



## Industrial and Power Boiler Wastewater Treatment with Forward Osmosis and OARO

MEMBRANE FILTRATION SOLUTIONS FOR INDUSTRIAL APPLICATIONS

WATER REUSE AND ZLD SOLUTIONS TO  
IMPROVE WATER EFFICIENCY

### Application Background

Steam generation for power production is a water intensive process, which in many regions of the world, has come under regulatory scrutiny. Utility companies and industrial steam and power generators require new ways to minimize water intake and reuse effluent streams, either within the power block, or in other plant process units.

Cooling water in the condenser cooling cycle is often recirculated and reused after running through the condenser cooling tower. Evaporation in the cooling tower reduces water volume and also concentrates minerals and salts in the cooling water. To prevent the scaling caused by mineral concentration, a blowdown stream of cooling water exits the loop. Make-up water compensates for the evaporation loss and the blowdown loss. While it is not feasible to recover the evaporated water, the blowdown water can be recovered, treated, and reused. The challenge is removing the scaling minerals and salts and returning the water to a condition that is safe for reuse.

Steam generators also operate in a closed loop, reusing the condensed steam as feed to the generator sections. A blowdown stream from the boiler helps to minimize build up of ions and salts that can cause boiler tube and turbine scaling. Fresh boiler feedwater is generated to

make up for this loss and requires multiple treatment steps to reach the purity required for steam generator feedwater.

Membrane based water reuse solutions by FTS can recover fresh water to be used as cooling tower make-up and boiler feedwater, reducing raw water intake, helping to meet new regulations, and helping to simplify the permitting process for new power and steam generator plant construction projects.

### Boiler Plant Streams for Reuse

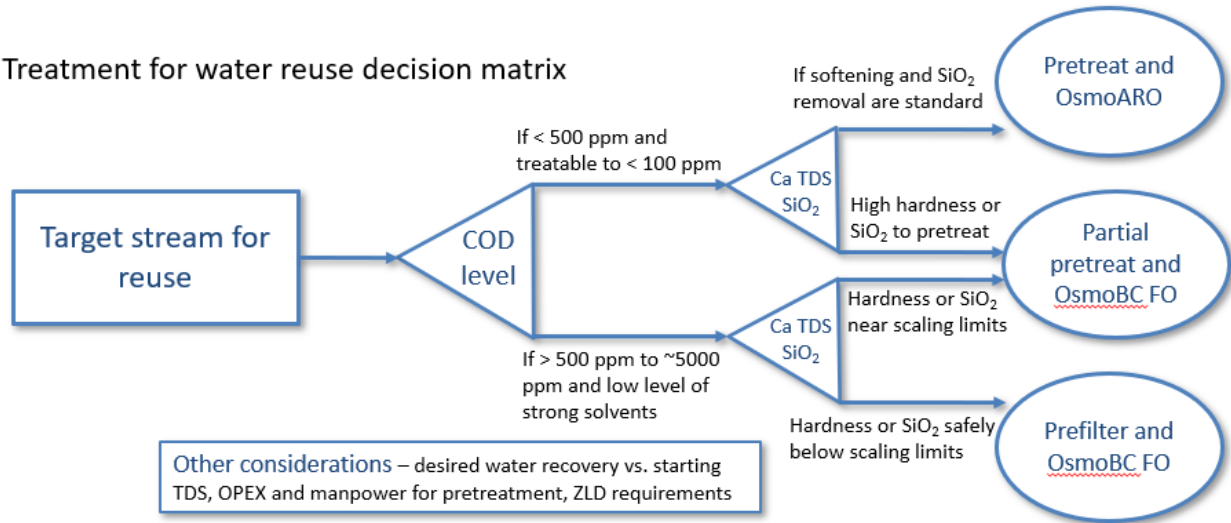
- Cooling tower blowdown
- Boiler blowdown
- Demineralizer plant regeneration streams
- RO reject streams

### Treatment Technologies by FTS

Depending on reuse targets and treatment requirements for existing effluent streams, FTS designs efficient solutions with the following -

- Tubular MF softening and WAC polishing
- UF, NF and RO for initial water recovery
- Forward Osmosis (FO) for brine concentration
- OsmoARO<sup>TM</sup> (OARO) for brine concentration
- Thermal technologies for ZLD treatment

Treatment for water reuse decision matrix



Determining the Best Treatment Process

FTS will review effluent stream water quality over time, reuse opportunities, customer regulatory issues, and input costs, to determine which set of available technologies can best meet customer goals at the lowest cost and highest reliability. A simplified decision matrix is shown above, describing some of the inputs for determining whether an FO based on OARO based treatment process is best.

Important factors, such as the ease of treatability of the stream to enable a high recovery OsmoARO based solution, help determine the best path forward. For waters that are very challenging to pretreat, an FO based treatment train will be the best approach. Many times a reuse solution via FO technology will require minimal pretreatment beyond 50-micron level filtration.

Shown below is an example reuse treatment process featuring OsmoARO technology. When this approach can be employed, it can provide the highest level of water recovery for the lowest energy consumption. Final wastewater brine levels of > 200 g/L can be reached, providing overall water recovery of > 90%. Most cooling tower, boiler blowdown, and demin plant wastewaters can be treated with an OsmoARO based process. When organics levels (COD or TOC) are >500 ppm or then hardness or scaling mineral reduction not feasible, an FO based treatment process is best.

Product Recommendations

For optimizing water reuse in Power and Industrial Boiler Plant waters, we recommend:

- OsmoBC™ FO Brine Concentrator System
- OsmoARO™ Assisted RO Brine Concentrator System
- OsmoF<sub>2</sub>O™ FO-CTA-8040-85 Industrial Elements
- HBCR™ HBR-TFC-8040 HighBrine Recovery Elements

Proposed process flow for near-ZLD ---

