FILMTEC Membranes
System Design: Permeate Staged System

Permeate Staged System

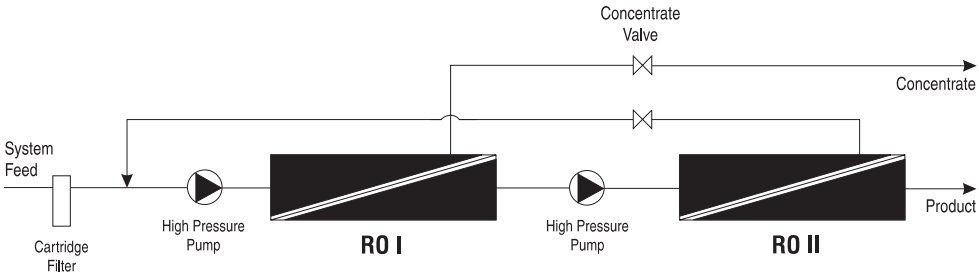
A permeate staged system may be considered for the following reasons:

- Standard permeate quality is not sufficient
- Post-treatment with ion exchange technology is not allowed (regeneration chemicals)
- Rejection of bacteria, pyrogens and organic matter is most important
- High reliability

The production of water for pharmaceutical and medical use is a typical application of permeate staged systems. A permeate staged system is the combination of two conventional RO/NF systems where the permeate of the first system (first pass) becomes the feed for the second system (second pass). Both RO/NF systems may be of the single-stage or multi-stage type, either with plug flow or with concentrate recirculation.

Figure 3.9 shows a schematic flow diagram of a permeate staged RO system. The concentrate of RO II is recycled back to the feed of RO I because its quality is usually better than the system feed water. Because the feed water to RO II is of high quality (RO permeate), RO II can be designed for a higher recovery than RO I, and with fewer membrane elements (see *Membrane System Design Guidelines, Section 3.9*).

Figure 3.9 Permeate staged system



Instead of having a separate high-pressure pump for the second pass, the whole system can also be operated with one single high-pressure pump, provided the maximum permissible feed pressure of the membrane element is not exceeded (600 psi (41 bar) for BW elements). The second pass is then operated with the permeate backpressure from RO I. For the maximum permeate backpressure allowed, please refer to *Pressure Vessels (Section 3.13.2)*. Care must be exercised that the permeate backpressure at no time exceeds the feed pressure by more than 5 psi (0.3 bar).

A surge tank can also be used to collect the permeate from the first pass. This tank must be carefully protected against dust and microbiological contamination.

The conductivity is in many cases the most important quality parameter of the product water. Since carbon dioxide is not rejected by the membrane, it is present in the product water, where it reacts to form carbonic acid and causes the conductivity to increase. The passage of carbon dioxide can be prevented by adjustment of the feed water pH to RO I to a value of about 8.2. At this pH, most carbon dioxide is converted into hydrogen carbonate, which is rejected well by the membrane. Sodium hydroxide (caustic soda, NaOH) can be injected either into the permeate of RO I or into the feed of RO I. The best product water

Permeate Staged System (cont.)

conductivity can be achieved if the pH in the feed to RO I is optimized. This however implies that the calcium carbonate scaling potential is under control at the required pH of 8.2 to 8.5. With this concept, a product conductivity of typically < 1 µS/cm can be achieved.

The recovery of RO I is normally limited by the scaling potential of the feed water, but the recovery of RO II can be as high as 90 - 95% in order to reduce system costs. On the other hand, a more moderate recovery for RO II helps to maximize the product water quality at the expense of a larger first pass (which has then to treat the increased RO II concentrate flow rate).

FILMTEC™ Membranes
For more information about FILMTEC membranes, call the Dow Liquid Separations business:
North America: 1-800-447-4369
Latin America: (+55) 11-5188-9222
Europe: (+32) 3-450-2240
Pacific (ex. China): +800-7776-7776
China: +10-800-600-0015
http://www.filmtec.com