FILPURE®

INSIDE OUT SERIES

User manual & Guide:
FILPURE 1560(45) / FILPURE 1860(55)
UF MODULE

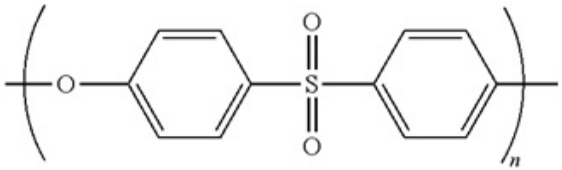
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Membrane technology

Membrane material: Polyethersulfone



- **Resistant to hydrolysis at extreme pH**
- **Good mechanical properties**
- **Hydrophilic in nature**

Fiber morphology:

- Seven bore tube structure
- Graded sponge structure for robust mechanical & filtration performance

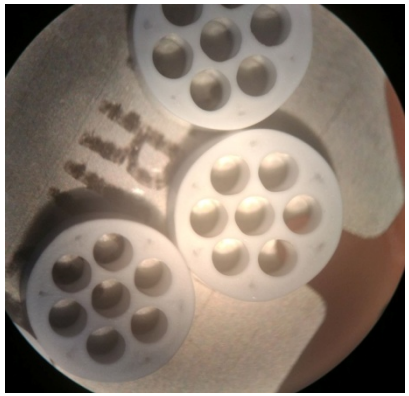


Figure 1. Image of membrane cross-section

Filtration configuration:

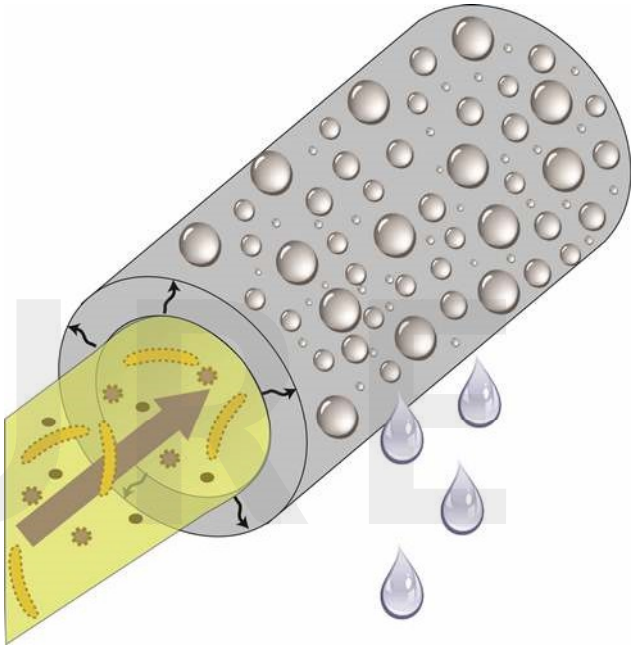


Figure 2. Scheme of filtration through membrane

- Selective skin on inner side of capillary
- Inside-out filtration in cross-flow or dead end mode

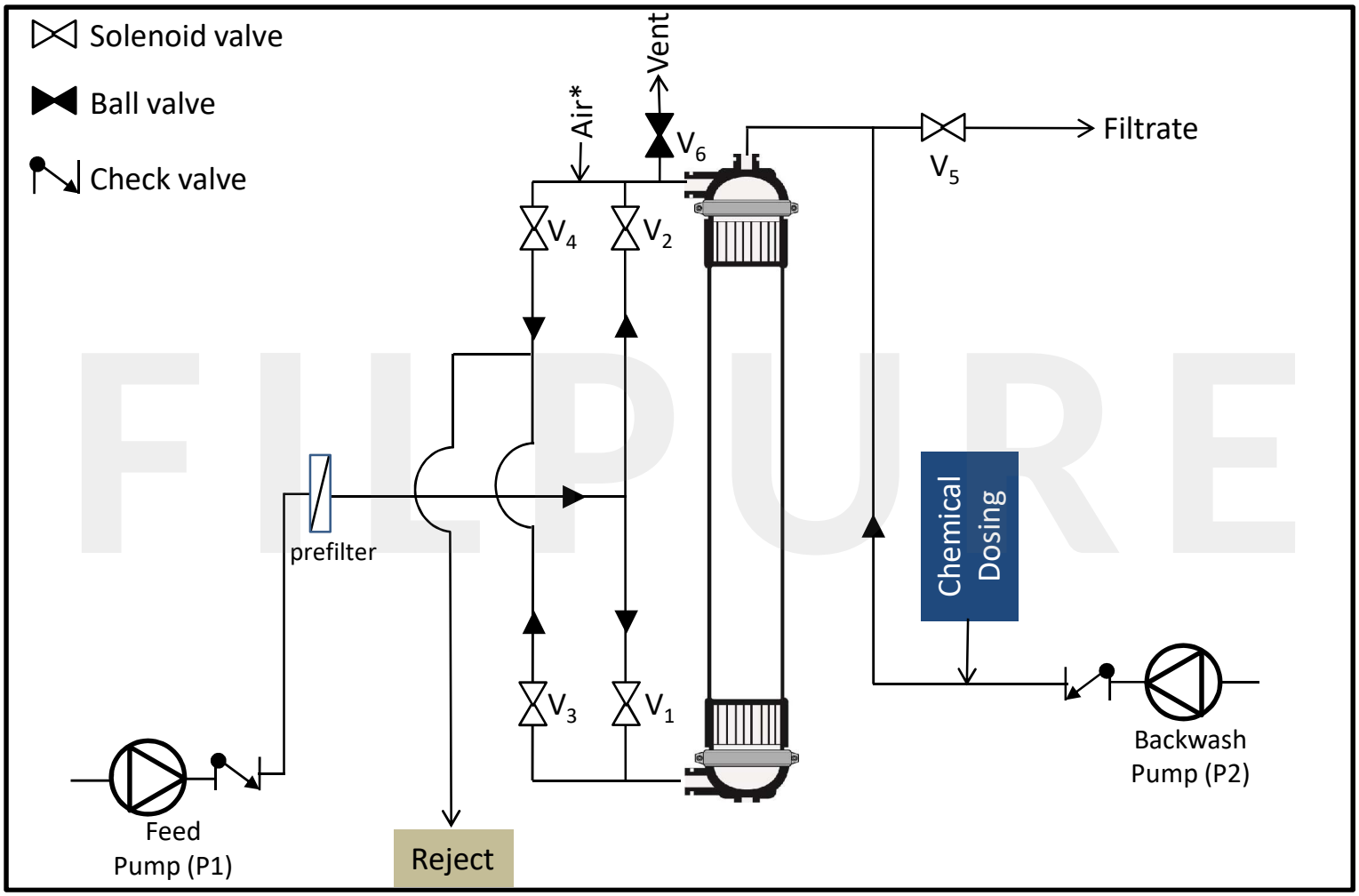
Installation

Precautions

- The FILPURE UF module should be mounted only in vertical position.
- The module should be installed on the skid with proper support without any mechanical stress.
- The skid setup should be clean, checked for the flow and program functions before module mounting.
- Only glycerine should be used as lubricant wherever required.
- Use of oily lubricants is strictly prohibited.
- A 100 micron prefilter should be used for UF feed water to avoid blockage or damage of membrane capillaries.

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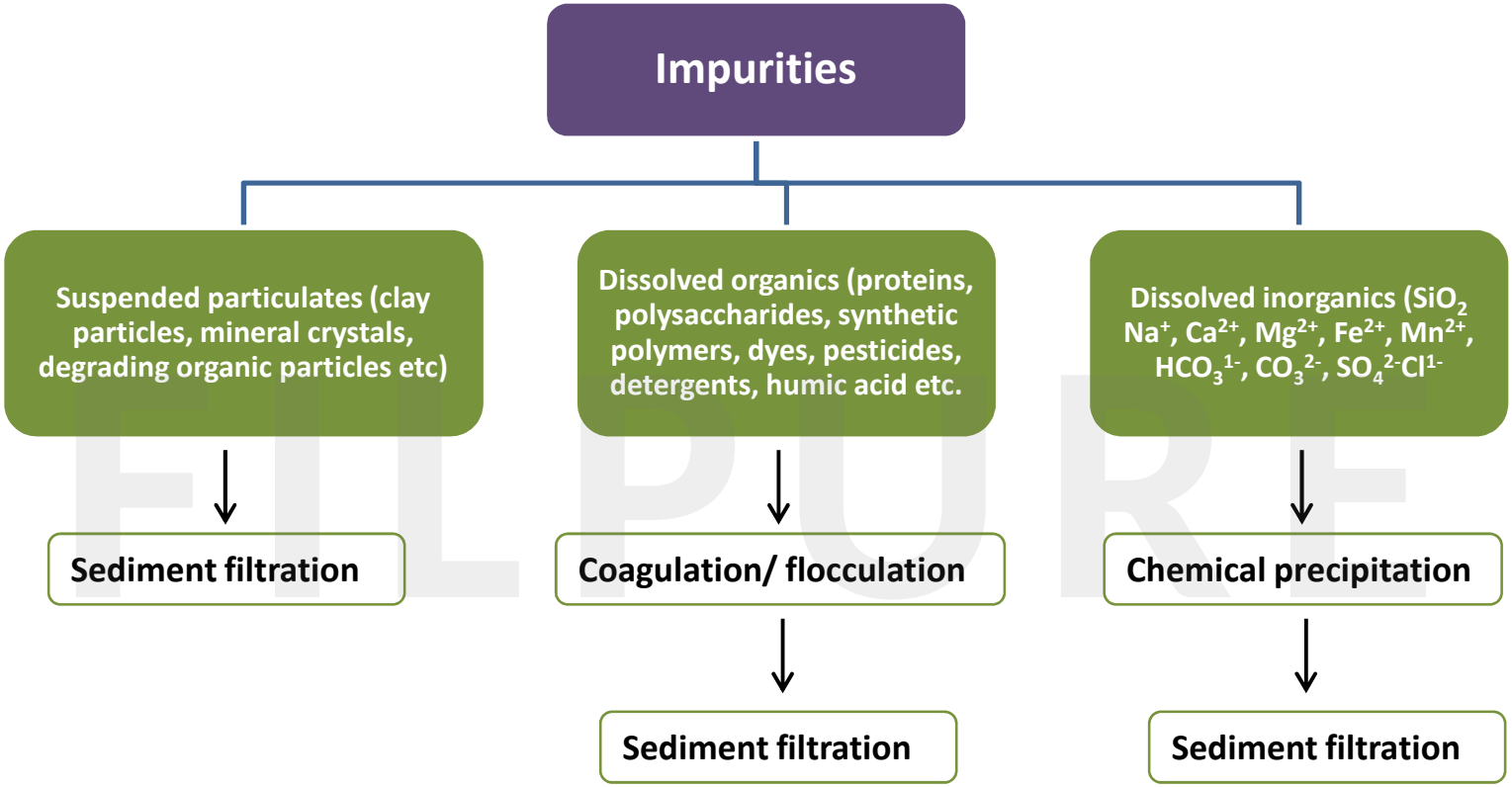
Plant design



*For membrane integrity testing

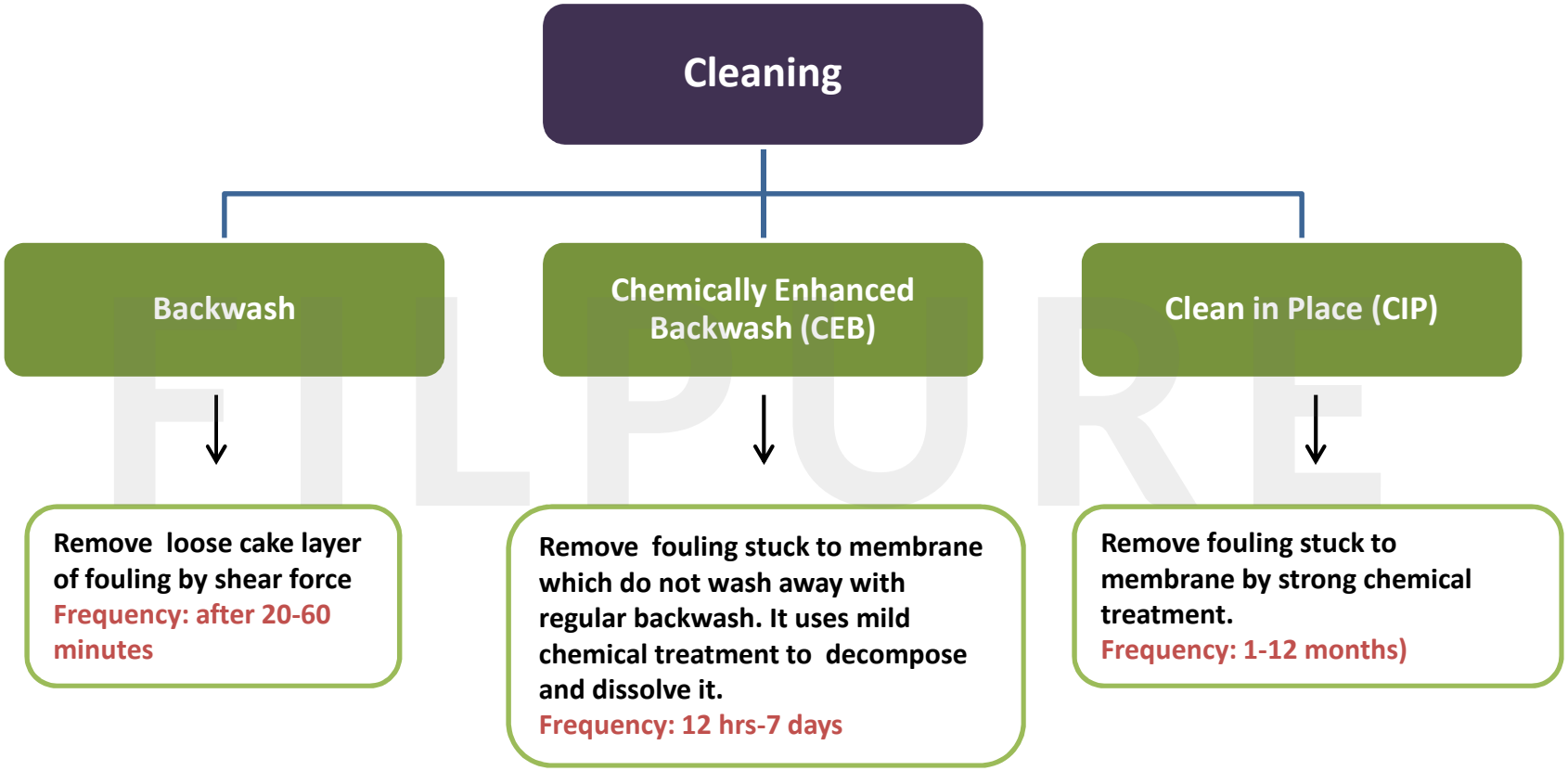
Figure 3. P & I diagram of UF plant

Feed pre-treatment considerations



- Coagulation and flocculation significantly reduce the dissolved organic carbon (DOC) from the water, hence reducing its fouling potential.
- In case of inline addition of coagulants/precipitants, it should be ensured that the process completes before the water comes in contact with membrane. Otherwise it can cause severe fouling of membrane.
- Excess residual coagulant/flocculant (>1%) may also cause serious fouling of membrane.

Cleaning


Cleaning
Backwash
Chemically Enhanced Backwash (CEB)
Clean in Place (CIP)
Remove loose cake layer of fouling by shear force
Frequency: after 20-60 minutes
Remove fouling stuck to membrane which do not wash away with regular backwash. It uses mild chemical treatment to decompose and dissolve it.
Frequency: 12 hrs-7 days
Remove fouling stuck to membrane by strong chemical treatment.
Frequency: 1-12 months)

Backwash

- The impurities accumulates on the membrane surface during the filtration process to form a cake layer. This cake layer exerts extra resistance to the water flowing through membrane. As a result, the pressure drop required for filtration (trans-membrane pressure) increases gradually.
- In order to remove the build-up of fouling from the membrane surface and reduce the TMP, Backwash is performed at regular intervals.
- In backwash mode, filtered/particle free water is pumped from filtrate side to feed side and rinsed out from reject outlet. Water flows from outside of capillary to inside of capillary and wash away the cake from membrane surface.
- The backwash reject can be drained either from the top or bottom feed opening as shown in the Figure 4.
- In the total duration of backwash, the reject water is drained from top side for half of the time and from the bottom side for remaining half of time.
- The backwash duration can vary from 30 seconds to 60 seconds, while backwash interval can be 15 minutes to 6 hrs.

The optimum backwash flow for FILPURE module is 150-200 LMH.

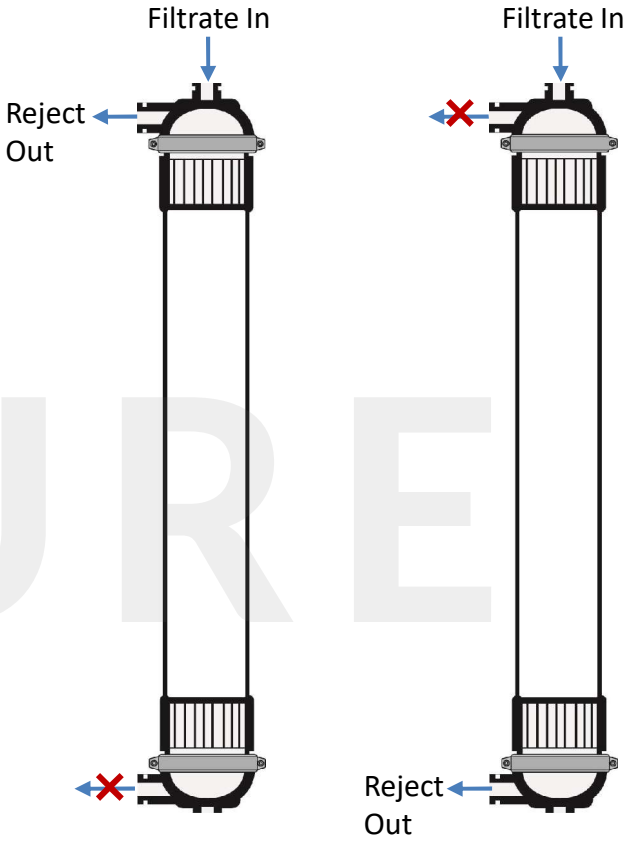


Figure 4. Water flow path in backwash modes

Chemically Enhanced Backwash (CEB)

How it works?

- CEB is mild chemical treatment to degrade and dissolve the fouling substance stuck on the membrane (which could not be swept away with normal backwash)
- Duration and frequency of CEB can be decided based on the nature and scale of fouling

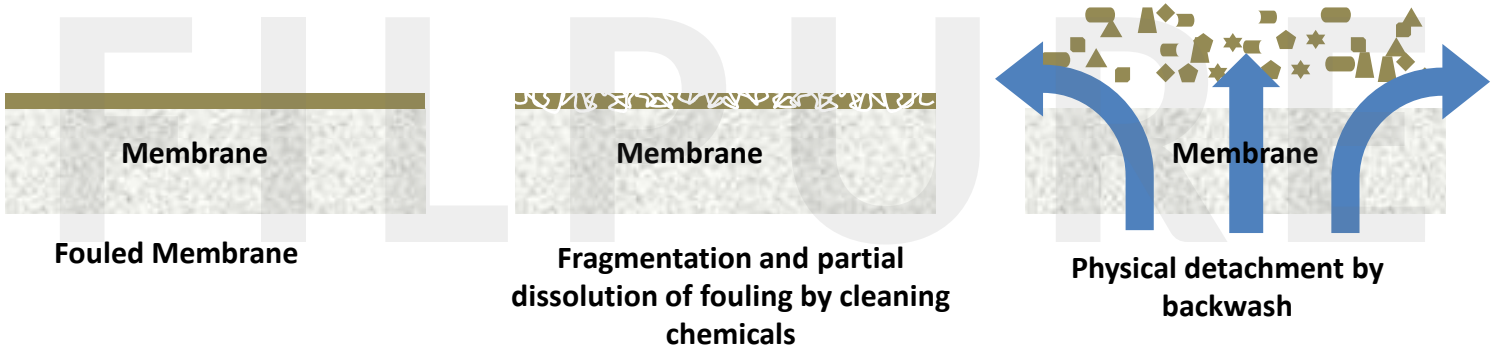
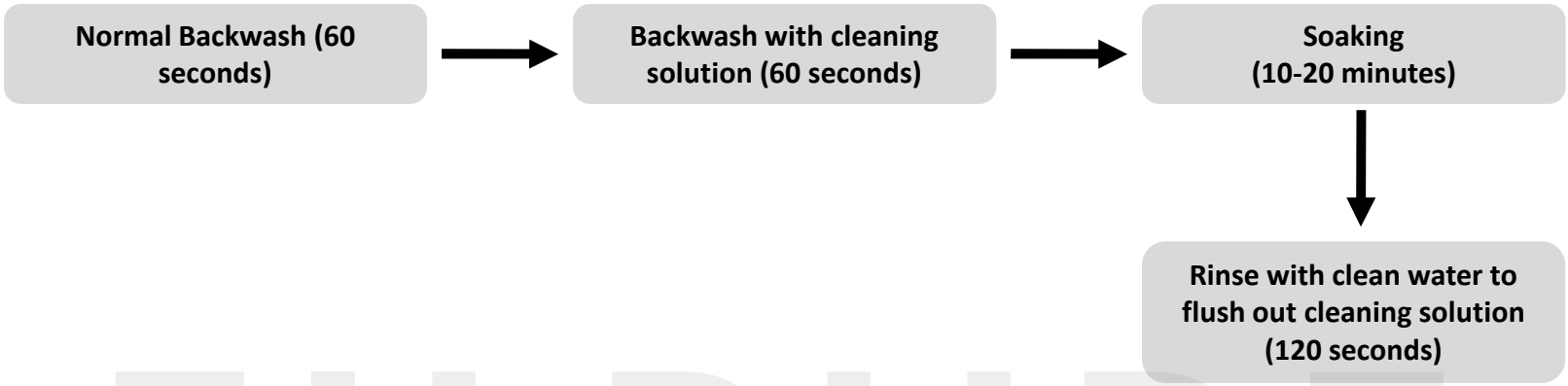


Figure 7. Mechanism of membrane fouling removal by CEB

How to do it?



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- Give alkaline CEB first to remove bio fouling and subsequently acid CEB to remove any inorganic fouling.
- If the flux recovery is not satisfactory, add the oxidation CEB step after the alkaline CEB to remove organic fouling more effectively.
- In case of ferric chloride coagulation, first do the acid CEB to remove Iron.
- Frequency and duration of CEB depends on the feed water fouling potential. It should be optimized to achieve maximum flow recovery with the mildest chemical treatment.

Chemicals and concentrations

Chemical	Purpose	Concentration/pH
HCl, H_2SO_4	Dissolving inorganic precipitates	pH2 - pH3
NaOH	Dissolving bio fouling (mostly) by hydrolysis	pH 10-pH 12
NaOCl	Dissolving organic fouling (both biological as well as synthetic origin) by oxidizing and breaking them into small molecules	pH 12, 40-60 ppm NaOCl (100 ppm max.)

Precautions

- Dosing input should be at maximum distance from the backwash inlet of membrane to insure thorough mixing of dosing chemical with water stream before it enters into module
- Backwash water should be of sufficiently low hardness that when used with sodium hydroxide for alkaline backwash, no precipitation occurs.
- Chlorine containing cleaning solution should not get mixed with the acidic water. It will release highly corrosive chlorine gas.

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Clean In Place (CIP)

When to do CIP?

The CEB may not restore the flux 100% always. So in longer span of time the flux reduce and TMP increases continuously. When it reaches 70-80% of maximum TMP or permeability reduced to 20-30%, it is suitable to do CIP to restore performance.

How to make CIP effective?

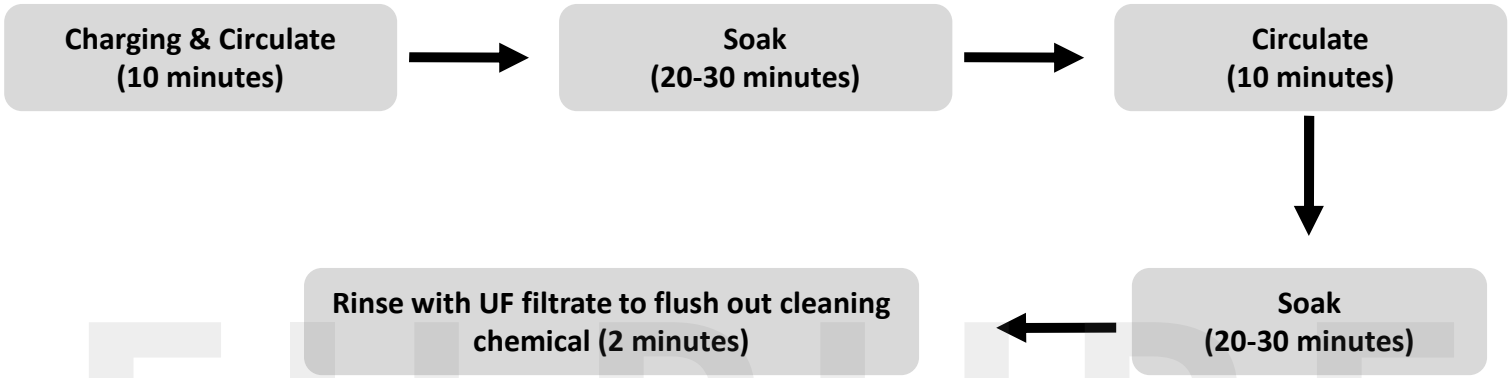
CIP is most effective when tailored to the specific cause of fouling. The previous history, analysis of feed or reject water can help to find out the nature of fouling and treat it accordingly.

Does CIP cause membrane degradation?

CIP involves strong chemical treatment. Excessively high concentration of oxidising agents or extreme pH will cause significant degradation of membrane material. Thus finding out right cause of fouling and giving optimal treatment will least affect the membrane.

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How to do it?



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- It is recommended to perform CIP cleaning in multiple short cycles (of 1-2 hrs), rather than of a single long cycle.
- Multiple cycles with different chemicals may be required to regain the flux of membrane.
- The soaking and circulation of cleaning solution should not be more than 8 hrs.
- A CIP could be called successful if flux recovery is up to 70 - 80% compared to reference value (flux at time of plant installation).

Cleaning chemicals and their concentration

Chemical	Purpose	Concentration/pH
HCl, H_2SO_4, Citric acid, Oxalic acid	Dissolving metal oxide and hydroxide scaling	pH 1 – pH2
NaOH,	Dissolving bio fouling by hydrolyzing	pH 10-pH 12
NaOCl	Dissolving organic fouling (both biological as well as synthetic origin) by oxidizing and breaking them into small molecules	pH 12, 100 ppm NaOCl (200 ppm max.)
Sodium lauryl sulphate	Dissolving oily/fatty substance	1-5 gm/Liter

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Precautions

- Use of RO water for alkaline CIP is most preferred. The use of UF filtrate water (with TDS above 200 ppm) for alkaline CIP is not advised as it may lead to severe scaling of minerals on the membrane causing irreparable damage.
- Alkaline CIP should always be followed by acidic CIP (or CEB) to remove any additional mineral precipitation caused by alkaline CIP.
- The CIP solution should be fed to module from the feed inlet only.
- In case of fouling suspected due to coagulants (like PACL, $FeCl_3$), acid CIP should be carried out first.
- In some cases warm cleaning solution may prove more effective in removing fouling. Heating of the cleaning solution should be carried out at slow rate (<5 ^{o}C/minute)
- Chemicals used for CIP should be premixed in storage tanks well before feeding into the UF module. They should not be injected inline. Insufficient mixing may cause a permanent damage to membrane.

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Integrity testing

- Close all water inlet and outlet valves.
- Open the air valve to get air pressure (1 bar) on the permeate side.
- Pressure decay rate of ≥10 mbar/minute (at feed side pressure of 1 bar with permeate side open to air) is also indicative of leak.
- Observe for air bubbles in the transparent tube (fitted on permeate outlet) see for the bubbles coming out from permeate side. If the air bubbles comes consistently, there is high possibility of leak.
- **Remove the module from skid, locate the exact fiber leaking at the testing rig.**
- Release the pressure, and surface dry the marked area/capillary.
- Apply fast cure epoxy to plug the marked capillary permanently.
- Let the adhesive cure for 15-20 minutes.

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