

T.U.T.O.R.

Using Reverse Osmosis for Boiler Pretreatment

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There are numerous makeup water pretreatment strategies for boiler systems including softeners, dealkalizers, demineralizers, and reverse osmosis. Factors such as makeup water characteristics, economics, manpower, system familiarity, boiler requirements, space requirements, will determine which pretreatment strategy is used. Reverse Osmosis (RO) has come of age in the past decade as a real, economical alternative for boiler pretreatment. RO pretreatment produces higher quality water than many other pretreatment strategies but can come with some operational trade-offs. These trade-offs may be positive or negative depending upon the situation.

In order to gain a better understanding of the practical uses RO for boiler pretreatment, it is helpful to compare a typical soft water pretreatment program to that of an RO pretreatment program. Advantages of RO over a softener boiler pretreatment program includes:

- 90 to 99.9% removal of dissolved solids to allow boilers to operator at higher cycles of concentration (up to 100 cycles).
- Removal of more than hardness (calcium & magnesium).
- Lower boiler makeup and blowdown rates.
- Lower fuel usage.
- Less internal boiler chemical treatment.
- Less alkalinity resulting in less neutralizing amine demand.
- Cleaner boilers.
- Reject water that may be of good enough quality for cooling tower makeup or wash water.
- Reduction in the regeneration costs of softeners (including salt and water) when softeners are used in conjunction with RO, which will depend upon the current condensate return and blowdown rate.
- No regenerant chemicals.
- Lower manpower requirements may be realized to generate the appropriate water quality.

Disadvantages of RO as compared to using a softener for boiler pretreatment program includes:

- Increased electrical costs.

- Handling acid for pretreatment, if used will be required.
- Product water flow rate are fixed, while ion exchange can manage variable flows.
- An antiscalant may be necessary upstream of the RO system.
- Chlorine removal upstream of the RO system with polyamide (PA) membranes.
- Increased monitoring to determine percent salt passage, pressure drops, SDI's, conductivity, temperatures, and RO normalized permeate flow.
- Up to 25% of the reject water diverted to drain if there are no other uses for it.
- Membranes that must be cleaned and replaced periodically.
- Microbiological fouling, which can have a negative impact on the RO operations.
- Temperature sensitive flow rates.
- Additional pretreatment equipment, if required.
- Higher manpower requirements for some water qualities.

Similar advantages and disadvantages apply when comparing RO to other boiler pretreatment systems as well. Table 1 outlines the additional advantages and disadvantages of RO as compared to dealkalizing and demineralizing.

Table 1: Reverse Osmosis Comparisons			
Pretreatment Strategy		RO Advantages	RO Disadvantages
Anion Exchange Dealkalizing		<ul style="list-style-type: none"> • Does not add chlorides • Removes alkalinity and other anions and cations 	<ul style="list-style-type: none"> • Higher capital cost
Demineralizing		<ul style="list-style-type: none"> • No acid or caustic regenerants • RO can be less expensive than demineralization for moderate or higher TDS levels 	<ul style="list-style-type: none"> • Produces high purity water, but possibly not as high purity as some demineralizer quality water. For higher purity water, two-pass RO may be required or other polishing systems.

RO units generally remove 90 to 99.9% of all dissolved solids in a water source. Dissolved gases, however, pass through an RO membrane. Knowing which impurities are removed by the various boiler pretreatment systems can facilitate the choosing of a proper system for your boiler. Table 2 is a general list of impurity removal capabilities.

Table 2: Pretreatment Impurity Removal				
	Systems			
Impurity	Reverse	Softener	Softener with Dealkalizer	Demineralizer Train
Total Dissolved Solids	Yes (90-99.9%)	No	No	Yes (>99%)
Hardness	Yes	Yes	Yes	Yes
Alkalinity	Yes	No	Yes (up to 90%)	Yes
Silica	Yes	No	No	Yes
Carbon Dioxide & Oxygen	No	No	No	Yes

Conclusion

The benefits for a properly applied RO pretreatment system in an ideal situation is: lower water costs, lower sewer costs, lower fuel costs, lower treatment chemical costs, lower or elimination of regenerant chemical costs, higher boiler reliability, and higher steam purity. As discussed, exceptions do exist. However, an RO boiler pretreatment system may be the proper choice, but each system is unique and must be carefully considered.

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