DOW™ Ultrafiltration

DOW™ Ultrafiltration Membranes Offer Reliable, Economical Answer to High Solids

Site Information

Location:
NingBo, China
Capacity:
549 m^3/h (2417 gpm)
Purpose:
Pretreat feed water to RO system
Time in Operation:
Since August 2005
Performance:
Turbidity = 0.1 NTU; SDI ≤ 2

DOW™ *Ultrafiltration and* FILMTEC™ *reverse osmosis installations at NingBo facility. (Photo courtesy of NingBo Jiufeng Co-gen Ltd.)*

Introduction

NingBo Jiufeng Co-gen Ltd. Co. participates in many public sectors, including heat and electricity development. The first phase heat and electricity production site handles the generation, installation, and repair of electrical services for the NingBo province. The site also maintains a steady supply of steam and hot water throughout the province with its 270 t/h production capacity. The planned expansion to a second site will double the existing heat-generation capacity.

Jiufeng uses the nearby XiePu River as source water for the factory's water treatment plants, one of which produces boiler make-up water. The XiePu River is high in total suspended solids and the river water temperature fluctuates. The water intake on the XiePu River is near an estuary, which results in seawater intrusion that increases the impurity level in the river. Nevertheless, DOW™ Ultrafiltration membranes are able to overcome these challenges and demonstrate solid performance with an average product water turbidity of 0.1 NTU and silt density index (SDI) ≤ 2.

DOW™ Ultrafiltration Modules

The SFP-2660 module is particularly ideal for systems with capacities of 50 m^3/h (220 gpm) or less, although customers with larger facilities also choose this module because of construction or economic constraints. At 6 inches (15 cm) diameter, the SFP-2660 module allows a more compact, alternative design for space-constrained installations.

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 longer 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 eliminates the need for costly pressure vessels

Water Treatment Process

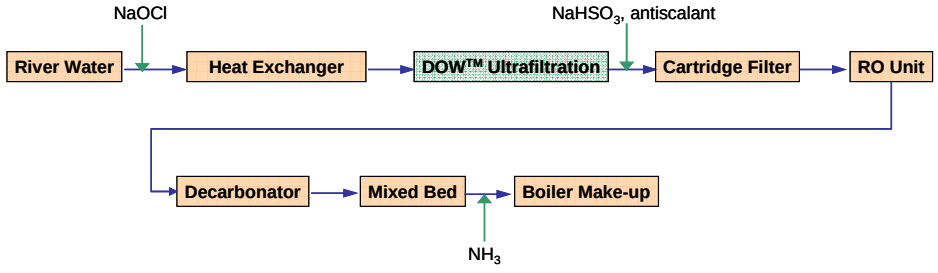
Table 1 indicates the average raw feed water quality. The river water has total suspended solids of 134.5 mg/L and total iron (Fe) of 0.3 mg/L. The Fe concentration is higher than typical surface water, but it can be easily removed with proper oxidation treatment. Seasonal, tidal, and weather-related events cause seawater intrusion in the source water, causing salt concentration and impurities to fluctuate unpredictably.

Table 1. Raw water analysis

Parameter	Unit	Value
Temperature	°C	18 to 25
pH	—	6.6
Total SiO_2	mg/L	22.5
R_2O_3	mg/L	13.75
Total Fe	mg/L	0.3
Total hardness	mmol/L	7.45
Chemical oxygen demand (COD)	mg/L	10.24
Total dissolved solids (TDS)	mg/L	523.75
Total suspended solids (TSS)	mg/L	134.5
Conductivity	µS/cm	1160

Figure 1 is a diagram of the water treatment process. Sodium hypochlorite (NaOCl) at a dosage of 2 ppm is added to the feed water to oxidize Fe and control biofouling. A heat exchanger adjusts the feed water temperature and lessens the effect of temperature fluctuation on the UF and reverse osmosis (RO) membranes. Sodium bisulfite ($NaHSO_3$) at a dosage of 5 ppm is added to remove any residual oxidizing agent remaining in the water. An antiscalant is added at a dosage of 3 ppm to prevent the RO membrane from scaling.

Figure 1. Water treatment process



Following the RO unit, a decarbonator removes excess CO_2 from the water. The mixed bed removes hardness, charged ions, and Cl^- to produce high purity water. Ammonia (NH_3) at a dosage of 1–2 ppm is added to adjust pH to the range required for boiler make-up supply.

Water Treatment Process, cont.

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 2660	FILMTEC™ BW30-400	—
Capacity	m^3/h	549	390	390
Number of skids	—	6	3	4(3:1)
Number of modules per skid	—	48	—	—
Total number of modules	—	288	—	—
Capacity per skid	m^3/h	91.5	130	130
Recovery	%	91	—	—
Flux	L/m^2h	53.7	—	—

Table 3. Ultrafiltration operating process

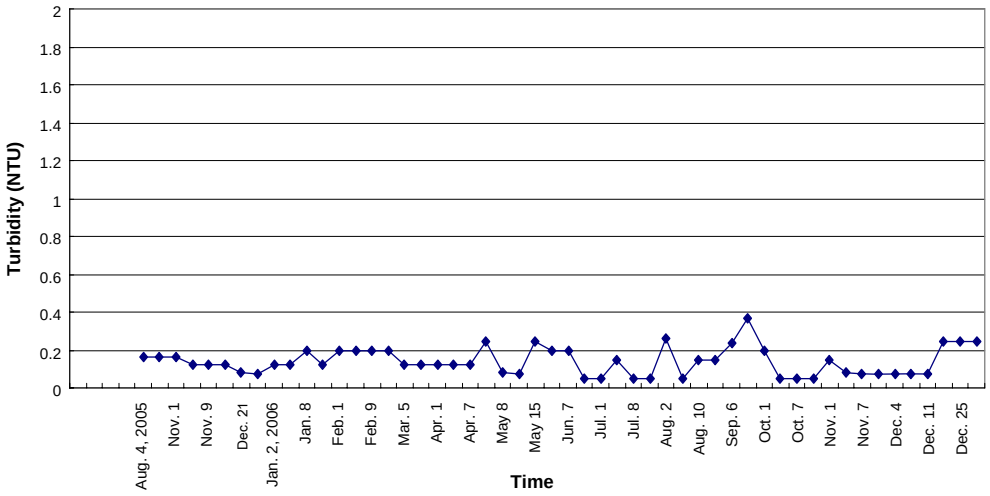
Parameter	Frequency	Duration	Chemical Consumption
Filtration	—	56 min	—
Air scour	Every 56 min	30 s	—
Backwash	Every 56 min	40 s	10-15 ppm NaOCl
Forward flush	Every 56 min	60 s	—
CEB[a]	None	None	—
CIP[b]	Every 3–4 months	8 h	*Alkaline*: 0.05% NaOH, 0.2% NaOCl *Acid*: 2% citric acid

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

UF System Performance

Figure 2 shows that turbidity has been maintained at less than 0.2 NTU 90% of the time, demonstrating stable performance. DOW™ Ultrafiltration modules are able to handle the variable swings in TSS and feed water conditions while removing turbidity to a very low level without the addition of pretreatment prior to the ultrafiltration system.

Figure 2. Product water turbidity versus time.



The DOW™ Ultrafiltration modules have been in operation since August 2005 without chemically enhanced backwash (CEB) and with only periodic clean in place (CIP) to restore and stabilize the transmembrane pressure (TMP). The TMP for UF skid #1 dropped down to less than 0.3 bar or approximately 5 psi (Figure 3) right after CIP cleaning. Water quality fluctuated at the beginning of the operation, thus affecting the operating pressure and TMP of the UF system and causing it to spike.

UF System Performance, cont.

Figure 3. UF operating pressure and TMP versus time.

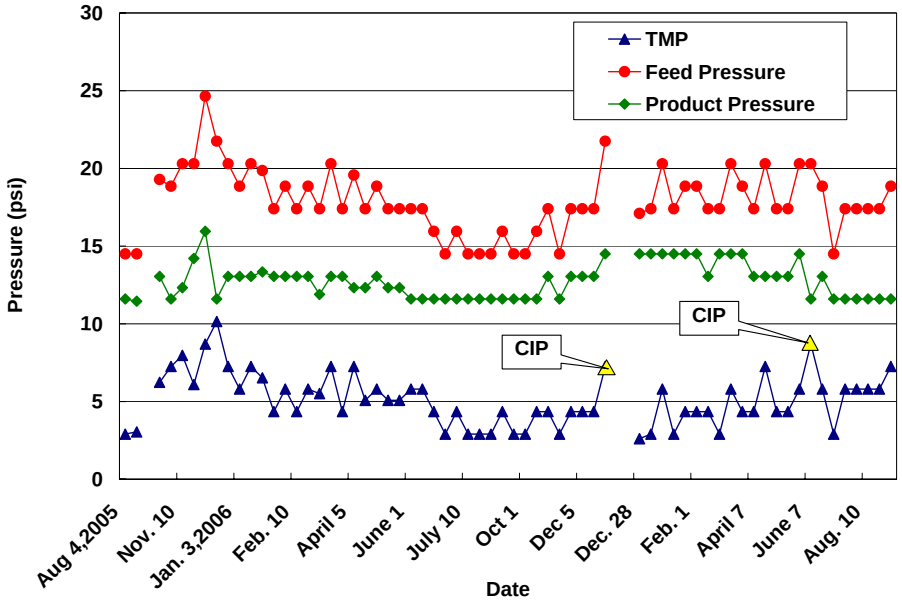
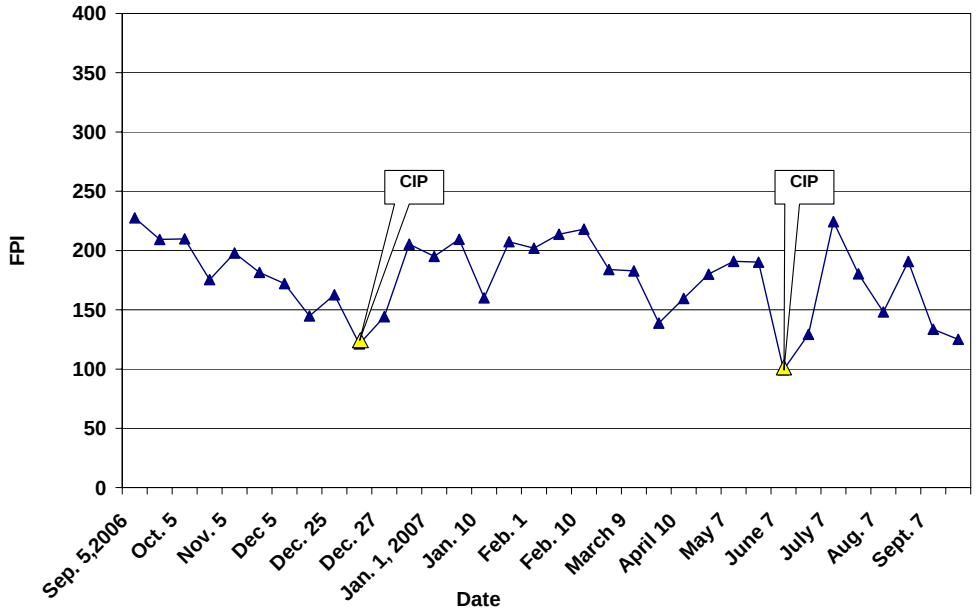


Figure 4 shows a plot of flow pressure index (FPI) vs time. A constant FPI value indicates good and stable UF operating performance. FPI is calculated as the skid's permeate flow (m^3/h) divided by TMP (bar). The FPI decreased over time, but increased after the CIP was performed in December 2006. Variable feed water quality caused the FPI to fluctuate, but the index remained relatively constant over the next six months even though the UF system was operated without CEB. The FPI was restored to its initial value after each CIP. This further shows the reliability and cleanability of DOW™ Ultrafiltration modules.

Figure 4. UF skid composite: flow pressure index versus time.



Summary

Jiufeng's water treatment process uses DOW™ Ultrafiltration as the sole pretreatment to the RO system. Raw water with high TSS and iron is directly fed into the UF unit and quality water is produced. The DOW™ Ultrafiltration modules overcome the feed water variability caused by seawater influx.

Reliable UF product water quality enhances and ensures the performance of the RO system, resulting in optimal flux and high recovery. The RO system has only required four chemical cleanings over a two-year period. With steady performance, the DOW™ Ultrafiltration modules demonstrate a reliable, economical, and efficient solution for RO pretreatment.

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

Form No. 795-00017-1008