4-1. Introduction

After the pretreatment of the raw water, the treated feed water enters an RO water desalination system. The goal of an efficient RO system for a certain required permeate flow is to minimize feed pressure and membrane costs (number of elements) while salt rejection and recovery should be maximized. The optimum design is influenced by the relative importance of these aspects (e.g. recovery vs. membrane costs) related to operating parameters. The desired salt rejection is usually achievable but the recovery determined by a permeate flow is affected by many factors.

An RO system design starts with prioritizing the relationship between the desired permeate flow and operating parameters followed by optimizing the parameters within physical limits levied by both RO membrane elements and the feed water possessing a potential of scaling and fouling. For examples, the recovery of brackish water systems is limited by the solubility of sparingly soluble salts and colloidal fouling potential of the feed water up to 88 % (achievable only by multi-array system). The recovery by a single brackish water element is limited to 15% by the scaling and fouling potential of the feed water with SDI of 3 to 5.

On the other hand, in sea water desalination, the limit of 30 to 45 % recovery (achievable only by multiple elements in series) is mainly imposed by the osmotic pressure of the concentrate stream, because a typical sea water element is durable only up to 69 bar (1000 psig). The recovery by a single sea water element is limited to 10 % of the seawater feed with SDI less than 5.

While in sea water systems the permeate flux is relatively low even at maximum allowed pressure, the permeate flux could be very high in brackish water systems without reaching the limit of 41 bar (595 psig) for brackish water elements. Although it is tempting to increase the permeate flux in order to minimize the costs for membrane elements, the flux has to be limited in order to avoid fouling and scaling. From experience, the flux limit in system design depends on the fouling tendency of the feed water.