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Dow
Liquid Separations

DOWEX MSA-2

Ion Exchange Resin

ENGINEERING INFORMATION

DOWEX MSA-2 Type 2, Macroporous Strong Base Anion Exchange Resin

General Information

DOWEX* MSA-2 resin is a type 2, macroporous strong base anion exchange resin with a high capacity and high regeneration efficiency. It is based on a styrene-divinylbenzene copolymer matrix with dimethylethanol ammonium functional groups. 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. The macroporous structure of the resin gives a high reversible capacity for the absorption of large organic molecules and permits the regenerant solution to pass through the resin to reach the sites of organic debris and remove it.

DOWEX MSA-2 has excellent resistance to osmotic shock and very good physical stability. It is recommended for demineralization processes where there is a high percentage of mineral acids as well as organic acids in the water being treated. It is also used in the chloride form for the dealkalization of water. DOWEX MSA-2 PS has a specially graded particle size distribution for use in counter-current regeneration systems.

Demineralization

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

1. Organic matter loading not exceeding 7g $KMnO_4$/liter resin per cycle.
2. SiO_2 + CO_2 load not exceeding 30% of total anions.
3. Water temperature not exceeding 35°C (95°F).

In cases when the weak anion (SiO_2 + CO_2) load is high or the water temperature exceeds 35°C (95°F), a type 1 resin such as DOWEX MSA-1 with higher basicity and temperature stability is recommended.

Dealkalization

Sodium chloride regeneration of DOWEX MSA-2 resin permits reduction of alkalinity in water without the use of acid. This is best suited for dealkalizing softened water for low pressure boiler feed make-up.

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Typical Physical and Chemical Properties		
Ionic form as delivered		Cl^-
Total exchange capacity, min.	eq/l kgr/ft³ as $CaCO_3$	1.0 21.9
Water content	%	48 - 56
Bead size distribution range >1.2 mm, max. <0.3 mm, max.	 µm % %	 0.3 - 1.2 2 3
Total swelling (Cl^- ♦ OH), approx.	%	15
Whole beads, min.	%	95
Particle density, approx.	g/ml	1.07
Shipping weight, approx.	g/l lbs/ft³	670 42

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	 5-50 m/h (2-20 gpm/ft²) See figure 1 1-10 m/h (0.4-4 gpm/ft²) 5-20 m/h (2-8 gpm/ft²)
Total rinse requirement	3-5 Bed volumes
Regenerant Type Temperature	 2-5% NaOH Ambient up to 35°C (95°F) for silica removal

Hydraulic Characteristics

Bed Expansion

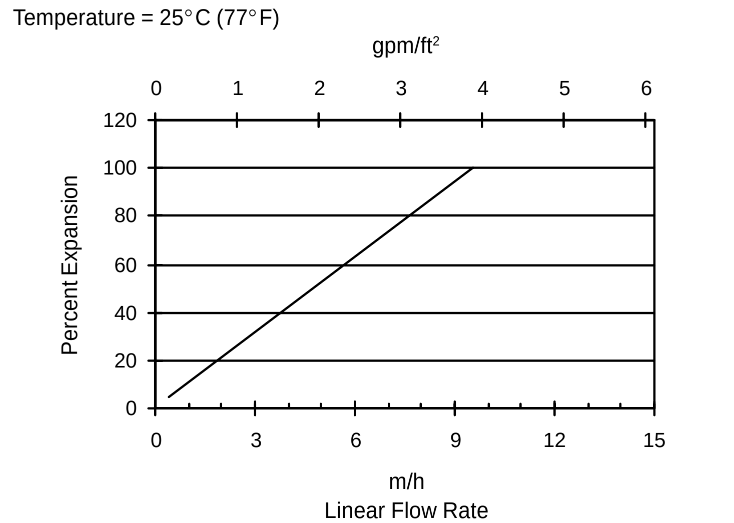
Under the upflow conditions of backwashing, the resin will expand its volume according to Figure 1. This expansion allows regrading of the resin, fines removal and avoids channelling during the subsequent service cycle. An expansion around 80% for 20 minutes is normally recommended to remove particulate 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, the strainers are cleaned by the regenerant flow. To retain the advantages of 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

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. 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.

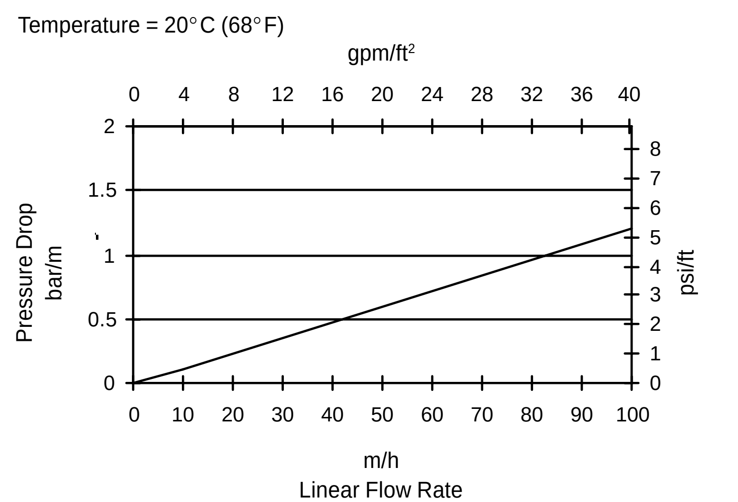
Figure 1. Backwash Expansion Data



For other temperatures use:

$F_T = F_{25°C}$ [1+0.008 (1.8$T_{°C}$ - 45)], where F … m/h
$F_T = F_{77°F}$ [1+0.008 ($T_{°F}$ - 77)], where F … gpm/ft²

Figure 2. Pressure Drop Data



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

The recommended operating conditions given 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% to 5% and even up to 8% under certain controlled conditions. A regenerant presentation rate of approximately 2 grams NaOH per liter of resin 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 (0.4 gpm/ft³). The use of heated regenerant (up to 35°C/95°F) gives an increased operating capacity and is especially useful for waters with a relatively high silica and/or organic matter load. It will only be efficient however, if the resin has been preheated during the last bed volume of the backwash preceding regeneration.

Figure 3. Silica Leakage in Co-Current Operation, Regeneration at 25°C (77°F)

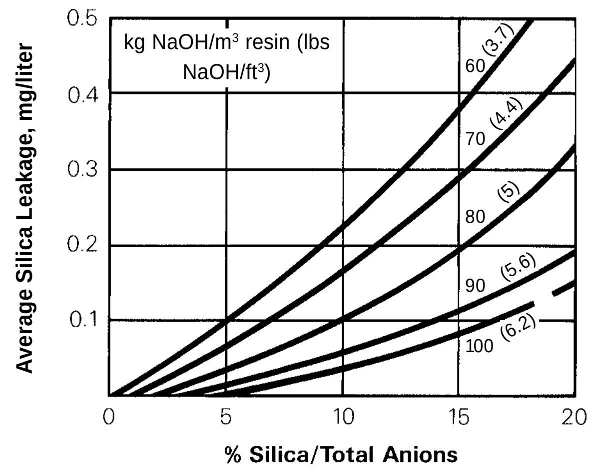
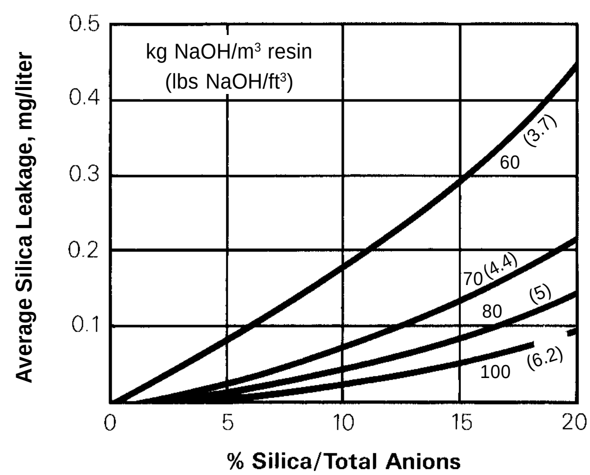


Figure 4. Silica Leakage in Co-Current Operation, Regeneration at 35°C (95°F)



Co-Current Operation

Silica leakage levels are shown in Figures 3 and 4 as a function of the regenerant level and % silica to total anions in the feed. The silica leakage is heavily 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. A low enough sodium level should preferably be ensured using a counter-current regenerated cation exchange unit.

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.

Operational capacities as a function of raw water composition and regenerant levels for co-current regeneration are given in Figure 7.

Figure 5. Temperature Correction for Co-Current Operation

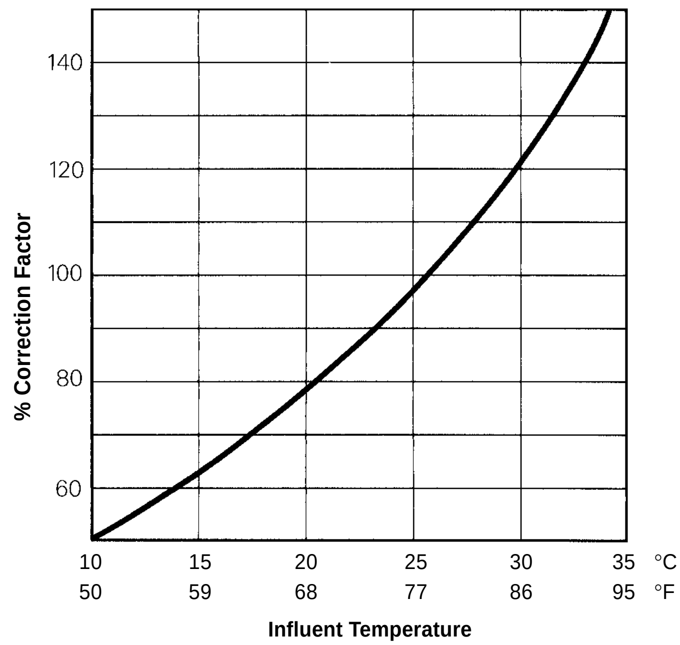
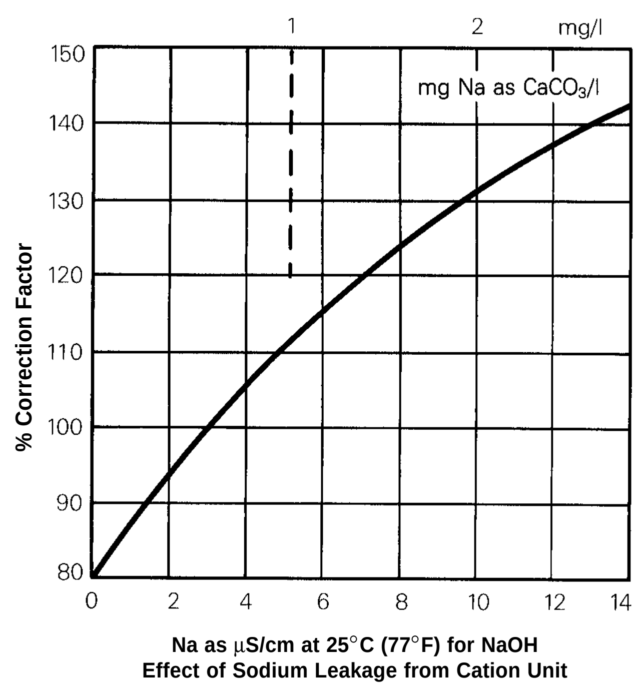


Figure 6. Sodium Leakage Correction for Co-Current Operation



Co-current operational capacity data

Use type 1 resin if CO_2 + SiO_2 exceeds 30% of total anions.

To calculate operational capacities:

1. Locate a point on the ordinate of graph A from carbon dioxide and 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 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 chosen regeneration level.
5. Now for regeneration at other 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.

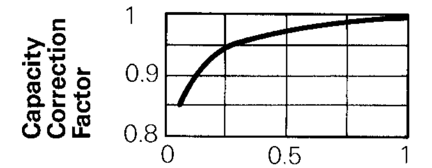
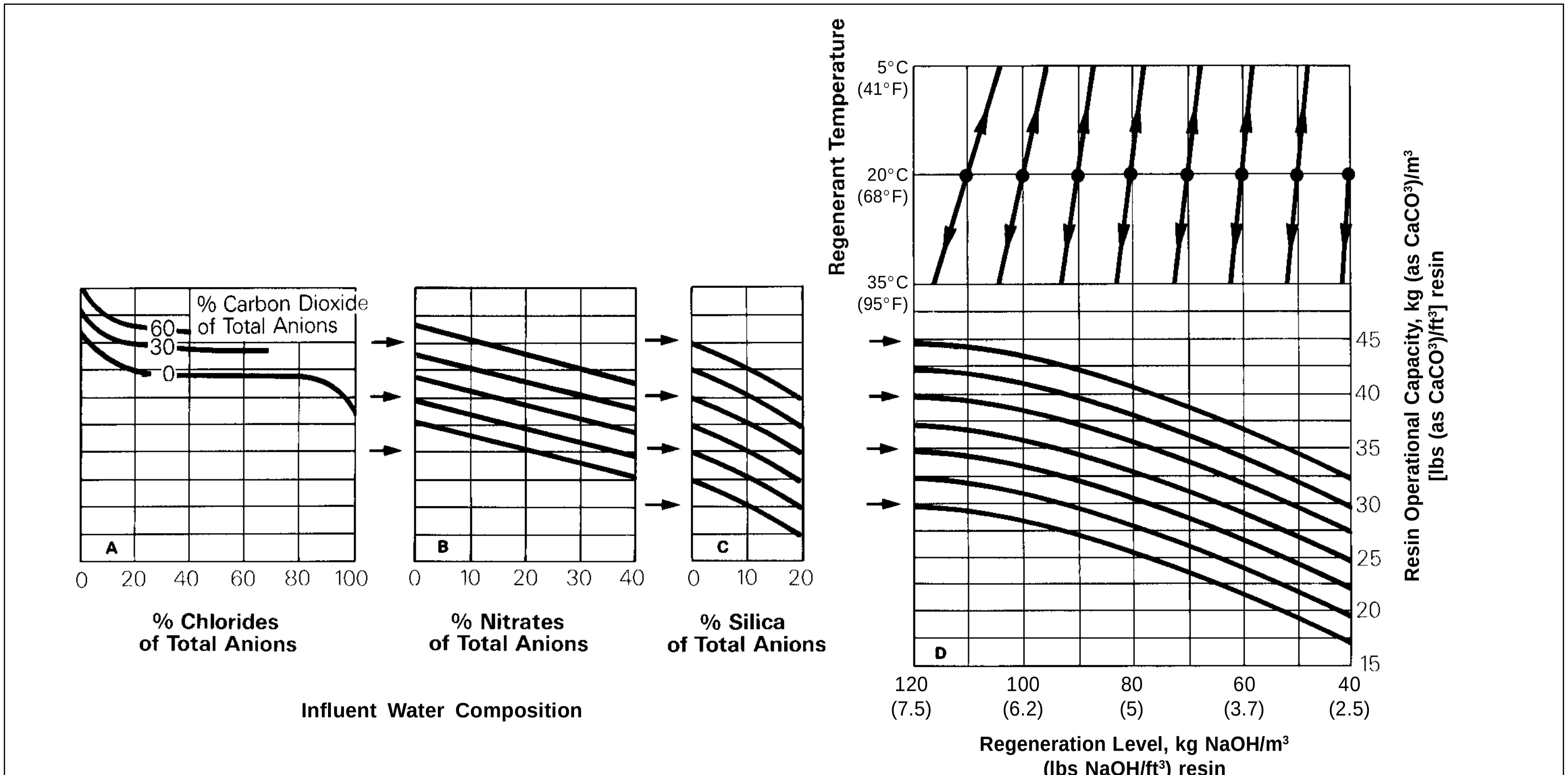


Figure 7. Co-current operational capacity data



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 and organic leakage. DOWEX MSA-2 PS is an excellent resin to use in counter-current operation. 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, the expected residual silica leakages for commonly used regeneration level ranges are shown in Figure 8. In treating higher temperature waters, increased silica hydrolysis will occur, resulting in higher leakages. However, the silica leakage should not exceed 50 µg/l for feed temperatures up to 35°C (95°F) with a well designed cation unit.

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 in Figures 3 and 4 demonstrates the advantages of counter-flow regeneration. For lower silica requirements, a type 1 anion resin such as DOWEX MSA-1 is recommended.

Operational capacities as a function of raw water composition and regenerant levels for counter-flow regeneration are given in Figure 10. The rinse requirements for DOWEX MSA-2 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

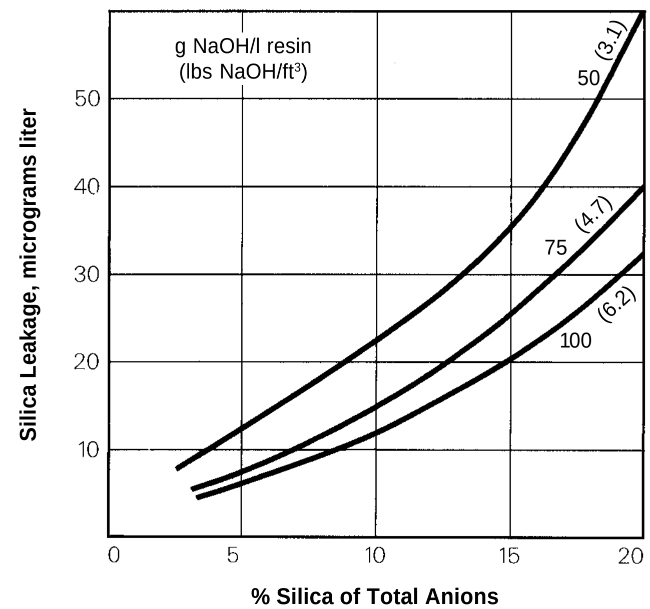
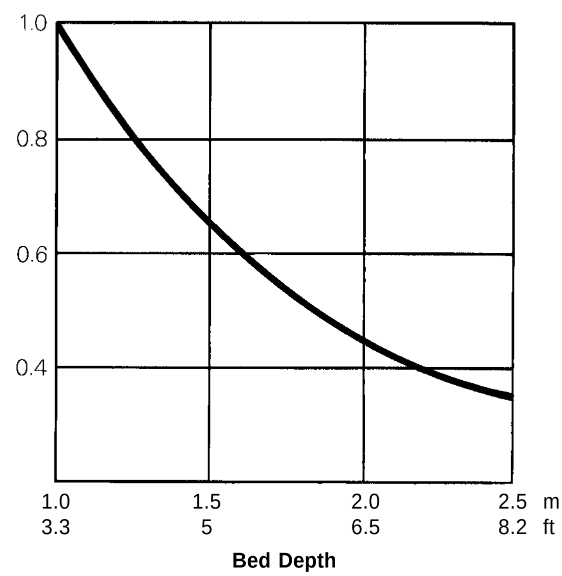


Figure 9. Correction Factor for Silica Leakage for Different Bed Depth in Counter-Current Operation



Counter-current operational capacity data

Use type 1 resin if $CO_2 + SiO_2$ exceeds 30% of total anions.

To calculate operational capacities:

1. Locate a point on the ordinate of graph A from carbon dioxide and 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 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 chosen regeneration level.
5. Now for regeneration at other 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.

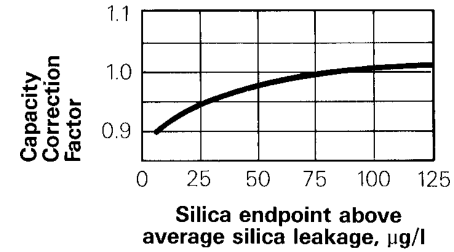


Figure 10. Counter-current operational capacity data