# DOWEX™ UPCORE™ Mono Ion Exchange Resins

## Water-Treatment Costs Decrease and Reliability Increases with UPCORE System

### Site Information

*Location:*
Hungary

*Size:*
4 Lines at 150 $m^3/h$ each

*Purpose:*
Overall reduction in costs with improved reliability and flow

*Comparative Performance:*

- 50% reduction in chemical and waste costs
- 50% reduction in service water
- 40% increase in flow
- Reliable operation over 8 years


*The new UPCORE™ water-treatment system at the AES Tiszapalkonyai Hőerőmű power plant has been operating reliably since 1995. The system uses DOWEX™ UPCORE Mono ion exchange resins. (Photo courtesy of AES Tiszapalkonyai Hőerőmű)*

### Introduction

AES Tiszapalkonyai Hőerőmű operates a power station in Tiszapalkonya, Hungary, that supplies 270 to 310 thousand megawatt-hours of power per year. Built in 1975, the demineralization plant treats Tisza River water or well water for use as boiler feed water. The well water has high levels of silica.

In 1995, the power station initiated a major upgrade of the water-treatment system. The primary goals were

- Reduce chemical costs
- Reduce service water
- Increase line capacity
- Increase reliability of water production
- Reduce waste load to the environment

The plant chose to install an UPCORE™ system using DOWEX™ UPCORE Mono ion exchange resins because of the system's established reputation for cost-efficient operation and ability to safely handle increased levels of solids during pretreatment upsets.

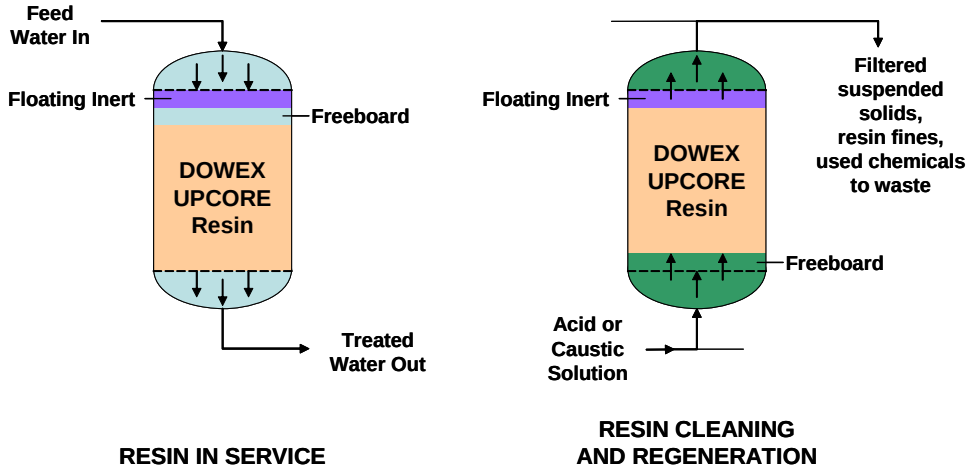
## UPCORE™ System

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 flexibility is possible. In this cycle, the 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 the compaction step of each regeneration cycle.

Figure 1. 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 generation of fines as the resins age in service.

## Water Treatment Operation

The feed water is pretreated with lime decarbonization. Table 1 gives the typical concentration of impurities in the feed water.

### Table 1. Typical feed water analysis

| Component | Tisza River | Well |
|---|---|---|
| Cations, meq/L (ppm $CaCO_3$) | | |
| Calcium | 1.2 (62) | 0.5 (25) |
| Magnesium | 0.4 (18) | 0.4 (21) |
| Sodium | 0.9 (45) | 0.5 (27) |
| *Total* | 2.5 (125) | 1.5 (73) |
| Anions, meq/L (ppm $CaCO_3$) | | |
| Sulfates | 0.9 (45) | 0.5 (26) |
| Chlorides | 0.9 (45) | 0.2 (9) |
| Nitrates | — | — |
| p value | 0.4 (20) | 0.4 (20) |
| m value | 0.7 (35) | 0.8 (38) |
| *Total* | 2.5 (125) | 1.5 (73) |
| Other, mg/L or ppm | | |
| Silica (as $SiO_2$) | 3.5 | 8.4 |
| Organic matter (as $KMnO_4$) | 6.0 | 2.0 |

## Plant Design

The original water-treatment system used co-current regeneration and had four lines, each with a capacity of 115 $m^3/h$ (506 gpm). The UPCORE™ system also has four lines, but with a capacity of 150 $m^3/h$ (660 gpm) each. The system cycles every 80 hours. Table 2 gives the mechanical details. Table 3 gives the process details.

### Table 2. Mechanical details of the UPCORE™ system

| Parameter | Cation | Weak Base Anion | Strong Base Anion |
|---|---|---|---|
| Vessel diameter, m (ft) | 2.5 (8.2) | 2.5 (8.2) | 2.0 (6.6) |
| Cylindrical height, m (ft) | 3.7 (12.1) | 4.2 (13.8) | 4.2 (13.8) |
| Distribution system | | | |
| Top | Collector | — | Collector |
| Bottom | Nozzle plate | Nozzle plate | Nozzle plate |

### Table 3. Process details of the UPCORE system

| Parameter | Cation | Weak Base Anion | Strong Base Anion |
|---|---|---|---|
| DOWEX™ UPCORE resin | Mono C-600 | MWA-1 | Mono A-625 |
| Volume, $m^3$ ($ft^3$) | 16 (565) | 10.4 (367) | 9.6 (339) |
| Operating capacity, eq/L (kgr/$ft^3$ as $CaCO_3$) | 1.15 (25.1) | 0.7 (15.3) | |
| Regenerant | HCl | NaOH | |
| Regeneration efficiency (% stoichiometry) | 120 | 120 | |

## Water Treatment Performance

Since installation was completed in 1995, production efficiency and water quality have exceeded expectations. Table 4 shows that production and regenerant efficiency increased by over 50%, along with significant drops in service water, conductivity, and silica.

### Table 4. Summary of process and water quality improvements

| Parameter | Original System | Expectations for UPCORE™ | Results from UPCORE |
|---|---|---|---|
| Flow, $m^3/h$ (gpm) | 115 (506) | 150 (660) | 160 (704) |
| Production, $m^3$/cycle (millions gal/cycle) | 8000 (2.1) | 12000 (3.2) | 13000 (3.4) |
| Acid efficiency (% stoichiometry) | 300 | 130 | <120 |
| Caustic efficiency (% stoichiometry) | 300 | 150 | <120 |
| Service water (% of production) | | | |
| Well | 4.7 | — | 2.1 |
| Tisza | 7.6 | — | 3.4 |
| Conductivity, µS/cm | 0.4 | 2 | 0.1–0.2 |
| Silica as $SiO_2$, µg/L or ppb | 60 | 40 | 13 |

Figure 2 shows the resultant cost decreases for acid and caustic. In addition, waste water costs dropped by 50% and flow per line increased by 40%.

### Figure 2. Effect of water-treatment system upgrade on acid and caustic costs.

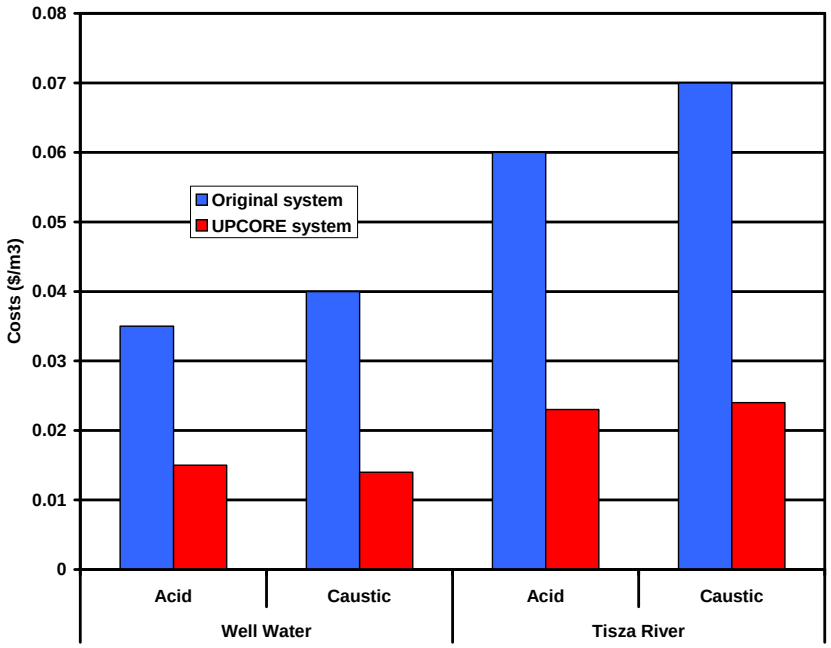


Table 5 shows the effect of the upgrade on the amount of regeneration eluate.

Table 5. Effect of water-treatment system upgrade on regeneration eluate

| Source | Original System $m^3$/yr (millions gal/yr) | UPCORE™ $m^3$/yr (millions gal/yr) |
|---|---|---|
| Well water | 84,000 (22) | 38,000 (10) |
| Tisza River | 137,000 (36) | 62,000 (16) |

## Conclusions

The new UPCORE™ water-treatment system at the AES Tiszapalkonyai Hőerőmű power plant has been operating reliably since 1995. In the first year after rebuilding, it produced the lowest-cost demineralized water in Hungary. Compared to the original system, costs for chemicals and waste water were reduced by 50%, so that the investment in rebuilding could be returned in only two years. Flow per line increased by 40%.

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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