Tech Note 102

MAR COR PURIFICATION
A Cantel Medical Company

RECOVERY

In the operation of a reverse osmosis system, most of the dissolved ionic material and organics are blocked by the membrane and passed to the drain with the waste water. The product water, with the concentration of impurities reduced, is then suitable for use in whatever application for which the system is designed.

To clarify the relationship between system performance and the water flow parameters, some of the nomenclature commonly used should be defined. The terms *'product', 'effluent',* and *'permeate'* are all applied to the purified water. The supply water is usually called *'feed' , 'supply'* or *'input'*. *'Waste', 'brine'*, and *'concentrate'* are all used to refer to the water passing over the membrane on the feed or input side carrying the dissolved and suspended material to the drain.

The waste flow to the drain must be sufficient to carry away the removed material and prevent either mechanical plugging or precipitation on the feed side of the membrane. For convenience in working with these systems, the ratio of the product water to the input water is most commonly used as an operating parameter. This ratio is called *'yield', 'recovery'*, or *'conversion'* and is usually expressed in a percentage. This can be stated mathematically as:

$$\text{Recovery (\%)} = 100 \times \left[{}^{\text{Product Flow}}/_{\text{Feed Flow}}\right]$$

As the sum of the product and waste is equal to the feed. The equation can also be written as:

$$\text{Recovery (\%)} = 100 \times \left[{}^{\text{Product Flow}}/_{(\text{Product Flow} + \text{Waste Flow})}\right]$$

Depending upon the application, the recovery will usually be from 10% to 75%. With higher TDS feed waters, a lower recovery will be required; conversely, higher recoveries are possible with low TDS feeds.

It can be easily deduced that a 10% recovery will cause an increase of approximately 10% in the TDS of the waste water relative to the feed. We can also see that a 50% recovery will cause the TDS in the waste to be approximately double that of the feed, as we will have almost all of the dissolved material in half of the water going to the drain.

An additional factor called *'polarization'* results in a further concentration of the dissolved material at or near the membrane surface within the module assembly. It is primarily a function of the transverse flow of water through the membrane and increases with higher recoveries. This factor is reduced by brine recirculation within the system but may give an increase in TDS within the module from 25% to 100%.

Some of the impurities requiring removal by reverse osmosis have a saturation characteristic which can result in precipitation and scaling on the membrane surface, blocking the flow of product water and eventually disabling the system. The most frequently encountered materials of this type are iron and calcium. For this reason, almost all reverse osmosis manufacturers set a limit of 0.05 ppm for iron in the feed water.

Calcium scaling as calcium carbonate is a complex function of temperature, hardness, TDS alkalinity and pH, and can be analyzed by means of the Langlier equations. This determination takes into account the concentration factors discussed above and provides a reasonable margin of safety as long as the waste flow is adequate.

Mar Cor Purification application engineers can assist in the analysis of a problem water which can pose scaling problems and provide recommendations for the safe recovery values as well as pre-treatment requirements for any system design.

Mar Cor Purification ◆ 14550 28TH AVE N Plymouth, MN 55447 ◆ (800) 633-3080