DOW™ FILMTEC™ Membranes

Improved modeling for high temperature and pressure operation and variable temperature operation of seawater reverse osmosis systems

The performance of spiral wound, thin film composite reverse osmosis (RO) elements under typical seawater operating conditions, e.g. 15-35 ºC and 55-70 bar (800-1,000 psi), is well understood and modeled by manufacturer's design programs. There is less historical experience at elevated temperatures and pressures. Since the early days of the technology, it has been observed that when seawater RO elements are operated at elevated temperatures (35ºC and above), they undergo an irreversible flow loss that becomes apparent if the system is later operated at lower temperatures (20-35ºC) [1, 2]. Therefore, higher operating pressure is required to achieve design permeate flow at lower temperatures, compared to the original design. This is a phenomenon common to all thin film composite RO membranes operated under similar conditions.

Today, with more plants being installed and operated under conditions where feed water temperatures can reach 40-45°C, Dow has the necessary experience and data to quantify this phenomenon and incorporate it into system performance modeling [3].

The effects of high temperature and pressure operation.

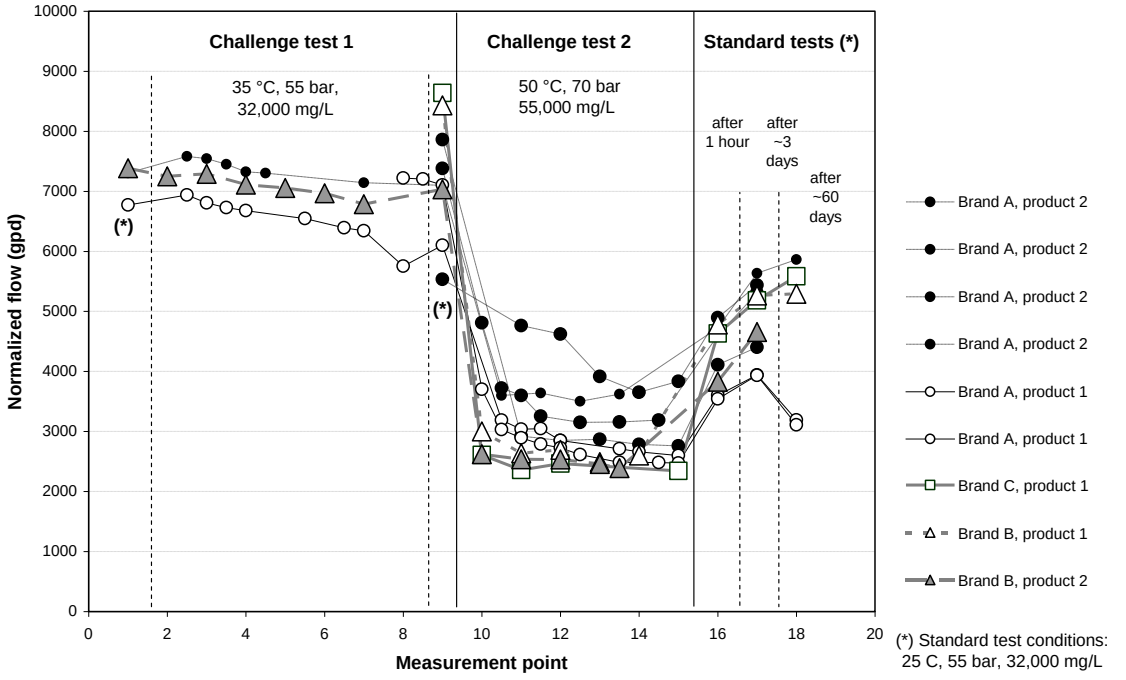
Permeate flow can be irreversibly reduced by both elevated pressure and temperature and the effect is strongest when elevated temperature and pressure occur simultaneously.

While a number of factors impact this permeate flow loss, the major factors are believed to be:

- Compaction of the microporous polysulfone layer which decreases membrane permeability. Long recognized but not well quantified.
- Intrusion of the membrane composite into the permeate carrier, leading to increased permeate-side pressure drop. This is a function of temperature and pressure, as well as spacer geometry and strength of the composite membrane.

Figure 1 shows the results of controlled tests on a number of commercially available seawater reverse osmosis elements. All membranes, regardless of the manufacturer, experience an irreversible reduction in permeability with increased temperature and pressure.

Figure 1



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Dow has improved modeling for accurate performance projections.

Accurate modeling is critical to ensure success in designing and operating desalination plants. This is especially important for seawater RO plants that see a large range in seasonal temperature in variation and peak temperatures > 35°C . Now, through field experience and research programs, Dow has developed models to more accurately project the performance of seawater systems under both elevated temperature and pressure conditions and where seasonal temperature variation is large.

ROSA now features distinct modeling enhancements:

1. Enhanced sophistication in the model to more accurately predict seawater system performance at elevated temperatures. The updated model more accurately projects operating pressure in the range of 35-45°C ([1]).
2. A new Maximum Temperature feature to account for the irreversible flow loss that occurs when seawater elements are operated at elevated temperature and pressure. This optional feature should be selected for the low temperature design when seasonal temperature variation is >10°C and the maximum temperature is > 30°C. When activated, ROSA will account for the irreversible impact of the maximum temperature history when the system returns to lower temperature operation.
3. To select this "temperature history" memory feature when running lower temperature designs, click on the "Max Temp" button in the Feedwater data tab, check the "account for flux at maximum temperature" box, and enter the maximum design temperature.

With these enhancements now available in ROSA, system designers can more accurately account for the effects of elevated temperature, pressure and salinity in seawater systems. It is no longer necessary to use fouling factors to indirectly model this phenomenon. Please refer to published system design guidelines for recommended use of fouling factors.

Literature;

[1] Hornburg, C.D., Morin Jr, O.J., "Design aspects of large seawater reverse osmosis desalination plants", Desalination 45 (1988), pp. 241-249

[2] Al-Bahri, Z.K., Hanbury, W.T., Hodgkess, T., "Optimum feed temperatures for seawater reverse osmosis plant operation in an MSF/SWRO hybrid plant", Desalination 138 (2001), pp. 335-339

[3] Gorenflo, A., Marsh, A.R., Busch, M., "Aspects of high temperature operation with spiral wound SWRO elements", IDA 2007 World Congress on Desalination and Water Reuse, Maspalomas, Gran Canaria, MP07-168.

DOW™ FILMTEC™ Membranes
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[1] However, the continuous nature of the model affects pressure predictions across the entire temperature range

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