BERGHOF MEMBRANE TECHNOLOGY

Operation Manual
Tubular Ultrafiltration Membrane Module

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Document No.: 32-3500-98-01-06-000

BERGHOF Membranes
Think outside the box

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1. General Use and Intent

The ultrafiltration membrane modules from Berghof Membranes are exclusively designed for solid and liquid separation as it relates to wastewater treatment. Any other use which is outside this scope is considered inappropriate and not covered under the product's warranty. Berghof Membranes will NOT be held liable for damages resulting from the misuse of its products.

"Appropriate use" is defined as:

- Adherance to all operating instructions and guidelines for the modules and system components
- Regular observation and monitoring of operating parameters
- Strict compliance to predefined inspection and maintenance schedules/guidelines

If there are any questions or concerns, especially during the first few weeks after the system's commissioning, please contact Berghof Membranes representatives via email (**info@berghofmembranes.com**) or telephone +31 58 81 00 110

Disclaimer

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Document No: 32-3500-98-01-06-000

2. New Module Handling

After receipt of your Berghof Membranes order, correct handling and storage precautions are necessary for ensuring that the membranes modules remain intact prior to installation and use.

Immediately upon receipt, conduct a visual inspection of the complete shipment to confirm that:

- Shipment arrived without damage to the packaging or its contents.
- All packages listed on the packing list were received in good order.
- If there is any damage or product shortage, please contact your carrier/freight forwarder and a Berghof Membranes customer support representative **immediately**.
- If any module parts are missing, please notify Berghof Membranes **immediately**.

To ensure the service life of your Berghof membrane modules, proper precautions should be taken to avoid damaging the modules or impeding their performance.

Additional requirements may be included in your performance warranty. If there is a conflict between the information provided in this manual and in your terms of warranty, the information provided in your warranty overwrite those outlined in this manual.

2.1. New module storage

The modules are packaged and supplied with sealed connections. It is important to keep in mind the following considerations:

Protection against sunlight
Do not subject modules to long-term sunlight exposure. Store modules in a dark place. For storage of used modules, please refer to section 6.2 of this operation manual.

Protection against frost
Store and use the modules in a place that is not subject to frost. Freezing may damage the membranes.

Protection against solvents
Organic solvents, once in contact with the module housing, may increase the risk of damaging the paint and material. This could result in critical failure of the module's operation. To clean the module housing, use ONLY water and/or ethanol.

Careful transport
New membrane modules are heavy and special precautions must be taken when transporting or handling each module. If a module is dropped or knocked, this can result in fractures within and on the module and its connectors, thus rendering it non-functional. Contact Berghof Membranes if this occurs. Please remember to keep all ports closed.

Storage Period
New modules can be stored as received, up to 2 years and under above-mentioned conditions. To store modules for longer than 2 years, please contact Berghof Membranes.

3. Prior to Installation

3.1. Safety considerations

Risk of injury from improper installation

- Before use, inspect the product for any leaks or cracks.
- Installation MUST ONLY be carried out by qualified technicians or operators.
- Modules can weigh more than 20 kilograms (44 lbs) and MUST be handled using the proper tools/equipment and ONLY by qualified technicians. Large diameter (10-inch) modules, for example, can weigh 95 kg (210 lbs).

Risk of injury from unintentional activation of the system and uncontrolled restart

- All precautions must be taken to secure the system from unintentional/unauthorized activation.
- Following installation of the modules, ensure a controlled (re)start according to the procedures outlined in section 4 of this operation manual.

Risk of poisoning, chemical burns, or contamination from escaping medium

- When handling hazardous substances, ALWAYS take appropriate precautionary measures and wear personal protective equipment in accordance with the requirements of the medium.
- Before disconnecting lines, the medium must first be FLUSHED from the entire system.

Risk of injury from high pressure in the UF system/module

- Before working on the system or product, make sure to release the presure and vent/drain the lines to avoid serious injury.

3.2. Module and system preparation

- Remove the protective caps from the module(s) shortly before installation. Once the protective caps are removed, the module must be handled carefully with all necessary precautions.
- Clean the system and pipelines to ensure that solids and oily substances are removed from the UF system.

4. Installation and Start-Up

4.1. Precautions for module installation

Risk of material breaking

- Attach and connect the module in such a way that system vibrations do not compromise the stability and positioning of the module.
- The modules must be installed in a rack or similar.
- Module must be supported in several places along its entire length.
- Due to the weight of the module, it is not safe to attach the module only via the connectors. The module must be attached to the rack by using appropriate brackets or clamps.

When using brackets or clamps to attach modules to the system frame:

- Thoroughly inspect the sealing clamps,
- Ensure that the seals are not displaced when establishing the connections,
- Check that none of the connections are or could be subject to mechanical stress,
- Check that the seals are seated correctly. For proper closing of clamps without causing any damage please follow instruction of clamp company,
- Tighten the clamp(s) only with appropriate force, making sure not to damage the module,
- Only use suitable, clean, quality clamps,
- Before disconnecting the lines, the medium must be flushed from the entire system.

DO NOT use excessive force to tighten the connections.

4.2. Start-Up

Rinsing Modules

Before the initial start-up with the process medium, the modules should first be rinsed with clean water, followed by the standard cleaning agent. The permeate flows from both the clean water (“clean water flux” or “CWF”) and cleaning agent rinse should be individually recorded.

Two weeks after start-up

A standard cleaning should be implemented no more than two weeks after the initial start-up. Once again, as previously outlined, the permeate flows from both the clean water and the cleaning agent rinse should be individually recorded and, after consultation with Berghof Membranes, evaluated as reference flows.

The success of subsequent cleaning procedures can be assessed by comparing the permeate fluxes, obtained after the cleaning agent or water rinse, against recorded reference values. It is important to ensure that identical conditions and parameters are set (pressure, crossflow velocity, temperature, detergent concentration, etc.) when recording permeate flow.

4.3. Important notices

Risk of damage to the UF system

Improper operation may result in injuries as well as damage to the UF system. Therefore, it is critical that the following conditions be observed:

- Before start-up, ensure that the operator(s) is qualified and trained to operate the UF system and thoroughly understands the instructions set forth in this operation manual,
- All health and safety regulations are strictly followed,
- Only qualified and trained personnel can operate the equipment, products, systems,
- Operator(s) should prevent water hammers, sudden increases in the feed's solid content, heavy pressure drops, temperature shocks and temperature swings.

Avoiding damage to the UF system/modules

Unlike pumps and pipelines, the membranes in a filtration system are relatively sensitive components. Therefore, every effort should be made during planning and operation to avoid pressure surges, sudden increases in the feed's solid content, heavy pressure drops, and temperature shocks. Pressure surges and vibrations, in particular, may damage the module and impair its performance.

- Please refer to the individual product data sheets when determining pH values, oxidants and other components.
- During filtration and backwashing, please adhere to the TMP pressure parameters stated on the individual module data sheet.
- NEVER exceed pressure and temperature parameters set forth in the module data sheets.
- Frequent temperature swings occurring by exchanging media can shorten the module lifetime. Temperature difference between both media exceeding 25°C must be avoided.
- Typical temperature slope for heating up/cooling down is 1°C/min. Disregarding this guideline can result in shorter module lifetime or even irreparable damage.
- Berghof Membranes recommends keeping the pressure level at the last positioned module to at least 0.5 bar (7.25 psi). The filtration system must be designed so that negative pressure does not occur in the feed chamber.
- Quick/rapid opening of the valves may cause water hammer, thus damaging the membrane modules and the UF system.

5. Module Operation

5.1. Data recording

To accurately monitor and maintain optimal membrane performance, Berghof Membranes recommends that the following operating values are recorded at least twice per day:

- Inlet and outlet pressure for each individual module
- Permeate flow, pressure and turbidity
- Operating temperature and pH
- Feed quality
- Circulated flow (crossflow velocity)

5.2. Decreased permeate flow

If the permeate flow decreases below the average value for an extended period of time, it is likely that the modules need to be cleaned. Instructions on how to clean your Berghof Membranes module(s) are outlined in section 5.5 of this manual.

In order to determine the effectiveness of the cleaning procedures, the post-cleaning permeate flow and pressure values should be logged and compared with the pre-cleaning permeate flow and pressure values.

5.3. Solids in the permeate

If solids are present in the permeate (check turbidity), it is likely that one or several tubular membranes in the system has or have been damaged. Individual sampling of the modules should be performed while the system is running so as to properly identify the source of the problem. If the color of the permeate has changed since the initial start-up and/or it has become darker and/or blurry, then a membrane inspection is recommended.

A module can be repaired if less than 15% of the membrane tubes inside the module are damaged. For questions on how to repair a module, please contact Berghof Membranes and a representative will assist you. If it is determined that a module needs to be returned to Berghof Membranes for repair, then the module should first be rinsed thoroughly and preserved. Detailed instructions for product returns are outlined in section 7 of this manual.

NOTE: Please make sure to complete and return the Health & Safety Declaration form indicating the module's use and any possible contamination with hazardous substances (see section 7). Any modules returned without prior approval and acceptance of the Health & Safety Declaration form from a Berghof Membranes representative will be shipped back to the customer.

5.4. Fouling and clogging

Increase in pressure drop / decrease in permeate flow
Increasing pressure drop across the module and/or decreasing permeate flow could indicate possible clogging and/or fouling.

Clogging refers to the agglomeration of solids or fibrous material within or at the entrance of the membrane tubes. Usually, this is the result of inadequate pretreatment.

Fouling refers to the coating of the membrane surface or the plugging of the membrane pores with colloidal or fine particles, which can be of different nature (biofouling, organic fouling and inorganic fouling/scaling).

Fouling of the membrane module
Clogging and fouling in the membrane module can be removed. If the inlet of the individual membrane tubes is significantly blocked, it is likely due to the accumulation of solids, hairs, fibers, etc. Therefore, the membrane tubes should be checked individually for blockages over the whole length. On the other hand, fouling occurs gradually in the medium-long term and is removed by the periodical chemical cleaning of the membranes (and/or with backwash if membranes are designed for it - Further details are provided in the membrane datasheets).

During startup the pressure loss typical for the equipment has to be recorded, with water and with the medium to be filtered. If there is a significant increase in pressure loss in the module, while operating with similar crossflow velocity, the modules are to be checked for blockages. Further details on pressure drop are provided in the datasheets.

Before starting filtration with the process medium, the permeate flows with clean water ("clean water flux" or "CWF") should be recorded. Moreover, the CWF should be recorded before and after the first chemical cleaning to be used as reference values and evaluate the efficiency of the cleaning.

Blocked membrane tubes can be identified visually by flushing each one with water to see if the water passes through to the other side of the tube. If clogs are present in the membrane tubes, please contact Berghof Membranes.

Do not attempt to manually unclog the tubes. Any mechanical attempt to unclog the membranes tubes can damage the membrane surface and will void the membrane module's warranty.

5.5. Cleaning

The following cleaning procedure explains how to manage fouling and maintain the optimal performance of the tubular UF membrane filtration system.

The degree of membrane fouling directly affects the filtration performance. If the permeate flow decreases significantly, and/or the pressure drop increases above operational values, a chemical cleaning is necessary.

The chemical cleaning of the membranes can be done with conventional chemical products such as sodium hydroxide (NaOH) and sodium hypochlorite (NaOCl) for the alkaline cleaning, and citric ($C_6H_8O_7$) or nitric acid (HNO_3) for the acid cleaning. For improved cleaning performance, the commercially available membrane cleaning products are recommended (only if they do not impair the function of the membranes and comply with the approved limits regarding pH values and temperature). The limits are specified in Berghof modules and

membranes data sheets. Please contact Berghof Membranes for further advise about membrane cleaning products.

This section describes the standard and intensive cleaning protocols:

- Standard: Cleaning can be done with different types of chemicals, depending on the fouling nature (organic, scaling, biofouling…). The most common cleaning – especially in wastewater treatment – is alkaline and also includes an oxidizing product (conventionally chlorine[1]) for removing the organic matter. In the case that alkaline cleaning is not efficient, acid or enzymatic products can be used.

- Intensive: When more difficult fouling needs to be removed, the intensive cleaning procedure combines high and low pH cleaning phases.

Cleaning instructions should always be followed, otherwise there may be unforeseen reactions between the cleaning solution and the medium to be filtered which might lead to membrane, modules and piping being damaged (for example, by heat generation).

Berghof Membranes advises to use special ultrafiltration membrane cleaning chemicals. If this is not possible, the standard chemicals outlined in this document can be used.

5.5.1. Standard alkaline / acid / enzymatic cleaning

Standard cleaning should be performed on a regular basis to prolong membrane lifetime. To ensure effective cleaning, it is important to first flush the dirty water and/or process medium out of the system.

A water test should be performed after a cleaning. Therefore, it is important to record the clean water flux (CFW) during start-up to have a reference point.

RO permeate, deionized water or similar quality water must be used to prepare the cleaning solutions. Otherwise, use tap water that must be softened to less than 80 ppm calcium carbonate ($CaCO_3$).

Alkaline cleaning

Alkaline cleaning is applied for removing organic and microbial fouling from the membranes. Chlorine[1] is also added (typically in form of sodium hypochlorite, NaOCl) to promote the oxidation and dislodgement of organic matter. Other foulants such as silica are also removed in alkaline conditions.

Alkaline cleaning (A): Sodium hydroxide and sodium hypochlorite mixture

- Add sodium hydroxide (NaOH) to reach pH 10 – 11. The concentration depends on the installation and type of water (RO permeate, deionized water or soft tap water). Check pH with pH meter or pH indicator strips.
- Add sodium hypochlorite (NaOCl) to reach 250 ppm (mg/L) chlorine concentration. Check the free chlorine concentration with chlorine stripes.
- Gradually increase temperature during cleaning up to 40°C within 30 – 60 min, in order to avoid membrane/module thermal shock. A heating velocity of approximate 1°C/minute is recommended. A temperature higher than 40°C can be applied in certain installations and/or applications. Consult the membrane data sheets for further information about temperature limits.
- Concentration of chlorine can be recommended for specific application with maximum value of 500 ppm.

[1] *For specific membrane materials and cut-offs chlorine should be avoided. Consult the membrane data sheets for further information.*

- Total membrane chlorine exposure 250,000 ppm·h at 25°C.

Acid cleaning

Acid cleaning is applied for removing inorganic fouling/scaling. It is usually done with citric acid ($C_6H_8O_7$), although other acids such as nitric acid (HNO_3) or phosphoric acid (H_3PO_4) can also be used.

Acid cleaning (B): Citric acid

- Add citric acid ($C_6H_8O_7$) to reach pH 2 – 3. The concentration depends on the installation and type of water (RO permeate, deionized water or soft tap water). Check pH with pH meter or pH indicator strips. Typical concentration required is 2 – 3 wt% of citric acid ($C_6H_8O_7$).
- Gradually increase temperature during cleaning up to 40°C within 30 – 60 min, in order to avoid membrane module thermal shock. A heating velocity of approximate 1°C/minute is recommended. A temperature higher than 40°C can be applied in certain installations and/or applications. Consult the membrane data sheets for further information about temperature limits.

Enzymatic cleaning

Enzymatic cleaning can be applied if alkaline and acid cleanings did not provide satisfactory results. There are several enzymatic cleaners commercially available, that present increased performance for the removal of specific foulants (such as proteins or deeply incrusted organic matter).

To improve the efficiency of enzymatic cleaning, in some cases it is recommended to carry out the enzymatic cleaning after the alkaline cleaning (that removes the bulk of the organic matter).

Enzymatic cleaning (C): Enzymatic cleaning agent

- Please refer to the supplier. The concentration depends on the installation and type of water (RO permeate, deionized water or soft tap water). Check pH with pH meter or pH indicator strips.
- Gradually increase temperature during cleaning up to 40°C within 30 – 60 min, in order to avoid membrane/module thermal shock. A heating velocity of approximate 1°C/minute is recommended. A temperature higher than 40°C can be applied in certain installations and/or applications. Consult the membrane data sheets for further information about temperature limits. Consult the technical information from the supplier of the enzymatic cleaning agent for the recommended temperature.

Standard alkaline / acid / enzymatic cleaning sequence					
Step 1	**Step 2**	**Step 3**	**Step 4** (optional[2])	**Step 5**	**Step 6**
Flush with water	Circulate A/B/C 30 – 120 min	Soak A/B/C 30 – 60 min	Flush 20% solution of A/B/C	Circulate A/B/C 30 – 120 min	Flush with water

Legend: A = (Sodium hydroxide + sodium hypochlorite), B = (Citric acid) and C = (Enzymatic cleaning agent)

The optimum duration for the 'Circulation' and 'Soaking' steps can differ between different installations, chemicals, type of fouling, etc. It is recommended that the permeability and pressure drop are monitored during the circulation. Circulation must be carried out until no further improvement is observed. The pH, chlorine concentration and temperature must be checked periodically and chemicals can be added along the cleaning for adjusting these values.

The first assessment can be made during step 2 by comparing the permeate flow with the corresponding reference value.

The effectiveness of cleaning can be judged after the final water flushing by comparing the permeate flow with clean water (clean water flux "CWF") against the reference value. Alternatively or in addition, the filtration performance with process medium and the recorded reference performance can also be compared.

[2] *Flushing a small part of the cleaning solution allows removing the volume from inside the modules after the soaking stage. This is optional, only recommended when an important amount of foulant compounds are expected to be released during the soaking stage.*

IMPORTANT:

1. If the cleaning solution shows heavy discoloration, discard the solution and prepare a new solution. Repeat this cleaning step. Flush out the membranes thoroughly with good quality water between each cleaning stage until pH is neutral.
2. Monitor pH and temperature during cleaning process to check that it is still under the recommended levels. If not, adjust it again during circulation.
3. Thermal shocks can cause irreversible damage to the membrane module. Both the temperature increase for chemical cleaning and the temperature decrease after it must be monitored.
4. During the circulation of cleaning solution the permeate line is open. As a standard, it is recommended to maintain the permeate flow in the same range than the design flow in filtration. Recommended crossflow velocity is CFV = 2 m/s, if the recirculation pump includes a frequency drive (if not, the same CFV than in filtration can be applied).
5. Times proposed for each stage are approximate and depend on each installation and the degree of fouling/scaling

5.5.2. Intensive cleaning

Intensive cleaning is a combination of high and low pH stages. This combination is used to clean the deepest fouling/scaling present in the membrane. It can be applied if standard alkaline / acid / enzymatic cleaning did not provide satisfactory results.

A water test should be performed after a cleaning. Therefore, it is important to record the clean water flux (CFW) during start-up to have a reference point.

RO permeate, deionized water or similar quality water must be used to prepare the cleaning solutions. Otherwise, use tap water that must be softened to less than 80 ppm calcium carbonate ($CaCO_3$).

For each cleaning stage, the procedure described in Section 5.5.1 must be applied. The temperature during the cleaning must be increased gradually up to 40°C, in order to avoid membrane/module thermal shock. A heating velocity of approximate 1°C/minute is recommended. A temperature higher than 40°C can be applied in certain installations and/or applications. Consult the membrane data sheets for further information about temperature limits.

Intensive cleaning sequence				
Step 1	**Step 2**	**Step 3**	**Step 4** (optional[3])	**Step 5**
Flush with water	Circulate A 30 – 120 min	Soak A 30 – 60 min	Flush 20% solution of A	Circulate A 30 – 120 min
Step 6	**Step 7**	**Step 8**	**Step 9** (optional[3])	**Step 10**
Flush with water	Circulate B 30 – 120 min	Soak B 30 – 60 min	Flush 20% solution of B	Circulate B 30 – 120 min
Step 11	**Step 12** (optional)	**Step 13** (optional)	**Step 14** (optional[3])	**Step 15** (optional)
Flush with water	Circulate A 30 – 120 min	Soak A 30 – 60 min	Flush 20% solution of A	Circulate A 30 – 120 min
Step 16				
Flush with water				

Legend: A = (Sodium hydroxide + sodium hypochlorite[4]), B = (Citric acid) and C = (Enzymatic cleaning agent)

[3] *Flushing a small part of the cleaning solution allows removing the volume from inside the modules after the soaking stage. This is optional, only recommended when an important amount of foulant compounds are expected to be released during the soaking stage.*

[4] *For specific membrane materials and cut-offs chlorine should be avoided. Consult the membrane data sheets for further information.*

The first assessment can be made during step 2 by comparing the permeate flow with the corresponding reference value.

The effectiveness of cleaning can be judged after the last flushing with water by comparing the permeate flow with clean water (clean water flux "CWF") against reference value. Alternatively or in addition, the filtration performance with process medium and the recorded reference performance can also be compared.

IMPORTANT:

1. If the cleaning solution shows heavy discoloration, discard the solution and prepare a new solution. Repeat this cleaning step. Flush out the membranes thoroughly with good quality water between each cleaning stage until pH is neutral.
2. Monitor pH and temperature during cleaning process to check that it is still under the recommended levels. If not, adjust it again during circulation.
3. Thermal shocks can cause irreversible damage to the membrane module. Both the temperature increase for chemical cleaning stage and the temperature decrease after it must be monitored.
4. During the circulation of cleaning solution the permeate line is open. As a standard, it is recommended to maintain the permeate flow in the same range than the design flow in filtration. Recommended crossflow velocity is CFV = 2 m/s, if the recirculation pump includes a frequency drive (if not, the same CFV than in filtration can be applied).
5. Times proposed for each stage are approximate and depend on each installation and the degree of fouling/scaling.

5.5.3. Intensive enzymatic cleaning

Intensive enzymatic cleaning is a combination of enzymatic and acid cleaning. Intensive enzymatic cleaning can be applied if intensive cleaning did not provide satisfactory results.

A water test should be performed after a cleaning. Therefore, it is important to record the clean water flux (CFW) during start-up to have a reference point.

RO permeate, deionized water or similar quality water must be used to prepare the cleaning solutions. Otherwise, use tap water that must be softened to less than 80 ppm calcium carbonate ($CaCO_3$).

For each cleaning stage, the procedure described in Section 5.5.1 must be applied. The temperature during the cleaning must be increased gradually up to 40°C, in order to avoid membrane module thermal shock. A heating velocity of approximate 1°C/minute is recommended. A temperature higher than 40°C can be applied in certain installations and/or applications. Consult the membrane data sheets for further information about temperature limits.

Intensive cleaning sequence				
Step 1	**Step 2**	**Step 3**	**Step 4** (optional[5])	**Step 5**
Flush with water	Circulate C 30 – 120 min	Soak C 30 – 60 min	Flush 20% solution of C	Circulate C 30 – 120 min
Step 6	**Step 7**	**Step 8**	**Step 9** (optional[5])	**Step 10**
Flush with water	Circulate B 30 – 120 min	Soak B 30 – 60 min	Flush 20% solution of B	Circulate B 30 – 120 min
Step 11	**Step 12** (optional)	**Step 13** (optional)	**Step 14** (optional[5])	**Step 15** (optional)
Flush with water	Circulate C 30 – 120 min	Soak C 30 – 60 min	Flush 20% solution of C	Circulate C 30 – 120 min
Step 16				
Flush with water				

Legend: A = (Sodium hydroxide[6] + Sodium hypochlorite), B = (Citric acid) and C = (Enzymatic cleaning agent)

The first assessment can already be made during step 2 by comparing the permeate flow with the corresponding reference value.

The effectiveness of cleaning can be judged after the last flushing with water by comparing the permeate flow with clean water (clean water flux "CWF") against reference value. Alternatively or in addition, the filtration performance with process medium and the recorded reference performance can also be compared.

IMPORTANT:

1. If the cleaning solution shows heavy discoloration, discard the solution and prepare a new solution. Repeat this cleaning step. Flush out the membranes thoroughly with good quality water between each cleaning stage until pH is neutral.
2. Monitor pH and temperature during cleaning process to check that it is still under the recommended levels. If not, adjust it again during circulation.
3. Thermal shocks can cause irreversible damage to the membrane module. Both the temperature increase for chemical cleaning stage and the temperature decrease after it must be monitored.
4. During the circulation of cleaning solution the permeate line is open. As a standard, it is recommended to maintain the permeate flow in the same range than the design flow in filtration. Recommended crossflow velocity is CFV = 2 m/s, if the recirculation pump includes a frequency drive (if not, the same CFV than in filtration can be applied).
5. Times proposed for each stage are approximate and depend on each installation and the degree of fouling/scaling.

[5] *Flushing a small part of the cleaning solution allows removing the volume from inside the modules after the soaking stage. This is optional, only recommended when an important amount of foulant compounds are expected to be released during the soaking stage.*

[6] *For specific membrane materials and cut-offs chlorine should be avoided. Consult the membrane data sheets for further information.*

6. Shut-down

Once the membranes become wet, do not allow them to dry out again. This may cause irreparable damage to the membranes.

- During a brief shut-down of up to 24 hours, flushing the modules with water or permeate is sufficient.
- In case of shut-downs lasting up to three days, standard cleaning must be implemented. The equipment then has to be filled with fresh water.
- In case the UF system shut-down lasts longer than three days, the membranes are to be kept in a cleaned and rinsed condition, filled with a 1.5% sodium bisulfite solution ($Na_2S_2O_5$). The preservation fluid must be replaced at least every two months.
- In the presence of wastewater which can aggressively contaminate the membrane, the membrane module should be cleaned prior to preservation

The instructions for module cleaning are outlined in section 5.5 of this manual. Instruction for the preservation of the modules are outlined in the following section.

6.1. Module Preservation

In order to prevent the build-up of biofouling, the modules must be conserved with an adequate biocide when being out of operation for longer than three days. Preservation follows the same sequence as CIP mode but does not include the soaking step. Upon completion of the preservation sequence, the chemical solution remains in the modules and must be renewed at least every two months as its effectivity gradually decreases over time.

For effective conservation and long shutdown periods, it is recommended to carry out standard or intensive cleaning before preservation (see Section 5.5.1 of this document).

The sequence of steps in the preservation process is listed in the table below. If flushing has already been performed, then operators can go directly to step 2 in the preservation sequence. Membrane modules and piping should then be left filled with preservation fluid.

RO permeate, deionized water or similar quality water must be used to prepare the preservation solution. Otherwise, use tap water that must be softened to less than 80 ppm calcium carbonate ($CaCO_3$).

Preservation (D): Sodium bisulfite

- Add 1.5% of sodium bisulfite ($Na_2S_2O_5$).
- Gradually increase temperature during recirculation up to 40°C within 30 – 60 min, in order to avoid membrane module thermal shock. A heating velocity of approximate 1°C/minute is recommended.

Preservation sequence		
Step 1	**Step 2**	**Step 3**
Flush with water	Circulate D 30 – 120 min	Stop with D inside Max. 2 months

Legend: D = (Sodium bisulfite)

IMPORTANT:

1. If the preservation solution shows heavy discoloration, discard the solution and prepare a new solution. Repeat this preservation step.
2. When conservation mode is ended and the installation is put back in service, a standard cleaning needs to be performed before Filtration mode is restarted.

6.2. Used Module Storage

When used modules are in storage, there is a risk that the membranes would dry out. This may cause irreversible damage to the membranes so it is important that certain precautions to be taken in order to avoid this from happening.

Protection against frost
If there is a risk of freezing during transport, modules must be soaked in a 30-40% glycerine solution for several hours and fully drained afterwards.

Used module transport
Membrane modules, especially when wet, are heavy and special precautions must be taken when handling each module. Remember to close all ports. If a module is dropped or knocked, this can result in fractures within and on the module and its connectors, rendering it non-functional. If this happens, please contact Berghof Membranes.

7. Product Returns

7.1. Module cleaning prior to return

Before modules are returned, they MUST be cleaned as outlined in the following table. Please make sure that ALL materials are cleaned out from both the feed and permeate side. Operators should always comply with the standard cleaning sequence as outlined in the table below. This will not only ensure efficient cleaning, but it will also minimize undesirable reactions between cleaning chemicals and the process medium.

Standard alkaline / acid / enzymatic cleaning sequence					
Step 1	**Step 2**	**Step 3**	**Step 4** (optional[7])	**Step 5**	**Step 6**
Flush with water	Circulate A/B/C 30 – 120 min	Soak A/B/C 30 – 60 min	Flush 20% solution of A/B/C	Circulate A/B/C 30 – 120 min	Flush with water

Legend: A = (Sodium hydroxide + sodium hypochlorite), B = (Citric acid) and C = (Enzymatic cleaning agent)

For detailed information on the cleaning sequences, refer to section 5.5 of this manual.

7.2. Module return procedure

Soaking of the module:
If there is a risk of freezing during transport, the *already cleaned and drained* membrane module MUST be soaked in a 30% (-9°C) to 40% (-15°C) glycerine solution for several hours then fully drained. No additional flushing will be required.

Handling and preparing for transport:

- After the modules have been soaked and drained, keep in mind that the weight of the module will increase.
- All ports MUST be drained well before closing them with end caps or plastic film to protect the membranes.
- To protect the module(s) from mechanical damage, please ensure that they are packed in a similar way as the original packaging.

Declaration form
BEFORE RETURNING the module(s), first complete the Health and Safety Declaration form (section 7.3 of this manual) and send it by email to: **aftersales.membranes@bergof.com**

Once the form has been received and accepted by Berghof Membranes, you will receive a case reference number specific to your product return.

IMPORTANT:
Please DO NOT return any module(s) to Berghof Membranes if you have not yet completed and returned the Health and Safety Declaration form, AND received a case reference number from a Berghof Membranes after sales representative.

[7] *Flushing a small part of the cleaning solution allows removing the volume from inside the modules after the soaking stage. This is optional, only recommended when an important amount of foulant compounds are expected to be released during the soaking stage.*

ANY MODULES SHIPPED WITHOUT PRIOR APPROVAL AND ACCEPTANCE OF THE HEALTH AND SAFETY DECLARATION FORM BY A BERGHOF MEMBRANES REPRESENTATIVE WILL BE SHIPPED BACK TO THE CUSTOMER.

Shipping address:

Send the module to the address below and be sure to include the case reference number;

Berghof Membrane Technology GmbH
Case Number: XXX
Arbachtalstrasse 26
72800 Eningen
Germany

Please send an email to **aftersales.membranes@berghof.com** and provide the *estimated date of delivery*. Make sure to include the case reference number in ALL communications and correspondence.

IMPORTANT:

Berghof Membranes considers the health and safety of its employees as our top priority and we take all necessary precautions to protect them from contact or exposure with contaminated materials. Therefore, we will not accept any returned modules without a completed and approved declaration form, signed by an authorized specialist.

LEGAL STATUTES:

BGV A1 Principles of Prevention (01.01.2004)
(BGV = Employer's Liability Insurance Association)
§ 4 ArbSchG (Occupational Health and Safety Act) "General Principles"
§ 7 – 11 Ordinance on Hazardous Substances

7.3. Health and Safety Declaration Form

Product / Component: _____
Serial Number: _____
Year of Production: _____

With which process medium(s) did the product/component last come into contact? List all.

_____
_____
_____
_____
_____

Designation of the process media and the constituents (if known). If necessary, attach an additional or separate sheet.

_____
_____
_____
_____
_____

General material properties (check all that apply):

☐ Caustic ☐ Toxic ☐ Corrosive
☐ Explosive ☐ Biologically hazardous ☐ Caustic

Has the product/component been decontaminated?

☐ Yes ☐ No

How and with which substances was the product/component cleaned prior to dispatch?

_____
_____
_____

IMPORTANT
Components contaminated by radioactivity MUST be decontaminated in compliance with the applicable radiation protection regulations prior to being repaired. We reserve the right to charge for additional costs of decontamination and cleansing of the module when necessary.

Legally-Binding Affidavit

I, the undersigned, hereby confirm that the information presented in this declaration is correct and complete.

Company / Organization _____
Address 1: _____
Address 2: _____
Postal code/City/Country _____
Telephone: _____
Email address: _____

Printed name of authorized personnel: Signature Place/Date:

_____ _____ _____