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## Cleaning Your RO

Eventually the day comes when your RO system will require cleaning. Cleaning is recommended when your RO shows evidence of fouling, just prior to a long term shutdown, or as a matter of scheduled routine maintenance. Fouling characteristics that signal you need to clean are a 10-15% decrease in normalized permeate flow, a 10-15% decrease in normalized permeate quality, or a 10-15% increase in normalized pressure drop as measured between the feed and concentrate headers.

RO cleaning frequency due to fouling will vary by site. A rough rule of thumb as to an acceptable cleaning frequency is once every 3 to 12 months. If you have to clean more than once a month, you should be able to justify further capital expenditures for improved RO pretreatment or a re-design of the RO operation. If cleaning frequency is every one to three months, you may want to focus on improving the operation of your existing equipment but further capital expenditure may be harder to justify.

One RO design feature that is commonly over-looked in reducing RO cleaning frequency is the use of RO permeate water for flushing foulants from the system. Soaking the RO elements during standby with permeate can help dissolve scale and loosen precipitates, reducing the frequency of chemical cleaning.

What you clean for can vary site by site depending on the foulant. Complicating the situation frequently is that one more than one fulant can be present. Typical foulants are:

- Calcium carbonate scale
- Sulfate scale of calcium, barium or strontium
- Metal oxides of iron, manganese, aluminum, etc.
- Silica scale
- Colloidal deposits (inorganic or mixed inorganic/organic)
- Organic material of natural origin or man-made origin
- Biological (bioslime, mold, or fungi)

There are a number of factors involved in the selection of a suitable cleaning chemical (or chemicals) and proper cleaning protocol. The first time you have to perform a cleaning, it is recommended to contact the manufacturer of the equipment, the RO

element manufacturer, or a RO specialty chemical supplier. Once the suspected foulant(s) are identified, one or more cleaning chemicals will be recommended. These chemical(s) can be generic and available from a number of suppliers or can be private-labeled proprietary cleaning solutions. The proprietary solutions can be more expensive but may be easier to use and you cannot rule out the advantage of the intellectual knowledge supplied by these companies. An invaluable service offered by some service companies is that they will determine the proper cleaning chemicals and protocol by testing at their facility an element pulled from your system.

It is not unusual to have to use a number of different cleaning chemicals in a specific sequence to achieve the optimum cleaning. There are times that a low pH cleaning is used first to remove foulants like mineral scale, followed by a high pH cleaning to remove organic material. However, there are times that a high pH cleaning is used first to remove foulants like oil followed by a low pH cleaning. Some cleaning solutions have detergents added to aid in the removal of heavy biological and organic debris, while others have a chelating agent like EDTA added to aid in the removal of colloidal material, organic and biological material, and sulfate scale. An important thing to remember is that the improper selection of a cleaning chemical or the sequence of chemical introduction can make the foulant worse.

There are a number of precautions in cleaning chemical selection and usage for a composite polyamide membrane:

- Follow the manufacturer's recommended chemical list, dosage, pH, temperature and contact time guidelines.
- Use the least harshest chemical cleaning to get the job done. This will optimize the useful life of the membrane.
- Be prudent in the adjustment of pH at the low and high pH range to extend the useful life of the membrane. A gentle pH range is 4 to 10, while the harshest is 2 to 12.
- Don't mix acids with caustics. Thoroughly rinse the 1st cleaning solution from the system before introducing the next solution.
- Flush out detergents with high pH permeate
- Verify that proper disposal requirements for the cleaning solution are followed.

If your system has been fouled biologically, you may want to consider the extra step of introducing a sanitizing biocide chemical after a successful cleaning. Biocides can be introduced immediately after cleaning, periodically (e.g. once a week), or continuously during service. You must be sure however that the biocide is compatible with the membrane, does not create any health risks, is effective in controlling biological activity, and is not cost prohibitive.

The successful cleaning of an RO on-site requires a well designed RO cleaning skid. Normally this skid is not hard piped to the RO skid and uses temporary hosing for connections. It is recommended to clean a multi-stage RO one stage at a time to optimize crossflow cleaning velocity. The source water for chemical solution make up

and rinsing should be RO permeate, DI water or at least soft water. Components must be corrosion proof. Major cleaning system components are:

- RO Cleaning Tank: This tank needs to be sized properly to accommodate the displacement of water in the hose, piping, and pressure vessels. The tank should be designed to allow 100 % drainage, easy access for chemical introduction and mixing, a recirculation line from the RO Cleaning Pump, proper venting, overflow, and a return line located near the bottom to minimize foam formation when using a surfactant.
- RO Cleaning Pump: This pump needs to be sized to develop the proper crossflow velocity to scrub the membrane clean. The cleaning rate for a 8-inch diameter vessel is 30 to 40 gpm and for a 4-inch diameter vessel is 8 to 10 gpm. The maximum recommended pressure is 60 psi to minimize the production of permeate during cleaning and reduce the convective redeposition of foulant back on to the membrane surface.
- RO Cleaning Cartridge Filter: Normally 5 to 10-micron and is designed to remove foulants that have been displaced from the cleaning process.
- RO Tank Heater or Cooler: The optimal temperature for cleaning is 35 to 45 ° C. One cannot forget that heat is generated and imparted by the RO Cleaning Pump during recirculation.
- RO Tank Mixer: This is recommended to get optimal mixing of chemical, though some designers rely solely on the slow introduction of chemical while maintaining a recirculation through the RO Cleaning Pump back to the tank.
- Instrumentation: Cleaning system instrumentation should be included to monitor flow, temperature, pressure, and tank level.
- Sample Points: Sample valves should be located to allow pH and TDS measurements off the RO Cleaning Pump discharge and the concentrate side recirculation return line.
- Permeate Return Line: A small amount of the cleaning solution can permeate through the membranes and so a permeate side return line is recommended.

RO cleaning procedures may vary dependent on the situation. The time required to clean a stage can take from 4 to 8 hours., The basic steps of cleaning are:

1. Perform a low pressure flush with feed or permeate water to remove service concentrate and foulants.
2. Make up the cleaning solution per the manufacturer s instructions.
3. Introduce the cleaning solution to the first stage for 60 minutes. You may want to throttle the flow up slowly to minimize the plugging of the feed path with dislodged foulant. Send the displaced water and up to 20% of the fouled cleaning solution to drain before returning the cleaning solution back to the RO Cleaning Tank. Readjust the pH to the target when it changes more than 0.5 pH units.
4. An optional soak and recirculation sequence can be used. The soak time can be from 1 hour to overnight depending on the manufacturer s recommendations, but be cautious that the proper temperature and pH be maintained and that this does increase the chemical exposure time of the membrane.
5. A low pressure Cleaning Rinse with permeate water is required to remove all traces of chemical from the Cleaning Skid and the RO Skid.

6. Once all the stages of a train are cleaned, the RO can be placed back into service. It is not unusual for it to take from a few hours to a few days for the RO permeate quality to stabilize, especially after high pH cleanings.

It is exciting to have a successful cleaning and watch your pressures and permeate quality improve. On the flip side it is frustrating to have an unsuccessful cleaning, though its no reason to become suicidal. If the cleaning did not provide the results you were hoping for, you may want to consider talking to those suppliers who offer off-site services rather than proceed with a trial-and-error approach on site. Pull one or two elements from the front or back end and ship them to a service company. A service company can determine the optimal cleaning procedure and also report how effective the cleaning was in restoring flow and salt rejection.