Dow
Liquid Separations

DOWEX SBR-P

Ion Exchange Resin

ENGINEERING INFORMATION

DOWEX SBR-P Type 1 Strong Base Anion Exchange Resin

General Information

DOWEX* SBR-P resin is a gel type 1 strong base anion exchange resin with a high capacity and regeneration efficiency, based on a styrene-divinyl benzene copolymer matrix with quaternary ammonium functional groups. It is a porous resin manufactured to incorporate the characteristics of conventional strong base anion resins together with the advantages of a high wet volume capacity and good mechanical strength. In this way, it combines fast equilibrium rates, low rinse requirements and high regeneration efficiencies with moderate volume changes when changing ionic form. Due to its high porosity, DOWEX SBR-P resin is resistant to organic fouling while providing good removal of organics from water. When the organic content of the incoming water is high, DOWEX MSA-1, DOWEX MSA-2 or DOWEX 11 resin may be a prefered choice to avoid problems of organic fouling of the resin.

DOWEX SBR-P resin is typically used in two or three bed demineralization systems. The particle size diztribution of DOWEX SBR-P resin allows it to be used at high flow rates. For more demanding conditions, such as treating high temperature waters (>50°C/120°F) in the presence of oxidants, another strong base anion gel type I resin DOWEX SBR, is preferred.

DOWEX SBR-P MB resin is graded for use in working mixed beds and DOWEX SBR-P PS resin is designed for counter-current regeneration systems. The specially graded DOWEX SBR-P C resin has a narrower bead size distribution with 2% max. above 1.19 mm and 1% max. below 0.35 mm and is used for higher flow rates or a lower pressure drop at equal flow conditions. DOWEX SBR-P C resin has increased mechanical strength which makes it a resin of choice for applications such as condensate polishing and high flow deep bed demineralization. In combination with DOWEX HCR-W2 resin, it will give excellent performance in polishing mixed beds.

This brochure relates to water demineralization using NaOH 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.

Typical Physical and Chemical Properties		
Ionic form as delivered		Cl^-
Total exchange capacity, min.	eq/l	1.2
	kgr/ft^3 as $CaCO_3$	26.2
Water content	%	53-60
Bead size distribution		
Range	mm	0.3 - 1.2
>1.2 mm	%	2
<0.3 mm	%	2
Total swelling (Cl ♦ OH), approx.	%	20
Whole perfect beads, min.	%	90
Particle density, approx.	g/ml	1.08
Shipping weight, approx.	g/l	690
	lbs/ft^3	43

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	5-50 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)
Total rinse requirement	3-6 Bed volumes
Regenerant:	
Type	2-5% NaOH
Temperature	Ambient or up to 50°C (122°F) for silica removal

Hydraulic Characteristics

Bed Expansion

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 better flow distribution during the subsequent regeneration cycle. An expansion of around 80% for 20 minutes is normally recommended to remove particulate matter from the resin bed. Occasionally, a longer backwash may be needed to fully remove contaminants.

In counter-current operation, backwashing is only required 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.

Pressure Drop Data

The pressure drop across a resin bed can vary depending on a number of factors. These include resin type, bead size and distribution, interstitial space (bed voidage), flow rate and temperature.

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 standard grade resin (0.3-1.2 mm). 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. Due to their narrower particle size distributions, DOWEX SBR-P PS and DOWEX SBR-P C resins can exhibit approximately 5% lower pressure drop characteristics than those illustrated in Figure 2.

Figure 1. Backwash expansion vs. flow rate

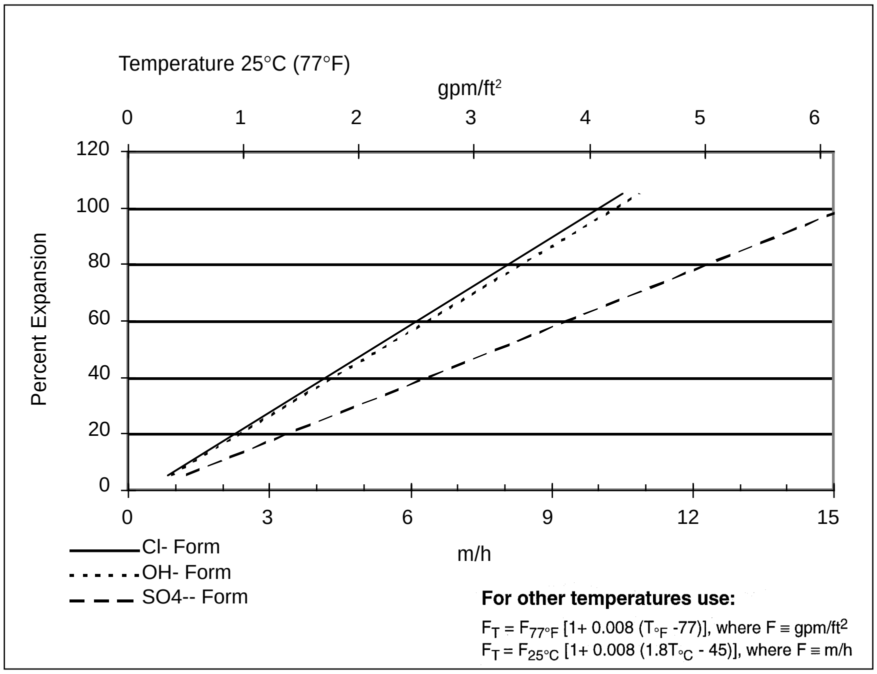
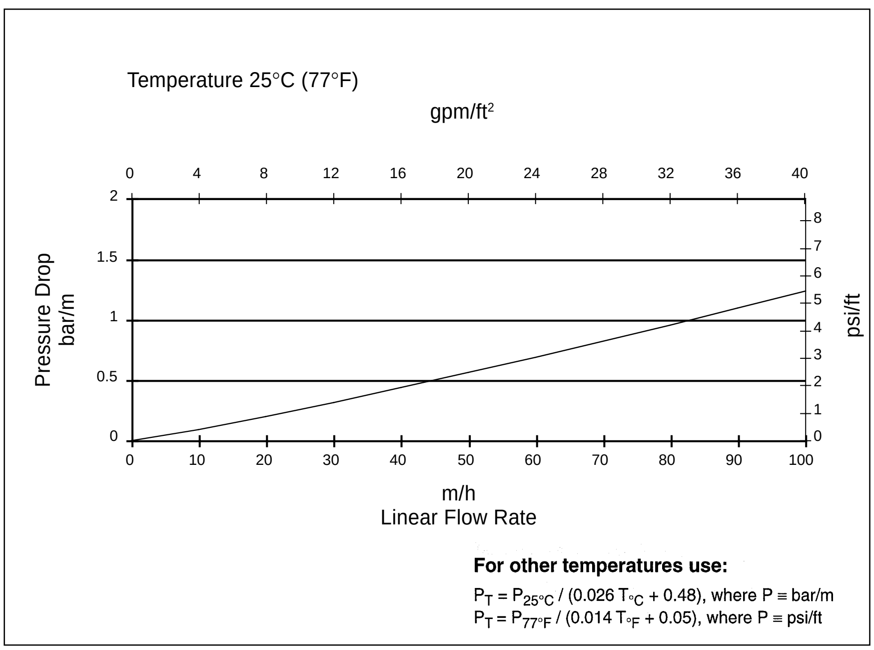


Figure 2. Pressure drop



Operating Characteristics

The suggested operating conditions in the table above are intended as a guide and should not be found restrictive. Excellent results will be obtained when using any 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 (0.4gpm/ft^3).

The use of hot regenerant (up to 50°C/120°F) gives an increased operational capacity and is especially useful for waters with a high silica load. Note that it will only be efficient if the resin has been preheated during the last bed volume of the preceding backwash.

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. The guidelines in the table are given to provide good operation conditions for DOWEX SBR-P resin.

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 dependent 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. A low enough sodium level should preferably be ensured using a counter-current regenerated cation exchange unit.

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 degassed feedwater is processed.

Irrespective of the CO_2 concentration, the figures given in the graphs 3 to 6 should be achieved. If silica exceeds 40% of the total anions, (this normally only occurs if a weak base anion resin preceeds the strong base anion), it is generally advisable not to exhaust the strong base anion 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 all cases in which a low silica residual is required, the use of counter-current regeneration, may prove more economical than heating the regenerant.

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 resul-tant silica may increase to double the normal figure until the water re-turns to normal temperature.

Capacity data for DOWEX SBR-P, 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 end-point determination.

Data on co-flow operational capacities for DOWEX SBR-P resin for other water qualities are presented in Figure 8.

Figure 3. Silica leakage in co-current operation, Regeneration in operational temperature

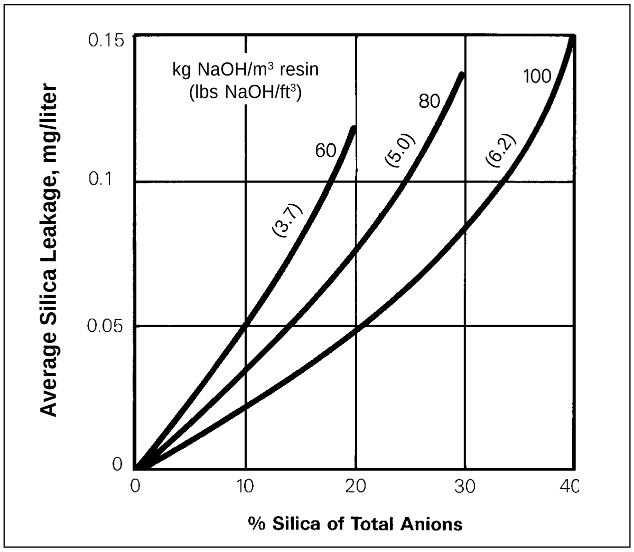


Figure 4. Silica leakage in co-current operation, Regeneration at 10°C (18°F) above operational temperature

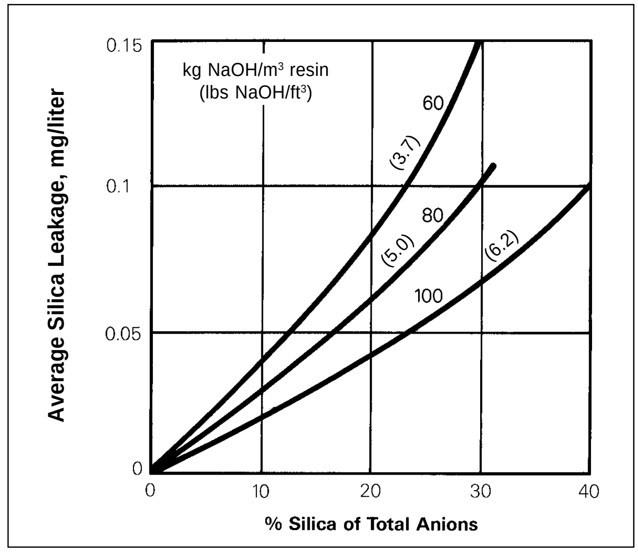


Figure 5. Silica leakage in co-current operation, Regeneration at 20°C (36°F) above operational temperature

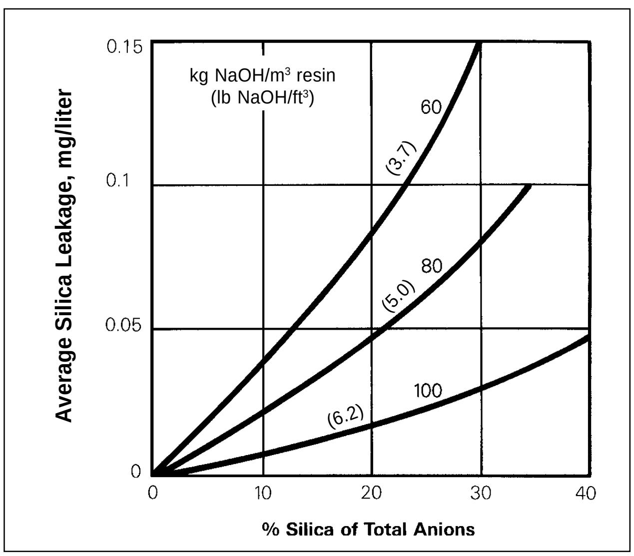


Figure 6. Sodium leakage correction for co-current operation

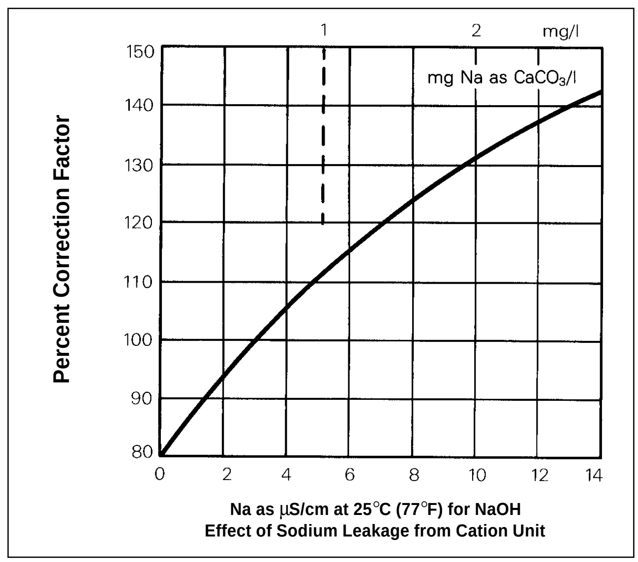
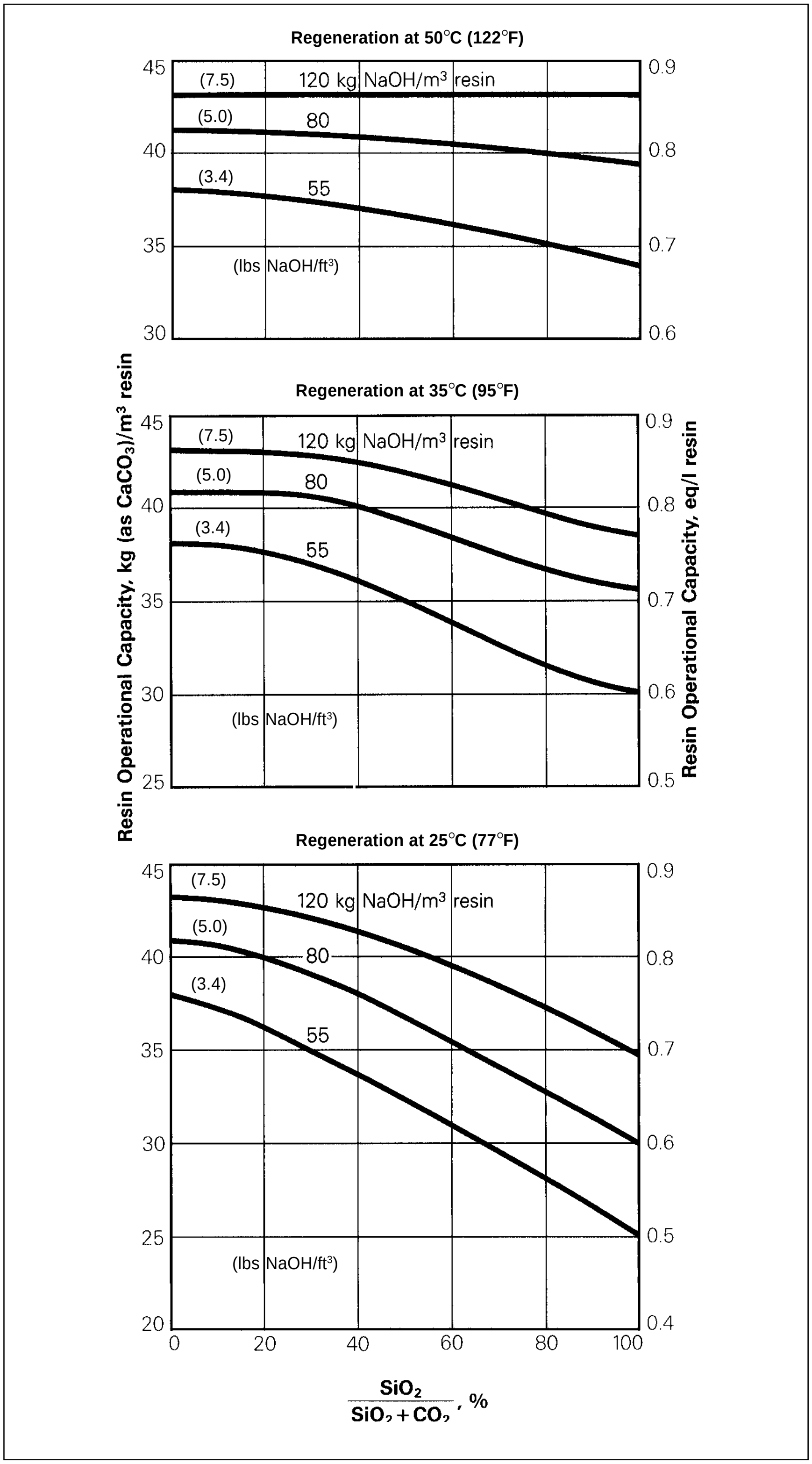


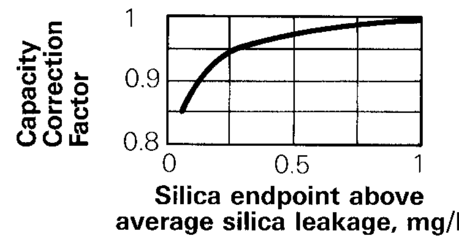
Figure 7. Co-current operational capacity data for CO_2 and SiO_2 loading of DOWEX SBR-P resin



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 capacit corresponding to the ordinate point located on graph D.



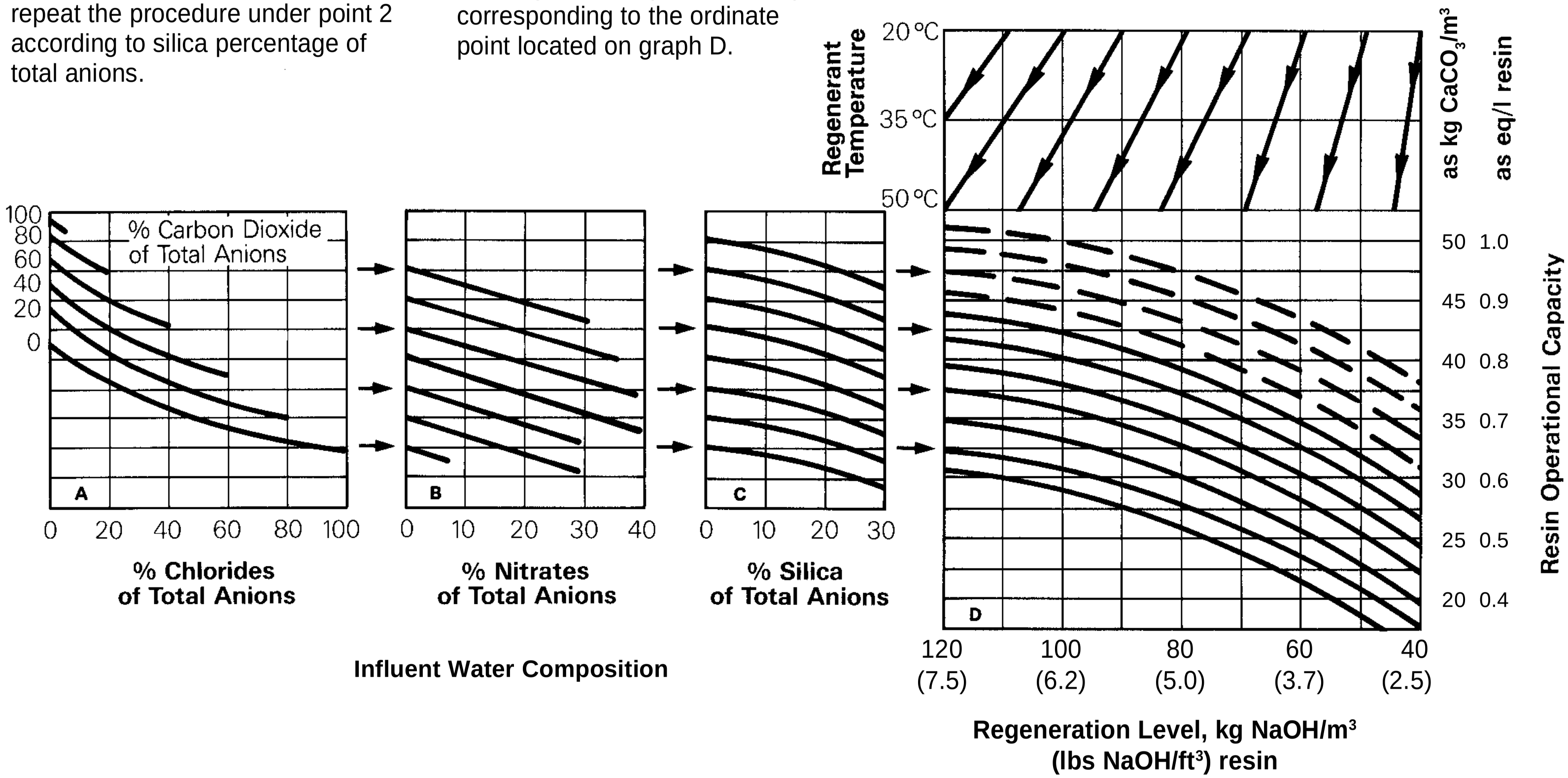


Figure 8. Co-current operational capacity data

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. 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. A type 2 anion exchanger such as DOWEX SAR or DOWEX MSA-2 may give such performance, but DOWEX SBR-P resin will mostly outperform such type 2 resins as far as silica leakage is concerned. 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.

Figure 9. Resident silica in counter-current operation

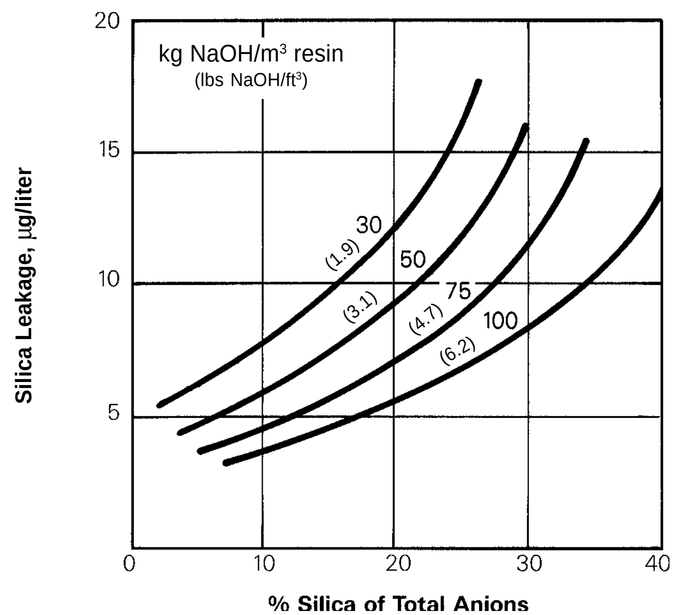
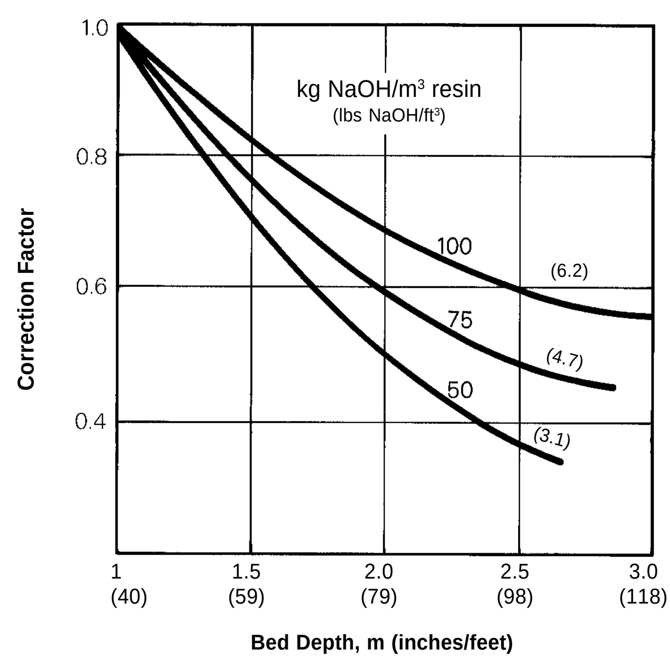


Figure 10. Silica leakage correction factor bed depth for counter-current operation operation

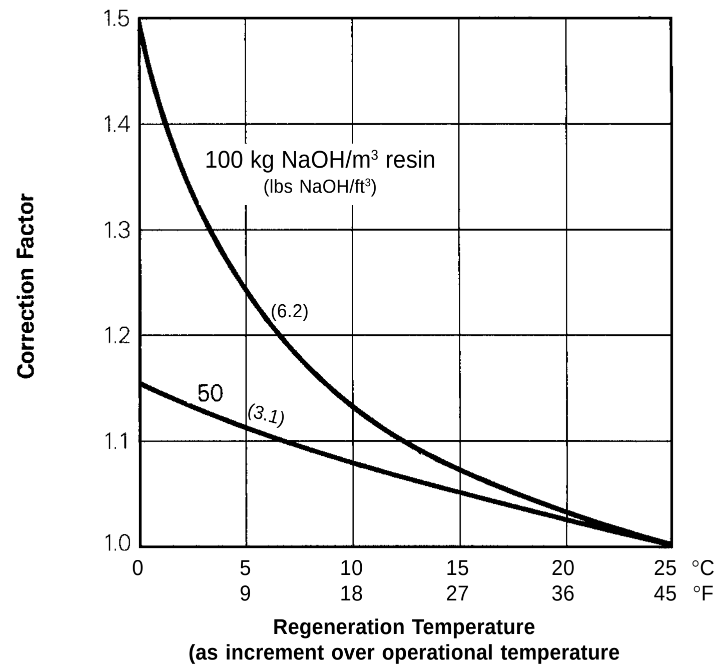


As a type 1 strong base anion resin operated in counter-current is often chosen to obtain a very low silica leakage, the following steps are recommended:

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 15g SiO_2 per liter resin.

Data on counter-current operational capacities for DOWEX SBR-P resin is given in Figure 12.

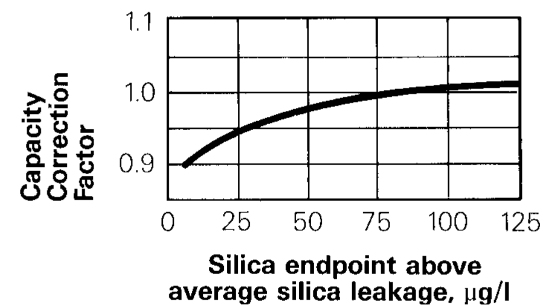
Figure 11. Silica leakage correction for regeneration temperature



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 percent age 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.



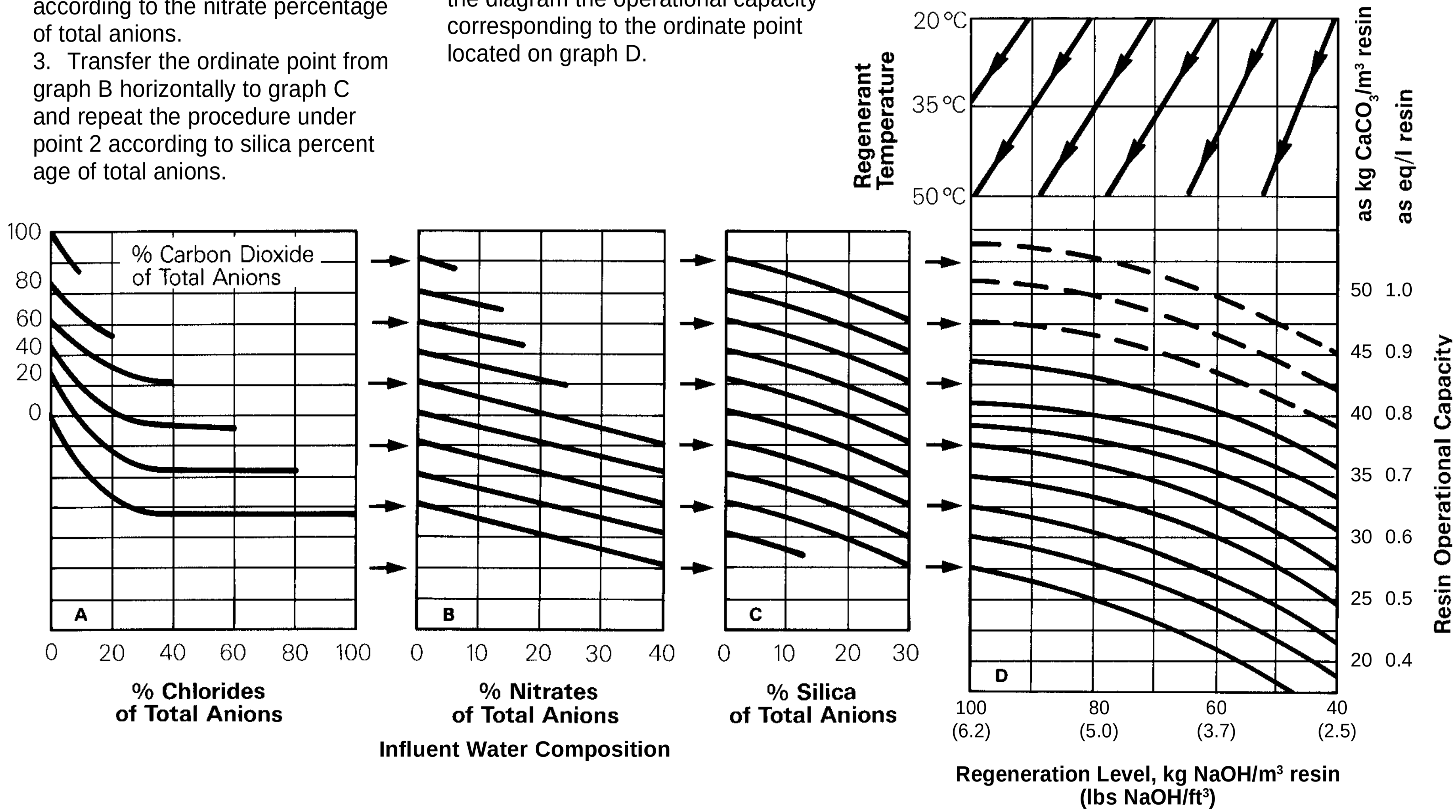


Figure 12. Counter-current operational capacity data

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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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