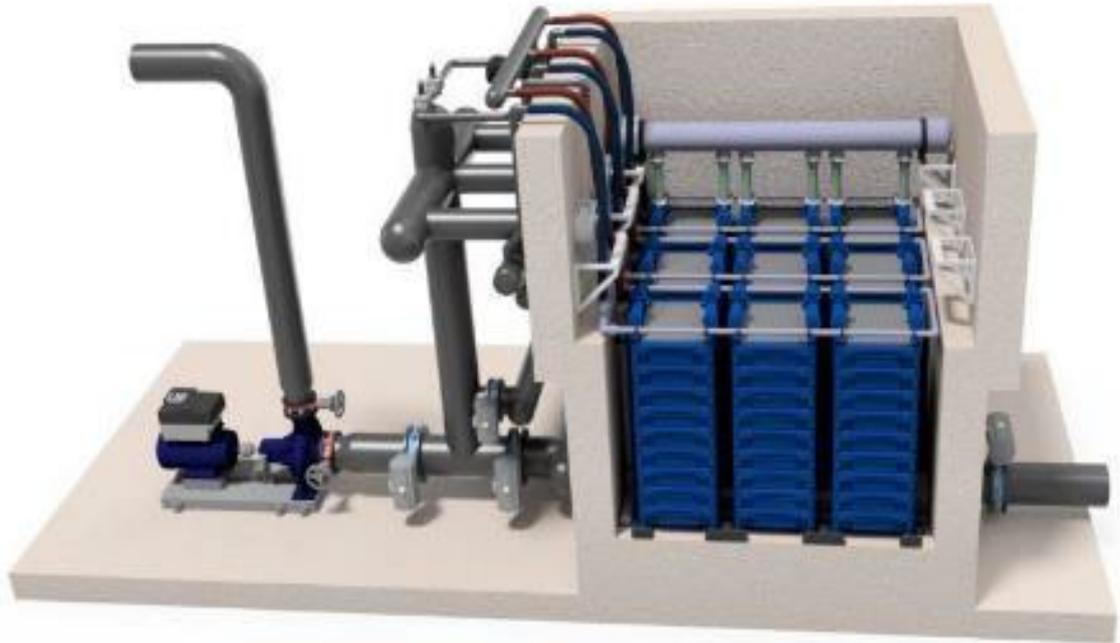
9. Installation of **sprinkler sets** on top of all tower lines.



10. Connection of installed sprinkler sets to common sprinkler pipe.

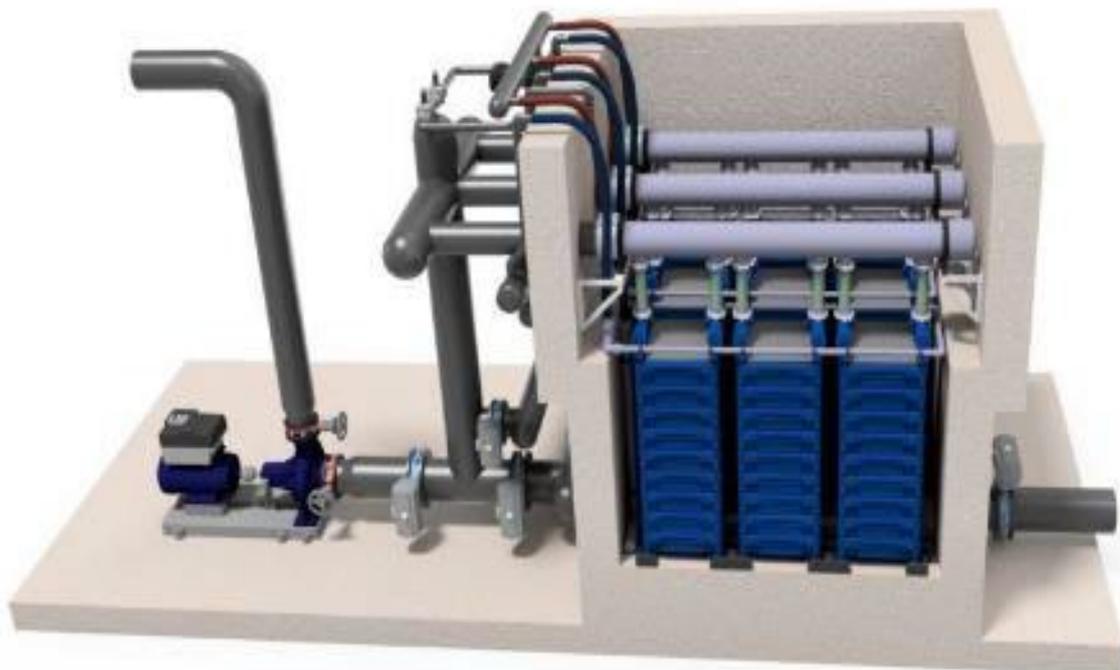


11. Installation of filtered water header pipe couplings and header pipe, connection to each tower, fixing on wall holders, and coupling.



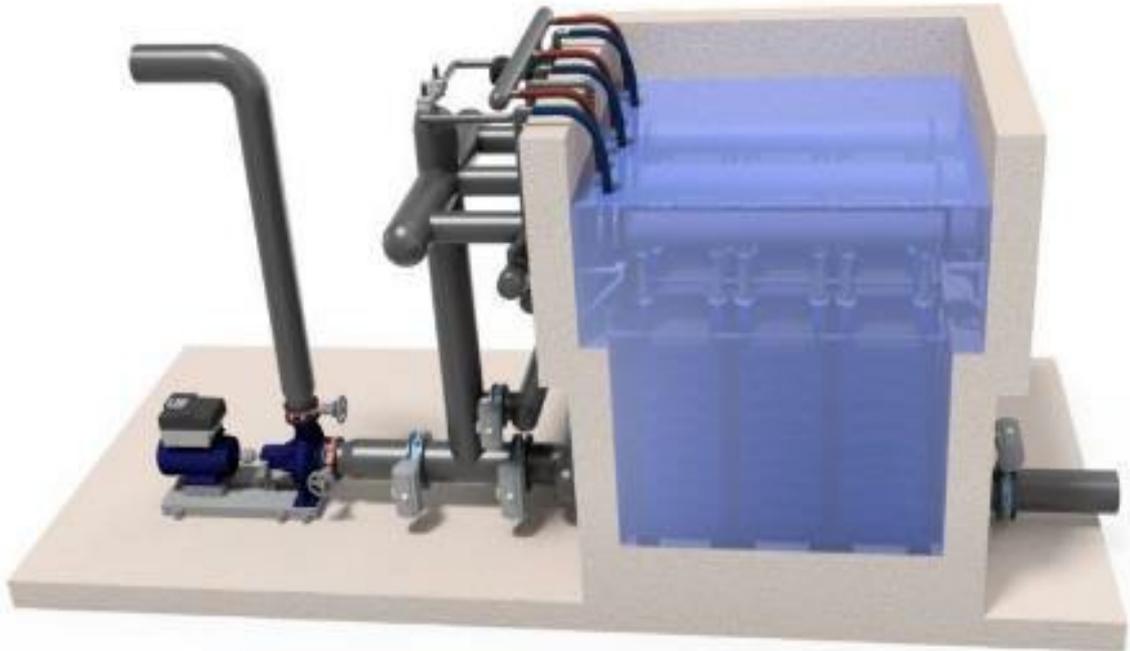
CERAFILTEC recommends using flexible PVC pipe as a connection pipe between the tower and the line header. However, in the case of using hard PVC pipe, make offsets by heating the connection pipe to prevent misalignment of the clamps at the towers.

12. Repetition of filtered water header pipe installation for all remaining tower lines.

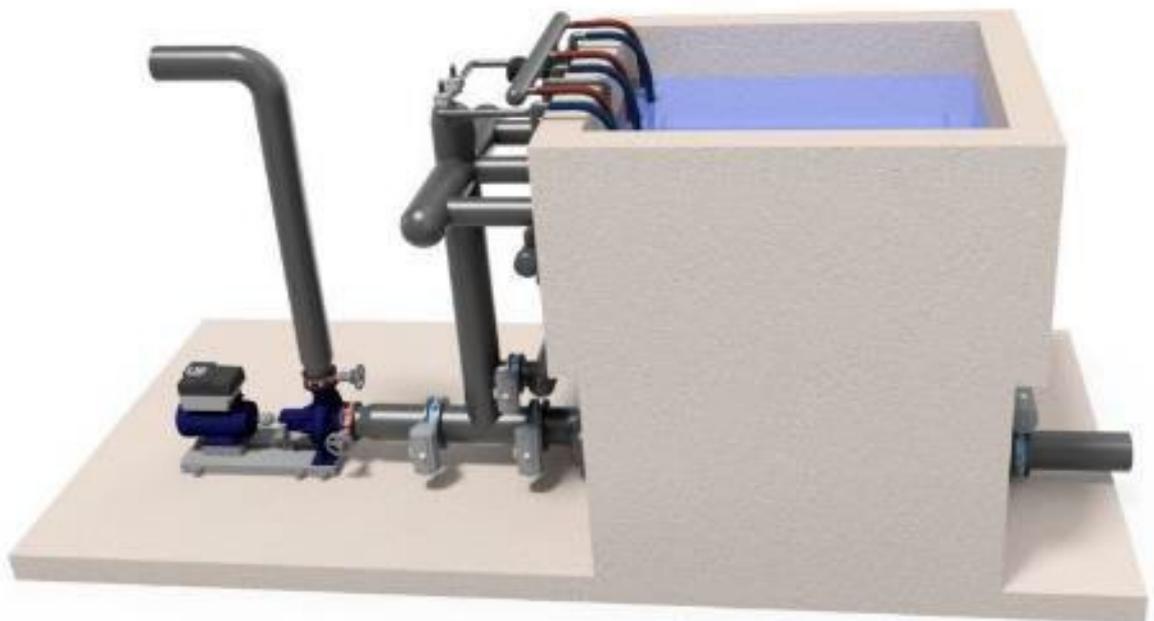


13. Ensure that all related electro-mechanical components are tested and working before the testing of the towers.

-
14. Conduct leak test and process start-up. Refer to sections 5.2.3 Leakage Testing and 5.3 Commissioning (Start-up Filtration).



-
15. Ready for operation. The train can be put into operation as per projection.



5.2.3 Leakage Testing

Before starting the filtration process, the filtration towers must be checked for any leakages as seen in Figure 11. A leakage test is a procedure to detect damage of a filtration tower which can result from manufacturing errors or damage during transport or handling.

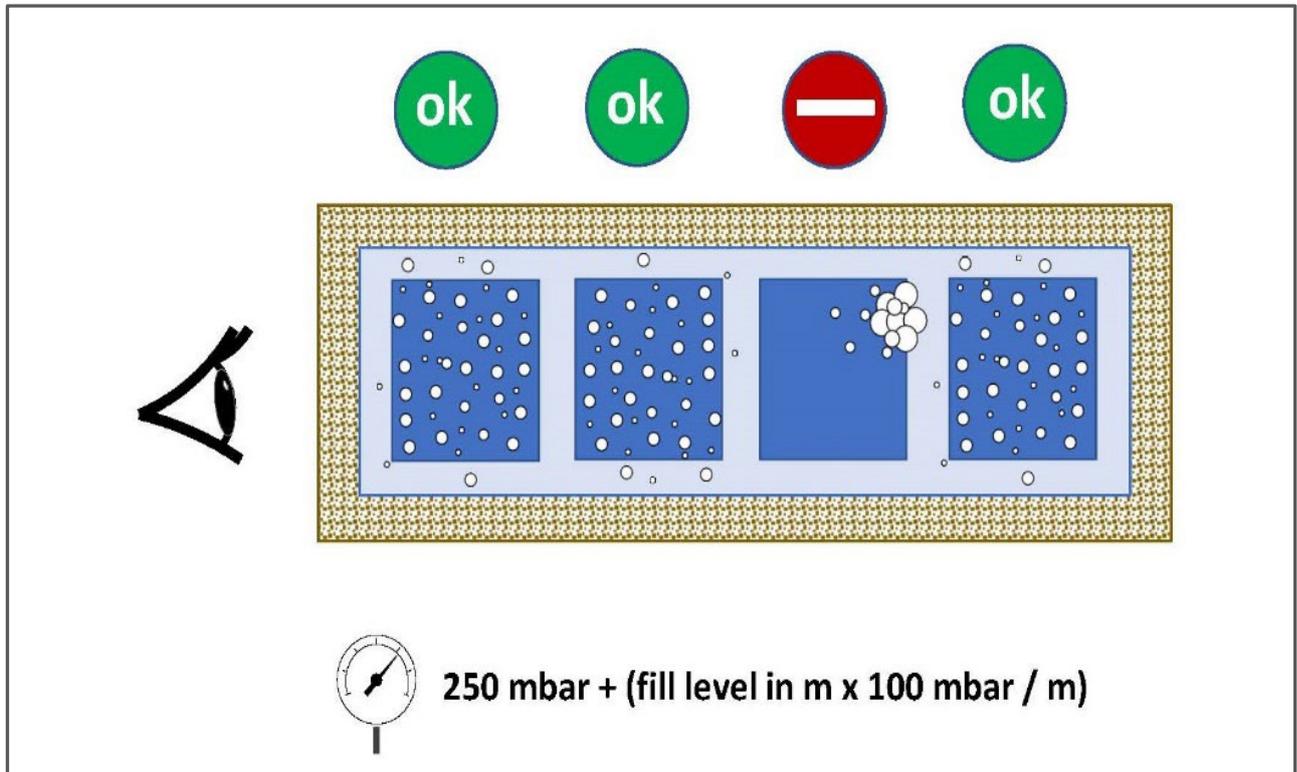


Figure 11: Observation of Leakages

Leakages can be detected with a bubble-point test. To do this, the filtered water header pipe is connected to an air pipe with a suitable adapter/connector. The complete tower including the header pipe must be submerged in clear water (filtration tank or separate tank).

While filling the tank, larger leakages can already be identified. In case of using the filtration tank, hand valves or all automatic valves related to the filtration line (filtration, degassing, circulation,...) have to be closed before the tank is smoothly filled with clear water (e.g. tap water). If there are any larger leakages, the air inside the filtration tower will exhaust, and coarse bubbles will occur in the water.

If no leakages are detected during filling, the filtered water pipe is afterward charged with an overpressure. The applied pressure depends on the actual submersion depth, respective to the hydrostatic head above the filtration tower. We recommend a submersion depth of about 3.0 m, thus, a total overpressure of 550 mbar. Actual overpressure is calculated as follows:

$$250 \text{ mbar} + (\text{fill level in m} \times 100 \text{ mbar} / \text{m}).$$

Before charging the full overpressure to the filtration tower, pressure is increased step by step as described in the following:

- Charging 50-100 mbar in order to detect leakages on the filtered water header and connected piping. Holding time: 5 minutes.
- Increasing pressure up to 100-150 mbar in order to detect leakages on the upper filtration modules and piping. Holding time: 5 minutes.
- Increasing pressure up to 200-250 mbar in order to detect leakages on the median filtration modules and piping. Holding time: 5 minutes.
- Increasing pressure to 550 mbar (depending on actual submersion depth, see above) in order to detect leakages on the lower filtration modules and piping. Holding time: 10 minutes.

Intact filtration towers exhibit an evenly distributed formation of fine bubbles exclusively above the ceramic membranes. If a filtration tower displays unevenly distributed coarse bubbles, it is likely that one or more membranes, sealings, or frame components are damaged. In such cases, thorough leak verification and fault correction must be conducted. The precise location of the leakage can be identified as shown in Figure 2. For instance, when searching for leaks in the header, the tank should be filled with water until the header.

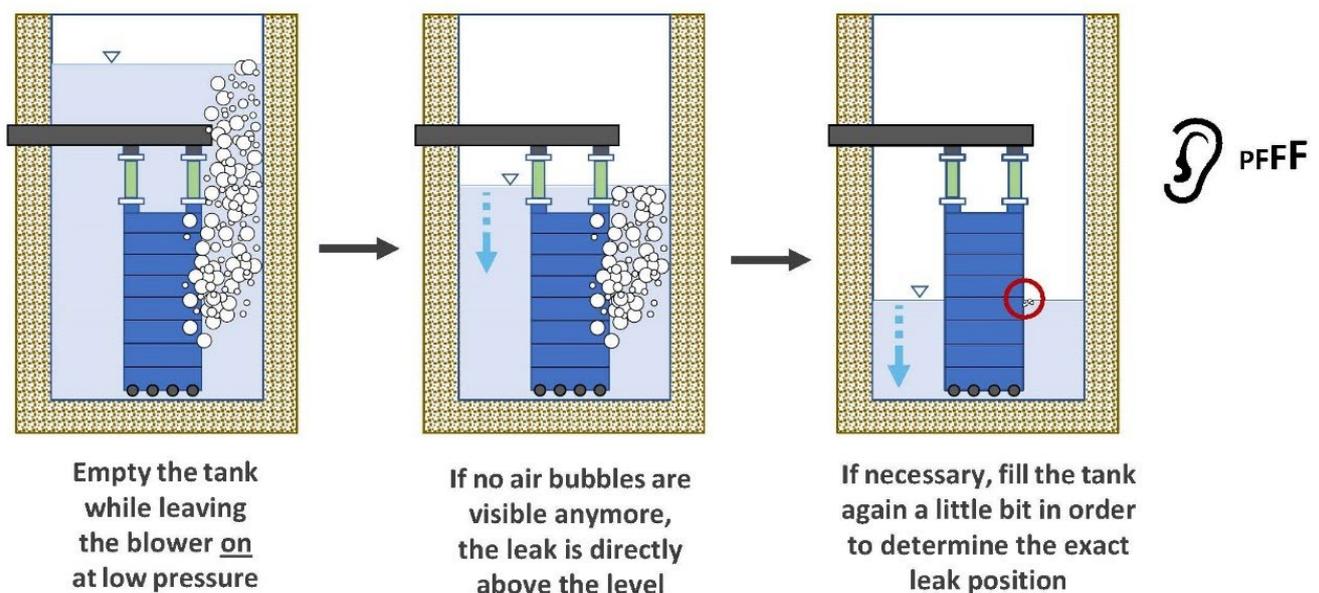


Figure 12: Finding exact location of the leakage

We recommend checking for leakages periodically, e.g. after every chemical cleaning (CIP).

To detect any leakages in the pipeline going to the filtration towers, conduct a water leakage test by using the backwash pump.

5.3 Commissioning (Start-up Filtration)

Before commissioning (start-up of the system), the functionality of all components like pumps, blowers, valves, sensors, and instruments are checked. Ensure that the feed flow is available, pre-treatment is working, all valves are in the right position as per the control philosophy.

Actual raw/feed water parameters should be checked and compared to the design parameters. In case of deviation, CERAFILTEC will provide support in adjusting the system's operation required to cater as per the site condition, however, CERAFILTEC will no longer be liable to its initial performance (quality and quantity) based on the original design.

Only filtration towers that are faultlessly assembled and installed may be started. A successful leakage test of the filtration towers is mandatory before start-up. All pipes and tanks should be rinsed and free from any deposits (e.g. production residues, sludge). If tank filling was combined with leakage test the degassing valve needs to be opened until all air is evacuated.

Once the preparation procedure is completed, the following sequence can be put into operation:

- After filling the filtration tank, the filtration should be started first with a reduced flow of 25% and after the trouble-free operation, it can be increased by 25% every hour. Recommended operation time: 3 hours
- Aeration system is started, and the functionality of blower and air pipes is checked. An even distribution of air bubbles must be ensured. Recommended operation time: 5 minutes
- Sprinkler system is started, and functionality is checked. Recommended operation time: 5 minutes
- Backwash (including aeration and sprinkler) is started as specified in the description of the operation after finishing 1 normal filtration step. Backwash pressure, flow, and time for emptying and filling the filtration tank should be recorded.

During the start-up time, the following parameters should be checked periodically, at least every hour:

- Transmembrane pressure filtration/backwash
- Flux
- Permeability
- Permeate quality: SDI, Turbidity, Metals, organic matters

After three hours of operation, the values of these parameters should be in accordance with the projection's design water parameters. During the first 3 days of operation, permeate quality, and all operation parameters (pressure, flow) should be checked and recorded every two hours.

In case of recommissioning, it is mandatory to conduct chemical cleaning of the membranes and leak test prior to recommissioning/filtration process can begin.

6 Operation

This section will guide you the basic process of operation with CERAFILTEC's ceramic ultrafiltration. However, to match your requirement, refer to the projection for the filtration time, flux, cleaning process, and other specifications to have a proper operation.

6.1 Basic Filtration Process

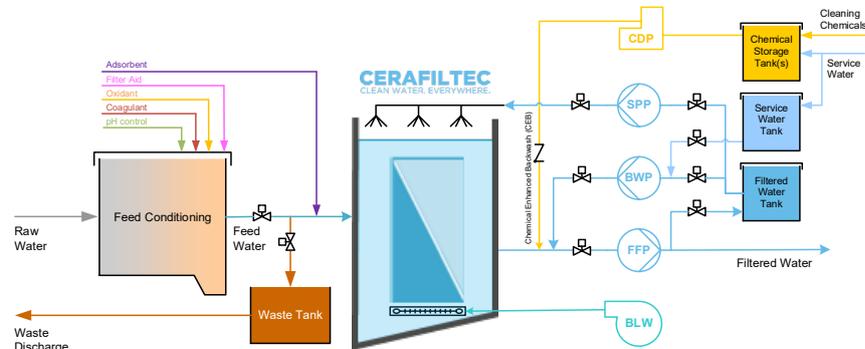


Figure 13: Basic Process Flow Diagram

The operation of the system will require the following processes:

I. Filtration

A separation process accomplished by filtering suspended matter. Feed water will be pumped from outside into the inside of the membrane where the contaminants are being filtered out.

II. Backwash

A process where part of the filtrate water is pumped in the reverse direction from the inside of the membrane to outside the membrane to remove the layer formation on the membrane surface. Backwash flow is typically set to 2-2.5 times the filtration flow.

III. Sprinkler

Filtrate is sprayed via nozzles from the top of the tower onto the modules to mobilize accumulated particles in between the plates and to support the backwash process.

IV. Air Scouring

The process of pumping air through a solution, to improve solids removal from the membrane surface.

V. Chemical Cleaning

Standard cleaning procedures using concentrated chemicals into the backwash feed line (CEB) or via sprinkler or (manual or semi-automatic, CIP).

VI. Degassing

During a suction process in water, outgassing is a normal phenomenon. To remove these gases from the filtration, line an air-trap should be built in front of the filtration pumps. From this trap the gas must be removed by an automatic air release system. The degassing is on the highest point of the filtration line and can be passive or active degassing depending on the application and recommendation by CERAFILTEC.

VII. Membrane Integrity Test (MIT)

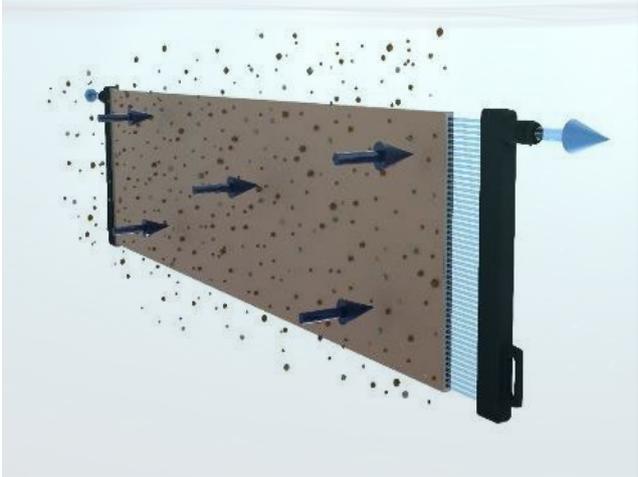
A verification of membrane integrity to detect leakage, pressure decay and visual inspection. Oil-free air will be applied on the filtrate side followed by a pressure hold test and visual inspection on air bubbles in the membrane tank.

6.2 Process Principles

6.2.1 Filtration and Backwash

Out-to-in filtration

The filtration principle works from OUT-TO-IN. Single ceramic plate with filter active layer on the outside of the membrane. Suspended solids are rejected on the membrane surface forming a cake layer while the clean water passes through the membrane body and is collected at both end caps.



In-to-out backwash

After some time, a backwash process is required to clean or remove the accumulated solids trapped outside the ceramic plate. This is done by reversing the flow direction, which works from IN-TO-OUT of the ceramic plate.

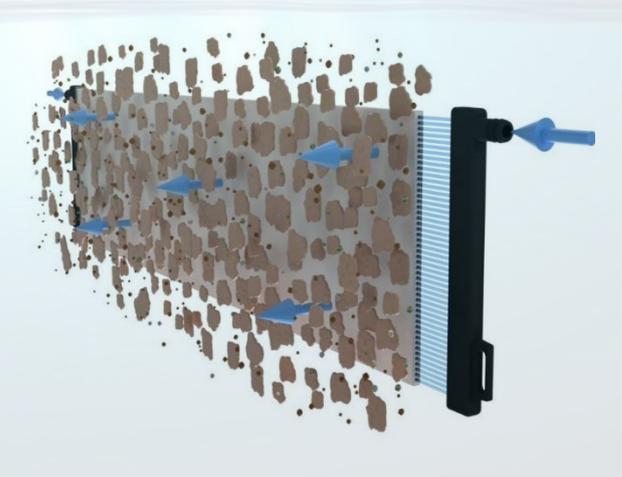


Figure 14: Membrane principle of the filtration and backwash processes

Filtered water from each single plate is collected inside the module housing and transported to the header set through 4 filtered water channels integrated in both module housing sides.



Filtered water from all 4 filtered water channels is transported to both module fronts and enters into each single plate.



Figure 15: Module principle of the filtration and backwash processes

The filtration towers are fully submerged in a tank (filtration train) which contains the feed (raw) water. All towers are connected at the top with a common header pipe. The filtered water is transported through the header set of each tower to the top and from there through the common header pipe to the tank outside where a filtration pump is connected to transfer the clean water to the filtered water tank.

A small portion of the produced filtered water is taken from the filtered water tank and is transferred by a backwash pump through the common header pipe into each filtration tower.

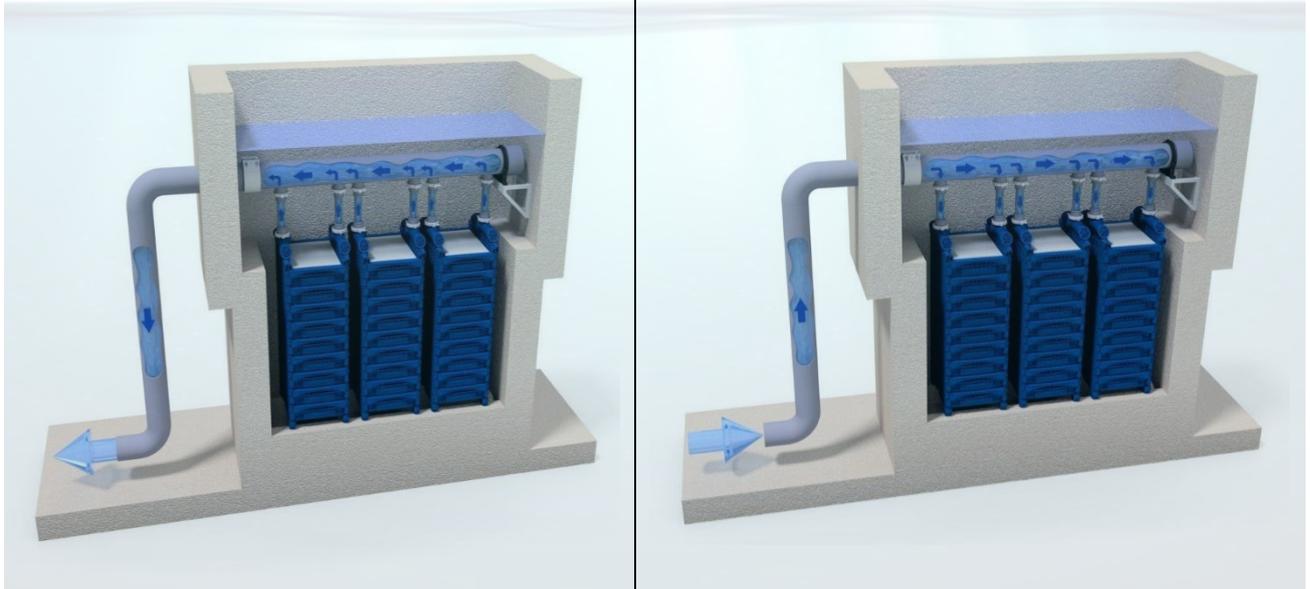


Figure 16: Train principle of the filtration and backwash processes

Submerged vacuum-driven (negative pressure) filtration and positive backwash pressure.

6.2.2 Sprinkler system

The integrated sprinkler system is used as water jet to enhance the removal of cake layers during on- air backwash. It prevents sludge clogging or accumulation due to the cake layer and deposits inside the filtration during backwash.



Figure 17: Sprinkler Mode and Chemical filling for CIP using the sprinkler system

6.2.3 Cleaning

6.2.3.1 Periodic Backwash drain

Inside the filtration tank, the membranes separate the solids from the liquid, which accumulate on the membrane surface (cake layer, TEP, EPS, etc). This leads to an increase in filtration resistance and thus to a decrease in the filtration performance of the membrane. If filtration performance is to be kept constant, this can only be compensated for by an increase in pressure or be contained by specific measures. For this purpose, periodic backwashing is performed.

The objective of periodic backwashing is to remove the outside layer and flush out the pores by reversing the filtrate flow for a short period. Membrane backwashing is usually carried out by stopping the filtration pump and changing the flow direction by starting the backwash pumps and drain.

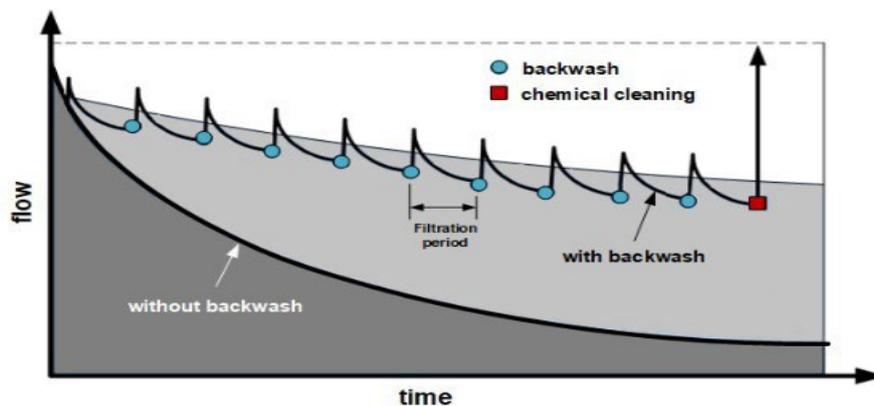


Figure 18: Flow diagram filtration process with periodical backwash

If the decreased flow and/or increased transmembrane pressure reach a certain defined value a chemical cleaning is required. The typical maximum transmembrane pressure for filtration is 0.5 - 0.7 bar, depending on the water source and process steps. The calculated maximum filtration pressure can be found in the specific technical projection document.

6.2.3.2 Chemical Cleaning

Due to the asymmetric membrane structure, all potential macro fouling or blocking effects will be generated only on the outside of the membrane. The results during all tests and running references had shown that only a cake layer on the outside is formed and the membrane body itself is not affected on fouling or blocking and no accumulations were detected.

Biological/colloidal fouling is the term used to describe the accumulation of colloidal dissolved substances on the membrane surface whereby a slimy film is formed. This is generated by bacterial growth caused by the nutrients available in the feed. This type of fouling occurs in all places where moistened surfaces are prevalent, and they are present in almost every technical system that does not operate on a sterile basis. This type of deposit on the surface can reduce pore diameter, which result in a decrease in membrane flux. Membrane blocking caused by fouling can be removed by cleaning with an oxidant. To make a rough estimate $p(\text{permeate}) \sim p(\text{backflush})$ can be applied.

Scaling is the term used to describe salts that have formed on the membrane and in the pore structure caused by inorganic precipitation. These are generated by exceeding the solubility product on the membrane surface in the form of sulphates, carbonates and phosphates. Since inorganic salts cannot degrade biologically and solubility cannot be increased by raising the pH value for example, the only possible way to prevent this is to avoid wastewater with high salt concentrations. In any case, salt concentration should be measured to detect possible scaling.

If scaling occurs, the deposits can generally be removed with acids. To make a rough estimate $p(\text{permeate}) < p(\text{backflush})$ can be applied.

Chemical cleaning can be chemical enhanced backwash (CEB) and Cleaning in Place (CIP). Cleaning frequency depends on the characteristics of the inflow water (concentration of inorganic, organic, and non-oxidized compounds).

Chemical enhanced backwash (CEB) is one of the regular cleaning process where the chemicals will be dosed into the backwash/filtration line and will be pushed backwards into the filters. It will require a short soaking time in an empty tank.

Cleaning in Place (CIP) is when the chemicals will be dosed into the backwash/filtration line and will be pushed backward into the filters similar as CEB or can be added directly into the membrane tank, manually or semi-automatically. CIP is an intense chemical cleaning mode with long soaking time in a filled tank, and will be done periodically as per projection (typically 1 - 3 months of operation) or when the membrane can no longer be sufficiently cleaned via backwash drain or CEB.

CERAFILTEC will recommend the best cleaning option to proceed as per the water characteristics.

Table 3: General Cleaning Recommendations

I. Chemical Enhanced Backwash

OXIDANT	ACID
Organic fouling, Disinfection	Inorganic fouling
Sodium Hypochlorite (NaOCl)	Hydrochloric Acid (HCl) Sulfuric Acid (H ₂ SO ₄)
20 - 3000 ppm as free chlorine	pH-range: 1 - 2.5 typical: pH 2.3
Soaking: 5 -15 min	Soaking: 15 min

II. Cleaning In Place

ACID	BASE	OXIDANT	SURFACTANTS
Inorganic fouling	Organic Fouling		
Hydrochloric Acid (HCl) Sulfuric Acid (H ₂ SO ₄) Oxalic Acid Citric Acid	NaOH (Opt. NaOCl)	NaOCl +(NaOH)	Sodium lauryl-sulphate + NaOH
pH-range: 1.5 - 2.5	4 g/l (at pH 2.0)	pH-range: 9-12	50 - 100 ppm as free chlorine
Soaking time: 2 - 12 h			
Temperature: < 40 °C / temperature change: < 1 °C/min			

III. Suspended Solids Mitigation

Solids Concentration	2 - 500 mg/l	>1 g/l	2 g/l	20 g/l	> 20g/l
Module Type	Module 6.0	Module 6.0	Module 6.0	Module 6.0	Module 2.8T
Cleaning Consideration	Intermittent Backwash with/without scouring	Intermittent backwash with scouring	Continuous Aeration	Drain backwash	Continuous aeration

6.3 Pre-treatment

CERAFILTEC is not responsible for pre-treatment, post-treatment, or biological treatment steps. However, we will provide recommendations based on the water conditions to optimize the system operation and protection of the membrane/module.

6.4 Data Recording

Data recording plays a crucial role in system operation for several reasons: it provides insights into how the system is performing, helps identify potential issues, and support decision-making for maintenance and optimization.

Unless specified separately in writing, the system’s minimum operating data must be recorded and kept up to date from the time of installation until the final shutdown or at the very least, at the end of the warranty period for warranty purposes.

Continuous/electronic data for each train (Table 4 and 5)

- Pressure during filtration, backwash, and chemical cleaning
- Flow during filtration, backwash, and chemical cleaning
- Filtration tank water level
- Aeration flow and pressure (of air scouring)
- Coagulation amount (if any)

For each executed chemical cleaning sequence:

- Chemical cleaning pump flow and duration
- Type and concentration of chemicals
- pH value and concentration of chemicals in the membrane tank during soaking
- Water and operating parameters as specified in Table 4 and 5.

CERAFILTEC reserves the right to request additional data as necessary to assess claims filed. In the event of any claim, the buyer bears the burden of proof for having installed and operated the plant in accordance with the warranty terms and conditions.

Table 4: Water Parameters Logging Intervals

Parameter	Inlet ¹	UF Filtrate	Cleaning Solutions
pH	3 min	-	1s
Temperature	3 min	-	
Turbidity	3 min	3 min	
TSS	24h	7days	
COD	24h	24h	
DOC	24h	24h	
ORP	3 min	3 min	1s

Table 5: Operational Parameters Logging Intervals

Parameter	Filtration	Backwash/CEB
Backwash pressure	3 min	1s
Filtration pressure	3 min	
Flowrate filtration	3 min	
Flowrate backwash		1s
Flowrate air scouring	3 min	1s
Pressure air scouring	3 min	1s
Membrane tank level	3 min	1s

¹ Inlet to Membrane Tank

7 Maintenance and Shutdown

CERAFILTEC modules, when handled well, operated in stable conditions following our recommendations require very low maintenance or replacement.

However, this section is for cases when such scenarios cannot be avoided.

7.1 Maintenance

Regular maintenance and service activities are to ensure the safe operation of the ceramic ultrafiltration system and to protect system components from getting damaged. The required maintenance work essentially consists of status and function checks as well as checking the operating parameters. Additionally, all checked status, function, and operating parameters shall be documented in the logbook. Deviations from target values and malfunctions shall be noted in a logbook and should be corrected immediately with the help of responsible maintenance personnel. Malfunctions that could adversely affect safety must be reported to the expert personnel responsible immediately. All described intervals and duties related to the parts and components delivered by CERAFILTEC, e.g. unusual noises of pumps, blowers, compressors, and any other component should be recorded as well. The operating instructions described in this document must be observed for all arising tasks!

7.1.1 Visual Check

- The membrane plate distance must be checked daily for clogging.
- The function of degassing must be checked daily. Degassing must be filled after the backwash sequence.
- The perforated aeration piping should be cleaned with water once a week via the flush connection.
- The aeration shall create uniform bubbles which should be checked daily.
- Functionality of all related equipment such as pumps, dosing systems, blowers, compressors, and related components must be checked daily.

7.1.2 Module Maintenance

Single membranes and spare parts/maintenance sets are provided (*check if included in the purchase*) in case there is a need to replace defective components as observed during operation, maintenance, or service work.

Contact your CERAFILTEC representative to guide you with the replacement procedure.
<https://www.cerafiltec.com/spare-parts/>

7.2 Shutdown

1. During temporary shutdown or system maintenance, ceramic membranes are required to be preserved to help maintain its integrity and performance over time. Membrane preservation procedure is as below:
2. Fill the filtration tank with water (feed, UF filtrate, service water, or RO permeate depending on the downtime period). Ensure that the membranes are fully submerged in the water. Additional procedures such as BW drain or CEB might be required depending on the down time period.
3. Prepare sodium hypochlorite, NaOCl, as per the recommended concentration in Table 6.
4. Add the prepared solution to the filtration tank.
5. Always ensure that the NaOCl concentration in the water will not be below 5 ppm. This must be measured daily and more NaOCl must be dosed, if required.
6. Keep a record for monitoring purposes.

Table 6: Ceramic Membrane Preservation

	< 24 hours	<2 days	<7 days	>7 days
Wet	Submerged in feed water	Submerged in feed water + NaOCl 100ppm	BW drain, submerged in UF filtrate +100ppm NaOCl	CEB, submerged in service water or RO permeate +100ppm NaOCl 1/w: check + adjust
Dry	< 1h if sun-exposed < 6h indoor		CEB, RO flushing, MIT, PDT test (air flushing filtrate side)	

8 Troubleshooting

Table 7: Troubleshooting Guide

Result	Direct Cause	Indirect Cause	Corrective Action
Less production than design capacity	Negative filtration pressure too high	Failure of pressure sensor	Check pressure sensor; replace if damaged
		Failure of flow sensor	Check flow sensor for: <ul style="list-style-type: none"> • replace if damaged • air passing through the sensor as degassing is not working well
		Membrane blocked	Refer details to "Membrane blocked"
	Negative filtration pressure too low	Failure of pressure sensor	Check pressure sensor; replace if damaged
		Failure of flow sensor	Check flow sensor for: <ul style="list-style-type: none"> • replace if damage • air passing through the sensor as degassing is not working well
		Flow control (FC) valve is not opening	Check FC valve; replace if damaged
	Train level too low	Level in the distribution channel is too low	Check flow capacity of feed pump, increase flow to match the requirement to fill and feed the trains
		Inlet valve is closed	Check valve; replace if damaged
		Drain valve is open	Check valve; replace if damaged
	Setpoint for flow too low	Automated setting for negative filtration pressure too high	Check setting and follow as recommended by CERAFILTEC
Wrong setting from operator		Check settings and follow as recommended by CERAFILTEC	
Membrane blocked	Inorganic scaling	Wrong feed pH value	<ul style="list-style-type: none"> • Check if acid dosing system is working • Check if enough acid solution in the dosing tank is available • Adjust pH setting to match the feed pH value requirement
		Insufficient chemical cleaning	<ul style="list-style-type: none"> • Check if cleaning dosing system is working • Check if the cleaning agent used and its concentration are correct. • Check if cleaning settings are correct.
	Organic fouling	Insufficient chemical cleaning	<ul style="list-style-type: none"> • Check if cleaning dosing system is working • Check if the cleaning agent used and its concentration are correct • Check if cleaning settings are correct
		Insufficient coagulant dosing	<ul style="list-style-type: none"> • Check if dosing system is working • Check if settings are correct
		Insufficient ultra sand dosing (if	<ul style="list-style-type: none"> • Check if dosing system is working • Check if settings are correct

Result	Direct Cause	Indirect Cause	Corrective Action
		applicable)	
	Thick cake layer	TSS in feed high	<ul style="list-style-type: none"> • Ensure no overdosing of chemicals (coagulant, ultrasand) • Check if raw water is in bad quality
		Filtration time too long	<ul style="list-style-type: none"> • Check filtration settings. Follow as recommended by CERAFILTEC
		Insufficient sludge removal during backwash drain	<ul style="list-style-type: none"> • Check if sprinkler is working well • Check if tank empty level is too high. Follow CERAFILTEC recommendations.
	Sludge accumulation between plates	Insufficient backwash	<ul style="list-style-type: none"> • Check backwash settings (flow might be too low and time too short. • Check if sprinkler is working well • Ensure aeration is ON during backwash and aeration pipes are not blocked
Bad Permeate Quality	High dissolved Ferric	Ferric dosing is too high	<ul style="list-style-type: none"> • Check dosing pump; replace if damaged • Check stock solution concentration (maybe it is too strong) • Check if settings are correct
		Sodium hypochlorite dosing is too low	<ul style="list-style-type: none"> • Check dosing pump; replace if damaged • Check stock solution (maybe empty or concentration is too weak/old) • Check if settings are correct
	High turbidity	Broken membrane plates	<ul style="list-style-type: none"> • Check any mechanical damage from outside; conduct leakage test • Check any sludge accumulation between plates
		Leakage in header piping	<ul style="list-style-type: none"> • Check for any broken clamp and replace • Check for any loose pipe and replace
		Ferric precipitation in permeate	<ul style="list-style-type: none"> • Check ferric dosing (maybe it is too high) • Check sodium hypo (maybe it is low)
	High free chlorine	Sodium hypochlorite dosing is too high	<ul style="list-style-type: none"> • Check dosing pump; replace if damaged • Check stock solution (maybe too strong) • Check if settings are correct
	Wrong pH value	pH sensor reading is wrong	<ul style="list-style-type: none"> • Calibrate pH sensor; replace if damaged
		Acid dosing is not working well	<ul style="list-style-type: none"> • Check dosing pump; replace if damaged • Check if enough acid solution in the dosing tank is available • Adjust pH setting to match the feed pH value requirement

9 Disclaimer

This product manual is provided for informational purposes only. CERAFILTEC makes no representations or warranties, either express or implied, regarding the accuracy, completeness, reliability, or suitability of the information contained herein.

All information, specifications, and descriptions provided in this manual are subject to change without notice. It is the responsibility of the user to ensure proper use and installation of the product in accordance with applicable laws and regulations.

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10 Contact Information

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