PCI Membranes®
Filtration Group®

Guidelines for Foam Ball Cleaning

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Guidelines for Foam Ball Cleaning

Maintaining an effective operation over the lifespan of a membrane filtration system is a critical factor for most end users. Factors such as membrane fouling and scaling play a vital aspect in the ability to run a membrane plant efficiently; as they may have an impact on the flux/permeation rate and quality, operating conditions or operating/differential pressure across the membrane and the overall operating cost of the system.

Fouling phenomenon refers to the accumulation of suspended solids, microorganisms, colloids, gel-like materials and other inorganic & organic matters on the membrane surface, which leads to the blockage of membrane pores and flow restriction.

Scaling phenomenon relates to the precipitation of inorganic salts when solubility limits are exceeded, i.e. precipitation from Calcium Sulphate, Calcium Carbonate, Silica and others, to form a crystallise material on the membrane surface.

The potential impacts from fouling and scaling phenomena can be associated with decreased operating flux or permeability, deterioration of the produced permeate stream quality, increased operating/differential pressure across the membrane system, increased production downtime, more frequent cleaning/CIP, higher CIP chemical usage and possible reduction to the membrane lifespan.

Some of the following procedures can be used to mitigate, control or minimise fouling and scaling in a membrane system:

- Pre-treatment or Pre-filtration: using technology such as multimedia filters, bag or cartridge filter and other solutions to remove larger particles from the solution to be processed with the membrane system.
- Chemical treatment: this may involve the use of antiscalants to control the scaling potential and inhibit crystallization phenomena, or the action of using acid injection to control the pH of the solution to minimise any precipitation or biocide to limit bio-gel growth.
- Operational optimisation: this relates to the effective management of the membrane operating conditions: managing the recovery rate to prevent going beyond the concentration limits, operating at lower pressure to prevent precipitation of particles and concentration polarisation.

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- Cleaning: chemical or physical cleaning. With chemical cleaning (CIP or cleaning in place) involving a periodic use of chemicals to clean and remove accumulated fouling materials from the membrane systems. Physical cleaning can be associated with membrane relaxation phenomena or Foam ball cleaning process. Membrane relaxation is a process during which the operating pressure and applied crossflow in the membrane system is reduced to as minimal as possible, and the system is left to rest, with the natural osmotic phenomena taking place to allow a reverse flow from the permeate side to the concentrate side and therefore, facilitating the dissolution of particles from the membrane layer. Foam ball clean is a physical/mechanical cleaning method which has been specifically designed for tubular membrane system.

Foam ball cleaning revolves around the use of a natural rubber ball together with the applied crossflow in the membrane, to scrub the surface of the membrane tube and therefore, remove any accumulated particles from the surface of the membrane. These dirt, solids and deposited materials on the membrane layer are removed by the combined action of the foam ball and the velocity of the feed water and leave the filtration module via the reject stream.

Originally, the foam ball cleaning method was developed for C10 systems, used in surface water treatment applications to produce drinking water; however, foam ball has also been used in other applications with high fouling and scaling potential such as fruit & vegetables juice concentration, industrial and process water applications. All filtration modules equipped with foam ball cleaning are designed in a tubular configuration, with the associated module end caps in series flow configuration. As of now, it is not practicable to design a foam ball cleaning system for modules with twin entry or parallel flow end cap configurations, as ensuring a uniform distribution of the foam balls across the tubes in a module with twin entry or parallel flow end caps can be challenging. Additionally, it is important to consider that the application of foam balls with some of the tubular RO, NF, or UF membranes may have an impact on the solute passage of the membrane in question. This is mainly due to the scouring/scrubbing effect of the foam ball which may remove some layer of membrane polymer from the surface of the membrane over time. Therefore, it is important for the end user to liaise with PCI Membranes®' technical, production and quality department to define the acceptable range of solute passage or to establish where foam ball application is reasonably practicable.

The implementation of a foam ball clean mostly helps to significantly reduce the need/frequency for a chemical in place clean – thus, resulting in a significant reduction of generated chemical wastewater. This has been proven to be the case for PCI Membranes®' FYNE® or surface water treatment process with C10 tubular membrane systems to produce drinking water. For the C10 system, the plants are mostly designed to operate 24 hrs/day, during which a foam ball operation only kicks in once every 4 to 6 hours for a duration of 5 to 10 minutes. During normal process operation, the foam balls are "parked" in the so-called "foam ball catcher" which is in the feed/reject stream piping.

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For PCI Membranes®' FYNE® or surface water treatment with C10 system, a chemical in place clean is only completed once every 3 to 4 months.

Foam ball and chemical in place cleaning frequency will vary for most other applications or tubular membrane type. Thus, it is imperative to evaluate the effectiveness of both chemical and mechanical/physical clean, how often the membranes should be cleaned, and make appropriate provision for the automation required for both cleaning procedures.

The instigation of the foam ball clean is often fully automatic, with the frequency being set during commissioning or this may be defined/updated as needed in function of the fouling/scaling potential of the process.

A typical sequence for a ball actuation is described below. The corresponding P&ID highlights the associated instrumentation involved in the process.

Automatic Foam Ball Cleaning:

1. Foam ball passes down the inside of the membrane tube, gently scours the surface of the membrane and removes the layer of dirt.
2. The foam ball is caught in a special trap situated at the inlet and outlet of each module. There is one foam ball per module.
3. During the foam ball clean, the plant automatically ramps down to foam ball speed (typically much lower that the actual speed used during process).
4. The flow through the feed flow control valve to the system is reduced via the closure of valve V8.
5. Bypass valve RCV15 is open to further reduce pressure from the system.
6. The two 3-way valves DV9 and DV10 are moved to a new position to reverse the direction of flow in the membranes.
7. The recycle pump is run for a pre-set time. This is the time required for the foam ball to travel all the way through the module to the far end. The arrival of the foam ball can be monitored in the transparent foam ball catchers fitted at the outlet and inlet of each module.
8. Flow and pressure at the membrane are reduced during the foam ball clean sequence. This reduces the permeation rate to prevent any of the wiped from the membrane surface being put back on.
9. When the foam ball time elapses, recycle pump stops, RCV15 will be closed, V8 is opened.
10. Recycle pump ramps up again to proceed with the process operation for the set process time.
11. The cycle continues until the plant is stopped manually.

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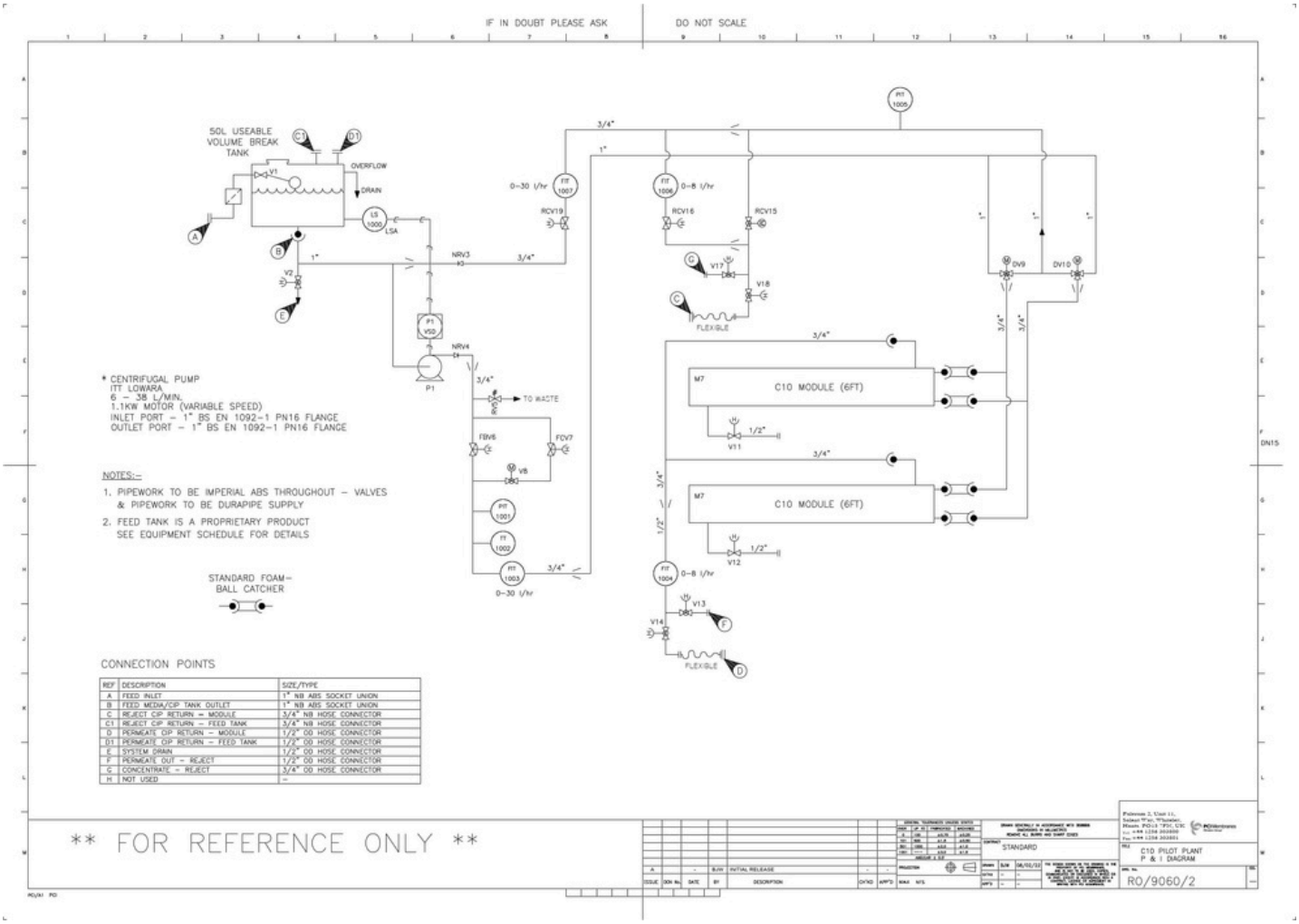
Manual Foam Ball Clean:

1. Open bypass valve RCV15, Close Valve V8.
2. Move DV9 & DV10 to opposite position
3. Start pump and run until foam ball appears in foam ball catcher.
4. Stop pump. Close RCV15. Open V8.
5. Start pump for process until the set duration.



REF	DESCRIPTION	SIZE/TYPE
A	FEED INLET	1" NB ABS SOCKET UNION
B	FEED MEDIA/CIP TANK OUTLET	1" NB ABS SOCKET UNION
C	REJECT CIP RETURN – MODULE	3/4" NB HOSE CONNECTOR
C1	REJECT CIP RETURN – FEED TANK	3/4" NB HOSE CONNECTOR
D	PERMEATE CIP RETURN – MODULE	1/2" OD HOSE CONNECTOR
D1	PERMEATE CIP RETURN – FEED TANK	1/2" OD HOSE CONNECTOR
E	SYSTEM DRAIN	1/2" OD HOSE CONNECTOR
F	PERMEATE OUT – REJECT	1/2" OD HOSE CONNECTOR
G	CONCENTRATE – REJECT	3/4" OD HOSE CONNECTOR
H	NOT USED	–