Technical Service Bulletin

July 2014 TSB 105.11

REVERSE OSMOSIS AND NANOFILTRATION MEMBRANE ELEMENT PRECAUTIONS

PERMEATE VALVE OPERATION

The membrane element shall not, at any time, be exposed to permeate back pressure (where permeate static pressure exceeds concentrate static pressure). There shall be no permeate back pressure at shutdown.

At no time during operation of a membrane element system should the permeate valve(s) be closed. This includes pre-start up flushing, pre-shutdown flushing, cleaning(s) and standard operation.

Closing the permeate valve during any phase of operation causes a pressure differential across the tail end of the system and will likely result in irreparable damage to the glue lines of the tail element(s). This damage will cause immediate increase in salt passage of the system.

NOTE: Permeate valve(s) may be closed during shutdown after the system has been flushed and/or when input of the feed water is stopped. In many cases this is necessary to prevent an aerobic environment in the pressure vessels. The permeate valve (as well as the concentrate) should be fully re-opened prior to re-introducing feed water.

Reference also Technical Service Bulletin 118.

CONCENTRATE VALVE OPERATION TO SET RECOVERY RATE

During start up of any system, the concentrate valve should be in the fully open position. This valve should be moved towards the closed position after start up in order to obtain the desired system recovery. NEVER START A SYSTEM WITH THE CONCENTRATE VALVE CLOSED AND THEN OPENING IT UNTIL THE SYSTEM RECOVERY IS ACHIEVED.

NOTE: System recovery should be set to the design setpoint as recommended by Hydranautics' IMSDesign© Software.

PRESENCE OF FREE CHLORINE OR OTHER OXIDANTS IN FEED WATER OF THIN FILM (POLYAMIDE) MEMBRANE ELEMENTS

At no time should there be a Free Chlorine or oxidant residual in the feed water. Even very low levels of chlorine or other oxidants in the feed stream can result in irreparable oxidation damage of the membrane. Therefore, operators should ensure that oxidant does not enter the RO system. To ensure that membranes are not harmed by oxidant, Hydranautics recommends that the feed to the RO/NF system is equipped with an ORP (Oxidation-

Reduction Potential) meter. The feedwater can then be continuously monitored for the presence of oxidant. Except in wastewater applications where chloramines are used and allowed up to a concentration of 5 ppm, the ORP meter reading should always be below 300 mV. If it exceeds 300 mV, the plant operator should receive a warning that a dangerous level of oxidant is getting to the membrane and should take action, such as adding or increasing the dose of sodium bisulfite (SBS), to reduce the oxidant concentration. If the ORP value reaches 350 mV, the plant should be shut down until the oxidant concentration can be reduced to a safe value (ORP < 300 mV). Please contact your system provider for various methods of removing Free Chlorine prior to the membrane system.

It should also be noted that studies have shown that excess amounts of sodium bisulfite can lead to oxidation of the polyamide membrane. Sommariva et al. have reported that polyamide membranes were oxidized at a plant where chlorination/dechlorination with SBS was practiced (Sommariva, C., et al. (2012). *IDA J. Desalination and Water Reuse,* 4(2), 40-44). They concluded that overdosing of SBS can lead to rapid membrane oxidation and loss of rejection. In particular, they found that in addition to excess SBS, there also needed to be oxygen, higher pH and some quantity of transition metal present. Thus, users should take care to dose enough SBS to prevent chlorination of the membrane, but not overdose SBS.

NOTE: The oxidative effects of Free Chlorine are strongly catalyzed in the presence of transition metals such as iron and manganese. If transition metals are present, it is recommended that there be NO Free Chlorine in the feed water.

LUBRICATION OF O-RINGS AND BRINE SEALS

At no time should petroleum based lubricants be used when lubricating interconnector o-rings, end adapter o-rings or the membrane element brine seal. Acceptable lubricants include glycerin, silicon-based Molykote III, or other silicone-based lubricants which contain no hydrocarbons.

PARTICULATE FREE FEEDWATER

At no time should the membrane be exposed to particulate matter that can accumulate on the surface of the membrane and mechanically damage the polyamide surface. There are many sources of unwanted particulate matter, including insufficient flushing of pipework before start-up, corrosion of metal pumps, pipes, values or sensors in the feedline, poorly operating pretreatment, and by-pass of the typical 5 micron cartridge filters. Studies have shown that such particles can become lodged between the feed spacer and the membrane. Vibration of the spacer can then cause the particle to be pushed into the membrane and abrade the surface of the membrane (Figure 1). This often leads to mechanical defects which leak feedwater into the permeate side of the element. These particles may be 6 to 100 microns in size. An example of the damage they cause is shown in Figure 2. It is common for such damage to only slightly increase water flow, but greatly increase the salinity of the permeate, because raw feedwater, nearly 1000 times saltier than product water, will leak into the permeate. Users should follow Hydranautics' recommendations for Pre-commissioning and Commissioning, listed in our technical documents or available from Technical Support Personnel.

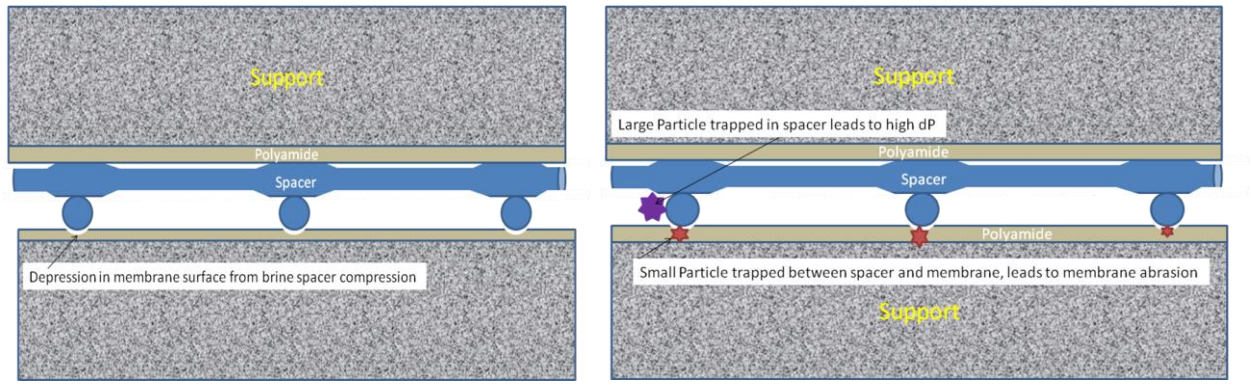

Figure 1. Schematic representation of particulate damage to RO membranes.

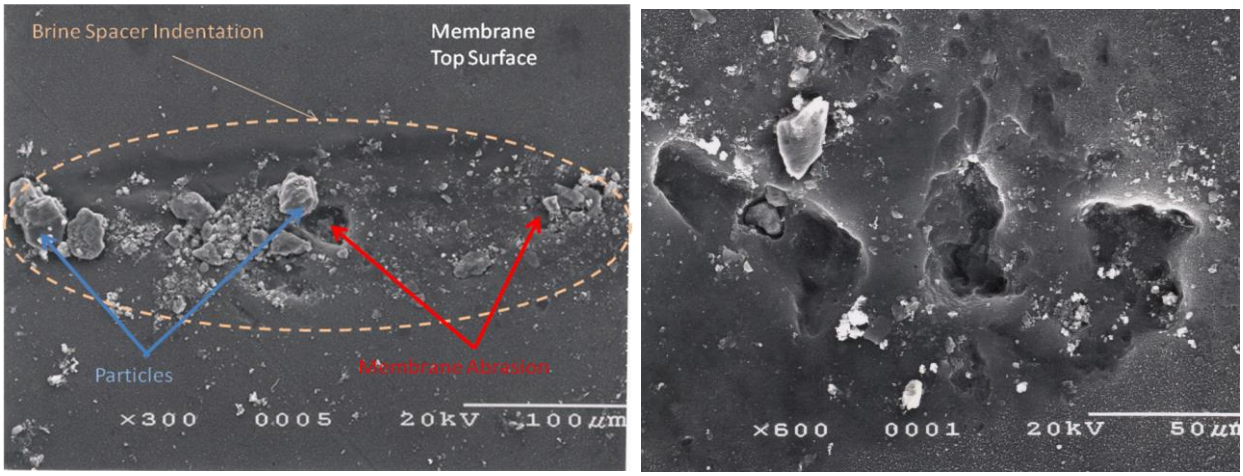

Figure 2. Membrane surface abraded by particles.

SYSTEM PRESSURIZATION RATE

Pressurization of an RO system must be done at a controlled rate. If the system is pressurized too quickly it can result in mechanical damage to the RO membrane elements. Damage to the RO elements can include cracking of the resin outerwrap and/or telescoping of the membrane due to axial stresses caused by the high rate of pressurization. Also, it can cause the resin outerwrap to burst due to momentary pressure differences between the inside of the element and outside of the element shell. Hydranautics recommends that the RO system be pressurized at no more than 10 psi (0.69 bar) per second to ensure no damage is done to the membrane element.

SAFE OPERATION AT HIGH TEMPERATURE AND PRESSURE

Since membranes are made from plastic materials, they are subject to plastic creep under certain high temperature and high pressure operating conditions. For reverse osmosis membranes, the primary concern is that the porous polysulfone support (Figure 3a) may undergo compression at these conditions, which decreases the porosity of the intermediate layer. This results in greater resistance to water flow through this layer. The end result is that the apparent permeability of the composite membrane will decrease and the pressure

required to achieve permeation rates at the reference temperature of 25ºC will thus increase. Also, high temperature can cause the polyamide layer to tighten. This results in both lower permeability and lower salt passage. In regards to the element construction, the combination of higher temperature and higher pressure can cause the permeate support to partially collapse and the membrane to emboss in the permeate spacer channels (Figure 3b). Both of these effects will cause more resistance to flow on the permeate side of the element, which in turn causes greater pressure drop. The result is that the operation at standard test conditions will require greater pressure to achieve the specified flow.

Hydranautics recommends that customers operate their systems in accordance to the Temperature-Pressure limitations given in Figure 4. This chart gives the maximum pressure that is allowed for a given feed temperature. The RO elements are designed to run at up to 45ºC. If the operator desires to run at temperatures in excess of 40ºC, they should first contact the Hydranautics Technical Department for advice on safe operation.

IMPORTANT NOTICE: Operation of RO elements in excess of these limiting values can potentially cause the permeate core tube to collapse and mechanically fail (see below). In that event, there will be a sudden flow of feedwater into the permeate side of the element. If the high pressure pump does not shut down immediately, there is potential of very high pressure on the permeate side of the element. This can be a significant safety issue and should be avoided. If operation is desired at higher pressure/temperature combinations, please contact Hydranautics for recommendations of higher strength materials for the permeate core tube.

Permeate core tube collapse and mechanical failure.

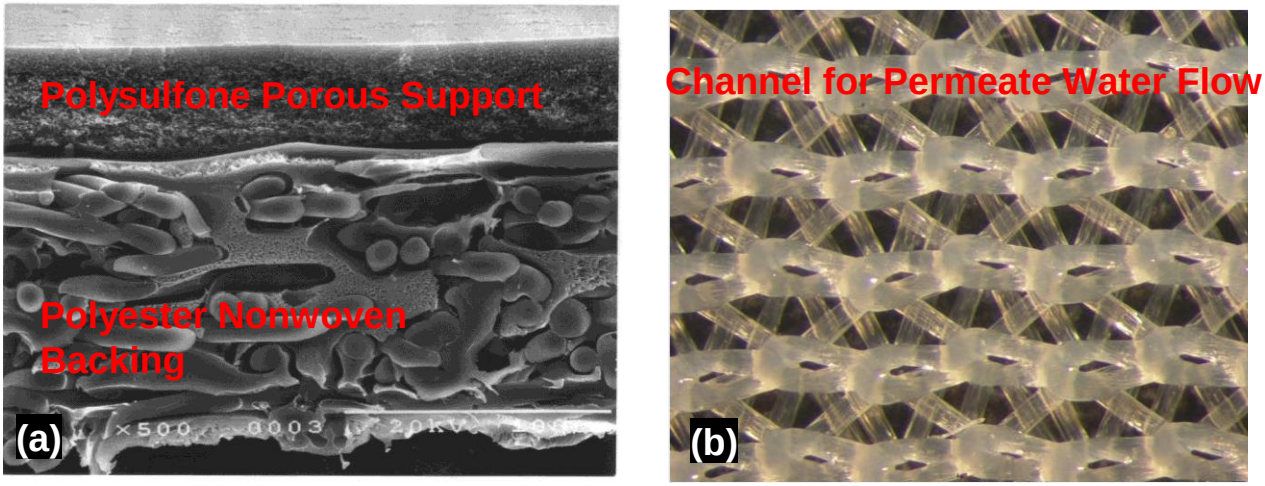

Figure 3. (a) Magnified cross-section of a typical composite polyamide membrane and (b) a top view of a permeate spacer showing channels for water flow.

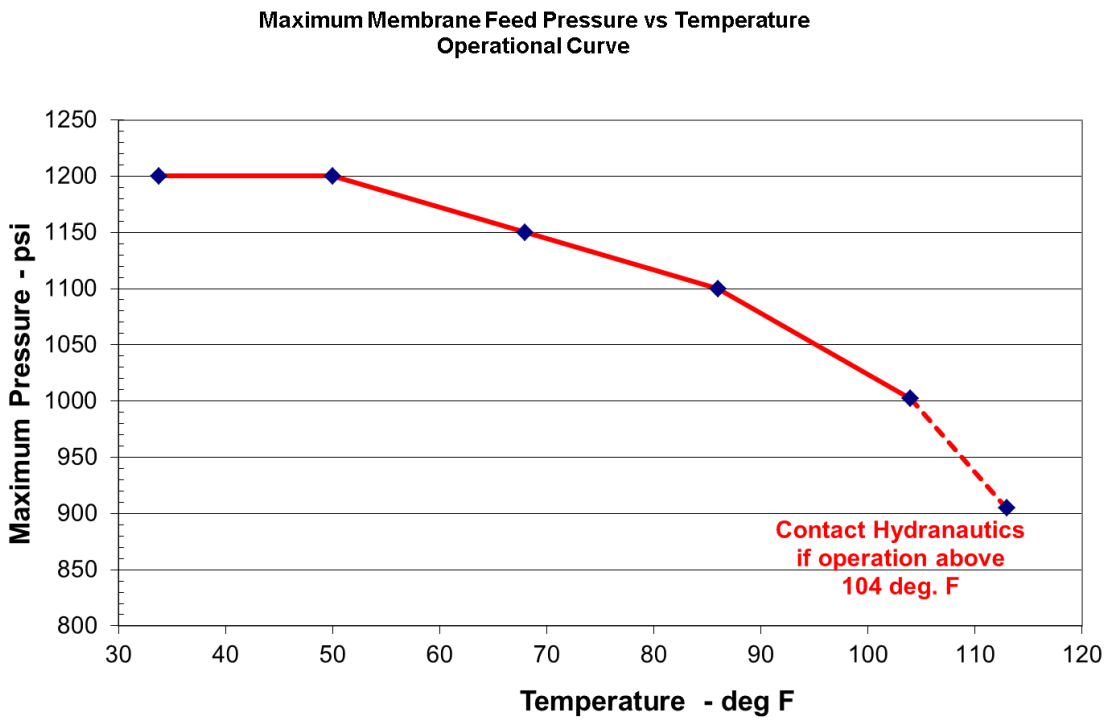

Figure 4a. Temperature versus Pressure Operation Limits for Seawater Membranes*-English Values:

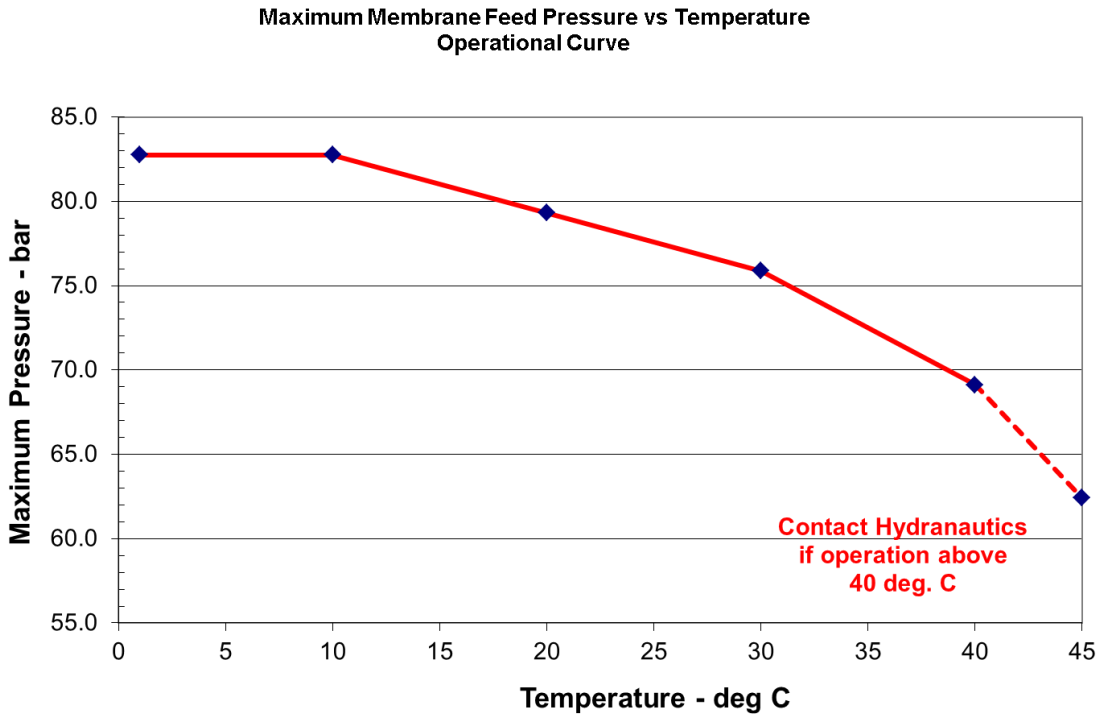

Figure 4b. Temperature versus Pressure Operation Limits for Seawater Membranes*-Metric Values:

* Brackish water elements shall not be operated above 600 psi (41.4 bar).

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