Dow
Liquid Separations

DOWEX MARATHON A

Ion Exchange Resin

ENGINEERING INFORMATION

DOWEX MARATHON A Type 1 Strong Base Anion Exchange Resin

General Information

DOWEX* MARATHON* A resin is a high capacity, gel type 1, strong base anion exchange resin of uniform bead size distribution. It is a based on a styrene-divinyl benzene copolymer matrix with quaternary ammonium functional groups. DOWEX MARATHON A resin is specifically designed to give high throughput and economical operation in both water and non-water applications. It's uniform particle size offers a number of advantages compared to conventional (polydispersed) resins. The small uniform bead size of DOWEX MARATHON A resin results in rapid exchange kinetics during operation, more complete regeneration of the resin and faster, more thorough rinse following regeneration.

The narrow particle size distribution of DOWEX MARATHON A makes this resin well suited for use in working mixed beds and layered beds.

DOWEX MARATHON A resin, in combination with DOWEX MARATHON C resin, gives outstanding separation and performance in mixed beds. These two resins are sold combined in a ready to use mixed resin, DOWEX MARATHON MR-3. DOWEX MARATHON A LB resin has a specially tailored particle size distribution to allow excellent separation from DOWEX MARATHON WBA resin in layered bed units.

This brochure relates to water demineralization using NaOH as regenerant in co-current or counter-current operation. The presented data permits the calculation of operational capacities and silica leakages for different influent waters at different temperatures and levels of regeneration.

Guaranteed Sales Specifications		Cl^- form	OH^- form
Total exchange capacity, min.	eq/l	1.3	1.0
	kgr/ft^3 as $CaCO_3$	28.4	21.9
Water content	%	50-60	60-72
Uniformity coefficient, max.		1.1	1.1

Typical Physical and Chemical Properties		Cl^- form	OH^- form
Mean particle size†	µm	575 ± 50	610 ± 50
Whole uncracked beads	%	95-100	95-100
Total swelling (Cl^- ♦ OH^-)	%	20	20
Particle density	g/ml	1.08	1.06
Shipping weight	g/l	670	640
	lbs/ft^3	42	40

Recommended Operating Conditions	
Maximum operating temperature:	
OH^- form	60°C (140°F)
Cl^- form	100°C (212°F)
pH range	0-14
Bed depth, min.	800 mm (2.6 ft)
Flow rates:	
Service/fast rinse	5-60 m/h (2-24 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)
Total rinse requirement	3-6 Bed volumes
Regenerant:	
Type	2-5% NaOH
Temperature	Ambient or up to 50°C (122°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

Bed Expansion

A resin with uniform particle size requires less backwash flow to expand to the same height as a conventional polydispersed resin of the same average particle size.

DOWEX MARATHON A resin has a smaller mean size, thereby reducing the backwash flow rate required even further. Under the upflow conditions of backwashing, the resin will expand its volume according to Figure 1. Backwash expansion allows reclassification of the resin, removes fines and helps prevent 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 before every regeneration. In counter-current operation, backwashing is only recommended if accumulated debris cause 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.

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 (void volume), 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 pressure drop. Compared to conventional resins, uniform beads have a higher voidage which compensates for the smaller mean bead diameter, resulting in similar pressure drop 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. 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 lateral design.

Figure 1. Backwash expansion vs. flow rate

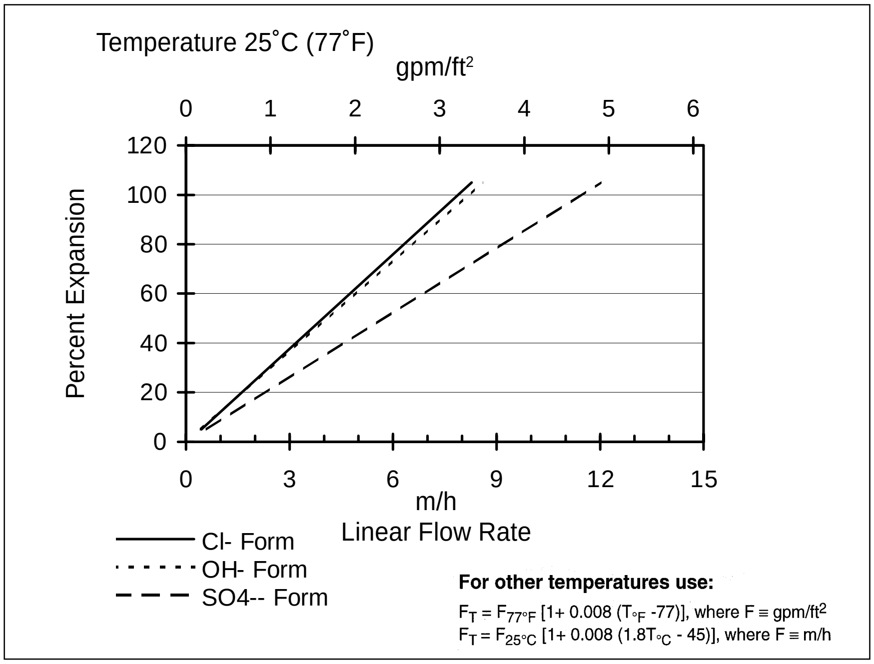
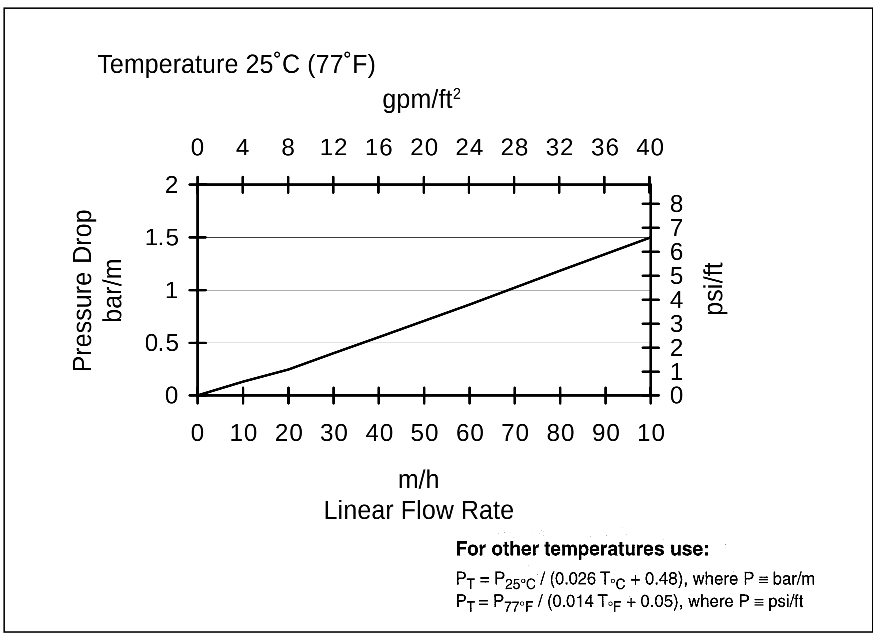


Figure 2. Pressure drop



Operating Characteristics

DOWEX MARATHON A resin regenerates more efficiently, resulting in added capacity compared to conventional resins under the same conditions. This results in lower operating costs, reduced waste leakages volume and lower silica.

The suggested operating conditions in the table shown on page 1 are intended as a guide and should not be found restrictive. Excellent results will be obtained when using alkali concentration from 2 to 5%. Even 8% can be used under certain controlled conditions. The regenerant flow is based on presenting approximately 2 grams NaOH per liter of resin per minute. This appears to give the best performance using 4% NaOH, resulting in a regeneration flow rate of 3 m^3/h per m^3 of installed resin (0.4 gpm/ft^3).

The use of hot regenerant (up to 50°C/120°F) gives an increased operational capacity, especially for waters with a high silica load. Note that it is most efficient if the resin bed has been preheated.

The engineering design, especially of the distribution and collection systems, will be strongly influenced by the operational flow rates. The compatibility of this design with the needs of an efficient regeneration will be of the utmost importance and may change the regeneration recommendations in some aspects to obtain an optimal system. In large plants for instance, a lower concentration and a proportionally higher regenerant flow rate may be appropriate to overcome problems of chemical distribution.

The performance of the anion exchange unit will be evaluated on the basis of its regeneration efficiency and the silica leakage. Most importantly, the resin must keep performing over long time periods and its capacity to do so will depend on its chemical and physical stability and its resistance to fouling by organic material or silica polymerization. DOWEX MARATHON A resin, with its excellent kinetics and physical strength, has the characteristics to provide such high performance.

Co-Current Operation

Silica leakage levels are shown in Figures 3 to 6 as a function of the regenerant level and percent silica to total anions in the feed. As the silica leakage is mainly dependant on the leakage of sodium through the cation exchanger, for the levels displayed in Figures 3 to 6 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.

With ideal design, silica figures around 0.005 mg/l can be obtained for a large percentage of the operating cycle, provided that CO_2 plus the silica do not exceed 30% of the total anions. This will mostly be the case when no weak base anion resin precedes the strong base anion exchanger, and certainly when degassified feedwater is processed. Irrespective of the CO_2 concentration, the figures given in the graphs 3 to 6 should be easily achieved. If silica exceeds 40% of the total anions, it is generally advised not to exhaust the strongly basic resin exclusively with silica.

If an anion exchange resin is heavily loaded with silica, warm NaOH is recommended to remove it. The maximum permitted temperature is 60°C (140°F), but is not normally necessary. Indeed, in cases in which a low silica residual is required, the use of counter-current regeneration, may prove more economical than heating the regenerant.

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

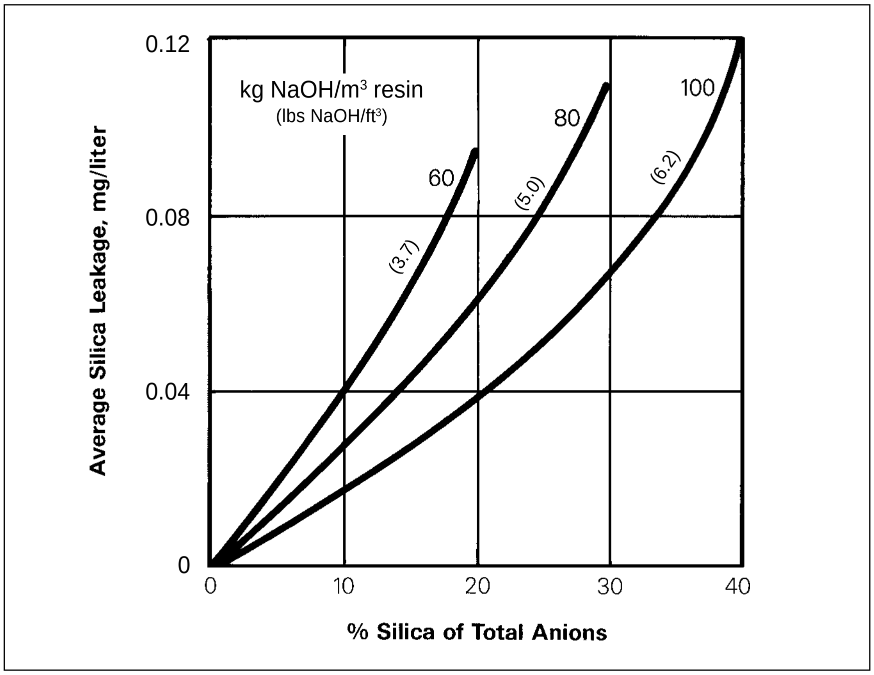
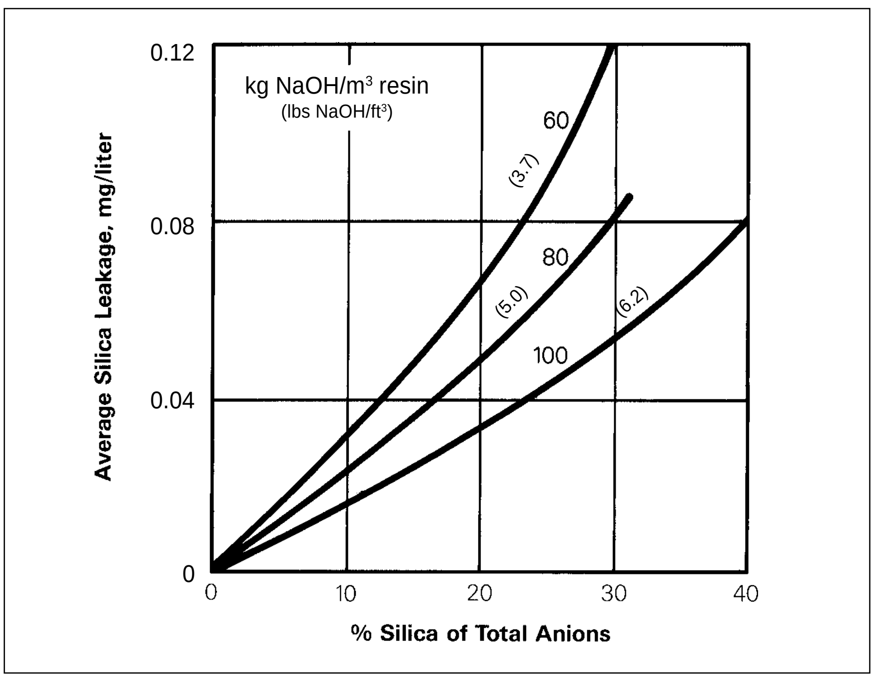


Figure 4. Silica leakage in co-current operation. Regeneration at 35°C (95°F) above operational temperature



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 figure until the water returns to normal temperature. Capacity data for DOWEX MARATHON A resin, exclusively loaded with CO_2 and SiO_2 are given in Figure 7. The influence of the regeneration level and temperature are expressed for different proportions of SiO_2. The data relate to a silica rinse of 1 mg/l as endpoint determination.
Data on co-flow operational capacities for DOWEX MARATHON A resin for other water qualities are presented in Figure 8.

Figure 5. Silica leakage in co-current operation. Regeneration at 50°C (120°F) above operational temperature

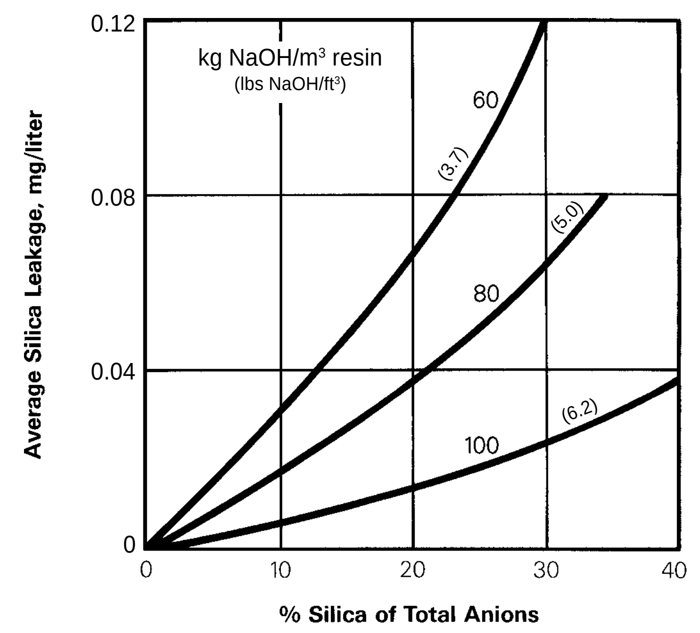


Figure 6. Leakage correction factor for sodium co-current operation

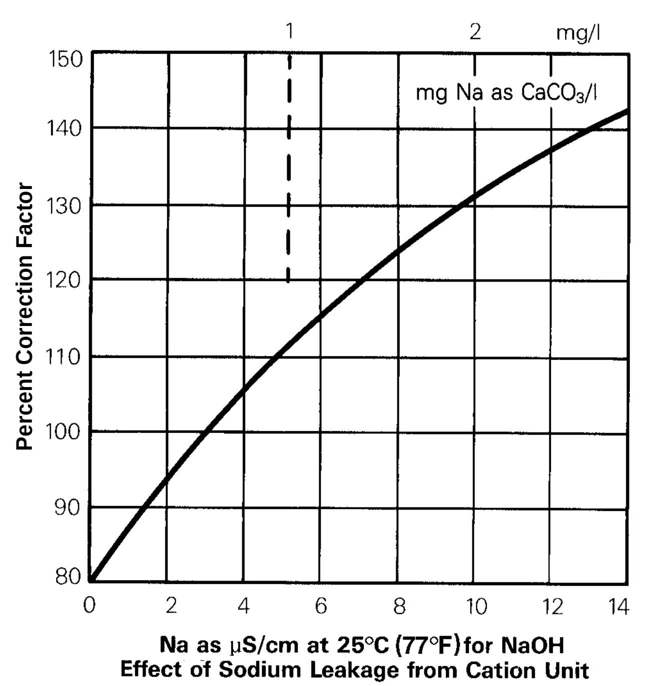
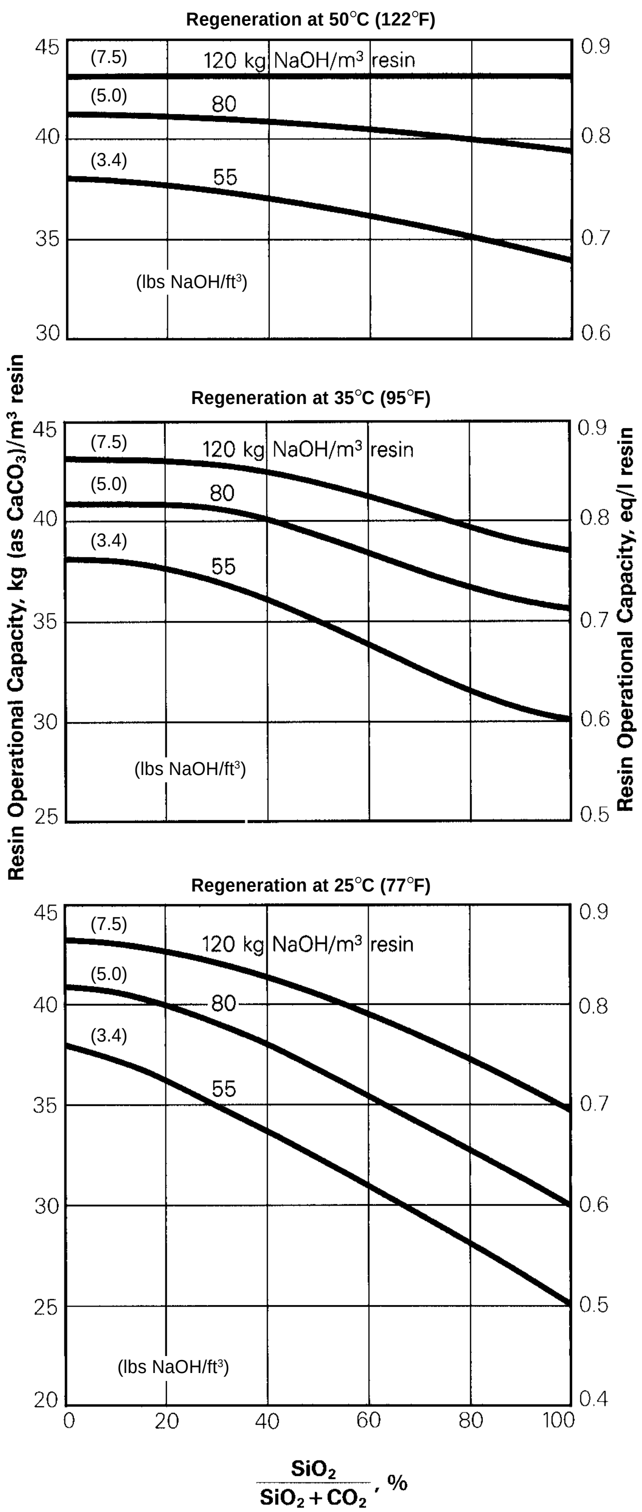


Figure 7. Co-current operational capacity data for CO_2 and SiO_2



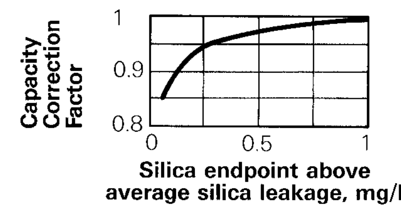
Co-current operational capacity data

To calculate operational capacities:

1. Locate a point on the ordinate of graph A from carbon dioxide and chloride percentage 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 nitrate percentage of total anions.
3. Transfer the ordinate point from graph B horizontally to graph C and repeat the procedure under point 2 according to silica percentage of total anions.
4. Transfer the ordinate point from graph C horizontally to graph D and repeat the procedure under point 2 according to the chosen regeneration level.
5. Now for regeneration at different temperatures modify the abscissa point on graph D according to the guidelines given at the top of this graph.
6. Read off on the right hand side of the diagram the operational capacity corresponding to the ordinate point located on graph D.

Note: eq/l x 21.85 = kgr/ft^3 as $CaCO_3$.

Counter-Current Operation



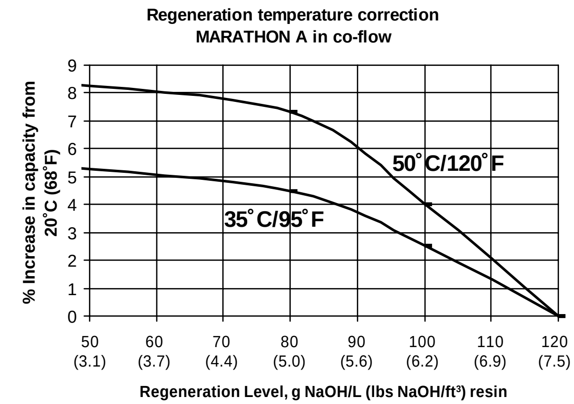
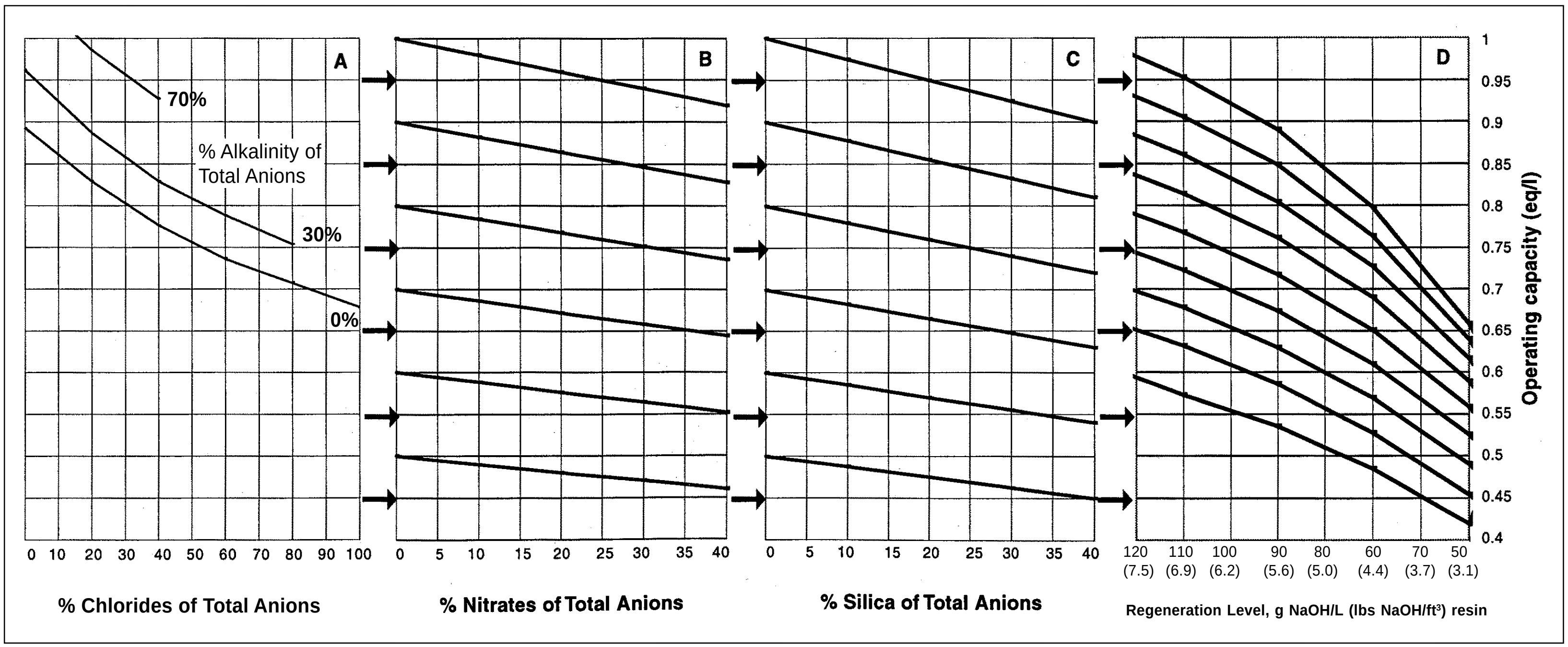


Figure 8. Co-current operational capacity data



The advantages of counter-current operation over co-current operation are well-known to be improved chemical efficiency (better capacity utilization and decreased regeneration waste) and lower silica leakage. These advantages are further enhanced with the use of uniform particle sized resins. 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. With this quality of decationized water, one can expect a residual silica below 5 micrograms per liter for about 90% of the operational cycle. Data on silica leakage levels are presented in Figures 9 to 11.

Demineralized water is needed to dilute the regeneration chemicals and for the displacement rinse, which is carried out in the flow direction of the regeneration. The final rinse is then carried out with decationized water from the cation exchange unit in the flow direction of the service cycle.

As a type 1 strongly basic resin

Figure 9. Residual silica in counter-current operation

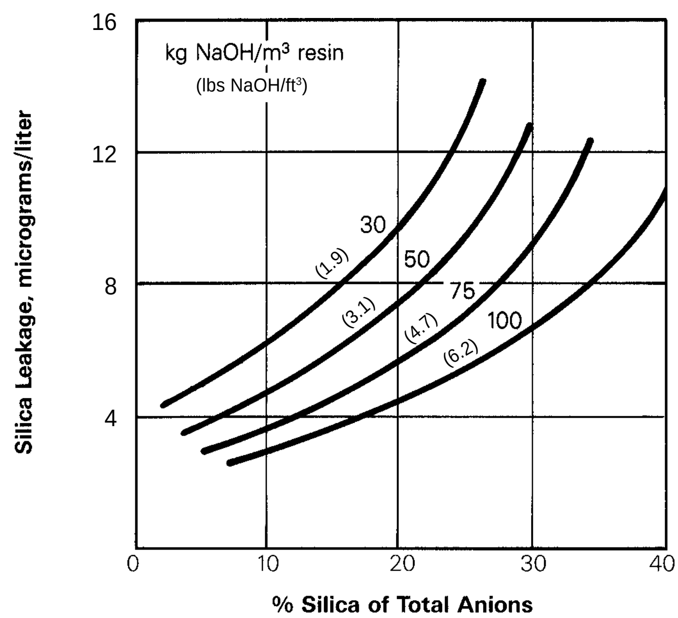
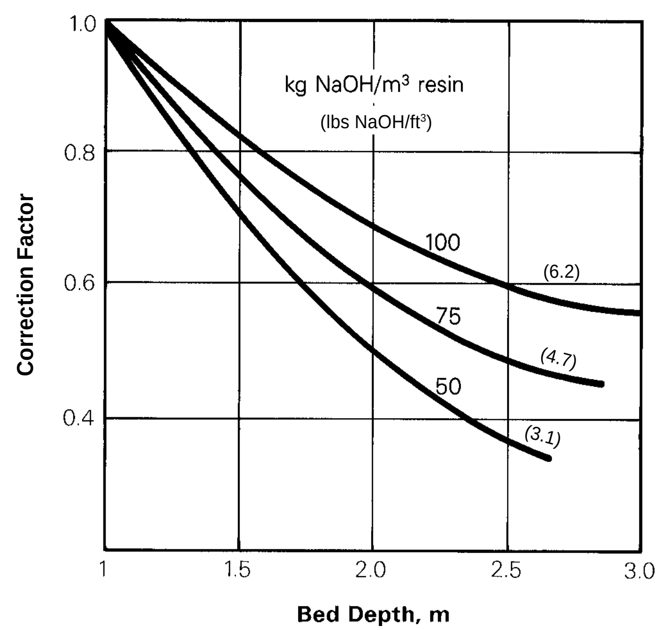


Figure 10. Correction factor for bed depth for counter-current operation

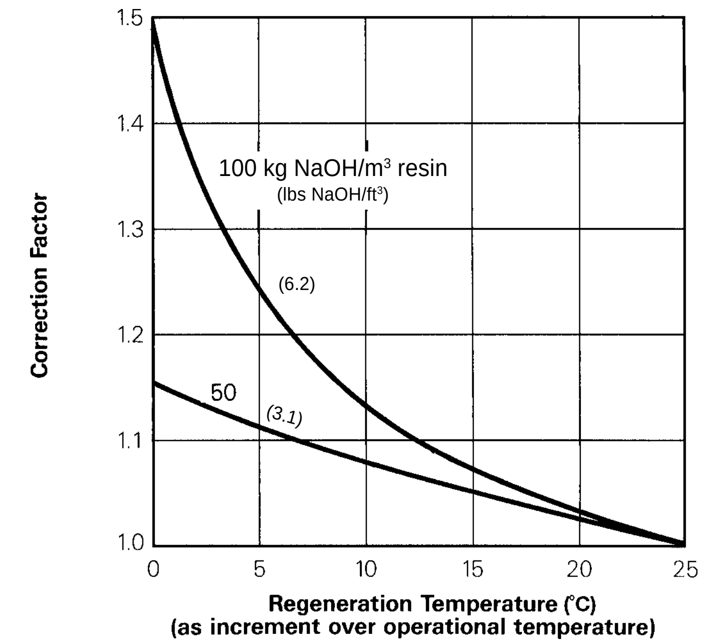


operated in counter-current is often chosen to obtain a very low silica leakage, the following steps are recommended:

1. Define bed depth and regeneration level from Figures 9 to 11 to design for the required silica leakage.
2. Assure a low sodium content in the feedwater.
3. Assure that regeneration chemicals are properly distributed over the entire resin bed and that no dilution occurs.
4. Minimize the organics in the feedwater, whether by proper pretreatment, organic scavenging or a preceding anion unit.
5. Avoid backwashing unless necessary to decompact the bed to avoid channelling.
6. Assure that the polishing zone of the bed is kept intact mechanically, during regeneration and service, and chemically by not overrunning the anion exchanger. Preferably terminate the service cycle prior to silica breakthrough.
7. Regenerate at a higher temperature than the operational temperature.
8. Avoid loading more than 15 g SiO_2 per liter resin.

Data on counter-current operational capacities for DOWEX MARATHON A resin are presented in Figure 12.

Figure 11. Correction for regeneration temperature

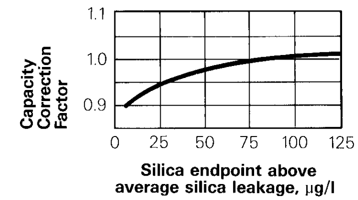


Counter-current operational capacity data

To calculate operational capacities:

1. Locate a point on the ordinate of graph A from carbon dioxide and chloride percentage 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 nitrate percentage of total anions.
3. Transfer the ordinate point from graph B horizontally to graph C and repeat the procedure under point 2 according to silica percentage of total anions.
4. Transfer the ordinate point from graph C horizontally to graph D and repeat the procedure under point 2 according to the chosen regeneration level.
5. Now for regeneration at different temperatures modify the abscissa point on graph D according to the guidelines given at the top of this graph.
6. Read off on the right hand side of the diagram the operational capacity corresponding to the ordinate point located on graph D.

Note: eq/l x 21.8 = kgr/ft³ as $CaCO_3$.



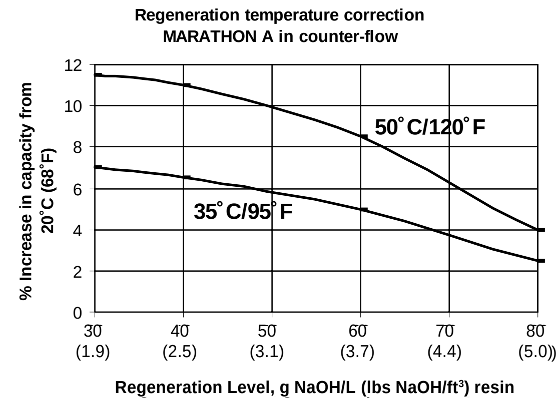
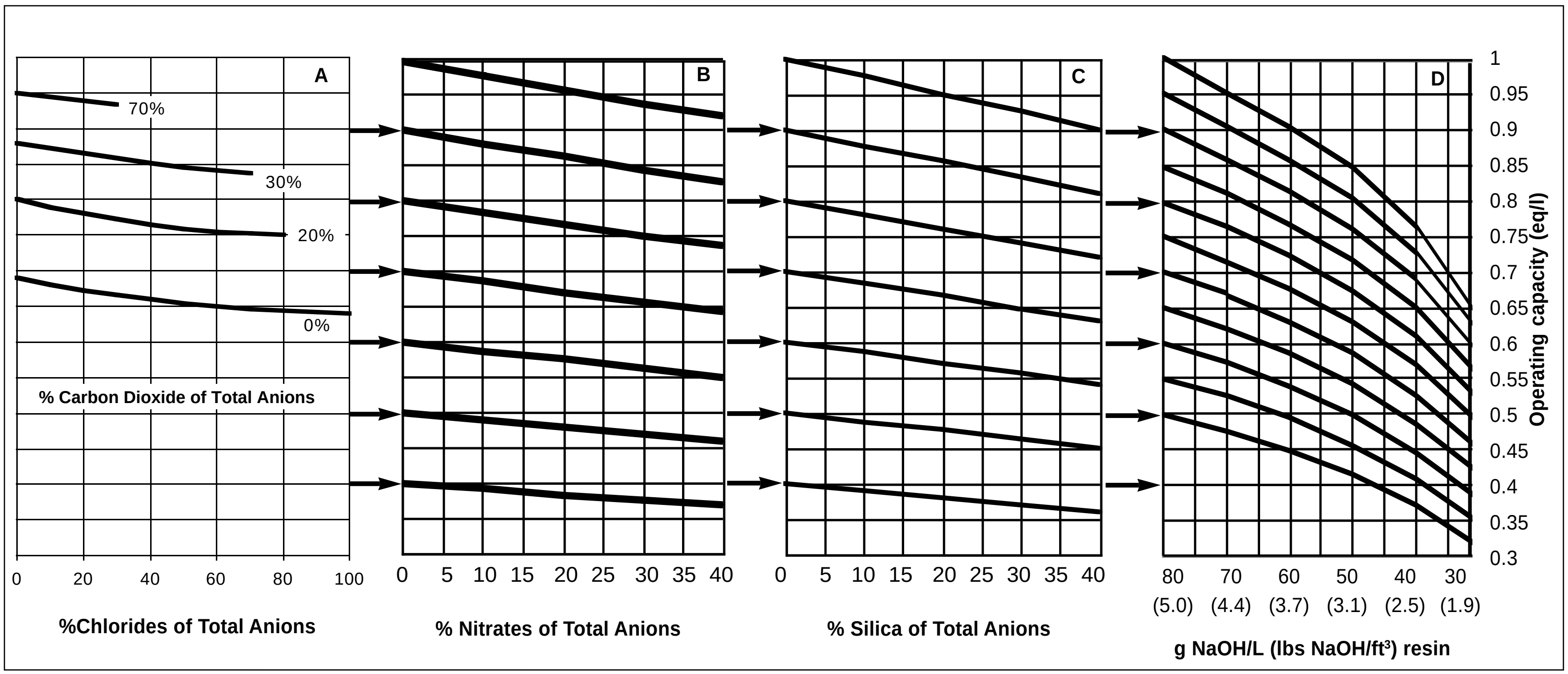


Figure 12. Counter-current operational capacity data



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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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DOW*

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