TECHNICAL INSTRUCTIONS

UF120-S2F MODULE

Technical instructions	UF120-S2F Module	Ref NF_ UF120-S2F _V6A
Last revision date:		June 08th 2022

SUMMARY

I GENERAL CARACTERISTICS

I.1 Module Description

The **Polymem UF120-S2F modules** are **specially designed for water treatment processing applications**. They use **Neophil™ PVDF hollow fiber membrane** technology operating in an **outside / in** and **dead-end filtration mode** which allows the following benefits:

- **a very high filtration area** (114 m^2/1,227 sqf) in a **compact module** (315 mm / 12.4 inches diameter, 930 mm / 36.6 inches height)
- the **ability to treat elevated suspended solid effluents** due to the high filtration area and the ease of solids retention on the outside surface of the membranes,
- **only two connections** which means simplified and cheaper installation (less connections, valves and pipes than other systems) due to the outside/In full dead-end filtration mode,
- **low transmembrane pressure** (0.1 to 1.5 bars / 1.45 to 22 psi) filtration means low operating costs
- an **efficient backwash** due to easy solids removal and air scour
- **very good mechanical and chemical resistance** due to Neophil™ PVDF characteristics, with a unique membrane porosity and a large outer to inner diameter ratio.

Moreover, the **advanced and original flexible bonding technique** used for the 19 bundles constituting the module allows a very **high resistance to mechanical stress**.

The **Polymem UF120-S2F modules** contain **0.015 µm pore size fibers** which retain suspended solids, bacteria and viruses.

I.2 Characteristics

Hollow fiber Membrane

Material :	**Neophil™ PVDF**
Outside diameter:	0.72 mm
Surface:	114 m² / 1,227 sqf
Pore size:	0.015 micron
Pure water permeability:	130 l/h.m².b (+/- 20%)@ 20°C / 76 gfd (+/- 20%)@ 68°F

Modules (vessels)

Housing:	PVC/PPh
Fibers potting:	Polyurethane flexible resin

Dimensions

Total length:	930 mm ± 5 / 36.6 inches ±0.2
Diameter:	315 mm / 12.4 inches
Weight:	90 kg conditioning liquid filled 55 kg empty

Performances

Pure water flow:	7.5 m^3/h ± 20% at 0.5 bar of Transmembrane pressure at 20 °C 33 US gpm ± 20% at 7.3 psi of Transmembrane pressure at 68°F
Raw water flow:	2.5 to 11 m^3/h at 20 °C depending on the quality of the raw water 11 to 50 US gpm at 68°F depending on the quality of the raw water

OPERATION LIMIT CONDITIONS

Failure to comply with the limit conditions listed below would void the warranty.

Raw water quality: - pre filtered water at 130 µm
- NTU mean value < 100
- NTU during peak events < 300

Maximum transmembrane pressure (TMP) during filtration: 1.5 bars / 21.8 psi

Maximum transmembrane pressure (TMP) during backwash: 2.5 bars / 36.3 psi

Maximum static pressure: 3.0 bars / 43.5 psi

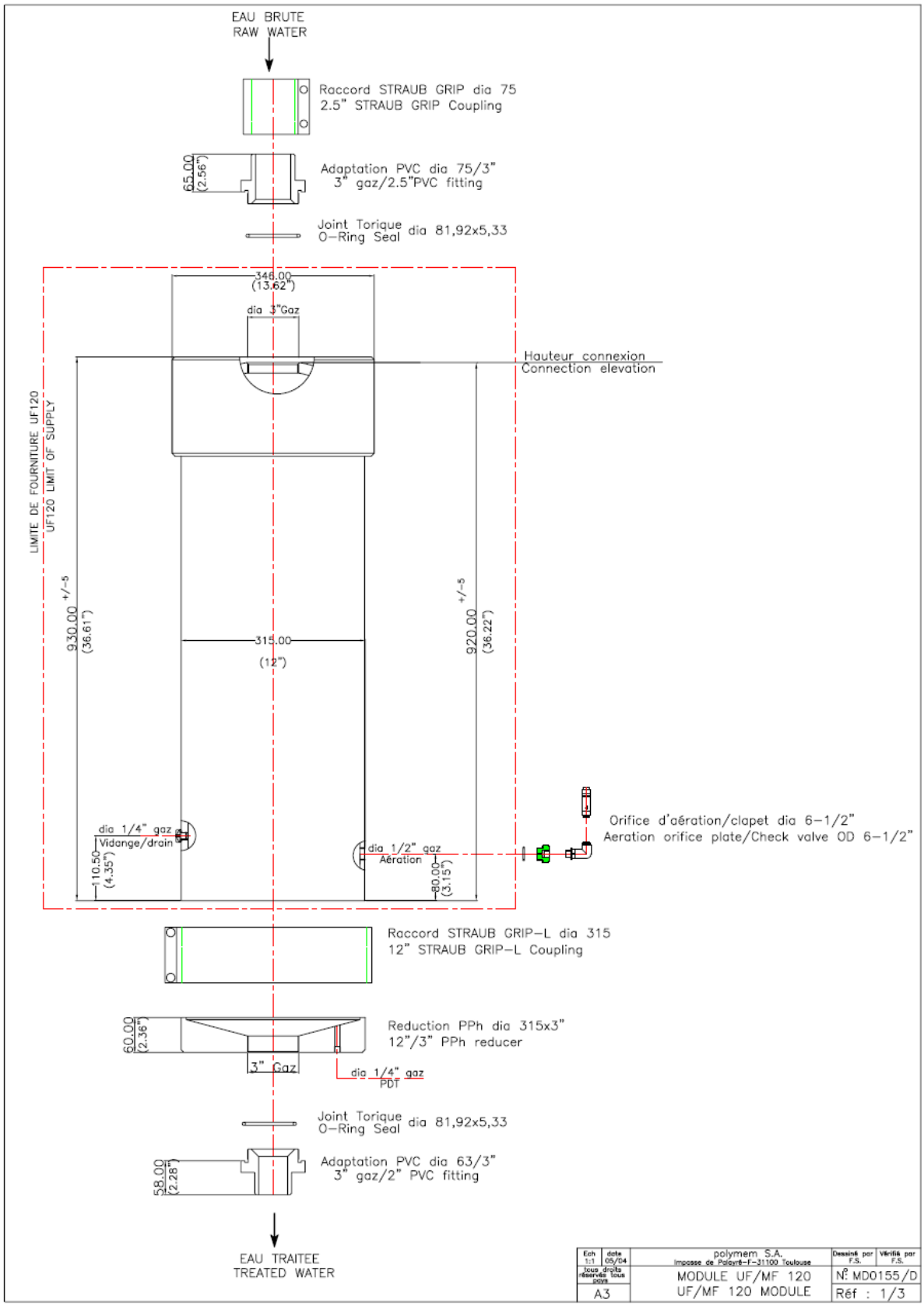
Normal air scour flow (during backwash): 2.5 Nm^3h (±10%) / 1.56 scfm

Maximum temperature: 35 °C / 95 °F

Chemical compatibility: pH 2 to 11

Disinfection: We recommend using a Clean In Place (C.I.P.) cycle with chlorine: see “Chemical Cleaning” (*chapter IV.2.*)

I.3 General Drawing



I.4 General Instructions

- The module must **be installed in a vertical position**. Mounting and assembly drawings (see chapter II.2) show the typical installation of a UF120 module. Note that the transparent PVC piping is required above the module to visually identify large bubbles during the integrity test of the module *(see chapter IV.3: on-line integrity test procedure).*

- **All piping and system components in contact with water entering the ultrafiltration module must be rinsed prior to first start up**. Every debris superior to 130 µm in size which would enter the module could definitely damage the fibers. **Failure to comply with this recommendation would void the warranty.**

- The general process description for an ultrafiltration unit with UF120 module(s) is presented in Appendix 1 *(chapter VI.1)*.

- **The procedures for production, backwash and cleaning are detailed in this document. The system based on UF120-S2F module shall allow to respect the "operation limit conditions"** *(chapter I.2).*
  Failure to comply with this recommendation would void the warranty.

- The **module is delivered filled with a preservative solution* (or conditioning solution)** to prevent fiber drying, bacteriological growth in the module and freezing.
  Before starting production with new modules, or adding new modules to an already operating system, this conditioning solution must be rinsed out. The initial **permeate should be drained** first to the waste during a **rinsing phase** *(see chapter III.1 for start-up instructions).*

- **In case of** storage, or transport it is recommended to **fill up the module with this conditioning solution*** to prevent contamination during storage *(see chapter III.6 for module stand-by instructions and chapter III.7 for conditioning and storage procedure).*

- **Waste disposal shall be in accordance with local regulations and standards.**

***** *The **conditioning solution** is composed of 50 wt % of glycerin, and 1 wt % food-grade sodium metabisulfite: this solution also protects the module from freezing.*

II INSTALLATION

II.1 Module mounting

Necessary tools:

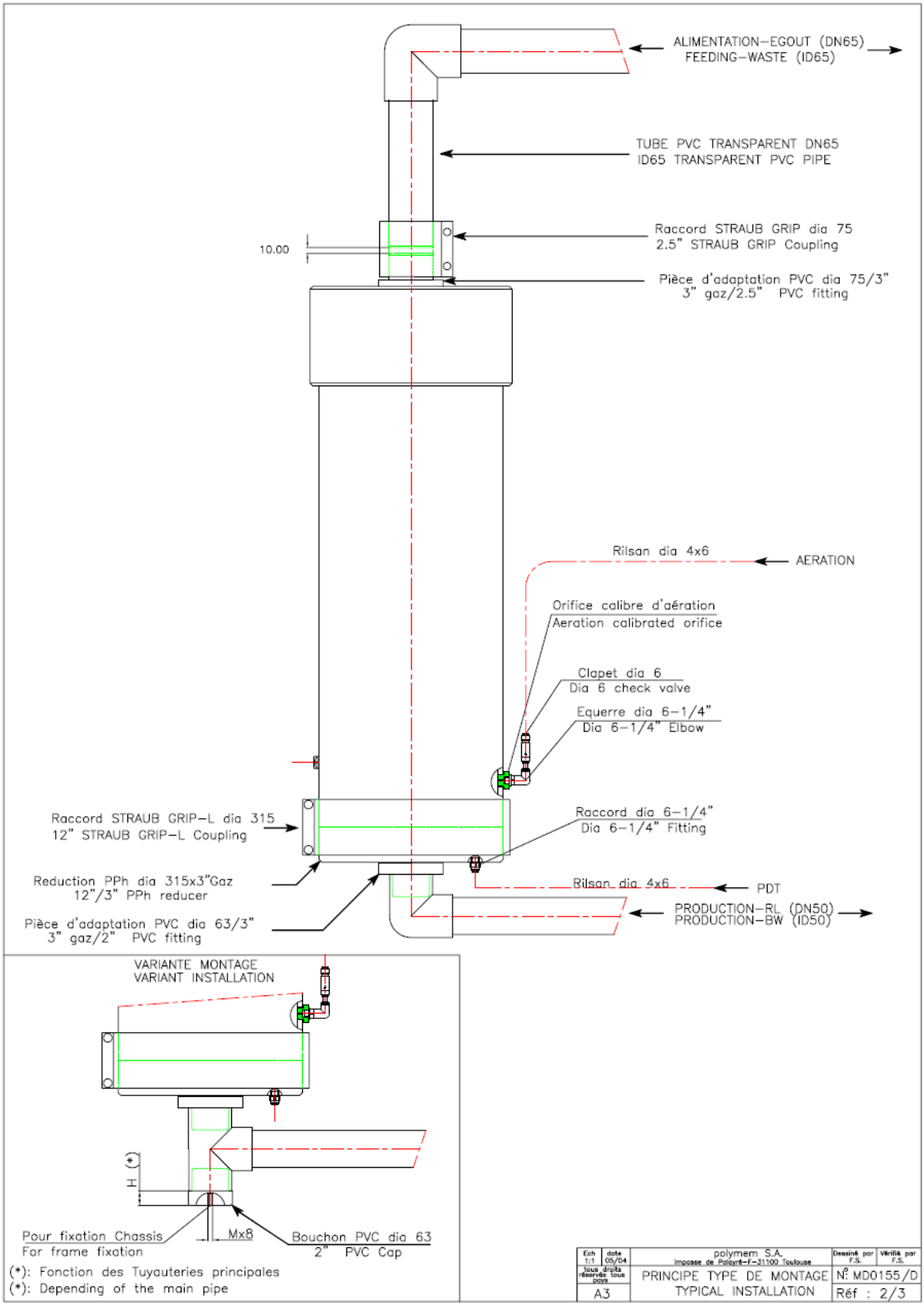
- screwdriver,
- strap wrench,
- drive torque wrench (0-10 kg.m),
- allen key diameter 6mm (for the drive torque wrench),
- allen key diameter 8mm (for the drive torque wrench).

The connection procedure of the module is the following:

- Place the module in vertical position, the module label right side up,
- Remove the 2.5" cap from the upper part of the module,
- Drain the module from its conditioning solution by removing the 1/2'' drain fitting,
- When the module is empty, unscrew the rubber cap located on the bottom of the module
- Coat the O-ring (82x2.5 diameter) with glycerin and place it around the raw water adapter (diameter 75x2.5"),
- Screw the 2.5'' raw water adaptor into the top of the module,
- Place the module on the system,
- Place the 315mm Straub Grip-L fitting on the base of the module (follow manufacturer torque recommendation). Line up the module exactly with the waterbox, take care not to scratch either surface,
- Place the Straub Flex fitting on the top of the module (follow manufacturer torque recommendation),
- On the lateral part of the module, connect the ½'' air scour fitting with the check valve, needle valve, **air flow restrictor**, and 1/4 " tubing.
- **Take care to use a fitting with a throttle depth of 7.5 mm length maximum.**

WARNING: If the air flow restrictor was not installed or was deficient, the warranty would be voided.

II.2 Mounting drawing



III MODULE OPERATION

III.1 Start-up or re-start after stand by

WARNING : **All piping and system components in contact with water entering the ultrafiltration module must be rinsed prior to first start up**. Every debris superior to 130 µm in size which would enter the module could definitely damage the fibers.
Failure to comply with this recommendation would void the warranty.

If the modules contain a preservative solution it is necessary to rinse them thoroughly before beginning production. Raw water is normally adequate, however tap water may be used in place of salt water or highly turbid feed waters. The recommended duration of the rinse to waste step is two hours. All permeate and concentrate flows should be directed to an approved waste disposal.

A "Start Up or Re-start" backwash (BW) cycle is then performed : **See chapter V.1 for detailed Start-up (or re-start) BW mode.**

The system should be purged from air before use.

III.2 Production

III.2.1 Production mode

We recommend operating UF120-S2F ultrafiltration systems at a constant filtrate flow or at a constant flux (L/h.m^2), the criteria of 1.5 bar (21.8 psi) as maximal transmembrane pressure (TMP) being respected.

Warning : The maximum allowed TMP during filtration (pressure peak event) is 2 bars (29 psi). Failure to comply with this recommendation would void the warranty.

The choice of the operating flux will depend on the raw water quality and on operational constraints. The higher the chosen operating flux, the higher the backwash frequency and/or the CIP frequency.

A UF120-S2F module can work from 2.5 to 11 m^3/h (11 to 48.4 gpm) at 20°C (68°C).

It is recommended to operate at a low to medium conservative flux to be able to temporarily increase the flux if needed when there is a temporary increase in the water demand.

III.2.2 Operating data

All data relevant to the operation of the UF system should be recorded (using a data acquisition system – data logger type). These data are necessary for monitoring system performance, troubleshooting, and warranty claims.

Two major parameters give an indication on the fouling of the membranes: transmembrane pressure and permeability. When one of these two criteria reaches the limit value, a chemical cleaning is needed:

1/ Transmembrane Pressure (TMP - bars) is normally between 0.2 to 1.5 bar (2.9 to 21.8 psi). When the TMP value reaches 1.5 bar (21.8 psi), a chemical cleaning is needed*: see chapter IV.2 for "chemical cleaning" instructions*.

2/ Membrane Permeability (Lp - l/h.m².b) should be between 50 and 130 l/h.m².b at 20°C (29.4 and 76.5 gfd/bar at 68°F), the criteria of 1.5 bar (21.8 psi) as maximal TMP being respected. When this value reaches approximately 50 l/h.m².b (29.4 gfd/bar) a chemical cleaning is needed. *See chapter IV.1 for permeability calculation and chapter IV.2 for "chemical cleaning" instructions.*

Record the following parameters regularly:

- Production flow,
- Module feed pressure (must be lower than 3.0 bars (43.5 psi)),
- Module permeate pressure,
- Water temperature (must be between 2 and 35°C / 36 and 95°F),
- pH of the feed water must be between 6 and 9,
- Complete water analysis of the feed and permeate water once at start-up periodically thereafter,
    - turbidity,
    - suspended solids,
    - total organic content
    - algae, iron, manganese, content of Chloroform extractable substances (hydrocarbons, grease)…etc
- Backwash flows (for air scour, non air scour cycles and rinse phase),
- Backwash pressure,
- Concentration of chemicals used during backwash,
- Concentration of residual chlorine in the water after backwash (directed to waste disposal).

The operating data table is given in appendix 2 (chapter VI.2).

III.3 Backwash

Periodically during treated water production, a backwash cycle is performed to remove particles and organic matter that have accumulated on the outside of the membrane surface. It consists of reverse flow of previously filtered water, potential air scour, and potential chemical addition.

III.3.1 Air Scour during backwash

The backwash cycle may be done with air scour for a better removal of particles contained in the bundles. The air scouring allows better separation and agitation of the fibers, insuring a better circulation of particles to be removed. Depending on raw water quality, the air scour may be used during every backwash, or only periodically.

The air scouring must be not higher than 2.5 Nm^3/h (1.56 scfm) which is the air flow normalised at 20°C and for 1 atm (absolute pressure). This recommendation for air flow is given with a normalised value, i.e. in Nm3/h, because in m^3/h it is dependant on the pressure after the flow meter.

For example : with 1 bar relative, i.e. 2 bar absolute, the flow meter will indicate 1.25 m^3/h for a normalised value of 2.5 Nm^3/h.

The maximum water flow allowed during air scour sequence is 10 m3/h (44 gpm) per UF120 module.

Warning : Maximum allowed air scour flow is 2.5 Nm3/h. Failure to comply with this recommendation would void the warranty.

Warning : Maximum allowed water flow during air scour is 10 m3/h (per UF120 module). Failure to comply with this recommendation would void the warranty.

III.3.2 Chemicals used during backwash

Backwash cycles may be performed without any chemical addition if the raw water quality allows the backwashes to be efficient enough. The recommended backwash cycle is thus the Air enhanced backwash (Air scour / No Chemical) - n°3- detailed in Table 1 in chapter V.1.

Using this mode of backwash without chemicals can increase the lifetime of the membranes, reduce the consumption of chemicals and thus respond to concerns of environmental preservation.

Chemicals may be added to the backwash water if required to maintain the design flux.

Chlorine

The recommended chemical to prevent biological fouling and organics adsorption is chlorine at a concentration of 5 to 20 ppm in the backwash water. If required the chlorination may be used during every backwash, or only periodically.

The necessary concentration of chlorine can be determined with a raw water analysis (TOC, COT/UV, algae content, NH_4…measurements). Then at the actual plant, the chlorine concentration may be adjusted based on the residual chlorine concentration in the backwash waste which should be approximately 3 ppm.

When a chemical is used during backwash, a final sequence with water must be performed to remove chemicals from the system before production re-starts.

III.3.3 Recommended backwash cycles

General specifications

- Frequency:	20 to 120 min.
- Total duration:	35 to 65 seconds.
- Recommended maximum water flow with air scour*:	10 m^3/h (44 gpm).
- Recommended maximum water flow with chemicals:	10 and 15 m^3/h (44 and 66 gpm).
- Recommended maximum water only flow:	10 and 15 m^3/h (44 and 66 gpm).
- Applied backwash pressure:	1.5 bar (21.8 psi)

**Air scour: To be connected on the ½'' fitting placed at the bottom of the module.*

- *Pressure: 1.0 bar (14.5 psi)*
- *Air scour flow: 2.5 Nm^3/h (1.56 scfm)*

Warning : Maximum allowed transmembrane pressure (TMP) during backwash is 2 bars continuously and is 2.5 bars during pressure peak event. Failure to comply with this recommendation would void the warranty.

Warning : Maximum allowed air scour flow is 2.5 Nm3/h. Failure to comply with this recommendation would void the warranty.

Warning : Maximum allowed water flow during air scour is 10 m3/h. Failure to comply with this recommendation would void the warranty.

Detailed specifications

Different backwash types are described in Tables 1 and 2 in chapter V.1 and V.2. Backwash types are chosen as a function of raw water quality and thanks to pilot trials (see also indications in chapter III.3.1 and III.3.2.).

Backwash types which may be performed during production are:

- Standard backwash:	**No Air / No Chemical**	**n°2**
- Air enhanced backwash:	**Air scour / No Chemical**	**n°3**
- Chemical enhanced backwash:	**Chemical / No air**	**n°4**
- Chemical and Air enhanced backwash:	**Air scour / Chemical**	**n°5**

How to perform these backwashes:

- Each backwash type and corresponding backwash number is detailed in Tables 1 and 2 in chapter V.1 and V.2. : Each type of backwash (BW) cycle is described in a column and composed of some of the different sequences described in the lines. For each sequence (line), the recommended flows (water and air) are given with the recommended duration. The recommended volume to be used per sequence and per module is also given (see hereunder : the volume may be used to control backwash when TMP is superior to 2.5 bar / 36.3 psi).
- **The backwash is controlled with time (a backwash being defined with sequences, each sequence being defined by timing and water and air flows) EXCEPT when the TMP is reaching 2.5 bar. When TMP in backwash mode is reaching 2.5 bar, then each sequence is performed with flow regulation to allow the necessary water volume to be used.**
- Each type of backwash (BW) cycle is described in a column and composed of some of the different sequences described in the lines:
  - Water only — Water flow = 10 m3/h (44 gpm)
  - Water and Chemical* — Water flow = 10 m3/h (44 gpm)
  - Water and Air — Water flow = 10 m3/h (44 gpm) andAir flow = 2.5 Nm3/h (1.56 scfm)
  - Water and Chemical* — Water flow = 15 m3/h (66 gpm)
  - Water Only — Water flow = 15 m3/h(66 gpm)

  For each cycle, the duration and the water volume to be used per sequence are given in the table.

* **For the Water and Chemical sequences; the chemical concentration are described hereunder:**

Chlorine : 5 to 20 ppm

Other product : please contact Polymem for compatibility check.

Warning : The maximal pH authorized for Neophil™ PVDF membranes is 11. Failure to comply with this recommendation would void the warranty.

III.4 Maintenance cleaning

A maintenance cleaning may be performed periodically for enhanced removal of adsorbed matters and biofilm on the membrane surface.

It is completed using:
- an acid water solution for oxidizable metals, particularly iron and manganese
or
- a chlorine OR caustic and chlorine water solution for organic removal, and soaking the solution for 20 minutes to 1 hour.

The frequency, duration and chemical concentration of this cleaning should be determined by the operator. It is dependent on design flux, the efficiency of backwash cycles (measured with the TMP and permeability levels recovered after each production backwash) and the chosen frequency for maintenance cleaning.

III.4.1 General specifications

- Frequency: About once a day to once a week,
- Duration: from 25 to 65 minutes,
- The maintenance cleaning is preferably performed in backwash mode
- The chemical solution used for maintenance cleaning must not contain particles bigger than 100 µm (it may be necessary to filter the solution at 100 µm before entering the UF module).

III.4.2 Maintenance cleaning / freshwater treatment

Recommended Maintenance cleaning procedure:

The maintenance cleaning is performed in backwash mode using the permeate tank and the backwash pump. The recommended flow is 2.5 m^3/h (11 gpm).

Note: Before initiating a Maintenance Cleaning, make sure to have the water volume needed which is of 515 liters per UF120 module installed).

- **Inject chemicals** as follows
  Chemicals concentration and procedure:
  - Chlorine (organic and bio fouling): Injection of chlorine (50 to 1,000 ppm)

  OR
  - Caustic/chlorine (hard organic fouling): Injection of soda to reach a pH of 11 (i.e. approx. 0.4 g/l) and chlorine (50 to 1,000 ppm) starting first the injection of soda, then adding soda and chlorine simultaneously and stopping first chlorine injection.

  OR
  - Acid (citric or oxalic) injected to reach a pH value of 3 to 4 (i.e. 10 g/l citric acid or 5 g/l oxalic acid).

  Injection volume: the recommended volume of water with chemical to be injected is 100 l (26.4 gal) per UF120 module (i.e. approx. 2.4 minutes with a flow of 2.5 m^3/h / 11 gpm).

- **Soaking with air scour sequences** (20 minutes).
- **Perform a "cleaning" backwash** (**n° 7)**. This backwash type is detailed in Table 2 in chapter V.2.
- **Perform a "start-up" backwash** (**n° 1)**. This backwash type is detailed in Table 1 in chapter V.1.

Warning : The maximal pH authorized for Neophil™ PVDF membranes is 11. Failure to comply with this recommendation would void the warranty.

Warning : The chemical solution used for a maintenance cleaning should not contain particles bigger than 100 µm.

III.4.3 Maintenance cleaning / saltwater treatment

Recommended Maintenance cleaning procedure:

When treating saltwater (brackish or seawater), chemical cleaning must be performed with freshwater.

The maintenance cleaning is performed in backwash mode **using freshwater (tap water OR RO Permeate)** and the backwash pump. The recommended flow is 2.5 m^3/h / 11 gpm.

- **Inject chemicals** as follows
  Chemicals concentration and procedure:
  - Chlorine : Injection of chlorine (50 to 1,000 ppm)

  OR
  - Caustic/chlorine: Injection of soda to reach a pH of 11 (i.e. approx. 0.4 g/l) and chlorine (50 to 1,000 ppm) starting first the injection of soda, then adding soda and chlorine simultaneously and stopping first chlorine injection.

  OR
  - Acid (citric, oxalic, sulfuric, hydrochloric) injected to reach a pH value of 3 to 4 (i.e. 10 g/l citric acid or 5 g/l oxalic acid or 2 g/l sulfuric, hydrochloric).

  Injection volume: the recommended volume of water with chemical to be injected is 100 l per UF120 module (i.e. approx. 2.4 minutes with a flow of 2.5 m^3/h).
- **Soaking with air scour sequences** (20 minutes).
- **Perform a "cleaning" backwash** (**n°7) with tap water**. This backwash type is detailed in Table 2 in chapter V.2.
- **Perform a "start-up" backwash** (**n° 1) with tap water**. This backwash type is detailed in Table 1 in chapter V.1.

Warning : The maximal pH authorized for Neophil™ PVDF membranes is 11. Failure to comply with this recommendation would void the warranty.

Warning : The chemical solution used for a maintenance cleaning must not contain particles bigger than 100 µm. Failure to comply with this recommendation would void the warranty.

III.5 Disinfection

We recommend to use a Clean In Place (C.I.P.) cycle with chlorine: see "Chemical Cleaning" (*chapter IV.2.*).

III.6 Stand-by

III.6.1 Short period (< 8 hours)

Before stopping the filtration system, even for a short period (even a few hours), it is necessary to perform a **"backwash before Stand-By"** cycle. It prevents bacteria re-growth inside the module. Chlorine is quickly consumed by reaction with organic matter: do not allow the modules to remain stagnant for more than 8 hours without completing a backwash.

See detailed sequence of backwash n°6 "backwash before Stand-By" in table 2 chapter V.2.

III.6.2 Short period (8 hours to 5 days)

Before stopping the filtration system, it is necessary to perform a **"backwash before Stand-By"** cycle. It prevents bacteria re-growth inside the module. Chlorine is quickly consumed by reaction with organic matter, one should do not allow the modules to remain stagnant for more than 8 hours : it is recommended, that if the water demand contact is not activated during 8 hours on the system, it automatically performs the following:

- a filtration cycle to fill the permeate tank to have a sufficient quantity of water to perform a backwash
- a **"backwash before Stand-By"**

See detailed sequence of backwash n°6 "backwash before Stand-By" in table 2 chapter V.2.

After five days it is recommended to perform a CIP before re-start.

III.6.3 Long period shutdown

If the filtration has to be **stopped for a longer period** (more than 5 days) it is necessary to fill the modules with a **preservative solution***, to prevent any long term bacteria growth. This operation is also called "**conditioning**":

- **perform a CIP** to remove the particles and bacteria from the fibers surface: See sequence in chapter IV.2

- **introduce the conditioning solution* into the module**. The sodium meta bisulfite traps oxygen and thus prevents bacteria growth. The glycerin prevents full drying and freezing. **This solution has to be checked every 6 months: see chapter III.7 for conditioning and storage procedure.**

***** The **conditioning solution** is composed of UF water, 50 wt % of glycerin, and 1 wt % food-grade sodium metabisulfite.

This conditioning solution has to be filtered through a 130 µm filter to avoid any particles to enter the module and potentially damage the fibers.

If the storage duration is less than one week and if there is no risk of freezing, the solution may be UF water with 1 wt % food-grade sodium metabisulfite.

Warning : Do not use any other product for conditioning. Failure to comply with this recommendation would void the warranty.

III.7 Module conditioning and storage

Polymem hollow fiber UF and MF modules should be handled in such a way that bio growth and change in membrane performance during long term storage, shipping or system shutdowns are prevented

Follow accepted safety practices when using biocide solutions as membrane preservations. Always wear eye protection. Consult the relevant Material Safety Data Sheets as supplied by the manufacturer of the chemicals.

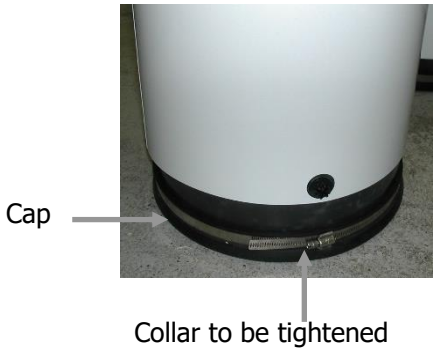
New Polymem modules are tested and shipped wet in a preservative solution. The solution is a standard storage solution of water containing a 1 wt % food-grade sodium metabisulfite (SMBS) and 50 wt % glycerine. The storage solution prevents biological growth and accidental drying during storage and shipping of modules.

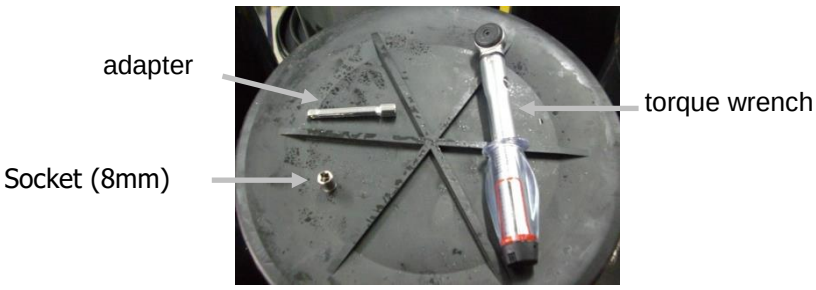
Please follow these guidelines for **storage of Polymem modules**:

- Store inside a cool building or warehouse and not in direct sunlight.
- Temperature limits: 1°C to 35 °C.
- **Preserved modules should be inspected for biological growth 6 months after shipment and thereafter every 6 months**.

III.7.1 Conditioning

1. Place the bottom cape and tight the collar on the bottom of the module.
   In order to prevent any loss of fluid from the module, the collar of the cap must be tighten with a torque wrench.

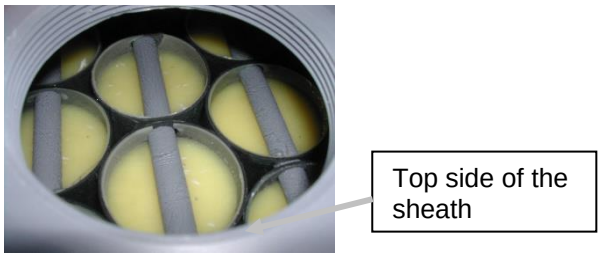


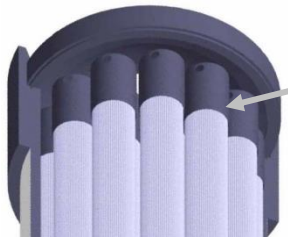


The tightening torque must be 7.5 N.m. to avoid any loss of conditioning solution.

2. Remove the top cap and introduce the filtered conditioning solution in the module. The pouring system has to be adapted to the module so that it cannot be in contact with the sheath and the fibers.

3. Fill the module: the conditioning solution is poured until the edge of top side of the sheath. Notice that the level of conditioning solution can lower because of fibers absorption. Check this level is not below fiber level of the bundle.





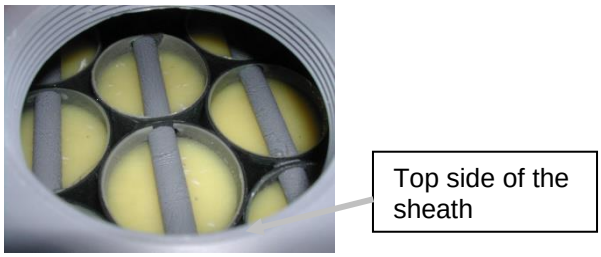
Note : Do not use any other product for conditioning.

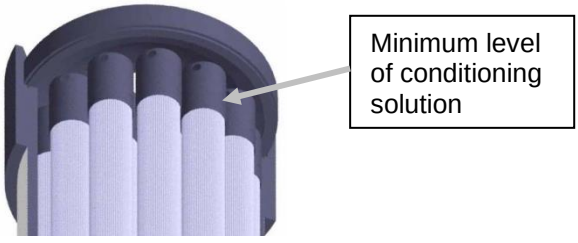
III.7.2 Conditioning liquid checkup procedure during storage

The conditioning solution level and quality must be checked every 6 months.

1. Conditioning solution level

Open the module (remove the red top cap) and visually check the conditioning solution level is not below fiber level of the bundle.





If conditioning solution is missing :

Refill the module with appropriate conditioning solution (UF water, 50 wt % of glycerin, and 1 wt % food-grade sodium metabisulfite).
This conditioning solution must be filtered through a 130 µm filter to avoid any particles to enter the module and potentially damage the fibers.
Identify the preservative solution filling date.
The storage conditions are the same as for new modules.

Warning : take care to use an appropriate pouring system allowing to avoid any contact with sheaths and fibers. Never introduce any instrument (pipe, tools …) inside the module.

2. Conditioning solution quality

The amount of sodium metabisulfite has to be sufficient to avoid any bacterial growth. Therefore the conditioning solution has to be checked every 6 months.
If the quantity of sodium meta bisulfite is superior to 0.5% by weight, the conditioning solution remains valid. Its quality will have to be rechecked after 6 months.
If the amount of sodium meta bisulfite is not sufficient (< 0.5% by weight), drain the module and renew the conditioning solution as follows:

Remove the (red) top cap,
Drain the module by opening the ¼'' drain fitting until the module is empty,

Prepare a new conditioning solution composed of UF water, 50 wt % of glycerin, and 1 wt % food-grade sodium metabisulfite,
Fill the module as described in part 1 of the current chapter.
Identify the preservative solution filling date.
The storage conditions are the same as for new modules.

Warning : take care to use an appropriate pouring system allowing to avoid any contact with sheaths and fibers. Never introduce any instrument (pipe, tools …) inside the module.

IV MAINTENANCE

IV.1 Permeability control of the module

The module permeability should be recorded periodically to have an indication of the fouling of the membranes.

Permeability is calculated as follows:

$$Lp\ (l/h.m^2.b) = \frac{Q \times 1000}{(Pi_1 - Pi_2 + K_c) \times S} \times k \qquad \text{at } 20\ °C$$

Q : Production flow (m3/h)
Pi_1 : Feed pressure (bar)
Pi_2 : Permeate pressure (bar)
S : Module filtration surface (m^2)
K_c : K circuit = $K_h - K_p$ (bar)
  K_h : Difference in height of the sensors Pi_1/Pi_2 (bar)
  K_p : Circuit pressure loss (negligible in most cases)
k : temperature coefficient corrector (see table)

The permeability value normalized at 20°C is normally between 50 and 130 l/h.m².b. If less than 50 l/h.m².b, it is necessary to perform a chemical cleaning.

Table of temperature coefficient corrector

T°C	K	T°C	K	T°C	K
35	0.72	23	0.93	11	1.27
34	0.74	22	0.95	10	1.31
33	0.75	21	0.98	9	1.35
32	0.77	20	1.00	8	1.39
31	0.78	19	1.03	7	1.43
30	0.80	18	1.05	6	1.47
29	0.82	17	1.08	5	1.52
28	0.83	16	1.11	4	1.57
27	0.85	15	1.14	3	1.62
26	0.87	14	1.17	2	1.68
25	0.89	13	1.20	1	1.73
24	0.91	12	1.23	0	

Note: The approximate formula for the temperature correction calculation is the following:
K=(1.002*exp(3.056*((20-T°C)/(T°C+105))))
Example of Lp correction as a function of temperature: an Lp of 60 l/h.m².b at 10°C will give an Lp of (60 x 1.31) = 78.6 l/h.m².b at 20°C.

IV.2 Chemical cleaning (CIP)

The chemical cleaning is necessary when a module requires a more thorough cleaning than the backwash cycles and maintenance cleaning. **A low permeability value (about 50 l/h.m².b at 20°C / (29.4 gfd/bar at 68°F) is the threshold value below which a CIP should be performed** (see chapter IV.1 above).

IV.2.1 Chemicals used for CIP

The most common chemical solutions are as follows depending on raw water characteristics:

- **For organics and biological fouling: inject 100 to 2,000 ppm of chlorine.**
- **For hard organic fouling: Inject first caustic to reach a pH value of 11 max THEN inject 100 to 2,000 ppm of chlorine.**
- **For colloidal iron and manganese fouling: acid (oxalic, citric, chloric, sulfuric) to reach a pH value of 3 to 4.**

Warning : The maximal pH authorized for Neophil™ PVDF membranes is 11. Failure to comply with this recommendation would void the warranty.

IV.2.2 General CIP operating mode

Warning : the water used for CIP must be pre filtered at 130 µm. Failure to comply with this recommendation would void the warranty.

Note: Before initiating a CIP, make sure to have the water volume needed which is of twice the volume necessary for a backwash (ie approx 400 liters per module).

The general recommended method is as follows, whichever chemicals are used. On certain systems these steps are performed automatically:

a) Check that the BW tank is full before stopping the system,
b) Connect the CIP system to the CIP in/out valves if necessary,
c) Fill the CIP tank with tap water
d) Open the CIP in/out valves
e) **Perform a backwash n°3 "Air Enhanced Backwash"** detailed in table 1 chapter V.I (The backwash must be directed to the waste*).
f) Start the CIP pump, begin re circulating the solution through the system. Introduce the chemical slowly into the CIP tank. The chemical(s) to be used and their concentration are described in chapter IV.2.1.
g) **Circulate the solution:** Let the pump circulate the solution in the system for 20 minutes to obtain a perfect mixing of this solution. The pH should be at the required value (pH value to be obtained depending on the chemical solution used : see chapter V.2.3 to V.2.5),
h) **Contact time:** Stop the CIP pump and let the module soak in the solution for 30 to 120 min, depending of the type of solution and temperature,

i) **Perform a backwash n°3 "Air Enhanced Backwash"** detailed in table 1 chapter V.I (The backwash must be directed to the waste*). **This backwash must be performed before rinsing the module ; it allows to eliminate from the module all the materials**

j) **Rinsing:** The systems is rinsed using production mode with raw or tap water (depending on the raw water quality) and sent to waste*. The rinse is complete when the pH returns to acceptable levels, and chlorine is non-detectable. This may take approximately 5-30 minutes.

*Waste disposal shall be in accordance with local regulations and standards.

Check the permeability of the membrane during the rinse step to be sure that the chemical cleaning is successful.

If the cleaning was successful, the system may return to water production.
If the cleaning is not successful, it is necessary to proceed to an acid cleaning.

Note: When treating saltwater (brackish or seawater), the chemical cleaning must be performed with freshwater:

- ***First drain permeate tank and rinse with tap water,***
- ***Fill permeate tank with ultrafiltrated tap water,***
- ***Initiate CIP as described here above***
- ***Perform final backwash and rinsing with tap water.***

IV.2.3 Operating mode for a Chlorine OR Caustic & Chlorine CIP

The chlorine & caustic CIP is performed as described here above (chapter IV.2.2) with:

- Circulation during **20 min,**
- **pH** should be **11 maximum** after circulation,
- **Contact time of 90 minutes**,
- A total duration of approximately **2 hours**.

IV.2.4 Operating mode for an acid CIP

The acid CIP is performed as described below (chapter IV.2.2) with:

- Circulation during **20 min,**
- **pH** should be **between 3 and 4** after circulation,
- **Contact time of 30 minutes**,
- The total duration of approximately **1 hour**.

IV.2.5 Operating mode for a Caustic & Chlorine + acid CIP

- Complete a chlorine & caustic CIP
- Complete an acid CIP
- The total duration of chlorine & caustic + acid CIP is approximately **6 hours**.

Note: it is recommended to heat the cleaning solution to a temperature > 20°C (maximum 35°C), to obtain a more efficient CIP.

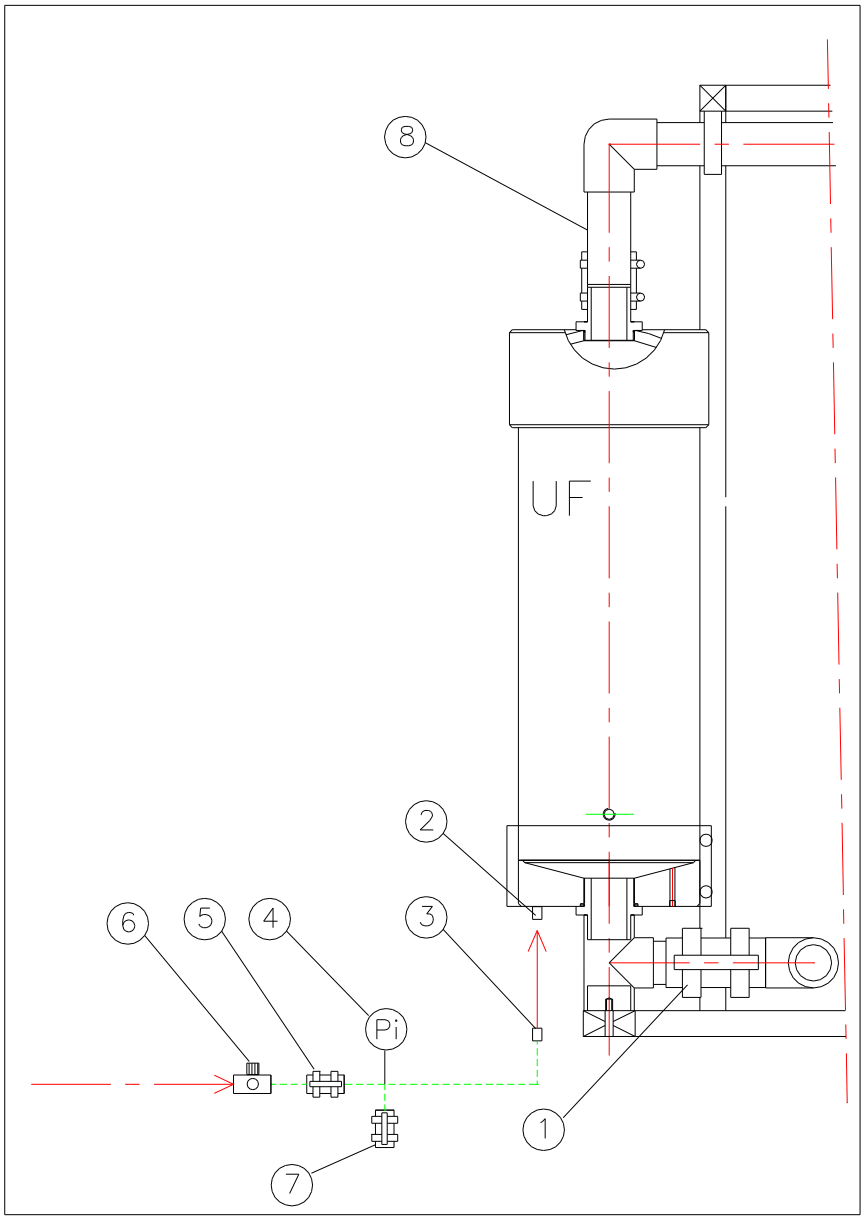
IV.3 Integrity Test (on-line)

Periodically and at an adjustable interval to be determined by the operator, it is necessary to check that the membrane barrier is intact and thus that the system is reliable.

The on-line pressure decay test (PDT) is done in place and may be automated. It is performed by using **compressed air to pressurize the module from the inside to the outside of the fibers** and by **checking the pressure decay.** The following procedure for PDT is in accordance with the ASTM International "**Standard Practice for Integrity Testing of Water Filtration Membrane Systems" (ASTM Designation: D 6908 – 06).**

IV.3.1 On-line PDT measurement protocol

The following drawing describes the module and its connections:



The Integrity online test protocol is as follows:

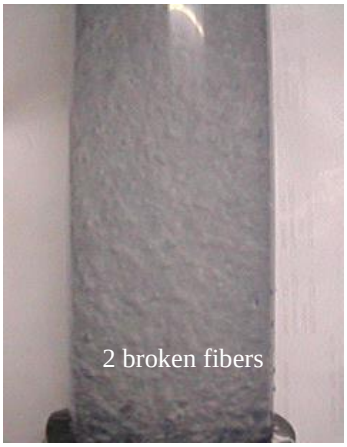
a) Stop the system
b) Close the permeate isolating valve of the module ①,
c) Open the Backwash to Waste Valve,
d) Connect the integrity test system (adaptor ③) on the fitting placed at the bottom of the module on the permeate side (adaptor ②),
e) Pressurize the module: set the pressure in ⑥ at 1 bar (15 psi) and open the valve ⑤,
f) Let the pressure stabilize by controlling pressure in ④ during 10 minutes,
g) Close the air feeding valve ⑤,
h) **Follow the pressure decay in ④ versus time during 3 minutes**
i) **Refer to the Polymem "Determination of the Upper Control Limit for Pressure Decay Test" document: the acceptable limit pressure decay value on a system is dependant on the treatment purpose and on the related national or local regulations.**

Visual Bubble Test (VBT) Protocol to detect the damaged module(s)

When an installation is composed of several modules assembled in racks where modules are operated together, a **Visual Bubble test (VBT) is used to detect which module(s) are responsible for PDT failure.**

Note in the transparent PVC pipe ⑧ if bubbles are present:

- No bubbles appear if the module is integral except some, not very often (1 or 2 per 5 seconds) due to air diffusion,
- **Intensive bubbling in the transparent part means potential compromised fibers. The VBT is used only to detect which of the modules of the tested system might be responsible for the PDT failure.**



At the end of the test, purge the air by opening the valve ⑦.

If the test is positive, the module can be returned to production

If the test is negative (the decay rate is greater than acceptable), broken fibers will have to be fixed. It is necessary to remove the compromised module(s), and fix the broken fibers as described in the next paragraph.

Tests interpretations

Pressure Decay Test	Visual bubbles test	Interpretations
< limit	Yes	Potential compromised fiber **Redo the test to confirm**
< limit	No	No compromised fiber **Integrity correct**
> limit	Yes	Compromised fibers **Integrity false**
> limit	No	Check leaks in the air system **Redo the test**

For the determination of the "limit" value; refer to the Polymem "Determination of the Upper Control Limit for Pressure Decay Test" document.

IV.4 Broken fiber identification and repair

IV.4.1 General

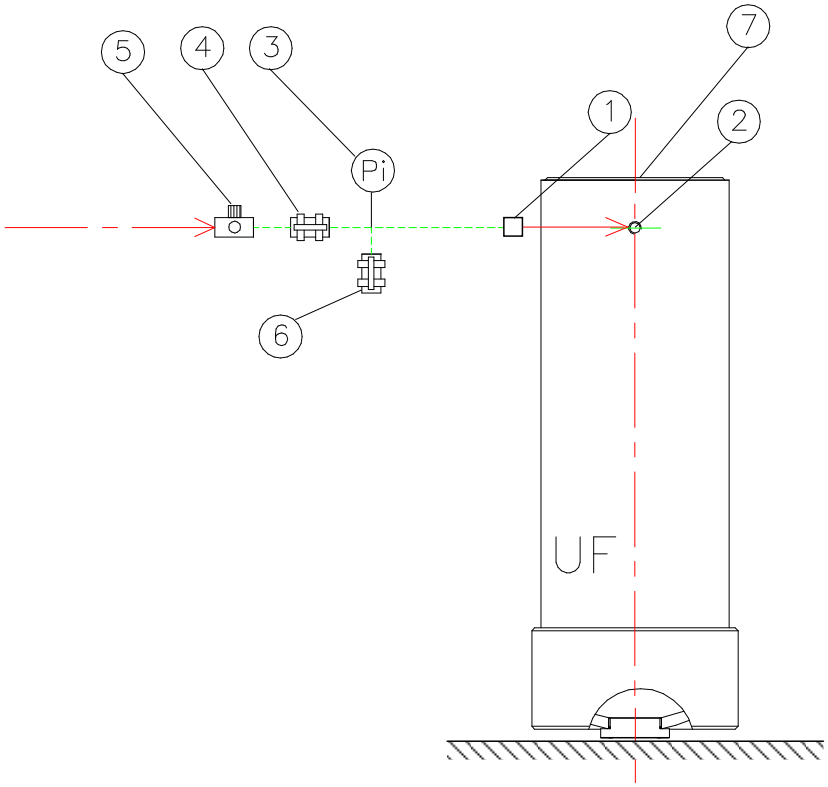
Before fixing the damaged fiber(s), an off-line integrity test is performed by using **compressed air to pressurize the module from the outside to the inside of the fibers** and by **checking the pressure decay**. The fixing of S fibers for a UF120-S2F module is completed by plugging the compromise fiber in the potting with a stainless-steel pin. Due to the **dead end filtration mode** performed in UF120 modules, the **fixing of a fiber has to be done only on one side**.

IV.4.2 Material

- Air supply with 2 ball valves, 1 manometer and one pressure regulator,
- Air connectors for module,
- Dry compressed air or hair dryer,
- Cyanoacrylate glue (Loctite 406),
- Wire cutters,
- Water spray,
- Stainless steel pins size 1 (for S fibers).

IV.4.3 Off line Integrity test protocol

1. Remove the module from the system and place the 2.5''cap on the raw water inlet fitting of the module,
2. Put the module in a vertical position; permeate side on the top side (ie. upside down),
3. Remove the ¼" drain cap of the module,
4. Fill the module at a low pressure with 5 micron filtered tap water through the ½" air scour opening. When the module is full, and water comes out the drain fitting, replace the ¼" drain cap,
5. Continue adding water through the air scour port for a further 2-5 minutes in order to drive the air out of the inside of the fibers.
6. Stop the tap water and connect the integrity test system (compressed air system) on the 1/2" air scour fitting, as shown in the following diagram,



7. Connect the adaptor ① with the fitting ②,
8. Set the pressure in ⑤ at 0.2 bars (3 psi) in order to drain the water from the permeate side,
9. Open the valve ④,
10. Let the pressure stabilize by controlling pressure in ③,
11. Once stabilized, set the pressure in ⑤ at 1 bar (14 psi) to perform the test,
12. Close the valve ④
13. Follow the pressure decay in ③ versus time during 3 minutes (PDT)

Check the PDT upper control limit is not over passed with off-line-test

14. Examine the bundles⑦ for air bubbles:

If no bubbles appear the module is integral. A slight foaming is most likely due to air diffusion. If the PDT value is over passed, the damaged module(s) will be identified thanks to visual observation of an intensive bubbling indicating compromised fiber(s). Proceed to the fiber fixing for the identified damaged modules.

IV.4.4 Fiber fixing protocol

If a fiber repair is required proceed as follows :

1. Set the pressure in ⑤ at 0.2 bar (3 psi)
2. Open the valve ④
3. In the potting of the module, check for sputtering and bubbling. Small, foamy bubbles are normal and correspond to air diffusion through wetted membranes pores. Larger bubbles (¼" or larger) and or sputtering indicate a broken fiber. The end of the fiber may be wetted with clean water to make leaks more apparent.

4. Insert a stainless steel pin size N°1 inside each broken fiber, bubbles should stop. Take care in inserting the pin not to pierce the fiber and possibly damage adjacent fibers. Repeat this same operation for all the detected fiber leaks.
5. Adjust the pressure to 1 bar to check that there are no other leaks.
6. When all the compromised fibers have been identified, depressurize the module, purge the air by opening the valve ⑥,
7. Use a stainless steel pin, size N°1, and put some glue (loctite 406) on the end (2 to 3 cm). Replace the marking pin with the glued one. The pin must be pushed 2 to 3 cm inside the fiber.
8. The glue dries quickly, a few minutes after having placed the pin, cut the pin off with a pair of cutting pliers.
9. At the end of the repair, pressurized the module again at 1 bar, and 2 bar to perform an off-line integrity test (see chapter V.4.3 above) and check if the module is correctly repaired.
10. Depressurize the module; and replace it on the system.

V TABLES FOR UF 120 BACKWASH SEQUENCES

Note 1: The dead volume for an UF120 module = 65 liters
Note 2: The chemical dosing pump is flow paced to the backwash flow. Chemical dosing is as needed, and may only be used periodically.

How to read the table:

Each type of backwash (BW) cycle is described in a column and composed of some of the different sequences described in the lines:

- Water only — Water flow = 10 m3/h
- Water and Chemical * — Water flow = 10 m3/h
- Water and Air — Water flow = 10 m3/h and Air flow = 2.5 Nm3/h
- Water and Chemical * — Water flow = 15 m3/h
- Water Only — Water flow = 15 m3/h

For each cycle, the durations of the sequences are given in the table.

* **For the Water and Chemical sequences; the chemical concentration are described hereunder:**

Chlorine : 5 to 20 ppm

Example : how to perform a "Air and chemical Enhanced Backwash" ?

Search in the table 1 and 2 the column corresponding to "Air and Chemical enhanced Backwash" =>The number of this backwash is 5.

Read the table to program the sequences as follows:

- *5 seconds of backwash with water only (water flow = 10 m3/h),*
- *15 seconds of backwash with water (water flow = 10 m3/h) and chlorine 5 to 20 ppm,*
- *15 seconds of backwash with water (water flow = 10 m3/h) and air flow 2.5 Nm3/h,*
- *10 seconds of backwash with water (water flow = 15 m3/h) and chlorine 5 to 20 ppm,*
- *20 seconds of backwash with water only (water flow = 15 m3/h),*

The total duration of this backwash cycle is 65 seconds. 222 liters of water are used for this backwash (per module).

V.1 TABLE 1 : Backwash (BW) cycles ½

		START UP	BACKWASH DURING PRODUCTION		
	BW type	Start up or re-start BW	Standard BW	Air Enhanced BW	Chemical Enhanced BW
	BW N°	1	2	3	4
	Air / No Air	*Air scour*	*No air*	*Air scour*	*No Air*
	Chemical Used	*Chlorine*	*No chemical*	*No Chemical*	*Chlorine*
WATER ONLY ***Water flow = 10 m3/h***	*no*	5 s (15 l)	5 s (15 l)	15 s (45 l)	5 s (15 l)
WATER AND CHEMICAL	*Chlorine*	20 s (55 l)			30 s (85 l)
Water flow = 10 m3/h	*Acid*				
Air flow = 0 m3/h	*Caustic*				
Chemical concentration*	*Caustic and/or Chlorine*				
WATER AND AIR ***Water flow = 10 m3/h*** ***Air flow = 2,5 Nm3/h******	*no*	15 s (45 l)		30 s (85 l)	
WATER AND CHEMICAL	*Chlorine*				10 s (45 l)
Water flow = 15 m3/h	*Acid*				
Air flow = 0 m3/h	*Caustic*				
Chemical concentration*	*Caustic and/or Chlorine*				
WATER ONLY ***Water flow = 15 m3/h***	*no*	20 s (85 l)	45 s (185 l)	20 s (85 l)	20 s (85 l)
TOTAL DURATION OF BACKWASH CYCLE (seconds)		60	50	65	65
VOLUME PER BACKWASH CYCLE PER MODULE (liters)		200	200	215	230

* see chemical concentration page 30

V.2 TABLE 2 : Backwash (BW) cycles 2/2

		BACKWASH DURING PRODUCTION	STAND BY	MAINTENANCE AND CIP
	BW type	Air & Chemical Enhanced BW	Backwash before Stand-By	Cleaning BW
	BW N°	5	6	7
	Air / No Air	***Air scour***	*No Air*	***Air scour***
	Chemical Used	***Chlorine***	***Chlorine***	*No Chemical*
WATER ONLY ***Water flow = 10 m3/h***	*no*	**5 s (15 l)**	**5 s (15 l)**	**5 s (15 l)**
WATER AND CHEMICAL ***Water flow = 10 m3/h*** ***Air flow = 0 m3/h*** ***Chemical concentration****	*Chlorine*	**15 s (45 l)**	**20 (55 l)**	
WATER AND AIR ***Water flow = 10 m3/h*** ***Air flow = 2,5 Nm3/h******	*no*	**15 s (45 l)**		**20 s (55 l)**
WATER AND CHEMICAL ***Water flow = 15 m3/h*** ***Air flow = 0 m3/h*** ***Chemical concentration****	*Chlorine*	**10 s (45 l)**		
WATER ONLY ***Water flow = 15 m3/h***	*no*	**20 s (85 l)**	**15 s (65)**	**35 s (145 l)**
TOTAL DURATION OF BACKWASH CYCLE (seconds)		**65**	**40**	**60**
VOLUME PER BACKWASH CYCLE PER MODULE (liters)		**235**	**135**	**215**

* see chemical concentration page 30

VI APPENDICES

VI.1 UF120 Unit General Process

Must be asked to Polymem

VI.2 Operating data table

Date		
Hour		
Installation code and number		
Module(s) serial number(s)		
Operating data recorded	***Min/Max/Avg***	
Raw water turbidity NTU	NTU	
Raw water temperature	°C	
Raw Water SS contents	mg/l	
Raw water pH		
Production flow	m^3/h	
Feeding Pressure	0.2/3/1.6 bar)	
Production Pressure	0/0.5/0.25 (bar)	
Differential Pressure (TMP)	0.1/1.5/0.7 (bar)	
Membranes permeability Lp at 20°C	L/h.m².bar	
BW water flow		
BW air flow		
BW CL_2 Concentration		
Concentration of residual Cl_2 in the water after backwash		
Maintenance Cleaning - flow - duration - Cl_2 concentration	 - m3/h - min - ppm	
Complete water analysis of the feed and permeate water		
Observations		

VI.3 Maintenance data table

Date			
Hour			
Installation code and number			
Module(s) serial number(s)			
Nature of the Operation	***Min/Max/Avg***	***Recorded values***	***Observation***
Permeability control (calculation done at 20°C)	30 to 130 l/h.m².bar		
Chemical cleaning (CIP)			
Chemical used	Chlorine /caustic / acid		
Concentration of used chemical	Caustic		
	Cl_2		
	acid		
	…		
BW flow			
BW duration			
Contact time			
Rinsing time			
Lp value after CIP	30 to 130 l/h.m².bar		
Integrity test			
On-line Pressure Decay	Mbar/min		
Off-line Pressure Decay	Mbar/min		