

TEMPERATURE & PRESSURE CORRECTION

Temperature of the feed water and the net driving pressure across the element must be taken into account before comparing or evaluating the performance of a membrane element or a reverse osmosis system.

TEMPERATURE CORRECTION FACTOR

The water temperature is one of the key factors in the performance of the reverse osmosis membrane element. The higher the temperature, the more the product flow, and vice versa. All reverse osmosis membrane elements and systems are rated at 77° Fahrenheit (25° Celsius). To find the membrane permeate rate at a different temperature, follow these steps:

Find the temperature correction factor (TCF) from the below table. Divide the rated permeate flow at 77° Fahrenheit by the temperature correction factor. The result is the permeate flow at the desired temperature.

EXAMPLE

QUESTION: For a thin-film membrane permeate rated at 1800 gallons per day at 77° Fahrenheit, what is the actual permeate rate at 59° Fahrenheit?

ANSWER: Temperature correction factor (from below table) for 59°F = 1.47

Permeate flow at 59 degrees Fahrenheit = $1800 \div 1.47 = 1224$ gallons/day

Feed Water Temperature C °	Feed Water Temperature F °	TCF for Thin Film	TCF for CTA/CAB
1	33.8	3.64	2.23
2	35.6	3.23	2.15
3	37.4	3.03	2.08
4	39.2	2.78	2.00
5	41	2.58	1.93
6	42.8	2.38	1.87
7	44.6	2.22	1.80
8	46.4	2.11	1.74
9	48.2	2.00	1.68
10	50	1.89	1.63
11	51.8	1.78	1.57
12	53.6	1.68	1.52
13	55.4	1.61	1.47
14	57.2	1.54	1.42
15	59	1.47	1.38
16	60.8	1.39	1.33
17	62.6	1.34	1.29
18	64.4	1.29	1.25
19	66.2	1.24	1.21
20	68	1.19	1.17
21	69.8	1.15	1.13
22	71.6	1.11	1.10
23	73.4	1.08	1.06
24	75.2	1.04	1.03
25	77	1.00	1.00

Feed Water Temperature C °	Feed Water Temperature F °	TCF for Thin Film	TCF for CTA/CAB
26	78.8	0.97	0.97
27	80.6	0.94	0.94
28	82.4	0.91	0.91
29	84.2	0.88	0.89
30	86	0.85	0.86
31	87.8	0.83	0.83
32	89.6	0.80	0.81
33	91.4	0.77	0.79
34	93.2	0.75	0.76
35	95	0.73	0.74
36	96.8	0.71	0.72
37	98.4	0.69	0.71
38	100.4	0.67	0.68
39	102.2	0.65	0.66
40	104	0.63	0.65
41	105.8	0.61	
42	107.6	0.60	
43	109.4	0.58	
44	111.2	0.56	
45	113	0.54	
46	114.8	0.53	
47	116.6	0.51	
48	118.4	0.49	
49	120.2	0.47	
50	122	0.46	

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NET PRESSURE CORRECTION

The higher the net pressure on a membrane element, the higher the permeate rate. A rough value of osmotic pressure of water can be calculated roughly by the following rule:

Osmotic pressure (PSI) = Total Dissolved Solids / 100

To estimate the effect of net pressure, follow these steps:

1. Calculate the net pressure at which the membrane element is rated (P_r)
 $P_r = \text{Rated pressure} - \text{Osmotic pressure of test solution}$
2. Calculate the net pressure under operating conditions (P_{op})
 $P_{op} = \text{Average applied pressure} - \text{Average osmotic pressure of the feed water}$
3. Expected permeate flow at operating conditions = (Rated permeate flow) x $P_{op} / (P_r)$

EXAMPLE

QUESTION:

For a thin-film membrane, 4 × 40" membrane element, using a 2000 ppm, sodium chloride solution at 225 psi and 77 degrees Fahrenheit, the permeate rate is 1800 gallons/day. What is the permeate rate at 150 psi, feed water with 1000 TDS and temperature of 59 degrees Fahrenheit?

ANSWER:

From the above example for the temperature correction, the permeate rate at 59 degrees Fahrenheit is 1224 gallons/day.

Using the steps above, the effect of net pressure is:

$$1224 \times (150 - 10) / (225 - 20) = 1224 \times (140) / (205) = 835.9 \text{ gallons/day}$$

NOTE

When designing a system additional detailed calculations are necessary to take into account the effect of pressure drop and variation in total dissolved solids (TDS) throughout the system. Please contact us if you require further information.