DOWEX™ UPCORE™ Mono Ion Exchange Resins

LED Manufacturer Combines UPCORE™ Packed Bed and FILMTEC™ RO Systems for Reliable Ultrapure Water Production

Site Information

Location:
Taiwan
Purpose:
Install new demineralizers for plant expansion
Time in Operation:
2 years
Performance:
System has exceeded water quality requirements

The new demineralizers at the OPTO Tech Corporation use the DOWEX™ UPCORE™ system and FILMTEC™ membranes to provide deionized and ultrapure water for plant processes. (Photo courtesy of OPTO Tech Corporation)

Introduction

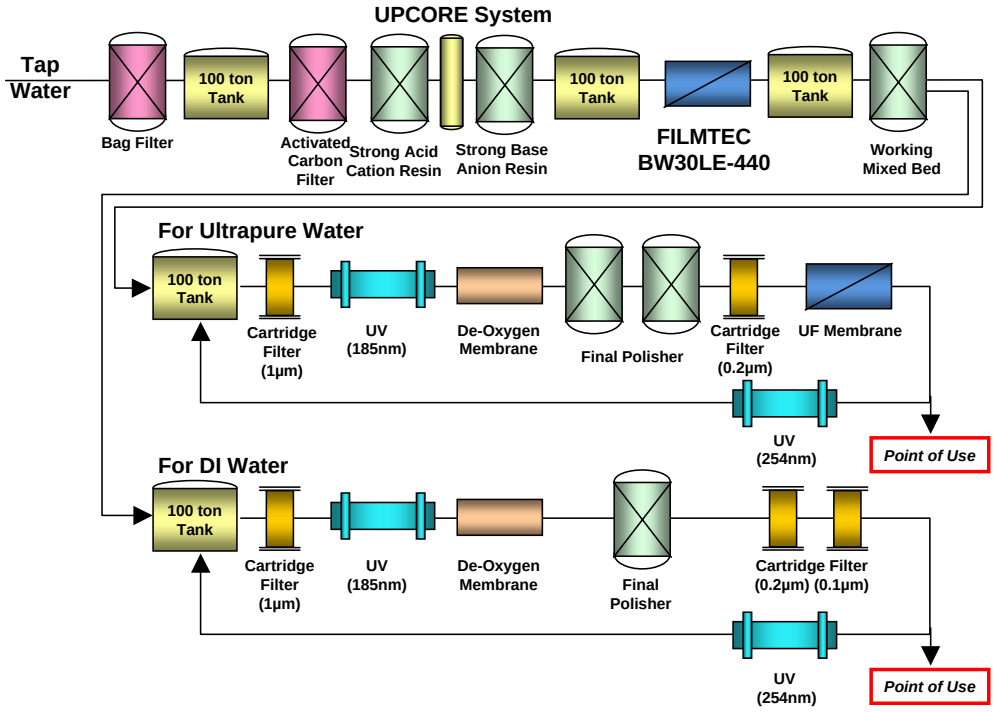
The Hsinchu Science-Based Industrial Park in Taiwan is a world-famous as a center for semiconductor research, development and manufacturing. The OPTO Tech Corporation is located in the park and is one of the largest LED (light-emitting diode) manufacturers in Taiwan. When OPTO decided to expand their plant, they planned to install new demineralizers for DI (deionized) water and ultrapure water production.

Many experts recommend double-pass RO (reverse osmosis) or EDI (electrodeionization) systems for ultrapure water production because of the small amount of chemicals required and waste produced during normal operation. These systems, however, can be sensitive to fluctuations in the inlet water composition. Such fluctuations can cause unexpected scaling of chemical compounds inside the equipment which affects performance and increases the need for frequent cleaning. Fluctuations in the inlet water composition can also cause variable permeate quality which increases ionic loading to the working mixed bed that follows the RO or EDI system. Installing ion exchange resin technology with counter-current regeneration in packed beds prior to the RO system allows for a relatively wide fluctuation in the inlet water composition and has several technical advantages for high-volume ultrapure water production.

In particular, water treated by a 2B3T (two bed, three tower) system of ion exchange resins has a low TDS (total dissolved solids) concentration. Thus, the role of the subsequent RO system is to remove residual TOC (total organic carbon) and further reduce the TDS level. Because almost all scale components are already removed from the feed, scaling risks are minimized and the RO system can run at a higher flux.

The Chang Hua Water Refiner Co., Ltd., an equipment manufacturer for industrial and ultrapure water applications and a licensee of the DOWEX™ UPCORE™ system in Taiwan, installed an UPCORE system with FILMTEC™ BW30LE-440 low-energy RO elements at the OPTO Tech Corporation in May 2001. Figure 1 is a flow diagram of the system.

Figure 1. Flow diagram of the demineralization system



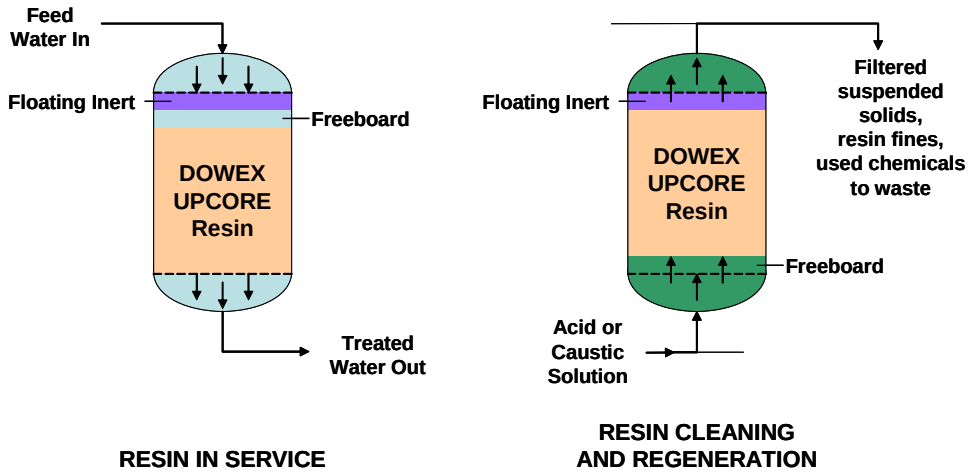
UPCORE™ System

The UPCORE™ system is based on the following principles:

- Counter-current ion exchange technology
- Packed bed design
- Upflow regeneration/downflow service
- Uniform particle size (UPS) resin technology

In the service cycle, a wide operational flow is possible. In this cycle, the feed water enters the vessel from the top (Figure 2). Before regeneration, compaction water flows at high velocity from the bottom to the top and compacts the resin bed against the inert resin and upper nozzle plate. Without flow interruption, the regenerant and, subsequently, the rinse water pass through the resin bed in an upflow direction. There is no need for a separate backwash tank because the suspended solids are automatically removed from the surface of the resin bed during the compaction step of each regeneration cycle.

Figure 2. The UPCORE™ system



The advantages to the UPCORE™ system include

- Excellent water quality
- High chemical efficiency
- Short regeneration time
- Simple construction and control
- Self cleaning
- Insensitivity to production flow variations and stops
- No risk of carry-over of resin fines
- Layered bed design without the need for a middle plate

The UPCORE system uses DOWEX™ UPCORE Mono ion exchange resins which provide high operating capacity and chemical efficiency, reduced waste production, and outstanding mechanical integrity. These resins have high resistance to attrition, preventing the generation of fines as the resins age in service.

No major modifications on the main equipment (vessels, main piping, etc.) were needed. This technology is well-suited for revamping older installations at a low capital investment.

FILMTEC™ RO Elements

The FILMTEC™ BW30LE-440 low energy RO element is 8inches in diameter. It enables lower pressure operation than the FILMTEC BW30-400 industrial-grade element by optimizing membrane chemistry. Increased surface area and element efficiency enable either higher productivity or lower flux operation, resulting in prolonged service life with low fouling. The FILMTEC SG30LE-430 low-energy semiconductor-grade RO element is also available for more stringent TOC removal requirements.

The increased surface area and element efficiency of FILMTEC™ BW30LE-440 elements increases flow rate, reduces fouling and prolongs service life. (Photo courtesy of OPTO Tech Corporation)

Plant Design

The raw water is obtained from tap water supplied by Hsinchu City and treated by a bag filter and activated carbon in the pretreatment system. Table 1 lists the feed water composition. Tables 2 and 3 give plant design data. In addition to the DOWEX™ UPCORE™ resins and FILMTEC™ RO elements, DOWEX resins were used for the working mixed bed and final polishers. In particular, DOWEX MONOSPHERE™ MR-3 UPW mixed resin is designed for polishing system in ultrapure water production.

Table 1. Feed water composition

Cations	Design	Anions	Design
Ca	37.5	Cl	8.5
Mg	8.0	NO_3	0.5
Na	95.1	SO_4	71.2
K	0.2	HCO_3	60.7
—	—	Silica	5.4
Total	140.8	Total	146.3

Unit: mg/L (ppm) as $CaCO_3$

Table 2. Plant design data: UPCORE system

Net throughput	120 m^3/h x 2 trains
Cation Resin	
Strong acid cation resin + Floating inert resin	DOWEX UPCORE Mono C-600 (H) 5,100 L + DOWEX UPCORE IF-62 500 L
Anion Resin	
Strong base anion resin + Floating inert resin	DOWEX UPCORE Mono A-500 6,925 L + DOWEX UPCORE IF-62 725 L

Table 3. Plant design data: RO system, mixed beds, and polishers

RO System	
Net throughput	35 m^3/h x 3 trains
RO element	FILMTEC™ BW30LE-440 5 elements x 6 vessels
Working Mixed Beds	
Net throughput	95 m^3/h x 2 trains
Strong acid cation resin + Strong base anion resin	DOWEX™ MARATHON™ C 1,600 L + DOWEX MARATHON A 2,400 L
Final Polishers (UPW)	
Net throughput	60 m^3/h x 1 train
Pre-mixed resin	DOWEX MONOSPHERE™ MR-3 UPW 1,950 L x 2 vessels
Final Polishers (DI)	
Net throughput	50 m^3/h x 1 train
Pre-mixed resin	DOWEX MONOSPHERE MR-3 UPW 1,500 L

Operational Performance

Table 4 shows the critical water quality requirements and actual operational performance at point-of-use. Although the requirements are stringent, the system using the UPCORE™ system, FILMTEC™ BW30LE-440 elements, and DOWEX™ MONOSPHERE™ UPW resins is working well and has attained better water quality than the original design required. This excellent operational performance has been maintained over the past 2 years.

Table 4. Operational performance

Water Quality	Requirements	Actual Data
Resistivity [MΩ·cm (25°C)]	> 18	18.0 ~ 18.2
Silica [ppb]	≤ 5	1.2 ~ 1.5
TOC [ppb]	≤ 5	0.3 ~ 0.7
Particle (≥ 0.1 μm) [pieces/ml]	≤ 10	0.05 ~ 0.07

Conclusions

An ultrapure water production demineralization system using UPCORE technology and low-energy RO elements was installed at the OPTO Tech Corporation by the Chang Hua Water Refiner Co. Ltd. in Taiwan. The system works well and has attained higher water quality than specified, demonstrating the excellent reliability of the UPCORE packed bed and FILMTEC RO systems.

DOWEX Ion Exchange Resins
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