Flow

A publication about cost-effective demineralization with the DOWEX™ UPCORE™ packed bed system from Dow Water Solutions

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And... Case histories from around the world
Whether you need to install a demineralizer system for a new or existing plant, there is a way to reduce your costs by as much as 50 percent and also improve water quality at the same time. The DOWEX™ UPCORE™ system combines upflow, counter-current regeneration technology with uniform particle size resins to achieve higher water quality, more efficient regeneration and greater operating capacity.

Because the DOWEX UPCORE system is an upflow regeneration system with downflow service, the packed resin bed is less vulnerable to fluctuations in water flow during the system cycle. The system’s downflow service also assures that ionic layering in the resin bed remains undisturbed so exhausted resin from the upper portion of the bed does not become mixed into the highly regenerated zone at the bottom. This produces higher water quality and uncompromised bed operating capacity, which ultimately adds up to savings.

With the DOWEX UPCORE system, you can gain a number of benefits over traditional cocurrent and counter current regeneration systems:

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

What’s more, the DOWEX UPCORE system is backed by the global expertise and resources of Dow Water Solutions. Read on for additional information and case histories about the DOWEX UPCORE system, which is currently at work in more than 400 locations on six continents around the world.
How Uniform Particle Size Improves Performance

Dowex™ upcore™ ion exchange resins are available with uniform particle size (ups), which contributes significantly to system performance and economics. While conventional or Guassian distribution resin beads range in size from 300 to 1200 microns, UPS resins have a much narrower particle size distribution, with 95 percent of the beads within 100 microns of the average particle diameter (see Figure 1).

For many years, UPS resins could only be produced by screening conventional resins – a cost-prohibitive process. In the 1980s, Dow researchers developed and patented a technology to produce UPS ion exchange resins without a mechanical screening process. As the world’s first supplier to master UPS technology, Dow continues to lead the industry in providing high-performance UPS ion exchange resins.

In the Dowex upcore packed bed system, UPS resins are sized specifically for demineralizer applications, offering excellent physical stability and minimizing any generation of fines. This means faster kinetics, greater operating capacity and longer service runs. Narrow particle size distribution also makes it possible to optimize size and density relationships to achieve desired separation in layered beds. Regeneration is faster and more efficient with UPS resins, reducing chemical and rinse requirements.

Benefits of Dowex™ upcore™

Uniform Particle Size Resins

- Faster kinetics
- Greater efficiency
- Higher operating capacity
- Less service water
- Faster rinse down
- Better separation
- Longer resin life
- Less resin loss
- Lower consumption of regenerants
- Lower service water consumption
- Further reduced regeneration time
- Longer production cycle
- Less ionic leakage
- Less silica and organic fouling
- Less regeneration effluent waste

Case History

Power Station Improves Process Water Quality and Reduces Costs

Location: Bulgaria  
Plant: Deven JSCo Power Station

Description: Located in Bulgaria, the Deven JSCo thermal power station was built in 1965. The station produces 0.4 million megawatt-hours of power per year and 3.5 million tons of steam per year. The station’s demineralization plant treats water from the Kamchia River for use as boiler feedwater. When station managers decided to modernize the water treatment plant, they were looking for ways to reduce chemical costs, service water and waste while increasing the system’s reliability. To achieve these goals, power station officials chose the Dowex™ upcore™ packed bed system and retrofitted their existing cocurrent system. After the installation, the plant achieved a 40 percent reduction in final water costs and a 70 percent reduction in waste water.
About Dow Water Solutions

The DOWEX™ UPCORE™ packed bed system is part of the broad portfolio of products and services offered by Dow Water Solutions, a world leader in water purification solutions.

With sales personnel, technical service representatives and research centers on five continents, Dow Water Solutions is equipped to serve you globally.

Global Presence

More than 25 Years of Reliable, Global Performance

The first DOWEX™ UPCORE™ system was installed at a metal processing and mining facility in the Netherlands in 1978. Since then, more than 400 systems have been installed in more than 40 countries across six continents throughout the world. These installations have included both retrofitted and new systems with many different layouts to serve a wide variety of industries. But all of these installations have one thing in common – the reliability that comes with Dow’s global presence and expertise.

Industries

The DOWEX UPCORE System is being used effectively in plants that serve the following industries:

- Automotive
- Beverage
- Chemical
- Electronics
- Fertilizer
- Light Industry
- Metal Processing and Mining
- Municipal
- Petrochemical
- Pharmaceutical
- Power Generation
- Pulp and Paper
- Sugar and Food Processing
- Textile
- Waste Treatment

Installations

The DOWEX UPCORE System is currently at work in these countries and regions:

- Argentina
- Australia
- Austria
- Belgium
- Belarus
- Brazil
- Bulgaria
- Chile
- Croatia
- Czech Republic
- Denmark
- Egypt
- Estonia
- Finland
- France
- Germany
- Hungary
- Indonesia
- Italy
- Japan
- Kuwait
- Malaysia
- Mexico
- Middle East
- Morocco
- Netherlands
- Norway
- Pakistan
- Poland
- Romania
- Russia
- Singapore
- Slovakia
- Slovenia
- South Africa
- Spain
- Sweden
- Switzerland
- Taiwan
- Thailand
- Ukraine
- United Kingdom
- United States

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Case History

Retrofit Project Cuts Chemical Costs by 50%

Location: Indiana, USA

Plant: Wabash River Coal Gasification Repowering Project

Description: After five years of problems with their make-up water demineralizer system, the CINergy Wabash River coal gasification plant installed a retrofit DOWEX™ UPCORE™ packed bed system. The result was a 50 percent reduction in regeneration chemical costs, as well as a 17 percent capacity increase of high-quality water, a 61 percent decrease in regeneration time, and overall reduced dependence on mobile water demineralization trailers.
System Guidelines

How to Convert to a DOWEX™ UPCORE™ System

If You Have a Cocurrent System
Cocurrent equipment can be converted to the DOWEX™ UPCORE™ packed bed system with minimal capital investment. The case histories in this publication are just a few examples of hundreds of successful conversions to the DOWEX UPCORE packed bed system. You may also be able to:

- Reduce regenerant chemical costs up to 50 percent.
- Nearly double total installed capacity.
- Reduce system downtime by almost 50 percent.
- Improve water quality (<2μS/cm conductivity).
- Reduce waste effluent volume up to 50 percent.
- Reduce regeneration time and expense.
- Reduce service water consumption up to 50 percent.

If You Have a Countercurrent System
If you are considering countercurrent regeneration technology for a new demineralizer system, you can gain these benefits:

- All the efficiency, economy and water quality advantages of countercurrent technology, without the problems associated with older countercurrent technologies.
- Reduced vulnerability to feed flow fluctuations
- Virtually no chance that exhausted resin will contaminate the highly regenerated zone closest to the service flow outlet.
- Lower capital costs compared to upflow service systems, because there is no need for holding tanks and transfer piping for backwashing operations.
- Fewer system problems due to resin fines and other particulates because resin beds are self-cleaning and particulates accumulate at the opposite end of the bed from the service flow outlet.
- Greater vessel utilization for maximum ion exchange capacity, because freeboard requirements are far lower than with air and water holddown systems.
- The option of using layered beds to improve demineralizer efficiency, extend resin life and achieve the highest water quality.

Case History
Reducing Demineralizer Costs by 50%

Location: Japan

Plant: Tomatoh-Atsuma Power Station, Hokkaido Electric Power Co., Inc.

Description: An increase in capacity at the Tomatoh-Atsuma power station called for a new demineralizer using the DOWEX™ UPCORE™ packed bed system to increase regeneration efficiency. The new system was installed in 2001, producing make-up water for utility boilers with the same quality as the existing demineralizers, while reducing regeneration chemicals, time and waste.
Case History

DOWEX™ UPCORE™ Boosts Production Efficiency of Refinery Process Water

**Location:** Poland

**Plant:** Polski Koncern Naftowy

**Description:** When the Polski Koncern Naftowy upgraded their equipment and installed a new boiler, their system required higher quality process water. To meet these requirements, the company was looking for a water treatment system that would be reliable, simple to operate and easy to automate with minimal downtime for maintenance. For all these reasons, the company chose the DOWEX™ UPCORE™ packed bed system for seven treatment lines of boiler feed water. Among numerous improvements, the upgraded system resulted in a 60 percent reduction in chemical consumption, a 25 percent reduction in service water and an 80 percent reduction in waste water.

Want to Know More?

If you want to find out more about how the DOWEX™ UPCORE™ packed bed system can improve your operation’s efficiency while improving water quality and reducing costs, visit www.dowwatersolutions.com.

Or, call one of our global locations and talk with a Dow Water Solutions representative who can arrange a complete analysis of your system. With our special CADIX assisted design for ion exchange computer program, we will simulate just how much you can potentially save by upgrading your present system to the DOWEX UPCORE downflow countercurrent packed bed system.

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Technical Information

Guidelines on Vessel Design and Layered Bed Configurations

Vessels designed for the DOWEX™ UPCORE™ packed bed system are straightforward and inexpensive. Freeboard is almost eliminated, so that when existing cocurrent resin beds are converted to this countercurrent technology, system modifications are minimal and ion exchange capacity can be nearly doubled. The top collector/distributor system in the vessel is surrounded by a shallow layer of floating inert material. This allows free passage of spent regenerants and rinse water, as well as resin fines and other small particulates, while restraining the normal size resin beads so that the bed is maintained in a compacted state during upflow regeneration.

Because the service cycle operates downflow, the compacted resin bed is insensitive to fluctuations in feed flow. If feed flow is interrupted, there is no danger that ionic stratification will be disturbed. The highly regenerated zone at the bottom of the bed remains intact and uncontaminated by exhausted beads higher up in the bed.

During upflow regeneration, the resin bed is lifted in the compacted state, moving up against the inert layer, while the regenerant passes upflow at a rate sufficient to maintain the resin in the packed state. Regeneration serves two purposes – it reactivates the ion exchange sites on the resin, and it cleans the vessel of resin fines and other particulates.

Benefits of Layered Bed Configurations

Layered beds are an efficient and economical alternative to using separate vessels for strongly and weakly functional resins in a demineralizer system. With layered beds, fewer vessels are needed and regenerant chemical efficiency is improved. A layered bed configuration is a highly cost-effective way to take advantage of the high exchange capacity and organics removal of a weak base anion resin. It also helps protect and optimize the capacity and service life of the strong base anion resin, which further enhances the system in silica removal capability.

Vessels for the DOWEX™ UPCORE™ packed bed system also can be designed without a middle plate, as shown in Figure 2. With the system, the layered bed consists of a weak functional resin layer on top of a strong functional resin layer. The separation of the layers is ensured by the difference in the particle size distribution and resin density.

The DOWEX UPCORE packed bed system can be installed in layered bed configurations without major modification of existing vessels, and it is possible to adjust the ratio of layered resin volumes in the event of changes in raw water supply.
Technical Information

Comparison of Various Countercurrent Systems

All countercurrent systems share two basic requirements:
1. An intact, highly regenerated zone that must be maintained in the portion of the resin bed near the service flow outlet.
2. A resin bed that must remain in a packed state during the service and regeneration cycles.

The way in which different countercurrent systems meet these requirements has a direct impact on their efficiency, productivity and economic advantages.

Air and Water Hold-Down Systems
• Good water quality
• Good regeneration efficiency

But:
• Limited vessel volume utilization
• Middle distributor sensitive to mechanical damage due to resin swelling and shrinking
• Additional equipment needed
• High consumption of water or air needed
• Time- and manpower-intensive regeneration
• Periodic backwash needed

Upflow Service Packed Bed System (“Fluidized” Bed)
• Good water quality
• Good regeneration efficiency
• Good vessel volume utilization
• Short regeneration time

But:
• Sensitive to changes in flow rate and/or interruptions during production cycle
• Accumulation of suspended solids by deep-bed filtration
• External backwash tank needed for cleaning
• Resin traps mandatory to avoid carry-over of fines
• Layered-bed designs require an intermediate nozzle plate

Why the DOWEX™ UPCORE™ System Is Better
The DOWEX™ UPCORE™ packed bed system is a downflow service/upflow regeneration technology with packed bed ion exchange demineralizers. This advanced technology provides the significant productivity and economic advantages of countercurrent regeneration without the drawbacks of earlier generation processes.

The DOWEX UPCORE system offers these advantages:
• Simple design that’s ideal for retrofitting or upgrading systems
• Easy to control and automate
• Self-cleaning system with no separate backwashing required
• Tolerates flow variations without disruption to the resin layers
• Reduces use of regeneration chemicals
• Increases water quality

Evaluate Your System’s Performance Online with CADIX

CADIX (Computer Assisted Design for Ion eXchange) is a comprehensive ion exchange engineering software tool for system design and evaluation of existing plant performance. CADIX allows an economic comparison of cocurrent and countercurrent regeneration for your particular system – and other valuable capabilities. To download CADIX, go to www.dowex.com and click on “Download Software.”
The DOWEX™ UPCORE™ packed bed system has distinct operational advantages over other countercurrent systems, including reduced resin loss and lower regenerant costs. In the DOWEX UPCORE packed bed system, the top collector/distributor system is surrounded by a layer of floating inert material. This material allows the compaction/regeneration effluent and suspended solids and resin fines to pass through while retaining the normal-size resin beads. With DOWEX UPCORE resins, resin loss can be virtually eliminated.

Feedwater enters at the top of the distributor system and passes through the layer of fluidized inert material. At the end of the service cycle, water flows up from the bottom distributor system, causing the resin bed to compact against the inert material at the top of the vessel. Immediately following compaction, the regenerant is passed upflow at a rate high enough to maintain bed compaction. Upflow displacement rinse follows and the bed is allowed to settle in the final step.

The Regeneration Cycle

The purpose of the regeneration cycle is to regenerate the resin and to remove suspended solids and resin fines. The efficiency of a countercurrent system depends on the maintenance of a highly effective polishing zone throughout the regeneration and service cycles. During service, the bed stays fixed against the bottom distribution system. During regeneration, this is achieved with the hysteresis effect, as shown in the diagram (see Figure 3).

The resin bed is initially compacted against the inert beads by an upflow stream of water. The flow rate needed for compaction is determined by the resin particle size and density, the amount of freeboard, and the water temperature. It takes only a few minutes for the bed to fully compact. The water is normally demineralized (or decationized for the cation unit) to prevent ionic contamination of the polishing zone (see Figure 4).

During compaction, the resin bed is substantially freed of suspended materials (filtered out on the surface during the service cycle), as well as resin fines, due to a hydrodynamic shear effect. The removal of unwanted solids is optimized by the choice of the correct DOWEX™ resin and collector system. This self-cleaning process is completed during the regeneration phase.

Once compacted, the resin bed remains in place even if the flow rate is reduced. This allows regeneration to take place at the flow rate that achieves the best results in terms of regenerant contact time and concentration. The volume change of the resin beads supports the cleaning effect.

In the DOWEX UPCORE packed bed system, the regeneration step is followed by a displacement or slow rinse cycle. The flow of water is in the upflow direction at the rate equal to that used during regeneration. After the displacement rinse is completed, the flow is stopped and the resin bed is allowed to fall freely. It takes between 5 and 10 minutes for the compacted bed to settle. During settling, the bed falls to the bottom of the vessel, layer by layer. Within the upmoving fluidized freeboard, a classification of the resin takes place, and any resin fines are kept in suspension. This settling results in a loosening of the bed and allows residual fines to rise to the top, where they are removed in the next compaction step. Carry-over of resin fines to the next vessel during the service cycle is thus prevented. The polishing zone is not disturbed by the settling phase.

The regeneration cycle is completed with a fast final rinse or the recirculation of rinse water between cation and anion vessels. In the fast final rinse, water flows down from the top of the vessel at a rate equal to the service flow. The water for the final rinse can be raw for cation resins and should be decationized or demineralized for anion resins. To save service water, the final rinse can also be based on recirculation from the cation to the anion vessel at the service cycle flow rate.
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