

### Criteria for Replacement of RO Membrane Elements

This bulletin provides general information about how to determine when it is time to replace the RO membrane elements in your RO system.

#### Background

Thin-film composite membrane elements can have a very long life when operated under optimal conditions, in some case over a decade. Good pretreatment, conservative design, and trained operators all contribute to longer membrane life. Eventually though, the membranes will need to be replaced. The criteria to determine when the membranes should be replaced vary from site to site. This Technical Bulletin will discuss the parameters that should be examined in making the replacement decision.

#### Permeate Quality

The most common reason for the replacement of RO membrane elements is that they are no longer producing the desired permeate quality. Permeate quality is affected by the feed salinity, flux rate, temperature, recovery, fouling, membrane age, and many other factors. Changing one of these variables can often lead to increased or decreased permeate quality. For example, if the membranes are fouled and the permeate quality is poor, cleaning of the membranes will often cause the permeate quality to improve. In addition, running at a higher flux rate, or at a lower feed temperature, or at a lower recovery will also improve permeate quality. But running at a higher flux rate can also lead to increased fouling, and running at lower recovery reduces the percentage of product water that is produced. In general, when the elements are fouled and cleaning of the membranes cannot restore the permeate quality to desired conditions it is usually time to consider replacing the elements.

Permeate Quality can also be affected by mechanical issues such as o-ring leakage or glue line damage. Probing of the pressure vessels (see TSB 114) will help determine the location of the possible o-ring leaks or suspect elements. Individual elements can

be bubble tested (see TSB 101) to determine if the glue lines and mechanical integrity are still good. Many times permeate quality can be restored if faulty o-rings or damaged elements are replaced. Keep in mind that if glue lines in the elements have been damaged, the cause should be investigated. Simply replacing the elements will not fix the cause and the same thing is likely to happen to the replacement elements.

Permeate quality requirements vary from application to application. Ultrapure water applications generally require very high rejection rates from the membrane elements, industrial and potable applications need moderately high rejection rates, and irrigation applications usually do not need very high rejection elements. It is up to the people in charge of each system to determine their specific requirements.

### **Feed Pressure Limitations**

As membrane elements age and they progressively foul, the feed pressure on the RO system may rise. In many cases, the feed pressure required by the high pressure pump becomes too high to maintain the designed permeate flow. Effective cleaning of the membranes is the best way to remedy this situation. In cases where the dP (the differential pressure between the feed pressure and the brine pressure) or feed pressure cannot be reduced, membranes may need to be changed. Sometimes the customer can avoid replacing all of the membranes though. Determining where the fouling is occurring can help determine which elements should be replaced. We recommend removing and weighing a lead and tail membrane from a pressure vessel and then draining (for 20 minutes) and weighing the elements. Elements typically weigh about 16 kg. when drained. If you find the tail element is significantly heavier than the lead membrane, then scaling has most likely occurred. Heavier lead elements are usually indicative of biological, colloidal, or particulate fouling. Weighing all of the elements from a pressure vessel may help to determine how many elements need to be replaced.

### **Complete Element Replacement Versus Partial Element Replacement**

Some RO plants will change all of the membrane elements in all trains at the same time, some will only change one train at a time, and other will only change some elements in each vessel at a time. It all depends on the particular situation. Many of the larger plants that decide to only change one or two elements per vessel every year or so need to manage this very carefully. It is important to keep records about new and old element positions inside the pressure vessels if partial replacement is performed.

New elements that are installed into the system should always be placed into the tail positions of the pressure vessels. This prevents these “new” elements from being over-fluxed and thus becoming fouled prematurely. The elements that are usually removed from the vessel are the lead membranes since they are the ones that work the hardest (they run at the highest flux rate and many times are the ones that become the most fouled). To do this requires either complete removal and reloading of all elements or else very carefully removing the lead elements and then slowly pushing the remaining elements forward. Care must be taken to not do this quickly or else the brine seals may roll (flip over) which may cause the elements to jam into the pressure vessel.

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