Membrane Protection Resins - Ion Exchange Resins and Reverse Osmosis in Partnership

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Classical Ion Exchange in Partnership with Membrane Processes

The most commonly encountered use of ion exchange with Reverse Osmosis is Mixed Bed Polishing.

IEx resins are used to achieve higher downstream quality, either as a regenerable or non regenerable mixed bed.

This is not the topic of today's presentation

Today's Presentation

1. Cyclic Ion Exchange – Softening using Purolite's SST (Shallow Shell Technology) Resins

2. Membrane Protection Resin – Purolite MPR1000

Reverse Osmosis – 30 years ago

- 30 years ago many people were predicting that most of the ion exchange resins used in IWT would be replaced by membranes.

- 30 years latter that is not the case. RO and other membrane processes have a share of the clean and waste water market but IEx still treats the bulk of the IWT market.

Water Usage by Membrane Processes

- Typically 15 to 30% of water is wasted by brackish water RO's and as high as 50 to 70% of water is wasted by some household and small commercial RO plants.

- Water is now a valuable commodity and there are concerns over scarce and dwindling fresh water supplies and the amount of "good quality" water being lost or sent to sewers and waste disposal facilities.

- Therefore it is essential we find ways to minimize waste water volumes and improve membrane performance.

We should not forget the importance membrane processes will have in the future treatment of high TDS waters for drinking water and industrial water applications, helping to preserve lower TDS supplies.

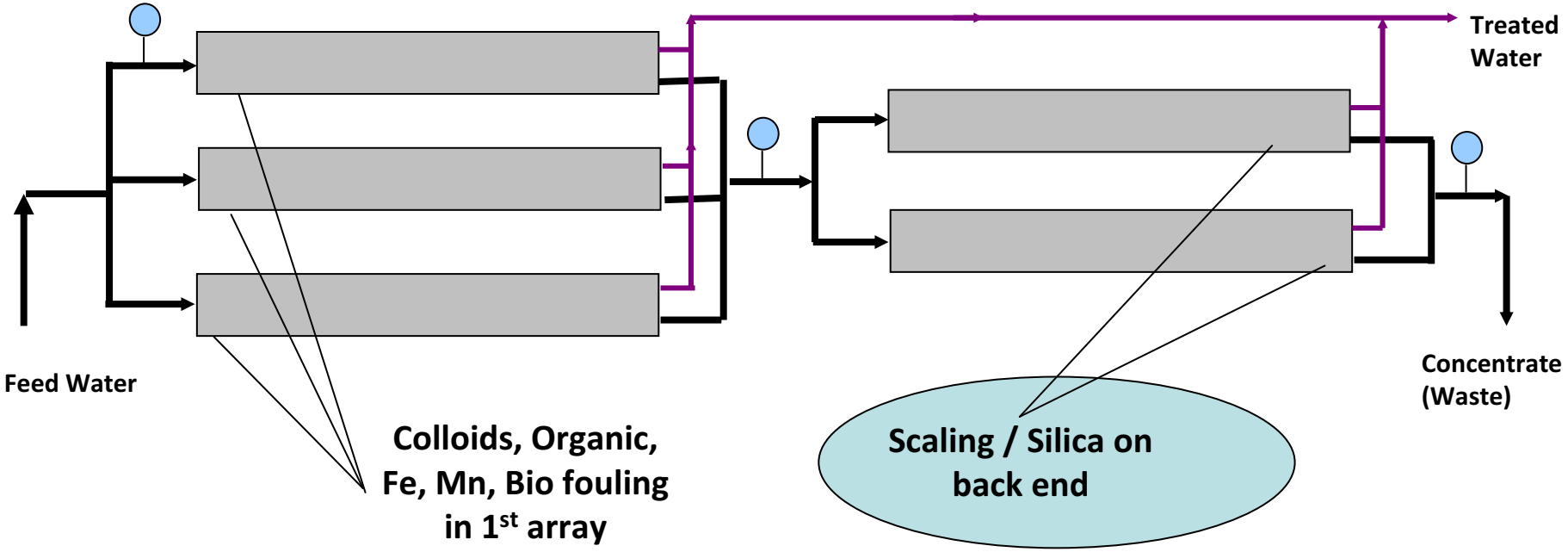
Modern Plant Designs

In an increasing competitive world market both ion exchange and membrane technology has suffered from some engineering companies designing plant with inadequate pretreatment and based on optimum performance with little of no safety margin.

In the case of RO operating at optimistic conversions and high flux rates to make their plant more attractively priced. Some plants have been undersized and need regular chemical cleaning to maintain performance which can be costly and requires increased down time with loss of production.

Factors Limiting RO Performance / Recovery

Colloids	Present as colloidal silica / organics / metals etc.
Organic Matter (TOC)	Dissolved Organics – large molecular weight.
Scaling	Sulphate & Carbonate Scales of Ba, Sr & Ca etc.
Silica, Fe, Mn Deposition	SiO_2, $CaSiO_3$, Fe_2O_3, MnO_2



Current Scale Control Methods for Pretreating RO's

1. Acid Dosing to reduce pH – Control of $CaCO_3$ scaling
2. Antiscalant Dosing – Control $CaSO_4$, $BaSO_4$, CaF_2, SiO_2, Fe, Mn, Al, PO_4
3. Combination of both 1. and 2. (acid and antiscalant dosing)
4. Conventional IEx Softening is sometimes used, employing conventional resins with NaCl regeneration.

Brine Regenerated Ion Exchange Softeners are Unpopular for RO pretreatment

They offer Effective at scale control, but the downside is:

- High Usage and Cost of NaCl Salt used for regeneration.
- Discharge of 10% waste brines is becoming increasingly unpopular.
- Higher capital cost compared to antiscalant dosing system

New Process Called Cyclic Ion Exchange™ (CIX-RO)™ which aims to make IX Softeners Popular Again

- Purolite USA have developed an approach using our SST Softening Resin using the RO Reject Brine for Regenerating the resin. (SST = Shallow Shell Technology)
- No Extra Salt is Needed for most waters
- Brine concentrations as low as 0.5% can be used.
- Very Low Hardness & Barium leakages is achievable with increased RO Permeate Recovery Possible,
- Antiscalant combined with CIX-RO = Recovery > 90%

Cyclic Ion Exchange (CIX-RO)™

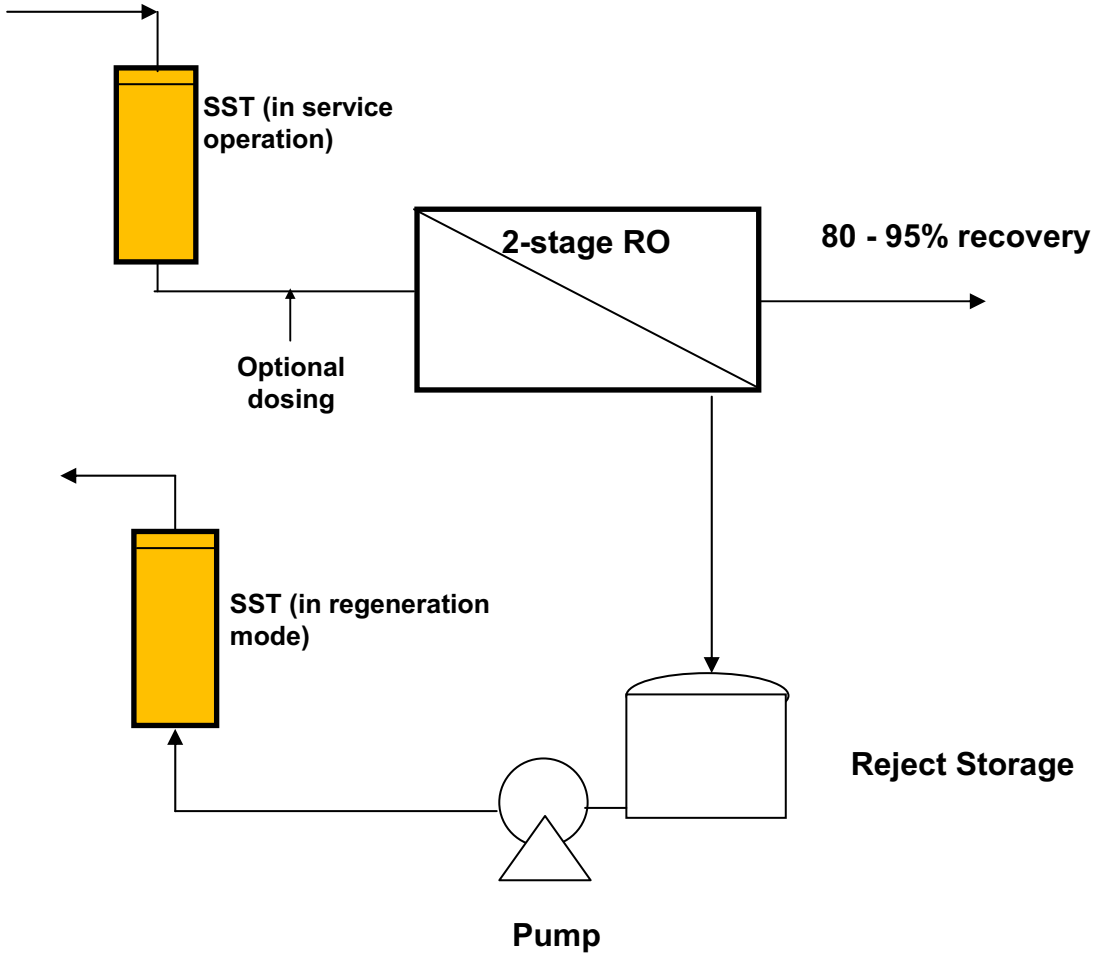
The application particularly lends it self to moderate TDS (Brackish waters) and requires a resin that can give effective performance at low brine concentrations.

The capacity of the resin in softening such high waters is relatively low due to the high TDS background and the weak brine solution used for regeneration.

Purolite have developed a design programme to predict SST performance.

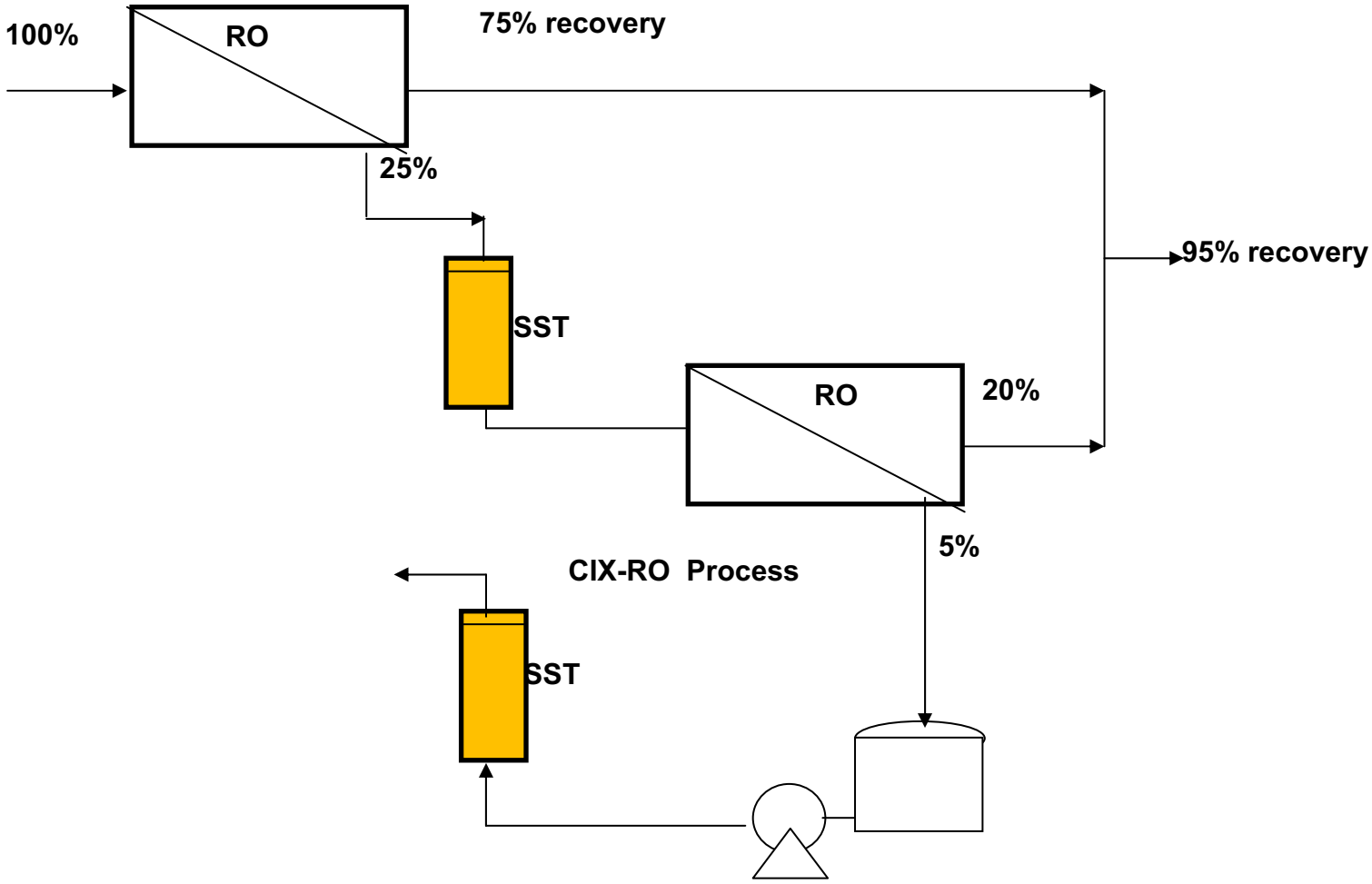
Cyclic Ion Exchange™

- Basic Pretreatment Design Option

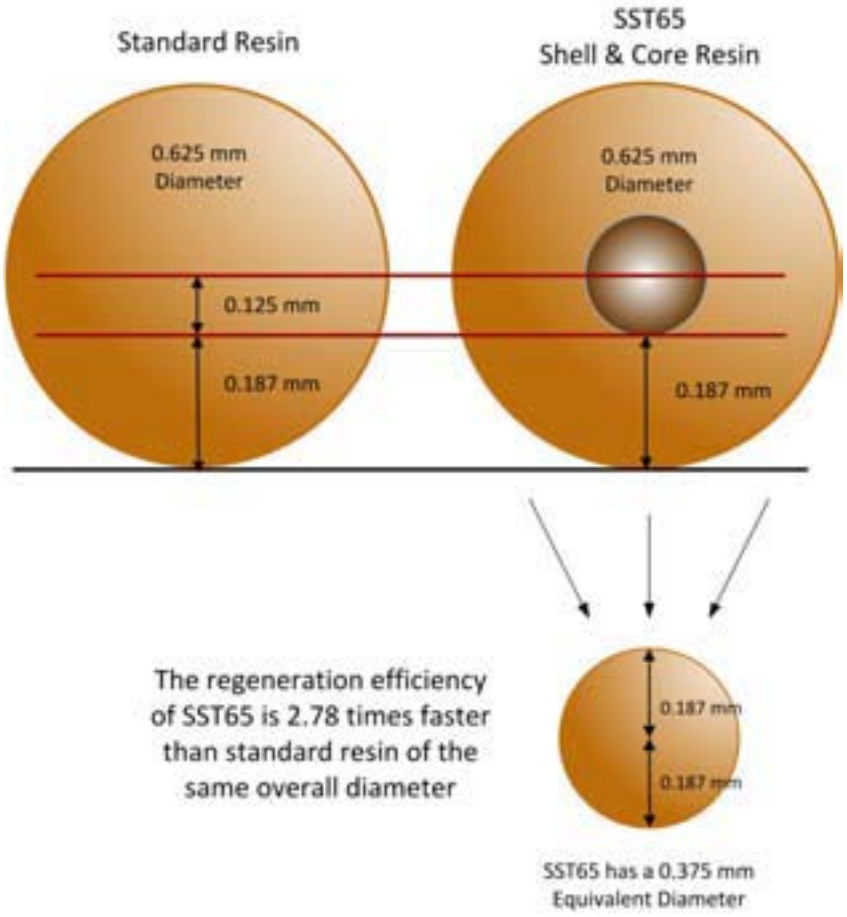


Cyclic Ion Exchange™

- Inter-Stage Option



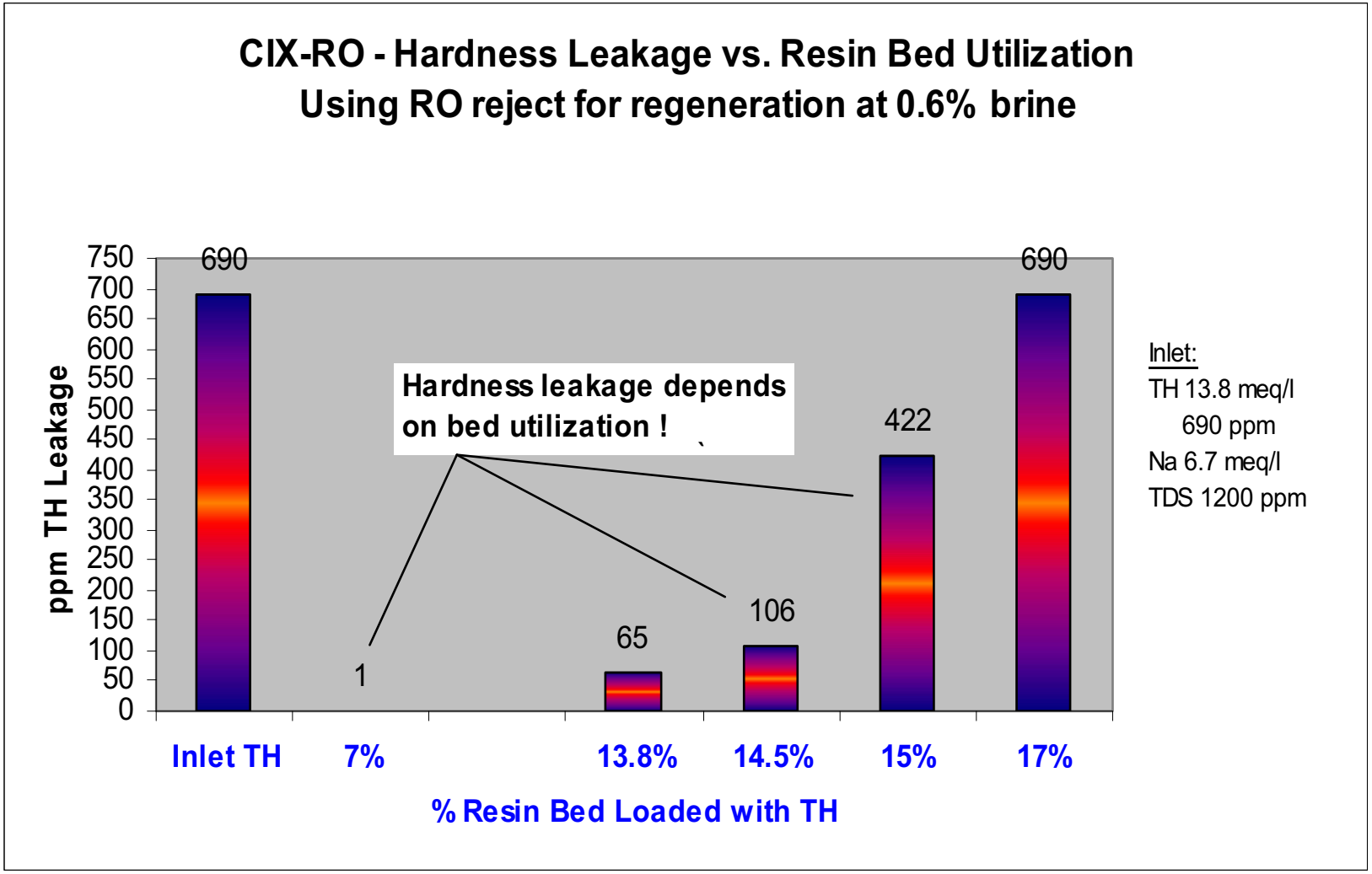
Why Shallow Shell Technology Resin Work Better



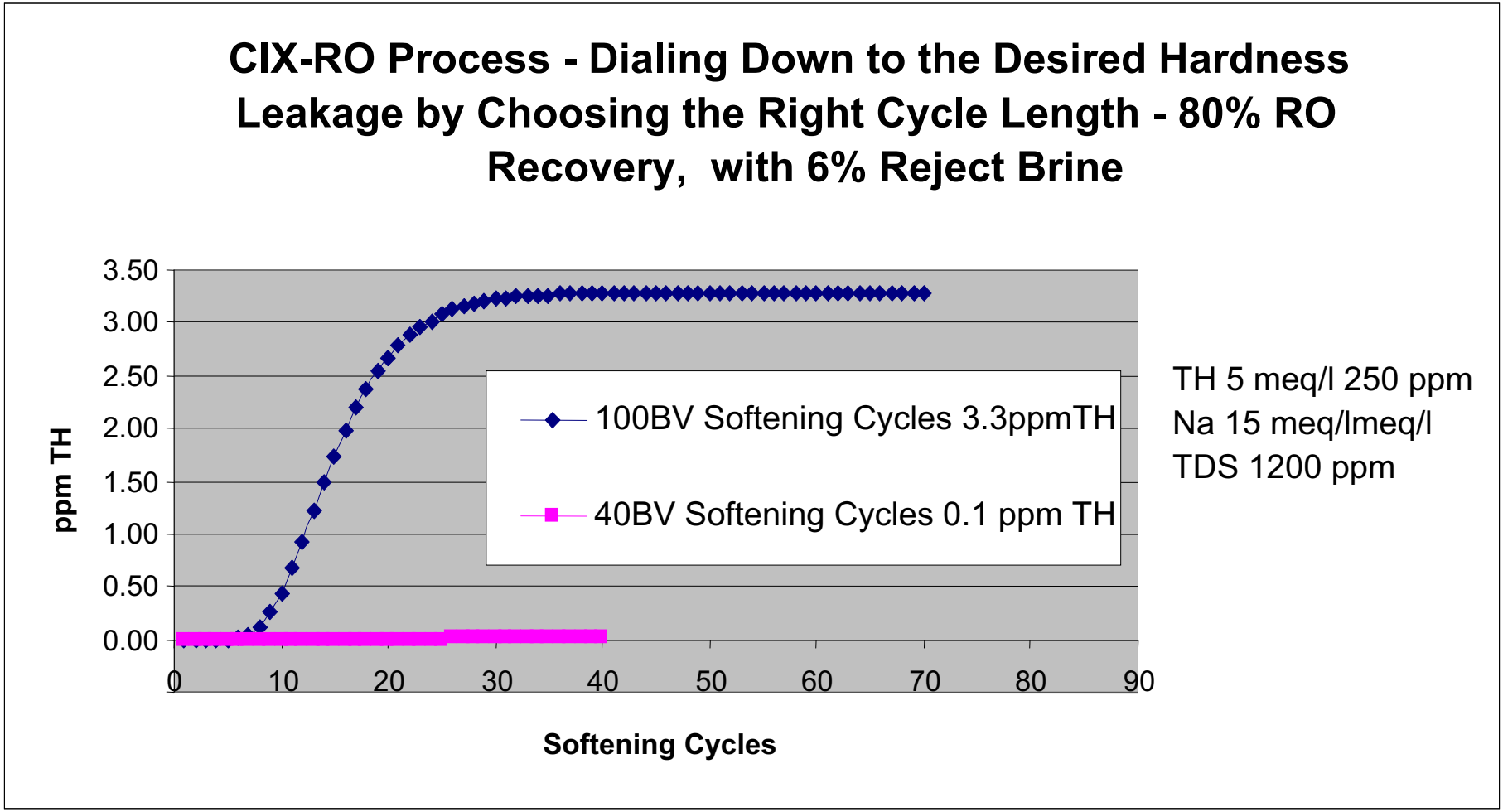
Why is SST resin so Efficient in Cyclic Ion Exchange?

- **Fine Mesh Resin Performance but without the high pressure drop**
- **Faster Regeneration Kinetics**
- **Better elution of contaminants (Fe)**
- **Reduced Rinse water requirements**

Hardness Loading Rate Determines Leakage



Software Simulations Can Predict Performance to Desired Maximum Hardness Leakage



Benefits of CIX-RO

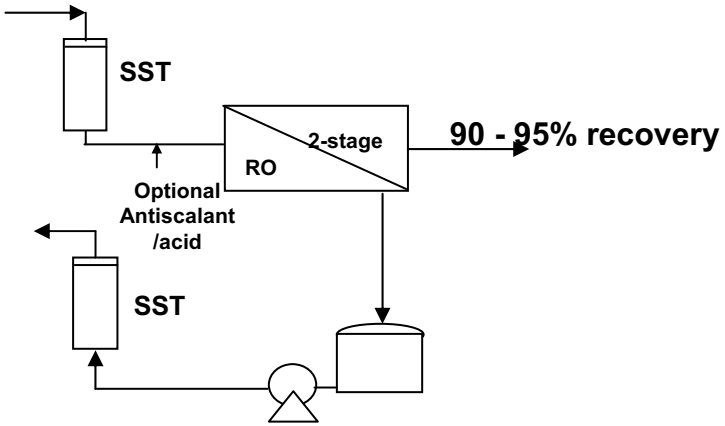
- CIX-RO + Antiscalant Dosing = Very High RO recovery

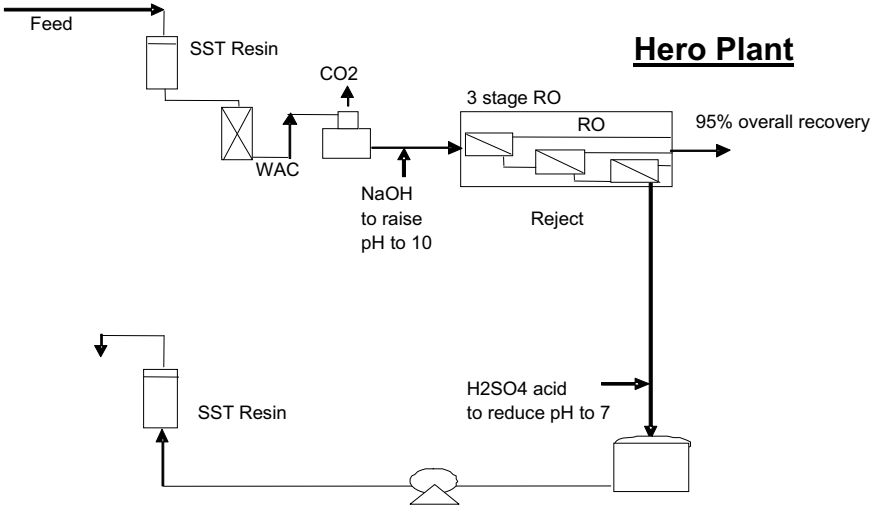
- Greater membrane reliability - ultra low hardness leakage
- RO brine is “Free” - No purchase/handling of salt required
- No extra salt discharge to the environment at lower TDS
- Savings on water purchases and concentrate disposal cost
- Lower pumping costs
- Competitively priced pretreatment easily retrofitted to existing plants.

Cyclic Ion Exchange™

Main Markets

- Brackish Water desalination – using RO reject brine > 0.5%
- HERO systems > 90 to 95% recovery





Cyclic Ion Exchange™

- Successful Plant Operated with Cyclic IEx:
  - 95 m^3 SST resin – Asia - with 1% brine and pH adjustment (2008)
  - BP Alaska Pilot SST resin – treating brackish water with 2200 mg/l TDS (2008)
  - Singapore Inter-Stage Pilot SST resin – 0.5% RO reject brine - 99% TH reduction; 1st Stage concentrate at 1200 mg/l TDS (2009)

Purolite MPR 1000

- Purolite MPR1000 is a relatively new Purolite resin
- The product is used to reduce colloids as well as dissolved organics from RO feedwater.
- Aimed at:

1. Improving pretreatment for membrane plants.
2. Reducing the frequency of chemical cleans.
3. Improving overall performance, maintaining high flux rates.
4. Longer membrane life

Purolite MPR 1000

- MPR1000 is a mix of two resins:

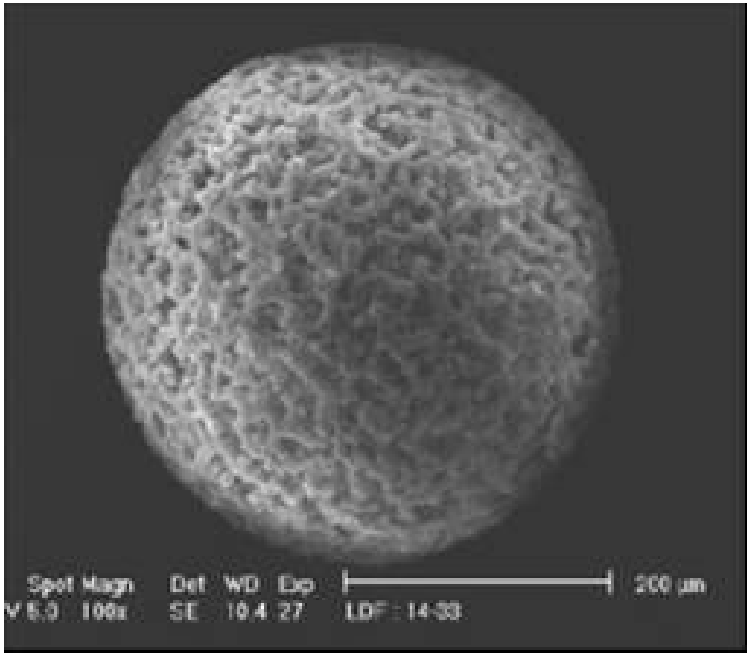
    A. Colloid Removal Resin

    B. Organic Scavenger

It can clearly be seen as a two resin product.

It is capable of dramatically improving the levels of TOC while reducing the SDI prior to RO plants,

Purolite MPR 1000



The most important component:

The colloid removal resin.

Highly porous structure but with good physical strength.

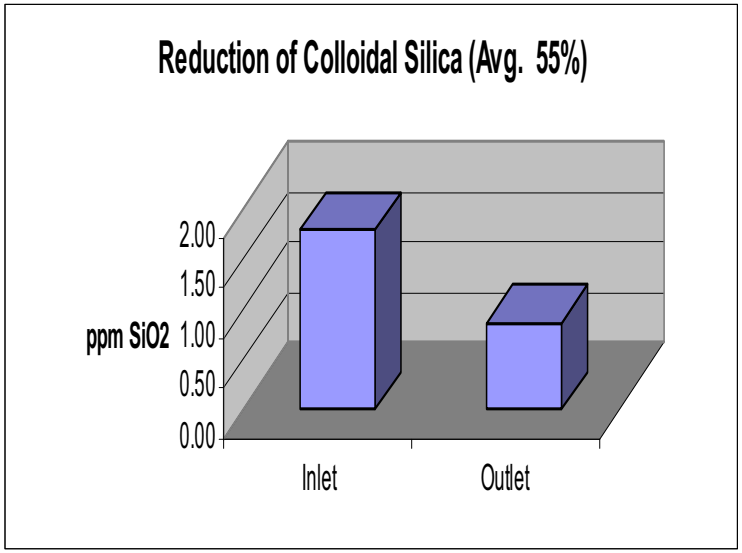
Purolite MPR 1000 – Typical Operating Conditions

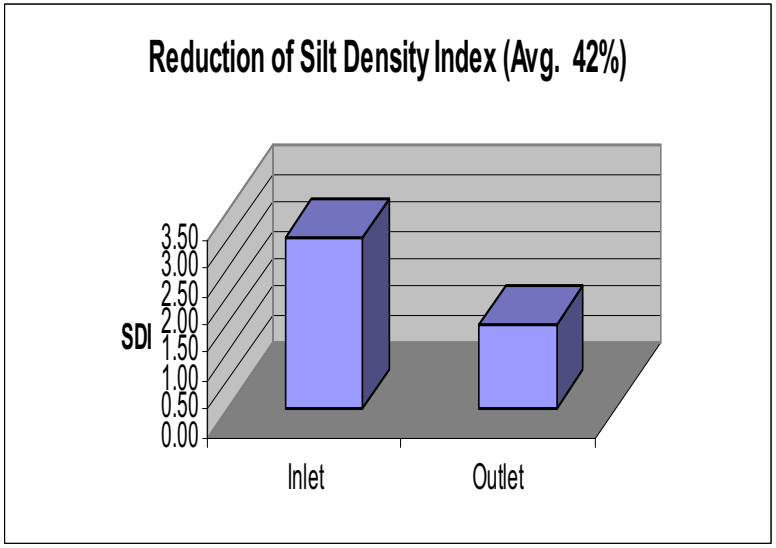
Should not be used as a conventional suspended solids filter!

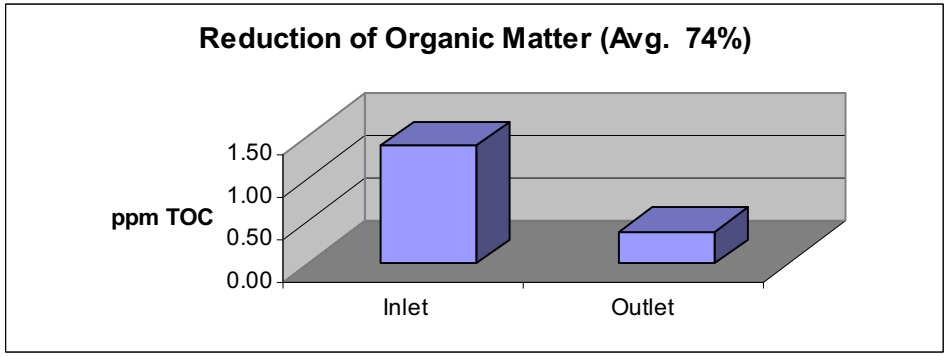
Service Flow Rate	-	8 to 16 BV/h
Service Cycle	-	Typically 24 – 72 hours
Minimum bed depth	-	1 metre
Regen conditions	-	150 g/l NaCL and 32 g/l NaOH (Possible occasional caustic addition)
Slow Rinse	-	2 BV
Final Rinse	-	4-6 BV

Possible use of RO reject for regeneration.

Purolite MPR 1000 – Results from Pilot Plant Studies







Purolite MPR 1000 – Results from Trials for Polish Power Authority

Data Presented in a Paper by Antoni Litwinowicz
ENERGOPOMIAR Sp. z o.o., Chemistry and Diagnostics Department
(September 2009)

Performance Tests of MPR1000® Ion-exchange Resin in Treatment of Actual Waters, as Used in Power Plants

Tests carried out on the water supplies to 4 different power plants, of varying quality employing different pretreatment designs prior to the Purolite MPR1000, measuring TOC, Permanganate Values, SDI, Iron etc.

Overall they concluded it should be considered for future projects on a case by case basis as an effective pretreatment for all kinds of plant and mentions specifically the improvement of water quality prior to RO systems and the significant reduction in SDI.

END

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