FILMTEC Membranes

Troubleshooting: Evaluation of System Performance and Operation

Evaluation of System Performance and Operation

If the performance of the membrane system is not satisfactory, the first step is to evaluate the performance and the operation of the entire system. This is done on the basis of normalized plant data, (see *Plant Performance Normalization - Section 5.6.6*). When the actual normalized plant performance is compared against the performance at start-up, any significant performance deterioration can be identified.

In case that the initial system performance at start-up is not satisfactory, a comparison of the actual system performance with the ROSA projected system performance under actual conditions is helpful.

ROSA is a tool used to estimate the stabilized performance of a new RO or NF system under design conditions, but it can also be used to estimate the performance of an existing RO/NF system under prevailing actual conditions. This projected performance is based on the nominal performance specification for the FILMTEC™ element(s) used in that system. A fouling factor of 1.00 in the projection is used to calculate the performance of new elements with exact nominal flow rate. A fouling factor of < 1 should be applied when making a design for long-term operation. In a real system, the elements may have a flow performance variation of +/-15% of the nominal value, or whatever variation is specified for this element type. Also the salt rejection of an individual element may be higher or lower than the nominal salt rejection (but not lower than the minimum salt rejection). Therefore, the measured stabilized performance is unlikely to exactly hit the projected performance, but for systems with more than 36 new elements it should come close.

The actual fouling factor of a stabilized new RO system with at least 36 elements should range between 0.95 and 1.05. The actual measured TDS of the permeate should be no higher than about 1.5 times the calculated TDS.

For systems with only one or a few elements, the deviation of the measured actual performance from the projected performance may become as large as the specified element performance variation.

If the normalized actual performance has deteriorated too much compared to the initial performance, or the measured actual performance does not match close enough with the projected performance, check the following:

- Are all meters, sensors and pressure gauges calibrated?

  Troubleshooting Tip:
  Use simple mass balance equations to confirm accuracy of flow and conductivity instruments. RO/NF systems should be operated at design flow and recovery rates in order to ensure trouble-free operation. Damage to membrane elements can result from operation at elevated flow rates, and fouling can result from flow rates which are too low to prevent deposition of particulate matter. Scaling or fouling can occur in RO systems when operated at above design recovery rates.

Evaluation of System Performance and Operation (cont.)

Equations 1 and 2 provide a simple method to check the accuracy of flow and conductivity meters. These equations should be used as an indicator and are not intended to replace periodic calibration of instruments. If deviation from unity is observed in equation 2, the accuracy of one of the meters is compromised, and calibration should be performed.

1. Feed flow = Permeate flow + Brine flow

2. $$\frac{\text{(Feed flow) (Feed Conductivity)}}{\text{(Permeate flow) (Permeate Conductivity) + (Brine flow) (Brine Conductivity)}} = 1 \pm 0.05$$

   In order for equation 2 to be valid, conductivity measurements should be taken after all chemical additions and accurately reflect the feed water.

- Has the system stabilized? It should have been in continuous operation for 24 to 72 hours when the readings are taken. Systems that have been in operation for extended time should be investigated by the evolution of the normalized system performance data. This can be done with the FTNORM program as described in *Plant Performance Normalization (Section 5.6.6)*.

- Has permeate pressure been taken into account? Neglected permeate pressure results in a higher than projected feed pressure.

- Is there any significant pressure losses from the feed to the concentrate? ROSA 5 and earlier versions anticipate a pressure loss in the piping of 5 psi (0.35 bar) per stage in addition to the pressure loss in the FILMTEC elements. Restrictions in feed or concentrate headers would result in higher pressure losses than projected. Check the distance of the pressure sensors from the feed and concentrate end of the pressure vessels. The locations of the pressure sensors should be as close as possible to the pressure vessel and in sufficient distance from valves or other places of high turbulence.

- Check the Process and Instrumentation Diagram of the system:
  - Are provisions made to avoid undue operating conditions? See *Shutdown Switches (Section 3.13.3)*.
  - Are the necessary valves installed? See *Valves (Section 3.13.4)*.
  - Are provisions made for efficient troubleshooting? See *System Design for Troubleshooting Success (Section 3.16)*.
  - Are provisions made to avoid siphoning of the pressure vessels during shutdown periods? See *RO and NF System Shutdown (Section 5.4)*.

- Check the start-up and shut-down procedure: is it safe with respect to hydraulic shocks, permeate backpressure and back-flow of permeate? See *Start-up (Sections 5.2.3)* and *Shut-down Procedures (Section 5.4)*.

- Check the cleaning procedure and chemicals used: is the procedure efficient and the chemicals safe with respect to membrane damage? See *Cleaning Procedure (Section 6.5)* and *Cleaning Chemicals (Section 6.8)*.

Evaluation of System Performance and Operation (cont.)

- How frequently is the system being cleaned? A high cleaning frequency (more than once per 4-6 weeks) may indicate a poor performance of the pretreatment or a RO/NF system operating outside of the design guidelines. As a guideline, anything from one to three chemical cleanings per year is considered good, while four and up to to six annual cleanings are typically still considered acceptable. A higher cleaning frequency is normally not justifiable and it is usually more economical to improve the pretreatment system.

- Have water analyses been performed? The conductivity is not sufficient for the calculation of TDS rejection. Particularly, carbon dioxide (CO_2) in the feed water will pass into the permeate, create carbonic acid and increase the permeate conductivity.

- Check the application of chlorine and other oxidizing chemicals – this can indicate a potential oxidation problem.

- Check the replacement rate of prefilters – a high replacement rate can indicate a potential fouling problem. A too low replacement rate e.g. of cartridge filters may also post a risk (sudden collapse, etc.).

- Check the SDI logsheets: the feed SDI should be consistently <5 or <3, depending on the system design.

- Check the scaling calculations and confirm the dosage rates of chemicals, e.g. scaling inhibitor.

If all this has been considered and the observed system performance is still outside of expectations, perform the system tests as described in *System Tests (Section 8.3)*.

FILMTEC Membranes
For more information about FILMTEC membranes, call the Dow Liquid Separations business:
North America: 1-800-447-4369
Latin America: (+55) 11-5188-9222
Europe: (+32) 3-450-2240
Pacific: +60 3 7958 3392
Japan: +813 5460 2100
China: +86 21 2301 9000
http://www.filmtec.com