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Dow
Liquid Separations

DOWEX MWA-1

Ion Exchange Resin

ENGINEERING INFORMATION

DOWEX MWA-1 Weak Base Anion Exchange Resin

General Information

DOWEX* MWA-1 resin is a macroporous weak base anion exchange resin with a polydispersed bead size distribution. It is based on a styrene-divinylbenzene copolymer matrix with dimethylamine functional groups. DOWEX MWA-1 is designed to give high throughput and economical operation in both water and non-water applications. It gives high chemical efficiency and reversible removal of that organic fraction that is soluble at the operation pH values. The high reversibility to organics leads to a good resistance to fouling and gives protection to the strong base anion resin typically used downstream.

DOWEX MWA-1 resin may be used in a simple two stage plant giving good quality water but without removal of silica or carbon dioxide. Alternatively, the resin may be used in combination with the strong base anion resin in a separate vessel, such as DOWEX SBR resin.

In a layered bed configuration with a strong base anion resin, the uniform particle sized resin DOWEX MARATHON* WBA has been specially developed. This resin provides excellent kinetic performance and separation from the strong base anion. The kinetics lead to high operating capacity and fast rinse-down. In addition, its high physical strength and small bead size make it highly resistant to bead breakage.

A separate brochure on DOWEX MARATHON WBA resin is available.

The combined use of DOWEX MWA-1 resin or DOWEX MARATHON WBA resin with a strong base anion resin can give an exceptional removal of organic matter and a very high level of regenerant chemical efficiency. Further information is given under *Operating Characteristics* in this leaflet.

The swelling of DOWEX MWA-1 resin in the operational cycle is important and must be considered in the engineering design. The maximum operational swelling of DOWEX MWA-1 resin is 20% in passing from the free amine form into the fully exhausted state. Operational swelling is around 15%.

The physical and chemical properties of the resin allow DOWEX MWA-1 resin to be used for applications in organic solvents or in highly concentrated solutions.

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Typical Physical and Chemical Properties

Ionic form as delivered		FB (free base)
Total exchange capacity, min.	eq/l kgr/ft^3 as $CaCO_3$	1.2 26.2
Water content	%	50 - 60
Bead size distribution		
Range	mm	0.3 - 1.2
	>1.2 mm, max.	% 2
<0.3 mm, max.	%	3
Total swelling (FB ♦ HCl), approx.	%	20
Whole beads, min.	%	95
Particle density, approx.	g/ml	1.04
Shipping weight, approx.	g/l lbs/ft^3	640 40

Recommended Operating Conditions

Maximum operating temperature:	
FB form	60°C (140°F)
HCl form	100°C (212°F)
pH range	0-7
Bed depth, min.	800 mm (2.6 ft)
Flow rates:	
Service/fast rinse	5-50 m/h (2-20 gpm/ft^2)
Backwash	See figure 1
Co-current regeneration/displacement rinse	1-10 m/h (0.4-4 gpm/ft^2)
Counter-current regeneration/displacement rinse	5-20 m/h (2-8 gpm/ft^2)
Regenerant	2-4% NaOH
Total rinse requirement	3-5 Bed volumes

Hydraulic Characteristics

Backwash Expansion

Backwash expansion of the resin to accomplish reclassification of the bed and removal of accumulated fine particles should be done at flowrates sufficient to expand the bed between 50 and 100% of its original height in the free base form. Figure 1 details percent bed expansion for DOWEX MWA-1 resin when backwashed at various flowrates. It includes data for two different bases:

1) Regenerated - The percent expansion is determined relative to the bed depth in the regenerated (free base) form. This is the data to use for backwashing new or completely regenerated resin.

2) Exhausted - Resin in the exhausted form swells by up to 20% of its original volume. This is the data to use for backwashing completely exhausted resin relative to the bed depth in the free base form.

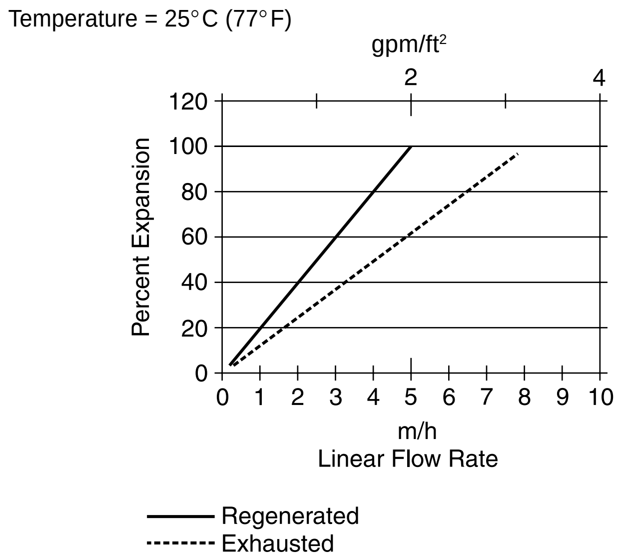
Example

Resin depth is 1.5 m (5 ft) in the free form. The goal is to expand the bed to 3.0 m (9.9 ft) during backwash. Bed depth in the exhausted form is 1.8 m (5.9 ft). Temperature of the backwash water is 15°C (60°F).

The target expansion of the exhausted resin is 100% relative to the free base form bed depth. {(3.0 m - 1.5 m) / 1.5 m} x 100 = 100%. Using figure 1, the flowrate required for 100% expansion in the regenerated form is determined to be 8.3 m/h (3.4 gpm/ft^2) at 25°C (77°F). The temperature correction factor is then applied to determine the required flowrate at 15°C (60°F).

8.3 m/h [1 + 0.008 {(1.8 x 15) - 45}] = 7.1 m/h (2.9 gpm/ft^2).

Figure 1. Backwash expansion vs. flow rate



For other temperatures use:

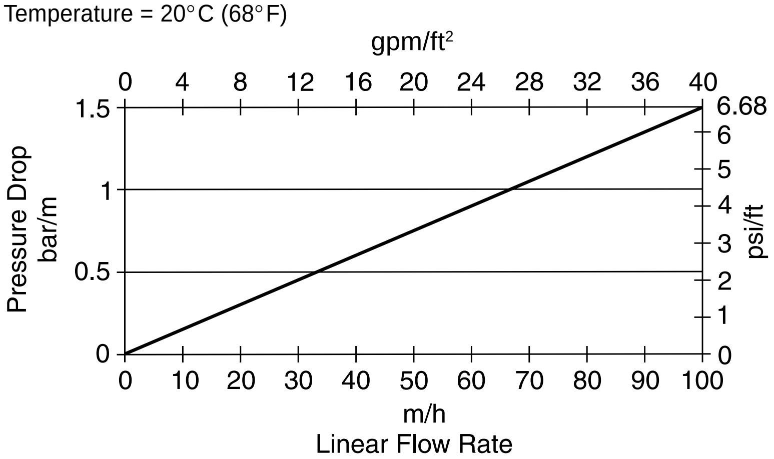
$F_T = F_{77°F}$ [1+0.008 ($T_{°F}$-77)], where F = gpm/ft^2

$F_T = F_{25°C}$ [1+0.008 (1.8$T_{°C}$-45)], where F = m/h

Pressure Drop Data

The data in Figure 2 shows the pressure drop per unit bed depth as a function of both flow velocity and water temperature. This figure refers to a new resin bed at the beginning of the operational cycle with the resin in the free amine form (i.e. regenerated) in a backwashed, settled condition and should be considered indicative. The total head loss of a unit in operation will also depend on the design, in addition to other factors such as level of fines and suspended solids. Vessel geometry is also an important consideration, as in very small diameter units, particularly with deep beds, bed compaction may occur which could substantially increase the head loss.

Figure 2. Pressure drop



For other temperatures use:

$P_T = P_{20°C} / (0.026\ T_{°C} + 0.48)$, where P … bar/m
$P_T = P_{68°F} / (0.014\ T_{°F} + 0.05)$, where P … psi/ft

Operating Characteristics

General

DOWEX MWA-1 resin used alone will remove free mineral acidity (FMA) from the cation effluent and, apart from a short period at the beginning of the operational cycle, it will not remove carbon dioxide or silica. The capacity of the resin is slightly higher if carbon dioxide is present in the water, thus the logical location of a degassing tower would be after the weak base anion resin. The chemical efficiency remains the same however, so the position of the degasser can be selected according to the overall chemical engineering.

Chemical Efficiency

The graphs in Figure 3 show the operating capacity for different feeds and the amount of caustic soda normally required based on a consumption of 135% of the stoichiometric chemical equivalent. This is a typical figure, but if the water is free from organic matter, 5-10% less chemical may be used. A water with a high organic content may need 10% more. If caustic soda is very expensive, it may be economical to use less caustic soda and heat to 40°C (104°F). The capacity of the resin, to an end point of 30 µS/cm, should not be affected by the regeneration level, always provided it exceeds the chemical equivalent of the acidity removed during service.

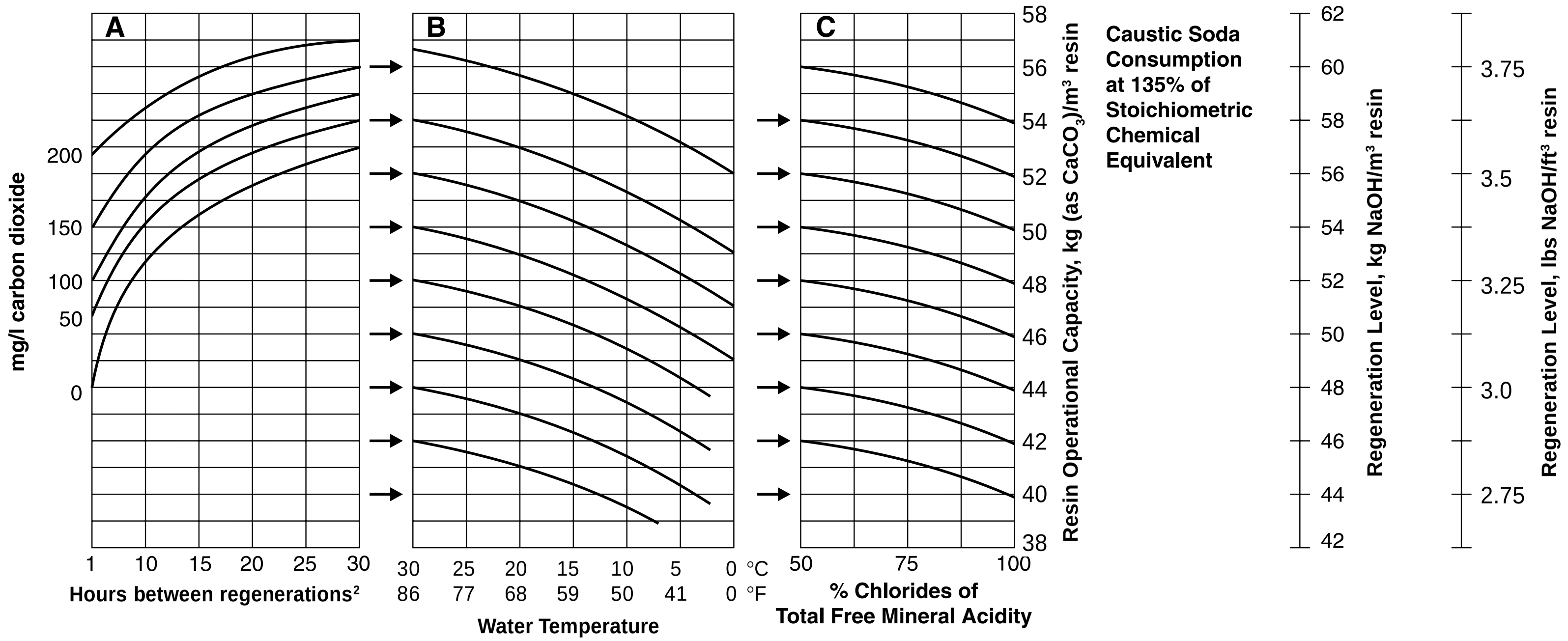
Operational capacity data

To calculate operational capacity and regeneration requirements:

1. Locate a point on graph A from carbon dioxide and hours between regenerations.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guidelines of graph B to locate a new point on the ordinate according to water temperature.
3. Transfer the ordinate point from graph B horizontally to graph C and repeat the procedure under point 2 according to percentage chlorides of FMA.
4. Using the ordinate obtained under point 3, read off the operational capacity on the right hand side of the diagram.
5. The required caustic soda may also be read off on the same ordinate (see *Operating Characteristics* section for greater detail and the use of other regenerants).

Note: eq/l x 21.8 = kgr/ft^3 as $CaCO_3$.

Figure 3. Operational capacity data



Regeneration Chemicals

Normally caustic soda is used as regenerant and the data in Figure 3 relates to this chemical. The resin may also be regenerated with sodium carbonate or ammonium hydroxide. If the amount of these chemicals is the equivalent of the recommended sodium hydroxide, there will be a 10% drop in operational capacity.

The elution of organic matter from DOWEX MWA-1 will remain excellent with any regenerant, providing the correct regeneration level is used.

Combination of Weak Base and Strong Base Anion Resins

Using a weak base anion resin, such as DOWEX MWA-1 or DOWEX MARATHON WBA resin in combination with a strong base anion resin allows complete demineralization. This is particularly suitable for waters containing a high proportion of FMA, as the loading and regeneration of FMA on the weak base is chemically very efficient. It is possible to extend this efficiency to the whole anion resin system by using the excess caustic from the strong base anion regeneration to regenerate the weak base anion. This is referred to as “thoroughfare” regeneration. In addition, the overall operating capacity is increased and the strong base anion is protected from organics by the weak base resin.

Overrun

With the weak base anion in front of a strong base anion, it is possible to run DOWEX MWA-1 to an FMA endpoint only, thereby using the strong base to adsorb silica and carbon dioxide. It is common practice, however, to operate the weak base resin through the FMA breakpoint in order to gain operating capacity by allowing the strong base resin to absorb the leakage and maintain product water quality. This is the overrun condition.

Layout

There are three main configurations for using a weak base anion resin in combination with a strong base anion resin.

1) The two anion resin types can be placed in separate vessels.

2) They can be used in one vessel with two compartments separated by an intermediate nozzle plate.

3) They can also be used in a single vessel without a plate as a layered bed.

In the latter case, DOWEX MARATHON WBA resin is recommended. In the separate vessel configuration, the weak base resin can also be regenerated in co-flow.

Silica Precipitation

It is important to consider the overall service run length and silica level in the feed when defining the plant operation and regeneration conditions.

Silica solubility is lowest at neutral pH and so during thoroughfare regeneration, care should be taken that the silica eluted from the strong base resin does not precipitate in the lower pH conditions prevailing within the weak base resin. To minimize this risk, the silica peak coming off the strong base anion should be diluted by limiting caustic temperature and concentration and ensuring adequate chemical injection velocity.