Dow
Liquid Separations

DOWEX MARATHON A2

Ion Exchange Resin

ENGINEERING INFORMATION

DOWEX MARATHON A2 Type 2 Strong Base Anion Exchange Resin

General Information

DOWEX* MARATHON* A2 resin is a high capacity, gel type 2, strong base anion exchange resin of uniform bead size distribution. It is based on a styrene-divinylbenzene copolymer matrix with dimethylethanol ammonium functional groups. DOWEX MARATHON A2 resin is specifically designed to give high throughput and economical operation in both water and non-water applications. Because of its uniform particle size, this resin offers a number of advantages compared to conventional (polydispersed) resins. The small uniform bead size of DOWEX MARATHON A2 resin results in rapid exchange kinetics during operation, more complete regeneration of the resin and faster, more thorough rinse following regeneration. Its high mechanical and osmotic strength gives it good resistance to bead breakage. The basicity of the type 2 functional group, being slightly lower than that of the trimethylammonium type 1 strong base anion resin and its hydrophilicity being enhanced by the polar ethanol group, both contribute to these good operational features.

Applications where DOWEX MARATHON A2 resin is recommended include demineralization, dealkalization, oxygen removal and nitrate removal.

Demineralization

Type 2 anion exchange resins are generally used in the absence of a weak base anion exchange unit. DOWEX MARATHON A2 resin performs extremely well in co-flow and counter-flow regeneration demineralization when observing the following conditions:

1. Organic matter loading should not exceed 5 g $KMnO_4$/liter resin per cycle.

2. SiO_2 + CO_2 loading should not exceed 30% of total anions.

3. Water temperature should not exceed 35°C (95°F).

In general, a type 2 resin is not recommended when the weak anion (SiO_2 + CO_2) load is high or the water temperature exceeds 35°C (95°F). In such cases, a type 1 resin such as DOWEX MARATHON A with higher basicity and temperature stability, is recommended.

DOWEX MARATHON A2 resin provides optimal treated water quality and rinse water requirements. The absence of fine beads in the uniform particle distribution ensures that blockage of collector systems is avoided.

Dealkalization

Sodium chloride regeneration of DOWEX MARATHON A2 resin permits reduction of alkalinity in water without the use of acid. This is best suited for dealkalizing softened water for boiler feed make up.

Oxygen Removal

DOWEX MARATHON A2 resin in the sulphite form is used to remove oxygen from deionized water. Oxygen in the water converts the sulphite to sulphate. The resin is regenerated using sodium sulphite.

Nitrate Removal

DOWEX MARATHON A2 resin can be used to lower nitrate levels in drinking water, using sodium chloride as a regenerant. If the water is pretreated with disinfecting agents such as chlorine, chlorine dioxide or ozone however, the lower oxidation resistance of a type 2 resin normally makes a type 1 resin, such as DOWEX MARATHON A, the preferred product.

This brochure relates to water demineralization using NaOH as a regenerant in co-current and counter-current operation. The data presented enables calculation of operating capacities and silica leakages under different operating conditions.

Guaranteed Sales Specifications		Cl⁻ form
Total exchange capacity, min.	eq/l kgr/ft^3 as $CaCO_3$	1.2 26.2
Water content	%	45 - 54
Uniformity coefficient, max.		1.1

Typical Physical and Chemical Properties		Cl^- form
Mean particle size†	µm	570 ± 50
Whole uncracked beads	%	95 - 100
Total swelling ($Cl^- \rightarrow OH^-$)	%	20
Particle density	g/ml	1.09
Shipping weight	g/l lbs/ft^3	690 43

Recommended Operating Conditions	
Maximum operating temperature: OH^- form Cl^- form	 35°C (95°F) 70°C (160°F)
pH range	0-14
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	3-6 Bed volumes
Regenerant: Type Temperature	 2-5% NaOH Ambient or up to 35°C (95°F) for silica removal

†For additional particle size information, please refer to the Particle Size Distribution Cross Reference Chart (Form No. 177-01775/CH 171-476-E).

Hydraulic Characteristics

Backwash Expansion

DOWEX MARATHON A2 resin has a smaller average particle size than conventional polydispersed resin. It's smaller size makes it possible to reduce the flowrate required to backwash the resin. Under the upflow conditions of backwashing the resin will expand its volume according to Figure 1. This expansion allows regrading of the resin, fines removal and avoids channelling during the subsequent service cycle. An expansion of 60-80% for 20 minutes is normally recommended to remove particulate matter from the resin bed.

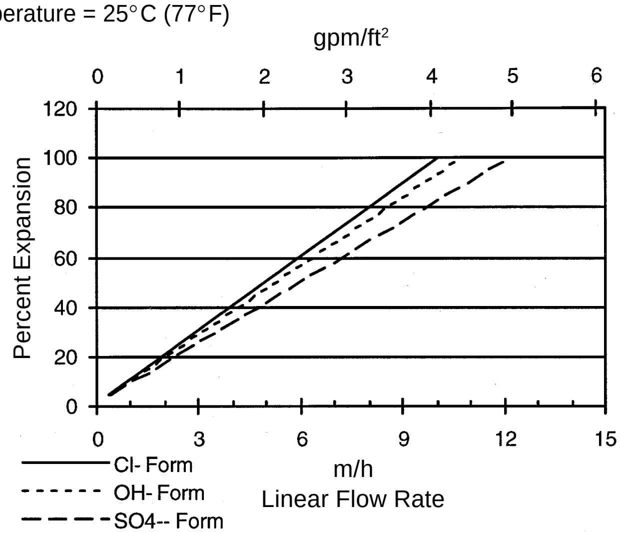
In co-current operation the resin is backwashed for a few minutes before every regeneration. Occasionally a longer backwash may be needed to fully remove contaminants. In counter-current operation, it is essential not to disturb the resin. Backwashing is only desirable if accumulated debris causes an excessive increase in pressure drop or to decompact the bed. Usually a backwash is performed every 15 to 30 cycles in conventional counter-current regeneration systems.

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 and temperature. The presence of smaller beads in conventional resins results in filling of the interstitial spaces between the larger beads, thereby increasing the head loss. The uniform sized beads of DOWEX MARATHON A resin have a higher bed voidage than conventional resin which compensates for their smaller mean bead diameter, resulting in similar head loss characteristics to the conventional resins.

Figure 1. Backwash expansion vs. flow rate

Temperature = 25° C (77° F)



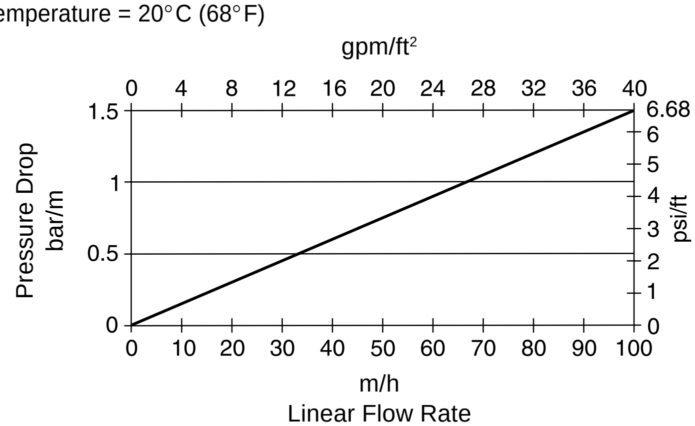
For other temperatures use:

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

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

Figure 2. Pressure drop

Temperature = 20° C (68° F)



For other temperatures use:

$P_T = P_{20°C} / (0.026T_{°C}+0.48)$, where $P \equiv bar/m$

$P_T = P_{68°F} / (0.014T_{°F}+0.05)$, where $P \equiv psi/ft$

The data in Figure 2 shows the pressure drop per unit bed depth as a function of both flow velocity and water temperature. These figures refer to new resin after backwashing and settling and should be considered indicative. The total head loss of a unit in operation will also depend on its design. It is substantially affected by the contribution of the strainers surrounded by the resin.

Operating Characteristics

DOWEX MARATHON A2 resin regenerates more efficiently, resulting in added capacity compared to conventional resins under the same conditions. This combination of high operating capacity and superior regeneration efficiency results in longer runs, increased throughput, lower operating costs and reduced waste disposal.

The recommended operating conditions in the table shown on page 3 are a guide and should not be restrictive. Excellent results in regeneration can be obtained when using NaOH in concentrations of 2% up to 8%.

A regenerant dosage rate of approximately 2 grams NaOH per liter of resin (0.1lb/ft^3) per minute has been found to be optimal. Also, the regenerant concentration should be chosen to give satisfactory chemical distribution and contact time. This often results in the use of 2 to 4% NaOH at a flow rate of about 3 bed volumes per hour (3 m^3/h/m^3 or 0.4 gpm/ft^3). The use of heated regenerant (up to 35°C/95°F) gives increased operating capacity and is especially useful for waters with a relatively high silica and/or organic matter load. Heating the regenerant is most effective if the resin has been pre-heated during the last bed volume of the backwash preceding regeneration.

Figure 3. Silica leakage in co-current operation. Regeneration at 15-20°C (60-70°F)

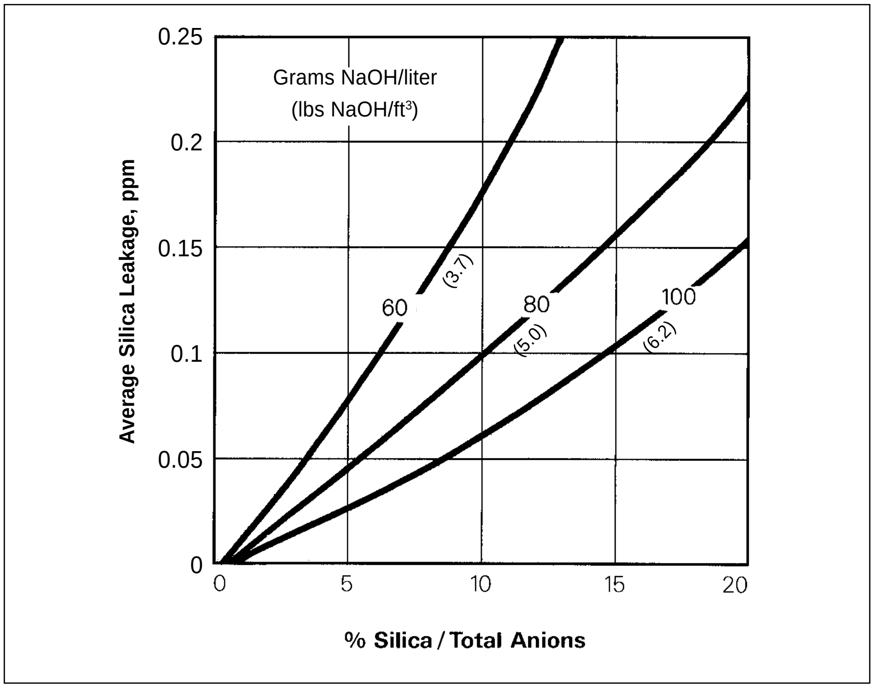
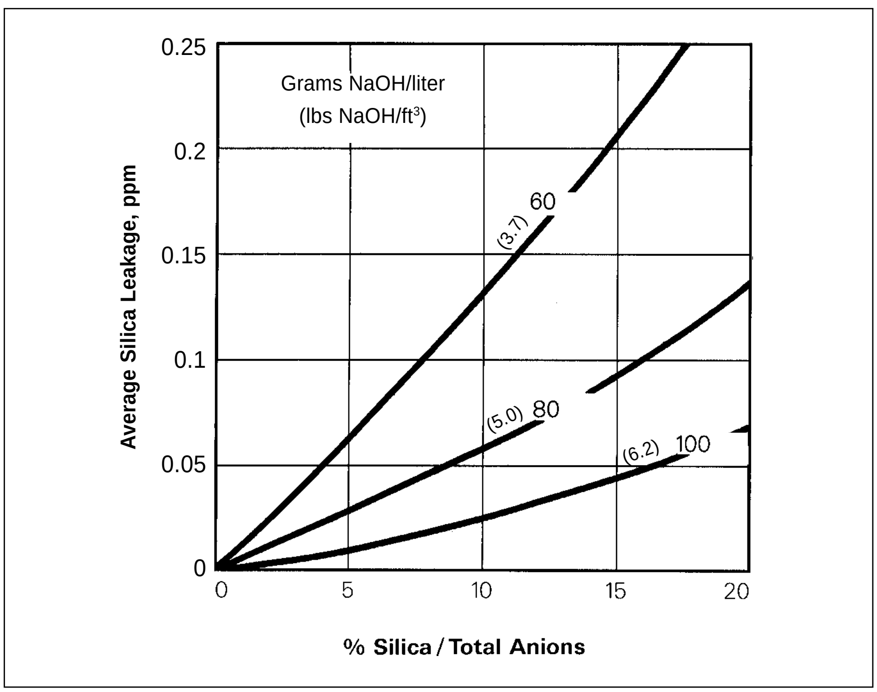


Figure 4. Silica leakage in co-current operation. Regeneration at 35°C (95°F)



Co-Current Operation

Silica leakage levels are shown in Figures 3 and 4 as a function of the regenerant level and percent silica to total anions in the feed. As the silica leakage is mainly dependent on the leakage of sodium through the cation exchanger, for the levels displayed in Figures 3 and 4 to be reached, a maximum leakage of 0.5 mg/l sodium should be maintained throughout the cycle, in order to avoid hydrolysis of the silica from the resin.

The temperature of the water being treated will have an effect on treated water quality. This shows particularly if a plant is shut down in high ambient temperature. The resultant silica may increase to double the normal value until the water returns to normal temperature.

Corrections for temperature and sodium leakage from the cation unit are given in Figures 5 and 6 for demineralization operation.

Typical operational capacities as a function of raw water composition and regenerant levels are given in Figure 7.

Figure 5. Temperature correction for co-current operation

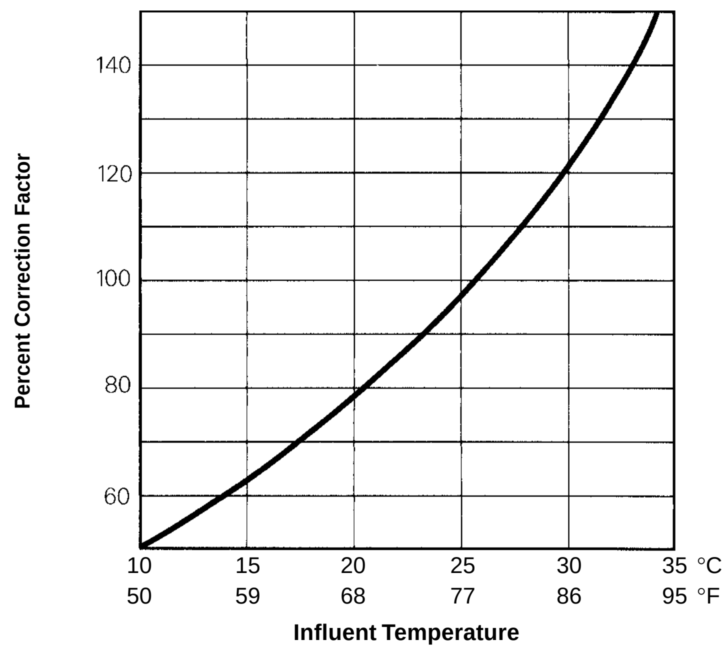
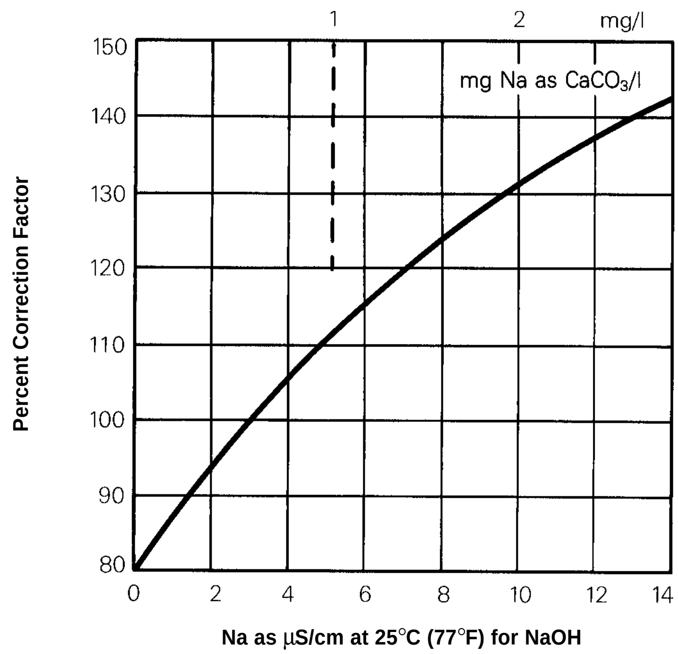


Figure 6. Sodium leakage correction for co-current operation



Co-current operational capacity data

Note: Use type 1 resin if $CO_2 + SiO_2$ exceeds 30%.
To calculate operational capacities:
1. Locate a point on the ordinate of graph A from chloride percentages of total anions.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guidelines on graph B to locate a new point on the ordinate according to the silica percentage of total anions.
3. Transfer the ordinate point from graph B horizontally to graph C and repeat the procedure in 2 above according to chosen regeneration level.
4. Read off horizontally the operational capacity corresponding to the ordinate point located on graph D.
5. For hot regeneration modify the abscissa point on graph C according to the guidelines given in graph D.
Note: eq/l x 21.8 = kgr/ft³ as $CaCO_3$.

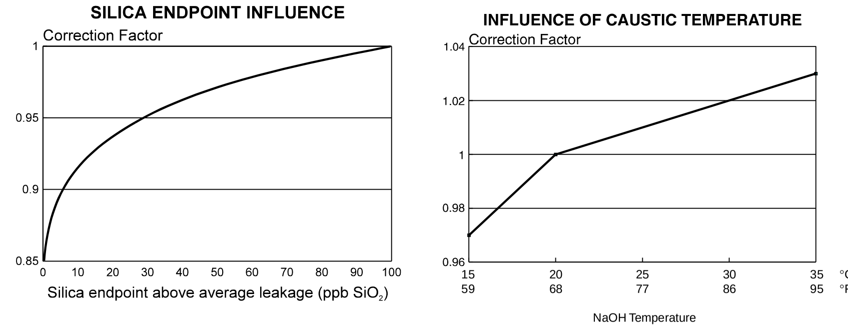
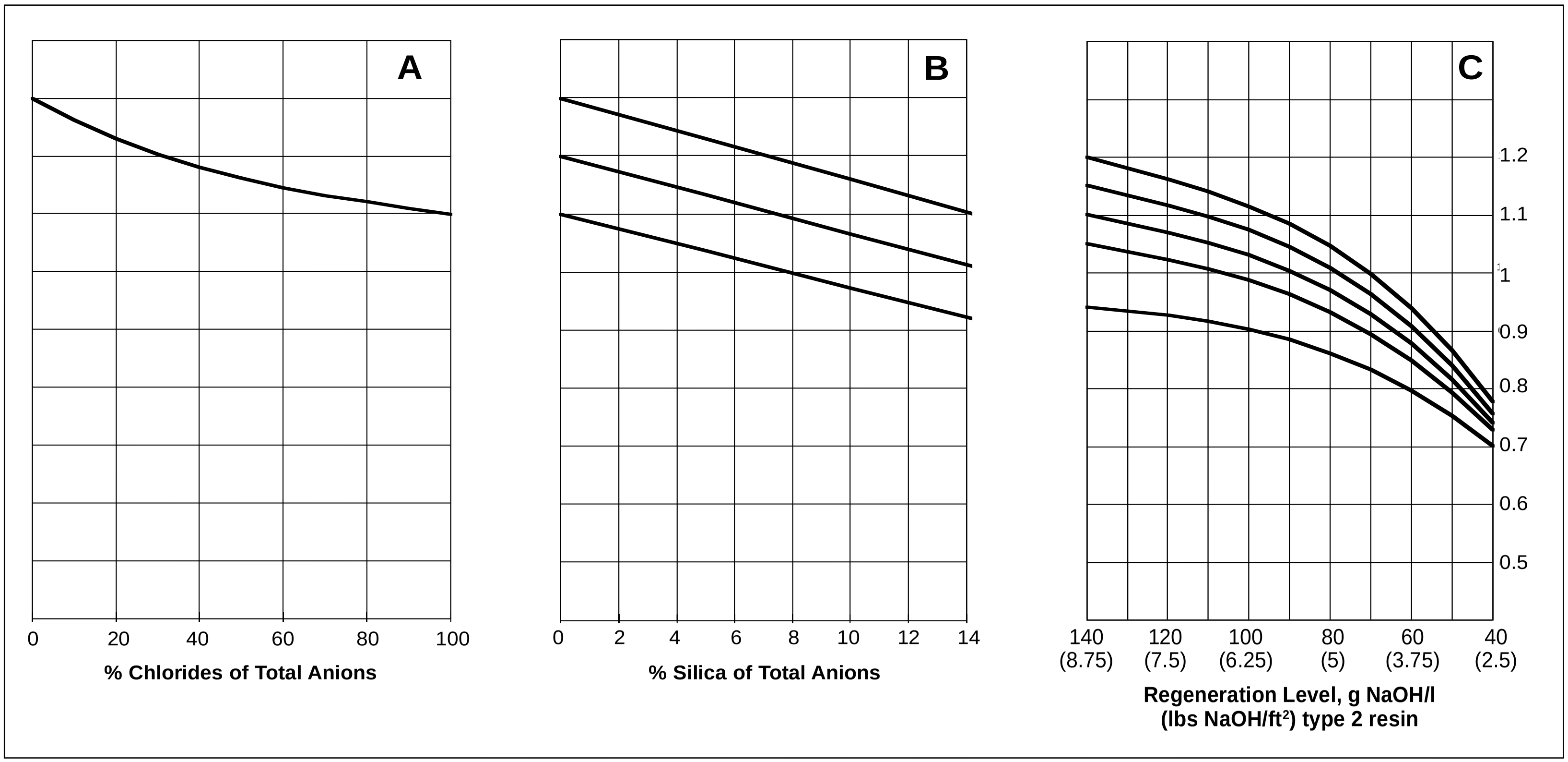


Figure 7. Co-current operational capacity data



Counter-Current Operation

The advantages of counter-current operation over co-current operation are well-known to be improved chemical efficiency (better capacity usage and decreased regeneration waste) and lower silica leakage. These advantages are further enhanced with the use of DOWEX MARATHON A2 uniform particle sized resin. A low silica leakage from the anion exchanger requires an equally good preceding cation exchange unit, delivering water with a residual sodium level below 0.25 mg/l. Such levels of sodium are preferably obtained by a well-designed counter-current cation exchange unit. With this quality of decationized water, one can expect the residual silica leakages for commonly used regeneration level ranges shown in Figure 8. Residual silica is further reduced by having a deep bed of resin as shown in Figure 9. It is possible to obtain values of half the levels given in Figure 8 for silica leakage under ideal circumstances. Comparing these silica leakage values to those for co-current regeneration (see Figures 3 and 4) demonstrates the advantages of counter-flow regeneration. For lower silica requirements, a type 1 anion resin such as DOWEX MARATHON A is recommended. Operational capacities as a function of raw water composition and regenerant levels are given in Figure 10.

The rinse requirements for DOWEX MARATHON A2 resin are very small, usually 2 m^3/m^3 of resin (0.25 gpm/ft^3). Note however, that larger diameter units are likely to have more non-uniform flow distribution, thereby increasing the likelihood of higher rinse requirements.

Figure 8. Residual silica for counter-current operation

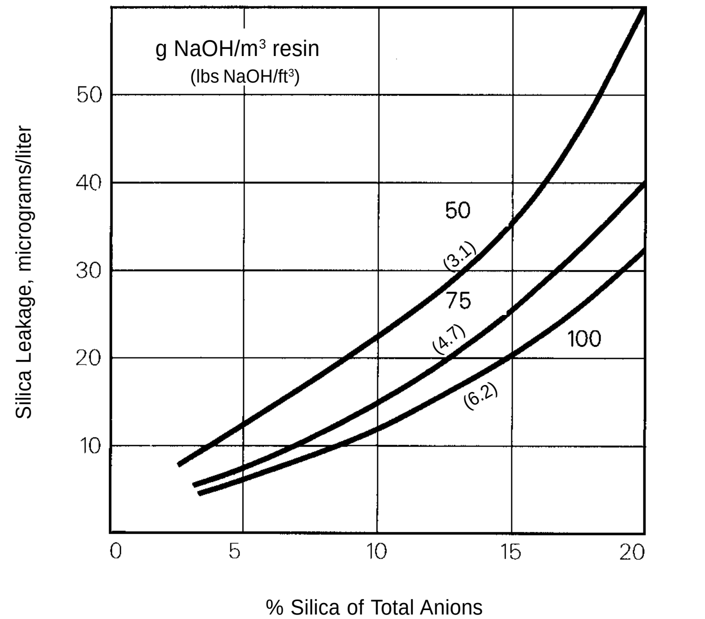
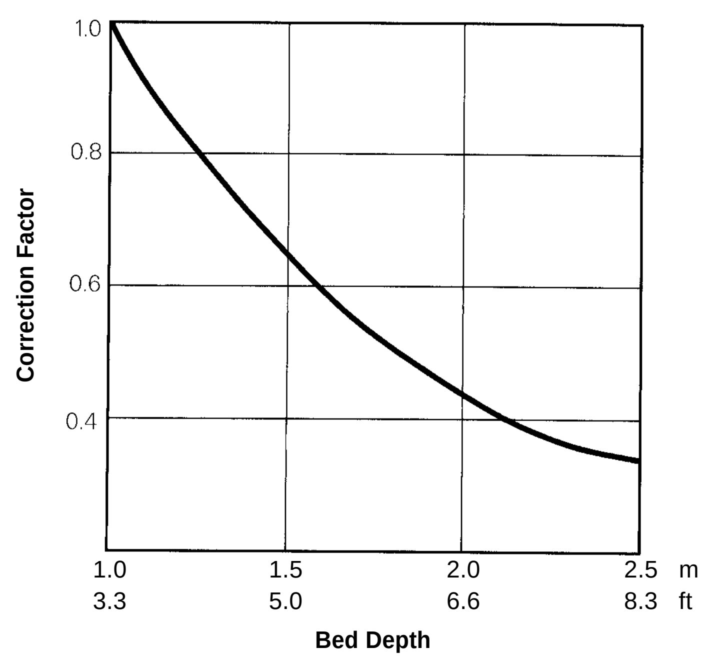


Figure 9. Correction factor bed depth for counter-current operation

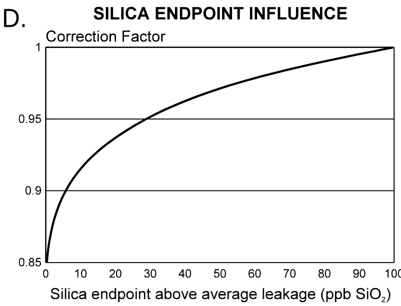


Counter-current operational capacity data

Note: Use type 1 resin if $CO_2 + SiO_2$ exceeds 30%.

To calculate operational capacities:

1. Locate a point on the ordinate of graph A from chloride percentages of total anions.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guidelines on graph B to locate a new point on the ordinate according to the silica percentage of total anions.
3. Transfer the ordinate point from graph C horizontally to graph D and repeat the procedure in 2 above according to chosen regeneration level.
4. Read off horizontally the operational capacity corresponding to the ordinate point located on graph D.
5. For hot regeneration modify the abscissa point on graph D according to the guidelines given in graph D.



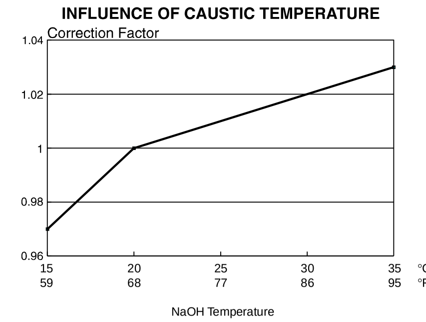
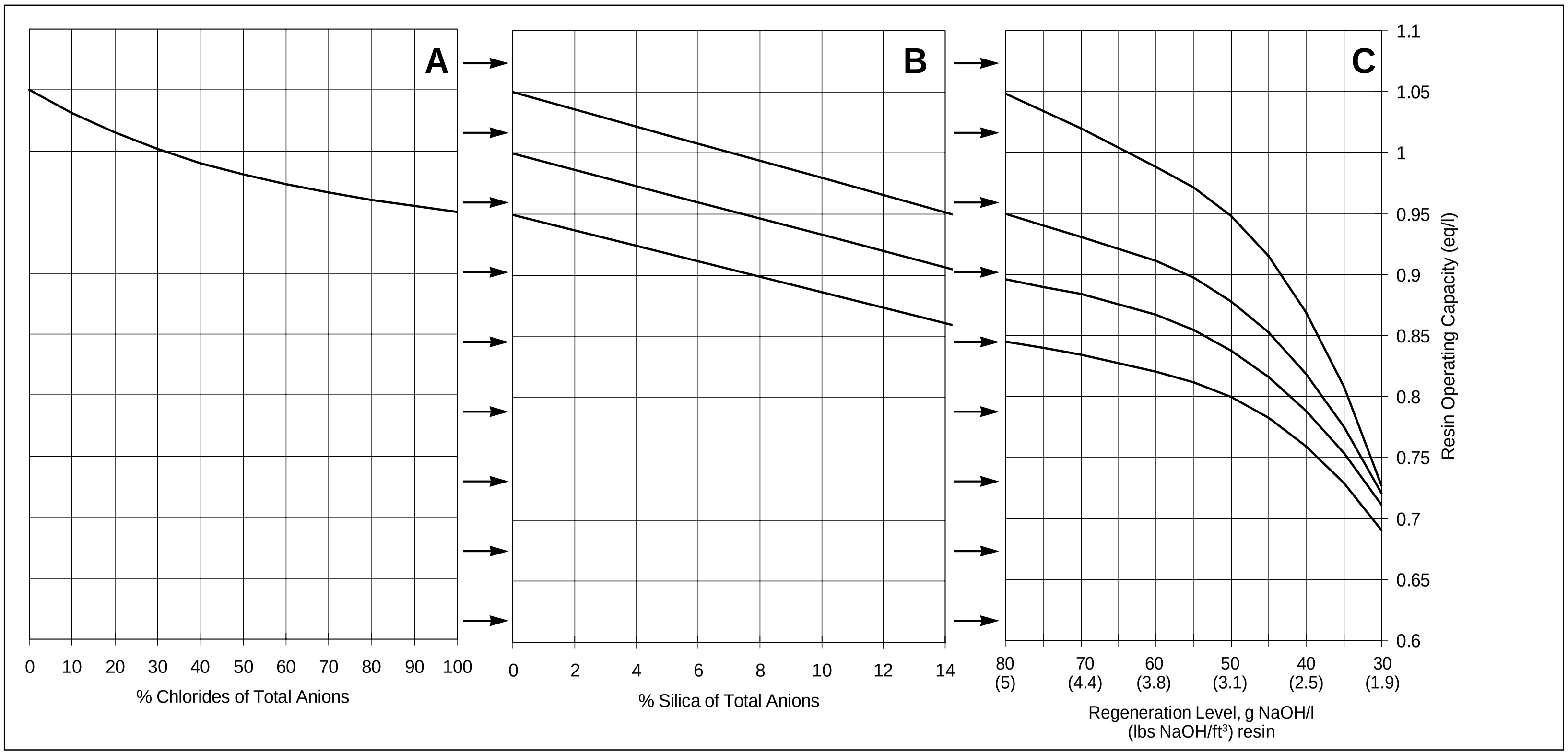


Figure 10. Counter-current operational capacity data



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† 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.

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