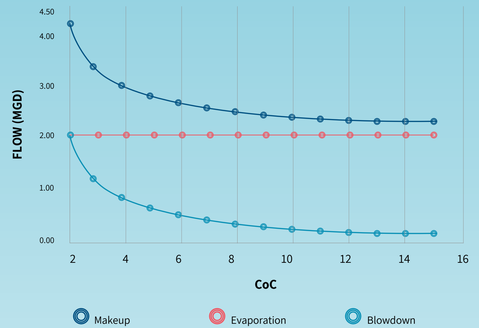
Case Study: 96% Recovery of Power Plant's Cooling Tower Blowdown (CTBD) by MAXH$_2$O Desalter | Demonstration unit in Chile

Introduction – Cooling Tower Blowdown

- The ratio between a parameter in cooling water blowdown to the parameter in Makeup water is called Cycle of concentration (CoC)

$$3 < CoC = \frac{\text{Concentration in Blowdown}}{\text{Concentration in Makeup}} < 7$$

- The COC normally varies from 3.0 to 7.0 depending on the Process Design and manufactures guidelines



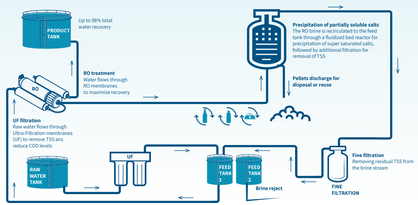
CoC limited by:

- Makeup water quality
- Regulation limitations on the allowable blowdown discharge quality
- Treating the blowdown or makeup can assist in increasing CoC > reducing water consumption and costs.
- Moving from CoC=3 to CoC=7 will result in 22% reduction in makeup flow and 66% reduction in blowdown flow.

Raw water quality

Parameter	Unit	Design	Actual
ph		8.44	8.26
Total Alkalinity	ppm $CaCO_3$	293	376
Total Hardness	ppm $CaCO_3$	1128	1220
Calcium	ppm $CaCO_3$	862.5	892
Magnesium	ppm $CaCO_3$	266	328
Chloride	ppm	128	185
Sulphate	ppm	764	918
Silicia	ppm	48.1	66
Phosphate	ppm	0.61	2.9
TDS	ppm	1847	-
Conductivity	microS/cm	-	2512
TOC	ppm	<10	-
TSS	ppm	<10	-
Turbidity	NTU	-	5
Free Chlorine	ppm	<0.1	0.16
Temperature	C°	29	20
Log SI	-	1.89	1.71

The actual water quality on site is more concentrated than the designed

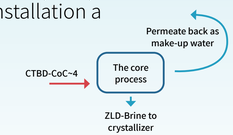


The exanimated power plant

- Power Plant is a gas fired power station comprising two Combined Cycle units
- 2 units with nominal power output of ~750MW each
- The current source of CT make-up water is high salinity brackish wells
- The challenge: Complying with the blowdown discharge regulations (D.S. N° 90).
- Sulphates ≤1000 ppm, Chlorides ≤400 ppm
- Currently, the operational CoC is ~2 and the CT blowdown is discharged directly to the river

IDE proposed solution for COC increase MAXH$_2$O Desalter

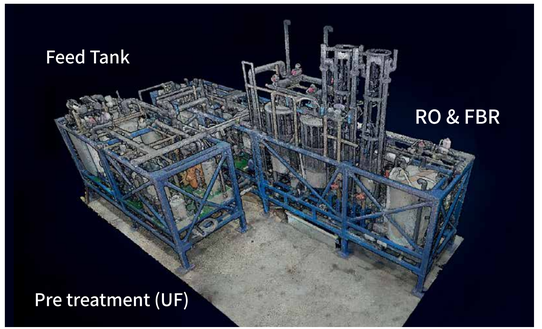
- Full ZLD solution: CoC~4 as per client requirement
- To Demonstrate that the **MAXH$_2$O** Desalter Technology is feasible, safe, and stable for the treatment of the San Isidro CTBD effluent by installation a demonstration unit
- Recovery >80%, Permeate TDS<300mg/lit
- Improve the operational efficiency



The core process:

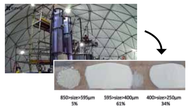
- The **MAXH$_2$O** Desalter overcomesvariable changes in the feed flow and composition
- Operates at very high recovery without compromising membrane service life
- Pushes the limits of calcium carbonate, calcium sulphate, and silica precipitation

MAXH$_2$O Desalter Demonstration Unit Specification



Description	Specifications
Feed flow rate	14-125 m3/d (2.6 - 23gal/min)
Produt flow rate	12-72 m3/d (2.2 - 13.2 gal/min)
Maximum revocery rate	Up to 98%. Actual recovery depends on feed water characteristics
Removal of sparingly soluble salts	CaCO3, CaSO4, SiO2
Pretreatment	UF included
Feed TSS	<50mg/L
Optional Chemicals	Antiscalant, Coagulant, SBS (optional), NaOH, Ca(OH)2, Na2Co3. Required chemicals are pending each specific case analyses.
UF flux	20-90 LMH (2x100%)
UF CEB System	Included. Manual chemicals addition
CIP System	Included. Manual chemicals addition
RO Flushing	Automated
Footprint	12.0 x 5.6 m I Desalter skid- 40ft container, Pretreatment -20ft container
Unit Height	6.1 / 5.4 m (with / without legs) (20.3/17.7ft)

Precipitation Unit

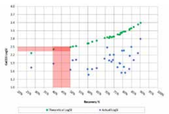


Operating conditions

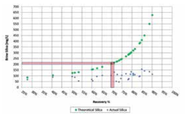
Parameter Analyte	Value
RO Flux	~ 13.5 LMH
RO local recovery	~ 20%
RO total recovery	70-96%
Salt precipitation reactor hydraulic loading rate	30-40 m3/hr/m2
Gravity media filter filtration velocity	~ 12 m3/hr/m2

Summery of results Performance

CaCO3 removal



Silica removal



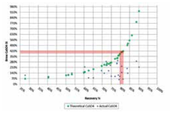
Notes

1) $Log\ SI = Log\frac{[Ca] \times [CO_3]}{K'_{sp}}$

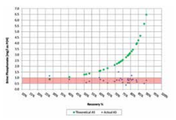
2) $SI = \frac{[Ca] \times [SO_4]}{K'_{sp}}$

3) The calcium Sulphate precipitates as Gypsum ($CaSO4{\cdot}2H2O$)

Gypsum removal

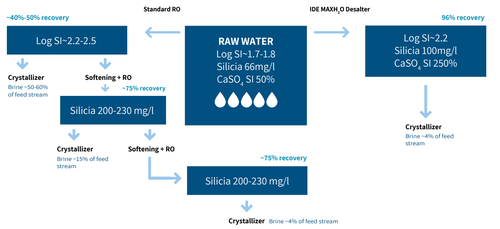


Antiscalant addition



- Reaching the maximum saturation of salts at muchhigher operational recoveries
- One cycle duration - 16 Hours
- Maximum RO feed pressure (at the end of the cycle) – 22-23barg
- Low electrical consumption of 3.5 kw/m3 (with no energy recovery device) compared to other technologies
- Only addition of Caustic soda for crystallizer pH adjustment for silica precipitation
- Low quantity of Antiscalant

Standard RO vs. MAXH$_2$O Desalter for the current blowdown (BD)



Conclusions

- The **MAXH$_2$O** Desalter can reach extremely high recovery compared with standard RO process
- It reduces the number of RO and softening stages, sludge handling units, and significantly minimizes the tail crystallization stage
- The demonstration unit was stable during the run period, confirming the process' capabilities and reliability
- COC's value can increase to 4 (and above) from value of 2