DOW™ Ultrafiltration

Pretreatment with DOW™ Ultrafiltration Membranes Beats Challenge of High Turbidity

Site Information

Location:
JiangShu, China
Capacity:
360 m^3/h
Purpose:
Pretreat feed water to RO system
Time in Operation:
Since August 2007
Performance:
Over 99% reduction in turbidity; SDI ≤ 3

Skid 2 at the GuanYinShan cogeneration facility, using DOW™ *Ultrafiltration SFP-2860 Modules. (Photo courtesy of Nantong GuanYinShan Environmental Protection Thermoelectricity Co. Ltd.)*

Introduction

The GuanYinShan cogeneration facility is located in the JiangShu province of China and supplies heat and electricity for major industries in the city of GuanYinShan. Because of an increase in demand for energy, the operating company (Nantong GuanYinShan Environmental Protection Thermoelectricity Co. Ltd.) invested in a second expansion that added a 12 MW cogeneration system, resulting in a 40 MW co-gen facility providing reliable and stable energy for the growing community.

To produce boiler feed water, the GuanYinShan facility uses ground water that has high turbidity, high iron concentration, and high total suspended solids, which poses a challenge for reverse osmosis (RO) membrane operation. Pretreatment with DOW™ Ultrafiltration modules facilitates stable RO membrane performance, resulting in product water with average turbidity of 0.12 NTU and silt density index (SDI) less than 3.

DOW™ Ultrafiltration Modules

The SFP-2860 module is ideal for systems with capacities greater than 50 m^3/h (220 gpm). This 8-inch-diameter module offers a high effective membrane area, which contributes to a more economical membrane system design. At 60 inches long, the SFP-2860 module offers high efficiencies over a wide range of feed water conditions.

DOW™ Ultrafiltration Modules, cont.

DOW™ Ultrafiltration modules are made with high-strength, hollow-fiber membranes that have excellent features and benefits:

- 0.03 µm nominal pore diameter for removal of bacteria, viruses, and particulates (including colloids) to protect downstream processes such as reverse osmosis
- Polyvinylidene fluoride (PVDF) polymeric hollow fibers for high strength and chemical resistance that lead to long membrane life
- Hydrophilic PVDF fibers for easy cleaning and wettability that help maintain long-term performance
- Outside-in flow configuration for high tolerance to feed solids that helps reduce the need for pretreatment processes
- Unplasticized polyvinylchloride (U-PVC) housing that helps eliminate the need for costly pressure vessels

Water Treatment Process

Table 1 indicates the average raw water analysis. Water treatment challenges included high turbidity (11.1 NTU), high iron (0.22 mg/L), and high total suspended solids (31.8 mg/L).

Table 1. Raw water analysis

Parameter	Unit	Value
Temperature	°C	25
Turbidity	NTU	11.1
pH	—	7.92
Total SiO_2	mg/L	11.3
NH_3	mg/L	0.46
Fe	mg/L	0.22
Chemical oxygen demand (COD)	mg/L	7.44
Total suspended solids (TSS)	mg/L	31.8

Figure 1 is a diagram of the water treatment process. Sodium hypochlorite (NaOCl) at a dosage of 2–5 ppm is added to the feed water to oxidize Fe and control biofouling. A self-cleaning filter (100 µm) removes particles that can damage the UF membranes, and a heater adjusts feed water temperature to lessen the effect of temperature fluctuation on the UF and RO system flow and pressure.

Sodium bisulfite ($NaHSO_3$) at a dosage of 2–4 ppm is added after the UF modules to remove residual NaOCl in the UF permeate water. Other additions include an antiscalant (4–5 ppm) to prevent RO membrane scaling and HCl to reduce pH. A 5-µm cartridge filter is installed upstream of the RO system as further protection against particulate fouling in the event of maintenance or operation mishaps.

Cation and anion beds further reduce ions in the water and operate with a decarbonator to remove excess CO_2. A mixed bed polishes the RO water for boiler make-up requirements. Ammonia (NH_3) at a dosage of 1–2 ppm is added to adjust pH to the range required for boiler make-up water supply.

Water Treatment Process, cont.

Figure 1. Water treatment process

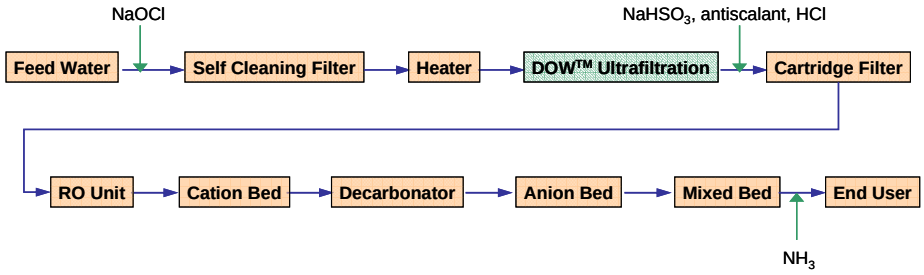


Table 2 provides the operating parameters for the ultrafiltration, reverse osmosis, and mixed bed unit operations. Table 3 further describes the ultrafiltration process.

Table 2. Operating parameters for unit operations

Parameter	Unit	UF	RO	Mixed Bed
Component	—	SFP-2860	FILMTEC™ BW30-400	—
Capacity	m^3/h	360	270	120
Number of skids	—	3	3	—
Number of modules per skid	—	40	—	—
Total number of modules	—	120	—	—
Capacity per skid	m^3/h	120	90	—
Recovery	%	90	—	—
Flux	L/m^2h	52.4	—	—

Table 3. Ultrafiltration operating process

Parameter	Frequency	Duration	Chemical Consumption
Filtration	—	56 min	—
Air Scour	Every 56 min	30 s	—
Backwash	Every 56 min	40 s	10-15 ppm NaOCl
Forward flush	Every 56 min	60 s	—
CEB[a]	None	None	—
CIP[b]	—	—	*Alkaline*: 0.05% NaOH, 0.2% NaOCl *Acid*: 2% citric acid

[a]Chemically Enhanced Backwash
[b]Clean-in-Place

UF System Performance

Figure 2 shows the dramatic decrease in turbidity through the DOW™ Ultrafiltration membranes, with turbidity being reduced 99% from 11.1 NTU to an average of 0.12 NTU. Minor turbidity spikes shown in the graph were caused by system maintenance. However, none of the spikes exceeded 0.2 NTU.

Figure 3 shows the expected rise in transmembrane pressure (TMP) values between cleanings. Off-line Clean In Place (CIP) was performed in November 2007 and in January 2008, as indicated by the sudden drop in transmembrane pressure. Other TMP spikes were caused by system maintenance and changes in the raw water source. Implementing a CIP effectively restores the operating TMP. The feed water iron concentration has not affected the performance of the UF membranes, and no fouling has been observed.

UF System Performance, cont.

Figure 2. Product water turbidity versus time.

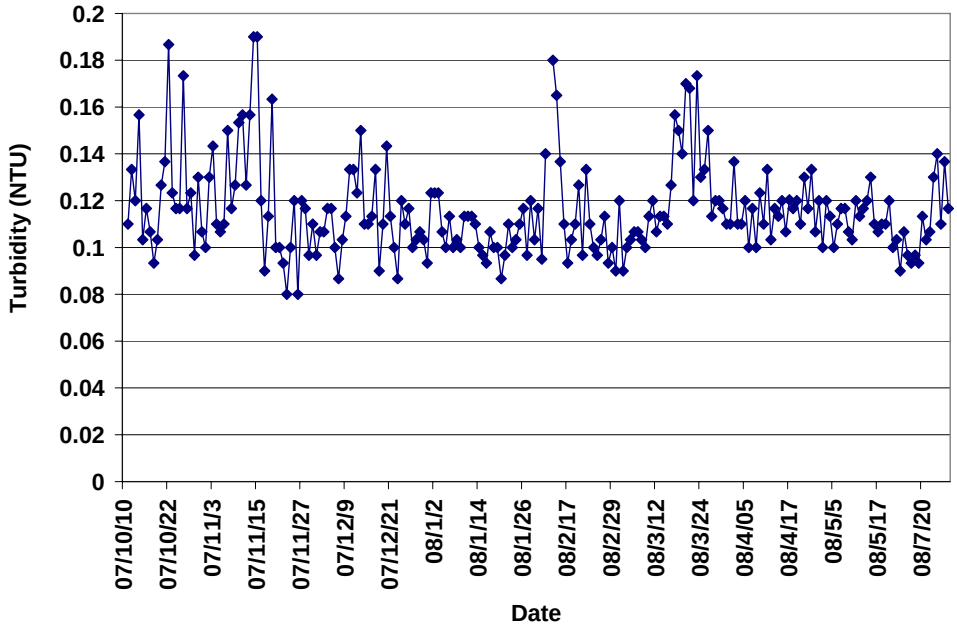
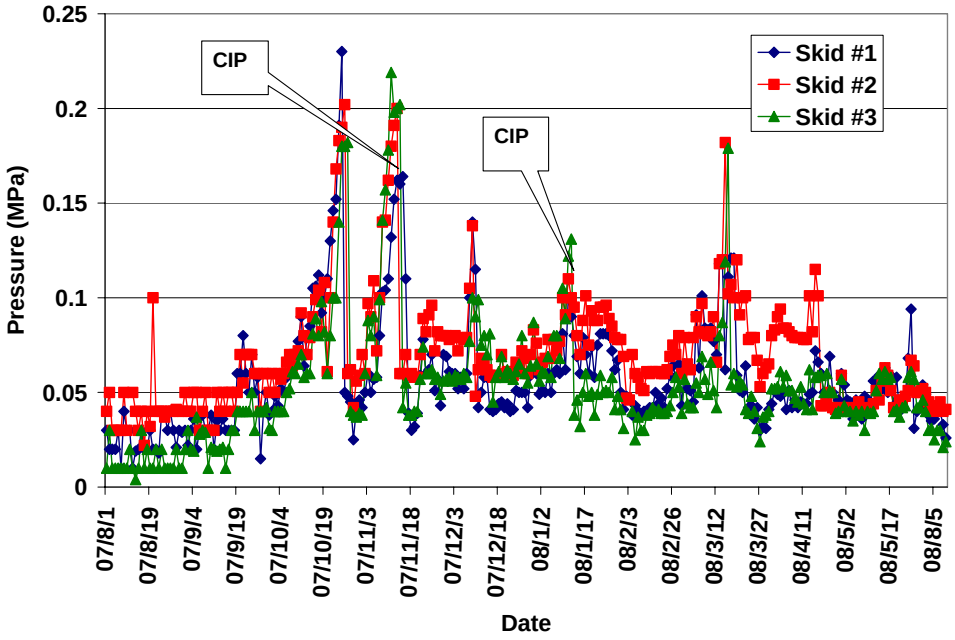


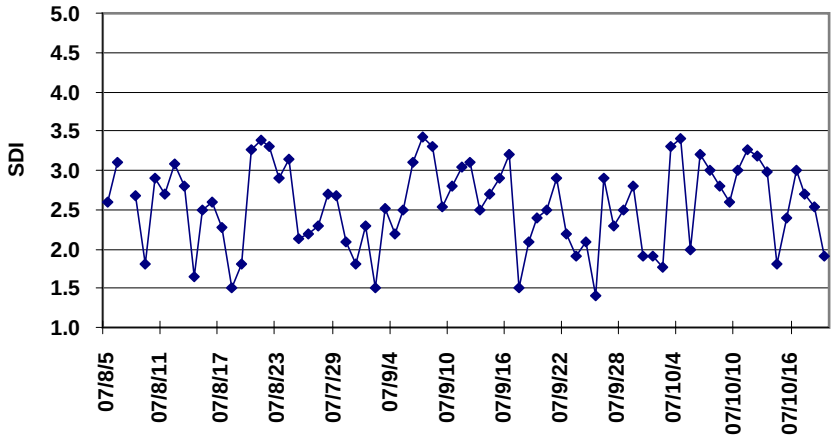
Figure 3. Ultrafiltration transmembrane pressure versus time.



UF System Performance, cont.

The UF permeate SDI has an average value of 2.6 and meets the requirement of SDI less than 3 for optimal RO feed water. Higher SDI values shown in Figure 4 occurred as a result of downtime and maintenance of other facility unit operations.

Figure 4. Ultrafiltration product water SDI value versus time.



Summary

Using a ground water source with high turbidity, high iron, and high suspended solids has not prevented GuanYinShan from producing desirable RO feed water. DOW™ Ultrafiltration membranes have successfully treated this water without other pretreatment processes. The UF product water has an average turbidity of 0.12 NTU and SDI less than 3. DOW™ Ultrafiltration provides an economic and reliable water treatment system for this ground water source.

DOW™ Ultrafiltration
For more information about DOW™ Ultrafiltration, call the Dow Water Solutions business:
North America: 1-800-447-4369
Latin America: (+55) 11-5188-9277
Europe: (+32) 3-450-2240
Japan: (+81) 3-5460-2100
Australia: (+61) 3-9226-3545
http://www.dowwatersolutions.com