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NF/RO DESIGN Considerations

The following is a quick summary of major factors that should be considered when designing NF/RO systems.

Water Quality and Pretreatment

One of the most important but complex decisions in designing NF/RO systems is establishing the feed water quality and pretreatment requirements. Inadequate pretreatment will cause major issues in NF/RO systems, cause frequent cleaning, and result in premature membrane replacement and failures. Make sure you are looking at historical source water quality and not just a few grab samples. Refer to AMTA Fact Sheet #12 for details on water quality parameters to test as well as pretreatment guidelines.

Finished Water Quality Goals and Objectives

Goals generally depend on client and regulatory requirements. If you are blending feed water with permeate, ensure hydraulics and controls are designed for flexibility in blending. Remember, neither membranes nor raw water quality will remain exactly the same. Be conservative! A good goal is typically to be less than 80% with worst conditions and aged membrane. Select reasonable worst cases for parameters such as water quality, water temperature, membrane age, fouling/scaling factor and expected recovery. Use your engineering judgement. Be reasonable!

Plant Capacity, Number of Skids and Redundancy

Plant capacity and number of skids are highly system dependent. Sometimes the regulatory agency will dictate maximum capacity based on source water limitations. Generally, at least two skids will be required if this is the only source. Many membrane plants are designed with a minimum of two to three skids and each skid is sized for maximum daily flow divided by the number of skids. In other words, 2x50%, 3x33.3%, etc. Most owners will require at least two skids, since one skid may be off-line for maintenance or Clean-In- Place (CIP) and won't be available for water production. For these types of plants, N+1 approach is used, In other words, 2x100%, 3x50%, etc. Size of NF/RO skids depends on many factors. One important factor to consider is the maximum practical size of the cleaning tank, piping and means of isolation. There are RO plants in which a single skid is comprised of multiple smaller skids (segments) with piping manifolds. An important factor to consider is isolation of skid stages/arrays for cleaning. Skids or segments with 80-100 pressure vessels appear to be the upper limits when considering practical cleaning provisions. This translates to 1.5 to 2.5 MGD skids for seawater and 2.5 to 3.5 MGD skids for brackish water RO systems with standard elements (dependent on flux and recovery rates). Remember, a higher number of skids for the same plant capacity typically translates into higher capital cost due to space, instruments, number of valves, pumps, etc. However, larger skids require more attention, maintenance, and larger components to maintain.

Concentrate Management

NF/RO facilities typically provide new sources of potable water via the treatment of lower quality resources, such as brackish water, tidal waters and seawater, as well as sources containing contaminants such as Arsenic, Nitrate and Radionuclides. Concentrations of compounds in NF/RO concentrate is 3-5 times more concentrated than the source water, depending on the plant recovery. The National Pollutant Discharge Elimination System (NPDES) sets the minimum treatment standards for surface water dischargers, and also establishes the framework for setting additional discharge standards under section 402 of the Clean Water Act. These regulations are typically enforced by all states and compliance is mandatory. Concentrate can be handled in a number of ways, including surface water discharge, discharge to sanitary sewer, recovery and reuse, deep well injection, evaporation ponds, spray irrigation or Zero Liquid Discharge (ZLD). Depending on the location and permitting requirements, some of these options can become very costly. NF/RO plants close to a bay or ocean are lucky to have the option of discharging to the saltwater body or tidal waters with minimal pumping and diffusers for dispersion. Inland desalting plants may have to implement much more expensive options, such as deep well injection, evaporation ponds and even ZLD. The proper approach to concentrate management should be fully evaluated side by side with the planning and design of a NF/RO facility early in process, so there are no surprises later. ■