Mistakes to Avoid in the Design and Operation of Reverse Osmosis Systems

By Gil K.Dhawan, Ph.D

Introduction

Reverse osmosis (RO) technology has evolved into a widely used process for the purification of water. Well designed and properly operated systems give trouble-free performance over long periods of time and membranes in these systems have a long, useful life. On the other hand, mistakes made during the design or operation of reverse osmosis systems can lead to ongoing problems and reduced membrane life.

This article reviews some of the common mistakes made during the design and operation of RO systems.

Membrane performance

There is one simple but extremely important fact to remember to keep the membranes at their peak performance: keep the membrane surface clean.

All impurities in water are removed at the membrane surface. The dynamics of this separation step must ensure that concentrated materials are not accumulating there. If concentrations are allowed to build up near the membrane, precipitation of low solubility substances will follow, resulting in a decline in membrane performance.

Water analysis

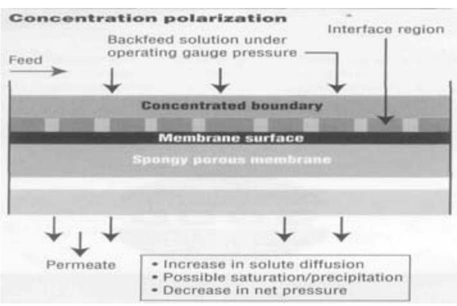
Understanding water analysis and the potential problems caused by the sparingly soluble substances is crucial for system success. Many reverse osmosis systems have been designed and sold with incomplete water analysis or none at all. Some of these mistakes are difficult to fix in the field and may even require discarding the existing system and starting all over again.

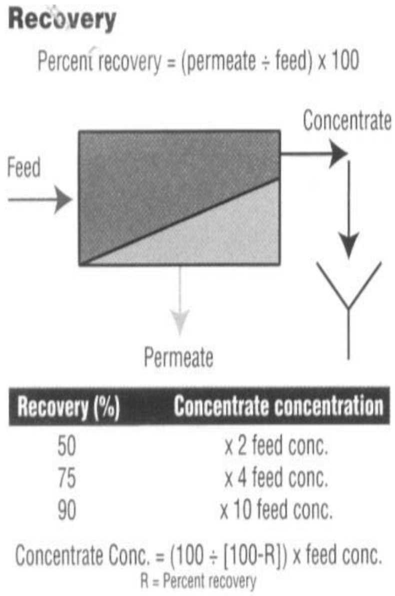
Recovery

Recovery is defined as the ratio of the permeate flow to feed flow.

Percent recovery = (permeate flow feed flow) x 100

In residential systems the recovery is expressed in terms of ratio of brine flow to





Example of how higher feed flow helps to reduce membrane fouling

permeate flow. For example, the brine: permeate flow ratio may be 6:1. This can be converted into recovery as follows

Feed flow = permeate flow + brine flow For brine to permeate ratio of 6:1, the feed flow is 7 (6+1).

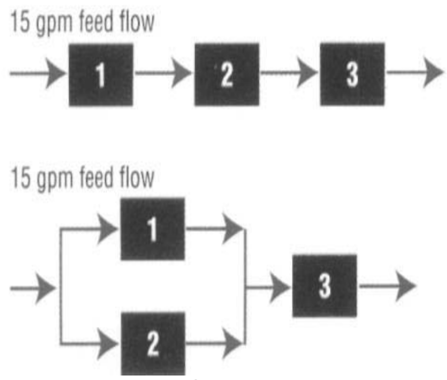
Percent recovery = (permeate flow or feed flow) x 100 or (1 + 7) x 100 = 14.3 percent For most tap water it is recommended that the recovery for each membrane be maintained between 10 to 15 percent. Operating membranes at higher than recommended recovery will result in surface fouling.

Membrane flux

All membranes have one common limitation. They can only produce a maximum flow of a certain maximum permeate flow for a given water. This limit is controlled by the quality of feed water and not by the make of the membrane. For example, a maximum permeate flow for most tap. water applications is 25 gallons per square foot per day. When membranes are run at fluxes higher than this value, fouling takes place. For surface water the flux is only 10 gallons per square foot per day.

Feed flow

A minimum feed flow must be maintained throughout the membrane. Feed velocity helps to



reduce build up of concentrated materials at the membrane surface. When several membranes are being used, the arrangement of these membranes is crucial in maintaining proper flow velocities. This arrangement must be checked against other related factors such as higher pumping costs, recycle flow, etc.

System shutdown

The fouling tendency of feed water when flowing through membranes is quite different than that of stagnant water at shutdown. Certain suspended solids may settle on the membrane surface during stagnant periods. On the other hand, silica is found to crystallize during shutdown. A proper flush cycle can eliminate these problems.

Residential systems

- Residential reverse osmosis systems need to take all of the preceding items into consideration. In addition, there are some other factors that require special attention in home systems. Most of these problems arise from improper selection of some key components in the manufacturing of these systems.
- Flow restrictors: Poor quality flow restrictors may cause systems to run at higher recoveries, resulting in shorter membrane life.
- Prefilters: Sediment and carbon filters used in the pretreatment of residential systems must not shed fibers or release carbon fines.
- Check valves: A faulty check valve can cause a backpressure on the permeate side of the membrane element resulting in physical damage to the membrane.

Conclusion

Mistakes in the design and operation of reverse osmosis systems can be avoided by following the recommendations outlined in this article. There are no short cuts in providing systems that give trouble-free performance with a long useful membrane life.

About the author

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