Dow
Liquid Separations

DOWEX MARATHON WBA

Ion Exchange Resin

ENGINEERING INFORMATION

DOWEX MARATHON WBA Weak Base Anion Exchange Resin

General Information

DOWEX* MARATHON* WBA resin is a high capacity, macroporous, weak base anion exchange resin of uniform bead size distribution. It is based on a styrene-divinylbenzene copolymer matrix with dimethylamine functional groups. DOWEX MARATHON WBA resin is specifically designed to give high throughput and economical operation in both water and non-water applications. Because of its small uniform particle size distribution, this resin offers a number of advantages compared to conventional (polydispersed) resins, as exchange kinetics are dependent on bead size for weak base resins. This leads to an increase in operating capacity and faster rinse-down during regeneration. In addition, its high physical strength and small bead size make it more resistant to bead breakage.

DOWEX MARATHON WBA resin is designed to give maximum chemical efficiency and reversible removal of that organic fraction that is soluble at the operation pH values. The high reversibility to organics, aided by the absence of large beads, leads to a good resistance to fouling and gives protection to the strong base anion resin typically used downstream.

DOWEX MARATHON WBA 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 a strong base anion resin in a separate vessel, such as DOWEX MARATHON A resin, or combined with DOWEX MARATHON A LB resin in a single vessel as a layered bed. The tailored bead sizes of DOWEX MARATHON WBA and DOWEX MARATHON A LB resins result in an excellent separation of the two resins. The combined use of DOWEX MARATHON WBA resin with a strong base anion resin can give an exceptional removal of organic matter as removal occurs at different pH values in the two resin environments. With such a combination of weak and strong base anion resins, a very high level of regenerant chemical efficiency can be achieved. Further information is given under *Operating Characteristics* in this leaflet.

The swelling of DOWEX MARATHON WBA resin in the operational cycle is important and must be considered in the engineering design. The maximum operational swelling of DOWEX MARATHON WBA is 25% in passing from the free amine form into the fully exhausted state. Operational swelling is around 20%.

The physical and chemical stability allow DOWEX MARATHON WBA resin to be used to treat organic solvents or highly concentrated solutions.

Specifications		FB (free base) form
Total exchange capacity, min.	eq/l kgr/ft^3 as $CaCO_3$	1.3 28.4
Water content	%	50 - 60
Uniformity coefficient, max.		1.1

Typical Physical and Chemical Properties		FB (free base) form
Mean particle size†	µm	525 ± 50
Whole beads	%	95 - 100
Total swelling (FB ♦ HCl)	%	20
Particle density	g/ml	1.04
Shipping weight	g/l lbs/ft^3	640 40

Recommended Operating Conditions	
Maximum operating temperature	100°C (212°F)
pH range	0-7
Bed depth, min.	800 mm (2.6 ft)
Flow rates: Service/fast rinse Backwash Co-current regeneration/displacement rinse Counter-current regeneration/displacement rinse	 5-60 m/h (2-24 gpm/ft^2) See figure 1 1-10 m/h (0.4-4 gpm/ft^2) 5-20 m/h (2-8 gpm/ft^2)
Total rinse requirement	2-4 Bed volumes
Regenerant	2-5% NaOH

†For additional particle size information, please refer to the Particle Size Distribution Cross Reference Chart (Form No. 177-01775).

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 MARATHON WBA 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.

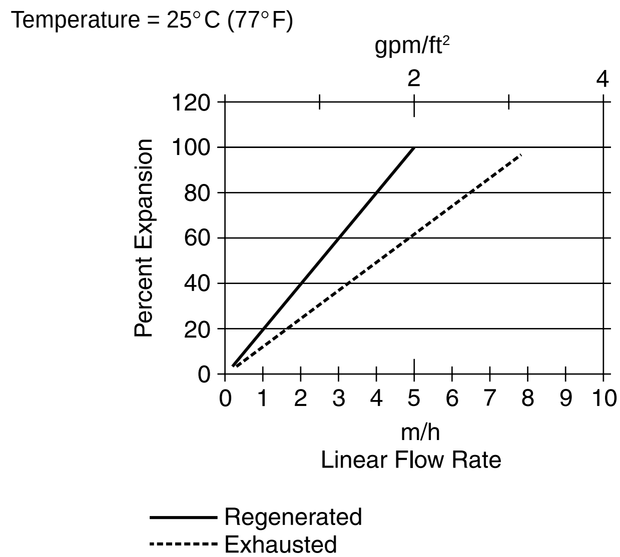
2) Exhausted - Resin in the exhausted form swells by up to 20% of it's original volume. This is the data to use for backwashing completely exhausted resin relative to the bed depth in the free base form.

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.
{(3.0m - 1.5m)/1.5m} x 100 = 100%.
Using Figure 1, the flowrate required for 100% expansion in the regenerated form is determined to be 9.0 m/h (3.7 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).
9.0 m/h [1 + 0.008 {(1.8 x 15) - 45}]
= 7.7 m/h (3.1 gpm/ft^2).

Figure 1. Backwash expansion vs. flow rate



For other temperatures use:

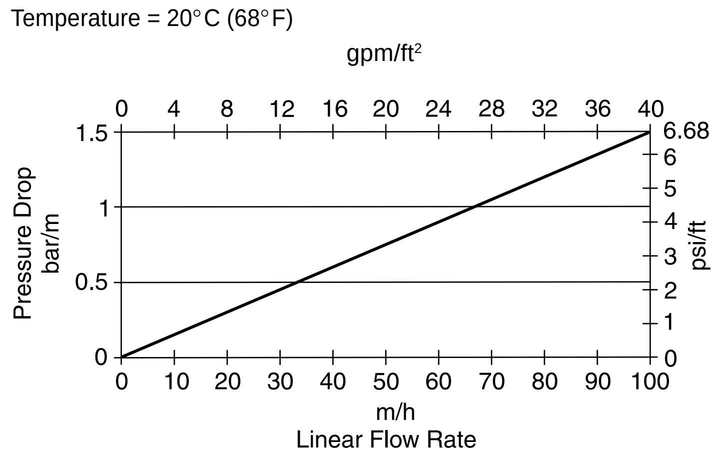
$F_T = F_{77°F}$ [1+0.008 ($T_{°F}$-77)], where F = gpm/ft^2
$F_T = F_{25°C}$ [1+0.008 (1.8$T_{°C}$-45)], where F = m/h

Pressure Drop Data

The pressure drop across a resin bed can vary depending on a number of factors. These include resin type, bead size, interstitial space (bed voidage), flow rate, temperature and degree of bed contamination. The presence of smaller beads in conventional resins results in filling of the interstitial spaces between the larger beads, thereby increasing the head loss. Compared to conventional resins, uniform beads have a higher bed voidage which compensates for the smaller mean bead diameter, resulting in similar head loss characteristics to the conventional resins.

The data in Figure 2 shows the pressure drop per unit bed depth as a function of both flow velocity and water temperature for the resin. These figures refer 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 MARATHON WBA resin removes free mineral acidity (FMA) from the cation effluent but, apart from a short period at the beginning of the operational cycle, will not remove carbon dioxide or silica. It therefore provides a highly efficient partial demineralization. The capacity of the resin is 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 degassifier can be selected according to the overall chemical engineering.

Chemical Efficiency

DOWEX MARATHON WBA resin regenerates extremely efficiently, leading to lower operating costs and reduced waste disposal. Figure 3 shows the amount of caustic soda normally required based on a consumption of 130% of the stoichiometric chemical equivalent. This is a typical figure. 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 work done.

Operational capacity data

To calculate operational capacity and regeneration requirements:

1. Locate a point on graph A from the plant feed flow rate (bed volumes per hour) and the feed carbon dioxide composition (degassed or undegassed).
2. Transfer the point from graph A horizontally to graph B and follow the guideline curves on graph B to locate a new point on the x-axis according to the feed water temperature.
3. Transfer the point from graph B horizontally to graph C and follow the guideline curves on graph C to locate a new point on the x-axis according to the percentage chlorides of FMA.
4. From the new point obtained on graph C, read off the resin operational capacity on the right hand side of the diagram.
5. Make a final correction to this operating capacity if higher caustic dosages are used by multiplying by the correction factor shown in graph D.

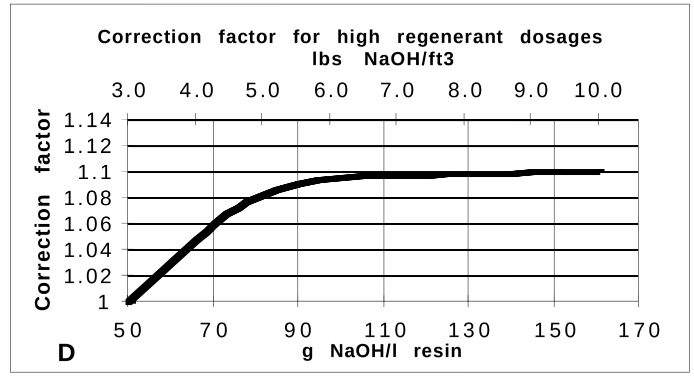
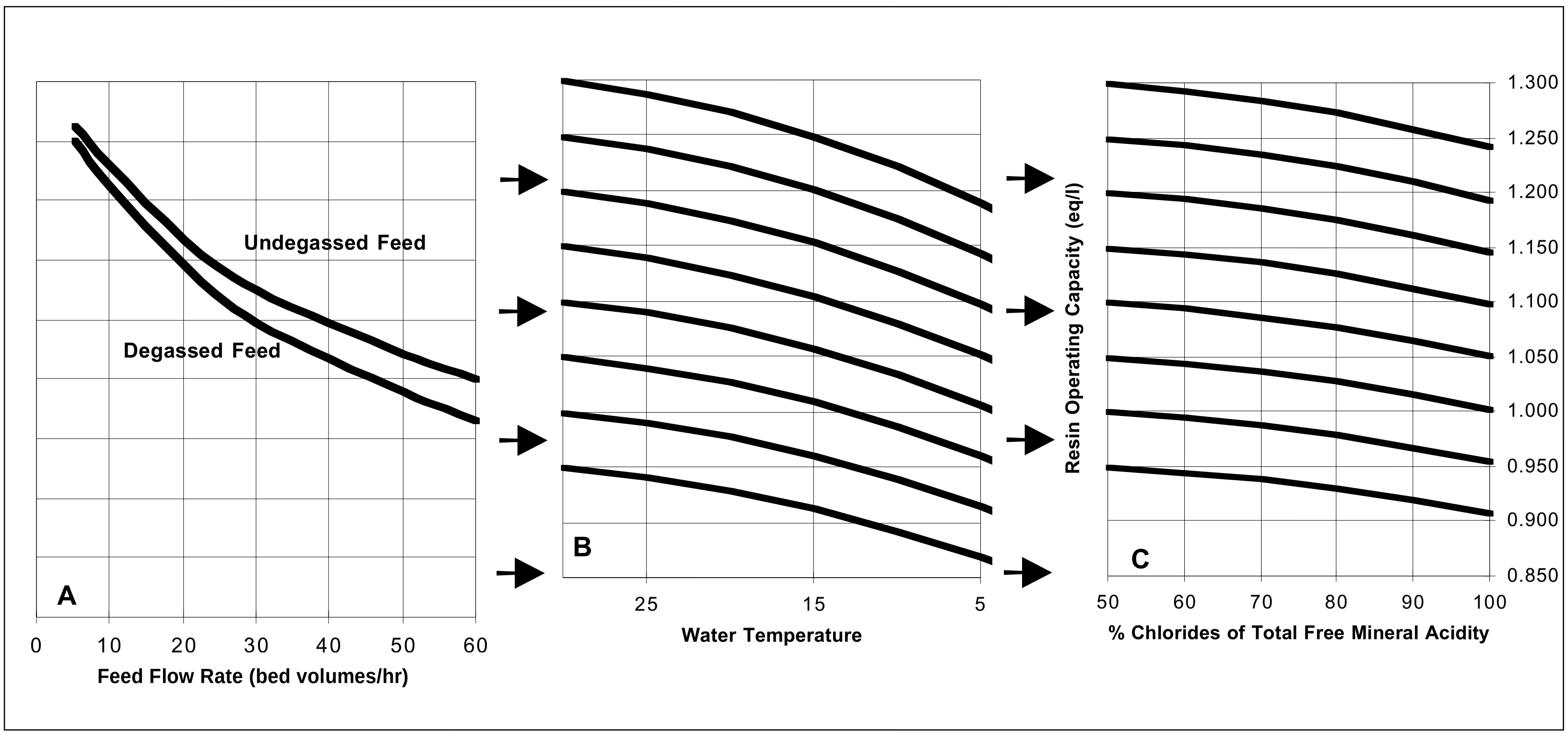


Figure 3. Operational capacity data



Regeneration Chemicals

The usual regenerant is caustic soda and Figure 3 relates to the use of 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 MARATHON WBA resin will remain excellent with any regenerant, providing the correct regeneration level is used.

Combination of Weak Base and Strong Base Anion Resins

For complete demineralization, particularly for waters containing a high proportion of free mineral acidity, it is advantageous to combine a weak base anion resin with a strong base anion resin, as the loading and regeneration of free mineral acidity on the weak base is chemically very efficient. Using thoroughfare regeneration, it is possible to extend this efficiency to the whole anion resin system by designing the process in such a way that the excess caustic from the strong base anion regeneration is used to regenerate the weak base anion. In addition, the overall operating capacity is increased and the strong base anion is protected from organics by the weak base resin.

Overrun

When a weak base anion is placed before a strong base anion, it is possible to run DOWEX MARATHON WBA resin to a free mineral acidity endpoint only, thereby using the strong base to adsorb silica and carbon dioxide. It is common practice however, to operate the weak base resin over the free mineral acidity breakpoint in order to gain operating capacity by allowing the strong base resin to absorb the leakage and maintain product water quality. This is called the overrun condition.

Layout

The two anion resins can be placed either in separate vessels, in one vessel with two compartments separated by an intermediate nozzle plate, or in a single vessel without a plate as a layered bed. In the separate vessel configuration, the weak base resin can also be regenerated in co-flow. In the case of two separate vessels, a degasser is normally placed downstream of the weak base resin to maximize its capacity.

Silica Precipitation

When defining the plant operation and regeneration conditions, it is important to consider the overall service run length and silica level in the feed, due to the tendency of silica to polymerise onto the strong base anion resin and become difficult to remove on regeneration. Silica solubility is lowest at neutral pH and increases with pH and temperature. 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, it is important to dilute the silica peak coming off the strong base anion by limiting caustic temperature and concentration and ensuring adequate chemical injection velocity.

Dow Liquid Separations Offices.
For more information call Dow Liquid Separations:

Dow Europe
Dow Customer Information Group
Liquid Separations
Prins Boudewijnlaan 41
B-2650 Edegem
Belgium
Tel. +32 3 450 2240
Tel. +800 3 694 6367 †
Fax +32 3 450 2815
E-mail: dowcig@dow.com

Dow Japan
Dow Chemical Japan Ltd.
Liquid Separations
Tennoz Central Tower
2-24 Higashi Shinagawa 2-chome
Shinagawa-ku, Tokyo 140-8617
Japan
Tel. +81 3 5460 2100
Fax +81 3 5460 6246

Dow Pacific
Dow Chemical Australia Ltd.
Liquid Separations
541-583 Kororoit Creek Road
Altona, VIC 3018
Australia
Tel. 61-3-9226-3545
Fax 61-3-9226-3534

Dow Latin America
Dow Quimica S.A.
Liquid Separations
Rua Alexandre Dumas, 1671
Sao Paulo – SP – Brazil
CEP 04717-903
Tel. 55-11-5188 9277
Fax 55-11-5188 9919

Dow North America
The Dow Chemical Company
Liquid Separations
Customer Information Group
P.O. Box 1206
Midland, MI 48641-1206
USA
Tel. 1-800-447-4369
Fax (989) 832-1465

Internet
http://www.dowex.com

† Toll-free telephone number for the following countries: Austria, Belgium, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom

Warning: Oxidizing agents such as nitric acid attack organic ion exchange resins under certain conditions. This could lead to anything from slight resin degradation to a violent exothermic reaction (explosion). Before using strong oxidizing agents, consult sources knowledgeable in handling such materials.

Published August 2002.

Form No. 177-01691-904