

### 6-4. Cleaning Procedure

1. Fill the cleaning tank with RO permeate water. The volume of cleaning solution should be sufficient to fill all the pressure vessels and pipe lines. Add the calculated amount of the cleaning chemicals to the tank. Use a mixer or recirculate the solution with the transfer pump to ensure that all chemicals are dissolved and well-mixed before circulating the solution to the elements.
2. Drain most of the water from the RO system to prevent the dilution of the cleaning solution by water within the RO system.
3. Heat the solution to the temperature recommended by the manufacturer to improve cleaning effectiveness.
4. Pump the preheated cleaning solution to the vessel at conditions of low flow rate (about half of that shown in Table 1) and low pressure to displace the process water remaining in the vessel. Dump the displaced water until the presence of the cleaning solution is evident in the RO concentrate system or in the return pipe, indicated by the pH and temperature of the cleaning solution. Adjust flow rate and pressure according to the Table 1. Open the RO concentrate throttling valve completely to minimize operating pressure during cleaning. Use only enough pressure to recirculate the cleaning solution without permeate coming out.

**Table 4.** Feed flow rate of cleaning solution per pressure vessel during recirculation

Element Diameter (in)	Maximum Feed Flow Rate	
	(gpm)	(m <sup>3</sup> /h)
2.5	5	1.1
4	10	2.3
8	40	9

5. Recycle the concentrate to the cleaning solution tank until the desired temperature is maintained throughout the system. Observe any increase in the turbidity to judge efficiency of the cleaning solution, especially in the case of an alkaline cleaning solution or a detergent solution. If the cleaning

solution becomes turbid or colored, drain the solution and restart with a freshly prepared cleaning solution. Check the pH during acid cleaning. The acid is consumed when it dissolves inorganic precipitates. If the pH increases more than 0.5 pH unit, add more acid.

6. Turn the pump off and allow the elements to soak. Sometimes a soak period of about 1 hour is sufficient. For difficult fouling an extended soak period is beneficial; soak the elements for 10-15 hours. To maintain a high temperature during an extended soak period, use a slow recirculation rate (about 10 % of that shown in Table 4).
7. Circulate the cleaning solution at the rates shown in Table 1 for 30-60 minutes. The high flow rate flushes out the foulants loosened from the membrane surfaces by the cleaning. If the elements are heavily fouled, a flow rate which is 50 % higher than shown in Table 1 may aid cleaning. At higher flow rates excessive pressure drop may be a problem. The maximum recommended drops are 1.4 bar (20 psig) per element or 4.1 bar (60 psig) per multi-element vessel. The direction of flow during cleaning must be the same as during normal operation to avoid telescoping of the elements.
8. Drain the used cleaning solution out of the system. Analyze a sample of the used solution to determine the types and the amount of substances (fouling materials) removed from the membrane elements. The results could tell the degree of cleaning and the causes of fouling.
9. RO permeate or good quality water (filtered, SDI < 3), free of bacteria and chlorine, conductivity < 10,000  $\mu\text{S}/\text{cm}$  is used for flushing out the residual cleaning solution. The minimum flush out temperature is 20 °C to prevent precipitation.
10. The RO plant is started up again resuming normal operating conditions. However, the permeate must be drained until conductivity and pH returns to normal. And also the permeate side draining is necessary when another cleaning cycle with another cleaning chemical is to follow. During the rinse out step, the operating parameters should be noted to judge the cleaning efficiency and to decide if another cleaning is required. If the system has to be shut-down after cleaning for longer than 24hours, the elements should be stored in a preservation solution such as 1 % sodium bisulfite and 0.5 % formaldehyde. For multi-array systems, cleaning should be carried out separately for each array. This can be accomplished either by using one cleaning pump and operating one array at a time, or using

# 6

## Cleaning and Disinfection

---

### 4. Cleaning Procedure

separate cleaning pump for each array.