

ULTRAPURE WATER WITHOUT A MIXED BED

Compressed-bed Ion Exchange Provides Superior Performance in a Small Package

By Lisa Hausz, MBA
Eco-Tec Inc.

Conventional practice when producing water with a conductivity of less than 0.1 $\mu\text{mho/cm}$ is to use a mixed-bed ion exchange unit. While the mixed-bed process has proven to be worthwhile over the years, it is not without issues¹ that can be avoided by using an advanced compressed-bed ion exchange system. High volume, high purity water can be economically achieved without the use of mixed-bed polishers.

CONVENTIONAL THINKING: *STATUS QUO*

The production of large quantities of high purity water for specific applications, such as boiler feed water for power generation, requires a well-designed process to prevent various issues. High-pressure boilers typically require make-up water with the characteristics outlined in Figure 1. Traditional process flows designed to produce this water quality typically consist of one of the following:

| | |
|---|-----------------------------|
| Conductivity | $\leq 0.1 \mu\text{mho/cm}$ |
| Silica | 5-20 ppb |
| TOC | $\leq 300 \text{ppb}$ |
| Na, Ca, Mg, Cu, SO ₄ , Cl | 3-20 ppb |

Figure 1: Typical Characteristics of Boiler Feed Water for Power Generation

1. Roughing demineralization using two conventional deep bed ion exchange columns followed by a mixed-bed polisher (SAC/SBA/MB)
2. Roughing demineralization using reverse osmosis (single or double-pass) followed by a mixed bed polisher (RO/MB)

With *unconventional* thinking and a desire to reduce operating costs, there is a simple, process design that can consistently achieve high purity water. The *compressed-bed* ion exchange technology offers continuous high purity effluent using a simple package with proven results.

Pictured right (Figure 2) is a component for high purity water treatment system that was installed as an alternative to outsourced water treatment. The full system was designed for a capacity of 45.4 m^3/hr (200 gpm). The system treats municipal water through direct filtration, followed by a compressed-bed TriFlo™ demineralizer, that provides purity of 0.05 $\mu\text{s/cm}$.



Figure 2: TriFlo Demineralizer

¹ Complex operating steps, resin “clumping”, resin mixing.

COMPRESSED-BED PERFORMANCE: *IN THE ZONE*

Within an ion exchange column there is a relatively shallow layer of resin where the exchange process is actually taking place. Upstream of this layer the resin has already been exhausted, while downstream the resin has yet to receive any significant loading. Compressed-bed ion exchange is based on the manipulation and control of this shallow layer or “mass transfer zone” (Figure 3). The depth of a compressed-bed column is reduced to just slightly greater than the mass transfer zone.

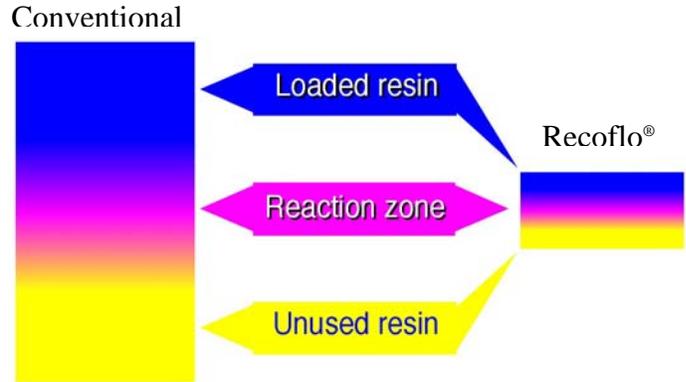
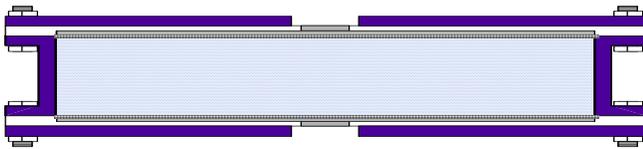


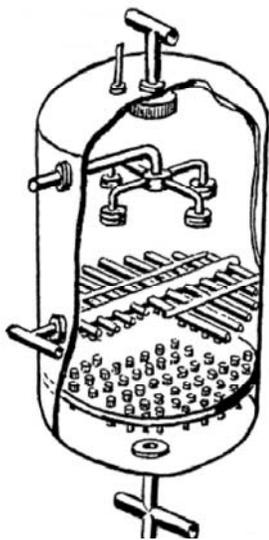
Figure 3: Mass Transfer Zone

UNCONVENTIONAL THINKING: *COMPRESSED BED DESIGN*

Decreased equipment size and increased efficiencies are derived from multiple features of compressed bed technology such as short bed height, small resin volume, low resin exchange loading, fine mesh resin, and shorter cycle times. These features result in higher throughput, lower operating costs, less waste, less space requirements, fast installation and commissioning, and simple maintenance processes.



The resin beds of the compressed bed technology are ~7.5 – 15cm (~3 to 6 inches) in depth requiring significantly less resin volume compared to the resin requirements of conventional counter-current columns. In addition to less volume, the design enables lower resin exchange loading, using only up to 15% of the total exchange capacity of the resin. By using only the most accessible exchange sites, exchange kinetics are enhanced. This process enables easy regeneration and virtually eliminates resin swelling and shrinking, reducing resin attrition that is typically found with mixed bed systems. With compressed-bed technology, a fully automated 3-inch cation bed easily replaces the mixed-bed system.



Mixed Bed with complicated internals



Innovative TriFlo Demineralizer with a 3-inch cation bed

FORWARD THINKING: A *SMALL PACKAGE WITH BIG SAVINGS*

The distinctive design and operation of compressed-bed ion exchange technology provide ultrapure water with lower operating costs than conventional systems. The compressed-bed consumes significantly less chemicals than co-current or packed bed ion exchange systems; avoids resin “clumping” and mixing as found with mixed-bed systems; and has many years of proven reliability.

Compressed-bed resin life can be up to five years or more depending on feed water quality. Additional savings are attributed to low resin replacement costs through lower inventory needs of the compressed-bed, and the lack of resin loss from backwash or breakage, as is typical of both co-current and packed bed systems.

The highly efficient regeneration and resin rinsing of compressed-bed systems result in reduced water and chemical consumption and subsequent waste generation. Typical compressed-bed systems produce considerably less waste than the conventional deep-bed co-current systems.

Through the utilization of common components, piping, wiring, and high quality technical standards, integrating compressed-bed water treatment technology can reduce space requirements, freeing up floor space for additional profit-generating equipment. The compressed-bed systems are fully automated avoiding the need for labor-intensive regeneration. A small footprint with big efficiencies, the compressed-bed technology offers superior water quality with reduced operations, maintenance, and installation costs all of which directly adds to bottom line profitability. 

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