

Calculating Adjusted Permeate Flow Rate for Thin Film Membranes



Permeate Flow Rate Variation

Permeate flow rate will vary depending on the temperature of your feed water and the net driving pressure on the membrane element. If your system is running at baseline operating conditions, permeate rate should be at 100% (matching the manufacturer's listed performance specs). Deviations from these baseline conditions will affect permeate flow rate. As feed water temperature and/or net driving pressure increases or decreases, permeate flow rate will proportionally increase or decrease.

Why Do I Need to Know This?

You will need to calculate the adjusted permeate rate to compare or evaluate the performance of your membrane(s) and RO system. This involves calculating Corrected Temperature Permeate Rate and Corrected Net Pressure.

Where Do I Start?

The manufacturer will provide the baseline operating conditions for your RO system. This includes the feedwater pressure (psi), temperature (°F), and TDS (ppm) parameters used to determine the published performance specs for your RO system. **You will need these figures to calculate adjusted permeate rate.** Check your product packaging, user manual, or the manufacturer's website to find this information. It should accompany system performance specs and will look something like:
"based on 50 psi / 77°F / 750 ppm."

Note: System flow rate is the combined permeate rate for all membranes in the RO system. It should also be noted that the permeate rate for all thin film membranes is based on feed water temperature of 77°F (25°C).

The following information is provided to help you roughly calculate the effects of baseline operating condition deviations on the permeate flow rate of your thin film membranes. There are more detailed calculations needed to determine flow rate efficacy for an entire RO system.

EXAMPLE CALCULATION

Let's calculate the adjusted permeate flow rate for a system deviating from baseline conditions.

If the manufacturer listed permeate rate is **360 GPD** with **BASELINE OPERATING CONDITIONS** of **50 psi / 77°F / 750 ppm**, let's calculate the adjusted permeate rate based on **DEVIATED OPERATING CONDITIONS** of **65 psi / 68°F / 500 ppm**.

Note: You will get your deviated pressure rating from the pressure gauge on your RO system.

(See Next Page for Calculation Instructions...)

INSTRUCTIONS

Baseline: 50 psi / 77°F / 750ppm = 360 GPD

Deviated: 65 psi / 68°F / 500ppm = ?? GPD

STEP 1 - CALCULATE THE TEMPERATURE CORRECTED PERMEATE RATE

FORMULA: System Flow Rate / TCF = Temperature Corrected Permeate Rate

(The table below provides the Temperature Correction Factor (TCF) for various feed water temperatures.)

- System Flow Rate is 360 GPD • Feed Water Temperature is 68°F • TCF for 68°F Feed Water Temperature is 1.189

(CALCULATION: 360 GPD / 1.189 TCF = 302.77 GPD) **ANSWER: Temperature Corrected Permeate Rate is 302.77 GPD**

TEMPERATURE CORRECTION FACTOR (TCF) CHART FOR THIN FILM MEMBRANE

FEED WATER TEMPERATURE		TCF	FEED WATER TEMPERATURE		TCF	FEED WATER TEMPERATURE		TCF	FEED WATER TEMPERATURE		TCF
°C	°F		°C	°F		°C	°F		°C	°F	
10	50	1.711	15	59	1.422	20	68	1.189	25	77	1
10.5	50.9	1.679	15.5	59.9	1.396	20.5	68.9	1.168	25.5	77.9	0.985
11	51.8	1.648	16	60.8	1.371	21	69.8	1.148	26	78.8	0.971
11.5	52.7	1.618	16.5	61.7	1.347	21.5	70.7	1.128	26.5	79.7	0.957
12	53.6	1.588	17	62.6	1.323	22	71.6	1.109	27	80.6	0.943
12.5	54.5	1.558	17.5	63.5	1.299	22.5	72.5	1.09	27.5	81.5	0.929
13	55.4	1.53	18	64.4	1.276	23	73.4	1.071	28	82.4	0.915
13.5	56.3	1.502	18.5	65.3	1.254	23.5	74.3	1.053	28.5	83.3	0.902
14	57.2	1.475	19	66.2	1.232	24	75.2	1.035	29	84.2	0.889
14.5	58.1	1.448	19.5	67.1	1.21	24.5	76.1	1.017	29.5	85.1	0.877

STEP 2: CALCULATE OSMOTIC PRESSURE

FORMULA: TDS / 100 = Osmotic Pressure

- TDS is 500 ppm

(CALCULATION: 500 / 100 = 5 psi) **ANSWER: Osmotic Pressure is 5 psi** (We will use this figure in the next 2 formulas)

STEP 3: CALCULATE RATED NET PRESSURE

FORMULA: Baseline Pressure - Osmotic Pressure = Rated Net Pressure

- Baseline Pressure is 50 psi • Osmotic Pressure is 5 psi

(CALCULATION: 50 - 5 = 45 psi) **ANSWER: Rated Net Pressure is 45 psi**

STEP 4: CALCULATE OPERATING NET PRESSURE

FORMULA: Current System Pressure - Osmotic Pressure = Operating Net Pressure

- Current System Pressure is 65 psi • Osmotic Pressure is 5 psi

(CALCULATION: 65 - 5 = 60 psi) **ANSWER: Operating Net Pressure is 60 psi**

Now that we have our **RATED NET PRESSURE** and our **OPERATING NET PRESSURE**, we can factor in our **TEMPERATURE CORRECTED RATE** (from Step 1) to determine the **ADJUSTED PERMEATE FLOW RATE**.

STEP 5: CALCULATE THE FINAL ADJUSTED PERMEATE FLOW RATE

FORMULA: Temperature Corrected Rate x Operating Net Pressure / Rated Net Pressure = Adjusted Permeate Flow Rate

- Temperature Corrected Rate is 302.77 GPD • Operating Net Pressure is 60 psi • Rated Net Pressure is 45 psi

(CALCULATION: 302.77 GPD x 60 psi / 45 psi = 403.69 GPD) **FINAL ANSWER: Adjusted Permeate Flow Rate is 403.69 GPD**

CONCLUSION

If the standard permeate flow rate under baseline conditions of **50 psi / 77°F / 750 ppm** is **360 GPD**, we can now conclude that our **ADJUSTED PERMEATE FLOW RATE** under our deviated conditions of **65 psi / 68°F / 500 ppm** is **403.69 GPD**. This is the output we can expect from our thin film membrane assuming our deviated conditions do not fluctuate. This will help you determine membrane efficacy and accurate replacement schedules.