Tech Fact

DuPont Ion Exchange Resins

Recommended Operating Conditions for Mixed Bed Ion Exchange Units

Introduction

Mixed Bed (MB) ion exchange units can provide treated water with excellent quality, though are not typically designed for efficiency in terms of regenerant consumption. Their use should therefore, mostly be reserved for waters having a low salinity, which will result in a long service cycle length. The practical limits for the use of a MB unit are approximately:

- Salinity < 1 meq/L (50 mg/L as $CaCO_3$)
- TDS < 100 mg/L
- Conductivity < 100 µS/cm

Higher salinity will result in low specific flowrate (also known as spatial velocity) requirements and lower than recommended linear velocity, thus making the ion exchange process less stable.

For optimum performance in water treatment, ion exchange resins should be used within a defined range of operating conditions. This document presents typical conditions of use for mixed bed units. Alternative conditions apply for separate beds.

The ion exchange cycle

The ion exchange cycle of a mixed bed consists of the service run (production cycle) followed by regeneration. Considering the complicated nature of the mixed bed regeneration process, which can take roughly four hours to complete, an ideal minimum service run would be 24 hours.

The regeneration steps include:

1. Separation by backwashing
2. Settling
3. Draining (optional)
4. Regenerant injection, simultaneous or sequential
5. Regenerant displacement
6. Draining water to resin level
7. Mixing with nitrogen or air
8. Filling the unit
9. Final rinse

Resin volume ratio

The cation to anion resin ratio should be within the range of 35:65 and 65:35 percent in volume, expressed in the standard/reference form resin volumes (cation resin in Na^+ form and anion resin in Cl^- form). Using less than one third of the minor of the two components can result in poor performance. A high cation ratio of msore than 50% of the total volume is most commonly used for condensate polishing, where condensates contain primarily ammonia or amines.

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Production

	DM Polishing	RO Polishing and UPW	Condensate
Bed Depth			
Total bed depth	915 – 1600 mm	1000 – 2000 mm	1000 – 1500 mm
Smaller component	> 450 mm	> 500 mm	> 500 mm
Specific Flowrate [1]	20 – 50 BV/h	15 – 40 BV/h	30 – 120 BV/h
Linear Flowrate [2]	24 m/h (10 gpm/ft^2) ΔP < 150 kPa (22 psi)	24 m/h (10 gpm/ft^2) ΔP < 150 kPa (22 psi)	24 m/h (10 gpm/ft^2) ΔP < 150 kPa (22 psi)
Temperature	Ambient water temperature, except for condensate polishing. See individual resin data sheets for acceptable limits.		

[1] Also called Spatial Velocity.
[2] Also called Linear Velocity. Lower flowrate limit is 24 m/h (10 gpm/ft^2); upper flowrate limit is determined by pressure drop, not to exceed 150 kPa (22 psi).

Additional Notes

- DM = demineralization by ion exchange, RO = reverse osmosis, UPW = Ultra Pure Water
- The bed depth data apply to MB units with a diameter of 600 mm (2 ft) or more.
- The recommendations for RO polishing also apply to “working mixed beds”, i.e., units fed with water having a relatively high salinity
- Condensate polishing: the bed depth data are for mixed bed units with internal regeneration, different recommendations may apply for units with external regeneration
- 1 BV (bed volume) = 1 m^3 of water or solution per m^3 of resin
- Bed depth and linear flowrate: the important parameter is pressure drop, which should not exceed 150 kPa (22 psi) as a design value, but preferably closer to 100 kPa (15 psi). Pressure drop typically increases during service, particularly in condensate polishing with long service runs and CRUD[1] in the condensate.
- Operating below the recommended minimum flowrate can cause serious quality problems, particularly when the salinity is relatively high. Therefore, if a minimum cycle length of one day is combined with a minimum specific flowrate of at least 15 BV/h (bed volumes per hour), it can be seen that the salinity limit is close to 1 meq/L or even less if the water contains high CO_2.

Backwash

Backwashing a mixed bed results in the separation of the anion resin from the cation resin. Backwashing should be done for at least 20 – 25 minutes, preferably 40 – 45 minutes to ensure perfect separation of the two resin layers.

Settling

It takes a few minutes for a bed to settle after separation.

1. CRUD (corrosion residual unidentified deposit) is impurities in the reactor water that deposit on hot cladding surfaces.

Draining (optional)

Draining the water in the unit down to about 300 mm (1 ft) above resin surface will prevent the caustic regenerant from being diluted through the water in the vessel. This step is not necessary for units equipped with a specific caustic distributor just above the bed surface.

Regeneration

	DM Polishing	RO Polishing	UPW	Condensate
Quantity				
HCl	75 – 150 g/L	75 – 100 g/L	100 – 150 g/L	~ 185 g/L
H_2SO_4	90 – 240 g/L	90 – 128 g/L	140 – 180 g/L	~ 240 g/L
NaOH	80 – 160 g/L	75 – 128 g/L	120 – 180 g/L	~ 160 g/L
Concentration				
HCl	5%	5%	5 – 6%	5 – 6%
H_2SO_4	5% in the absence of calcium in the feed water			
NaOH	4%	4 – 5%	4 – 5%	4 – 5%
Flowrate	The flowrate derives from regenerant volume and contact time			
Contact Time	> 30 minutes for each regenerant			

With simultaneous injection, acid and caustic are injected at the same time. The time for injection + regenerant displacement must be adjusted in such a way that their sum is identical for both regenerants.

Displacement rinse

After the prescribed quantity of regenerant has been introduced, the regenerant stream is stopped and only the dilution water continues to be injected in order to displace the regenerant. Displacement is stopped when the pH approaches neutrality (in case of sequential regeneration). A rough guideline is to use 3 bed volumes of displacement water.

Draining

Before air mixing can take place, the water in the vessel must be drained down to the level of the resin. Otherwise it is impossible to obtain a homogeneous mixture of resin, the components having the tendency to separate again while settling. The level of water must be drained down to less than 50 mm (2 inches) above the resin bed surface.

Mixing

The resin bed is mixed using nitrogen or clean air. In particular, the air must be totally oil-free (traces of oil can originate from the air compressor).

Filling

The vessel is filled with water (from the top) before the final rinse. Filling the vessel will take a few minutes. To prevent disturbance of the resin bed after mixing, the first few minutes of filling can be done with the NaOH dilution water, followed by feed water at the service flowrate.

Final rinse

The fast/final rinse is carried out at the service flowrate until the required effluent quality is obtained. With successful regeneration of high quality resins (absence of cross-contamination) the final rinse should consume less than 10 bed volumes of water.

Note

All the above steps are described with additional details and illustrations in Regeneration of Mixed Bed Units (Form No. 45-D01129-en).

Have a question? Contact us at:

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