

AG7 – Cleaning reverse osmosis (RO) and nanofiltration (NF) membranes

All RO/NF installations experience a degree of membrane fouling which will impact on operational efficiency and cost. The consequences of fouling include a decrease in production, increased differential pressure and or a decrease in permeate quality. In practical terms cleaning frequency and duration increases, membrane life decreases and both operational input and downtime increase. The type and the quality of feed water, the effectiveness of the pre-treatment regime and also other factors relating to system design and operating practices determine the degree and type of fouling.

The types of contamination most commonly detected can be classified as:

Organic and biofilm fouling: Feed water with high organic matter content is the cause of these deposits. The presence of such compounds also facilitates biofilm formation on the surface of the membranes, and is the most commonly occurring type of fouling.



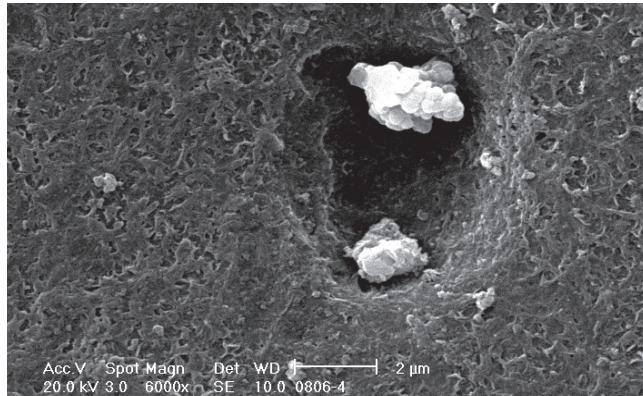
Picture 1: Severely biofouled membrane

Colloidal Fouling: Colloids present in the feed water should normally be removed by the pre-treatment system; failure of pre-treatment systems may lead to colloidal membrane fouling.



Picture 2: Colloidal fouling samples removed during autopsy

Inorganic scale deposits: The most common types of scale found in membranes are calcium carbonate and calcium sulphate with barium and strontium sulphate occurring less frequently. This can often be attributed to incorrect application or poor antiscalant control. In addition it is also common to find iron and silica deposits.



Picture 3: Aluminosilicate particles damaging membrane surface

Membrane cleaning

"Each cleaning situation is different; therefore, specific cleaning recommendations are dependent on the type of foulant."

DOW FilmTec Technical manual

The cleaning strategies and products used will be different for each type of foulant. The following are general recommendations and tips to consider when designing a membrane cleaning programme.

"Most effective cleaning allows longer system operating time between cleanings and results in the lowest operating costs"

DOW FilmTec Technical manual

General Recommendations

When to clean?

All membranes must be cleaned periodically; as a minimum at least one routine clean per year is required. Although the symptoms of contamination are not always immediately detectable, the membranes should be cleaned whenever there are variations of 10-15% of normalised data for the parameters of: differential pressure (dP), product flow or permeate quality.

What equipment is needed to clean?

Most RO/NF systems include a clean-in-place (CIP) system. The basic design consists of a tank for preparation and mixing of cleaning solutions, heating element, and a centrifugal pump for re-circulating the cleaning solution throughout the system. It should also incorporate control instrumentation for the process parameters (flow, pressure, temperature) and points for sampling.

It is also advisable to install a simple filtration system (cartridge filters) in the recirculation loop in order to prevent suspended solids from re-entering the system and damaging the membranes.

How to clean?

The general cleaning procedure for RO /NF membranes comprises four main stages:

- 1 – preparation of cleaning solution
- 2 – recirculation of cleaning solution in the system
- 3 – removal and rinsing of the used cleaning solution
- 4 – start of production once the process is complete.

Preparation of the cleaning solution

The volume of cleaning solution is calculated using the number of membranes to clean (volume in each pressure vessel) and the volume of the cleaning circuit and pipe work. As accurate data is sometimes difficult to ascertain, a rule of thumb is to use between 1.2 and 1.5 volumes of cleaning solution per volume of membranes. Membrane manufacturers recommend using 30-50 litres per 8" membrane.

Cleaning solutions should be prepared with good quality chlorine free water (permeate water). The chemicals used should be added to water ensuring that changes in pH and temperature (heating of the cleaning solution is often essential) are carried out gradually. If necessary adjust the pH to the membrane manufacturer's specification using hydrochloric acid or sodium hydroxide. Removal of organic foulants is dependent on achieving optimum temperature and pH.

Re-circulation of cleaning solution

For optimal cleaning, the maximum flow recommended by the manufacturer of the membranes and the pressure must be within 1.5 - 4.0 bar. In order to optimise the contact between the cleaning solution and the deposits and successfully remove them it is recommended to alternate periods of recirculation and soaking. Throughout the cycle, monitor changes in pH and colour of the cleaning solution. If the pH changes by >1.0 pH unit or the solution becomes discoloured then discard and prepare a fresh solution. This helps avoid membrane abrasion and improves cleaning efficiency.

Removing the cleaning solution and rinsing

After cleaning (often sequential cleaning steps are necessary with different chemicals) the membranes should be rinsed with product water (flushing at high flow rates may be required to remove suspended particles loosened by the cleaning process) to fully displace the cleaning solution (until the pH in the feed and reject are the same).

Start of production

Following the rinse and before the plant is returned to production, discard the initial production volume to ensure the total elimination of chemicals used in cleaning, preventing contamination of the product water. **Always follow the membrane manufacturer's guidelines.**

Cleaning products

The choice of cleaning products used in each case depends on the type of membrane fouling. We recommend performing an autopsy of membranes to determine the exact nature and extent of contamination. For membranes contaminated with different foulants it may be necessary to use a combination of different products in one or more stages of cleaning to ensure efficient removal.



Picture 4: Laboratory cleaning tests

HINTS FOR THE SELECTION OF CLEANING PRODUCTS

- Ideally always start cleaning with alkaline products and finish with acid products.
- Deposits of organic matter and biofilm form in the first membranes and can be difficult to remove, use a combination of biocides and alkaline cleaners.
- Colloidal matter (aluminosilicates) is also cleaned with alkaline formulations. Genesol 703 is especially effective against this type of deposit.
- Calcium carbonate scales are formed very quickly in the final membranes. Genesol 37 is the most effective product.
- Calcium sulphate is also formed in the final membranes, this is especially difficult to clean. although Genesol 34, a chelating agent, may be successful.
- Genesol 40 is a highly effective in cleaning silica.
- Iron deposits are easily cleaned with acid cleaners, such as Genesol 38.

Product	Description	CaCO ₃	CaSO ₄	BaSO ₄	SiO ₂	CaPO ₄	Mg(OH) ₂	Fe/Mn	Organic	Colloids
Genesol 30	Fast Acting Biocide								✓	
Genesol 32	Preserving Biocide								✓	
Genesol 34	Alkaline chelant								✓	✓
Genesol 36	Surfactant		✓	✓		✓		✓	✓	✓
Genesol 37	Strong acid	✓	✓							
Genesol 38	Liquid acid	✓				✓	✓	✓	✓	
Genesol 40	Alkaline cleaner							✓	✓	✓
Genesol 50	Alkaline chelant				✓				✓	
Genesol 703	Powdered alkaline cleaner		✓	✓	✓				✓	✓

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