PALL

Food and Beverage

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Application Bulletin

28 % Costs Improvement by Effectively Protecting your Reverse Osmosis Unit

Overview

The Food and Beverage industry is going green and has water management programs in place to optimize water usage to reduce the water footprint (*) and achieve overall costs improvements.

Reverse osmosis (RO) systems are used for the production of process water and water recovery within F&B plants. Membrane fouling is an issue regarding operation and cost efficiency. Consequences are uneconomical increase in applied pressure and need for frequent cleaning that shorten membrane life and lead to overall costs increase (water, chemicals, labour, downtime, energy).

Effective pretreatment of the feed water is key to increase efficiency and improve economics of RO systems.

* Water footprint: water volume used in the process to produce 1 L or 1 kg of finished product.

The Challenge

In order to choose the correct and economical pre-treatment, an assessment of the fouling potential of the feed water has to be done. Various methods or indices have been proposed to predict the fouling potential of feed water, mainly:

- **Turbidity** [1], caused by suspended and colloidal particulate matter such as clay, silt, finely organic and inorganic matter. Most of RO systems suppliers specify that turbidity of the feed water should be less than 1 NTU as one of the minimum requirement of the feed water.
- **Silt Density Index** [2] gives a useful indication of the fouling potential of the feed water. The test measures the rate at which a 0.45 µm filter is plugged when subjected to a constant water pressure of 206.8 kPa (30 psi). For an effective RO protection, the general guideline is to maintain an SDI lower than 5, however to minimize fouling, an SDI lower than 3 is recommended [3].

By achieving the required SDI, the pre-treatment will allow:

- optimized sizing of the RO system and increased membrane life time to lower the investment costs
- fewer cleaning cycles, lowering chemical, water and labour costs and lower RO pressure drops for decreased energy costs to lower operational costs

The Solution

Most RO manufacturers usually protect their units with cartridge filters, also they can and do use conventional media beds. Cartridge filters with an absolute pore size of less than 10 µm as the minimum suggested pre-treatment are often used as a final protection barrier in front of the high pressure pumps of the RO units.

The better the pre-filtration, the less RO membrane cleaning is required, hence a 5 µm filter is preferably installed. If there is a risk of fouling with colloidal matter, 1 to 3 µm filters are recommended.

Filter cartridge removal efficiency is key to achieve stable water filterability as required upstream the RO system (see Table I).

Table I - Removal efficiency of different filter cartridges rated at 5 µm

	Claris® filter	Nexis® T filter	Ultipleat® High Flow filter
Grade (µm)	5	5	4.5
Removal efficiency at 90 % (beta** 10)	N/A	N/A	1.2
Typical Relative beta 5000 rating	50 - 70	12 - 15	4.5

** Beta ratio: number of particles upstream the filter larger than diameter X divided by the number of particles downstream larger than diameter X

Table II - SDI*** reduction achieved with different filter cartridges rated at 5 µm

	Feed water (Inlet)	Filtered water (Outlet)	SDI reduction (%)
Claris® filter	5.4	4.5	17
Nexis® T filter	5.8	3.8	34
Ultipleat® High Flow filter	6.4 3.3	2.8 1.4	56 57

*** Punctual SDI measurements done on different water quality and different period

Table II shows that depending on removal efficiency of the filters installed to protect RO units, the SDI reduction achieved varies (in the example shown, from 17 to 57 %).

However, it becomes difficult to achieve stable RO feed water quality with conventional pre-treatment systems on “complex” feed water with unstable SDI values and/or peaks. When colloidal matter is present in the feed water, a membrane based pre-treatment such as Pall Aria™ system provides a superior particulate and colloidal matter removal efficiency with SDI typically lower than 1 and turbidity lower than 0.1 NTU independent of upstream conditions.

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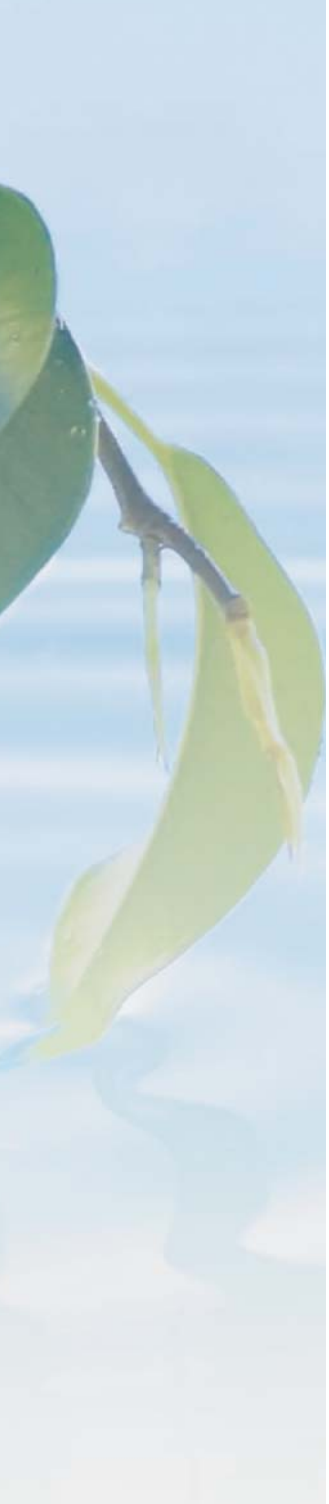

The Benefits

Table III shows an economical approach using data from an existing customer case study.

Parameters :

A customer is using a 25 m³/h RO system to produce the required water quality for his process use. The RO system is protected by a conventional treatment using sand filter and consumables (as a trap filter for RO protection).

The SDI measurements done before and after the existing 5 µm filters installed gave a SDI reduction of less than 4 % (SDI inlet: 5.62, SDI outlet: 5.42) leading to poor RO membrane protection and intensive cleaning (twice per month). The costs associated to the RO cleaning (excluding water costs, as data not available) are resumed on the table below. Pall worked with the customer on improving the RO protection in order to allow economical operation of the RO unit.

Table III - Case study

	Wound cartridges 5 µm < beta 10	Ultipleat High Flow filter 4.5 µm beta 5000
SDI reduction (%)	4 (poor SDI reduction)	55
Filtration costs per year (€)	3960	5790
RO Cleaning cycles per year	24	6
Costs associated with cleaning per year		
•Chemical costs (€)	1560	390
•Labour costs (€)	4800	1200
RO membrane replacement (months)	24	> 36
RO membrane life time improvement		> 50 %
Savings per year		
•Chemical savings (€)		+ 1170 (75 % improvement)
•Labour savings (€)		+ 3600 (75 % improvement)
TOTAL SAVINGS (per year in €)		+ 2940 (28 % improvement)

For this customer, the change from a 5 µm nominal filter to an absolute 5 µm filter (Ultipleat High Flow filter, Figure 1) for RO protection allowed:

- 75 % less cleaning cycles of RO membrane per year
- More than 50 % RO membrane life time improvement
- 75 % cost savings on chemical and labour costs
- 28 % total cost savings

In conclusion, by choosing the correct filter for protecting the RO membrane unit the F&B account will see an increase in the life of the membrane, less cleaning and an overall improvement of the management of the system. This will also result in a better economical return on their equipment.

Figure 1 - Ultipleat High Flow 4.5 µm filter for RO protection

References :

[1] ASTM D1889-00, Standard Test Method for turbidity of water - American Society for Testing Materials

[2] ASTM D4189-07, Standard Test Method for Silt Density Index (SDI) of water – American Society for Testing Materials

[3] Reverse Osmosis Desalination: water sources, technology and today's challenges, Greenlee, L.F., Lawler, D.F., Freeman, B.D., Marrot, B. and Moulin, P., Water Research 43 2317-2348, 2009

[4] RO and NF pre-treatment. Membrane protection or conventional multimedia filters?, Bultiauw, J., Pall Corporation, 2004

About Pall Corporation

Pall Corporation is the largest and most diverse filtration, separation, and purification company in the world. Pall serves the food and beverage industries with advanced membrane filtration technology and systems engineered for reliability and cost-effectiveness. Easy to install and simple to use, our systems satisfy a wide range of filtration requirements. Our **Total Fluid Management** approach offers customers solutions to address the needs of an entire process, encompassing filtration products, services, systems and training.

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