DOWEX™ UPCORE™ Ion Exchange Resins
UPCORE System Reduces Demineralizer Costs by 50%

Site Information
Location
Japan
Purpose
- Improve regeneration efficiency
- Reduce costs

Comparative Performance
- 50% reduction of regenerant chemicals, regeneration time and waste water

An increase in capacity at the Tomatoh-Atsuma power station called for a new demineralizer using the DOWEX™ UPCORE™ system to increase regeneration efficiency. (Photo courtesy of Hokkaido Electric Power Co., Inc.)

The EBARA Corporation, a large equipment manufacturer in water and environmental applications and a licensee of the DOWEX UPCORE system in Japan, installed an UPCORE system at the Tomatoh-Atsuma Power Station in July 2001. The new demineralizer produces make-up water for utility boilers with the same quality as their existing demineralizers while reducing regeneration chemicals, time, and waste.

Introduction
The Tomatoh-Atsuma power station (Hokkaido Electric Power Co., Inc.) is a large, coal-fired power plant that began operation in 1985. The station increased their capacity to 1,735 MW with the construction of Unit 4 (700 MW), which is presently being commissioned. Part of this expansion was the installation of a new demineralizer using the DOWEX™ UPCORE™ system to increase regeneration efficiency.

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Background

There were two existing demineralizers for the make-up water with a capacity per train of 600 m^3/cycle (158,500 gal/cycle). With the expansion, a new demineralizer with the same capacity was installed. The existing demineralizers use a four bed-five tower (4B5T) system with co-current regeneration. The 4B5T system is often used for make-up water production at utility boiler plants in Japan as well as the two bed-three tower (2B3T) system followed by a polishing mixed bed.

Thoroughfare regeneration from the rear polisher into the front bed in the 4B5T is usually conducted with cation and anion resins, respectively. The UPCORE™ system is often used in the 2B3T or the front beds in 4B5T. In this case, the UPCORE system was adopted not only for the front beds but also for the rear polishers with thoroughfare regeneration to increase regeneration efficiency. This was the first time that EBARA Corporation installed the advanced UPCORE system.

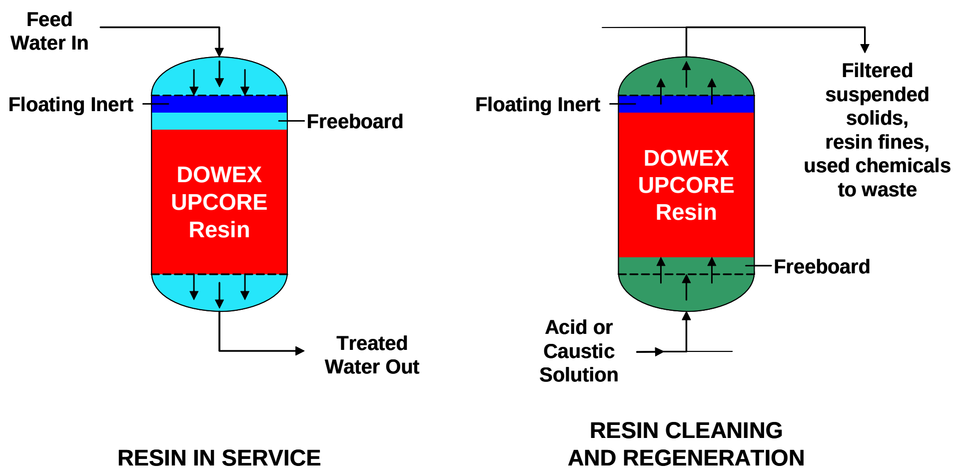
UPCORE™ Technology

UPCORE™ technology is based on these 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 flexibility is possible. Feed water enters the vessel from the top (Figure 1). 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 passes 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 each regeneration cycle.

Figure 1. The UPCORE system



The advantages of the UPCORE™ system are

- High chemical efficiency
- Excellent water quality
- 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

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.

Plant Design

The raw water is obtained from a local river (Abira River) and treated by coagulation and filtration in the pretreatment system. Table 1 lists the feed water composition for the demineralizers. The ratio of silica to total anions in the water is very high, as much as 34.7%.

Table 1. Feed water composition

Cations	Design	Ave.	Anions	Design	Ave.
Ca	58	34.9	Cl	38	20.3
Mg	—	16.1	NO_3	—	10.1
Na	42	21.8	SO_4	38	22.5
K	—	4.3	HCO_3	24	24.5
—	—	—	Silica	37	31.9
Total Cations	100	77.1	Total Anions	120	91.8

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

Figures 2 and 3 describe system configurations of both existing and new demineralizers; Table 2 gives plant design data. Installed resin volume for each vessel is almost the same, and thoroughfare regeneration is conducted in both systems. However, the flow direction of regenerant chemicals is different.

Figure 2. Configuration of the existing 4B5T system

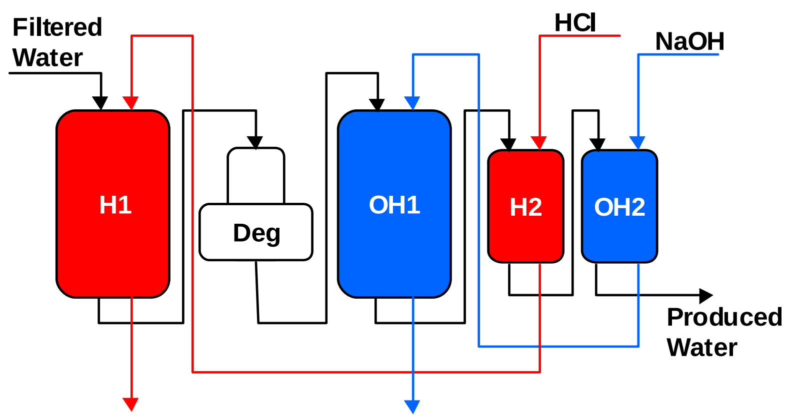


Figure 3. Configuration of the UPCORE™ 4B5T system

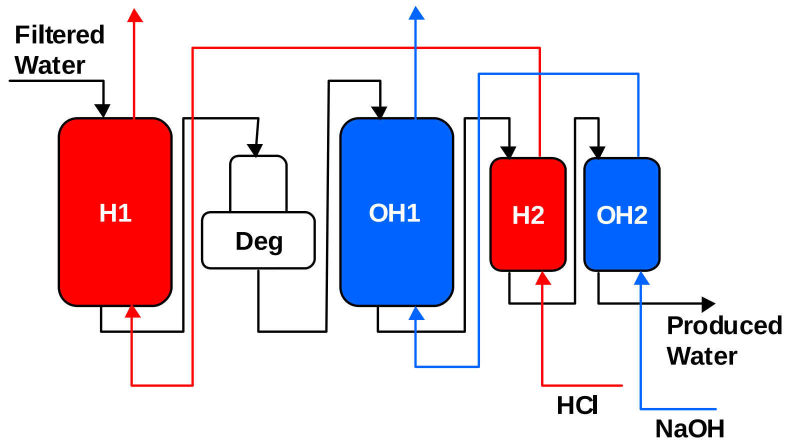


Table 2. Plant design data

	Existing 4B5T	UPCORE 4B5T
Net throughput	30 $m^3/h \times 20$ h = 600 m^3	30 $m^3/h \times 20$ h = 600 m^3
Vessel H1		
Strong acid cation resin	DOWEX™ HCR-W2 (H)	DOWEX UPCORE™ MONO C-600 (H)
	1,200 L	1,470 L
Vessel OH1		
Weak base anion resin	No	DOWEX UPCORE MONO WB-500
		1,150 L
+	+	+
Strong base anion resin	DOWEX MSA-2	DOWEX UPCORE MONO A-625
	2,700 L	1,400 L
Vessel H2		
Strong acid cation resin	DOWEX MONOSPHERE™ 650C (H)	DOWEX MONOSPHERE 650C (H)
	300 L	400 L
Vessel OH2		
Strong base anion resin	DOWEX MONOSPHERE 550A (OH)	DOWEX MONOSPHERE 550A (OH)
	400 L	400 L
Floating inert resin	No	DOWEX UPCORE IF-62

1 m^3 = 264 gal

1 L = 0.264 gal

Type 2 strong anion resin is preferred for Vessel OH1 in the 4B5T system from the viewpoint of regeneration efficiency. The existing system was designed with type 2 gel anion resin at the beginning. However, it was changed into type 2 macroporous resin (DOWEX™ MSA-2) after severe organic fouling occurred. To attain high regeneration efficiency and organic fouling resistance at the same time, a layered anion bed (combination of weak and type 1 strong base anion resins) has been installed in Vessel OH1.

Water containing such a high level of silica will cause silica fouling, depending on regeneration conditions. Currently, the UPCORE system is operated with 58% regeneration efficiency with a constant 600 m^3/cycle to prevent silica fouling, while the designed capability is 77%. The regeneration temperature is 45°C.

Operational Performance

Table 3 shows the consumption of regenerant chemicals. Although the resin volume installed in the existing systems and the UPCORE™ system is almost same, the consumption in the UPCORE system decreased by 53% for hydrochloric acid and 43% for caustic soda compared with the existing systems. In addition, the process was simplified because the UPCORE system reduced regeneration time by 56% and wastewater by 49%.

Table 4 shows the water quality. Although consumption of regenerant chemicals significantly decreased, as mentioned above, conductivity and silica remained as good as those in the existing systems.

Conclusions

A new 4B5T system using UPCORE™ technology was installed at the Tomatoh-Atsuma Power Station by EBARA Corporation. The UPCORE system performs as well as the existing systems and with a 50% reduction of regenerant chemicals, regeneration time, and waste water. In addition, the layered anion bed is working well, with high regeneration efficiency and organic fouling resistance. The UPCORE system reduced operating costs for demineralization by about 50%.

Table 3. Consumption of regenerant chemicals

Parameter	Existing 4B5T	UPCORE 4B5T	UPCORE vs. existing
Consumption of HCl	151 kg	80 kg	53%
Regeneration efficiency of cation resins	29%	55%	—
Ratio of regeneration to stoichiometry	345%	182%	—
Consumption of NaOH	176 kg	76 kg	43%
Regeneration efficiency of cation resins	33%	77%	—
Ratio of regeneration to stoichiometry	303%	130%	—
Regeneration time	197 min	110 min	56%
Wastewater	49 m^3	24 m^3	49%

1 kg = 2.2 lb

Table 4. Operational performance in conductivity and silica

	Conductivity [mS/m] ([μS/cm])		Silica [μg/L]	
System	Ex OH1	Ex OH2	Ex OH1	Ex OH2
Existing 4B5T	0.2 ~ 0.3 (2 ~ 3)	0.007 ~ 0.011 (0.07 ~ 0.11)	5 ~ 10	~ 2
UPCORE 4B5T	0.2 ~ 0.3 (2 ~ 3)	0.007 ~ 0.008 (0.07 ~ 0.08)	5 ~ 10	~ 2

DOWEX™ Ion Exchange Resins
For more information about DOWEX resins, call the Dow Liquid Separations business:
North America: 1-800-447-4369
Latin America: (+55) 11-5188-9222
Europe: (+32) 3-450-2240
Pacific: +60 3 7958 3392
Japan: +813 5460 2100
China: +86 21 2301 9000
http://www.dowex.com

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