



DOW™ Ultrafiltration

DOW™ Ultrafiltration Membranes Meet Challenge of High COD, Oil-Contaminated Waste Water

Site Information

Location:

Beijing, China

Capacity:

560 m³/h (2465 gpm)

Purpose:

Pretreat oil-refining waste water prior to RO system

Time in Operation:

Since November 2004

Performance:

Turbidity < 0.4 NTU;
SDI ≤ 2.5; COD < 25 mg/L



DOW™ Ultrafiltration modules in the YanShan facility are stacked via a mezzanine in an efficient, space-saving design. (Photo courtesy of Beijing YanShan Petrochemical Co. Ltd.)

Introduction

Beijing YanShan Petrochemical Co. Ltd. is located in the Fangshan district in southwest Beijing city. Its crude oil refining capacity of 9.5 million ton/yr and ethylene production capacity of 450,000 ton/yr are among the largest in China. In order to meet more stringent environmental protection requirements for the city of Beijing, YanShan Petrochemical installed DOW™ Ultrafiltration modules and FILMTEC™ reverse osmosis membranes to reclaim petrochemical waste water.

Waste water from the oil-refining process is first treated using a biological process and then filtered through DOW™ Ultrafiltration modules before being processed as deionized water for boiler make-up. The feed water is high in chemical oxygen demand (COD) and contains a trace amount of oil, which creates a challenge for membrane performance. Despite the oil contamination and high COD, DOW™ Ultrafiltration modules operate free of process problems and produce permeate water with low turbidity and reduced COD.

DOW™
Ultrafiltration
Modules

The SFP-2660 module is particularly ideal for systems with capacities of 50 m³/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 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 (RO)
- 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 helps eliminate the need for costly pressure vessels

Water Treatment
Process

Table 1 indicates the average raw water analysis, showing the high chemical oxygen demand (COD).

Table 1. Raw water analysis.

Parameter	Unit	Value
Total dissolved solids (TDS)	mg/L	≤1000
Total suspended solids (TSS)	mg/L	≤5
Chemical oxygen demand (COD _{Cr})	mg/L	≤40
Total SiO ₂	mg/L	≤10
Ca ²⁺	mg/L	240
Fe ²⁺	mg/L	0.2
Turbidity	NTU	≤5
Temperature	°C	10 to 35
Oil	mg/L	≤2
pH	—	6.5 to 8.5
NH ₃	mg/L	≤1

Figure 1 is a diagram of the water treatment process. Raw waste water is biologically treated, stored in a tank, disinfected with 2 ppm of sodium hypochlorite (NaOCl) to prevent membrane fouling, then fed into the DOW™ Ultrafiltration system. Sodium bisulfite (NaHSO₃) is dosed at 1–2 ppm to the RO feed water to remove any residual sodium hypochlorite remaining in the water. An antiscalant is dosed at 1–3 ppm to prevent scaling and membrane damage caused by calcium carbonate precipitation. The chemical dosage varies with feed water quality.

Water Treatment Process, cont.

Figure 1. Water treatment process.

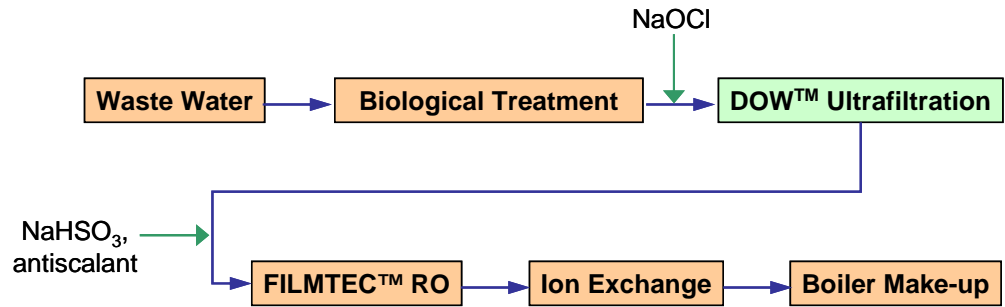


Table 2 provides the operating parameters for the ultrafiltration and reverse osmosis unit operations. Table 3 further describes the ultrafiltration process.

Table 2. Operating parameters for unit operations.

Parameter	Unit	UF	RO
Component	—	SFP 2660	FILMTEC™ BW 30-365FR
Capacity	m ³ /h	560	412
Number of skids	—	10 (8R:2S)	4
Number of modules per skid	—	60	—
Total number of modules	—	600	—
Capacity per skid	m ³ /h	70	103
Recovery	%	>95	—
Design flux	L/m ² h	37.2	—

Table 3. Ultrafiltration operating process.

Parameter	Frequency	Duration	Chemical Consumption
Filtration	—	55 min	—
Air scour	After every filtration	30 s	1152 Nm ³ /day (air)
Backwash	After every filtration	50 s	10–15 ppm NaOCl
Forward flush	After every backwash	70 s	—
CEB ^a	None	None	—
CIP ^b	3–6 months	8 h	<i>Alkaline:</i> 0.1% NaOH, 0.2% NaOCl <i>Acid:</i> 0.2% oxalic acid

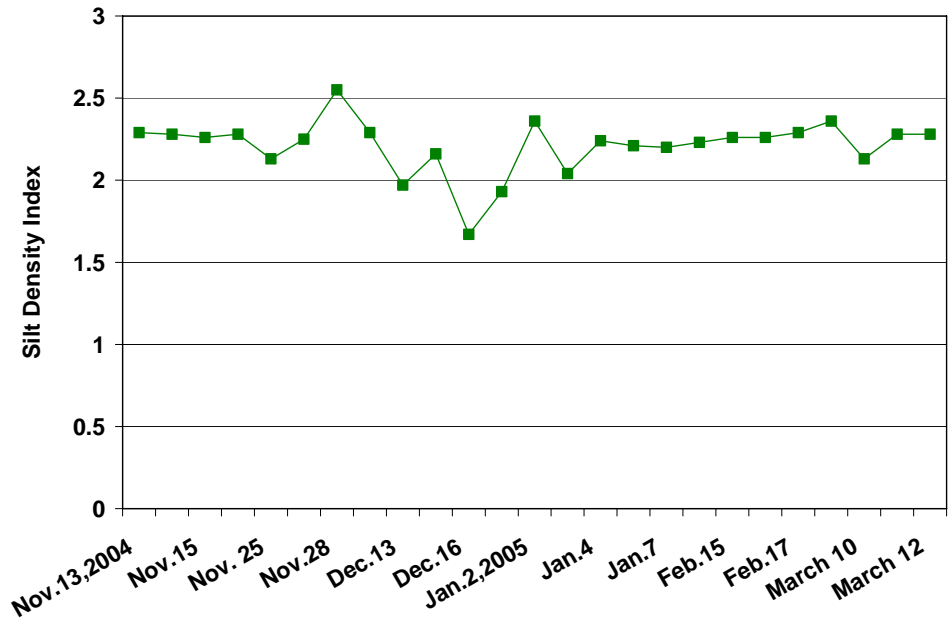
^aChemically Enhanced Backwash

^bClean-in-Place

UF System Performance

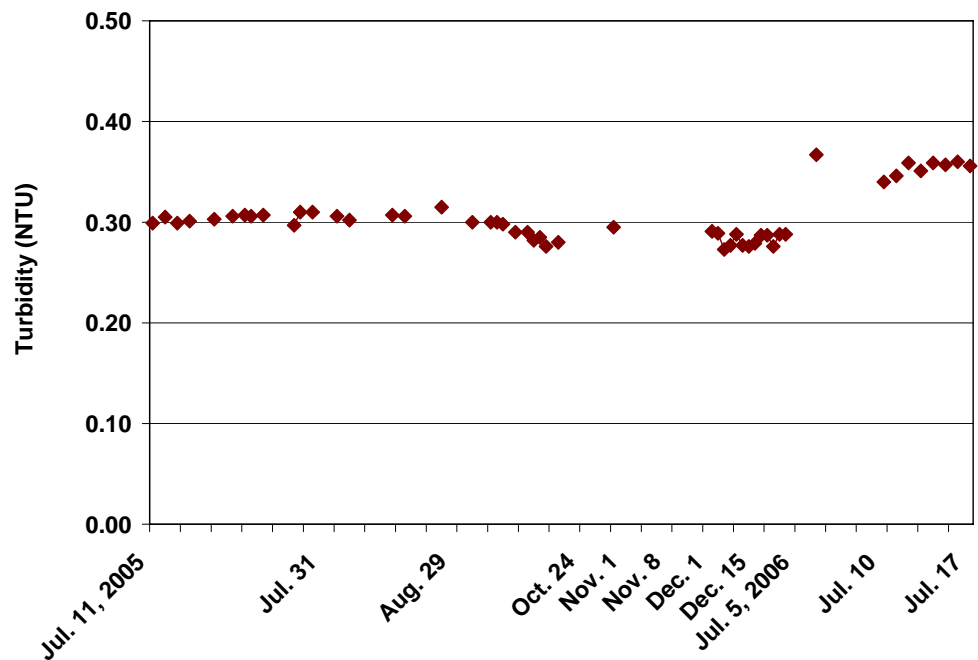
Figure 2 shows permeate SDI₁₅ values at less than 2.5 for 95% of the time. This indicates that the ultrafiltration membrane is able to produce water that meets the RO feed water quality requirement.

Figure 2. Permeate silt density index versus time.



The ultrafiltration permeate water averages less than 25 mg/L COD with less than 0.4 NTU turbidity (Figure 3). Due to the complexity of the raw water, the UF pretreatment was designed to lower the water turbidity from 5 NTU to 1 NTU for the downstream process. DOW™ Ultrafiltration is able to meet the requirement and produce better-than-designed water quality with turbidity less than 0.4 NTU. In less challenging applications the permeate turbidity levels would be expected to be less than 0.1 NTU.

Figure 3. Turbidity versus time.



Summary

Despite the high COD content in the raw water feed, DOW™ Ultrafiltration modules produce permeate water with low turbidity and reduced COD content while operating at a high recovery. The ultrafiltration modules produce water with SDI less than 2.5 and turbidity less than 0.4 NTU for the majority of the time, enabling trouble-free RO system operation.

Chemical cleaning of the ultrafiltration modules is required every 4 months. DOW™ Ultrafiltration modules are able to withstand the challenge of petrochemical waste water treatment, providing an excellent pretreatment solution for this demanding raw 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>

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