

Introduction

Global stress on available water sources makes innovation necessary in the path forward for the water use in the European chemical industry. Recycling and using unconventional water sources as a feed source in cooling towers can reduce the water footprint. The aim of the CS1-Case Study is to explore the options for alternative feed water sources to produce mild desalinated water (<1 mS/cm) at affordable costs. A pilot, with a product capacity of 2-3 m³/h to test the configuration (Figure 1), showed the following results (Table 1) and conclusions.

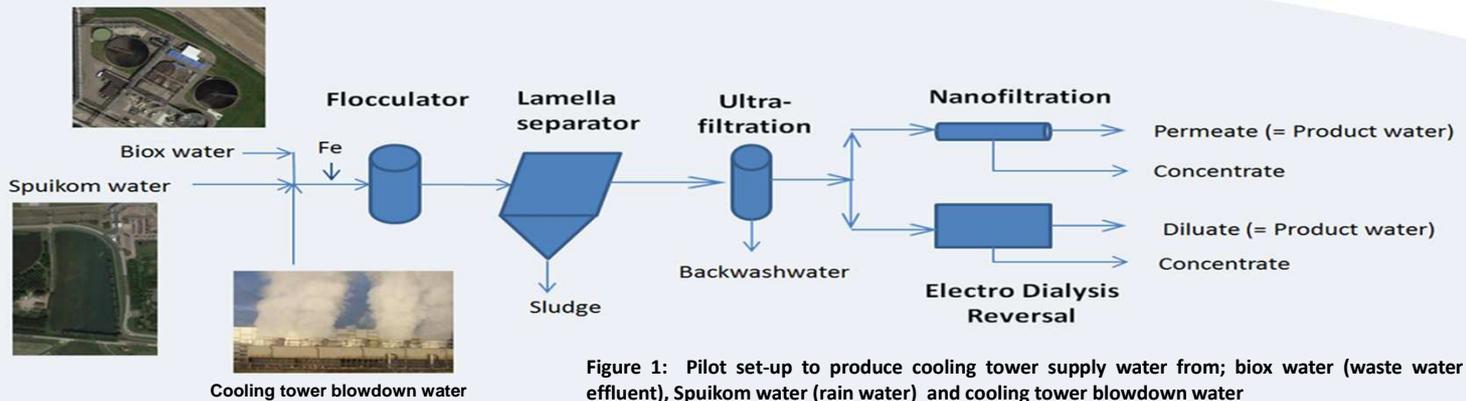


Figure 1: Pilot set-up to produce cooling tower supply water from; biox water (waste water effluent), Spuikom water (rain water) and cooling tower blowdown water

Results

Table 1: Summary pilot results, green is stable performance, red is unstable performance and orange is not meeting specification.

	Spuikom	Cooling tower blow down	Biox-water
Ultrafiltration Inge membranes	Flux 70 l/mh, Tf 25 min, Rec. 86%, Fe 10 mg/l	Flux 60-70 l/mh, Tf 20-25min, Rec. 83%, Fe 5-10 mg/l	Flux 70-80 l/mh, Tf 45 min, Rec. 92%-95% rec., Fe 10 mg/l
Ultrafiltration Dow membranes	Flux 45-50 l/mh, Tf 30-20 min, Rec. 87-90%, 0 mg/l Fe	Flux 45, Tf 25-30 min, 88-Rec. 90%, 0 ppm Fe	Flux 70 l/mh, Tf 45 min, Rec. 96%, 5 mg/l Fe
Nanofiltration	Flux 20 l/mh, Recovery 75%	Flux 20 l/mh, Recovery >40-65%	Flux 20 l/mh, Recovery 75%
Nanofiltration Quality	EC < 0.2 mS/cm, TOC < 1 mg/l	EC < 0.25 mS/cm, TOC < 1.5 mg/l	EC < 0.15 mS/cm, TOC < 1 mg/l
Electrodialysis Reversal	Recovery 85%	Recovery 70%	Recovery 85%
Electrodialysis Reversal Quality	EC < 0.3 mS/cm	EC < 1 mS/cm, TOC 25 mg/l	EC < 0.25 mS/cm

Conclusion

A stable operation was achieved with the coagulation, sedimentation and ultrafiltration process (Table 1) on all three feed water sources. Where sedimentation is not necessary with the relatively low iron dosages (5-10 mg/l).

The mild desalination with the use of the nanofiltration has a better product quality in terms of EC and TOC than is required, although stable operation is hard to maintain on cooling tower blow down water and biox-water (Figure 2).

Electrodialysis reversal, a potential driven process, has a product quality within specification except for TOC. The operation is more stable and robust compared to nanofiltration. The higher TOC level can be lowered via post treatment with ion exchange resins.



Figure 2: Autopsied NF membrane, the fouling layer is visible in the middle. Due to the presence of the fouling the flux declined from reference 42 to 12 l/m².h. Cleaning tests revealed irreversibility of the fouling with a maximum improvement to 19 l/m².h. Analysis of the fouling showed biofouling, mostly consisting of hydrocarbons (70%) from which 31% aromatic hydrocarbons.

"EDR more robust mild-desalination technique compared to NF"



This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 280756.

Project start: May 2012; Project duration: 48 months

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