



LENNTECH

info@lennotech.com Tel. +31-152-610-900
www.lennotech.com Fax. +31-152-616-289

Dow
Water Solutions

DOWEX™ Ion Exchange Resins

Product Information Catalog

DOWEX™ Ion Exchange Resins

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2. Demineralization
3. Condensate Polishing
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DOWEX™ Ion Exchange Resins

1. Product Overview

- Uniform Particle Size Resins for Demineralization in Industrial Water Applications
- DOWEX Ion Exchange Resins for Condensate Polishing
- DOWEX Ion Exchange Resins for Nuclear Applications
- DOWEX MONOSPHERE UPW Resins



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DOWEX™ Ion Exchange Resins

Uniform Particle Size Resins for Demineralization
in Industrial Water Applications

DOWEX Ion Exchange Resins – Uniform Particle Size Resins for Demineralization

PRODUCT		RESIN TYPES	IONIC FORMS	GUARANTEED SALES SPECIFICATIONS ¹								COMMENTS
				TOTAL EXCHANGE CAPACITY, min. eq/l	43.7 kgr/ft ³	WATER CONTENT %	UNIFORMITY COEFFICIENT, max.	MEAN PARTICLE SIZE microns	PARTICLE SIZE LIMITS		WHOLE UNCRACKED BEADS, % min.	
DOWEX UPCORE	DOWEX™ UPCORE™ Mono C-600	Strong Acid	Na ⁺ H ⁺	2.0 1.8	43.7 39.3	42-48 50-56	1.1 1.1	585 ± 50 600 ± 50	5 5	0.5 0.5	95 95	Uniform particle size gel cation resin specifically designed for the UPCORE system. It is well suited for both softening and demineralization applications.
	DOWEX UPCORE Mono MC-575	Strong Acid	H ⁺	1.6	35.0	50-56	1.1	575 ± 50	5	0.5	95 ³	Uniform particle size macroporous cation resin designed for the UPCORE system. High capacity, exceptional physical stability, and excellent osmotic shock resistance.
	DOWEX UPCORE MAC-3 ²	Weak Acid	H ⁺	3.8	83.0	44-52	—	—	—	—	95 ³	Gaussian particle size polyacrylic, macroporous cation resin specifically designed for the UPCORE system. Efficiently removes hardness associated with alkalinity.
	DOWEX UPCORE Mono A-500	Strong Base Type 1	Cl ⁻	1.3	28.4	50-58	1.1	575 ± 50	5	0.5	95	Uniform particle size gel anion resin specifically designed for the UPCORE system. High operating capacity and good resistance to silica fouling.
	DOWEX UPCORE Mono A-625	Strong Base Type 1	Cl ⁻	1.3	28.4	47-54	1.1	670 ± 50	5	0.5	95	Uniform particle size gel anion resin, with a particle size selected to maintain excellent separation in UPCORE system layered beds when used with DOWEX UPCORE Mono WB-500.
	DOWEX UPCORE Mono A2-500	Strong Base Type 2	Cl ⁻	1.2	26.2	46-55	1.1	550 ± 50	5	0.5	95	Uniform particle size gel anion resin specifically designed for use in the UPCORE system. It has high operating capacity, chemical efficiency and resistance to organic fouling.
	DOWEX UPCORE Mono MA-600	Strong Base Type 1	Cl ⁻	1.1	24.0	55-65	1.1	640 ± 50	5	0.5	95 ³	Uniform particle size macroporous anion resin specifically designed for use in the UPCORE system. Exceptional physical stability and osmotic shock resistance.
	DOWEX UPCORE Mono WB-500	Weak Base	FB (free base)	1.3	28.4	52-60	1.1	540 ± 50	5	0.5	95 ³	Uniform particle size macroporous anion resin specifically designed for use in the UPCORE system. Used in layered beds with DOWEX UPCORE Mono A-625.
	DOWEX UPCORE IF-62	Floating Inert	None	—	—	—	—	Typical size range 2,500-4,000	—	—	—	A polyethylene floating inert resin specifically designed for use in the UPCORE system. Allows dirt and resin fragments to pass through while retaining whole resin beads in the bed.
DOWEX MARATHON	DOWEX MARATHON™ C	Strong Acid	Na ⁺ H ⁺	2.0 1.8	43.7 39.3	42-48 50-56	1.1 1.1	—	—	—	—	Uniform particle size gel cation resin for make-up demineralization. The small uniform beads result in improved regeneration, efficiency and higher operating capacity versus conventional-sized resins.
	DOWEX MARATHON C-10	Strong Acid	Na ⁺ H ⁺	2.2 1.9	48.1 41.5	40-45 46-51	1.1 1.1	—	—	—	—	Uniform particle size, high capacity gel cation resin with high cross-linking for exceptional mechanical and chemical stability.
	DOWEX MARATHON MSC	Strong Acid	Na ⁺ H ⁺	1.7 1.6	37.1 35.0	44-50 50-56	1.1 1.1	—	—	—	—	Uniform particle size, high capacity, highly cross-linked macroporous cation resin for demineralization.
	DOWEX MAC-3 ²	Weak Acid	H ⁺	3.8	83.0	44-50	—	—	—	—	—	Gaussian polyacrylic, macroporous cation resin with high exchange capacity, excellent regeneration efficiency, plus good chemical and mechanical stability. Removes hardness associated with alkalinity.
	DOWEX MARATHON A	Strong Base Type 1	Cl ⁻ OH ⁻	1.3 1.0	28.4 21.9	50-60 50-60 ⁴	1.1 1.1	—	—	—	—	Uniform particle size, high capacity, gel anion resin designed to give high throughput and economical operation in primary demineralized beds and mixed beds.
	DOWEX MARATHON A LB	Strong Base Type 1	Cl ⁻	1.3	28.4	48-55	1.1	—	—	—	—	Uniform particle size gel anion resin specifically designed for use in layered anion beds.
	DOWEX MARATHON 11	Strong Base Type 1	Cl ⁻	1.3	28.4	48-58	1.1	—	—	—	—	Uniform particle size, porous gel anion resin specifically suited for demineralization of high organic water and as an organic scavenger.
	DOWEX MARATHON A2	Strong Base Type 2	Cl ⁻	1.2	26.2	45-54	1.1	—	—	—	—	Efficient, uniform particle size gel anion resin normally used for waters in which silica and carbon dioxide do not exceed 25% of the total anions.
	DOWEX MARATHON MSA	Strong Base Type 1	Cl ⁻	1.1	24.0	56-66	1.1	—	—	—	—	Uniform particle size, high capacity, macroporous anion resin with exceptional physical stability and osmotic shock resistance.
	DOWEX MARATHON WBA	Weak Base (free base)	FB	1.3	28.4	50-60	1.1	—	—	—	—	Uniform particle size, high capacity, macroporous weak base anion resin that effectively removes mineral acids and organics. Excellent kinetic properties make this resin well suited for high flow rate applications.
	DOWEX MARATHON WBA-2	Weak Base (free base)	FB	1.7	37.1	40-51	1.1	—	—	—	—	Uniform particle size, high capacity, macroporous weak base anion resin that effectively removes mineral acids and organics.
	DOWEX MARATHON MR-3	Mixed Resin Strong Acid/Base	H ⁺ OH ⁻ 1:1 by capacity	1.8 1.0	39.3 21.9	50-56 50-60 ⁴	1.1 1.1	—	—	—	—	A 1:1 equivalent mixture of DOWEX MARATHON C (H) and DOWEX MARATHON A (OH) for mixed bed demineralization.
	DOWEX IF-59	Floating Inert	None	—	—	—	—	Typical size range 1,000-1,700	—	—	—	A polypropylene floating inert resin for upflow service packed bed counter-current regeneration systems.

¹For additional information, please refer to the product data sheets.

²Gaussian particle size resins – see specific product data sheet for additional information.

³Whole bead % min.

⁴Water content in Cl⁻ form.

Dow Water Solutions Offices.

For more information call Dow Water Solutions:

Dow Europe

Dow Customer Information Group
Dow Water Solutions
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.
Dow Water Solutions
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 China

Dow Chemical (China) Investment Company Ltd.
Dow Water Solutions
23/F, One Corporate Avenue
No. 222, Hu Bin Road
Shanghai 200021
China
Tel. +86 21 2301 9000
Fax +86 21 5383 5505

Dow Pacific

Customer Information Group – Dow Water Solutions
All countries except Indonesia and Vietnam:
Toll free phone: +800 7776 7776
Toll free fax: +800 7779 7779

All countries:
Tel. +60 3 7958 3392
Fax +60 3 7958 5598
E-mail: dowcig@dow.com

Dow Latin America

Dow Quimica S.A.
Dow Water Solutions
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
Dow Water Solutions
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

Notice: 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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DOWEX™ Ion Exchange Resins

For Condensate Polishing

DOWEX Ion Exchange Resins – For Condensate Polishing

Product Overview

DOWEX* condensate polishing grade resins are premium grade products with high exchange capacity, excellent resistance to attrition, and good resistance to thermal and oxidative degradation. DOWEX MONOSPHERE* resins are uniform particle size resins specifically designed for use in mixed beds. These resins are ideally suited to the high flow rate demands of condensate polishing applications.

Product	Resin Types	Matrix	Ionic Forms	Total Capacity eq/l, min.	Water Content %	Uniformity Coefficient	Particle Size microns			WUBS	Crush Strength g/bead		H+, min. %	Cl-, max. %
							mean	% >850	% <300		Avg., min.	% >200		
DOWEX MONOSPHERE 650C	Strong Acid Cation	Styrene DVB Gel	H ⁺	2.0	46-51	1.1	650±50	5	0.5	95	500	95	99.7	-
DOWEX MONOSPHERE 545C	Strong Acid Cation	Styrene DVB Gel	H ⁺	2.5	36-42	1.1	525±50	3	1	95	500	95	99.7	-
DOWEX MONOSPHERE 575C	Strong Acid Cation	Styrene DVB Gel	H ⁺	2.3	41-46	1.1	550±50	5	0.5	95	500	95	99.7	-
DOWEX MONOSPHERE 650 HXC	Strong Acid Cation	Styrene DVB Gel	H ⁺	2.2	39-44	1.1	650±50	5	0.2	95	500	95	99.7	-
DOWEX MONOSPHERE 750C	Strong Acid Cation	Styrene DVB Gel	H ⁺	2.0	46-51	1.15	765±25	5 ¹	0.5 ²	95	500	95 ³		-
DOWEX MONOSPHERE MP-525C	Strong Acid Cation	Styrene DVB Macroporous	H ⁺	1.6	50-54	1.1	500±50	-	1	95 ¹			-	-
DOWEX MONOSPHERE 550A	Strong Base Anion Type 1	Styrene DVB Gel	OH ⁻	1.1	55-65	1.1	590±50	5	0.5	95	350	95	-	0.5
DOWEX MONOSPHERE 700A	Strong Base Anion Type 1	Styrene DVB Gel	OH ⁻	1.1	55-65	1.1	700±580	5	0.5	95	350	95	-	0.5
DOWEX MONOSPHERE MP-725A	Strong Base Anion Type 1	Styrene DVB Macroporous	OH ⁻	0.8	65-75	1.1	690±50	5	0.5	95 ¹	-	-	-	0.5
DOWEX MONOSPHERE 600 BB	Inert	Styrene DVB Acrylate Gel	Inert	-	-	1.1	600±50	-	-	-	-	-	-	-
Product	Resin Types	Matrix	Ionic Forms	Total Capacity eq/l, min.	Water Content %	Uniformity Coefficient	Particle Size % max.			WUBS	Crush Strength g/bead		H+, min.	Cl-, max.
							>16 mesh	<40 mesh	<45 mesh		Avg., min.	% >200		
DOWEX HCR-W2	Strong Acid Cation	Styrene DVB Gel	H ⁺	1.8	48-54	-	2	1	-	95	350	95	-	-
DOWEX HGR-W2	Strong Acid Cation	Styrene DVB Gel	H ⁺	2.0	47-51	-	2	1	-	95	350	95	-	-
DOWEX SBR-C	Strong Base Anion Type 1	Styrene DVB Gel	Cl ⁻ OH ⁻	1.4 1.1	43-48 50-60	- -	2 5	- -	1 1	95 95	350 350	95 95	- -	- 1
DOWEX SBR-LC NG	Strong Base Anion Type 1	Styrene DVB Gel	OH ⁻	1.2	60 max	-	2	1	0.2	95	350	95	-	-

[†] Data represents Whole Beads, min.

¹ %>900

² %<400

³ %>300

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DOWEX™ Ion Exchange Resins

For Nuclear Applications

DOWEX Ion Exchange Resins – For Nuclear Applications

Product Overview

DOWEX® NG grade resins are high quality resins with very good mechanical and chemical resistance. DOWEX NG grade resins have extremely low levels of residual metallic impurities and high levels of ionic conversion. DOWEX LC NG resins have residual chloride and sulfate levels less than 0.1% of the total ionic sites of the anion resin. These resins may be used in a variety of applications including radwaste treatment, pond water cleanup, reactor coolant cleanup, and high purity mixed bed demineralization.

Product	Resin Types	Ionic Forms	Total Capacity eq/l, min.	Water Content %	Particle Size <300 microns, max. (50 mesh)	WUBS [†] % min.	Crush Strength g/bead		Trace Metals (ppm dry resin, max.)									Heavy metals as Pb
							Avg., min.	% >200	Na	Fe	Cu	Al	Mg	Ca	Co	Pb	Hg	
DOWEX MONOSPHERE® 545C NG	Strong Acid Cation	H ⁺	2.5	36-42	1	95	500	95	50	50	10	50	50	50	30	10	10	10
DOWEX MONOSPHERE 575C NG	Strong Acid Cation	H ⁺	2.3	41-46	0.2	95	500	95	50	50	10	50	50	50	30	10	10	10
DOWEX MONOSPHERE 650C NG	Strong Acid Cation	H ⁺	2.0	46-51	0.2	95	500	95 ¹	50	50	10	50	50	50	30	10	10	10
DOWEX MONOSPHERE 650HXC NG ²	Strong Acid Cation	H ⁺	2.2	39-44	0.5	95	500	95	50	50	50	50						20
DOWEX HGR NG	Strong Acid Cation	H ⁺	2.0	46-52	0.1	95	500	95 ¹	50	50	10	50	50	50	30	10	10	10
DOWEX MONOSPHERE 550A LC NG	Strong Base Type 1 Anion	OH ⁻	1.1	55-65	0.2	95	350	95	40	50	10	50	50	50	30	10	10	10
DOWEX MONOSPHERE MR-575 LC NG	Strong Acid Strong Base Type 1	H ⁺	2.3	41-46	0.2	95	500	95	20	25	10	15			8	20	15	10
		OH ⁻	1.1	55-65	0.2	95	350	95	40	50	10	50	50	50	30	10	10	10
DOWEX SBR LC NG	Strong Base Type 1 Anion	OH ⁻	1.2	60 max.	0.2	95	350	95	40	50	10	50	50	50	30	10	10	10
DOWEX MR-3 LC NG	Strong Acid Strong Base Type 1	H ⁺	2.0	46-52	0.1	95	500	95	50	50	10	50	50	50	30	10	10	10
		OH ⁻	1.2	60 max.	0.2	95	350	95	40	50	10	50	50	50	30	10	10	10
DOWEX MR-5 LC NG	Strong Acid Strong Base Type 1	Li ⁺	2.0 (H ⁺)	46-52(H ⁺)	0.1	95	500	95	50	50	10	50	50	50	30	10	10	10
		OH ⁻	1.2	60 max.	0.2	95	350	95	40	50	10	50	50	50	30	10	10	10

[†] Whole uncracked beads

¹ %>300 g/bead

² Additional metal specs not listed. See product data sheet for more information.

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DOWEX MONOSPHERE UPW Resins

Product Overview

Product name Description	Total capacity eq/L min.	Uniformity coefficient max.	Water content %	Max. operating temp °C	Composition
DOWEX™ MONOSPHERE™ 650C UPW (H) Cation exchange resin, gel type	1.9	1.1	46-51	120	99% min. H conversion
DOWEX MONOSPHERE 550A UPW (OH) Anion exchange resin, gel type	1.0	1.1	55-65	60	95% min. OH conversion
DOWEX MONOSPHERE MR-3 UPW Mixed ion exchange resins, gel type	1.9 (H) 1.0 (OH)	1.1 1.1	46-51 55-65	60	DOWEX MONOSPHERE 650C UPW (H) DOWEX MONOSPHERE 550A UPW (OH)
DOWEX MONOSPHERE MR-450 UPW Mixed ion exchange resins, gel type	1.9 (H) 1.0 (OH)	1.1 1.1	46-53 55-65	60	DOWEX MONOSPHERE 350C UPW (H) DOWEX MONOSPHERE 550A UPW (OH)

General Information

DOWEX MONOSPHERE UPW grade resins are polymerized to meet the evolving and stringent performance requirements for ultrapure water used by the semiconductor and microelectronics industry.

Significant product properties of UPW grade resins that influence performance are:

- Very high conversion to an ionic form.
- Lowest ionic and metallic residuals characteristic of the manufacturing process.
- Lowest TOC extractables.
- Attainment of 18.3 megaohm.cm (0.055 μ S/cm) water quality in less than four bed volumes of rinse (mixed bed UPW grade resins).
- Greater than 95% WUB (whole uncracked bead) count.
- High resistance to attrition, thus preventing generation of fines as the resin ages in service.
- Outstanding mechanical integrity.

This product portfolio is designed to meet roughing stage, polishing stage, two bed and mixed bed application in the production of ultrapure water.

For additional information, please refer to specific data sheets.

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DOWEX™ Ion Exchange Resins

2. Demineralization

- DOWEX MARATHON™ C
- DOWEX MARATHON MSC
- DOWEX MARATHON C-10
- DOWEX MAC-3
- DOWEX MARATHON A
- DOWEX MARATHON A LB
- DOWEX MARATHON 11
- DOWEX MARATHON A2
- DOWEX MARATHON MSA
- DOWEX MARATHON WBA
- DOWEX MARATHON WBA-2
- DOWEX MARATHON MR-3
- DOWEX IF-59



DOWEX™ MARATHON™ C

A Uniform Particle Size, High Capacity Cation Exchange Resin for Softening (Industrial and Residential) and Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ MARATHON™ C	Strong acid cation	Styrene-DVB, gel	Sulfonic acid

Guaranteed Sales Specifications		Na ⁺ form	H ⁺ form
Total exchange capacity, min.	eq/L	2.0	1.8
	kg/ft ³ as CaCO ₃	43.7	39.3
Water content	%	42 - 48	50 - 56
Uniformity coefficient, max.		1.1	1.1

Typical Physical and Chemical Properties		Na ⁺ form	H ⁺ form
Mean particle size†	μm	585 ± 50	600 ± 50
Whole uncracked beads	%	95 - 100	95 - 100
Total swelling (Na ⁺ → H ⁺)	%	8	8
Particle density	g/mL	1.28	1.20
Shipping weight	g/L	820	800
	lbs/ft ³	51	50

Recommended Operating Conditions

- Maximum operating temperature 120°C (250°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/ft²)
 - Backwash see figure 1
 - Co-current regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm /ft²)
 - Counter-current regeneration/displacement rinse 5 - 20 m/h (2 - 8 gpm /ft²)
- Total rinse requirement 2 - 5 Bed volumes
- Regenerant 1 - 8% H₂SO₄, 4 - 8% HCl or 8 - 12% NaCl

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

Typical Properties and Applications

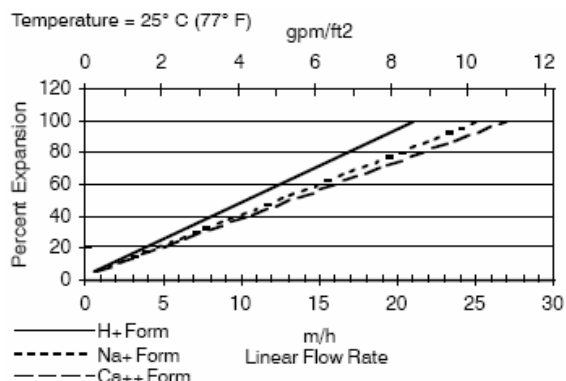
DOWEX™ MARATHON™ C strong acid cation exchange resin is a uniform particle size resin designed for industrial and residential softening and demineralization applications. The small uniform beads exhibit faster kinetics than conventionally sized resins. The improved kinetics results in improved regeneration efficiency, higher operating capacity, reduced regenerant usage and less waste water.

DOWEX MARATHON C resin also shows outstanding stability to compressive and osmotic stress.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

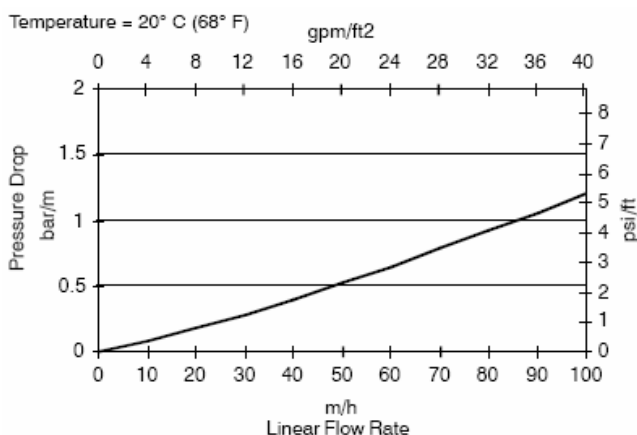


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

$$P_T = P_{20^\circ C} / (0.026 T_C + 0.48), \text{ where } P \equiv \text{bar/m}$$

$$P_T = P_{68^\circ F} / (0.014 T_F + 0.05), \text{ where } P \equiv \text{psi/ft}$$

Note: These resins may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

DOWEX™ Ion Exchange Resins

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DOWEX™ MARATHON™ MSC

A Uniform Particle Size, High Capacity Macroporous Cation Exchange Resin for Industrial Softening and Water Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ MARATHON™ MSC	Strong acid cation	Styrene-DVB, macroporous	Sulfonic acid

Guaranteed Sales Specifications		Na ⁺ form	H ⁺ form
Total exchange capacity, min.	eq/L	1.7	1.6
	kg/ft ³ as CaCO ₃	37.1	35.0
Water content	%	44 - 50	50 - 56
Uniformity coefficient, max.		1.1	1.1

Typical Physical and Chemical Properties		Na ⁺ form	H ⁺ form
Mean particle size [†]	μm	550 ± 50	575 ± 50
Whole beads	%	95 - 100	95 - 100
Total swelling (Na ⁺ → H ⁺)	%	4	4
Particle density	g/mL	1.28	1.20
Shipping weight	g/L	800	760
	lbs/ft ³	50	47

Recommended Operating Conditions

- Maximum operating temperature 150°C (300°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/ft²)
 - Backwash see Figure 1
 - Co-current regeneration/displacement rinse 1-10 m/h (0.4-4 gpm /ft²)
 - Counter-current regeneration/displacement rinse 5-20 m/h (2-8 gpm /ft²)
- Total rinse requirement 3 - 6 Bed volumes
- Regenerant 1-10% H₂SO₄, 4-8% HCl or 8-12% NaCl

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

Typical Properties and Applications

DOWEX™ MARATHON™ MSC strong acid cation resin is a highly cross-linked resin with high porosity giving excellent osmotic shock resistance and chemical and thermal stability.

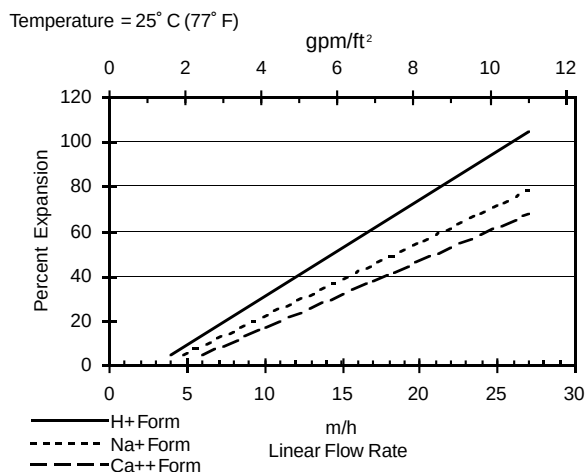
The resin has a variety of uses, such as:

- Hot process softening
- Demineralization
- Adsorbent
- Processes with oxidizing conditions
- Recovery of metals from plating baths

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

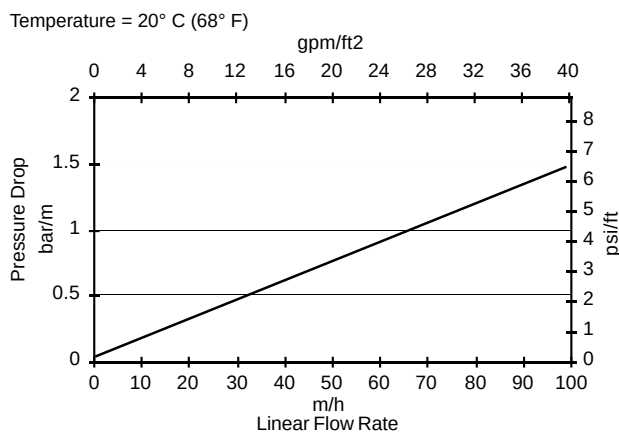


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

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

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

DOWEX™ Ion Exchange Resins

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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DOWEX™ MARATHON™ C-10

A Uniform Particle Size, High Capacity Cation Exchange Resin for Industrial Softening and Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ MARATHON™ C-10	Strong acid cation	Styrene-DVB, gel	Sulfonic acid

Guaranteed Sales Specifications		Na ⁺ form	H ⁺ form
Total exchange capacity, min.	eq/L	2.2	1.9
	kgr/ft ³ as CaCO ₃	48.1	41.5
Water content	%	40 - 45	46 - 51
Uniformity coefficient, max.		1.1	1.1

Typical Physical and Chemical Properties		Na ⁺ form	H ⁺ form
Mean particle size†	μm	740 ± 50	760 ± 50
Whole uncracked beads	%	95 - 100	95 - 100
Total swelling (Na ⁺ → H ⁺)	%	7	7
Particle density	g/mL	1.31	1.22
Shipping weight	g/L	845	810
	lbs/ft ³	53	50

Recommended Operating Conditions

- Maximum operating temperature 130°C (265°F)
- pH range 0 - 14
- Bed depth, min. 800 mm (2.6 ft)
- Flow rates:
 - Service/demineralizing and softening 5 - 50 m/h (2 - 20 gpm/ft²)
 - Service/sodium or amine cycle polishing 38 - 75 m/h (15 - 30 gpm/ft²)
 - Backwash See Figure 1
 - Co-current regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm/ft²)
 - Counter-current regeneration/displacement rinse 5 - 20 m/h (2 - 8 gpm/ft²)
- Total rinse requirement 2 - 5 bed volumes
- Regenerant 1 - 8% H₂SO₄, 4 - 8% HCl or 8 - 12% NaCl

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

Typical Properties and Applications

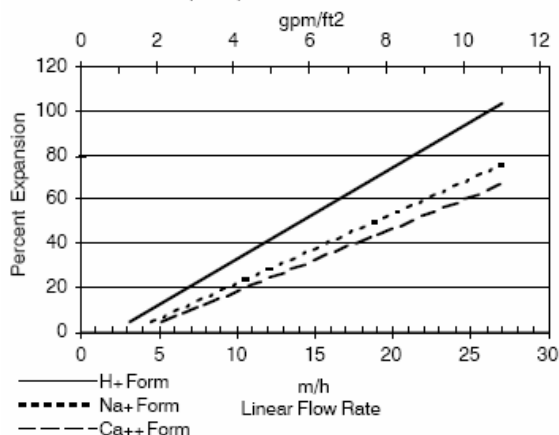
DOWEX™ MARATHON™ C-10 strong acid cation exchange resin is a uniform particle size resin designed for demineralizing, industrial softening, and single-bed condensate polishing applications. The uniform particle size beads exhibit more uniform exhaustion, regeneration, and backwash compared to conventionally sized resins. The higher level of crosslinking in DOWEX MARATHON C-10 resin also shows exceptional stability to compressive, osmotic, and oxidative stresses.

Packaging

25 liter bags, 1 cubic foot bags or 5 cubic foot fiber drums.

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



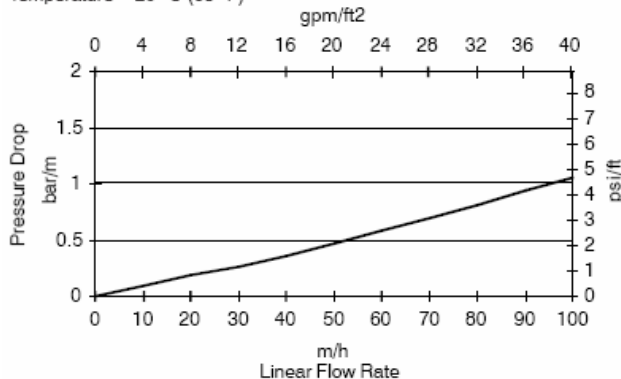
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

$$P_T = P_{20^\circ\text{C}} / (0.026 T_C + 0.48), \text{ where } P \equiv \text{bar/m}$$

$$P_T = P_{68^\circ\text{F}} / (0.014 T_F + 0.05), \text{ where } P \equiv \text{psi/ft}$$

DOWEX™ Ion Exchange Resins

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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DOWEX™ MAC-3

A Macroporous Weak Acid Cation Exchange Resin used for Water Softening, Dealkalization and Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ MAC-3	Weak acid cation	Polyacrylic, macroporous	Carboxylic acid

Guaranteed Sales Specifications		H ⁺ form
Total exchange capacity, min.	eq/L	3.8
	kg/ft ³ as CaCO ₃	83.0
Bead size distribution range† 300 - 1,200 µm, min. (50 mesh - 16 mesh)	%	90

Typical Physical and Chemical Properties		H ⁺ form
Water content	%	44 - 50
Whole beads	%	95 - 100
Total swelling (H ⁺ → Na ⁺)	%	~70
Particle density	g/mL	1.18
Shipping weight	g/L	750
	lbs/ft ³	47

Recommended Operating Conditions

- Maximum operating temperature 120°C (250°F)
- pH range 5 - 14
- Bed depth, min. 800 mm (2.6 ft)
- Flow rates:
 - Service/fast rinse 5-50 m/h (2-20 gpm/ft²)
 - Backwash See figure 1
 - Regeneration/displacement rinse 1-10 m/h HCl (0.4-4 gpm /ft²),
5-20 m/h H₂SO₄ (2-8 gpm /ft²)
 - Rinse 5-20 m/h (2-8 gpm /ft²)
- Total rinse requirement 3 - 6 Bed volumes
- Regenerant 1 - 5% HCl or 0.5 - 0.8% H₂SO₄

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

Typical Properties and Applications

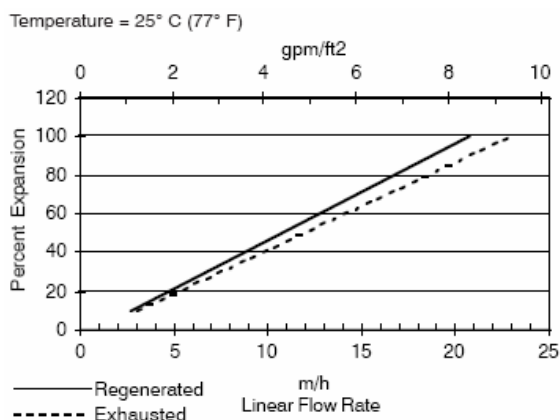
DOWEX™ MAC-3 weak acid cation resin has high exchange capacity, excellent regeneration efficiency, very good resistance to osmotic shock, plus good chemical and physical stability.

DOWEX MAC-3 resin is effective in removal of temporary hardness (hardness associated with alkalinity) and dealkalization. It is also used for recovery of metals. DOWEX MAC-3 resin can be supplied on request for use in food and potable water applications in accordance to the TOC (Total Organic Carbon) requirements of the major European legislations. In such cases, a recommendation is given for resin conditioning before use.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

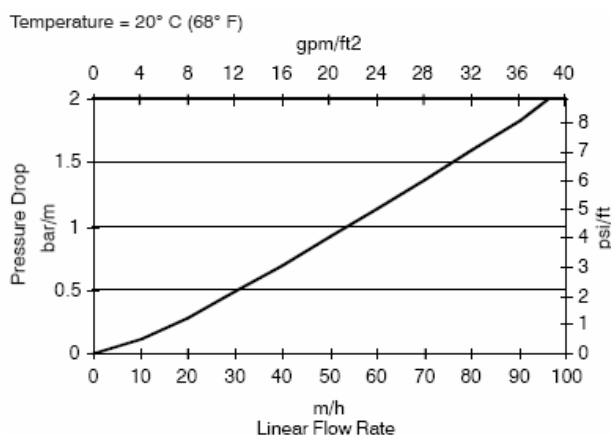


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

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

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

Note: These resins may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

DOWEX™ Ion Exchange Resins

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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DOWEX™ MARATHON™ A

A Uniform Particle Size, High Capacity, Strong Base Anion Exchange Resin for Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ MARATHON™ A	Type I strong base anion	Styrene-DVB, gel	Quaternary amine

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, approx.	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/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm /ft²)
 - Counter-current regeneration/displacement rinse 5 - 20 m/h (2 - 8 gpm /ft²)
- 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 Particle Size Distribution Cross Reference Chart (Form No. 177-01775).

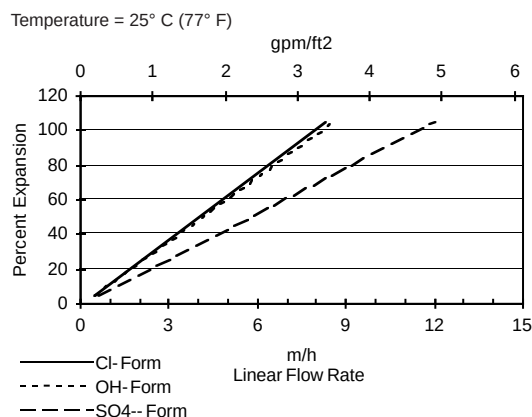
Typical Properties and Applications

DOWEX™ MARATHON™ A anion exchange resin is specifically designed to give high throughput and economical operation in primary demineralizer beds. Because of its uniform particle size, this resin offers a number of economic advantages over 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. It can be used for all types of water but especially for waters that have a high percentage of silica and carbon dioxide.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

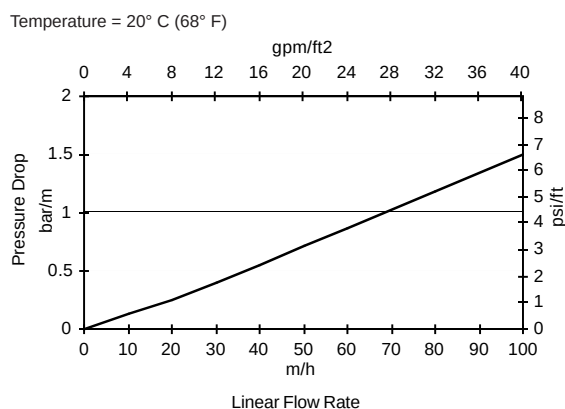


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

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

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

Note: These resins may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

DOWEX™ Ion Exchange Resins

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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DOWEX™ MARATHON™ A LB

A Uniform Particle Size, Strong Base Anion Exchange Resin Specifically Designed for Layered Bed Applications

Product	Type	Matrix	Functional group
DOWEX™ MARATHON™ A LB	Type I strong base anion	Styrene-DVB, gel	Quaternary amine

Guaranteed Sales Specifications		Cl ⁻ form
Total exchange capacity, min.	eq/L kgr/ft ³ as CaCO ₃	1.2 26.2
Water content	%	50 - 56
Uniformity coefficient, max.		1.1

Typical Physical and Chemical Properties		
Mean particle size†	μm	650 ± 50
Whole uncracked beads	%	90
Total swelling (Cl ⁻ → OH ⁻)	%	20
Particle density	g/mL	1.09
Shipping weight	g/L lbs/ft ³	670 42

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. 760 mm (2.5 ft)
- Flow rates:
 - Service/fast rinse 5 - 60 m/h (2 - 24 gpm/ft²)
 - Regeneration/displacement rinse 4 - 10 m/h (1.6 - 4 gpm/ft²)
- Total rinse requirement 3 - 5 Bed volumes
- Regenerant:
 - Type 2 - 4% NaOH

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

Typical Properties and Applications

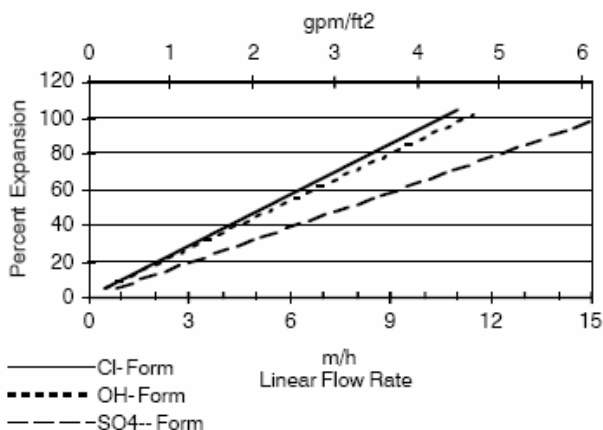
DOWEX™ MARATHON™ A LB strong base anion resin is a uniform particle size resin designed specifically for use in layered anion beds. It is sized roughly 75 microns larger than standard DOWEX MARATHON A resin. When used with DOWEX MARATHON WBA weak base anion resin, the differences in densities and size ensure the resins maintain excellent separation.

Packaging

25 liter bags or 5 cubic foot fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



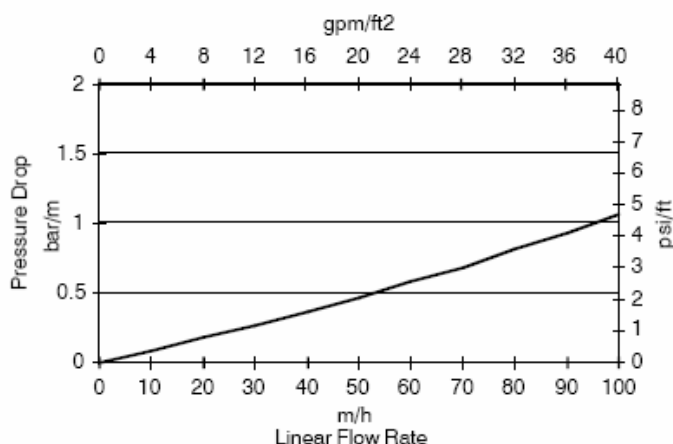
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

$$P_T = P_{20^\circ C} / (0.026 T_C + 0.48), \text{ where } P \equiv \text{bar/m}$$

$$P_T = P_{68^\circ F} / (0.014 T_F + 0.05), \text{ where } P \equiv \text{psi/ft}$$

DOWEX Ion Exchange Resins

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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DOWEX™ MARATHON™ 11

A Uniform Particle Size, Porous Gel, Strong Base Anion Exchange Resin Specifically Designed for Demineralization of High Organic Waters and as an Organic Scavenger

Product	Type	Matrix	Functional group
DOWEX™ MARATHON™ 11	Type I strong base anion	Styrene-DVB, gel	Quaternary amine

Guaranteed Sales Specifications		Cl ⁻ form
Total exchange capacity, min.	eq/L kgr/ft ³ as CaCO ₃	1.3 28.4
Water content	%	48 - 58
Uniformity coefficient, max.		1.1

Typical Physical and Chemical Properties		Cl ⁻ form
Whole uncracked beads	%	95 - 100
Mean particle size†	µm	550 ± 50
Total swelling (Cl ⁻ → OH ⁻)	%	20
Particle density	g/mL	1.08
Shipping weight	g/L lbs/ft ³	670 42

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/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1-10 m/h (0.4-4 gpm /ft²)
 - Counter-current regeneration/displacement rinse 5-20 m/h (2-8 gpm /ft²)
- Total rinse requirement 2 - 5 Bed volumes
- Regenerant:
 - Type 2-5% NaOH
 - Type (organic screen) 10% NaCl / 1% NaOH mixture
 - Temperature Ambient or up to 50°C (122°F) for silica removal
 - Temperature (organic screen) Ambient or up to 50°C (122°F)

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

Typical Properties and Applications

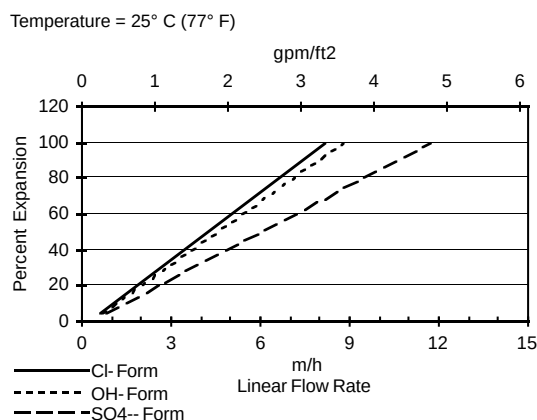
DOWEX™ MARATHON™ 11 strong base anion resin is a high capacity resin with excellent kinetics, very good regeneration efficiency and very good resistance to organic fouling. It also has excellent resistance to osmotic shock and good physical and chemical stability.

It's unique resistance to organic fouling enables this resin to be used in Cl form as an organic scavenger with great success. DOWEX MARATHON 11 anion exchange resin can be used to remove organics in both single bed and mixed bed units.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

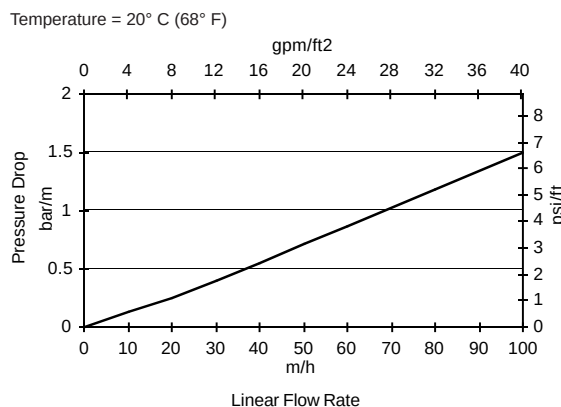


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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DOWEX MARATHON A2

An Efficient, Uniform Particle Size, High Capacity, Type 2 Strong Base Anion Exchange Resin for Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ MARATHON™ A2	Type 2 strong base anion	Styrene-DVB, gel	Dimethylethanol amine

Guaranteed Sales Specifications		Cl ⁻ form
Total exchange capacity, min.	eq/L	1.2
	kgr/ft ³ as CaCO ₃	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 ⁻ → OH ⁻)	%	15
Particle density	g/mL	1.09
Shipping weight	g/L	690
	lbs/ft ³	43

Recommended Operating Conditions

- Maximum operating temperature:
 - OH⁻ form 35°C (95°F)
 - Cl⁻ form 70°C (160°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/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm /ft²)
 - Counter-current regeneration/displacement rinse 5 - 20 m/h (2 - 8 gpm /ft²)
- Total rinse requirement 3 - 6 Bed volumes
- Regenerant:
 - Type 2-5% NaOH
 - Temperature Ambient or up to 35°C (95°F) for silica removal

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

Typical properties and applications

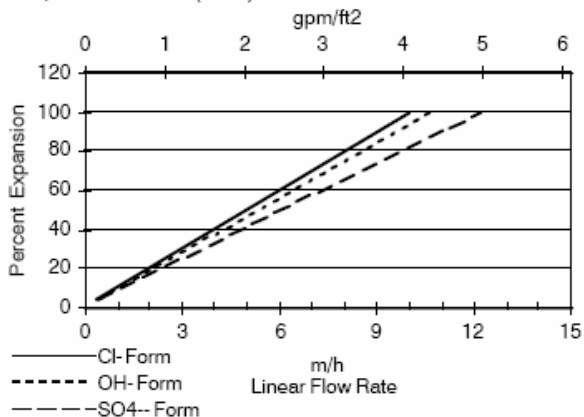
DOWEX MARATHON A2 anion exchange resin is specifically designed to give high throughput and economical operation in primary demineralizer beds. Its uniform particle size offers a number of economic advantages over conventional polydispersed resins. The small uniform bead size of DOWEX MARATHON A2 resin results in rapid exchange kinetics during operation, more complete regeneration of the resin and faster, more thorough rinse following regeneration. It is normally used for waters in which silica and carbon dioxide do not exceed 25% of the total anions. For water containing higher levels of these "weak" acids, DOWEX MARATHON A resin is recommended.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



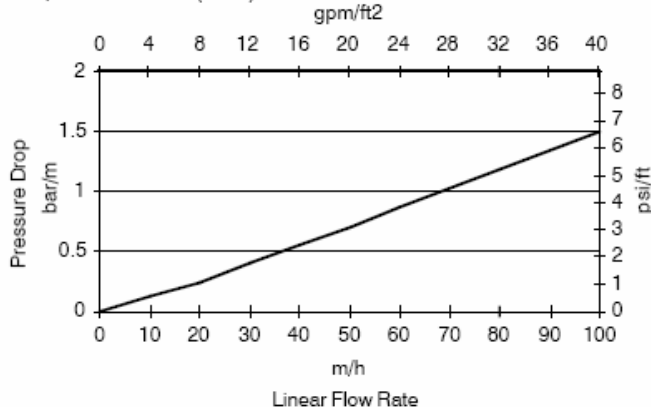
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

$$P_T = P_{20^\circ C} / (0.026 T_C + 0.48), \text{ where } P \equiv \text{bar/m}$$

$$P_T = P_{68^\circ F} / (0.014 T_F + 0.05), \text{ where } P \equiv \text{psi/ft}$$

DOWEX Ion Exchange Resins

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DOWEX™ MARATHON™ MSA

Uniform Particle Size, High Capacity, Macroporous Strong Base Anion Exchange Resin for Water Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ MARATHON™ MSA	Type I strong base anion	Styrene-DVB, macroporous	Quaternary amine

Guaranteed Sales Specifications		Cl ⁻ form
Total exchange capacity, min.	eq/L kgr/ft ³ as CaCO ₃	1.1 24.0
Water content	%	56 - 66
Uniformity coefficient, max.		1.1

Typical Physical and Chemical Properties		Cl ⁻ form
Mean particle size†	μm	640 ± 50
Whole beads	%	95 - 100
Total swelling (Cl ⁻ → OH ⁻)	%	15
Particle density	g/mL	1.06
Shipping weight	g/L lbs/ft ³	670 42

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/ft²)
 - Backwash See Figure 1
 - Co-current regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm/ft²)
 - Counter-current regeneration/displacement rinse 5 - 20 m/h (2 - 8 gpm/ft²)
- Total rinse requirement 5 - 7 Bed volumes
- Regenerant:
 - Type 4 - 8% 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).

Typical Properties and Applications

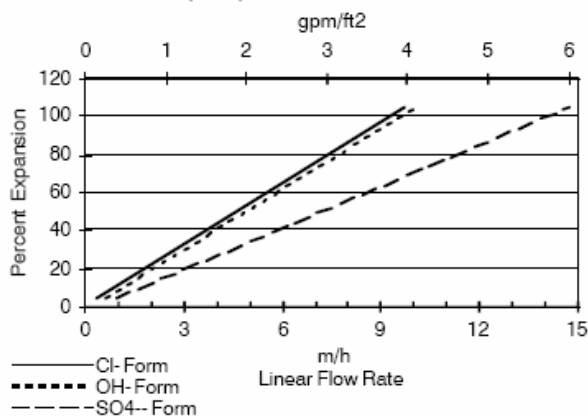
DOWEX™ MARATHON™ MSA resin is a uniform particle size macroporous strong base anion resin which has exceptional physical stability, excellent resistance to osmotic shock, and very good organic fouling resistance. It is well suited for use in demineralization of high organic waters, catalysis, and the extraction of heavy metals in the form of complex anions.

Packaging

25 liter bags or 5 cubic foot fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



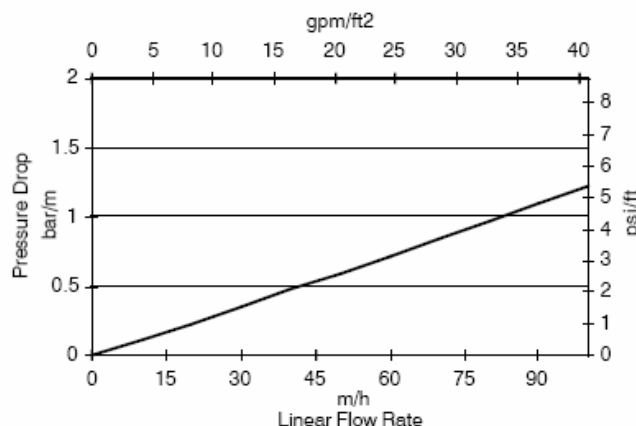
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX™ Ion Exchange Resins

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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DOWEX MARATHON WBA

A Uniform Particle Size, High Capacity, Weak Base Anion Exchange Resin for Water Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ MARATHON™ WBA	Weak base anion	Styrene-DVB, macroporous	Tertiary amine

Guaranteed Sales Specifications		FB (free base) form
Total exchange capacity, min.	eq/L kg/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	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	2 - 4 Bed volumes
	• Regenerant:	2 - 5% NaOH

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

Typical properties and applications

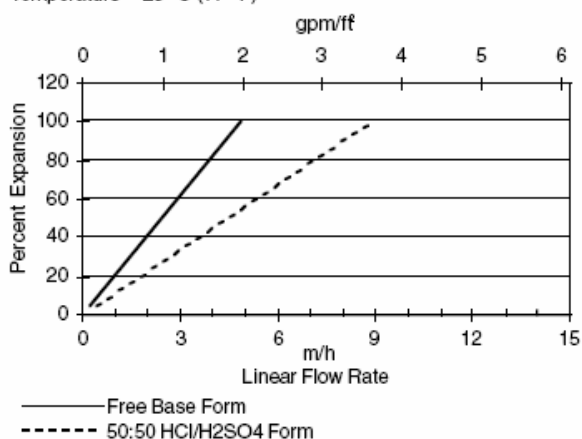
DOWEX MARATHON WBA resin is a high capacity, macroporous, weak base anion resin of narrow bead-size distribution. The small uniform bead size yields significantly higher throughput capacity than macroporous weak base resins with conventional polydispersed bead size distribution. This means more water can be produced per regeneration so regeneration costs are minimized. DOWEX MARATHON WBA resin is especially well suited for use with strong base resins. It effectively removes mineral acids (formed by Cl^- and SO_4^{2-}) and organics, reducing the ionic load on the strong base anion and protecting it from organic fouling.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



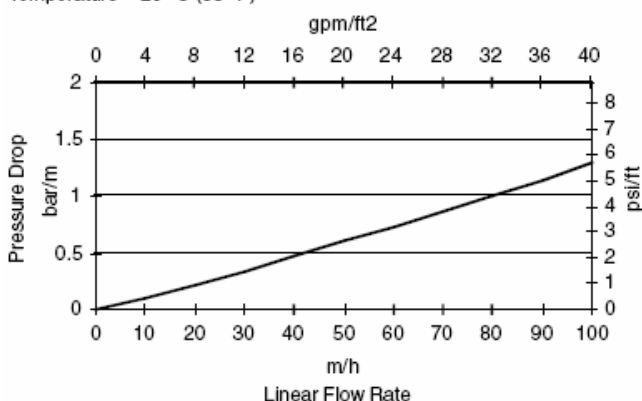
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

$$P_T = P_{20^\circ\text{C}} / (0.026 T_C + 0.48), \text{ where } P \equiv \text{bar/m}$$

$$P_T = P_{68^\circ\text{F}} / (0.014 T_F + 0.05), \text{ where } P \equiv \text{psi/ft}$$

DOWEX Ion Exchange Resins

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DOWEX MARATHON WBA-2

Uniform Particle Size, High Capacity, Weak Base Anion Exchange Resin for Water
Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX* MARATHON* WBA-2	Weak base anion	Styrene-DVB, macroporous	Tertiary amine

Guaranteed Sales Specifications		FB (free base) form
Total exchange capacity, min.	eq/L	1.7
	kg/ft ³ as CaCO ₃	37.1
Water content	%	40 - 51
Uniformity coefficient, max.		1.1

Typical Physical and Chemical Properties		FB (free base) form
Mean particle size [†]	μm	550 ± 50
Whole beads	%	95 - 100
Total swelling (FB → HCl)	%	23
Particle density	g/mL	1.04
Shipping weight	g/L	640
	lbs/ft ³	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	5 - 30 m/h (2 - 12 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	2 - 4 bed volumes
	• Regenerant	2 - 5% NaOH

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

Typical properties and applications

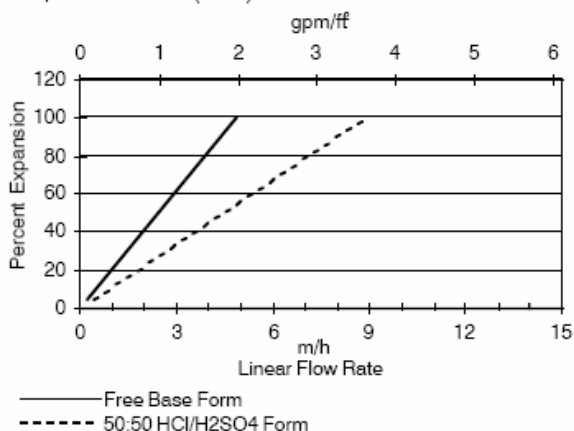
DOWEX MARATHON WBA-2 resin is a macroporous, weak base anion resin of narrow bead size distribution that has very high exchange capacity and physical durability. The small uniform bead size yields significantly higher throughput capacity than macroporous weak base resins with conventional polydispersed bead size distribution. When operated at moderate co-current demineralization flow rates, this resin offers excellent operating capacity, particularly with feed containing high alkalinity (undegassed). This means more water can be produced per regeneration so regeneration costs are minimized. DOWEX MARATHON WBA-2 resin is especially well suited for use with strong base resins. It effectively removes mineral acids (formed by Cl^- and SO_4^{2-}) and organics, reducing the ionic load on the strong base anion and protecting it from organic fouling.

Packaging

25 liter bags or 5 cubic foot fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



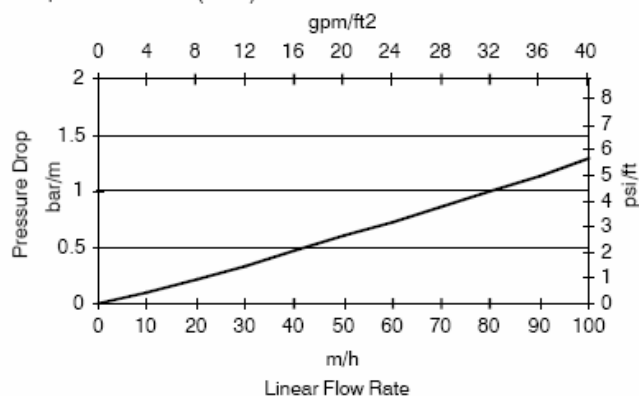
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

$$P_T = P_{20^\circ\text{C}} / (0.026 T_C + 0.48), \text{ where } P \equiv \text{bar/m}$$

$$P_T = P_{68^\circ\text{F}} / (0.014 T_F + 0.05), \text{ where } P \equiv \text{psi/ft}$$

DOWEX Ion Exchange Resins

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DOWEX™ MARATHON™ MR-3

Uniform Particle Size, High Capacity, Mixed Ion Exchange Resin for Demineralization

Product	Type	Matrix	Functional group
DOWEX™ MARATHON™ MR-3	1:1 by equivalents cation:anion	Styrene-DVB, gel	Sulfonic acid Quaternary amine

Guaranteed Sales Specifications		OH ⁻ form	H ⁺ form
Total exchange capacity, min.	eq/L	1.0	1.9
	kg/ft ³ as CaCO ₃	21.9	41.5
Water content	%	60 - 72	46 - 51
Uniformity coefficient, max.		1.1	1.1
Whole uncracked beads, min.	%	90	90

Typical Physical and Chemical Properties		OH ⁻ form	H ⁺ form
Mean particle size [†]	μm	610 ± 50	760 ± 50
Particle density	g/mL	1.06	1.22
Shipping weight	g/L		672
	lbs/ft ³		42

Recommended Operating Conditions	• Maximum operating temperature	60°C (140°F)
	• pH range	0 - 14
	• Bed depth, min.	800 mm (2.6 ft)

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

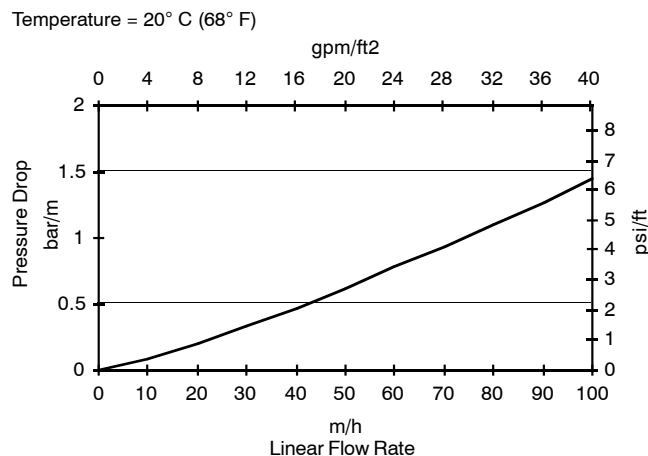
Typical properties and applications

DOWEX™ MARATHON™ MR-3 ion exchange resin is a 1:1 equivalent mixture of DOWEX MARATHON A (OH) anion and DOWEX MARATHON C-10 (H) cation resins. This product is a ready-to-use regenerable uniform particle size mixed resin for demineralization.

Packaging

25 liter bags or 5 cubic foot fiber drums

Figure 1. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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**DOWEX IF-59**

A Floating Inert Resin Specially Designed for use in Upflow Service Ion Exchange Packed Bed Counter-Current Regeneration Systems

Product	Type	Matrix	Functional group
DOWEX™ IF-59	Inert resin	Polypropylene	None

Typical Physical and Chemical Properties

Bead size distribution†			
Range 1,000 - 1,700 µm (18 mesh - 12 mesh)		%	95
< 1,000 µm, max. (18 mesh)		%	1
Particle density		g/mL	0.97
Shipping weight		g/L	560
		lbs/ft³	35

**Recommended
Operating
Conditions**

- Maximum operating temperature 100°C (212°F)
- pH range 0 - 14
- Bed depth, min. 150 mm (0.5 ft)
- Flow rates:
Service 5 - 60 m/h (2 - 24 gpm/ft²)

**Typical Properties
and Applications**

DOWEX IF-59 resin has a density less than water which insures it stays above the ion exchange resin bed. It protects the collector system against blockage and prevents resin fragments from being flushed from the bed during the service cycle.

Packaging

25 liter bags

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

LENNTECH

info@lennotech.com Tel. +31-152-610-900

www.lennotech.com Fax. +31-152-616-289

DOWEX Ion Exchange Resins

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DOWEX™ Ion Exchange Resins

3. Condensate Polishing

- DOWEX MONOSPHERE™ 575C (H)
- DOWEX MONOSPHERE 650C (H)
- DOWEX MONOSPHERE 750C (H)
- DOWEX MONOSPHERE MP-525C (H)
- DOWEX MONOSPHERE 550A (OH)
- DOWEX MONOSPHERE 700A (OH)
- DOWEX MONOSPHERE MP-725A (OH)
- DOWEX MONOSPHERE 600BB Inert Resin
- DOWEX HCR-W2
- DOWEX HGR-W2
- DOWEX MSC-1 C (H)
- DOWEX SBR-C
- DOWEX SBR-P C
- DOWEX MSA-1 C



DOWEX MONOSPHERE 575C (H)

A Uniform Particle Size Strong Acid Cation Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group
DOWEX* MONOSPHERE* 575C (H)	Strong acid cation	Styrene-DVB gel	Sulfonic acid

Guaranteed Sales Specifications			H ⁺ form			
Total exchange capacity, min.		eq/l	2.3			
		kgr/ft ³ as CaCO ₃	50.3			
Water content		%	41 – 46			
Bead size distribution†						
Mean particle size		μm	550 ± 50			
Uniformity coefficient, max.			1.1			
>850μ, max.		%	5			
<300μ, max.		%	0.5			
Whole uncracked beads, min.		%	95			
Crush strength						
Average, min.		g/bead	500			
> 200 g/bead, min.		%	95			
Ionic conversion, min.		%	99.7			
Trace metals, ppm dry resin, max.						
Na	Fe	Cu	Al	Co	Pb	Heavy metals (as Pb)
100	50	50	50	30	10	10

Typical Physical and Chemical Properties

Total swelling (Na ⁺ → H ⁺)	%	7
Particle density	g/ml	1.25
Shipping weight	g/l	800
	lbs/ft ³	50

Recommended Operating Conditions

- Maximum operating temperature 130°C (265°F)
- pH range 0-14
- Bed depth, min. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5-60 m/h (2-24 gpm/ft²)
 - Service/condensate polishing 40-150 m/h (16-60 gpm/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1-10 m/h (0.4-4 gpm /ft²)
- Total rinse requirement 3 – 6 Bed volumes
- Regenerant 1-10% H₂SO₄ or 4-8% HCl

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

Typical properties and applications

DOWEX MONOSPHERE 575C (H) cation exchange resin is a condensate polishing grade high-capacity gel resin with uniform particle size designed specifically for use in mixed beds. It is ideally suited to the high flow rate demands of condensate polishing applications. The increase in total exchange capacity enables a greater volume of anion resin in mixed beds that are designed with a 1:1 equivalent ratio. This is especially important for reducing reactor water sulfate in BWR (Boiling Water Reactor) power stations.

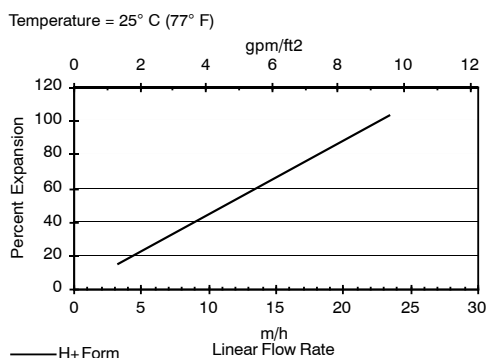
The smaller bead size of the DOWEX MONOSPHERE 575C (H) resin is intended to improve the mass transfer surface kinetics and increase the capability for particulate iron (crud) removal compared to larger uniform size cation resins. This can bring a performance advantage to condensate polishing systems in either BWR or PWR (Pressurized Water Reactor) power stations.

Although DOWEX MONOSPHERE 575C (H) resin is designed with a 550 micron bead size, separation from the less dense anions such as DOWEX MONOSPHERE 550A (OH) resin is easily accomplished. DOWEX MONOSPHERE 575C (H) resin has outstanding mechanical strength and very good stability to oxidation.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

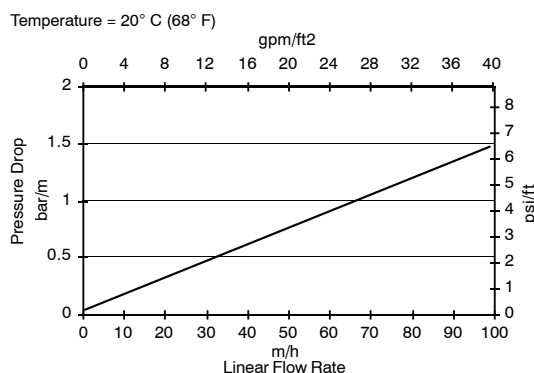


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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DOWEX™ MONOSPHERE™ 650C (H)

A Uniform Particle Size Strong Acid Cation Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group
DOWEX™ MONOSPHERE™ 650C (H)	Strong acid cation	Styrene-DVB gel	Sulfonic acid

Guaranteed Sales Specifications		H ⁺ form		
Total exchange capacity, min.	eq/L	2.0		
	kgr/ft ³ as CaCO ₃	43.7		
Water content	%	46 – 51		
Bead size distribution†				
Mean particle size	μm	650 ± 50		
Uniformity coefficient, max.		1.1		
>850 μm, max.	%	5		
<300 μm, max.	%	0.5		
Whole uncracked beads, min.	%	95		
Crush strength				
Average, min.	g/bead	500		
> 200 g/bead, min.	%	95		
Ionic conversion, min.	%	99.7		
Trace metals, ppm dry resin, max.				
Na	Fe	Cu	Al	Heavy metals (as Pb)
100	50	50	50	20

Typical Physical and Chemical Properties

Total swelling (Na ⁺ → H ⁺)	%	7
Particle density	g/mL	1.22
Shipping weight	g/L	785
	lbs/ft ³	49

Recommended Operating Conditions

- Maximum operating temperature 130°C (265°F)
- pH range 0-14
- Bed depth, min. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5-60 m/h (2-24 gpm/ft²)
 - Service/condensate polishing 40-150 m/h (16-60 gpm/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1-10 m/h (0.4-4 gpm /ft²)
- Total rinse requirement 3 - 6 Bed volumes
- Regenerant 1-10% H₂SO₄ or 4-8% HCl

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

Typical properties and applications

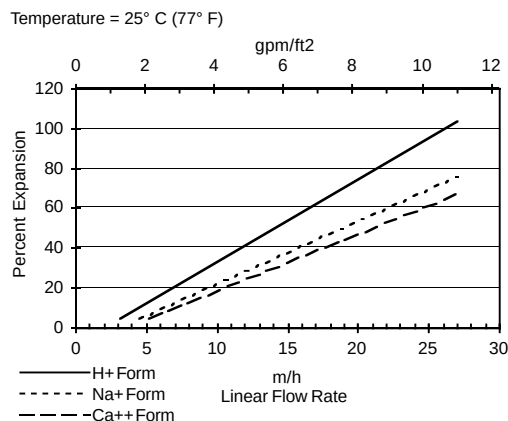
DOWEX™ MONOSPHERE™ 650C (H) cation exchange resin is a premium quality gel resin with uniform particle size designed specifically for use in mixed beds. It is ideally suited to the high flow rate demands of condensate polishing applications. The bead size uniformity is tailored to complement the smaller, less dense DOWEX MONOSPHERE 550A (OH) anion resin. Together, these resins offer near perfect separation in mixed beds.

The color distinction between the two resins allows easy visual confirmation of separation following backwash. DOWEX MONOSPHERE 650C resin has outstanding mechanical strength and very good stability to oxidation.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

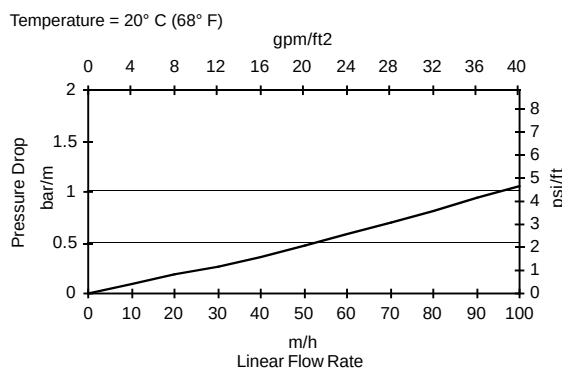


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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DOWEX MONOSPHERE 750C (H)

A Uniform Particle Size Strong Acid Cation Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group
DOWEX* MONOSPHERE* 750C (H)	Strong acid cation	Styrene-DVB gel	Sulfonic acid

Guaranteed Sales Specifications			H ⁺ form
Total exchange capacity, min.		eq/l	2.0
		kg/ft ³ as CaCO ₃	43.7
Water content		%	46 – 51
Bead size distribution [†]			
Mean particle size		μm	765 ± 25
Uniformity coefficient, max.			1.15
> 900μ, max.		%	5
< 400μ, max.		%	0.5
Whole uncracked beads, min.		%	95
Crush strength			
Average, min.		g/bead	500
> 300 g/bead, min.		%	95
Trace metals, ppm dry resin, max.			
Na	Fe	Cu	Al
60	50	10	50

Typical Physical and Chemical Properties		
Total swelling (Na ⁺ → H ⁺)	%	7
Particle density	g/ml	1.22
Shipping weight	g/l	784
	lbs/ft ³	49

Recommended Operating Conditions

- Maximum operating temperature 130°C (265°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/ft²)
 - Service/condensate polishing 40-150 m/h (16-60 gpm/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1-10 m/h (0.4-4 gpm /ft²)
- Total rinse requirement 3 – 6 Bed volumes
- Regenerant 1-10% H₂SO₄ or 4-8% HCl

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

Typical properties and applications

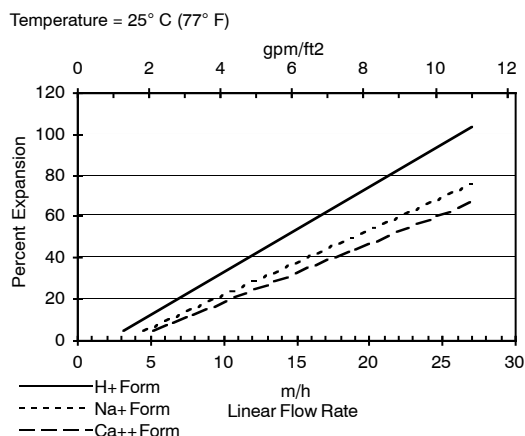
DOWEX MONOSPHERE 750C (H) cation exchange resin is a condensate polishing grade resin with high total exchange capacity, uniform particle size, exceptional bead integrity and a distinguishable dark color. It is ideally suited to the high flow rate demands of condensate polishing applications.

The combination of uniform particle size and a 765-micron average bead diameter makes this resin an excellent choice for use with the DOWEX MONOSPHERE 700A (OH) anion resin. The uniform particle size will enable excellent separation to reduce contaminant ion leakage, while the larger bead diameters will minimize pressure drop across the mixed bed resin. This is especially important in high velocity condensate polishing conditions of systems with a Tripol-design.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

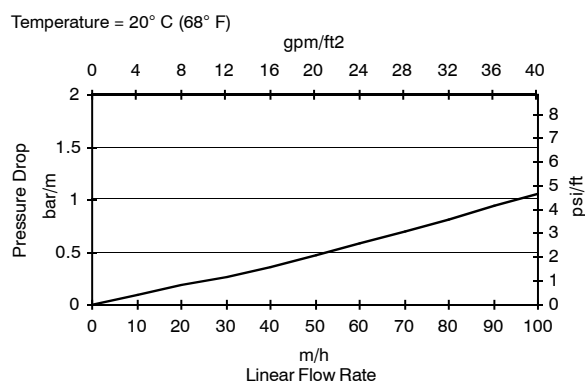


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX™ MONOSPHERE™ MP-525C (H)

A Uniform Particle Size Macroporous Strong Acid Cation Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group
DOWEX™ MONOSPHERE™ MP-525C (H)	Strong acid cation	Styrene-DVB macroporous	Sulfonic acid

Guaranteed Sales Specifications				H ⁺ form
Total exchange capacity, min.		eq/L		1.6
		kgr/ft ³ as CaCO ₃		35.0
Water content		%		50 – 54
Bead size distribution†				
Mean particle size		μm		500 ± 50
Uniformity coefficient, max.				1.1
< 300 μm, max.		%		1
Whole beads, min.		%		95
Crush strength				
Average, min.		g/bead		350
> 200 g/bead, min.		%		95
Trace metals, ppm dry resin, max.				
Na	Fe	Cu	Al	Heavy metals (as Pb)
100	50	50	50	20

Typical Physical and Chemical Properties			
Total swelling (Na ⁺ → H ⁺)		%	4
Particle density		g/mL	1.18
Shipping weight		g/L	760
		lbs/ft ³	47

Recommended Operating Conditions

- Maximum operating temperature 150°C (300°F)
- pH range 0 - 14
- Bed depth, min. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5 - 50 m/h (2 - 20 gpm/ft²)
 - Service/condensate polishing 40 - 150 m/h (16 - 60 gpm/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm /ft²)
- Total rinse requirement 3 - 6 Bed volumes
- Regenerant 1 - 10% H₂SO₄, 4 - 8% HCl

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

Typical properties and applications

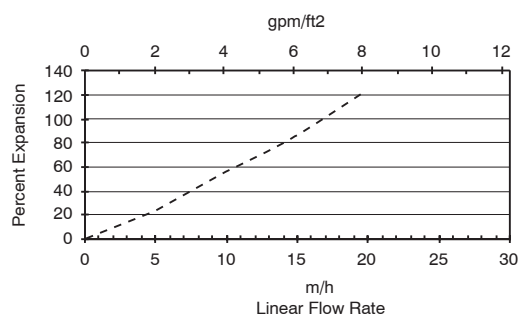
DOWEX™ MONOSPHERE™ MP-525C (H) strong acid cation exchange resin is a condensate grade macroporous resin with uniform particle size, exceptional physical stability and resistance to osmotic shock. This resin is specially sized to give excellent separation after backwash when used in conjunction with DOWEX MONOSPHERE MP-725A (OH) anion exchange resin in mixed beds. In addition, the smaller bead size of DOWEX MONOSPHERE MP-525C (H) is intended to improve insoluble iron removal and reduce the regeneration and rinse water requirements compared to larger conventional type macroporous resins.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



--- 2:1 volume ratio of
DOWEX MONOSPHERE MP-525C
and DOWEX MONOSPHERE MP-725A (OH)

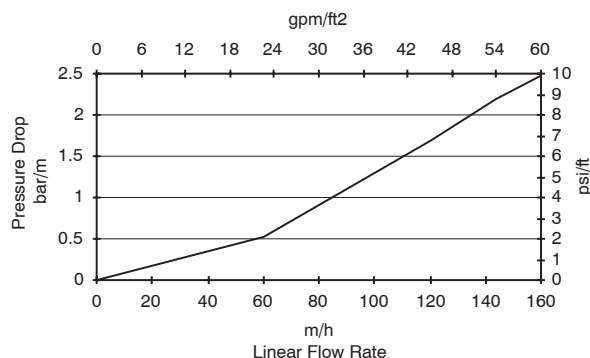
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 100° F (37.8° C)



— 2:1 volume ratio of
DOWEX MONOSPHERE MP-525C
and DOWEX MONOSPHERE MP-725A (OH)

For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX™ MONOSPHERE™ 550A (OH)

A Uniform Particle Size Strong Base Anion Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group	
DOWEX™ MONOSPHERE™ 550A (OH)	Type 1 strong base anion	Styrene-DVB gel	Quaternary amine	
Guaranteed Sales Specifications			OH ⁻ form	
Total exchange capacity, min.		eq/L kgr/ft ³ as CaCO ₃	1.1 24.0	
Water content		%	55 – 65	
Bead size distribution†				
Mean particle size		μm	590 ± 50	
Uniformity coefficient, max.			1.1	
>850 μm, max.		%	5	
<300 μm, max.		%	0.5	
Whole uncracked beads, min.		%	95	
Crush strength				
Average, min.		g/bead	350	
> 200 g/bead, min.		%	95	
Ionic conversion	OH ⁻ 94% min.	Cl ⁻ 0.5% max.	CO ₃ ⁻ 6% max.	
Trace metals, ppm dry resin, max.				
Na	Fe	Cu	Al	Heavy metals (as Pb)
50	80	40	40	20

Typical Physical and Chemical Properties

Total swelling (Cl ⁻ → OH ⁻)	%	25
Particle density	g/mL	1.08
Shipping weight	g/L lbs/ft ³	657 41

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. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5-60 m/h (2-24 gpm/ft²)
 - Service/condensate polishing 40-150 m/h (16-60 gpm/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1-10 m/h (0.4-4 gpm /ft²)
- Total rinse requirement 2-5 Bed volumes
- Regenerant:
 - Type 4-8% NaOH
 - Temperature Ambient or up to 60°C (140°F) for silica removal

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

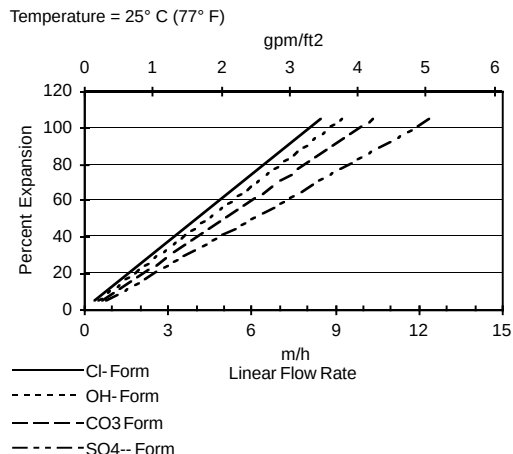
Typical properties and applications

DOWEX™ MONOSPHERE™ 550A (OH) anion resin is a premium quality resin with high total exchange capacity, exceptional bead integrity and a distinguishable light color. It is ideally suited to the high flow rate demands commonly encountered in power plant condensate polishing systems. The bead size uniformity of this anion resin and its smaller average particle size results in rapid exchange kinetics and helps provide excellent separability when used with DOWEX MONOSPHERE 650C (H) cation resin.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

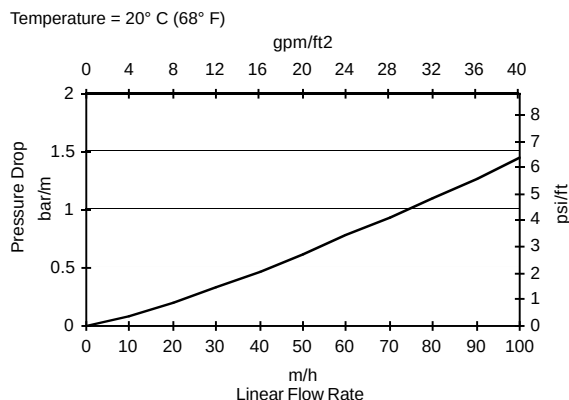


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

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

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

DOWEX™ Ion Exchange Resins

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DOWEX MONOSPHERE 700A (OH)

A Uniform Particle Size Strong Base Anion Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group	
DOWEX* MONOSPHERE* 700A (OH)	Type 1 strong base anion	Styrene-DVB gel	Quaternary amine	
Guaranteed Sales Specifications			OH ⁻ form	
Total exchange capacity, min.		eq/l kgr/ft ³ as CaCO ₃	1.1 24.0	
Water content		%	55 – 65	
Bead size distribution†				
Mean particle size		μm	700 ± 50	
Uniformity coefficient, max.			1.1	
>850μ, max.		%	5	
<300μ, max.		%	0.5	
Whole uncracked beads, min.		%	95	
Crush strength				
Average, min.		g/bead	350	
> 200 g/bead, min.		%	95	
Ionic conversion	OH ⁻ 93% min.	Cl ⁻ 0.5% max.	CO ₃ ⁻ 7% max.	
Trace metals, ppm dry resin, max.				
Na	Fe	Cu	Al	Heavy metals (as Pb)
50	80	40	40	20

Typical Physical and Chemical Properties

Total swelling (Cl ⁻ → OH ⁻)	%	25
Particle density	g/ml	1.08
Shipping weight	g/l lbs/ft ³	640 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. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5-60 m/h (2-24 gpm/ft²)
 - Service/condensate polishing 40-190 m/h (16-80 gpm/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1-10 m/h (0.4-4 gpm /ft²)
- Total rinse requirement 2-5 Bed volumes
- Regenerant:
 - Type 4-8% NaOH
 - Temperature Ambient or up to 60°C (140°F) for silica removal

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

Typical properties and applications

DOWEX MONOSPHERE 700A (OH) anion exchange resin is a condensate polishing grade resin with high total exchange capacity, uniform particle size, exceptional bead integrity and a distinguishable light color. It is ideally suited to the high flow rate demands of condensate polishing applications.

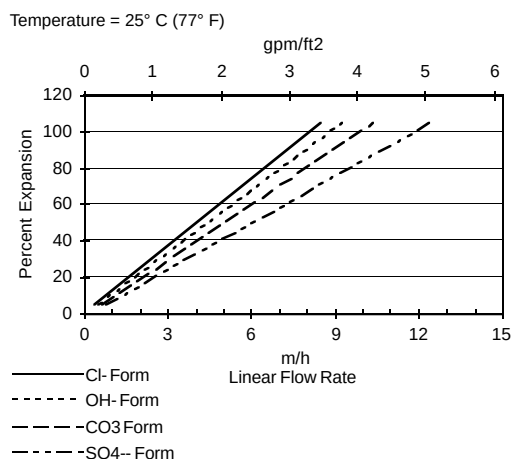
The combination of uniform particle size and a 700-micron average bead diameter makes this resin an excellent choice for use with the DOWEX MONOSPHERE 750C (H) cation resin. The uniform particle size will enable excellent separation to reduce contaminant ion leakage, while the larger bead diameters will minimize pressure drop across the mixed resin bed. This is especially important in high velocity condensate polishing conditions or Tripol-designed systems.

The DOWEX MONOSPHERE 700A (OH) anion resin can also be used in combination with the DOWEX MONOSPHERE 575C cation resin as a less-separable mixed resin. A mixed resin with reduced separability is a desired characteristic by some BWR (Boiling Water Reactor) nuclear power stations since their condensate polishing resin does not require separation and regeneration, and less-separable resin mixtures can help reduce the contaminant sulfate level in the BWR system.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

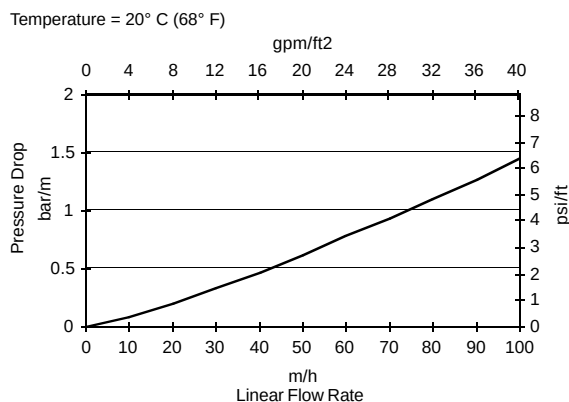


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

For more information about DOWEX resins, call the Dow Liquid Separations business:

North America: 1-800-447-4369
 Latin America: (+55) 11-5188-9277
 Europe: (+32) 3-450-2240
 Japan: (+81) 3-5460-2100
 Australia: (+61) 3-9226-3545
<http://www.dowex.com>

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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DOWEX™ MONOSPHERE™ MP-725A (OH)

A Uniform Particle Size Macroporous Strong Base Anion Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group
DOWEX™ MONOSPHERE™ MP-725A (OH)	Type I strong base anion	Styrene-DVB, macroporous	Quaternary amine

Guaranteed Sales Specifications			OH ⁻ form	
Total exchange capacity, min.		eq/L	0.8	
		kgr/ft ³ as CaCO ₃	17.5	
Water content		%	65 – 75	
Bead size distribution†				
Mean particle size		μm	690 ± 50	
Uniformity coefficient, max.			1.1	
> 850 μm, max.		%	5	
< 300 μm, max.		%	0.5	
Whole beads, min.		%	95	
Trace metals, ppm dry resin, max.	Na	Fe	Cu	Al
	50	50	50	50

Typical Physical and Chemical Properties			OH ⁻ form	
Total swelling (Cl ⁻ → OH ⁻)		%	15	
Particle density		g/mL	1.04	
Shipping weight		g/L	625	
		lbs/ft ³	39	

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. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5 - 50 m/h (2 - 20 gpm/ft²)
 - Service/condensate polishing 40 - 150 m/h (16 - 60 gpm/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm /ft²)
- Total rinse requirement 3 - 6 Bed volumes
- Regenerant:
 - Type 4 - 8% NaOH
 - Temperature Ambient or up to 50°C (122°F) for silica removal

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

Typical properties and applications

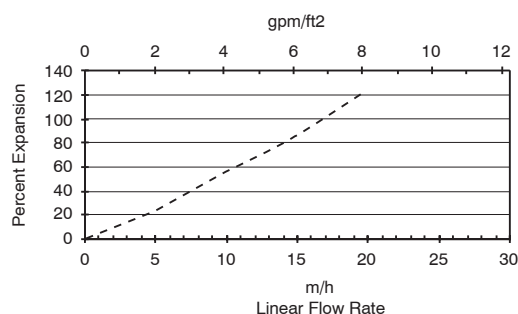
DOWEX™ MONOSPHERE™ MP-725A (OH) strong base anion exchange resin is a condensate grade macroporous resin with uniform particle size, exceptional physical stability and resistance to osmotic shock. This resin is specially sized to give excellent separation after backwash when used in conjunction with DOWEX MONOSPHERE MP-525C cation exchange resin in condensate polishing mixed beds. In addition, the smaller bead size of DOWEX MONOSPHERE MP-725A (OH) provides for a greater mass transfer area compared to larger conventional type macroporous resins. This is especially important for contaminant ion removal during a condenser leak.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



--- 2:1 volume ratio of
DOWEX MONOSPHERE MP-525C
and DOWEX MONOSPHERE MP-725A (OH)

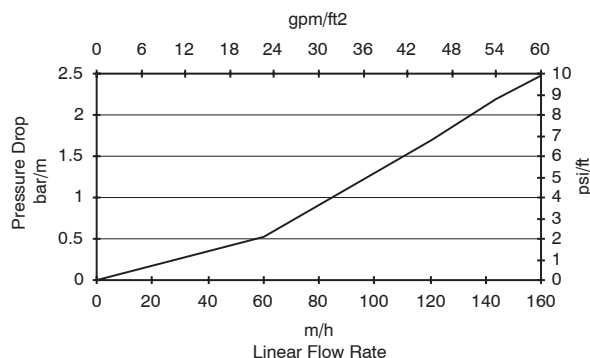
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 100° F (37.8° C)



— 2:1 volume ratio of
DOWEX MONOSPHERE MP-525C
and DOWEX MONOSPHERE MP-725A (OH)

For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX™ MONOSPHERE™ 600BB Inert Resin

A Uniform Particle Size Inert Resin for use in Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group
DOWEX™ MONOSPHERE™ 600BB	Inert	Styrene-DVB-acrylate terpolymer	None

Guaranteed Sales Specifications

Bead size distribution range†		
Mean particle size	μm	600 ± 50
Uniformity coefficient, max.		1.1
Specific gravity @ 77°F		1.14 - 1.16

Typical Physical and Chemical Properties

Particle density	g/mL	1.15
Shipping weight	g/L	670
	lbs/ft³	42

Recommended Operating Conditions

- Maximum operating temperature 60°C (140°F)
- pH range 0 - 14
- Bed depth, min. 150 mm (0.5 ft)

Typical Properties and Applications

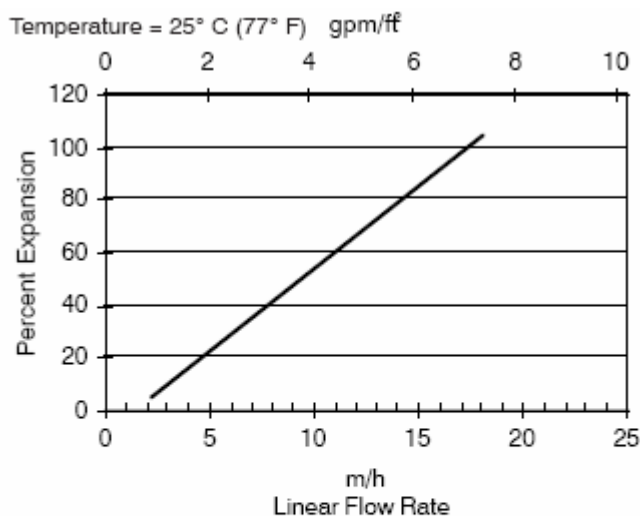
DOWEX MONOSPHERE 600BB inert resin is a non-functionalized resin used to enhance separation of mixed beds during regeneration. Its density is between the densities of strong acid cation exchange resin and strong base anion exchange resin. It also has a tightly controlled, uniform particle size. These combined properties ensure the terminal settling velocity is intermediate to that of the cation and anion resins creating an inert "Buffer Zone" between the functional resins following backwash. Separation of the two functional components of a mixed bed reduces the risk of crossregeneration, improving water quality and reducing rinse time.

Packaging

25 liter bags or 5 cubic foot fiber drums

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

Figure 1. Backwash Expansion Data



For other temperatures use:

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

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

DOWEX™ Ion Exchange Resins

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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DOWEX HCR-W2

A High Capacity Strong Acid Cation Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group
DOWEX™ HCR-W2	Strong acid cation	Styrene-DVB gel	Sulfonic acid

Guaranteed Sales Specifications				H ⁺ form		
Total exchange capacity, min.		eq/L		1.8		
		kg/ft ³ as CaCO ₃		39.3		
Water content		%		48 - 54		
Bead size distribution [†]						
> 1,200 μm, max. (16 mesh)		%		2		
< 420 μm, max. (40 mesh)		%		1		
Whole uncracked beads, min.		%		95		
Crush strength						
Average, min.		g/bead		350		
> 200 g/bead, min.		%		95		
Trace metals, ppm dry resin, max. (H ⁺ form)						
Na	Fe	Cu	Al	Mg	Ca	Heavy metals (as Pb)
50	50	10	50	50	50	10

Typical Physical and Chemical Properties		H ⁺ form
Total swelling (Na ⁺ → H ⁺)	%	8
Particle density	g/mL	1.22
Shipping weight	g/L	785
	lbs/ft ³	49

Recommended Operating Conditions

- Maximum operating temperature: 120°C (250°F)
- pH range: 0-14
- Bed depth, min. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse: 5-50 m/h (2 - 20 gpm/ft²)
 - Service/condensate polishing: 40-150 m/h (16 - 60 gpm/ft²)
 - Backwash: See figure 1
 - Co-current regeneration/displacement rinse: 1-10 m/h (0.4 - 4 gpm /ft²)
- Total rinse requirement: 3-6 Bed volumes
- Regenerant: 1-10% H₂SO₄ or 4-8% HCl

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

Typical properties and applications

DOWEX HCR-W2 strong acid cation exchange resin is a premium grade resin with high exchange capacity, excellent resistance to attrition and good resistance to thermal and oxidative degradation.

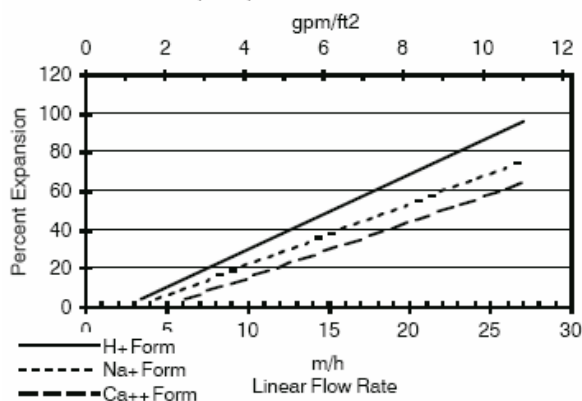
The resin is specially sized for use in working or polishing mixed beds. DOWEX HCR-W2 resin is recommended for use alone as a single lead cation or with DOWEX SBR-C (OH) or DOWEX SBR-P C (OH) anion exchange resins in mixed beds for deep-bed condensate polishing.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



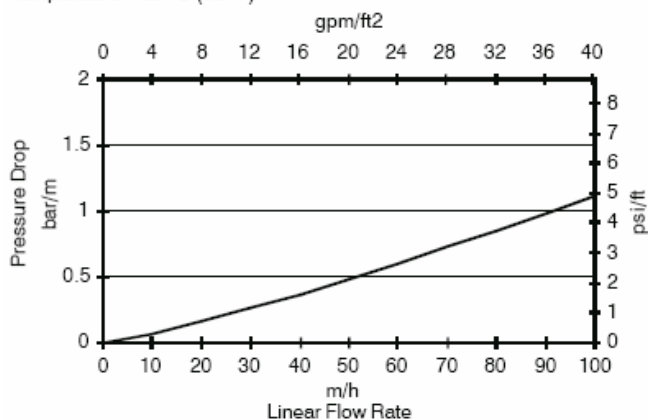
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

For more information about DOWEX resins, call the Dow Liquid Separations business:

North America: 1-800-447-4369
 Latin America: (+55) 11-5188-9222
 Europe: (+32) 3-450-2240
 Pacific: +60 3 7958 3392
 Japan: +813 5460 2100
 China: +86 21 2301 9000
<http://www.dowex.com>

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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DOWEX HGR-W2

A High Capacity Strong Acid Cation Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group
DOWEX™ HGR-W2	Strong acid cation	Styrene-DVB gel	Sulfonic acid

Guaranteed Sales Specifications			H ⁺ form			
Total exchange capacity, min.		eq/L	2.0			
		kg/ft ³ as CaCO ₃	43.7			
Water content		%	47 - 51			
Bead size distribution†						
> 1,200 μm, max. (16 mesh)		%	2			
< 420 μm, max. (40 mesh)		%	1			
Whole uncracked beads, min.		%	95			
Crush strength						
Average, min.		g/bead	350			
> 200 g/bead, min.		%	95			
Ionic conversions, H ⁺ form, min.		%	99			
Trace metals, ppm dry resin, max. (H ⁺ form)						
Na	Fe	Cu	Al	Mg	Ca	Heavy metals (as Pb)
50	50	10	50	50	50	10

Typical Physical and Chemical Properties		H ⁺ form
Total swelling (Na ⁺ → H ⁺)	%	7
Particle density	g/mL	1.23
Shipping weight	g/L	820
	lbs/ft ³	51

Recommended Operating Conditions

- Maximum operating temperature: 130°C (265°F)
- pH range: 0 - 14
- Bed depth, min.: 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse: 5 - 50 m/h (2 - 20 gpm/ft²)
 - Service/condensate polishing: 40 - 150 m/h (16 - 60 gpm/ft²)
 - Backwash: See figure 1
 - Regeneration/displacement rinse: 1 - 10 m/h (0.4 - 4 gpm /ft²)
- Total rinse requirement: 3 - 6 Bed volumes
- Regenerant:
 - 1 - 10% H₂SO₄, 4 - 8% HCl or
 - 8 - 12% NaCl

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

Typical properties and applications

DOWEX HGR-W2 strong acid cation resin is a premium grade product with high exchange capacity, excellent resistance to attrition and good resistance to thermal and oxidative degradation.

The high cross-linkage results in increased density which improves separation following backwash in mixed bed applications.

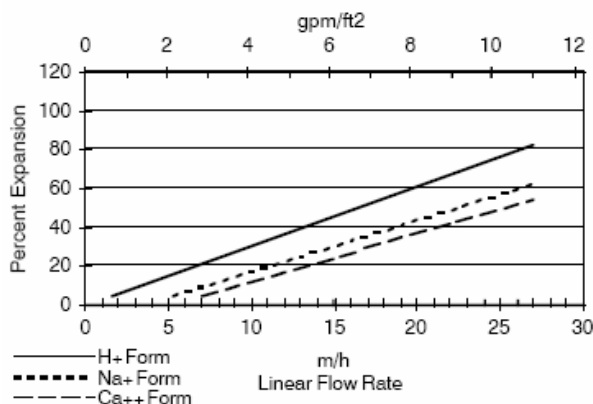
DOWEX HGR-W2 resin can be used in combination with DOWEX MONOSPHERE™ 550A, DOWEX SBR-P C (OH) or DOWEX SBR C (OH) anion exchange resins in mixed beds for deep-bed condensate polishing. It is also used in single beds for sodium cycle condensate polishing.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



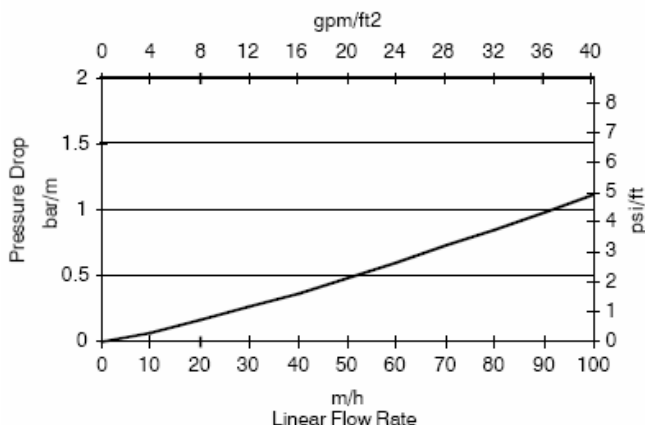
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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DOWEX MSC-1 C (H)

A Macroporous Strong Acid Cation Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group
DOWEX™ MSC-1 C (H)	Strong acid cation	Styrene-DVB, macroporous	Sulfonic acid

Guaranteed Sales Specifications		H ⁺ form
Total exchange capacity, min.	eq/L kgr/ft ³ as CaCO ₃	1.6 35.0
Water content	%	50 - 56
Bead size distribution†		
> 1,200 µm, max. (16 mesh)	%	2
< 420 µm, max. (40 mesh)	%	1
Whole beads, min.	%	95
Crush strength		
Average, min.	g/bead	350
> 200 g/bead, min.	%	95

Typical Physical and Chemical Properties		H ⁺ form
Total swelling (Na ⁺ → H ⁺)	%	4
Particle density	g/mL	1.18
Shipping weight	g/L lbs/ft ³	760 47

Recommended Operating Conditions

- Maximum operating temperature 150°C (300°F)
- pH range 0 - 14
- Bed depth, min. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5 - 50 m/h (2 - 20 gpm/ft²)
 - Condensate polishing 40 - 150 m/h (16 - 60 gpm/ft²)
 - Backwash See Figure 1
 - Regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm/ft²)
- Total rinse requirement 3 - 6 bed volumes
- Regenerant 1 - 10% H₂SO₄, 4 - 8% HCl

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

Typical Properties and Applications

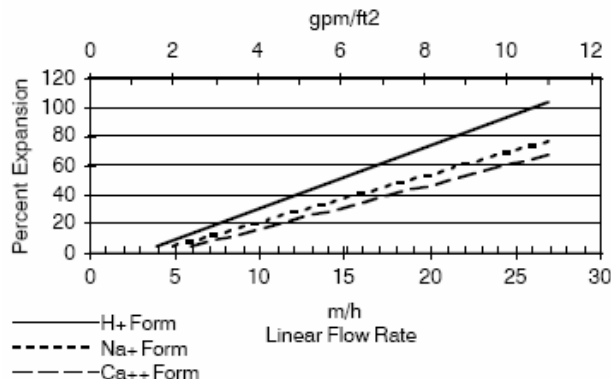
DOWEX MSC-1 C (H) strong acid cation exchange resin is a condensate grade macroporous resin with exceptional physical stability and resistance to osmotic shock. This resin is specially sized to give good separation after backwash when used in conjunction with DOWEX MSA-1 C anion exchange resin in condensate polishing mixed beds.

Packaging

25 liter bags or 5 cubic foot fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



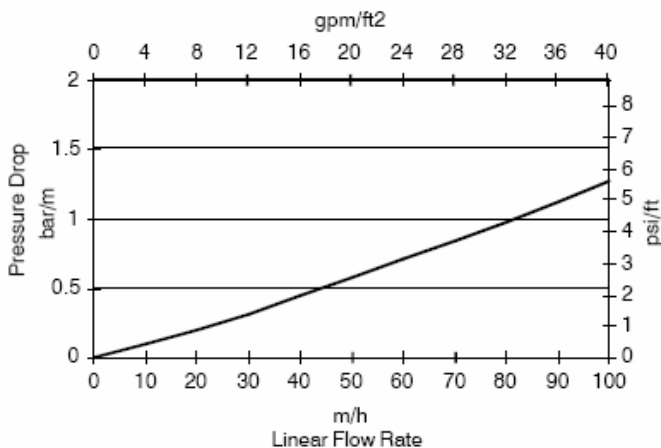
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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DOWEX™ SBR-C

A High Capacity Strong Base Anion Exchange Resin for Mixed Bed Demineralization and Condensate Polishing Applications

Product	Type	Matrix	Functional group			
DOWEX™ SBR-C	Type I strong base anion	Styrene-DVB, gel	Quaternary amine			
Guaranteed Sales Specifications		Cl ⁻ form	OH ⁻ form			
Total exchange capacity, min.	eq/L kgr/ft ³ as CaCO ₃	1.4 30.6	1.1 24.0			
Water content	%	43 - 48	50 - 60			
Bead size distribution†						
> 1,200 μm, max. (16 mesh)	%	2	5			
> 840 μm, max. (20 mesh)	%	20	—			
< 350 μm, max. (45 mesh)	%	1	1			
Whole uncracked beads, min.	%	95	95			
Crush strength						
Average, min.	g/bead	350	350			
> 200 g/bead, min.	%	95	95			
Ionic conversions (OH ⁻ form)						
OH ⁻ 93% min.	Cl ⁻ 3% max.		CO ₃ ⁻ 7% max.			
Trace metals, ppm dry resin, max. (OH ⁻ form)						
Na	Fe	Cu	Al	Mg	Ca	Heavy metals (as Pb)
50	50	10	50	50	50	10
Typical Physical and Chemical Properties		Cl ⁻ form	OH ⁻ form			
Total swelling (Cl ⁻ → OH ⁻)	%	15	15			
Particle density	g/mL	1.10	1.08			
Shipping weight	g/L	672	655			
	lbs/ft ³	42	41			

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. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5 - 50 m/h (2 - 20 gpm/ft²)
 - Service/condensate polishing 40 - 150 m/h (16 - 60 gpm/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm /ft²)
- Total rinse requirement 2 - 5 Bed volumes
- Regenerant:
 - Type 4 - 8% NaOH
 - Temperature Ambient or up to 50°C (122°F) for silica removal

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

Typical properties and applications

DOWEX™ SBR-C strong base anion exchange resin has extremely high capacity, very good kinetics, excellent physical and chemical stability and resistance to osmotic shock.

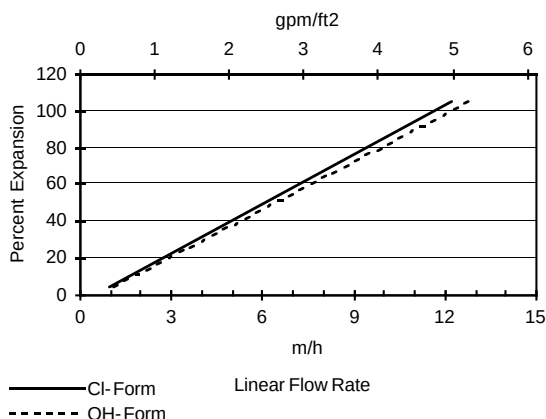
The resin is specially graded to give good separation after backwash when used in conjunction with DOWEX HCR-W2 or DOWEX HGR-W2 cation exchange resins in condensate polishing mixed beds.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



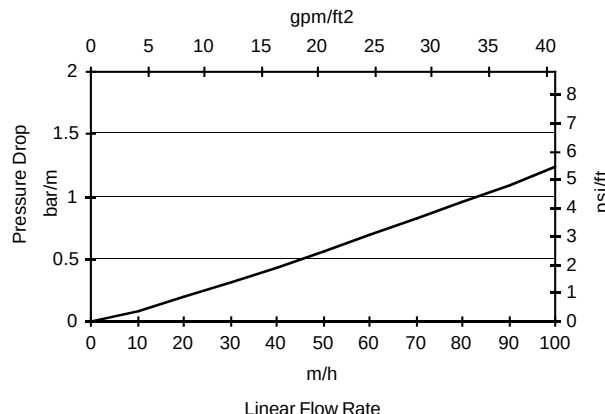
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX™ Ion Exchange Resins

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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DOWEX™ SBR-P C

A Strong Base Anion Exchange Resin with Excellent Regeneration Efficiency for Condensate Polishing and Mixed Bed Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ SBR-P C	Type 1 strong base anion	Styrene-DVB gel	Quaternary amine

Guaranteed Sales Specifications				Cl ⁻ form	OH ⁻ form	
Total exchange capacity, min.		eq/L		1.2	1.0	
		kgr/ft ³ as CaCO ₃		26.2	21.9	
Water content		%		50 - 57	60 - 68	
Bead size distribution†						
> 1,200 µm, max. (16 mesh)		%		2	5	
> 840 µm, max. (20 mesh)		%		20	20	
< 350 µm, max. (45 mesh)		%		1	1	
Whole uncracked beads, min.		%		95	95	
Crush strength						
Average, min.		g/bead		350	350	
> 200 g/bead, min.		%		95	95	
Ionic conversions (OH ⁻ form)		OH ⁻		Cl ⁻		
		93% min.		3% max.		
Trace metals, ppm dry resin, max. (OH ⁻ form)						
Na	Fe	Cu	Al	Mg	Ca	Heavy metals (as Pb)
50	50	10	50	50	50	10

Typical Physical and Chemical Properties		Cl ⁻ form	OH ⁻ form
Total swelling (Cl ⁻ → OH ⁻)	%	20	20
Particle density	g/mL	1.10	1.08
Shipping weight	g/L lbs/ft ³	672 42	641 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. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5 - 50 m/h (2 - 20 gpm/ft²)
 - Service/condensate polishing 40 - 150 m/h (16 - 60 gpm/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm /ft²)
- Total rinse requirement 2 - 5 Bed volumes
- Regenerant:
 - Type 4 - 8% NaOH
 - Temperature Ambient or up to 50°C (122°F) for silica removal

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

Typical properties and applications

DOWEX™ SBR-P C strong base anion exchange resin is a high capacity resin with excellent kinetics and very good physical and chemical stability.

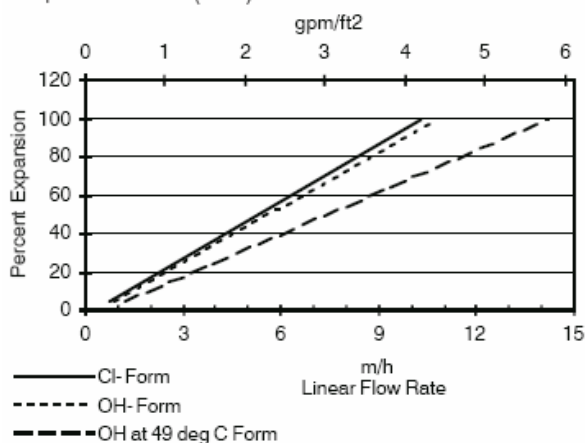
This resin's high porosity results in enhanced regeneration efficiency and resistance to organic fouling. The particle size distribution is designed to enhance separation and reduce pressure drop in mixed beds. DOWEX SBR-P C resin can be used in mixed beds with DOWEX HCR-W2 (H) or DOWEX HGR-W2 (H) cation resins to treat recycled condensate at up to 150 m/h (60 gpm/ft²).

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



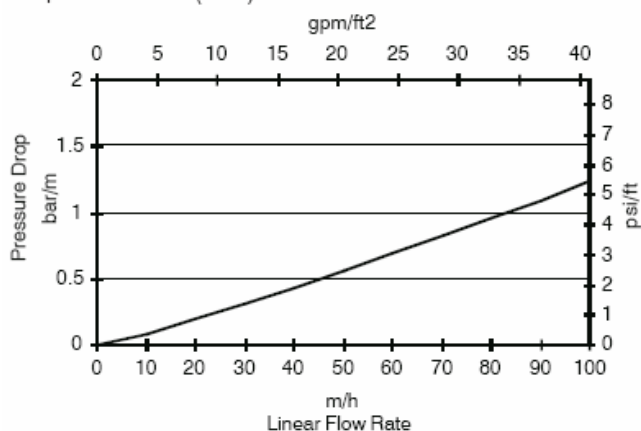
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX™ Ion Exchange Resins

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DOWEX™ MSA-1 C

A Macroporous Strong Base Anion Exchange Resin for Mixed Bed Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ MSA-1 C	Type I strong base anion	Styrene-DVB, macroporous	Quaternary amine

Guaranteed Sales Specifications		Cl ⁻ form
Total exchange capacity, min.	eq/L	1.0
	kgr/ft ³ as CaCO ₃	21.9
Water content	%	56 - 64
Bead size distribution†		
> 1,400 µm, max. (14 mesh)	%	0
> 1,200 µm, max. (16 mesh)	%	2
< 420 µm, max. (40 mesh)	%	2
Whole beads, min.	%	95

Typical Physical and Chemical Properties		Cl ⁻ form
Total swelling (Cl ⁻ → OH ⁻)	%	15
Particle density	g/mL	1.06
Shipping weight	g/L	670
	lbs/ft ³	42

Recommended Operating Conditions

- Maximum operating temperature 100°C (212°F)
- pH range 0 - 14
- Bed depth, min. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5 - 50 m/h (2 - 20 gpm/ft²)
 - Service/condensate polishing 40 - 150 m/h (16 - 60 gpm/ft²)
 - Backwash See Figure 1
 - Regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm/ft²)
- Total rinse requirement 3 - 6 Bed volumes
- Regenerant:
 - Type 4 - 8% NaOH
 - Temperature Ambient or up to 50°C (122°F) for silica removal

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

Typical Properties and Applications

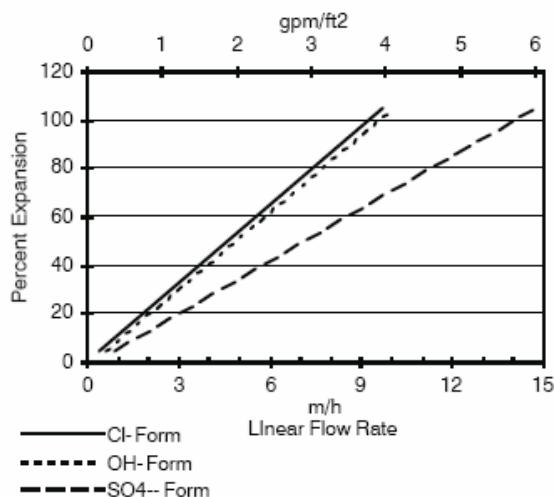
DOWEX™ MSA-1 C strong base anion exchange resin is a condensate grade macroporous resin with exceptional physical stability and resistance to osmotic shock.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

Temperature = 25° C (77° F)



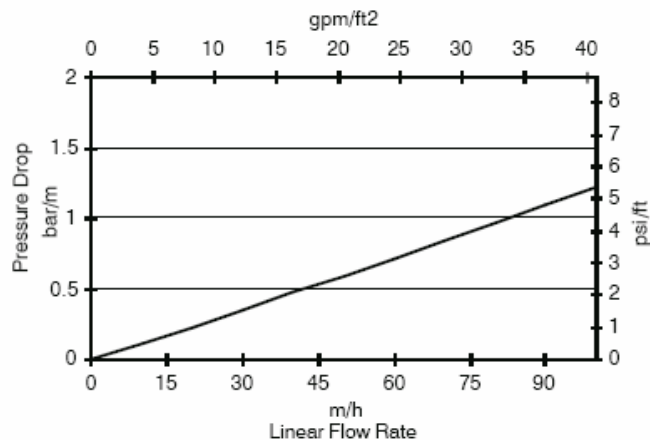
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

$$P_T = P_{20^\circ\text{C}} / (0.026 T_C + 0.48), \text{ where } P \equiv \text{bar/m}$$

$$P_T = P_{68^\circ\text{F}} / (0.014 T_F + 0.05), \text{ where } P \equiv \text{psi/ft}$$

DOWEX™ Ion Exchange Resins

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DOWEX™ Ion Exchange Resins

4. Nuclear

- DOWEX MONOSPHERE™ 575C NG (H)
- DOWEX MONOSPHERE 650C NG (H)
- DOWEX MONOSPHERE 550A LC NG (OH)
- DOWEX MONOSPHERE MR-575 LC NG
- DOWEX HGR NG (H)
- DOWEX C-75 NG (H)
- DOWEX SBR LC NG (OH)
- DOWEX MR-3 LC NG
- DOWEX MR-72 LC NG
- DOWEX MR-75 LC NG
- DOWEX MR-5 LC NG



DOWEX MONOSPHERE 575C NG (H)

A Uniform Particle Size Strong Acid Cation Exchange Resin for Steam Generator
Blowdown, Reactor Water Clean-up and Other Nuclear Water Applications

Product	Type	Matrix	Functional group
DOWEX* MONOSPHERE* 575C NG (H)	Strong acid cation	Styrene-DVB gel	Sulfonic acid

Guaranteed Sales Specifications					H ⁺ form		
Total exchange capacity, min.		eq/l		2.3			
		kgr/ft ³ as CaCO ₃		50.3			
Water content		%		41 – 46			
Bead size distribution†							
Mean particle size		μm		550 ± 50			
Uniformity coefficient, max.				1.1			
>800μ, max.		%		3			
<300μ, max.		%		0.2			
Whole uncracked beads, min.		%		95			
Crush strength							
Average, min.		g/bead		500			
> 200 g/bead		%		95			
Ionic conversion, min.		%		99.7			
Trace metals, ppm dry resin, max.							
Na	Fe	Cu	Al	Co	Pb	Hg	Heavy metals (as Pb)
50	50	10	50	30	10	10	10

Typical Physical and Chemical Properties

Total swelling (Na ⁺ → H ⁺)	%	7
Particle density	g/ml	1.25
Shipping weight	g/l	800
	lbs/ft ³	50

Recommended Operating Conditions

- Maximum operating temperature 130°C (265°F)
- pH range 0-14
- Bed depth, min. 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 5-60 m/h (2-24 gpm/ft²)
 - Service/condensate polishing 40-150 m/h (16-60 gpm/ft²)
 - Backwash See figure 1
 - Co-current regeneration/displacement rinse 1-10 m/h (0.4-4 gpm /ft²)
- Total rinse requirement 3 – 6 Bed volumes
- Regenerant 1-10% H₂SO₄ or 4-8% HCl

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

Typical properties and applications

DOWEX MONOSPHERE 575C NG (H) is a high-capacity, uniform particle size gel cation exchange resin with outstanding purity and performance.

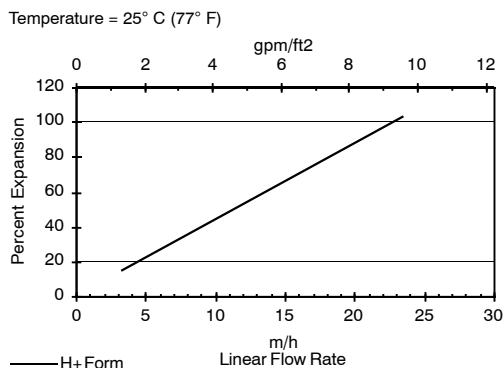
This resin is supplied with a minimum of 99% of ionic sites in the H⁺ form. It also has excellent physical and chemical stability and low metallic impurity levels.

DOWEX MONOSPHERE 575C NG (H) resin can be used as a single resin or in mixed beds together with DOWEX MONOSPHERE 550A LC NG (OH) anion exchange resin.

Packaging

50 liter or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

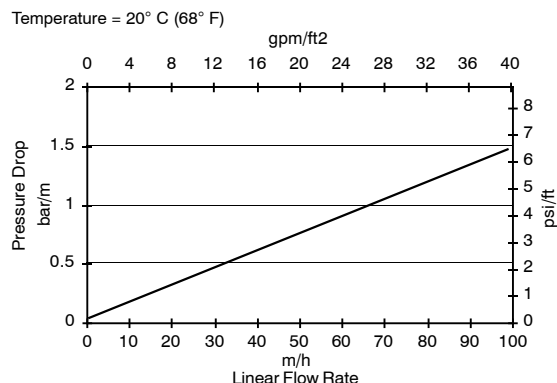


For other temperatures use:

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

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

Figure 2. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX MONOSPHERE 650C NG (H)

A Uniform Particle Size Strong Acid Cation Exchange Resin for Demineralization in Nuclear Water Applications

Product	Type	Matrix	Functional group
DOWEX™ MONOSPHERE™ 650C NG (H)	Strong acid cation	Styrene-DVB, gel	Sulfonic acid

Guaranteed Sales Specifications							H ⁺ form		
Total exchange capacity, min.		eq/L			2.0				
		kgr/ft ³ as CaCO ₃			43.7				
Water content		%			46 - 51				
Bead size distribution†									
Mean particle size		μm			650 ± 50				
Uniformity coefficient, max.					1.1				
< 300 μm, max.		%			0.2				
Whole uncracked beads, min.		%			95				
Crush strength									
Average, min.		g/bead			500				
> 300 g/bead, min.		%			95				
Ionic conversion, min.		%			99.7				
Trace metals, ppm dry resin, max.									
Na	Fe	Cu	Al	Mg	Ca	Co	Pb	Hg	Heavy metals (as Pb)
50	50	10	50	50	50	30	10	10	10

Typical Physical and Chemical Properties		H ⁺ form
Particle density	g/mL	1.22
Shipping weight	g/L lbs/ft ³	785 49

Recommended Operating Conditions

- Maximum operating temperature 130°C (265°F)
- pH range 0 - 14
- Bed depth, min. 450 mm (1.5 ft)

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

Typical Properties and Applications

DOWEX MONOSPHERE 650C NG (H) uniform particle size, nuclear grade cation resin has outstanding purity and performance.

This resin is supplied with a minimum of 99.7% of ionic sites in the H⁺ form. It also has excellent physical and chemical stability and low metallic impurity levels.

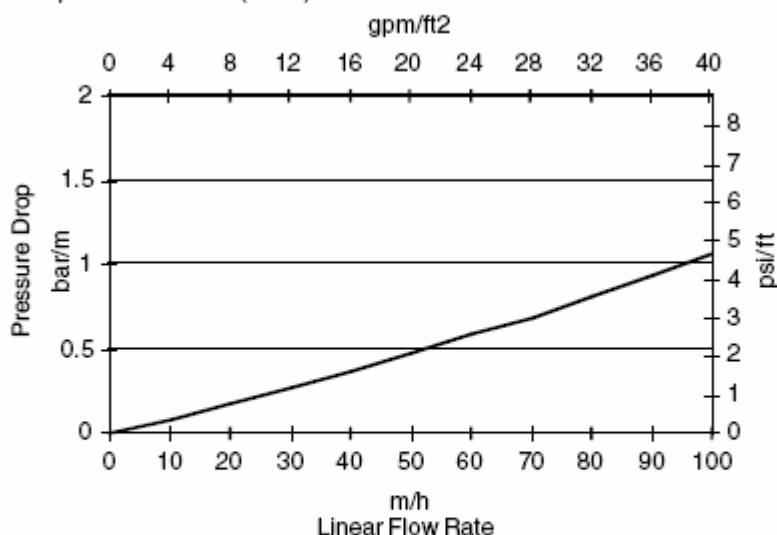
DOWEX MONOSPHERE 650C NG (H) resin can be used as a single resin or in mixed beds together with DOWEX MONOSPHERE 550A LC NG (OH) anion exchange resin.

Packaging

50 liter or 5 cubic foot fiber drums

Figure 1. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX MONOSPHERE 550A LC NG (OH)

A Uniform Particle Size Strong Base Anion Exchange Resin for Non-Regenerable
Demineralizers in Nuclear Water Applications

Product	Type	Matrix	Functional group
DOWEX™ MONOSPHERE™ 550A LC NG (OH)	Type I strong base anion	Styrene-DVB, gel	Quaternary amine

Guaranteed Sales Specifications							OH ⁻ form		
Total exchange capacity, min.		eq/L					1.1		
		kgr/ft ³ as CaCO ₃					24.0		
Water content		%					55 - 65		
Bead size distribution†									
Mean particle size		μm					590 ± 50		
Uniformity coefficient, max.							1.1		
< 300 μm, max.		%					0.2		
Whole uncracked beads, min.		%					95		
Crush strength									
Average, min.		g/bead					350		
> 200 g/bead, min.		%					95		
Ionic conversions		OH ⁻		Cl ⁻		CO ₃ ⁻		SO ₄ ⁼	
		95% min.		0.1% max.		5% max.		0.1% max.	
Trace metals, ppm dry resin, max.									
Na	Fe	Cu	Al	Mg	Ca	Co	Pb	Hg	Heavy metals (as Pb)
40	50	10	50	50	50	30	10	10	10

Typical Physical and Chemical Properties		OH ⁻ form				
Particle density	g/mL	1.08				
Shipping weight	g/L	640				
	lbs/ft ³	40				

Recommended Operating Conditions

- Maximum operating temperature 60°C (140°F)
- pH range 0 - 14
- Bed depth, min.:
 - Mixed bed 450 mm (1.5 ft)
 - Single bed 800 mm (2.6 ft)

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

Typical Properties and Applications

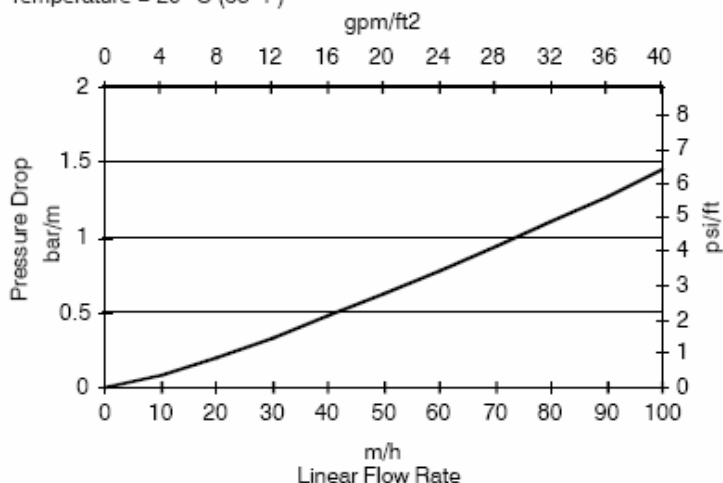
DOWEX MONOSPHERE 550A LC NG (OH) anion resin has outstanding purity and performance. The uniform particle size and absence of fine beads result in a low pressure drop. It also has excellent physical stability and low metallic impurity levels.

Packaging

50 liter or 5 cubic foot fiber drums

Figure 1. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX MONOSPHERE MR-575 LC NG

Uniform Particle Size Mixed Bed Resin for Demineralization in Nuclear Water Applications

Product	Type	Matrix	Functional group
DOWEX* MONOSPHERE* MR-575 LC NG	1:1 by equivalent cation:anion	Styrene-DVB, gel	Sulphonic acid Quaternary amine

Guaranteed Sales Specifications						OH ⁻ form		H ⁺ form		
Total exchange capacity, min.		eq/l kgr/ft ³ as CaCO ₃		1.1 24.0		2.3 50.3				
Water content		%		55 - 65		41 - 46				
Bead size distribution†										
Mean particle size		µm		590 ± 50		550 ± 50				
<0.3 mm, max., uniformity coefficient, max.				1.1		1.1				
<300 µm, max.		%		0.2		0.2				
Whole uncracked beads, min.		%		95		95				
Crush strength										
Average, min.		g/bead		350		500				
>200 g/bead, min.		%		95		95				
Ionic conversions										
Cation resin										H ⁺ 99.7% min.
Anion resin		OH ⁻ 95% min.		Cl ⁻ 0.1% max.		CO ₃ ⁻ 5% max.		SO ₄ 0.1% max.		
Trace metals, ppm dry resin, max.										
	Na	Fe	Cu	Al	Mg	Ca	Co	Pb	Hg	Heavy Metals (as Pb)
Cation	20	25	10	15	—	—	8	20	15	—
Anion	40	50	10	50	50	50	30	10	10	10

Typical Physical and Chemical Properties		OH ⁻ form	H ⁺ form
Particle density	g/ml	1.08	1.22
Shipping weight	g/l lbs/ft ³	705 44	705 44

Recommended Operating Conditions	• Maximum operating temperature	60°C (140°F)
	• pH range	0-14
	• Bed depth, min.	800 mm (2.6 ft)

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

Typical properties and applications

DOWEX MONOSPHERE MR-575 LC NG uniform particle size mixed resin has outstanding purity to meet the requirements of high quality water applications such as the nuclear industry. It is a 1:1 stoichiometric mixture of DOWEX MONOSPHERE 575C NG (H) and DOWEX MONOSPHERE 550A LC NG (OH) resins. It also has excellent physical and chemical stability.

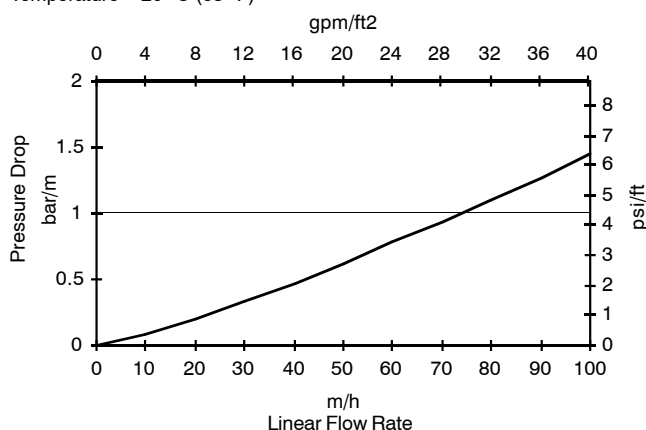
Extremely low levels of residual metallic impurities make this resin well suited for high purity water applications.

Packaging

50 liter or 5 cubic foot fiber drums

Figure 1. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX HGR NG (H)

A High Capacity Strong Acid Cation Exchange Resin for Water Demineralization in Nuclear Applications

Product	Type	Matrix	Functional group
DOWEX™ HGR NG (H)	Strong acid cation	Styrene-DVB, gel	Sulfonic acid

Guaranteed Sales Specifications							H ⁺ form		
Total exchange capacity, min.		eq/L					2.0		
		kgr/ft ³ as CaCO ₃					43.7		
Water content		%					46 - 52		
Bead size distribution [†]									
> 1,200 μm, max. (16 mesh)		%					2		
< 420 μm, max. (40 mesh)		%					1		
< 300 μm, max. (50 mesh)		%					0.1		
Whole uncracked beads, min.		%					95		
Crush strength									
Average, min.		g/bead					500		
> 300 g/bead, min.		%					95		
Ionic conversion, min.		%					99.7		
Trace metals, ppm dry resin, max.									
Na	Fe	Cu	Al	Mg	Ca	Co	Pb	Hg	Heavy metals (as Pb)
50	50	10	50	50	50	30	10	10	10

Typical Physical and Chemical Properties		H ⁺ form
Particle density	g/mL	1.22
Shipping weight	g/L lbs/ft ³	800 50

Recommended Operating Conditions

- Maximum operating temperature 130°C (265°F)
- pH range 0 - 14
- Bed depth, min.:
 - Mixed bed 450 mm (1.5 ft)
 - Single bed 800 mm (2.6 ft)

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

Typical Properties and Applications

DOWEX HGR NG (H) strong acid cation exchange resin is a high capacity gel resin with excellent physical and chemical stability. It is supplied with low residual metallic impurities and greater than 99.7% of its ionic sites in the hydrogen form.

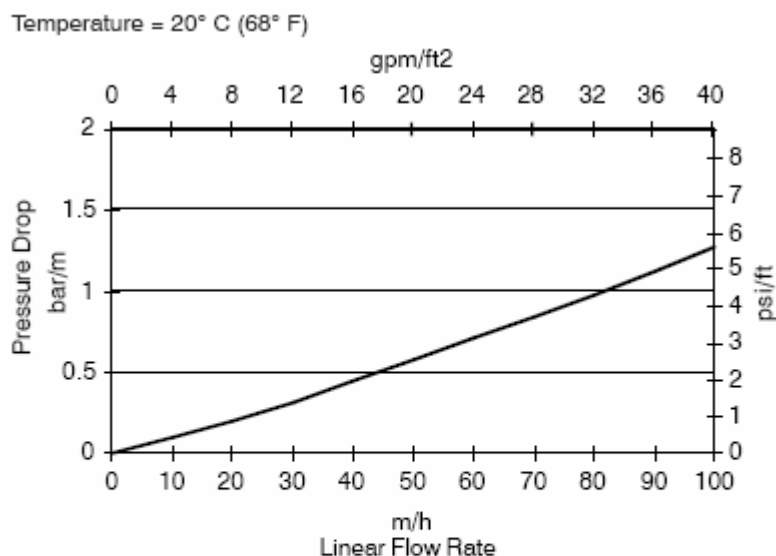
DOWEX HGR NG (H) resin may be used to removed cationic radioisotopes in the following applications:

- radwaste treatment
- pond water treatment
- reactor coolant cleanup

Packaging

50 liter or 5 cubic foot fiber drums

Figure 1. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX C-75 NG (H)

A Macroporous Strong Acid Cation Exchange Resin for Nuclear Water Applications

Product	Type	Matrix	Functional group
DOWEX™ C-75 NG (H)	Strong acid cation	Styrene-DVB, macroporous	Sulfonic acid

Guaranteed Sales Specifications		H ⁺ form
Total exchange capacity, min.	eq/L kgr/ft ³ as CaCO ₃	1.7 37.1
Water content	%	50 - 56
Bead size distribution [†]		
> 1,200 µm, max. (16 mesh)	%	3
< 300 µm, max. (50 mesh)	%	0.2
Whole beads, min.	%	95
Ionic conversion, min.	%	99.7
Trace metals, ppm dry resin, max.		
Na	Fe	Cu
60	100	30
		Al
		50
		Co
		30
		Pb
		30
		Hg
		20

Typical Physical and Chemical Properties		H ⁺ form
Particle density	g/mL	1.20
Shipping weight	g/L	750
	lbs/ft ³	47

Recommended Operating Conditions

- Maximum operating temperature 150°C (300°F)
- pH range 0 - 14
- Bed depth, min.:
 - Mixed bed 450 mm (1.5 ft)
 - Single bed 800 mm (2.6 ft)

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

Typical Properties and Applications

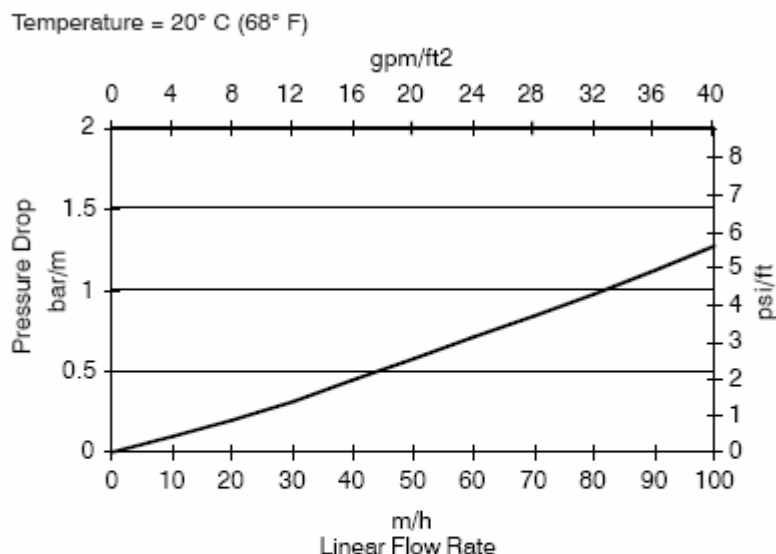
DOWEX C-75 NG (H) strong acid cation exchange resin is a macroporous resin with excellent physical and chemical stability. It is supplied with a minimum of 99.7% of ionic sites in the H⁺ form and a low level of impurities. DOWEX C-75 NG (H) resin exhibits outstanding selectivity for Cs and Co isotopes resulting in high decontamination factors for these species.

It is available as a mixed bed resin together with DOWEX SBR LC NG (OH) anion exchange resin as DOWEX MR-72 LC NG.

Packaging

50 liter or 5 cubic foot drums

Figure 1. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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DOWEX™ SBR LC NG (OH)

A High Capacity Strong Base Anion Exchange Resin Designed for CVCS and Radwaste Demineralizers in Nuclear Power Systems

Product	Type	Matrix	Functional group
DOWEX™ SBR LC NG (OH)	Type I strong base anion	Styrene-DVB, gel	Quaternary amine

Guaranteed Sales Specifications							OH ⁻ form			
Total exchange capacity, min.					eq/L	1.2				
					kgr/ft ³ as CaCO ₃	26.2				
Water content					%	60 max.				
Bead size distribution†										
> 1,200 μm, max. (16 mesh)					%	2				
> 420 μm, max. (40 mesh)					%	1				
< 300 μm, max. (50 mesh)					%	0.2				
Whole uncracked beads, min.					%	95				
Crush strength										
Average, min.					g/bead	350				
> 200 g/bead, min.					%	95				
Ionic conversion										
OH ⁻			Cl ⁻		CO ₃ ⁻			SO ₄ ²⁻		
95% min.			0.1% max.		5% max.			0.1% max.		
Trace metals, ppm dry resin, max.										
Na	Fe	Cu	Al	Mg	Ca	Co	Pb	Hg	Heavy metals (as Pb)	
40	50	10	50	50	50	30	10	10	10	

Typical Physical and Chemical Properties			OH ⁻ form
Particle density		g/mL	1.08
Shipping weight		g/L	655
		lbs/ft ³	41

Recommended Operating Conditions

- Maximum operating temperature 60°C (140°F)
- pH range 0 - 14
- Bed depth, min.:
 - Mixed bed 450 mm (1.5 ft)
 - Single bed 800 mm (2.6 ft)

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

Typical properties and applications

DOWEX™ SBR LC NG (OH) resin is a high quality anion resin with very good mechanical and chemical resistance. It is supplied with a low level of residual chloride and sulfate, each less than 0.1% of exchangeable sites. The resin can be used in a variety of applications, either in single or mixed beds.

Applications include:

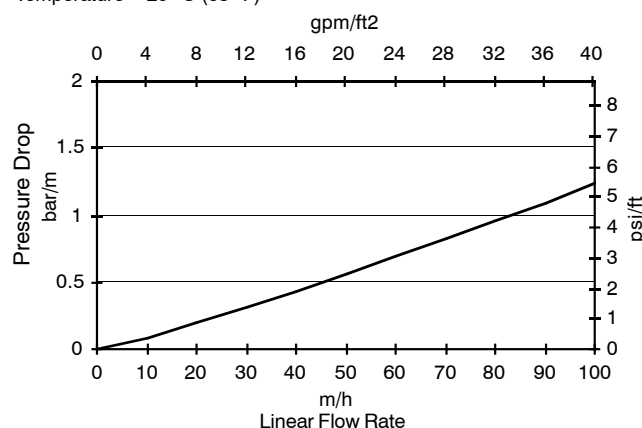
- Boric acid recovery
- Radwaste decontamination
- Reactor coolant treatment

Packaging

50 liter or 5 cubic feet fiber drums

Figure 1. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX MR-3 LC NG

A Mixed Ion Exchange Resin for Demineralization in Nuclear and High Purity
Demineralization Water Applications

Product	Type	Matrix	Functional group
DOWEX™ MR-3 LC NG	1:1 by equivalents cation:anion	Styrene-DVB, gel	Sulfonic acid Quaternary amine

Guaranteed Sales Specifications						OH ⁻ form			H ⁺ form	
Total exchange capacity, min.		eq/L				1.2			2.0	
		kgr/ft ³ as CaCO ₃				26.2			43.7	
Water content		%				60 max.			46 - 52	
Bead size distribution [†]										
> 1,200 μm, max. (16 mesh)		%				2			2	
< 420 μm, max. (40 mesh)		%				1			1	
< 300 μm, max. (50 mesh)		%				0.2			0.1	
Whole uncracked beads, min.		%				95			95	
Crush strength										
Average, min.		g/bead				350			500	
> 200 g/bead, min.		%				95			—	
> 300 g/bead, min.		%				—			95	
Ionic conversions										
Cation resin									H ⁺ 99.7%, min.	
Anion resin		OH ⁻ 95% min.		Cl ⁻ 0.1% max.		CO ₃ ⁻ 5% max.		SO ₄ ⁼ 0.1% max.		
Trace metals, ppm dry resin, max.										
	Na	Fe	Cu	Al	Mg	Ca	Co	Pb	Hg	Heavy metals (as Pb)
Cation	50	50	10	50	50	50	30	10	10	10
Anion	40	50	10	50	50	50	30	10	10	10

Typical Physical and Chemical Properties		OH ⁻ form	H ⁺ form
Particle density	g/mL	1.08	1.22
Shipping weight	g/L lbs/ft ³		720 45

Recommended Operating Conditions

- Maximum operating temperature 60°C (140°F)
- pH range 0 - 14
- Bed depth, min. 800 mm (2.6 ft)

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

Typical Properties and Applications

DOWEX MR-3 LC NG ion exchange resin is a 1:1 equivalent mixture of DOWEX HGR NG (H) cation and DOWEX SBR LC NG (OH) anion resins. This mixed resin product consists of high purity cation and anion components to enable high quality water production in nuclear applications. Residual chloride and sulfate levels are each less than 0.1% of the total ionic sites of the anion resin.

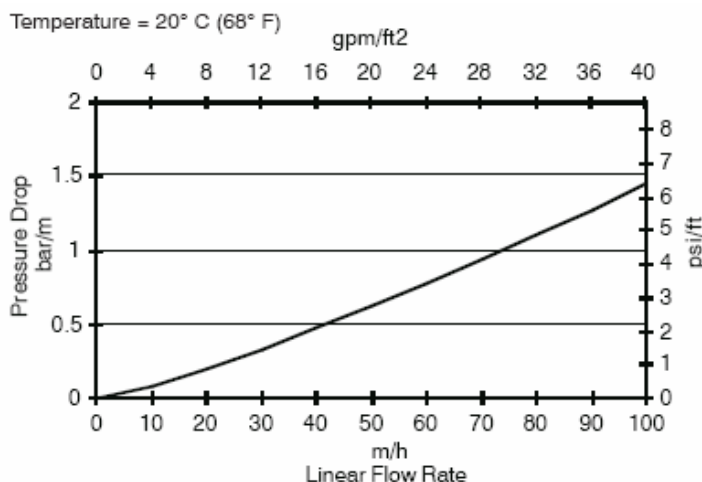
DOWEX MR-3 LC NG resin may be used in a variety of applications, including:

- radwaste treatment
- pond water treatment
- reactor coolant cleanup
- high purity mixed bed demineralization

Packaging

50 liter or 5 cubic foot fiber drums

Figure 1. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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DOWEX MR-72 LC NG

A Mixed Ion Exchange Resin for use in Non-Regenerable Demineralization Systems in Nuclear Water Applications

Product	Type	Matrix	Functional group
DOWEX™ MR-72 LC NG	1:1 by equivalents cation:anion	Styrene-DVB, macroporous Styrene-DVB, gel	Sulfonic acid Quaternary amine

Guaranteed Sales Specifications						OH ⁻ form		H ⁺ form		
Total exchange capacity, min.		eq/L				1.2		1.7		
		kgr/ft ³ as CaCO ₃				26.2		37.1		
Water content		%				60 max.		50 - 56		
Bead size distribution [†]										
> 1,200 μm, max. (16 mesh)		%				2		3		
< 420 μm, max. (40 mesh)		%				1		—		
< 300 μm, max. (50 mesh)		%				0.2		0.2		
Whole uncracked beads, min.		%				95		95 ^{††}		
Crush strength										
Average, min.		g/bead				350		—		
> 200 g/bead, min.		%				95		—		
Ionic conversions										
Cation resin								H ⁺ 99.7%, min.		
Anion resin		OH ⁻ 95% min.		Cl ⁻ 0.1% max.		CO ₃ ⁻ 5% max.		SO ₄ ⁼ 0.1% max.		
Trace metals, ppm dry resin, max.										
	Na	Fe	Cu	Al	Mg	Ca	Co	Pb	Hg	Heavy metals (as Pb)
Cation	60	100	30	50	—	—	30	30	20	—
Anion	40	50	10	50	50	50	30	10	10	10

Typical Physical and Chemical Properties		OH ⁻ form	H ⁺ form
Particle density	g/mL	1.08	1.20
Shipping weight	g/L lbs/ft ³		700 44

Recommended Operating Conditions

- Maximum operating temperature 60°C (140°F)
- pH range 0 - 14
- Bed depth, min. 800 mm (2.6 ft)

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

†† Data represents Whole Beads, min.

Typical Properties and Applications

DOWEX MR-72 LC NG mixed resin is a 1:1 equivalent mixture of DOWEX C-75 NG (H) cation and DOWEX SBR LC NG (OH) anion resins. DOWEX MR-72 LC NG resin has a low level of metallic impurities thus making it suited to the production of high quality water. The cation component, DOWEX C-75 NG (H) resin exhibits outstanding selectivity for Cs and Co isotopes resulting in high decontamination factors for these species. Applications include:

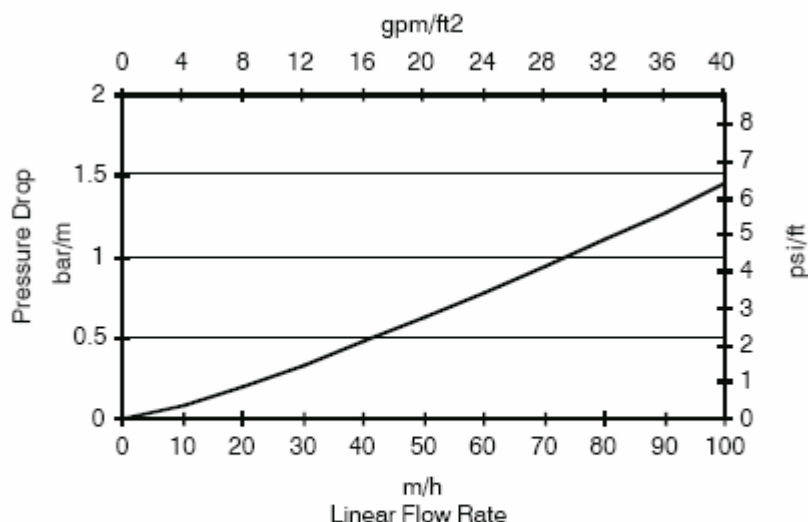
- reactor coolant cleanup
- pond water treatment
- radwaste treatment

Packaging

50 liter drums

Figure 1. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX MR-75 LC NG

A Mixed Ion Exchange Resin for use in Primary Systems (CVCS) of PWR Nuclear Power Plants

Product	Type	Matrix	Functional group
DOWEX™ MR-75 LC NG	1:1 by equivalents cation:anion	Styrene-DVB, macroporous Styrene-DVB, gel	Sulfonic acid Quaternary amine

Guaranteed Sales Specifications						OH ⁻ form		Li ⁺⁷ form		
Total exchange capacity, min.		eq/L		1.2		1.7 (H ⁺ form)				
		kgr/ft ³ as CaCO ₃		26.2		37.1				
Water content		%		60 max.		50 - 56 (H ⁺ form)				
Bead size distribution [†]										
> 1,200 μm, max. (16 mesh)		%		2		3				
< 420 μm, max. (40 mesh)		%		1		—				
< 300 μm, max. (50 mesh)		%		0.2		0.2				
Whole uncracked beads, min.		%		95		95 ^{††}				
Crush strength										
Average, min.		g/bead		350		—				
> 200 g/bead, min.		%		95		—				
Ionic conversions										
Cation resin						Li ⁺⁷ 99%, min.				
Anion resin		OH ⁻ 95% min.		Cl ⁻ 0.1% max.		CO ₃ ⁻ 5% max.		SO ₄ ⁼ 0.1% max.		
Trace metals, ppm dry resin, max.										
	Na	Fe	Cu	Al	Mg	Ca	Co	Pb	Hg	Heavy metals (as Pb)
Cation	60	100	30	50	—	—	30	30	20	10
Anion	40	50	10	50	50	50	30	10	10	10

Typical Physical and Chemical Properties		OH ⁻ form	Li ⁺⁷ form
Particle density	g/mL	1.08	1.20
Shipping weight	g/L lbs/ft ³		700 44

Recommended Operating Conditions

- Maximum operating temperature 60°C (140°F)
- pH range 0 - 14
- Bed depth, min. 800 mm (2.6 ft)

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

†† Data represents Whole Beads, min.

Typical Properties and Applications

DOWEX MR-75 LC NG mixed resin is a 1:1 equivalent mixture of DOWEX C-75 NG (Li^{+7}) cation and DOWEX SBR LC NG (OH) anion resins.

DOWEX MR-75 LC NG resin has a low level of metallic impurities making it suited to the production of high quality water. It may be used for the purification of the chemical and volume control system in PWR's. The removal of radioactive species is accomplished without lowering the pH as Li^{+7} OH is the normal pH control additive.

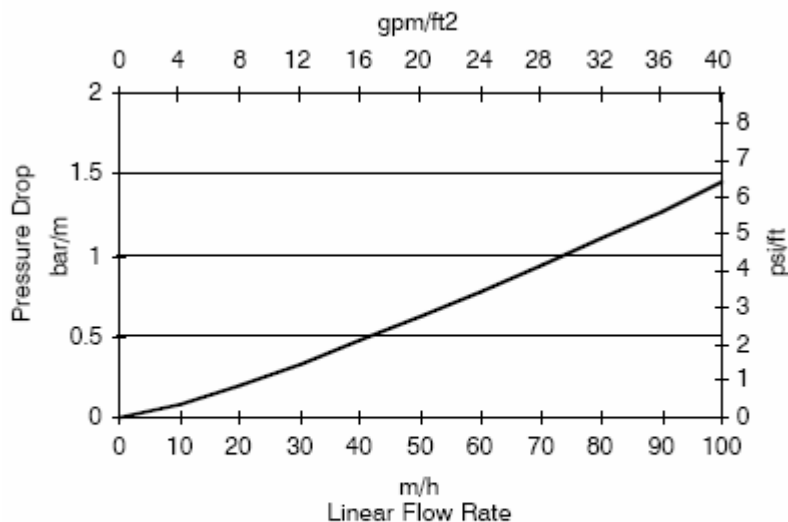
The cation component DOWEX C-75 NG (Li^{+7}) resin, exhibits outstanding selectivity for Cs and Co isotopes resulting in high decontamination factors for these species.

Packaging

50 liter drums

Figure 1. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX™ MR-5 LC NG

Mixed Ion Exchange Resin for Demineralization in Nuclear Water Applications

Product	Type	Matrix	Functional group
DOWEX™ MR-5 LC NG	1:1 by equivalents cation:anion	Styrene-DVB, gel	Sulfonic acid Quaternary amine

Guaranteed Sales Specifications					OH ⁻ form				Li ⁺⁷ form	
Total exchange capacity, min.					eq/L	1.2			2.0 (H ⁺ form)	
					kgr/ft ³ as CaCO ₃	26.2			43.7	
Water content					%	60 max.			46 - 52 (H ⁺ form)	
Bead size distribution†										
> 1,200 μm, max. (16 mesh)					%	2			2	
< 420 μm, max. (40 mesh)					%	1			1	
< 300 μm, max. (50 mesh)					%	0.2			0.1	
Whole uncracked beads, min.					%	95			95	
Crush strength										
Average, min.					g/bead	350			—	
> 200 g/bead, min.					%	95			—	
Ionic conversions										
Cation resin										Li ⁺⁷
										99%, min.
Anion resin		OH ⁻		Cl ⁻		CO ₃ ⁻		SO ₄ ⁼		
		95% min.		0.1% max.		5% max.		0.1% max.		
Trace metals, ppm dry resin, max.										
	Na	Fe	Cu	Al	Mg	Ca	Co	Pb	Hg	Heavy metals (as Pb)
Cation	50	50	10	50	50	50	30	10	10	10
Anion	40	50	10	50	50	50	30	10	10	10

Typical Physical and Chemical Properties		OH ⁻ form	Li ⁺⁷ form
Particle density	g/mL	1.08	1.22
Shipping weight	g/L lbs/ft ³		660 41

Recommended Operating Conditions

- Maximum operating temperature 60°C (140°F)
- pH range 0-14
- Bed depth, min. 800 mm (2.6 ft)

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

Typical Properties and Applications

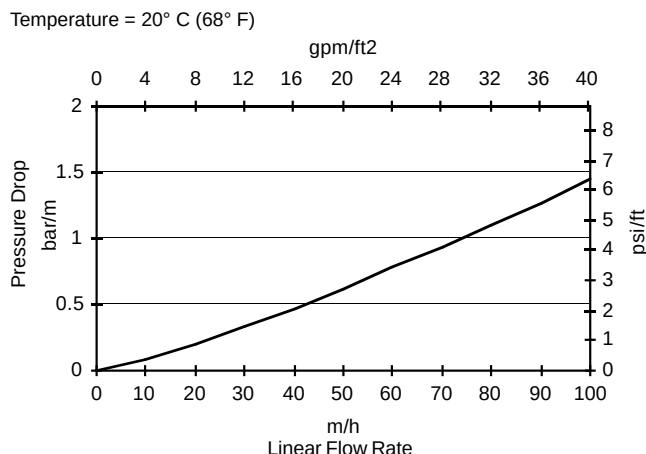
DOWEX™ MR-5 LC NG resin is an equivalent mixture of DOWEX HGR NG (Li⁺) and DOWEX SBR LC NG (OH) resins. DOWEX MR-5 LC NG resin has a low level of metallic impurities which makes it suitable for the production of high quality water. This resin is used for the purification of the chemical and volume control system in PWRs. The removal of radioactive species is accomplished without lowering the pH as Li⁺OH is the normal pH control additive. The cation component, DOWEX HGR NG (Li⁺) resin, exhibits outstanding selectivity for Cs and Co isotopes resulting in high decontamination factors for these species. Applications include:

- reactor coolant clean-up
- spent fuel pond water deactivation
- radwaste treatment

Packaging

50 liter or 5 cubic foot fiber drums

Figure 1. Pressure Drop Data



For other temperatures use:

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

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

DOWEX™ Ion Exchange Resins

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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DOWEX™ Ion Exchange Resins

5. The UPCORE™ System

- DOWEX UPCORE Mono C-600
- DOWEX UPCORE Mono A-500
- DOWEX UPCORE Mono A-625
- DOWEX UPCORE Mono A2-500
- DOWEX UPCORE Mono MA-600
- DOWEX UPCORE Mono WB-500
- Flow – A publication about cost-effective demineralization with the DOWEX UPCORE packed bed system from Dow Water Solutions



DOWEX™ UPCORE™ Mono C-600

A Uniform Particle Size, Strong Acid Cation Exchange Resin Specifically Designed for the UPCORE System

Product	Type	Matrix	Functional group
DOWEX™ UPCORE™ Mono C-600	Strong acid cation	Styrene-DVB, gel	Sulfonic acid

Guaranteed Sales Specifications		Na ⁺ form	H ⁺ form
Total exchange capacity, min.	eq/L	2.0	1.8
	kgr/ft ³ as CaCO ₃	43.7	39.3
Water content	%	42 - 48	50 - 56
Bead size distribution†			
Mean particle size	μm	585 ± 50	600 ± 50
Uniformity coefficient, max.		1.1	1.1
> 850 μm, max.	%	5	5
< 300 μm, max.	%	0.5	0.5
Whole uncracked beads, min.	%	95	95

Typical Physical and Chemical Properties		Na ⁺ form	H ⁺ form
Total swelling (Na ⁺ → H ⁺)	%	8	8
Particle density	g/mL	1.28	1.22
Shipping weight	g/L	820	800
	lbs/ft ³	51	50

Recommended Operating Conditions

- Maximum operating temperature 120°C (250°F)
- pH range 0 - 14
- Bed depth, min. 1,200 mm (4 ft)
- Pressure drop, design max. 1.5 bar (22 psi)
- Pressure drop, max. 2.5 bar (37 psi)
- Flow rates:
 - Service/fast rinse 5 - 60 m/h (2 - 24 gpm/ft²)
 - Regeneration/displacement rinse 5 - 20 m/h (2 - 8 gpm /ft²)
- Total rinse requirement 2 - 5 Bed volumes
- Regenerant 8 - 12% NaCl, 4 - 6% HCl, or 1 - 4% H₂SO₄,

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

Typical Properties and Applications

DOWEX™ UPCORE™ Mono C-600 strong acid cation exchange resin is a uniform particle size resin specifically designed for use in the UPCORE packed bed counter-current regeneration system. It is well suited for use in both demineralization and softening applications.

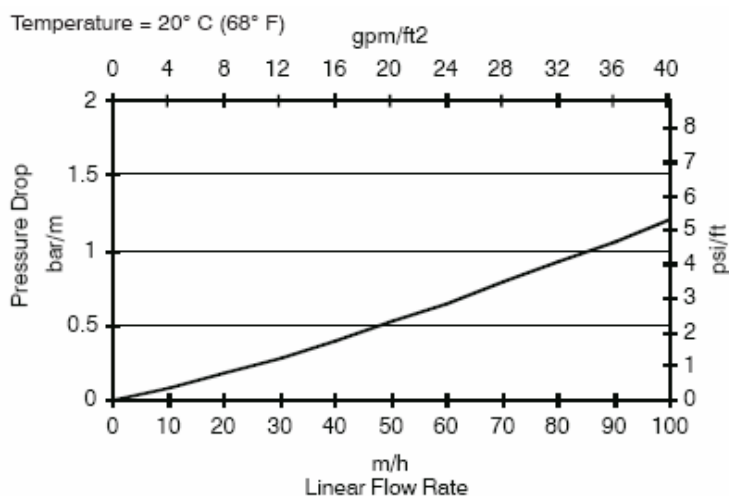
DOWEX UPCORE Mono C-600 resin has a smaller average particle diameter than conventional polydispersed cation resin. Its smaller, uniform size enhances operating capacity and regeneration efficiency while maintaining a moderate pressure drop.

DOWEX UPCORE Mono C-600 resin also has outstanding resistance to attrition due to compressive and osmotic stress.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX UPCORE Mono A-500

A Uniform Particle Size, Strong Base Anion Exchange Resin Specifically Designed for the UPCORE System

Product	Type	Matrix	Functional group
DOWEX* UPCORE* Mono A-500	Type 1 strong base anion	Styrene-DVB, gel	Quaternary amine

Guaranteed Sales Specifications		Cl ⁻ form
Total exchange capacity, min.	eq/l kgr/ft ³ as CaCO ₃	1.3 28.4
Water content	%	50 - 58
Bead size distribution†		
Mean particle size	μm	575 ± 50
Uniformity coefficient, max.		1.1
>850 μ, max.	%	5
<300 μ, max.	%	0.5
Whole uncracked beads, min.	%	95

Typical Physical and Chemical Properties		Cl ⁻ form
Total swelling (Cl ⁻ → OH ⁻)	%	20
Particle density	g/ml	1.08
Shipping weight	g/l lbs/ft ³	670 42

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. 1,200 mm (4 ft)
- Pressure drop, design max. 1.5 bar (22 psi)
- Pressure drop, max. 2.5 bar (37 psi)
- Flow rates:
 - Service/fast rinse 5-60 m/h (2-24 gpm/ft²)
 - Regeneration/displacement rinse 4-10 m/h (1.6-4 gpm /ft²)
- Total rinse requirement 2 - 4 Bed volumes
- Regenerant 2-5% NaOH

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

Typical properties and applications

DOWEX UPCORE Mono A-500 strong base anion resin is a uniform particle size, gellular, type 1 anion exchange resin designed for use in the UPCORE packed bed counter-current regeneration system.

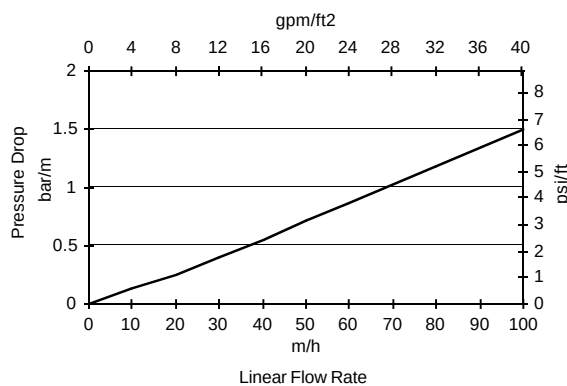
The absence of large beads in DOWEX UPCORE Mono A-500 resin results in high operating capacity and good resistance to silica fouling. DOWEX UPCORE Mono A-500 resin has an excellent resistance to mechanical and osmotic stress which helps minimize resin attrition.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX™ UPCORE™ Mono A-625

A Uniform Particle Size, Strong Base Anion Exchange Resin Specifically Designed for Layered Anion Beds in the UPCORE System

Product	Type	Matrix	Functional group
DOWEX™ UPCORE™ Mono A-625	Type I strong base anion	Styrene-DVB, gel	Quaternary amine

Guaranteed Sales Specifications		Cl ⁻ form
Total exchange capacity, min.	eq/L	1.2
	kgr/ft ³ as CaCO ₃	26.2
Water content	%	50 - 56
Bead size distribution†		
Mean particle size	μm	670 ± 50
Uniformity coefficient, max.		1.1
>850 μ, max.	%	5
<300 μ, max.	%	0.5
Whole uncracked beads, min.	%	90

Typical Physical and Chemical Properties		Cl ⁻ form
Total swelling (Cl ⁻ → OH ⁻)	%	20
Particle density	g/mL	1.09
Shipping weight	g/L	670
	lbs/ft ³	42

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)
- Pressure drop, design max. 1.5 bar (22 psi)
- Pressure drop, max. 2.5 bar (37 psi)
- Flow rates:
 - Service/fast rinse 5-60 m/h (2-24 gpm/ft²)
 - Regeneration/displacement rinse 4-10 m/h (1.6-4 gpm /ft²)
- Total rinse requirement 2 - 4 Bed volumes
- Regenerant 2-5% NaOH

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

Typical properties and applications

DOWEX™ UPCORE™ Mono A-625 strong base anion resin is a uniform particle size, gellular, type I anion resin designed for use in the UPCORE counter-current regeneration packed bed system. The particle size is specially selected to maintain excellent separation in layered beds when used with DOWEX UPCORE Mono WB-500 weak base anion resin.

The absence of large beads in DOWEX UPCORE Mono A-625 resin results in high operating capacity and good resistance to silica fouling.

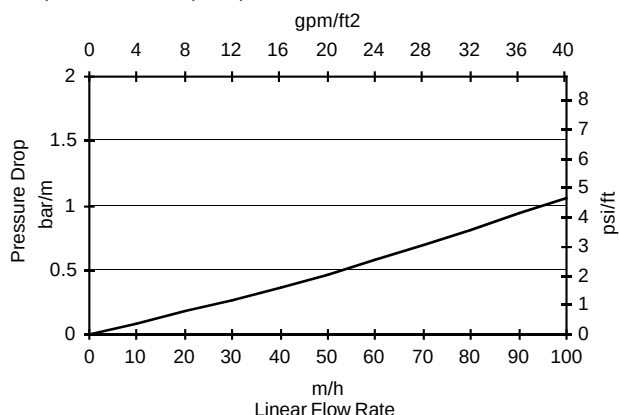
DOWEX UPCORE Mono A-625 resin has an excellent resistance to mechanical and osmotic stress which helps minimize resin attrition.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX UPCORE Mono A2-500

A Uniform Particle Size, Type 2 Strong Base Anion Exchange Resin Specifically Designed for the UPCORE System

Product	Type	Matrix	Functional group
DOWEX™ UPCORE™ Mono A2-500	Type 2 strong base anion	Styrene-DVB, gel	Dimethylethanol amine

Guaranteed Sales Specifications		Cl ⁻ form
Total exchange capacity, min.	eq/L	1.2
	kgr/ft ³ as CaCO ₃	26.2
Water content	%	46 - 55
Bead size distribution†		
Mean particle size	μm	550 ± 50
Uniformity coefficient, max.		1.1
> 850 μm, max.	%	5
< 300 μm, max.	%	0.5
Whole uncracked beads, min.	%	95

Typical Physical and Chemical Properties		Cl ⁻ form
Total swelling (Cl ⁻ → OH ⁻)	%	15
Particle density	g/mL	1.09
Shipping weight	g/L	690
	lbs/ft ³	43

Recommended Operating Conditions

- Maximum operating temperature:
 - OH⁻ form 35°C (95°F)
 - Cl⁻ form 70°C (160°F)
- pH range 0 - 14
- Bed depth, min. 1,200 mm (4 ft)
- Pressure drop, design max. 1.5 bar (22 psi)
- Pressure drop, max. 2.5 bar (37 psi)
- Flow rates:
 - Service/fast rinse 5 - 60 m/h (2 - 24 gpm/ft²)
 - Regeneration/displacement rinse 4 - 10 m/h (1.6 - 4 gpm/ft²)
- Total rinse requirement 2 - 4 Bed volumes
- Regenerant 2-5% NaOH

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

Typical properties and applications

DOWEX UPCORE Mono A2-500 strong base anion resin is a uniform particle size, gellular, type 2 anion resin designed for use in the UPCORE system. It has a special pore structure which facilitates the removal of organic matter from water and its subsequent elution from the resin.

The absence of large beads in DOWEX UPCORE Mono A2-500 resin results in extremely high operating capacity and good chemical efficiency.

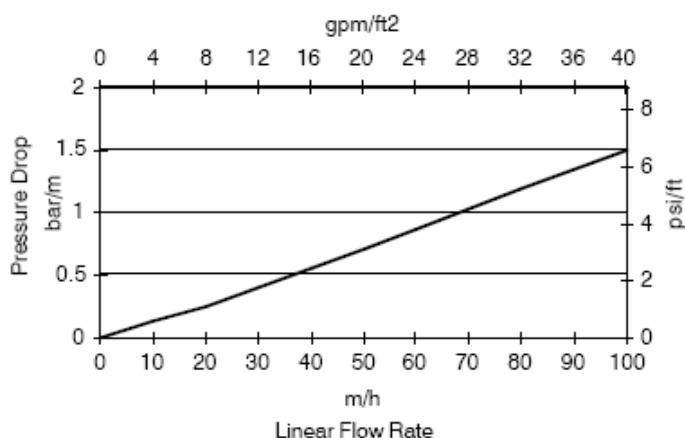
DOWEX UPCORE Mono A2-500 resin has an excellent resistance to mechanical and osmotic stress which helps minimize resin attrition.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX UPCORE Mono MA-600

Uniform Particle Size, Macroporous, Strong Base Anion Exchange Resin

Product	Type	Matrix	Functional group
DOWEX* UPCORE* Mono MA-600	Type 1 strong base	Styrene-DVB, macroporous	Quaternary amine

Guaranteed Sales Specifications		Cl ⁻ form
Total exchange capacity, min.	eq/l	1.1
	kgr/ft ³ as CaCO ₃	24.0
Water content	%	55 - 65
Bead size distribution†		
Mean particle size	µm	640 ± 50
Uniformity coefficient, max.		1.1
> 850 µm, max.	%	5
< 300 µm, max.	%	0.5
Whole beads, min.	%	95

Typical Physical and Chemical Properties		Cl ⁻ form
Total swelling (Cl ⁻ → OH ⁻)	%	15
Particle density	g/ml	1.06
Shipping weight	g/l	670
	lbs/ft ³	42

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. 1,500 mm (4 ft)
- Pressure drop, design max. 1.5 bar (22 psi)
- Pressure drop, max. 2.5 bar (37 psi)
- Flow rates:
 - Service/fast rinse 5-50 m/h (2-20 gpm/ft²)
 - Regeneration/displacement rinse 6-12 m/h (2.4-4.8 gpm/ft²)
- Total rinse requirement 2 - 4 Bed volumes
- Regenerant 2-4% NaOH

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

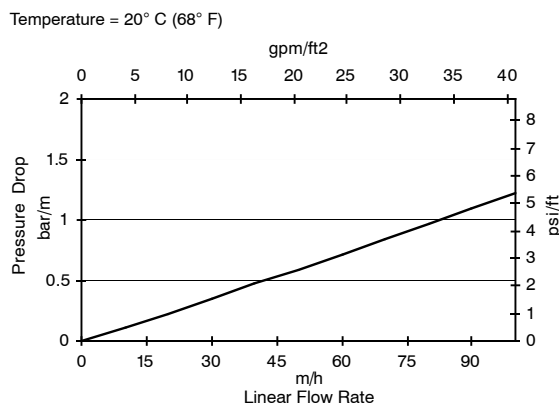
Typical Properties and Applications

DOWEX UPCORE Mono MA-600 uniform particle size macroporous strong base anion resin is designed for use in a packed bed counter-current regeneration system. The particle size is specially selected to give a high degree of compaction prior to regeneration and to minimize pressure drop across the bed. The macroporous structure of this resin makes it the resin of choice in treating waters with high level of organic matter if operating capacity is not of high concern.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Pressure Drop Data



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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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DOWEX UPCORE Mono WB-500

A Uniform Particle Size, Weak Base Anion Exchange Resin Specifically Designed for the UPCORE System in Either Single Bed or Layered Bed Applications

Product	Type	Matrix	Functional group
DOWEX* UPCORE* Mono WB-500	Weak base anion	Styrene-DVB, macroporous	Tertiary amine

Guaranteed Sales Specifications		FB (freebase) form	
Total exchange capacity, min.	eq/l	1.3	
	kgr/ft ³ as CaCO ₃	28.4	
Water content	%	52 - 60	
Bead size distribution†			
Mean particle size	μm	540 ± 50	
Uniformity coefficient, max.		1.1	
>850 μ, max.	%	5	
<300 μ, max.	%	0.5	
Whole beads, min.	%	95	

Typical Physical and Chemical Properties		FB (freebase) form	
Total swelling (FB → HCl)	%	20	
Particle density	g/ml	1.04	
Shipping weight	g/l	640	
	lbs/ft ³	40	

Recommended Operating Conditions

- Maximum operating temperature:
 - FB form 60°C (140°F)
 - HCl form 100°C (212°F)
- pH range 0 - 7
- Bed depth, min.:
 - Layered bed 600 mm (2 ft)
 - Single bed 1,200 mm (4 ft)
- Pressure drop, design max. 1.5 bar (22 psi)
- Pressure drop, max. 2.5 bar (37 psi)
- Flow rates:
 - Service/fast rinse 5-60 m/h (2-24 gpm/ft²)
 - Regeneration/displacement rinse 4-10 m/h (1.6-4 gpm/ft²)
- Total rinse requirement 2 - 4 Bed volumes
- Regenerant 2-5% NaOH

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

Typical properties and applications

DOWEX UPCORE Mono WB-500 weak base anion resin is a uniform particle size, macroporous resin designed for use in the UPCORE system. The particle size is specially selected to maintain excellent separation in layered beds when used with DOWEX UPCORE Mono A-625 strong base anion resin. It can also be used as a single resin. The small, uniform bead size provides excellent kinetics and resistance to organic fouling.

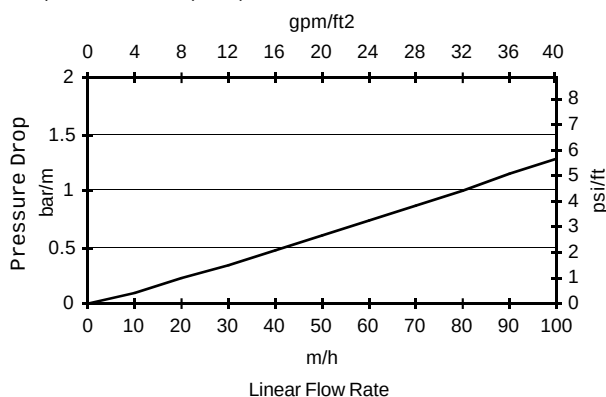
DOWEX UPCORE Mono WB-500 resin has an excellent resistance to attrition and osmotic stress.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

DOWEX Ion Exchange Resins

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Flow

A publication about cost-effective demineralization with the DOWEX™ UPCORE™ packed bed system from Dow Water Solutions

How to Reduce Costs and Improve Water Quality – see page 1

How Uniform Particle Size Improves Performance – see page 2

More Than 25 Years of Reliable, Global Performance – see page 3

How to Convert to a DOWEX™ UPCORE™ System – see page 5

How to Evaluate System Performance Online with CADIX – see page 8

And... Case histories from around the world

Key Advantages of the DOWEX™ UPCORE™ Packed Bed System

- Simple design
- Easy to control and automate
- Inexpensive
- Ideal for upgrades
- Easy configurability of layered beds
- Optimized vessel volume utilization
- Insensitive to flow rate variations
- Self-cleaning, no separate backwash step needed
- Excellent suspended solids removal

Product Overview

How to Reduce Costs and Improve Water Quality

Whether you need to install a demineralizer system for a new or existing plant, there is a way to reduce your costs by as much as 50 percent and also improve water quality at the same time. The DOWEX™ UPCORE™ system combines upflow, counter-current regeneration technology with uniform particle size resins to achieve higher water quality, more efficient regeneration and greater operating capacity.

Because the DOWEX UPCORE system is an upflow regeneration system with downflow service, the packed resin bed is less vulnerable to fluctuations in water flow during the system cycle. The system's downflow service also assures that ionic layering in the resin bed remains undisturbed so exhausted resin from the upper portion of the bed does not become mixed into the highly regenerated zone at the bottom. This produces higher water quality and uncompromised bed operating capacity, which ultimately adds up to savings.

With the DOWEX UPCORE system, you can gain a number of benefits over traditional cocurrent and counter current regeneration systems:

- Excellent water quality
- High chemical efficiency
- Short regeneration time
- Simple construction and control
- Self-cleaning
- Insensitivity to product flow variations and stops
- No risk of carry-over of resin fines
- Layered bed design without the need for a middle plate

What's more, the DOWEX UPCORE system is backed by the global expertise and resources of Dow Water Solutions. Read on for additional information and case histories about the DOWEX UPCORE system, which is currently at work in more than 400 locations on six continents around the world.



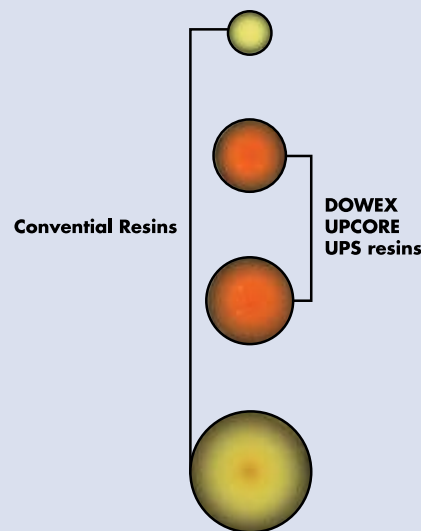
How Uniform Particle Size Improves Performance

DOWEX™ UPCORE™ ion exchange resins are available with uniform particle size (UPS), which contributes significantly to system performance and economics. While conventional or Gaussian distribution resin beads range in size from 300 to 1200 microns, UPS resins have a much narrower particle size distribution, with 95 percent of the beads within 100 microns of the average particle diameter (see Figure 1).

For many years, UPS resins could only be produced by screening conventional resins – a cost-prohibitive process. In the 1980s, Dow researchers developed and patented a technology to produce UPS ion exchange resins without a mechanical screening process. As the world's first supplier to master UPS technology, Dow continues to lead the industry in providing high-performance UPS ion exchange resins.

In the DOWEX UPCORE packed bed system, UPS resins are sized specifically for demineralizer applications, offering excellent physical stability and minimizing any generation of fines. This means faster kinetics, greater operating capacity and longer service runs. Narrow particle size distribution also makes it possible to optimize size and density relationships to achieve desired separation in layered beds. Regeneration is faster and more efficient with UPS resins, reducing chemical and rinse requirements.

Figure 1



Benefits of DOWEX™ UPCORE™ Uniform Particle Size Resins

- Faster kinetics
- Greater efficiency
- Higher operating capacity
- Less service water
- Faster rinse down
- Better separation
- Longer resin life
- Less resin loss
- Lower consumption of regenerants
- Lower service water consumption
- Further reduced regeneration time
- Longer production cycle
- Less ionic leakage
- Less silica and organic fouling
- Less regeneration effluent waste



Case History

Power Station Improves Process Water Quality and Reduces Costs

Location: Bulgaria

Plant: Deven JSCo Power Station

Description: Located in Bulgaria, the Deven JSCo thermal power station was built in 1965. The station produces 0.4 million megawatt-hours of power per year and 3.5 million tons of steam per year. The station's demineralization plant treats water from the Kamchia River for use as boiler feedwater. When station managers decided to modernize the water treatment plant, they were looking for ways to reduce chemical costs, service water and waste while increasing the system's reliability. To achieve these goals, power station officials chose the DOWEX™ UPCORE™ packed bed system and retrofitted their existing cocurrent system. After the installation, the plant achieved a 40 percent reduction in final water costs and a 70 percent reduction in waste water.

About Dow Water Solutions

The DOWEX™

UPCORE™ packed

bed system is part of

the broad portfolio of

products and services

offered by Dow

Water Solutions, a

world leader in water

purification solutions.

With sales personnel,

technical service

representatives and

research centers on five

continents, Dow Water

Solutions is equipped to

serve you globally.

Global Presence

More than 25 Years of Reliable, Global Performance

The first DOWEX™ UPCORE™ system was installed at a metal processing and mining facility in the Netherlands in 1978. Since then, more than 400 systems have been installed in more than 40 countries across six continents throughout the world. These installations have included both retrofitted and new systems with many different layouts to serve a wide variety of industries. But all of these installations have one thing in common – the reliability that comes with Dow's global presence and expertise.

Industries

The DOWEX UPCORE System is being used effectively in plants that serve the following industries:

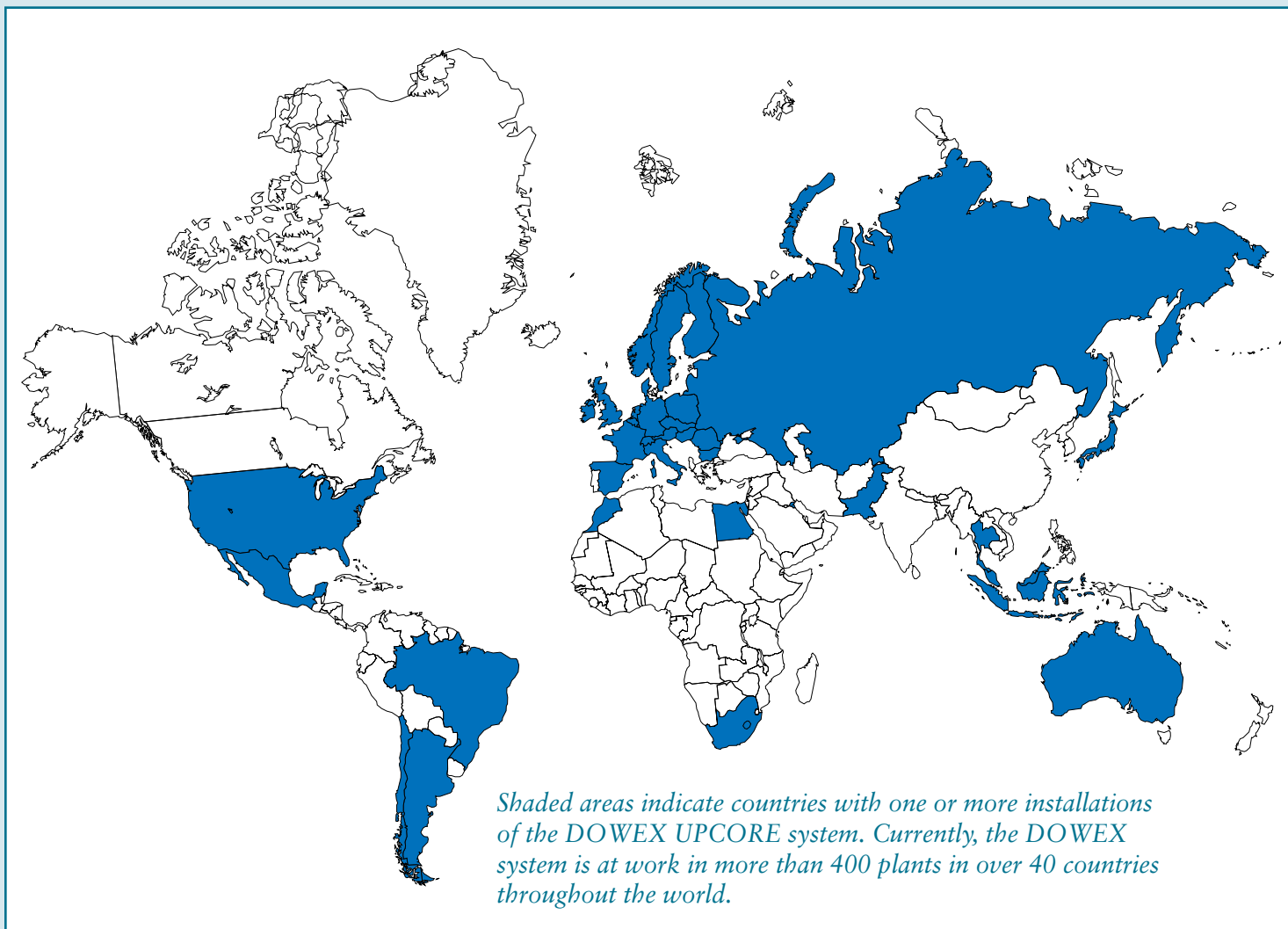
- Automotive
- Beverage
- Chemical
- Electronics
- Fertilizer
- Light Industry
- Metal Processing and Mining
- Municipal
- Petrochemical
- Pharmaceutical
- Power Generation
- Pulp and Paper
- Sugar and Food Processing
- Textile
- Waste Treatment

Installations

The DOWEX UPCORE System is currently at work in these countries and regions:

- Argentina
- Australia
- Austria
- Belgium
- Belarus
- Brazil
- Bulgaria
- Chile
- Croatia
- Czech Republic
- Denmark
- Egypt
- Estonia
- Finland
- France
- Germany
- Hungary
- Indonesia
- Italy
- Japan
- Kuwait
- Malaysia
- Mexico
- Middle East
- Morocco
- Netherlands
- Norway
- Pakistan
- Poland
- Romania
- Russia
- Singapore
- Slovakia
- Slovenia
- South Africa
- Spain
- Sweden
- Switzerland
- Taiwan
- Thailand
- Ukraine
- United Kingdom
- United States

Installations of the DOWEX™ UPCORE™ System Worldwide



Case History Retrofit Project Cuts Chemical Costs by 50%

Location: Indiana, USA

Plant: Wabash River Coal Gasification Repowering Project

Description: After five years of problems with their make-up water demineralizer system, the CInergy Wabash River coal gasification plant installed a retrofit DOWEX™ UPCORE™ packed bed system. The result was a 50 percent reduction in regeneration chemical costs, as well as a 17 percent capacity increase of high-quality water, a 61 percent decrease in regeneration time, and overall reduced dependence on mobile water demineralization trailers.



System Guidelines

How to Convert to a DOWEX™ UPCORE™ System

If You Have a Cocurrent System

Cocurrent equipment can be converted to the DOWEX™ UPCORE™ packed bed system with minimal capital investment. The case histories in this publication are just a few examples of hundreds of successful conversions to the DOWEX UPCORE packed bed system. You may also be able to:

- Reduce regenerant chemical costs up to 50 percent.
- Nearly double total installed capacity.
- Reduce system downtime by almost 50 percent.
- Improve water quality (<2µS/cm conductivity).
- Reduce waste effluent volume up to 50 percent.
- Reduce regeneration time and expense.
- Reduce service water consumption up to 50 percent.

If You Have a Countercurrent System

If you are considering countercurrent regeneration technology for a new demineralizer system, you can gain these benefits:

- All the efficiency, economy and water quality advantages of countercurrent technology, without the problems associated with older countercurrent technologies.

- Reduced vulnerability to feed flow fluctuations
- Virtually no chance that exhausted resin will contaminate the highly regenerated zone closest to the service flow outlet.
- Lower capital costs compared to upflow service systems, because there is no need for holding tanks and transfer piping for backwashing operations.
- Fewer system problems due to resin fines and other particulates because resin beds are self-cleaning and particulates accumulate at the opposite end of the bed from the service flow outlet.
- Greater vessel utilization for maximum ion exchange capacity, because freeboard requirements are far lower than with air and water holddown systems.
- The option of using layered beds to improve demineralizer efficiency, extend resin life and achieve the highest water quality.

Case History

Reducing Demineralizer Costs by 50%



Location: Japan

Plant: Tomatoh-Atsuma Power Station,
Hokkaido Electric Power Co., Inc.

Description: An increase in capacity at the Tomatoh-Atsuma power station called for a new demineralizer using the DOWEX™ UPCORE™ packed bed system to increase regeneration efficiency. The new system was installed in 2001, producing make-up water for utility boilers with the same quality as the existing demineralizers, while reducing regeneration chemicals, time and waste.

Case History

DOWEX™ UPCORE™ Boosts Production Efficiency of Refinery Process Water

Location: Poland

Plant: Polski Koncern Naftowy

Description: When the Polski Koncern Naftowy upgraded their equipment and installed a new boiler, their system required higher quality process water. To meet these requirements, the company was looking for a water treatment system that would be reliable, simple to operate and easy to automate with minimal downtime for maintenance. For all these reasons, the company chose the DOWEX™ UPCORE™ packed bed system for seven treatment lines of boiler feed water. Among numerous improvements, the upgraded system resulted in a 60 percent reduction in chemical consumption, a 25 percent reduction in service water and an 80 percent reduction in waste water.



Want to Know More?

If you want to find out more about how the DOWEX™ UPCORE™ packed bed system can improve your operation's efficiency while improving water quality and reducing costs, visit www.dowwatersolutions.com.

Or, call one of our global locations and talk with a Dow Water Solutions representative who can arrange a complete analysis of your system. With our special CADIX assisted design for ion exchange computer program, we will simulate just how much you can potentially save by upgrading your present system to the DOWEX UPCORE downflow countercurrent packed bed system.

Stay Current – Subscribe to *StreamLine*

Keep up to date on the latest water purification news, issues and products with our online newsletter, *StreamLine*. Just go to www.dowwatersolutions.com and click on "Subscribe for Info."

Technical Information

Guidelines on Vessel Design and Layered Bed Configurations

Vessels designed for the DOWEX™ UPCORE™ packed bed system are straightforward and inexpensive. Freeboard is almost eliminated, so that when existing cocurrent resin beds are converted to this countercurrent technology, system modifications are minimal and ion exchange capacity can be nearly doubled. The top collector/distributor system in the vessel is surrounded by a shallow layer of floating inert material. This allows free passage of spent regenerants and rinse water, as well as resin fines and other small particulates, while restraining the normal size resin beads so that the bed is maintained in a compacted state during upflow regeneration.

Because the service cycle operates downflow, the compacted resin bed is insensitive to fluctuations in feed flow. If feed flow is interrupted, there is no danger that ionic stratification will be disturbed. The highly regenerated zone at the bottom of the bed remains intact and uncontaminated by exhausted beads higher up in the bed.

During upflow regeneration, the resin bed is lifted in the compacted state, moving up against the inert layer, while the regenerant passes upflow at a rate sufficient to maintain the resin in the packed state. Regeneration serves two purposes – it reactivates the ion exchange sites on the resin, and it cleans the vessel of resin fines and other particulates.

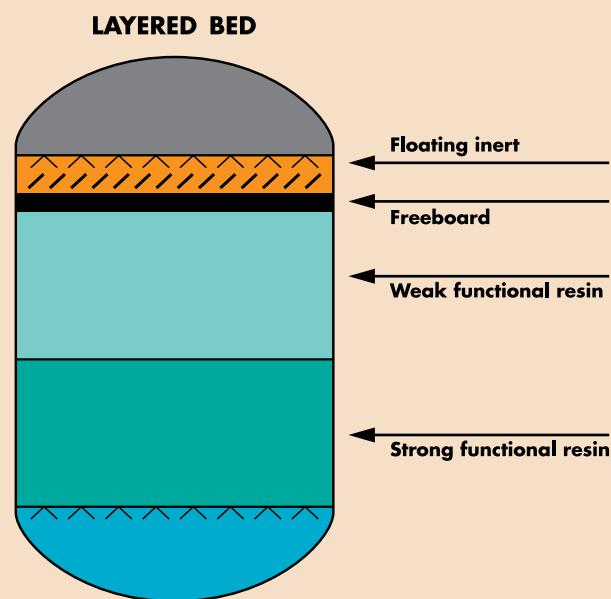
Benefits of Layered Bed Configurations

Layered beds are an efficient and economical alternative to using separate vessels for strongly and weakly functional resins in a demineralizer system. With layered beds, fewer vessels are needed and regenerant chemical efficiency is improved. A layered bed configuration is a highly cost-effective way to take advantage of the high exchange capacity and organics removal of a weak base anion resin. It also helps protect and optimize the capacity and service life of the strong base anion resin, which further enhances the system in silica removal capability.

Vessels for the DOWEX™ UPCORE™ packed bed system also can be designed without a middle plate, as shown in Figure 2. With the system, the layered bed consists of a weak functional resin layer on top of a strong functional resin layer. The separation of the layers is ensured by the difference in the particle size distribution and resin density.

The DOWEX UPCORE packed bed system can be installed in layered bed configurations without major modification of existing vessels, and it is possible to adjust the ratio of layered resin volumes in the event of changes in raw water supply.

Figure 2



Key Advantages of Layered Bed Configurations

- Fewer vessels needed – one instead of two
- Higher total chemical efficiency (85 percent to 95 percent)
- Higher exchange capacity by weak base anion resin
- Optimal silica removal capacity by the strong base anion resin
- Increased resin life because the weak base resin protects the strong base resin from irreversible organic fouling
- Adjustable ratio of resin volume to accommodate changes in water supply
- Easy modification of existing vessels to a DOWEX™ UPCORE™ layered-bed system



Technical Information

Comparison of Various Countercurrent Systems

All countercurrent systems share two basic requirements:

1. An intact, highly regenerated zone that must be maintained in the portion of the resin bed near the service flow outlet.
2. A resin bed that must remain in a packed state during the service and regeneration cycles.

The way in which different countercurrent systems meet these requirements has a direct impact on their efficiency, productivity and economic advantages.

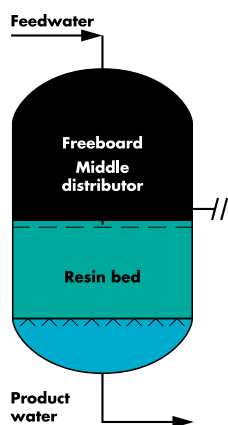
Air and Water Hold-Down Systems

- Good water quality
- Good regeneration efficiency

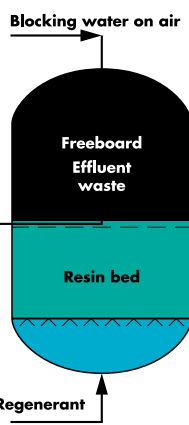
But:

- Limited vessel volume utilization
- Middle distributor sensitive to mechanical damage due to resin swelling and shrinking
- Additional equipment needed
- High consumption of water or air needed
- Time- and manpower-intensive regeneration
- Periodic backwash needed

PRODUCTION CYCLE



REGENERATION CYCLE



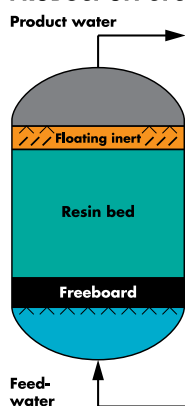
Upflow Service Packed Bed System ("Fluidized" Bed)

- Good water quality
- Good regeneration efficiency
- Good vessel volume utilization
- Short regeneration time

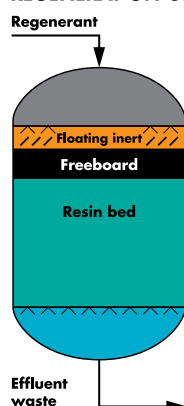
But:

- Sensitive to changes in flow rate and/or interruptions during production cycle
- Accumulation of suspended solids by deep-bed filtration
- External backwash tank needed for cleaning
- Resin traps mandatory to avoid carry-over of fines
- Layered-bed designs require an intermediate nozzle plate

PRODUCTION CYCLE



REGENERATION CYCLE



System can operate with partly fluidized or compact bed

Why the DOWEX™ UPCORE™ System Is Better

The DOWEX™ UPCORE™ packed bed system is a downflow service/upflow regeneration technology with packed bed ion exchange demineralizers. This advanced technology provides the significant productivity and economic advantages of countercurrent regeneration without the drawbacks of earlier generation processes.

The DOWEX UPCORE system offers these advantages:

- Simple design that's ideal for retrofitting or upgrading systems
- Easy to control and automate
- Self-cleaning system with no separate backwashing required
- Tolerates flow variations without disruption to the resin layers
- Reduces use of regeneration chemicals
- Increases water quality

Evaluate Your System's Performance Online with CADIX

CADIX (Computer Assisted Design for Ion eXchange) is a comprehensive ion exchange engineering software tool for system design and evaluation of existing plant performance.

CADIX allows an economic comparison of cocurrent and countercurrent regeneration for your particular system – and other valuable capabilities. To download CADIX, go to www.dowex.com and click on "Download Software."

A Closer Look at the Regeneration Process

The DOWEX™ UPCORE™ packed bed system has distinct operational advantages over other countercurrent systems, including reduced resin loss and lower regenerant costs. In the DOWEX UPCORE packed bed system, the top collector/distributor system is surrounded by a layer of floating inert material. This material allows the compaction/regeneration effluent and suspended solids and resin fines to pass through while retaining the normal-size resin beads. With DOWEX UPCORE resins, resin loss can be virtually eliminated.

Feedwater enters at the top of the distributor system and passes through the layer of fluidized inert material. At the end of the service cycle, water flows up from the bottom distributor system, causing the resin bed to compact against the inert material at the top of the vessel. Immediately following compaction, the regenerant is passed upflow at a rate high enough to maintain bed compaction. Upflow displacement rinse follows and the bed is allowed to settle in the final step.

The Regeneration Cycle

The purpose of the regeneration cycle is to regenerate the resin and to remove suspended solids and resin fines. The efficiency of a countercurrent system depends on the maintenance of a highly effective polishing zone throughout the regeneration and service cycles. During service, the bed stays fixed against the bottom distribution system. During regeneration, this is achieved with the hysteresis effect, as shown in the diagram (see Figure 3).

The resin bed is initially compacted against the inert beads by an upflow stream of water. The flow rate needed for compaction is determined by the resin particle size and density, the amount of freeboard, and the water

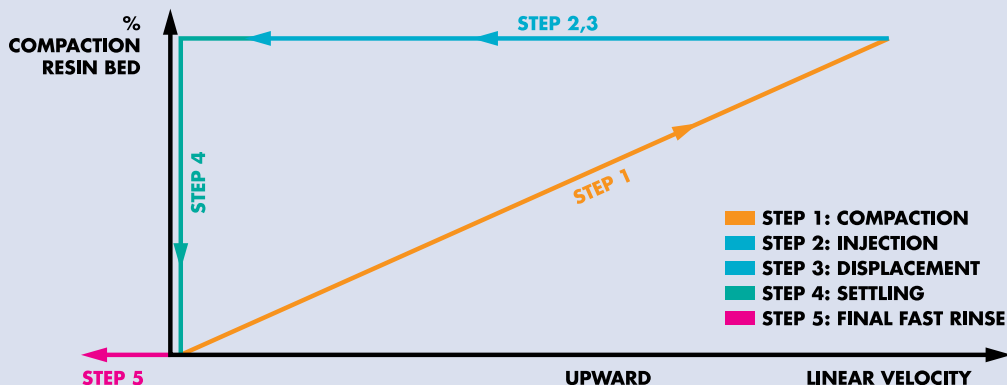
temperature. It takes only a few minutes for the bed to fully compact. The water is normally demineralized (or decationized for the cation unit) to prevent ionic contamination of the polishing zone (see Figure 4).

During compaction, the resin bed is substantially freed of suspended materials (filtered out on the surface during the service cycle), as well as resin fines, due to a hydrodynamic shear effect. The removal of unwanted solids is optimized by the choice of the correct DOWEX™ resin and collector system. This self-cleaning process is completed during the regeneration phase.

Once compacted, the resin bed remains in place even if the flow rate is reduced. This allows regeneration to take place at the flow rate that achieves the best results in terms of regenerant contact time and concentration. The volume change of the resin beads supports the cleaning effect.

In the DOWEX UPCORE packed bed system, the regeneration step is followed by a displacement or slow rinse cycle. The flow of water is in the upflow direction at the rate equal to that used during regeneration. After the displacement rinse is completed, the flow is stopped and the resin bed is allowed to fall freely. It takes between 5 and 10 minutes for the compacted bed to settle. During settling, the bed falls to the bottom of the vessel, layer by layer. Within the upmoving fluidized freeboard, a classification of the resin takes place, and any resin fines are kept in suspension. This settling results in a loosening of the bed and allows residual fines to rise to the top, where they are removed in the next compaction step. Carry-over of resin fines to the next vessel during the service cycle is thus prevented. The polishing zone is not disturbed by the settling phase.

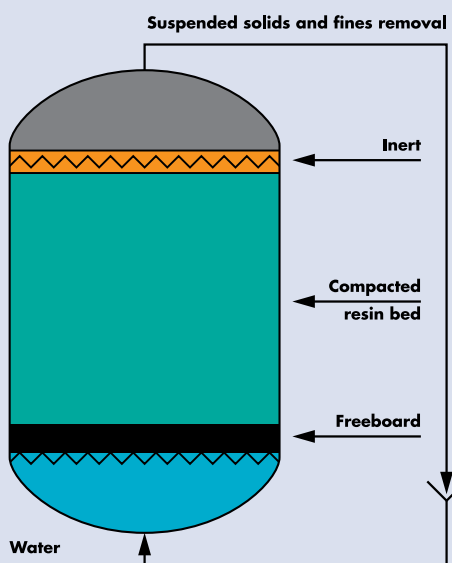
Figure 3 Hysteresis Effect



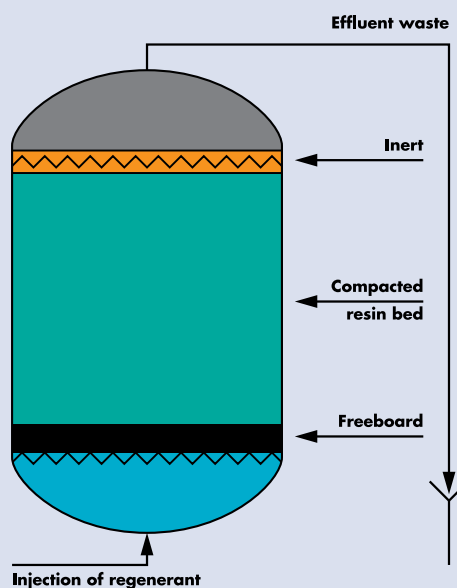
The regeneration cycle is completed with a fast final rinse or the recirculation of rinse water between cation and anion vessels. In the fast final rinse, water flows down from the top of the vessel at a rate equal to the service flow. The water for the final rinse can be raw for cation resins and should be decationized or demineralized for anion resins. To save service water, the final rinse can also be based on recirculation from the cation to the anion vessel at the service cycle flow rate.

Figure 4

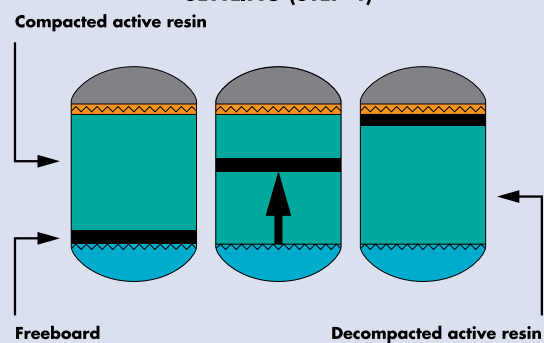
COMPACTION (STEP 1)



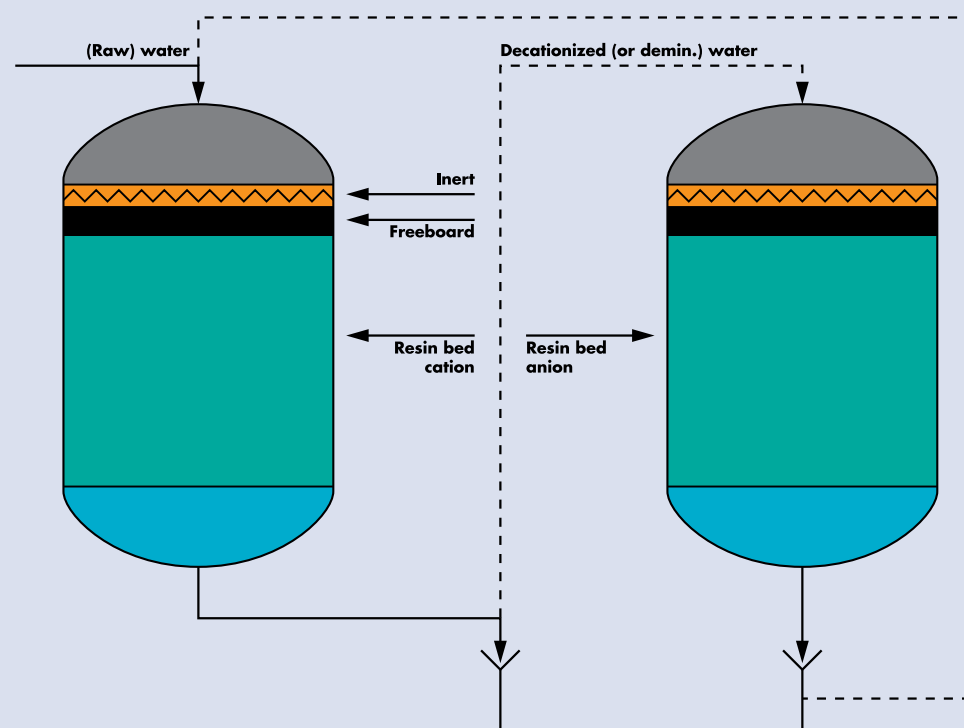
INJECTION/DISPLACEMENT (STEP 2/3)



SETTLING (STEP 4)



FAST FINAL RINSE (STEP 5)



For more information, contact us:

LENNTECH

info@lennotech.com Tel. +31-152-610-900

www.lennotech.com Fax. +31-152-616-289

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DOWEX™ Ion Exchange Resins

6. Engineering Information

- DOWEX MARATHON C
- DOWEX MAC-3
- DOWEX HCR-W2 and HGR-W2
- DOWEX MARATHON A
- DOWEX MARATHON 11
- DOWEX MARATHON A2
- DOWEX MARATHON WBA

Dow
Liquid Separations



DOWEX MARATHON C

Ion Exchange Resin

ENGINEERING INFORMATION

DOWEX MARATHON C Strong Acid Cation Exchange Resin

General Information

DOWEX® MARATHON® C resin is a high capacity, gel strong acid cation exchange resin of uniform bead size distribution. It is based on a styrene-divinyl benzene copolymer matrix with sulfonate functional groups. DOWEX MARATHON C 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 C 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 due to its specially designed structure and small bead size gives it outstanding resistance to bead breakage.

This brochure relates to water demineralization, using HCl or H₂SO₄ as regenerant in co-current or counter-current operation. The presented data allows the calculation of operational capacities and sodium leakages for different water qualities at different temperatures and levels of regeneration. Separate information is available on its use in softening applications. The resin is normally delivered in the hydrogen form but is also available in the sodium form.

Guaranteed Sales Specifications		Na ⁺ form	H ⁺ form
Total exchange capacity, min.	eq/l kg/ft ³ as CaCO ₃	2.0 43.7	1.8 39.3
Water content	%	42 - 48	50 - 56
Uniformity coefficient, max.		1.1	1.1

Typical Physical and Chemical Properties		Na ⁺ form	H ⁺ form
Mean particle size [†]	µm	585 ± 50	600 ± 50
Whole uncracked beads	%	95 - 100	95 - 100
Total swelling (Na ⁺ ♦ H ⁺)	%	8	8
Particle density	g/ml	1.28	1.20
Shipping weight	g/l lbs/ft ³	820 51	800 50

Recommended Operating Conditions	
Maximum operating temperature:	120°C (250°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	2-5 Bed volumes
Regenerant	1-8% H ₂ SO ₄ , 4-8% HCl or 8-12% NaCl

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

Bed Expansion

A uniform bead resin requires less flow to expand to the same height as a conventional polydispersed resin. DOWEX MARATHON C resin has a smaller mean size, thereby reducing the backwash flow rate required even further. Backwash expansion characteristics for MARATHON C resin are displayed in Figure 1. Backwash expansion reclassifies the resin, removes any accumulated fines, and prevents channeling 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. Occasionally, extended 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 "blocked" 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 (void volume), flow rate, and temperature. The presence of smaller beads in conventional polydispersed resins can result in filling of the interstitial spaces between the larger beads, thereby increasing the head loss pressure drop. Compared to conventional resins, uniform beads have a higher void volume which compensates for the smaller mean bead diameter, resulting in similar head loss characteristics to the conventional resins.

Figure 1. Backwash expansion vs. flow rate

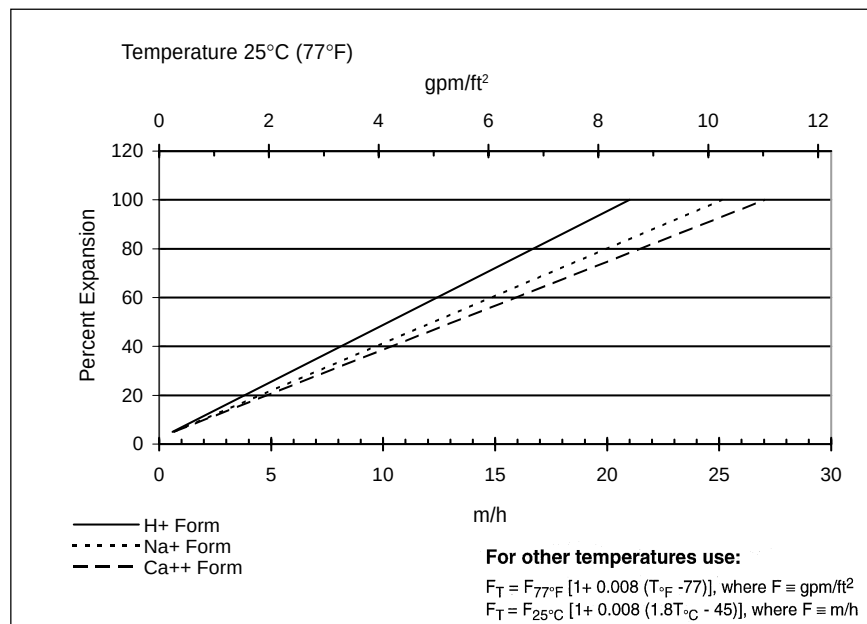
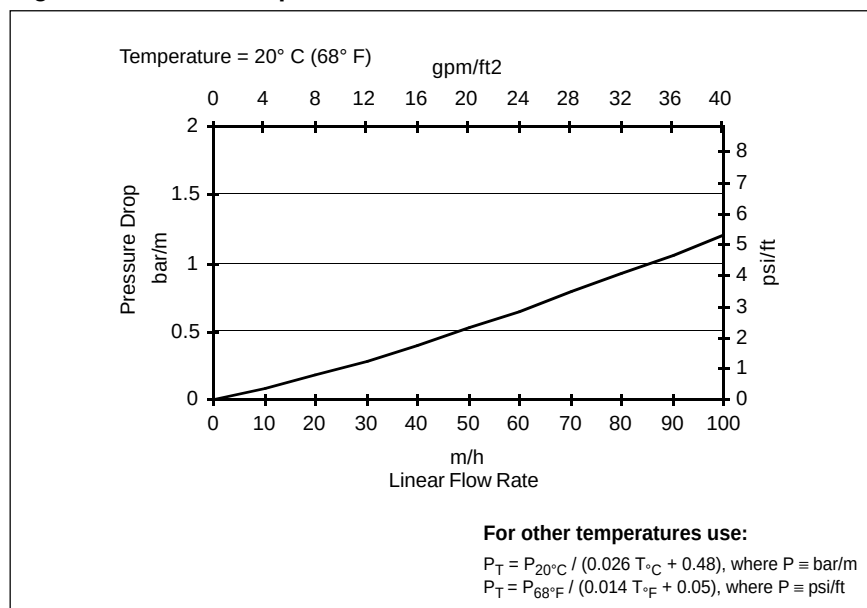


Figure 2. Pressure drop vs. flow rate



The data in Figure 2 shows the pressure drop per unit bed depth as a function of flow velocity. These figures are based on new resin which has been backwashed and settled and must be considered representative only. 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. It is substantially affected by the contribution of the strainers surrounded by resin.

Operating Characteristics

DOWEX MARATHON C resin's uniform beads results in more efficient regeneration and increased operating capacity compared to conventional resins. This reduces both operating costs and waste disposal volumes.

The performance of the cation exchange resin is evaluated on the basis of the regeneration efficiency and the sodium leakage. Figure 3 indicates the contribution to conductivity due to sodium leakage. This leakage is expressed as NaOH as it appears in the effluent of a strong base resin. When a weak base resin follows the cation exchange unit, sodium will leak as NaCl and contribute to the conductivity accordingly. In this case, conductivity will also be due in part to CO_2 , which should also be taken into account.

Sodium leakage will not only affect the conductivity of the final effluent, but also influences the silica leakage from a strong base resin. Data related to this influence are presented in the relevant anion exchange resin engineering brochures. Silica leakage and conductivity are the important features of the final demineralized water. The correct design of the cation exchange unit will therefore have a critical impact on the overall performance and the ion exchange plant.

When H_2SO_4 is used as regenerant, the maximum permitted concentration of H_2SO_4 is determined by the percentage of calcium in the feed water, as shown in Figure 4. If H_2SO_4 concentration is too high, or the regeneration flow rate is too slow, calcium sulfate will be precipitated in the resin bed. A step-wise regeneration may be used to improve the regeneration efficiency. As this applies especially to high regeneration levels, it may be more attractive to use counter-current techniques in such cases. Concentrations of

Figure 3. Contribution to conductivity

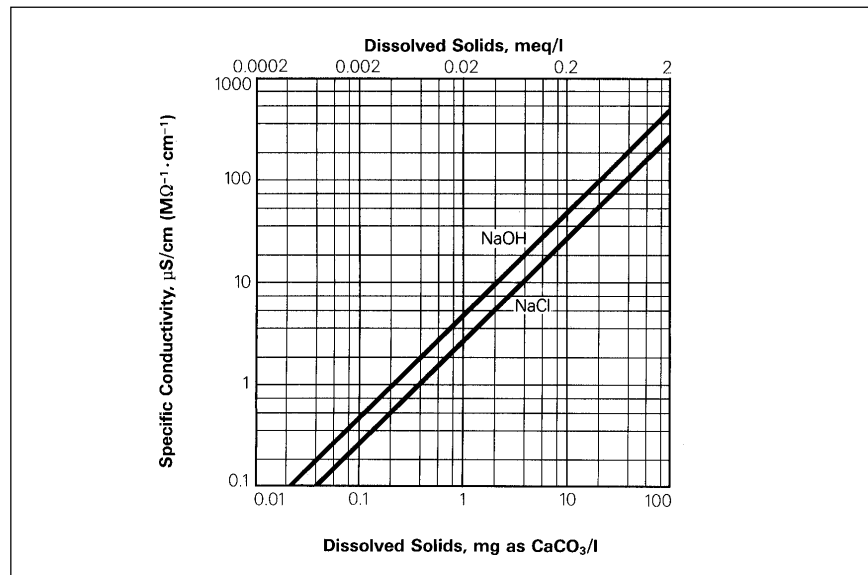
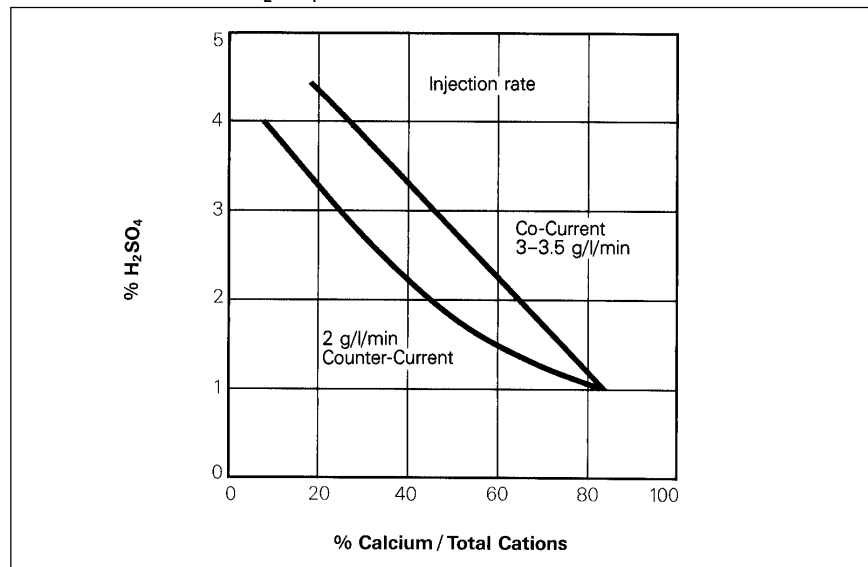


Figure 4. Permitted H_2SO_4 concentration



sulfuric acid recommended for step-wise regeneration are given in Figure 5. At a constant presentation rate of regenerant, a higher flow rate will thus be used when regenerating at a low acid concentration. At a presentation rate of 3 g H_2SO_4 /min per liter of resin at a concentration of 1% H_2SO_4 , this will amount to a regenerant flow rate of 18 m^3/h per m^3 (2.2 gpm/ft^3) of resin.

Hydrochloric acid may be used at concentrations of 4 to 8%, irrespective of the calcium content in the feed water. High concentrations of HCl and long regeneration times will be preferred when calcium and magnesium predominate. When sodium is the main constituent, HCl at 4 to 5% will give the best efficiency.

Co-Current Operation

Co-current operation gives a lower quality water and poorer regeneration efficiency than counter-current operation. It may nevertheless be preferred, especially when low level sodium leakage levels may not be necessary. Figures 6 and 7 show the average sodium leakage from DOWEX MARATHON C resin relative to different regeneration levels and using HCl or H₂SO₄ as regenerants. These leakages are expressed as percentages of equivalent mineral acidity (E.M.A.). Leakage levels will be higher at the beginning and towards the end of the cycle. When very high regeneration levels are required to obtain the desired leakage, it is advisable to consider counter-current operation.

Data on typical operational capacities for DOWEX MARATHON C resin using HCl or H₂SO₄ in co-flow are given in Figures 8 and 9.

Figure 5. Permitted H₂SO₄ concentrations (Step-wise)

Calcium % in feed water	H ₂ SO ₄ % permitted
Ca% < 15	H ₂ SO ₄ 3%
15 < Ca% < 50	H ₂ SO ₄ 1.5% for 30% H ₂ SO ₄ 3% for 70%
50 < Ca% < 70	H ₂ SO ₄ 1.5% for 50% H ₂ SO ₄ 3% for 50%
Ca% > 70	H ₂ SO ₄ 1% or use HCl

Figure 6. Average Na leakage in co-current operation with

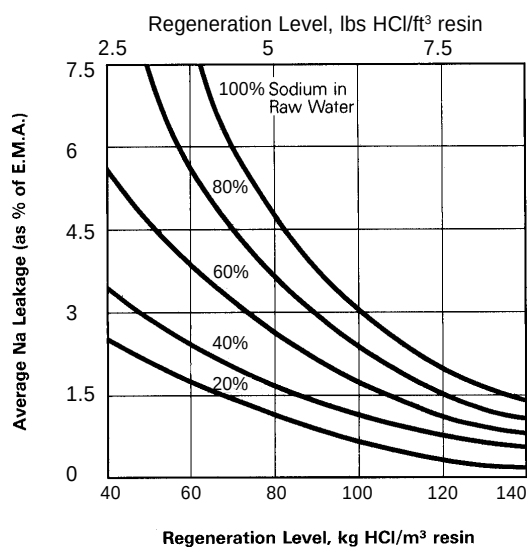
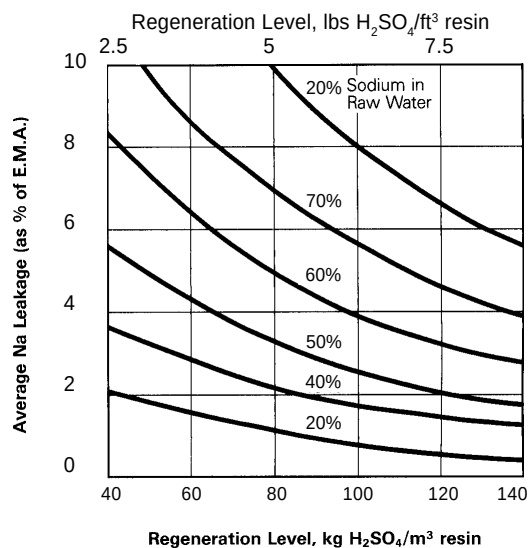


Figure 7. Average Na leakage in co-current operation with



Co-current operational capacity data

(Step-wise Concentration in H_2SO_4 Regeneration)

To calculate operational capacities:

1. Locate a point on the ordinate of graph A from % sodium and % alkalinity in the feed water.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guideline to the chosen regeneration level thus establishing a new ordinate.
3. Read off operational capacity on the right hand side of the diagram corresponding to this new ordinate.
4. Make a final correction to this operating capacity for the % magnesium in the feed by multiplying by the correction factor shown in Figure C.

Note: $\text{eq/l} \times 21.8 = \text{kg/ft}^3$ as CaCO_3 .

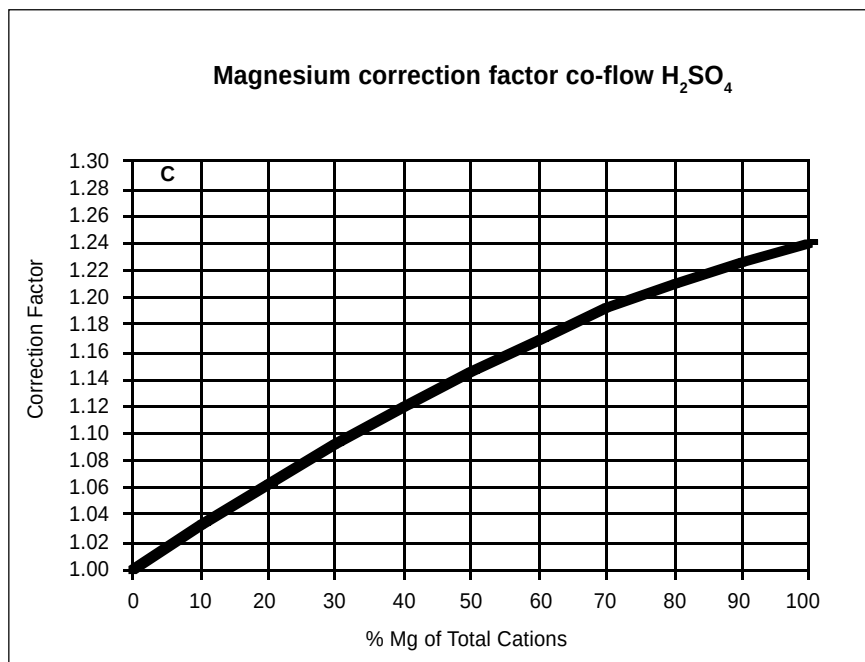
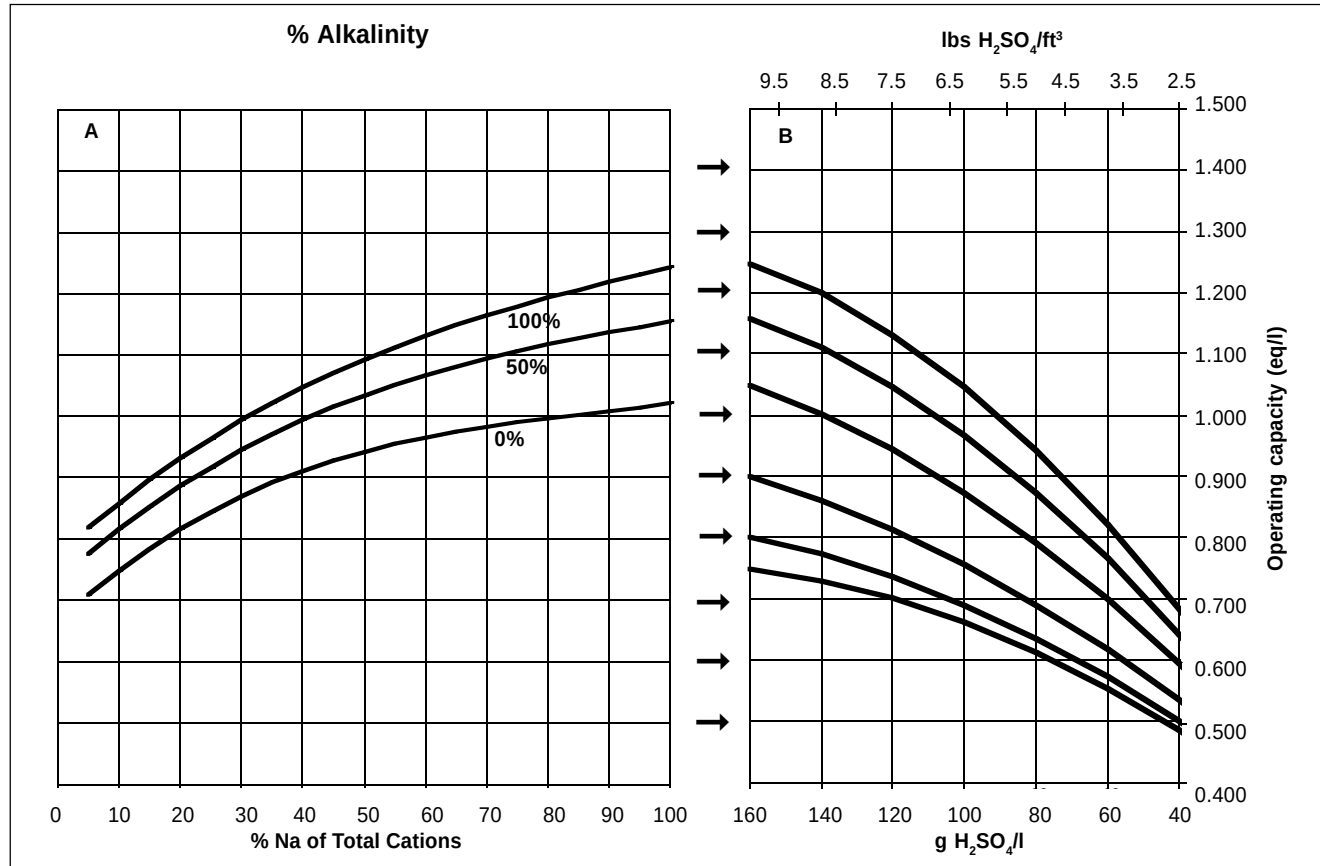


Figure 8. Co-current operational capacity data (Step-wise H_2SO_4)



Co-current operational capacity data

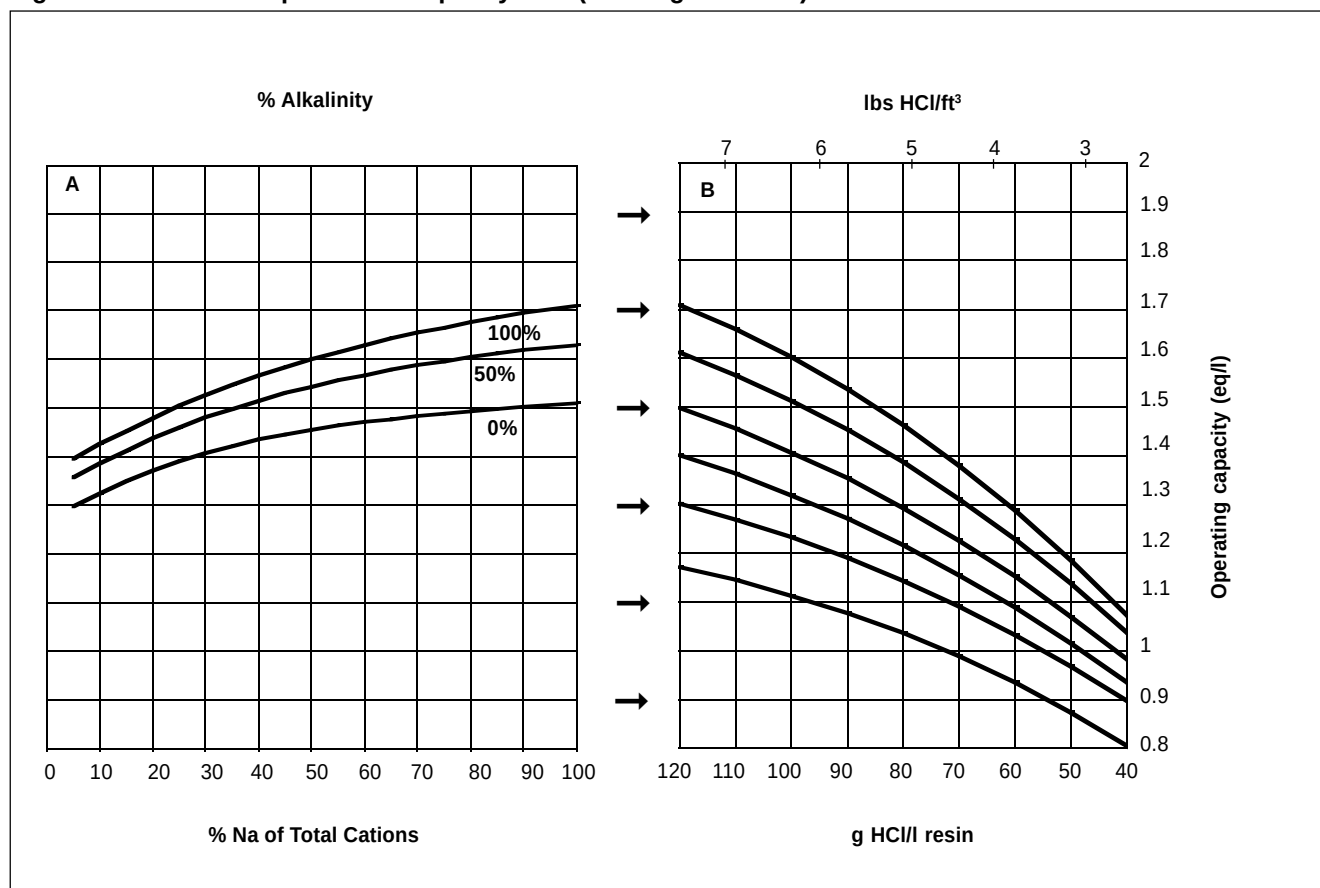
(HCl Regeneration)

To calculate operational capacities:

1. Locate a point on the ordinate of graph A from % sodium and % alkalinity.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guideline to the chosen regeneration level thus establishing a new ordinate.
3. Read off operational capacity on the right hand side of the diagram corresponding to this new ordinate.

Note: $\text{eq/l} \times 21.8 = \text{kg}/\text{ft}^3 \text{ as } \text{CaCO}_3$.

Figure 9. Co-current operational capacity data (HCl Regeneration)



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 volume) and lower sodium leakage. These advantages are further enhanced by using small uniform bead size resins. Initial capital costs can be higher for a counter-current operation and more care has to be taken in the design of a unit as it has to be able to give the highest quality of treated water. Also, treated (or at least decaionized) water must be used for diluting the regeneration chemicals and for the displacement rinse. The design must further ensure that the chemicals contact the resin at the correct concentration by avoiding any excessive dilution. In conventional counter-current regeneration, a presentation rate of 2 gram regenerant per minute and per liter of resin has shown the best results for optimum regeneration efficiency. This results in a regenerant flow rate of 3 m³/h per m³ (0.4 gpm/ft³) of resin when 4% regenerant concentration is used.

Data operational capacities for DOWEX MARATHON C resin using HCl or H₂SO₄ are given in Figures 12 and 13. Levels of average sodium leakage can be calculated from data presented in figures 10 and 11. The desired level of leakage is divided by the alkalinity correction factor, which takes into account the alkalinity percentage of the influent. This corrected leakage value together with the percent Na in the influent is now used to establish the required regeneration level. Conversely, the sodium leakage for a given regeneration level can be established by reading off a value, taking into account again the percentage Na in the influent, and by multiplying this value with the alkalinity correction factor. Lower Na leakages are obtained using step-wise regeneration with H₂SO₄.

Figure 10. Average Na leakage, HCl regeneration

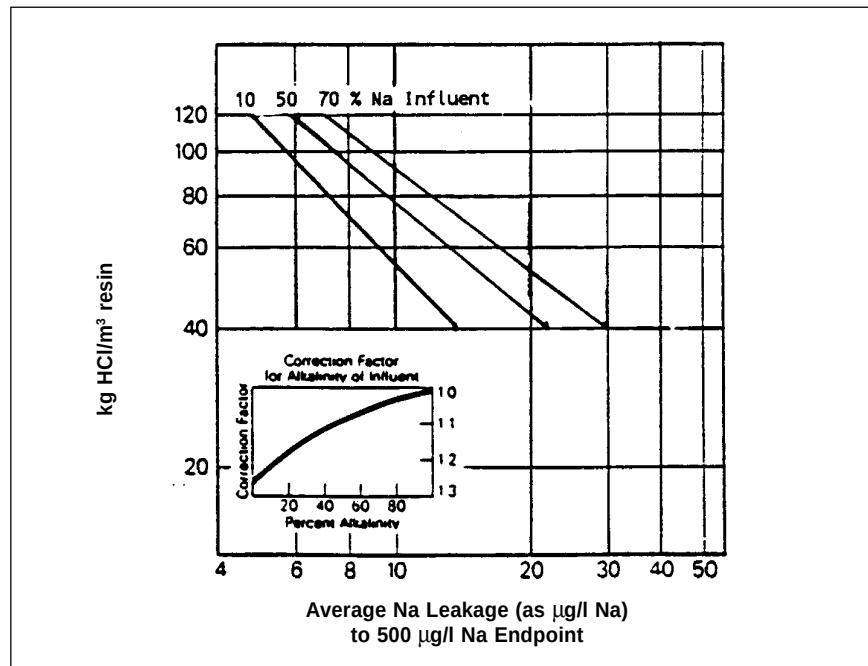
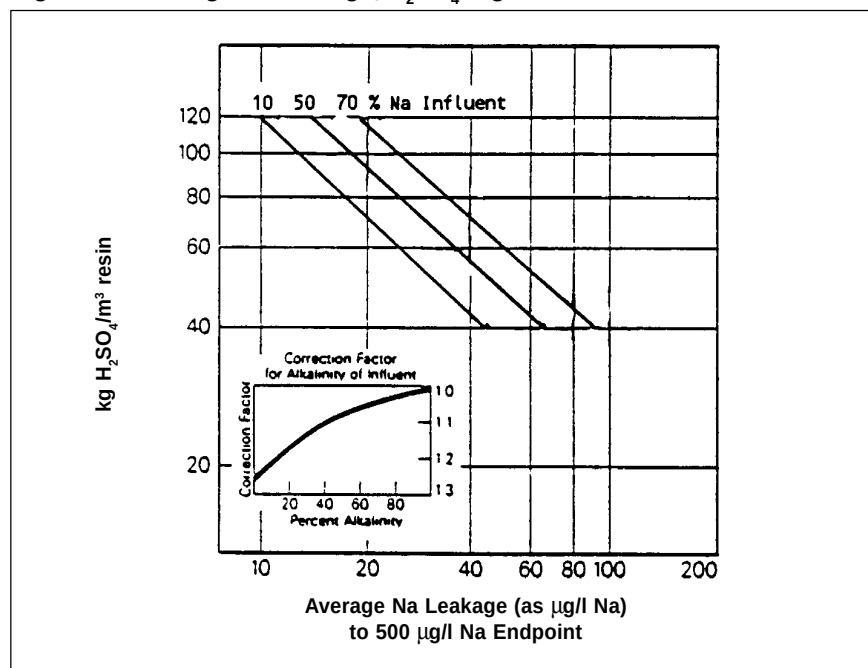


Figure 11. Average Na leakage, H₂SO₄ regeneration



Counter-current operational capacity data

(H₂SO₄ Regeneration)

To calculate operational capacities:

1. Locate a point on the ordinate of graph A from % sodium and % alkalinity in the feed water.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guideline to the chosen regeneration level thus establishing a new ordinate.

3. Read off operational capacity on the right hand side of the diagram corresponding to this new ordinate.

Note: eq/l x 21.8 = kgr/ft³ as CaCO₃.

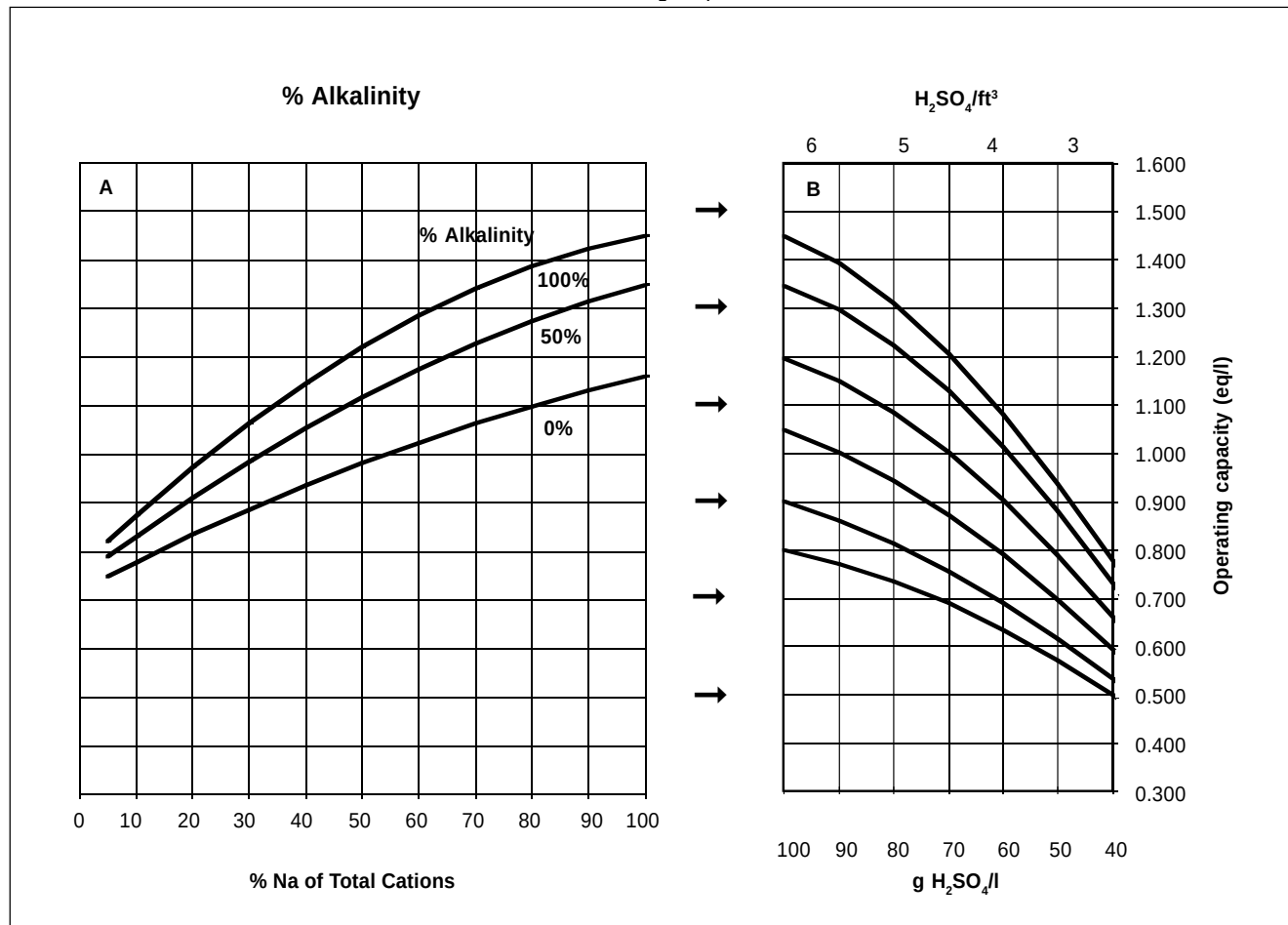
Important:

See correction graph for resin bed depth of less than 2 meters (6.5 ft).

Standard conditions:

- BV/H x Salinity (meq/l) = 200
- gpm/ft³ x Salinity (kgr/ft³) = 0.55
- Temp. 15°C (60°F)

Figure 12. Counter-current operational capacity data (H₂SO₄ regeneration)



Counter-current operational capacity data

(HCl Regeneration)

To calculate operational capacities:

1. Locate a point on the ordinate of graph A from % sodium and % alkalinity in the feed water.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guideline to the chosen regeneration level thus establishing a new ordinate.

3. Read off operational capacity on the right hand side of the diagram corresponding to this new ordinate.

Note: $\text{eq/l} \times 21.8 = \text{kg}/\text{ft}^3 \text{ as } \text{CaCO}_3$.

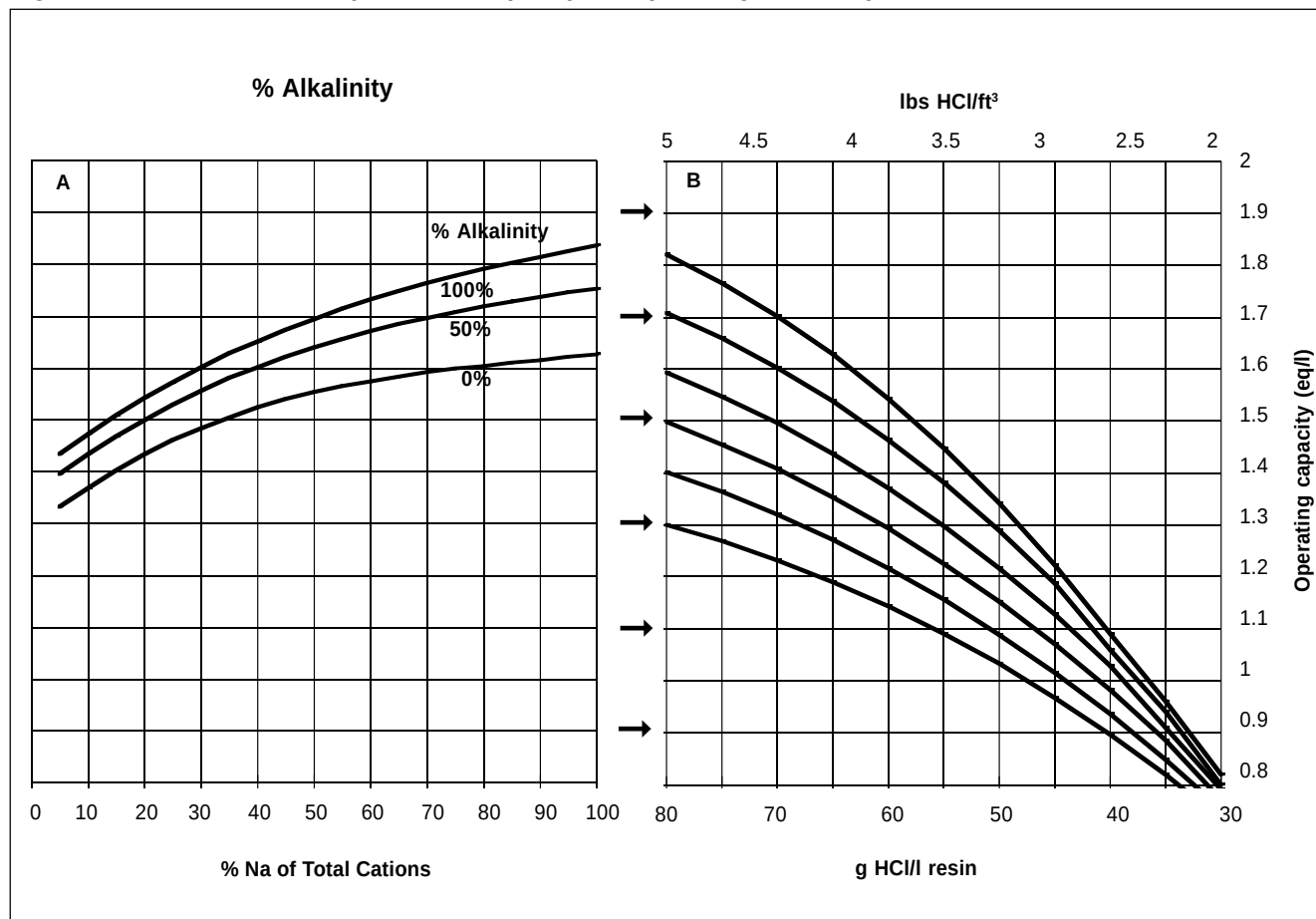
Important:

If alkalinity is less than 30%, use 1.5 m (5 ft) bed depth or not less than 50 g/l (3 lbs/ft³ HCl).

Standard conditions:

- $\text{BV}/\text{H} \times \text{Salinity (meq/l)} = 200$
- $\text{gpm}/\text{ft}^3 \times \text{Salinity (kg}/\text{ft}^3) = 0.55$
- Temp. 15°C (60°F)

Figure 13. Counter-current operational capacity data (HCl Regeneration)

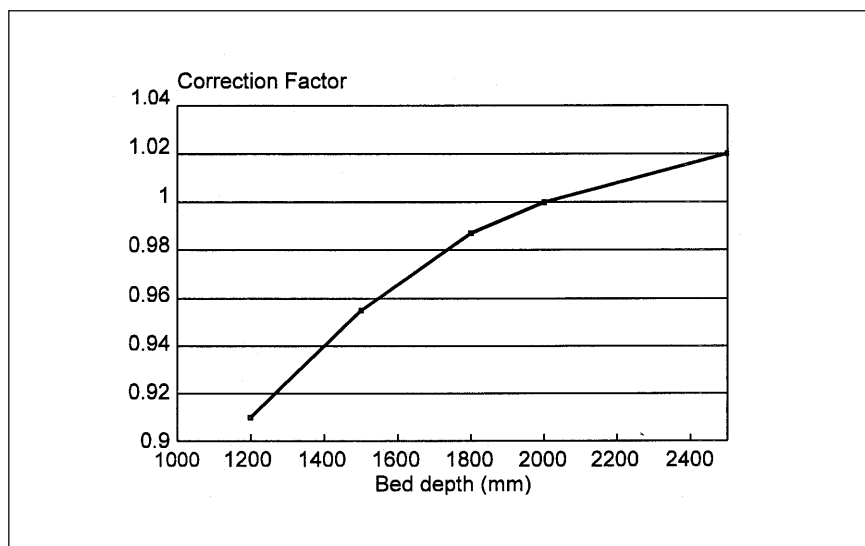


The bed depth effect

The geometry of an ion exchange plant affects the capacity and the quality of the produced water. A bed depth of about 1 m (3.3 ft) is ideal for co-current operation but little difference exists going from 0.75 m to 2 m bed depth (30" to 6.5 ft). A flow velocity of 20-30 m/h (8-12 gpm/ft²) may give slightly better performance than operating at 50-60 m/h (20-24 gpm/ft²). On the other hand, there is great advantage to gain from using a deep bed in counter-current operation with H₂SO₄ as regenerant. The high physical strength of DOWEX MARATHON C resin allows it to be used in deep beds, thereby obtaining better capacity usage and water quality.

The bed depth effect is given in Figure 14 for bed depths from 1 to 2.5 m (3.3 to 8.2ft)

Figure 14. Effect of bed depth on capacity (counter-current) of DOWEX MARATHON C resin



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

LENNTECH

info@lenntech.com Tel. +31-152-610-900

www.lenntech.com Fax. +31-152-616-289

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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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Form No. 177-01686-502XQRP
CH 171-396-E-502R



Dow
Liquid Separations

DOWEX
Ion Exchange Resin

DOWEX MAC-3 Engineering Information

July 2003

DOWEX MAC-3 Weak Acid Cation Exchange Resin

General Information

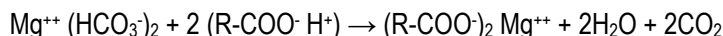
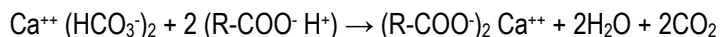
DOWEX* MAC-3 resin is a high capacity, macroporous weak acid cation exchange resin with excellent regeneration efficiency, very good resistance to osmotic shock and good chemical and physical stability. The resin is based on a polyacrylic-divinylbenzene matrix containing carboxylic acid functional groups. The resin is available in four grades:

DOWEX MAC-3: standard grade for use in single beds.

DOWEX MAC-3 PS: specially graded for use in packed bed counter-current regeneration systems.

DOWEX UPCORE* MAC-3: specially graded for use in the packed bed, counter-current, up-flow regeneration UPCORE system.

In water treatment applications, DOWEX MAC-3 is very effective in removing calcium and magnesium at nearly 100% chemical efficiency. Due to the weak acid functionality, DOWEX MAC-3 removes temporary hardness (calcium and magnesium associated with the water alkalinity) but not the permanent hardness (hardness associated with free mineral acidity, FMA):



Where as:

$\text{Ca}^{++} (\text{Cl}^-)_2 + 2 (\text{R-COO}^- \text{H}^+)$ or $\text{Mg}^{++}\text{SO}_4 + 2 (\text{R-COO}^- \text{H}^+)$
does not proceed.

In addition to water treatment, this resin can be used for a variety of applications including wastewater and the recovery of metals. DOWEX MAC-3 can be supplied on request for use in food and potable water applications in accordance with health authority guidelines or requirements for TOC (Total Organic Carbon). In such cases, a recommendation is given for resin conditioning before use.

Guaranteed Sales Specifications

		H ⁺ form
Total exchange capacity, min.	eq/l	3.8
	kg/ft ³ as CaCO ₃	83.0
Bead size distribution range†		
0.3 mm – 1.2 mm, min. (50 mesh – 16 mesh)	%	90

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

Typical Physical and Chemical Properties

		H ⁺ form
Water content	%	44 – 50
Whole beads	%	95 – 100
Total swelling (H ⁺ → Ca ⁺)	%	15
Particle density	g/ml	1.18
Shipping weight	g/l	750
	lbs/ft ³	47

Recommended Operating Conditions

Maximum operating temperature	120°C (250°F)
pH range	5 – 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
Regeneration/displacement rinse	1 – 10 m/h HCl (0.4 – 4 gpm/ft ²), 5 – 20 m/h H ₂ SO ₄ (2 – 8 gpm/ft ²)
Rinse	5 – 20 m/h (2 – 8 gpm/ft ²)
Total rinse requirement	3 – 6 bed volumes
Regenerant	1 – 5% HCl or 0.5 – 0.8% H ₂ SO ₄

Hydraulic Characteristics

Backwash Expansion

Backwash expansion data for DOWEX MAC-3 is given in Figure 1. The resin is normally operated in co-flow mode and is backwashed for a short time before each regeneration to regrade and to discharge resin particles that may be trapped in the collecting strainers. An expansion of around 80 – 100% for 15 minutes is recommended to remove particulate matter from the resin bed. Depending on the quality of the inlet water, the resin may require a longer backwash (20 – 30 minutes) to clean the resin of accumulated contamination.

After regeneration and before the final rinse, the resin may also be backwashed for 1 minute before commencing the service flow in order to release the pressure built up on the bed surface due to resin expansion. The resin volume change during the operational cycle is substantial, and may be nearly 10% if the resin is operated to full exhaustion. This means that the backwash flow must be reduced by about 10% if the bed is backwashed in the regenerated condition.

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. Plant geometry can also affect overall head loss and the head loss in strainers surrounded by resin may be considerable. These factors should be included in engineering calculations.

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 MAC-3 PS and DOWEX UPCORE MAC-3 can exhibit ~5% lower pressure drop characteristics than those illustrated in Figure 2.

Figure 1. Backwash expansion vs. flow rate

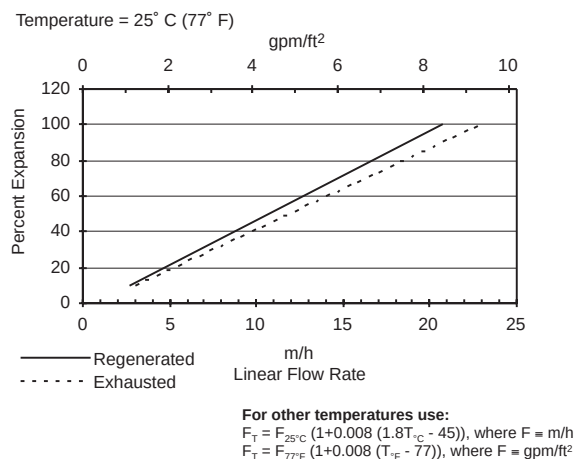
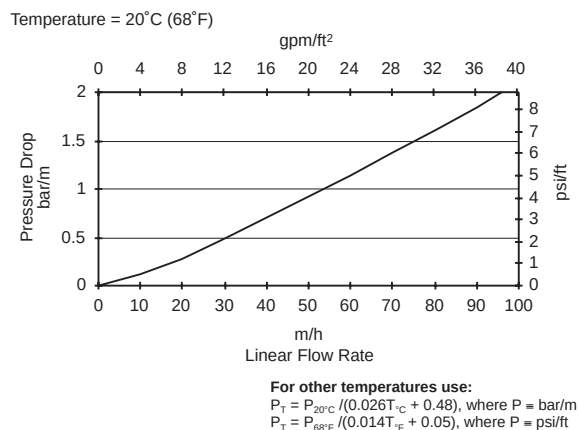


Figure 2. Pressure drop



Operating Characteristics

The recommended operating conditions in the table shown on page 2 are intended as a guide and should not be found restrictive. The kinetics of DOWEX MAC-3 are such that regeneration with either HCl or H₂SO₄ does not affect the resin capacity and regeneration times are minimized. It is important to note however, that when using H₂SO₄ as regenerant, the concentration of calcium sulfate produced will greatly exceed its solubility. The resultant supersaturation is acceptable as long as the regeneration is performed according to certain guidelines: it is recommended to regenerate with not greater than 0.8% sulfuric acid and to ensure that the acid passes through in less than 30 minutes. It is also important to rinse the acid out immediately.

Operating Processes

DOWEX MAC-3 may be used alone or in combination with other resins in a variety of processes.

Partial Demineralization (Dealkalization) using DOWEX MAC-3 alone

This is a very effective process involving DOWEX MAC-3 on its own to remove temporary hardness and the corresponding alkalinity (if a degasser is installed downstream of the resin). In this combination, the resin usually operates in co-flow regeneration and at nearly 100% chemical efficiency.

As the resin capacity is affected by the kinetics, flow changes or water changes which cause early resin exhaustion will result in slight loss of capacity. Ideally, the amount of acid used to regenerate should then also be reduced, but this is usually not possible and the resin becomes over-regenerated. The resultant pH of the treated water is affected, especially at the beginning of the operational cycle (see Figure 3). The pH variation can be reduced if the pH is raised by adding approximately 5 – 10 mg/l of NaOH to the degassed water sump (see Figure 4). The other alternative is to monitor the in-line addition of NaOH with a pH instrument. With sufficient storage of final treated water (as in a cooling tower sump), degassing occurs naturally and the problem does not arise.

If the total calcium and magnesium in the feed exceed the alkalinity (as equivalents), they will be removed up to the level of alkalinity present. Under these circumstances, no sodium bicarbonate is present and the resin capacity is high (see Figure 9A curves with hardness/alkalinity ratio >1).

If alkalinity exceeds calcium and magnesium, then sodium bicarbonate is present and a reduction in capacity of the weak acid cation resin will occur, due to the presence of sodium ions, although only if it is necessary to remove the sodium (Figure 9A curves with hardness/alkalinity ratio <1).

Figure 3.

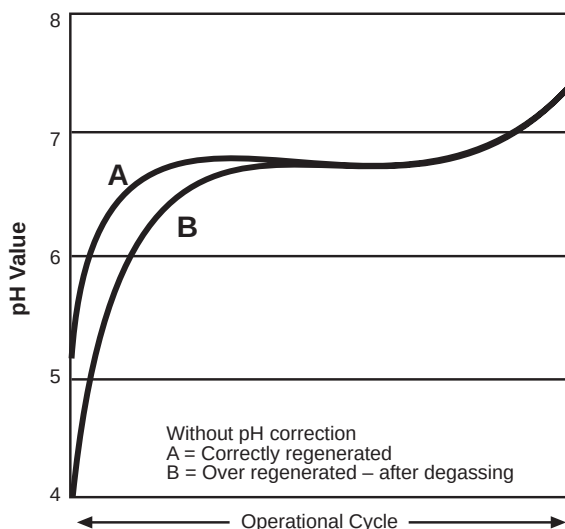
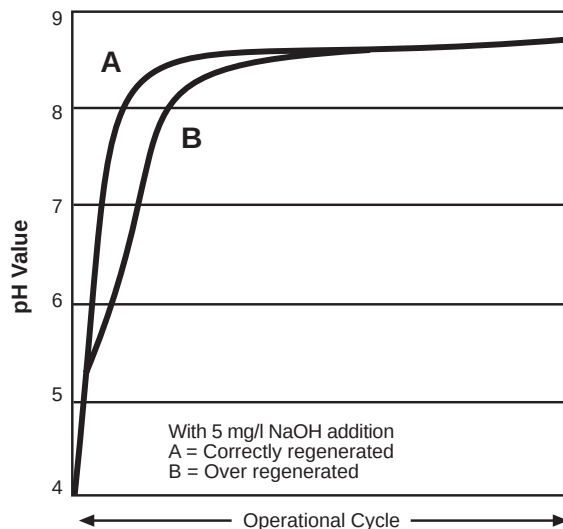


Figure 4.



Full Demineralization using DOWEX MAC-3 with a Strong Acid Cation Resin

To remove all cations in a full demineralization plant, a strong acid cation resin is placed downstream of DOWEX MAC-3. This combination of weak and strong cation exchange resins is particularly suitable for treating hard, alkaline waters and almost 100% chemical efficiency is obtainable. If the water contains a large percentage of sodium, however, nearly the same efficiency may be obtained by a correctly designed counter-current cation unit alone using DOWEX MARATHON* C.

By using DOWEX MAC-3 with a strong acid cation, the normal alkalinity end-point of the resin can be exceeded and the leakage picked up by the strong acid cation. In this overrun condition, the total performance of the DOWEX MAC-3 increases due to additional capacity utilization of the resin.

If the feed hardness/alkalinity ratio is >1 , the total performance of the DOWEX MAC-3 exceeds that shown in the capacity graph in Figure 9, and may even approach the total capacity of the resin. This is illustrated in Figure 5. If the alkalinity/hardness ratio is >1 , the overall capacity of DOWEX MAC-3 is reduced if sodium bicarbonate has to be removed, but overrunning will still result in additional weak acid cation resin capacity and its performance is shown in Figure 6. However, at a certain point the sodium bicarbonate will leak through.

Figure 5. Hardness > Alkalinity

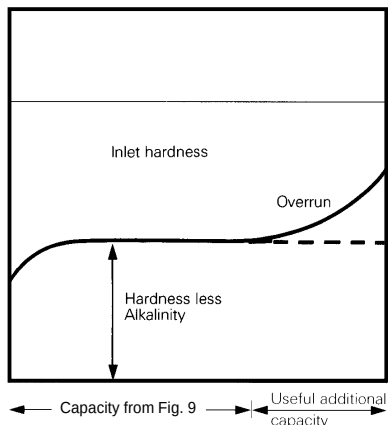
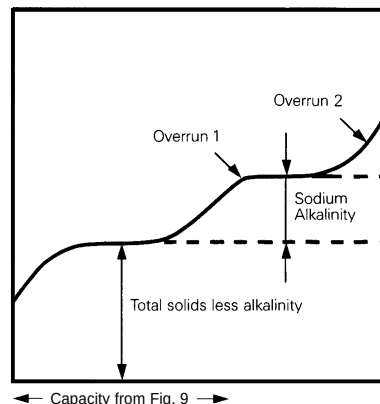


Figure 6. Alkalinity > Hardness



In contrast to weak acid cations, the capacity of strong acid cation resins e.g. DOWEX MARATHON C, can increase in the presence of sodium bicarbonate, so the omission of the weak acid cation resin might be considered if the hardness/alkalinity ratio in the feed is below 0.8.

There are two main designs for a combination of weak and strong cation resins. The first is to have DOWEX MAC-3 in a separate unit followed by a plant containing a strong acid cation resin, e.g. DOWEX MARATHON C. The water first passes through the DOWEX MAC-3 and then through the strong acid cation resin. If HCl is used as regenerant, it can be passed in series through both vessels in the opposite direction (see Figure 7). With H_2SO_4 , it is advisable to dilute the acid to $<1\%$ after the strong acid cation, or else regenerate the two resins separately (e.g. in co-flow).

The other arrangement is a layer of DOWEX MAC-3 on top of a bed of DOWEX HGR-W2 or DOWEX MONOSPHERE* 650C in the same vessel. The resin is preferably regenerated up-flow and operated down-flow, i.e. counter-current (Figure 8). In order to prevent CaSO_4 precipitation, the whole bed should either be regenerated with $<1\%$ concentration of H_2SO_4 , (which decreases the capacity of the strong acid resin) or provision for acid dilution at the resin boundary should be made. This is facilitated if a separating nozzle plate is installed in the vessel.

Figure 7. Separate unit

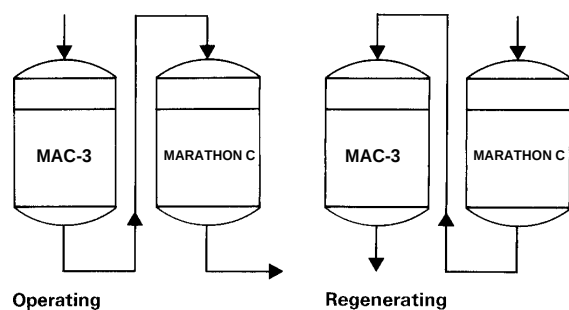
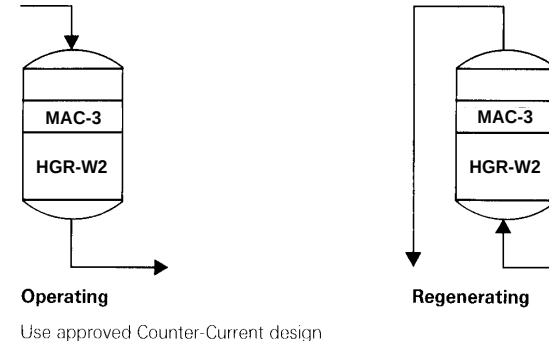


Figure 8. Layered bed



Due to the increased complexity of the layered bed option, it may be worthwhile to consider a strong acid cation resin alone operating in counter-current regeneration as an alternative. This can be so chemically efficient that the combination of the weak acid layer may not yield a substantial advantage. Nevertheless, there are occasions when it is appropriate to install and the combination of DOWEX MAC-3 and DOWEX HGR-W2 or DOWEX MONOSPHERE 650C is ideal, providing an adequate separation of the resins can be maintained.

Co-current Operational Capacity Data

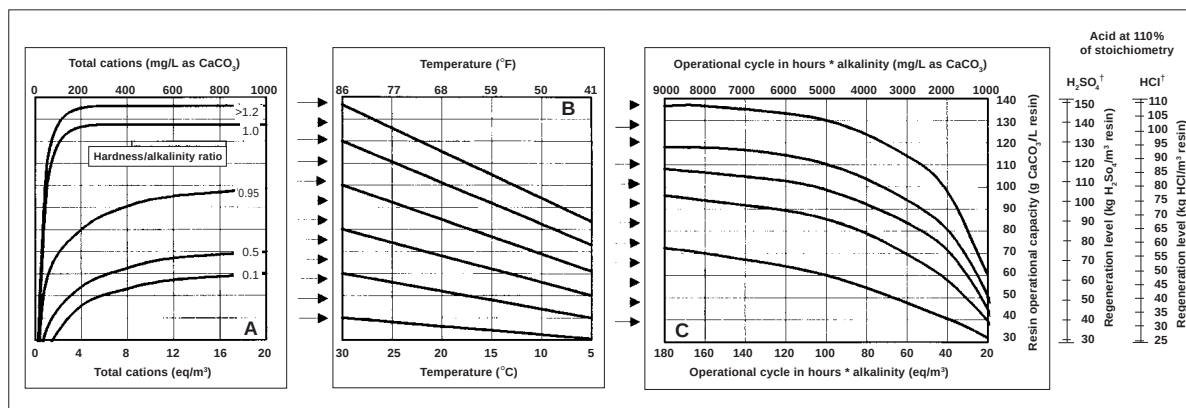
Instructions:

1. Locate a point on the ordinate of graph A from total cations and ratio of hardness to alkalinity (usually 1.0 or more).
2. Transfer the ordinate from graph A horizontally to graph B and follow the guidelines of graph B to locate a new point on the ordinate according to the water temperature.
3. Transfer the ordinate point from graph B horizontally to graph C and follow the guidelines to a new ordinate point according to the hours of the operational cycle times the alkalinity. Now read off the capacity.

Definition:

Hours of the operational cycle means the number of hours from the delivery of treated water to the time of breakthrough. It does not include the time taken to regenerate or the overrun time.

Figure 9. Co-current operational capacity data



*Divide by 16.03 to convert from kg acid/m³ resin to lb acid/ft³ resin

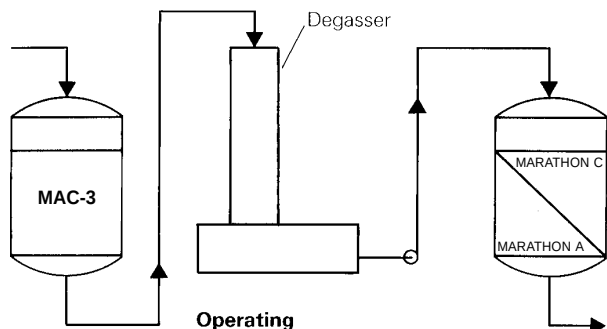
Full Demineralization using DOWEX MAC-3 with a Mixed Bed Plant

This type of combination plant (Figure 10) is an alternative to full demineralization using counter-current cation and anion plants. The decision on which type of plant to install depends on a number of factors, including the detailed engineering of the mixed bed plant.

In this system, it is usual to have a small amount of strong acid cation resin such as DOWEX MARATHON C mixed with the DOWEX MAC-3 to produce an acid water at the beginning of the operational cycle to ensure there is no salt splitting on the mixed bed plant.

It is not normal procedure to use series regeneration of the acid from the mixed bed plant to the DOWEX MAC-3 as the detailed design can give rise to flow difficulties. Although in theory the series use of the acid is perfectly feasible.

Figure 10. With a mixed bed plant



Regenerate each resin separately

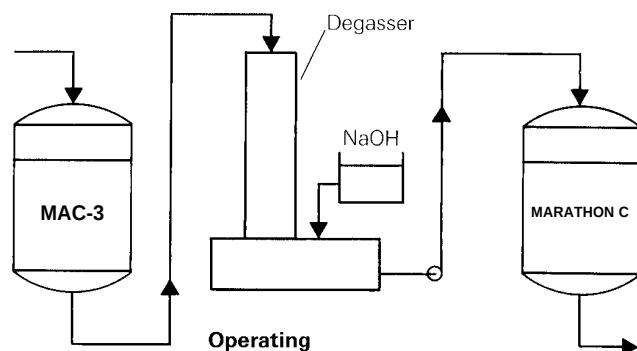
Alkalinity and Hardness Removal (DOWEX MAC-3 with a Sodium Exchanger)

This is an excellent process for producing water of very low hardness and low alkalinity (Figure 11). It has been used for nearly 40 years for feed water to low pressure boilers and cooling systems. The analysis of the treated water closely resembles treated water from a cold lime soda water softener.

The treated water alkalinity should be 20 – 40 mg/l and the hardness less than 5 mg/l, but only the reduction in alkalinity will reduce the total solids.

The pH can be adjusted at will, usually about 9.0 for low-pressure boilers and 7.8 for cooling systems.

Figure 11. With a sodium exchanger



Regenerate both units in normal manner using common salt (NaCl) for sodium exchanger

Special Applications

The special selectivity characteristics of DOWEX MAC-3 resin make it suitable for a wide range of applications. Some examples are given here.

It is increasingly standard practice to design ion exchange plants so that the waste acid effluent of the cation stage is used to neutralize the waste alkali from the anions. However, the total wastewater with these chemicals may be quite large and above effluent discharge limits. One method to treat this waste is to pass it through a bed of DOWEX MAC-3 and then add a small amount of caustic soda to raise the pH, e.g. to 7.5. This can be achieved by installing sensing equipment.

Another interesting aspect of weak acid cation ion exchange technology has been noticed by beer manufacturers who wish to control magnesium content. As an example, if 60% calcium and 20% magnesium are present in the feed and the alkalinity is 80%, then calcium and magnesium will be removed, but not to the same extent throughout the operational cycle. At the beginning of the cycle, more magnesium will be removed and less calcium, while at the end the position will be reversed. If two or more units are working in parallel and are out of step, then a constant calcium/magnesium ratio can be obtained.

Dow Liquid Separations Offices.

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Notice: 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
Water Solutions

DOWEX HCR-W2 and HGR-W2
Ion Exchange Resins

Engineering Information

DOWEX HCR-W2 and HGR-W2 Strong Acid Cation Exchange Resin

General Information

DOWEX™ HCR-W2 and DOWEX HGR-W2 strong acid cation exchange resins are premium quality gel-type produced by the sulfonation of styrene divinylbenzene copolymers. The resins are designed to combine a high operational capacity with superior physical stability. This quality is assured by the specifications which call for average friability of over 350 g/bead (for beads in the size fraction between 0.6 and 0.85 mm) and a whole uncracked bead count of at least 95% after a quality control check of every production batch of resin. The amount of coarse and fine resin particles in the polydispersed particle size distribution are also closely controlled in the manufacturing process. Specifications assure that no more than 2% of the resin beads are larger than 16 mesh (1.2 mm) and no more than 1% are finer than 40 mesh (0.42 mm). This results in good hydraulic characteristics and enables effective separation from the anion resin when used in mixed bed applications. The combination of such characteristics make DOWEX HCR-W2 and DOWEX HGR-W2 the resins of choice whenever high performance is required in continuous operation modes and where resin transfer is necessary for external regeneration, crud removal or resin separation.

Many years of very successful field experience have made DOWEX HCR-W2 and DOWEX HGR-W2 resins a standard in industrial water treatment applications. The products are particularly suited for deep bed condensate polishing, where high capacity, physical stability and ion removal kinetics are important. For this and other mixed bed applications, the particle size and density characteristics of these resins assure fast and sharp separations when used in combination with DOWEX SBR C and DOWEX SBR-P C gel anion resins.

DOWEX HGR-W2 resin has a higher degree of cross-linking and is the preferred resin for more aggressive polisher conditions or when a higher resistance to oxidation by dissolved oxygen or chlorine is required. For optimal separation in mixed beds, especially in combination with an inert interface, DOWEX HGR-W2 resin is recommended because of its higher density. In other instances its higher total exchange capacity makes it the preferred resin for a particular application.

This brochure relates to water demineralization, using HCl or H₂SO₄ as regenerant in co-current and counter-current operation. The presented data allow the calculation of operational capacities and sodium leakages for different water qualities at different temperatures and levels of regeneration. Resins are available in both the sodium and hydrogen forms. The physical and chemical characteristics of the resins are listed in the table shown on page 3.

Guaranteed sales specifications			HCR-W2	HGR-W2		
Ionic form as delivered			H ⁺	H ⁺		
Total exchange capacity, min.	eq/L		1.8	2.0		
	kgr/ft ³ as CaCO ₃		39.3	43.7		
Water content	%		48 - 54	47 - 51		
Bead size distribution†						
> 1.2 mm, max. (16 mesh)	%		2	2		
< 0.42 mm, max. (40 mesh)	%		1	1		
Whole uncracked beads, min.	%		95	95		
Crush strength						
Average, min.	g/bead		350	350		
> 200 g/bead, min.	%		95	95		
Ionic conversions, H ⁺ form, min.	%		99	99		
Trace metals, ppm dry resin, max. (H ⁺ form)						
Na	Fe	Cu	Al	Mg	Ca	Heavy metals (as Pb)
50	50	10	50	50	50	10

Typical physical and chemical properties		HCR-W2	HGR-W2
Total swelling (Na ⁺ → H ⁺)	%	8	7
Particle density	g/mL	1.22	1.23
Shipping weight	g/L	785	800
	lbs/ft ³	49	50

Recommended operating conditions	HCR-W2	HGR-W2
Maximum operating temperature	120°C (250°F)	130°C (265°F)
pH range	0 - 14	0 - 14
Bed depth, min.	450 mm (1.5 ft)	450 mm (1.5 ft)
Flow rates:		
Service/fast rinse	5 - 50 m/h (2 - 20 gpm/ft ²)	5 - 50 m/h (2 - 20 gpm/ft ²)
Service/condensate polishing	40 - 150 m/h (16 - 60 gpm/ft ²)	40 - 150 m/h (16 - 60 gpm/ft ²)
Backwash	See Figure 1	See Figure 1
Regeneration/displacement rinse	1 - 10 m/h (0.4 - 4 gpm/ft ²)	1 - 10 m/h (0.4 - 4 gpm/ft ²)
Total rinse requirement	3 - 6 bed volumes	3 - 6 bed volumes
Regenerant	1 - 10% H ₂ SO ₄ or 4 - 8% HCl	1 - 10% H ₂ SO ₄ , 4 - 8% HCl or 8 - 12% NaCl

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

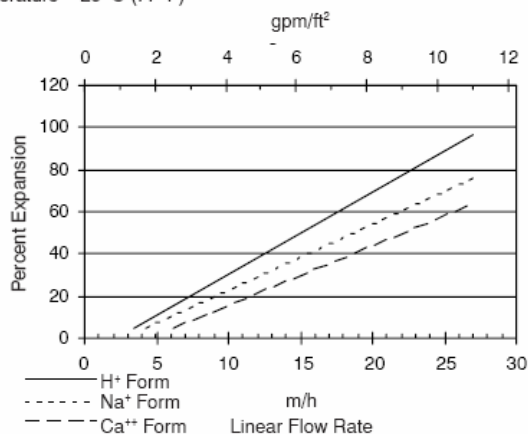
Hydraulic Characteristics

Backwash Expansion

Under the up-flow conditions of backwashing the resin will expand its volume (see Figures 1(a) and 1(b)). Such expansion allows the regrading of the resin, fines removal and avoids channeling during the subsequent service cycle. An efficient backwash will require an expansion of over 50% of the original resin volume. At the same time, accumulated particulates are removed. 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 the particulates. In counter-current operation the strainers are cleaned by the regenerant flow. To retain the advantages of counter-current ration 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 countercurrent regeneration.

Figure 1(a). Backwash expansion data for
DOWEX HCR-W2 resin

Temperature = 25°C (77°F)



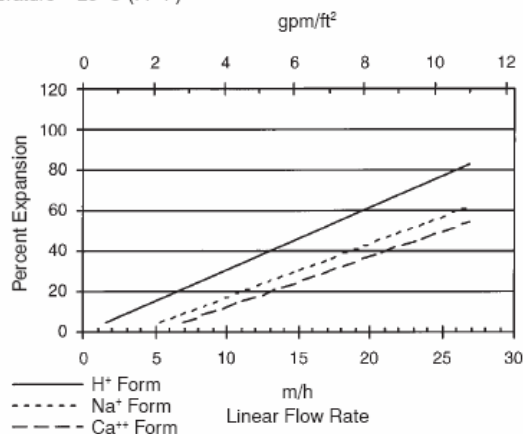
For other temperatures use:

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

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

Figure 1(b). Backwash expansion data for
DOWEX HGR-W2 resin

Temperature = 25°C (77°F)



For other temperatures use:

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

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

Pressure Drop Data

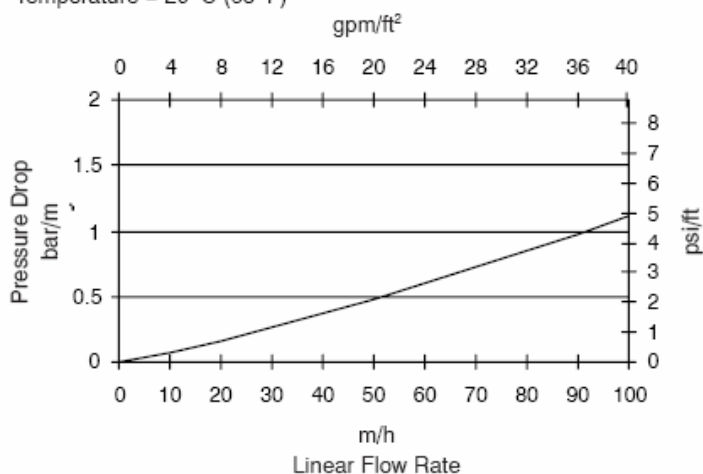
The pressure drop across a resin bed can vary depending on a number of factors. These include resin type, bead size and distribution, interstitial space (bed voidage), flow rate and temperature.

The data in Figure 2 shows the pressure drop per unit bed depth as a function of both flow velocity and water temperature for both DOWEX HCR-W2 and DOWEX HGR-W2 resins. This data refers 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.

DOWEX HCR-W2 and DOWEX HGR-W2 resins exhibit low pressure drop due to their optimized size distribution. This makes them particularly suitable for operation at high flow rates.

Figure 2. Pressure drop data

Temperature = 20°C (68°F)



For other temperatures use:

$$P_T = P_{20^\circ\text{C}} (0.026T_c + 0.48), \text{ where } P \equiv \text{bar/m}$$

$$P_T = P_{68^\circ\text{F}} (0.014T_F + 0.05), \text{ where } P \equiv \text{psi/ft}$$

Operating Characteristics

The suggested operating conditions in the table shown on page 3 are intended as a guide and should not be found restrictive. The engineering design of an ion exchange unit will be influenced by certain factors such as the operational flow rates, so the compatibility of the design with the needs of an efficient regeneration need to be considered and may change the suggested operating conditions given in the table in order to obtain an optimal system.

The performance of the cation exchange resin will be evaluated on the basis of the regeneration efficiency and the sodium leakage. Figure 3 indicates the contribution to conductivity due to sodium leakage. This leakage is expressed as NaOH as it appears in the effluent of a strong base anion resin. When a weak base anion resin follows the cation exchange unit, sodium will leak as NaCl and contribute to the conductivity accordingly. In this case conductivity will also be due in part to CO₂, and this must be taken into account.

Any sodium leakage will not only affect the conductivity of the final effluent, but also influence the silica leakage from a strong base anion resin. Data related to this influence are presented in the relevant engineering brochures of these anion exchange resins. Silica leakage and conductivity are the important features of the final demineralized water. The correct design of the cation exchange unit will therefore have a critical impact on the overall performance of the ion exchange plant.

When H₂SO₄ is used as regenerant, the permitted concentration of H₂SO₄ is determined by the percentage of calcium in the feed water as shown in Figure 4. If the regenerant concentration is too high or the regeneration is performed too slowly, calcium sulfate will be deposited in the resin bed. A step-wise regeneration may be used to improve the regeneration efficiency. As this applies especially to high regeneration levels, it may be more attractive to use counter-current techniques in such cases. Concentrations of sulfuric acid recommended for stepwise regeneration are given in Figure 5. At a constant presentation rate of regenerant, a higher flow rate will thus be used when regenerating at a low acid concentration. At a presentation rate of 3 g H₂SO₄/min per liter of resin (0.2 lbs H₂SO₄/min per ft³) at a concentration of 1% H₂SO₄, this will amount to a regenerant flow rate of 18 m³/h per m³ (2.2 gpm/ft³) of resin.

Figure 3. Na leakage expressed as conductivity at 25°C (77°F) after anion exchange

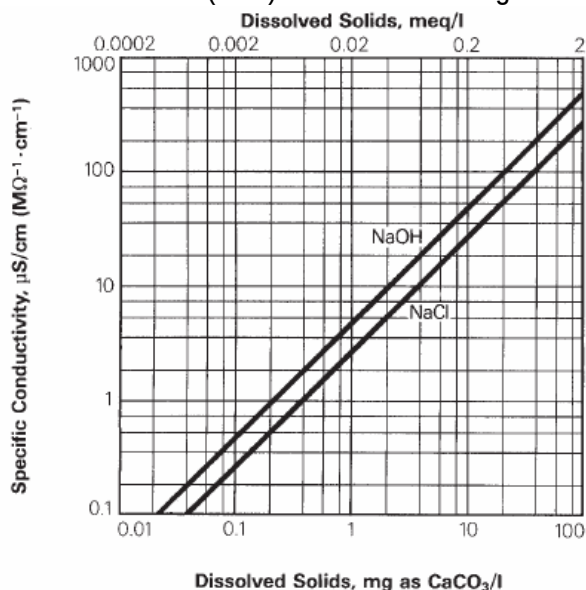


Figure 4. Permitted H₂SO₄ concentration

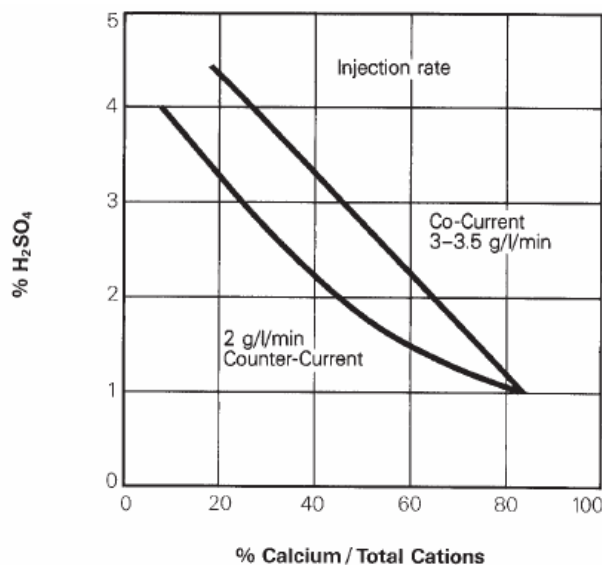


Figure 5. Permitted H₂SO₄ concentrations (step-wise)

Calcium % in feed water	H ₂ SO ₄ % permitted	
Ca % < 15	H ₂ SO ₄	3%
15 < Ca % < 50	H ₂ SO ₄	1.5% for 30% 3% for 70%
50 < Ca % < 70	H ₂ SO ₄	1.5% for 50% 3% for 50%
Ca % > 70	H ₂ SO ₄	1% or use HCl

Hydrochloric acid may be used at concentrations of 4 to 8% irrespective of the calcium content in the feed water. High concentrations of HCl and long regeneration times will be preferred when calcium and magnesium predominate. When sodium is the main constituent, HCl at 4 to 5% will give the best efficiency.

Co-Current Operation

Co-current operation gives a lower quality water with poorer regeneration than counter-current operation. It may nevertheless be preferred, especially when high sodium leakage levels are acceptable. Figures 6 and 7 show the average sodium leakage from DOWEX HCR-W2 and DOWEX HGR-W2 resins relative to different regeneration levels and using HCl or H₂SO₄ as regenerants. These leakages are expressed as percentages of equivalent mineral acidity (EMA). Leakage levels will be higher at the beginning and towards the end of the cycle. When very high regeneration levels are required to obtain the desired leakage, it is advisable to consider counter-current operation.

Figure 6. Average Na leakage from DOWEX HCR-W2 and DOWEX HGR-W2 resins in co-current operation with HCl as regenerant

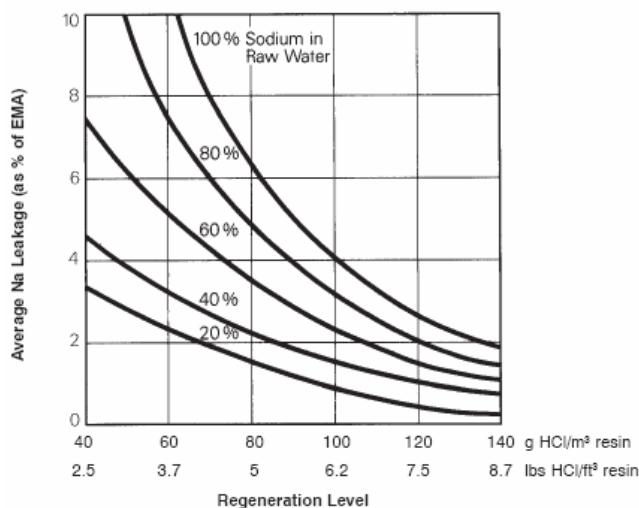
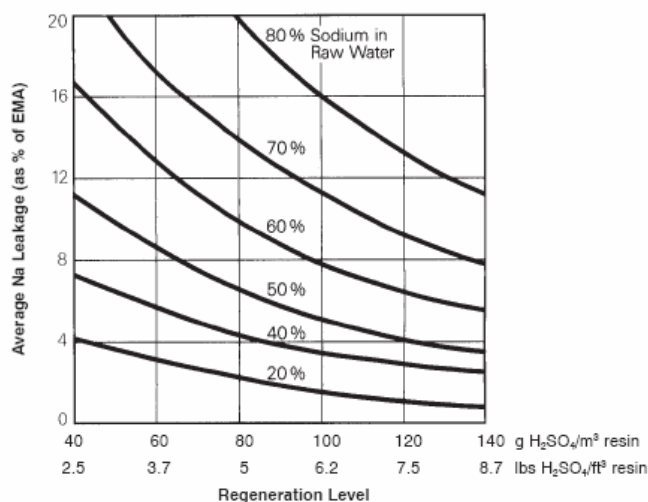


Figure 7. Average Na leakage from DOWEX HCR-W2 and DOWEX HGR-W2 resins in co-current operation with H₂SO₄ as regenerant



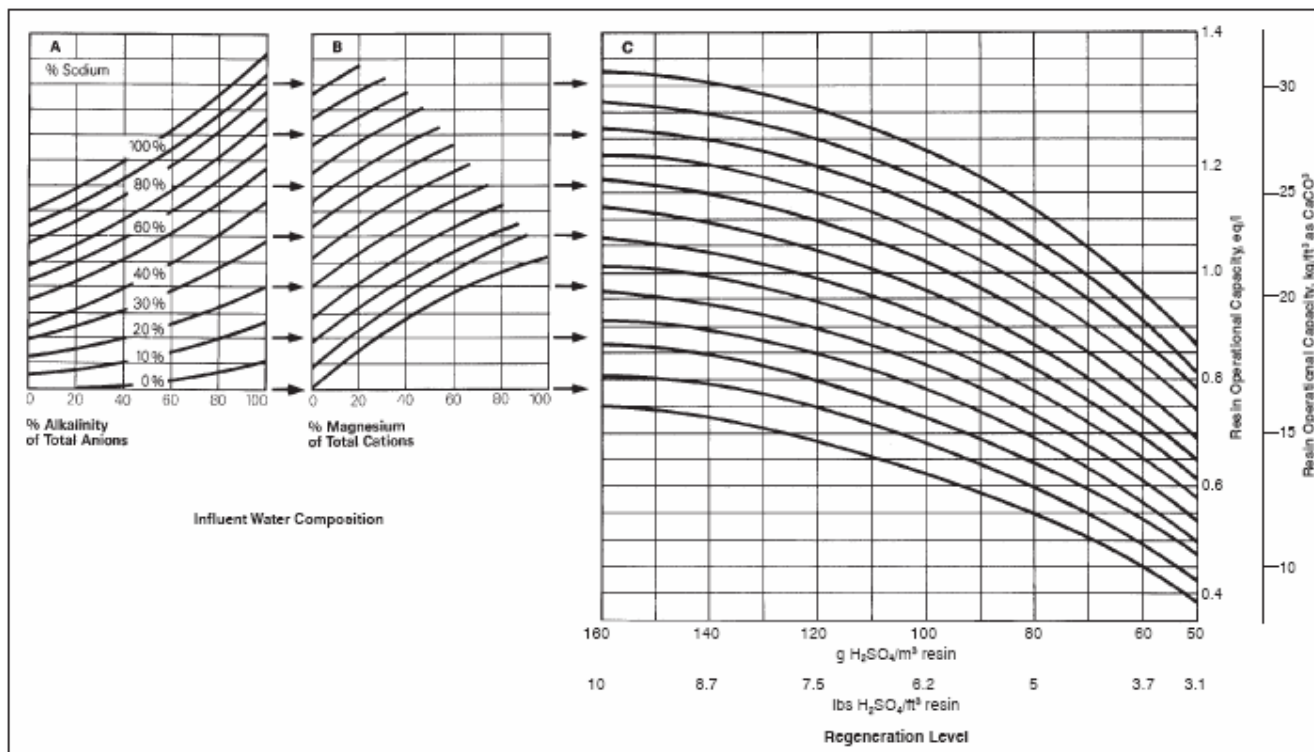
Data on co-flow operational capacities for DOWEX HCR-W2 and DOWEX HGR-W2 resins using HCl or H₂SO₄ for different water qualities are given in Figures 8 and 9.

Co-current operational capacity data (Step-wise concentration in H₂SO₄ regeneration)

Instructions:

1. Locate a point on the ordinate of graph A from % sodium and % alkalinity.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guideline to locate a new point on the ordinate according to the % magnesium.
3. Transfer the ordinate point from graph B horizontally to graph C and repeat the procedure under point 2 according to chosen regeneration level. Read off the operational capacity on the right hand side of the diagram corresponding to this new ordinate.

Figure 8. Co-current operational capacity data

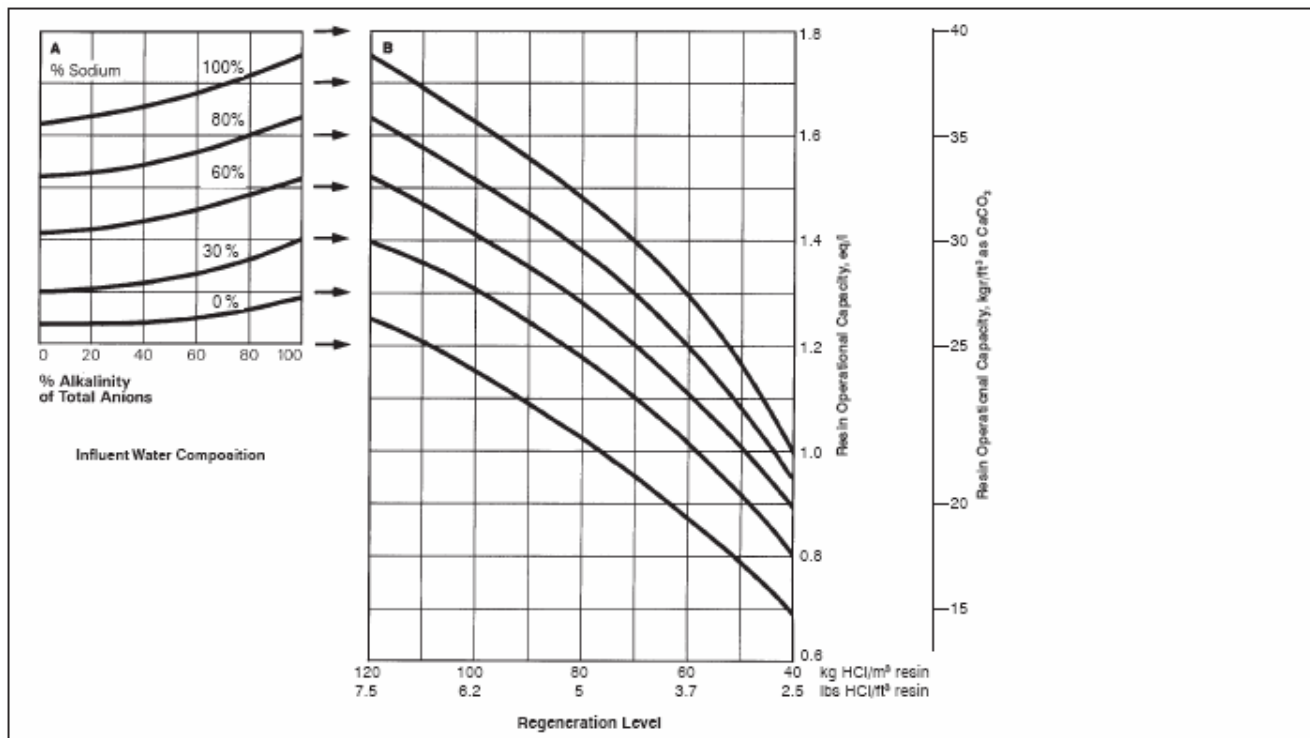


Co-current operational capacity data (HCl regeneration)

Instructions:

1. Locate a point on the ordinate of graph A from % sodium and % alkalinity.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guideline to the chosen regeneration level thus establishing a new ordinate.
3. Read off operational capacity on the right hand side of the diagram corresponding to this new ordinate.

Figure 9. Co-current operational capacity data (HCl regeneration)



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 regenerant waste) and lower sodium leakage. Initial capital costs can be higher for a counter-current operation and more care has to be taken in the design of a unit as it has to be able to give the highest quality of treated water. Also, treated (or at least decationized) water must be used for diluting the regeneration chemicals and for the displacement rinse. The design must ensure that the chemicals contact the resin at the correct concentration by avoiding any excessive dilution. In conventional counter-current regeneration, a presentation rate of 2 gram regenerant per minute and per liter resin (0.1 lbs/min per ft³) has shown the best results for optimum regeneration efficiency. This results in a regenerant flow rate 3 m³/h per m³ (0.4 gpm/ft³) of resin when a 4% regenerant concentration is used.

Average sodium leakage levels can be calculated from data presented in Figures 10 and 11. The desired leakage level is divided by the alkalinity correction factor, which takes into account the alkalinity percentage of the influent. This corrected leakage value together with the percentage Na in the influent is now used to establish the required regeneration level. Conversely, the sodium leakage for a given regeneration level can be established by reading off a value taking into account again the percentage Na in the influent and by multiplying this value with the alkalinity correction factor.

Data on operational capacities for DOWEX HCR-W2 and DOWEX HGR-W2 resins using HCl or H₂SO₄ are given in Figures 10 and 11.

Figure 10. Average Na leakage for DOWEX HCR-W2 and DOWEX HGR-W2 resins in counter-current operation and H₂SO₄ as regenerant (step-wise concentrations)

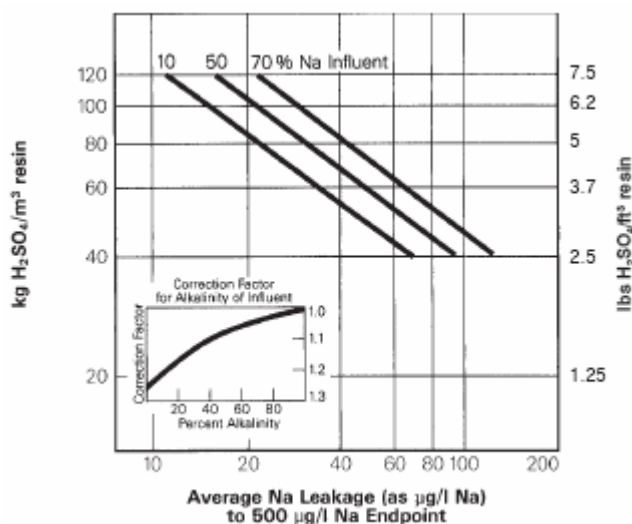
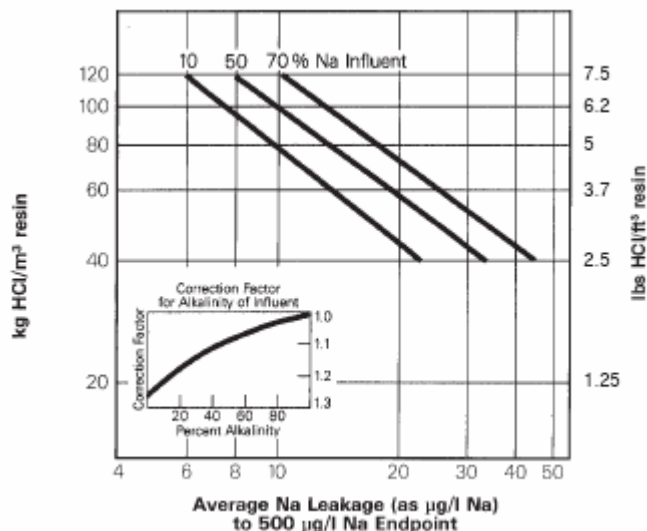


Figure 11. Average Na leakage for DOWEX HCR-W2 and DOWEX HGR-W2 resins in counter-current operation and HCl as regenerant



Counter-current operational capacity data (H₂SO₄ regeneration)

Instructions:

1. Locate a point on the ordinate of graph A from % sodium and % alkalinity.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guideline to the chosen regeneration level thus establishing a new ordinate.
3. Read off operational capacity on the right hand side of the diagram corresponding to this new ordinate.

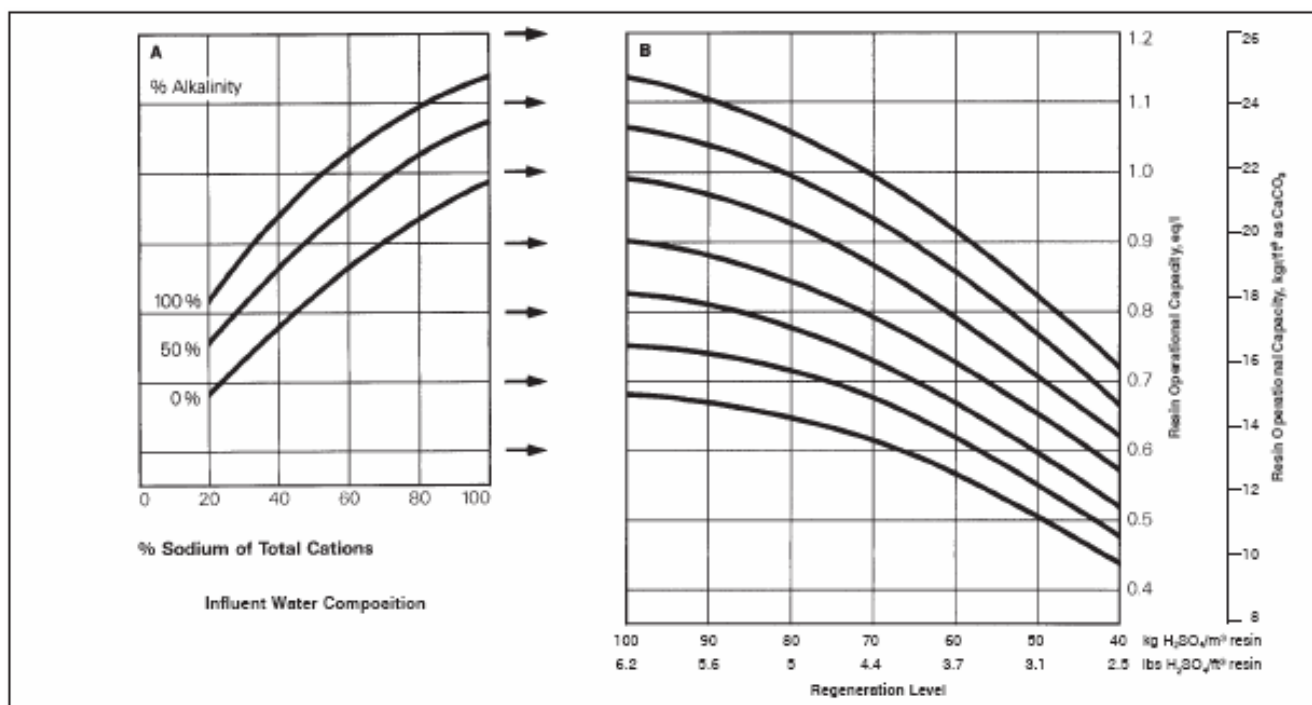
Important:

See correction graph for resin bed depth of less than 2 meters (6.5 ft).

Standard conditions:

- $\text{BV/H} \times \text{salinity (meq/l)} = 200$
- $\text{gpm/ft}^3 \times \text{salinity (kgr/ft}^3) = 0.55$
- Temp. 15°C (60°F)

Figure 12. Counter-current operational capacity data (H₂SO₄ regeneration)



Counter-current operational capacity data (HCl regeneration)

Instructions:

1. Locate a point on the ordinate of graph A from % sodium and % alkalinity.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guideline to the chosen regeneration level thus establishing a new ordinate.
3. Read off operational capacity on the right hand side of the diagram corresponding to this new ordinate.

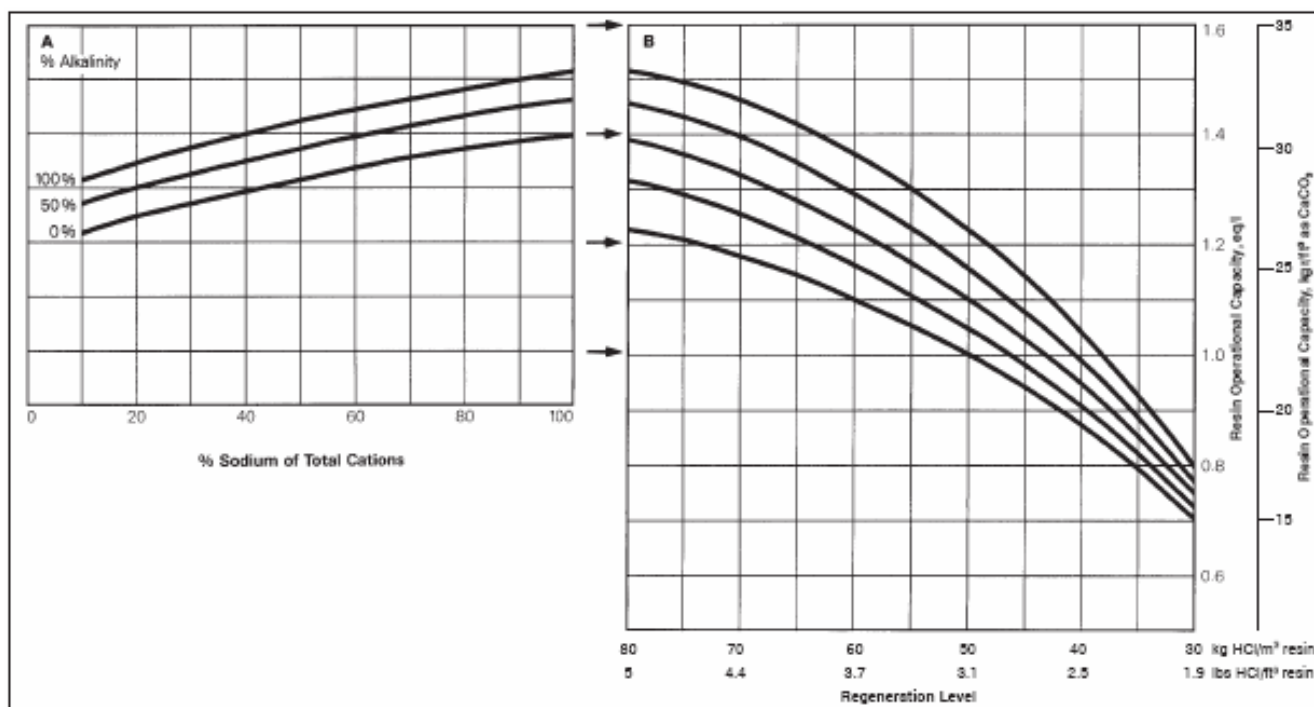
Important:

If alkalinity is less than 30%, use 1.5 m (5 ft) bed depth or not less than 50 g/l (3 lbs/ft³ HCl).

Standard conditions:

- $BV/H \times \text{salinity (meq/l)} = 200$
- $\text{gpm/ft}^3 \times \text{salinity (kgr/ft}^3) = 0.55$
- Temp. 15°C (60°F)

Figure 13. Counter-current operational capacity data (HCl regeneration)



The Bed Depth Effect

The geometry of an ion exchange plant affects the plant capacity and the quality of the produced water. A bed depth of about 1 m (3.3 ft) is ideal for co-current operation but little difference exists going from 0.75 m to 2 m bed depth (30" to 6.5 ft). A flow velocity of 20-30 m/h (8-12 gpm/ft²) may give slightly better performance than operating at 50-60 m/h (20-24 gpm/ft²). On the other hand, there is great advantage to gain from using a deep bed in counter-current operation with H₂SO₄ as regenerant. The high physical strength of DOWEX HCR-W2 and DOWEX HGR-W2 resins allow them to be used in deep beds, thereby obtaining better capacity usage and water quality.

The bed depth effect is given in Figure 14.

Effect of bed depth on capacity (counter-current)

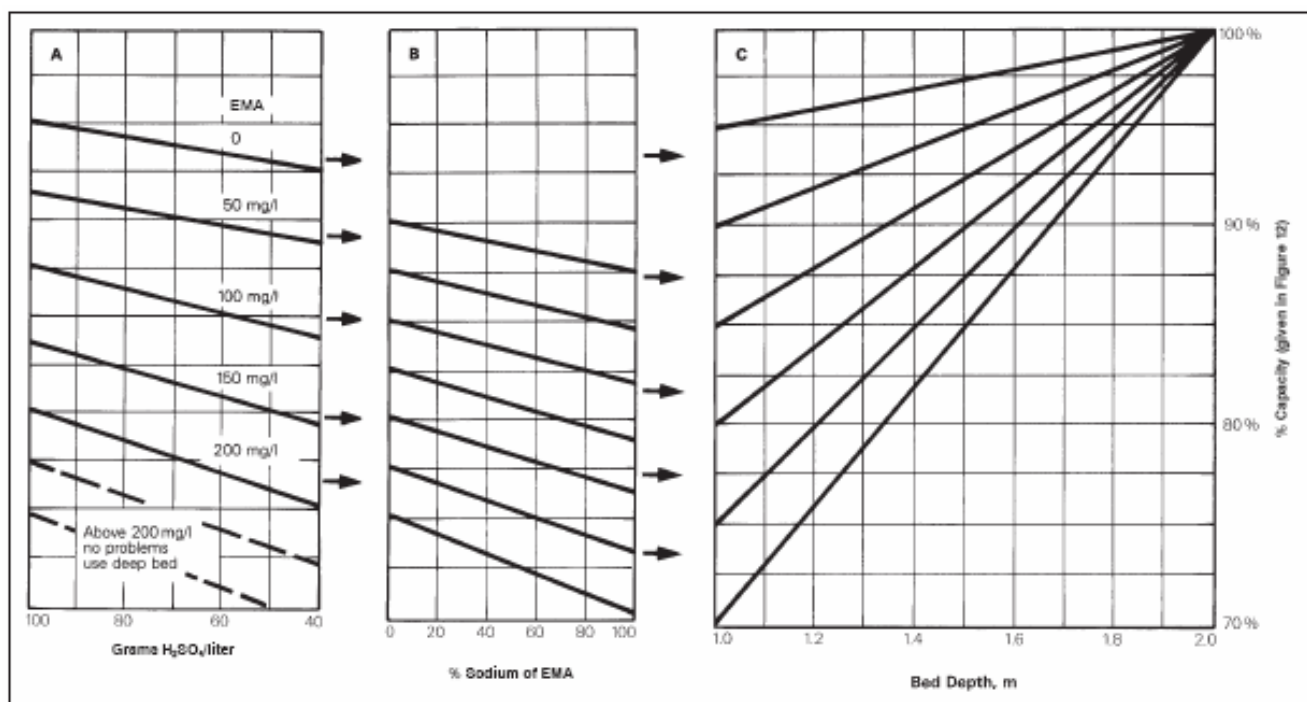
Instructions:

1. Locate a point on the ordinate of graph A from amount of EMA and chosen regeneration level.
2. Transfer the ordinate point from graph A horizontally to graph B and follow the guideline to locate a new point according to the % sodium of EMA.
3. Transfer the ordinate point from graph B horizontally to graph C and repeat the procedure under point 2 according to the desired bed depth and read off the reduction in capacity.

Important:

The minimum bed depth when using 60 g/l (2.7 lbs/ft³) H₂SO₄ is 1.5 m (5 ft).

Figure 14. Effect of bed depth on capacity



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LENNTECH

info@lennotech.com Tel. +31-152-610-900
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Notice: 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
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 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. Its 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 kgr/ft ³ as CaCO ₃	1.3 28.4	1.0 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 lbs/ft ³	670 42	640 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

Figure 1. Backwash expansion vs. flow rate

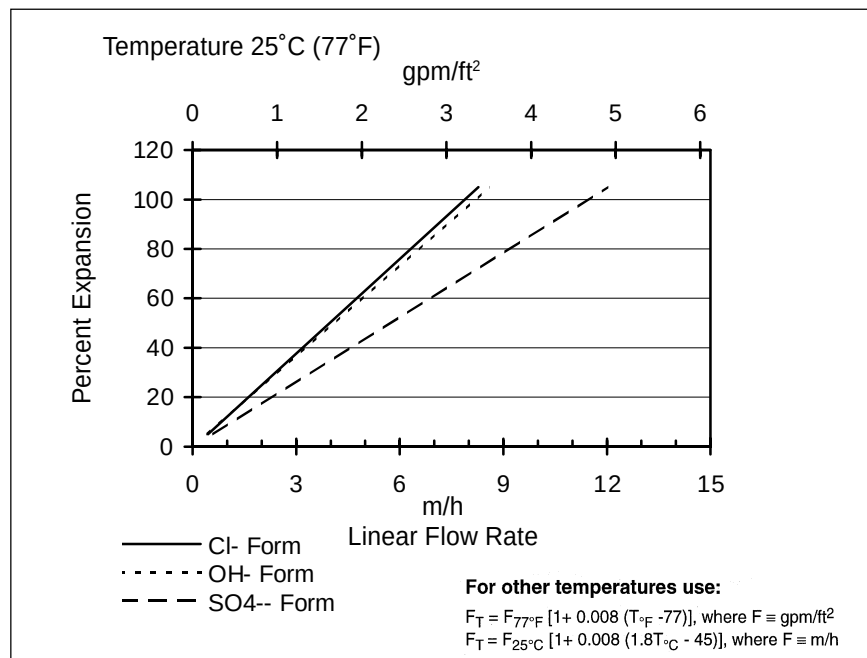
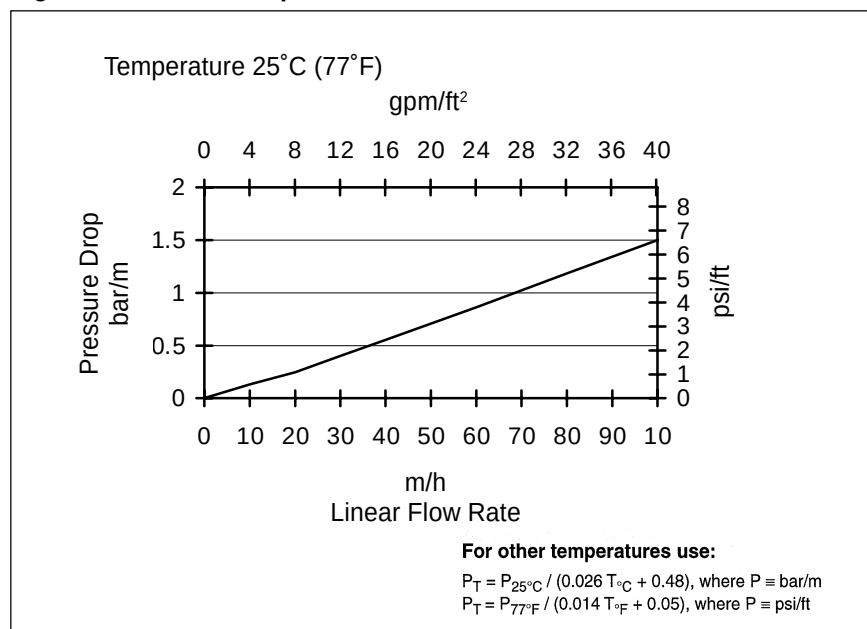


Figure 2. Pressure drop



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.

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 m³/h per m³ of installed resin (0.4 gpm/ft³).

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.

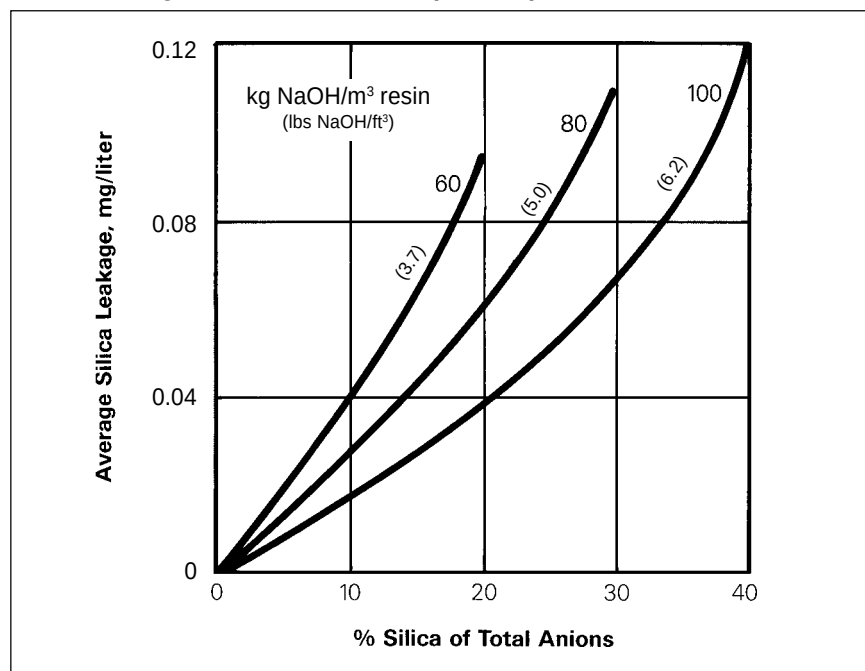
Co-Current Operation

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.

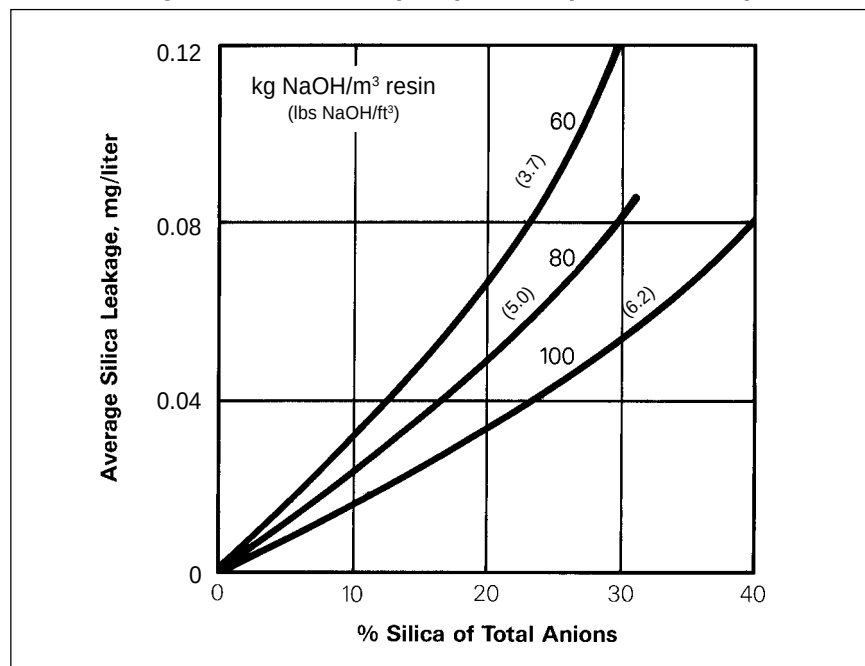
With ideal design, silica figures around 0.005 mg/l can be obtained for a large percentage of the operating cycle, provided that CO₂ plus the silica do not exceed 30% of the total anions. This will mostly be the case when no weak base anion resin precedes the strong base anion exchanger, and certainly when degassed feedwater is processed. Irrespective of the CO₂ 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

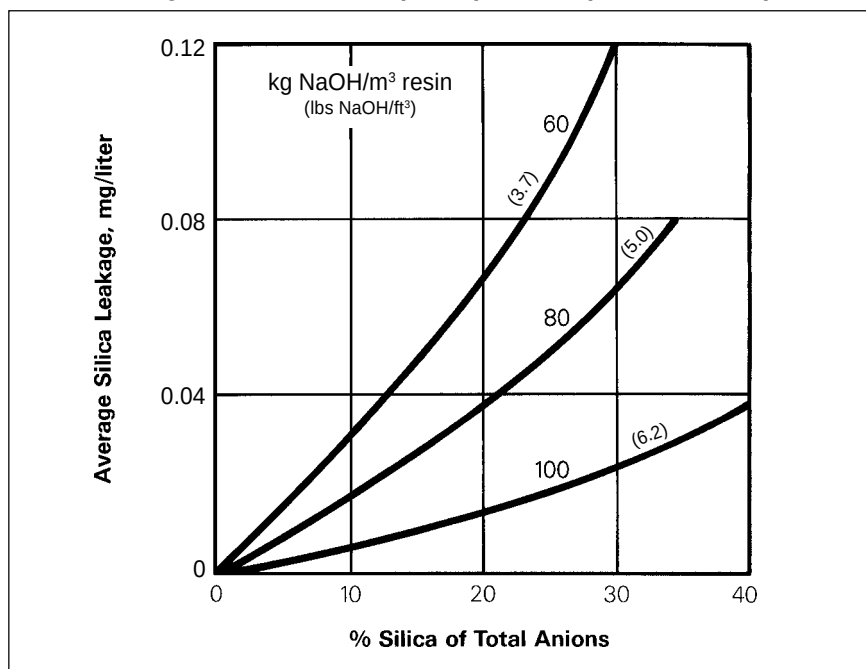


Figure 6. Leakage correction factor for sodium co-current operation

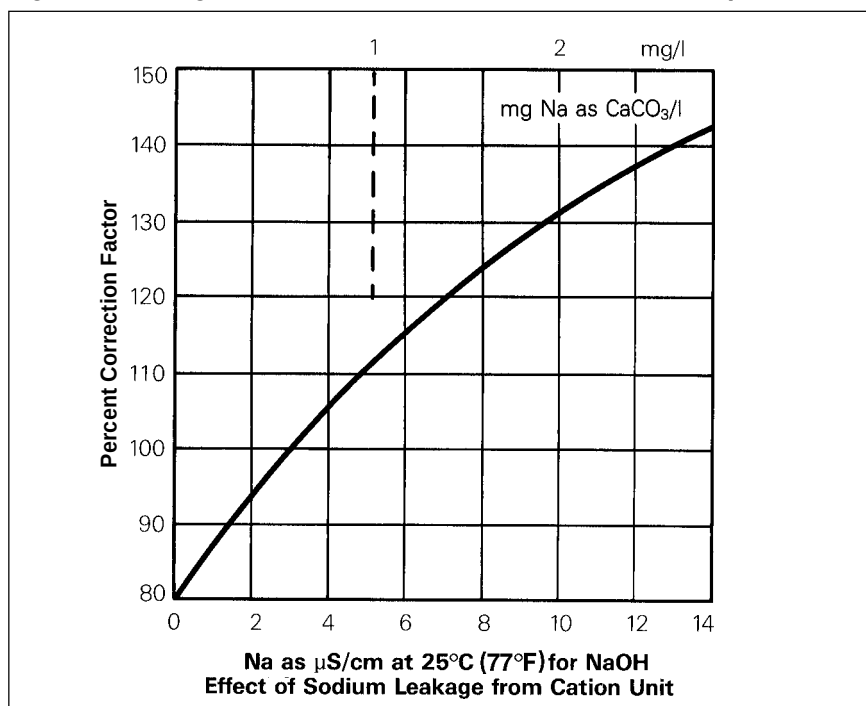
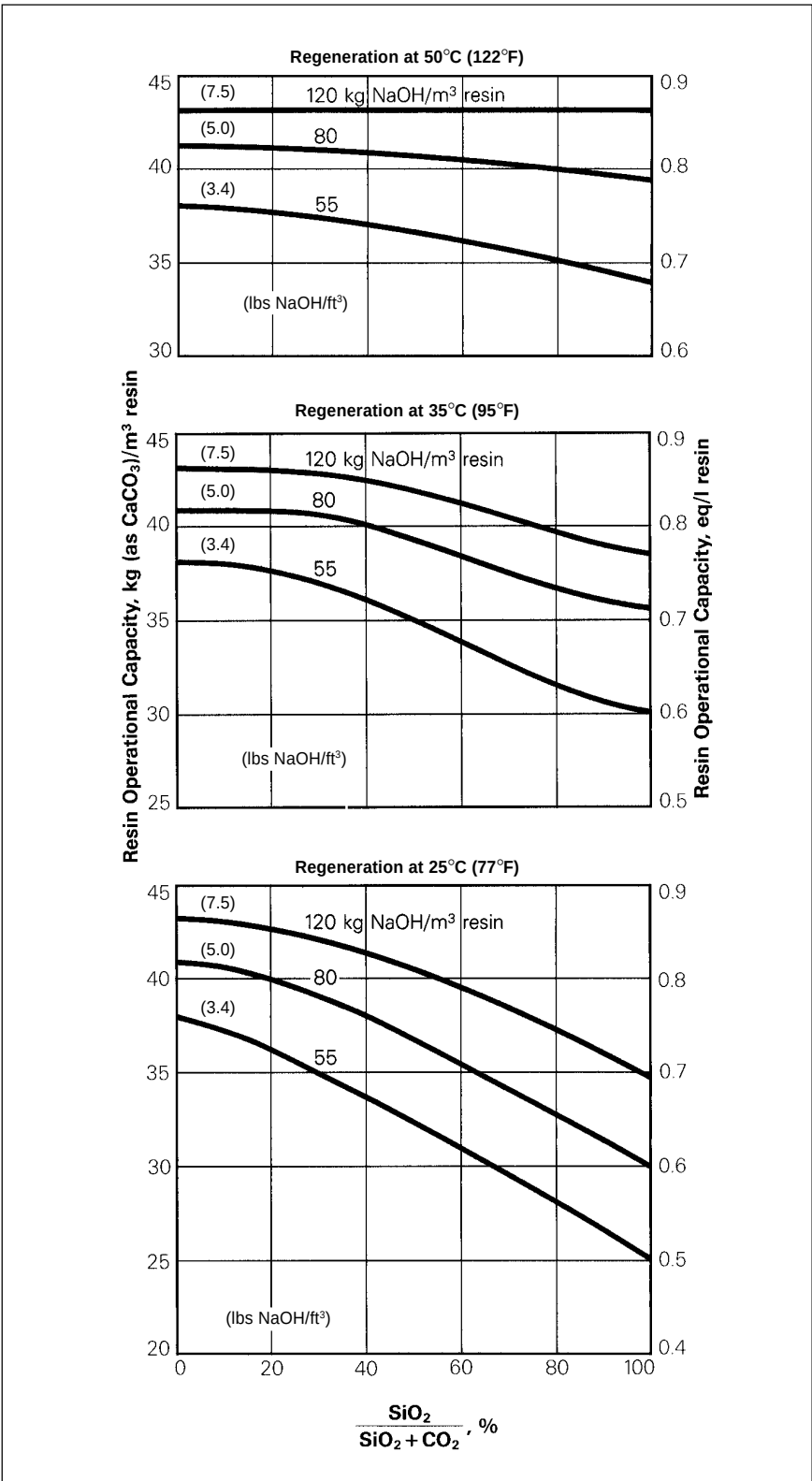


Figure 7. Co-current operational capacity data for CO₂ and SiO₂



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: $\text{eq/l} \times 21.85 = \text{kg}/\text{ft}^3$ as CaCO_3 .

Counter-Current Operation

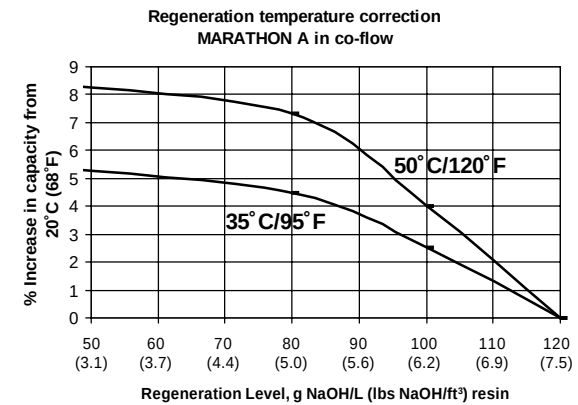
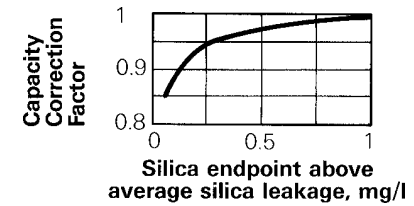
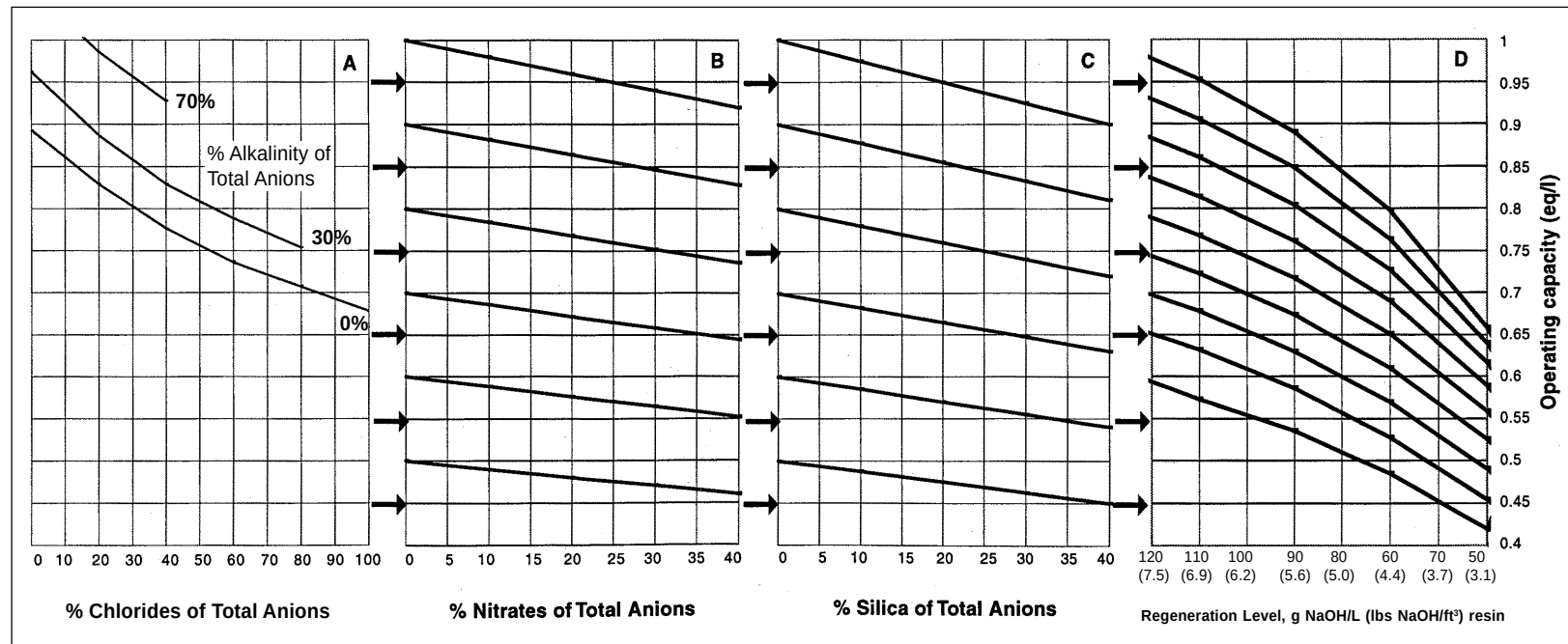


Figure 8. Co-current operational capacity data



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

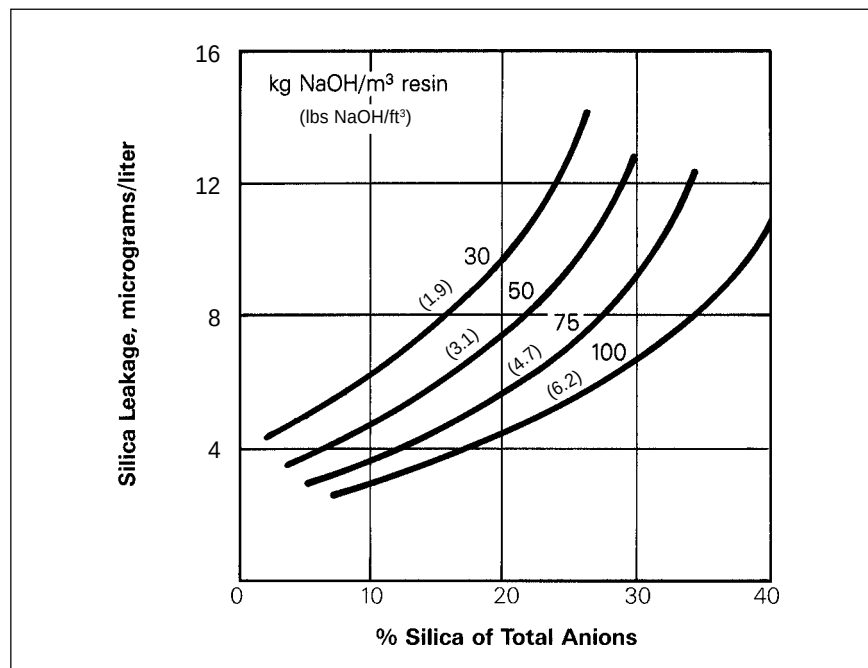
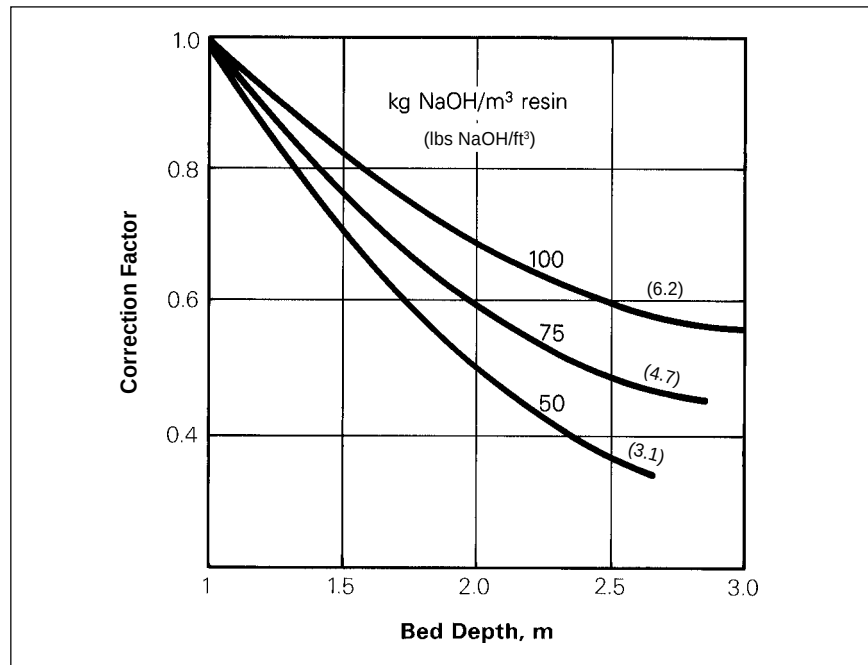


Figure 10. Correction factor for bed depth for counter-current operation

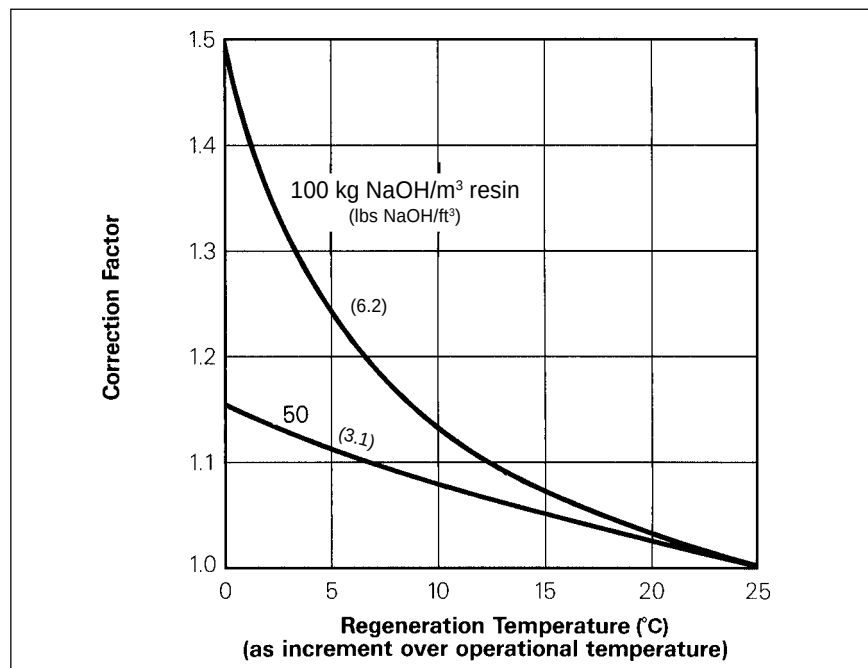


operated in counter-current is often chosen to obtain a very low silica leakage, the following steps are recommended:

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 pre-treatment, 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: $\text{eq/l} \times 21.8 = \text{kg}/\text{ft}^3 \text{ as } \text{CaCO}_3$.

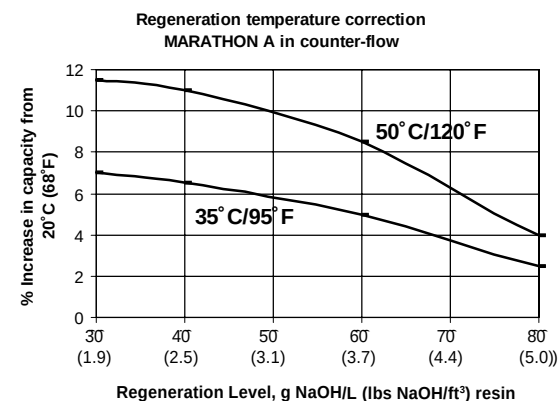
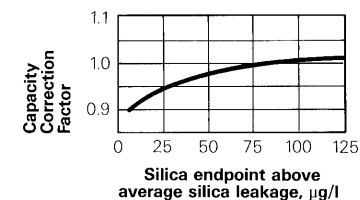
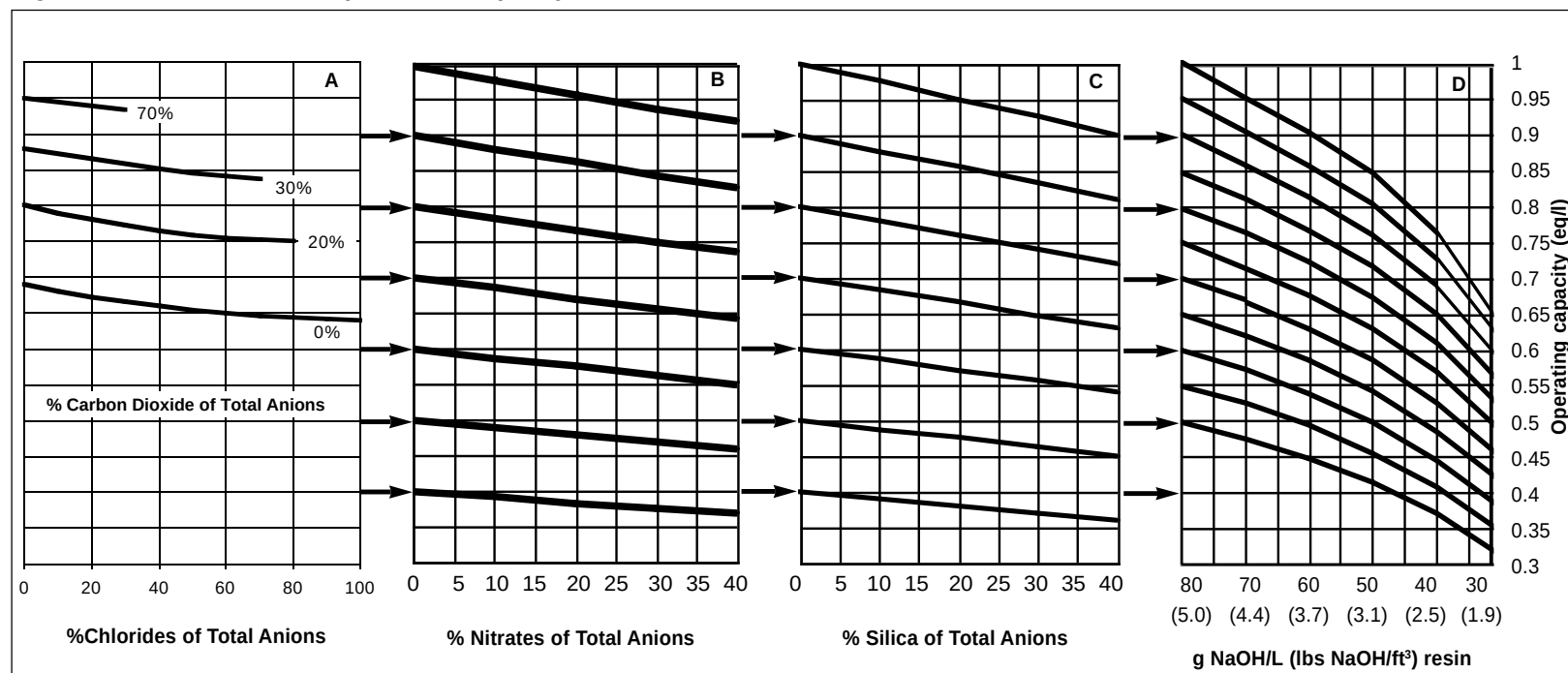


Figure 12. Counter-current operational capacity data



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

LENNTECH

info@lennotech.com Tel. +31-152-610-900

www.lennotech.com Fax. +31-152-616-289

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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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Liquid Separations

DOWEX™ MARATHON™ 11
Ion Exchange Resin

Engineering Information

March 2006

DOWEX™ MARATHON™ 11 Type I Strong Base Anion Exchange Resin

General Information

DOWEX™ MARATHON™ 11 resin is a high capacity, high porosity, strong base type I anion exchange resin of uniform bead size distribution. Based on a styrene-divinylbenzene copolymer matrix, this gel type resin has proven to be an excellent choice for use in the anion exchange unit of multi-bed demineralizer trains, in mixed beds, or as an organic trap. It is especially recommended for treating waters that contain naturally occurring organic matter. Its unique porosity and high thermal stability provide for more complete removal of organics over long periods of service, resulting in consistently high quality water.

In addition to its organic removal properties, the uniform particle size offers a number of advantages compared to conventional (polydispersed) resins. The absence of large diameter beads and the high surface area to volume ratio enable rapid exchange kinetics during operation. This results in more complete regeneration of the resin, increased capacity and faster, more thorough rinse following regeneration.

Installed in front of the cation exchange unit, chloride form DOWEX MARATHON 11 resin acts as an organic screen, removing organic molecules that would foul the working strong base anion resin. This results in dramatic increases in demineralization efficiency.

The excellent thermal stability of DOWEX MARATHON 11 resin (up to 100°C (212°F) in the Cl⁻ form), is superior to acrylic type resins which start to degrade at temperatures above 35°C (95°F), giving rise to capacity loss and long rinses. DOWEX MARATHON 11 resin is therefore better able to withstand high temperature brine cleaning and the use of heated caustic, resulting in better, long term performance for operating capacity and silica leakage.

This brochure gives operational data on the use of DOWEX MARATHON 11 resin in water demineralization using NaOH regenerant in both co-current or counter-current operation. It also covers the use of DOWEX™ MARATHON™ 11 resin as an organic trap using NaCl as the regenerant. 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
Total exchange capacity, min.	eq/L	1.3
	kg/ft ³ as CaCO ₃	28.4
Water content	%	48 - 58
Uniformity coefficient, max.		1.1

Typical Physical and Chemical Properties		Cl ⁻ form
Mean particle size†	µm	550 ± 50
Whole uncracked beads	%	95 - 100
Total swelling (Cl ⁻ → OH ⁻)	%	20
Particle density	g/mL	1.08
Shipping weight	g/L	670
	lbs/ft ³	42

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

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)
Counter-current regeneration/displacement rinse	5 - 20 m/h (2 - 8 gpm/ft ²)
Total rinse requirement	2 - 5 Bed volumes
Regenerant:	
Type	2 - 5% NaOH
Type (organic screen)	10% NaCl / 1% NaOH mixture
Temperature	Ambient or up to 50°C (122°F) for silica removal
Temperature (organic screen)	Ambient or up to 50°C (122°F)

Hydraulic Characteristics

Backwash Expansion

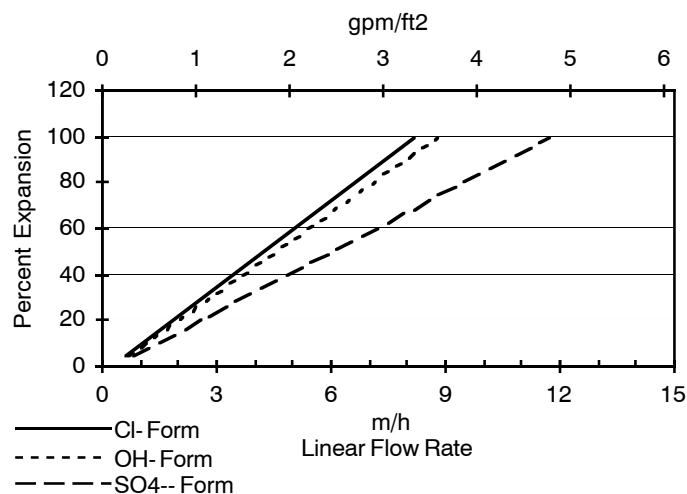
In co-current operation a backwash expansion precedes every regeneration. This expansion allows regarding of the resin, fines removal and avoids channeling during the subsequent service cycle. An expansion of 60-80% for 20 minutes is normally recommended to remove particulate matter from the resin bed. 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 back-wash is performed every 15 to 30 cycles in conventional counter-current regeneration.

Under the upflow conditions of backwashing, the resin will expand its volume according to Figure 1. The data in Figure 1 shows the expansion behavior as a function of both flow rate and backwash water temperature.

The smaller, uniform size of DOWEX™ MARATHON™ 11 resin requires less flow to expand to the same height as a conventional polydispersed resin.

Figure 1. Backwash expansion

Temperature = 25° C (77° F)

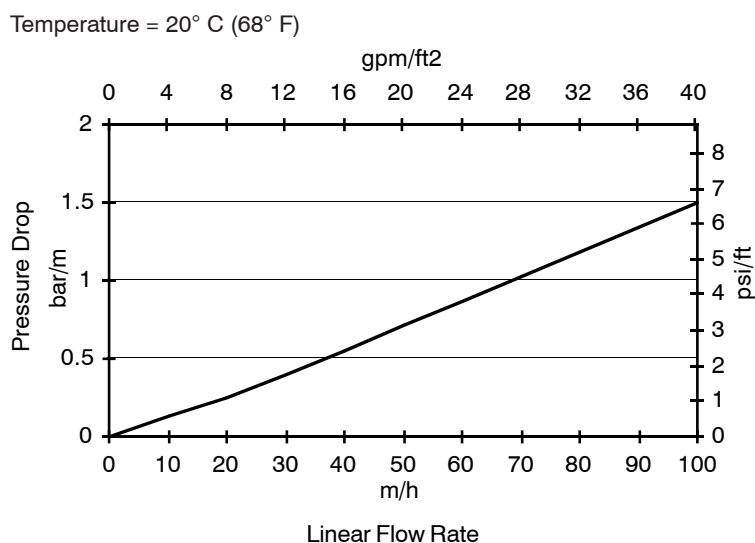


Pressure Drop Data

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, polydispersed size resins results in some filling of the interstitial spaces between the larger beads, thereby increasing the head loss across the resin bed. In contrast, uniform size beads have a higher, more uniform 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. 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 and the contribution of the internal laterals and resin strainers.

Figure 2. Pressure drop



Operating Characteristics

DOWEX™ MARATHON™ 11 resin regenerates more efficiently, resulting in added capacity compared to conventional, polydispersed resins under the same conditions. This should result in lower operating costs, reduced waste disposal and better water quality.

The recommended operating conditions in the table shown on page 3 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 (0.1 lbs/ft³) per minute. This appears to give the best performance using 4% NaOH, resulting in a regeneration flow rate of 3 m³/h per m³ of installed resin (0.4 gpm/ft³).

The use of hot regenerant (up to 50°C (122°F)) gives an increased operational capacity and is especially useful for waters with high organic and silica loading. Note that the highest efficiency is obtained by preheating the resin bed during the last bed volume of the preceding backwash, or with dilution water used for regeneration.

The engineering design, especially of the distribution and collection lateral 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 performance. 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 operational efficiency and effluent silica leakage. Most importantly, the resin must provide consistent long term performance 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™ 11 resin, with its unique porosity, uniform bead size and chemical structure 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 dependent on the leakage of sodium through the cation exchanger, 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. Lower sodium leakage levels are obtained using a counter-current regenerated cation exchange unit.

Silica leakages around 0.05 mg/L can be obtained for a large percentage of the operating cycle, provided that CO₂ plus the silica do not exceed 30% of the total anions. This generally occurs when no weak base anion resin precedes the strong base anion exchanger, or when a degasifier is used to process the cation effluent ahead of the anion exchanger.

Irrespective of the CO₂ concentration, the figures given in graphs 3 to 6 should be easily achieved. If silica exceeds 40% of the total anions, it is generally advised not to exhaust the strong base anion resin exclusively with silica.

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

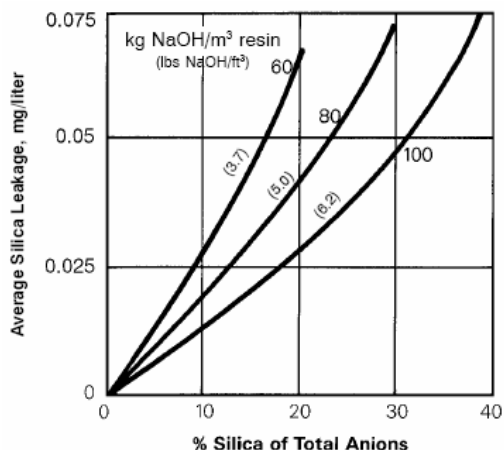


Figure 4. Silica leakage in co-current operation
Regeneration at 35°C (95°F)

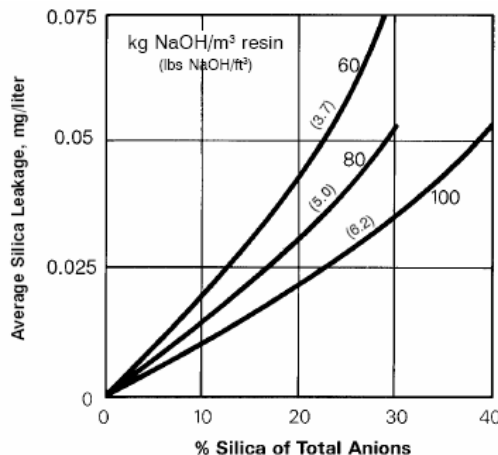


Figure 5. Silica leakage in co-current operation
Regeneration at 50°C (120°F) above
operational temperature

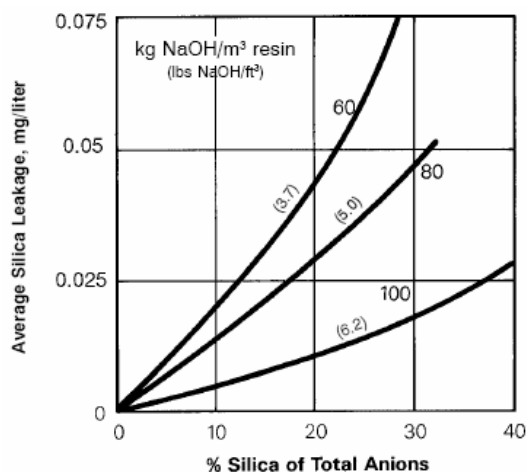
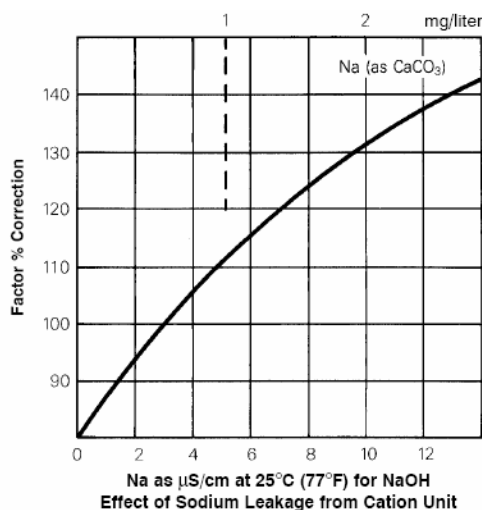


Figure 6. Leakage correction factor for sodium
co-current operation



If an anion exchange resin is heavily loaded with silica, warm NaOH is necessary to effectively remove it. The maximum permitted temperature is 60°C (140°F), but 50°C (122°F) is more commonly used. In cases where 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 the treated water quality, particularly if a plant is shut down in high ambient temperature. The resultant silica may increase to double the normal level until the water returns to normal temperature.

Data on typical co-current operational capacities for DOWEX™ MARATHON™ 11 resin are presented in Figure 7.

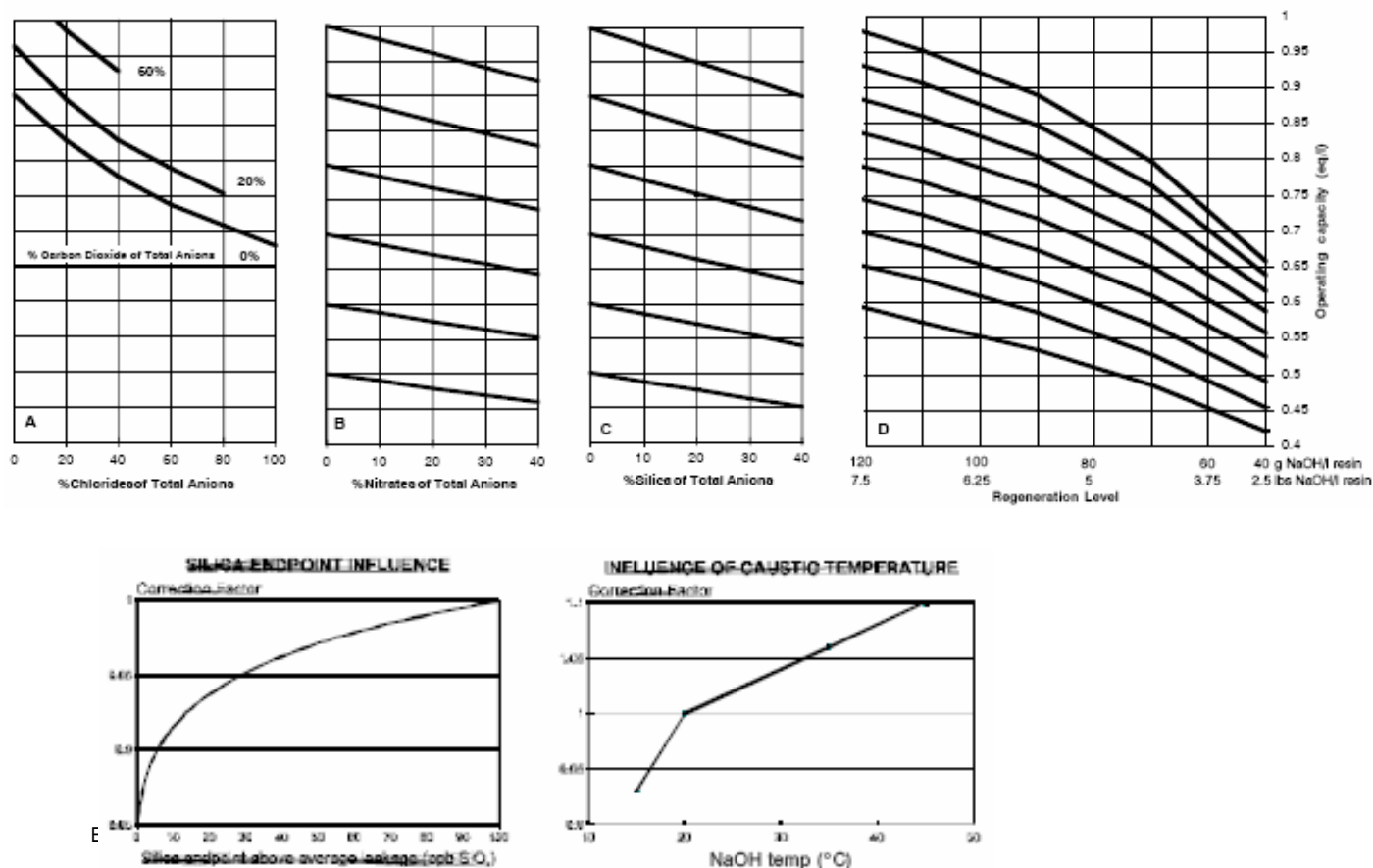
Co-current operational capacity data

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. Read off on the right hand side of the diagram the operational capacity corresponding to the ordinate point located on graph D.
6. For regeneration at different temperatures, modify the abscissa point on graph D according to the guidelines given at the top of graph E.

Note: eq/L x 21.8 = kg/ft³ as CaCO₃

Figure 7. Co-current operational capacity data



Counter-current Operation

The advantages of counter-current operation over co-current operation are improved chemical efficiency (better capacity usage 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 ppb for about 90% of the operational cycle. Data on silica leakage levels are presented in Figure 8 and the counter-flow bed depth correction factor is given in Figure 9.

Figure 8. Silica leakage in counter-current operation
Regeneration at 50°C (120°F) above
operational temperature

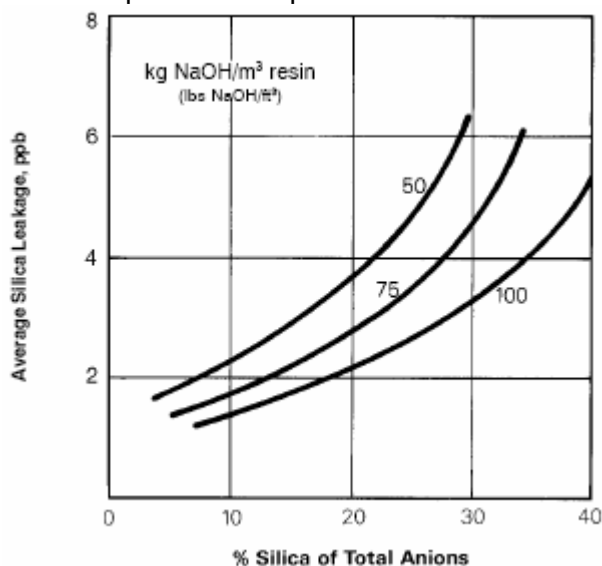
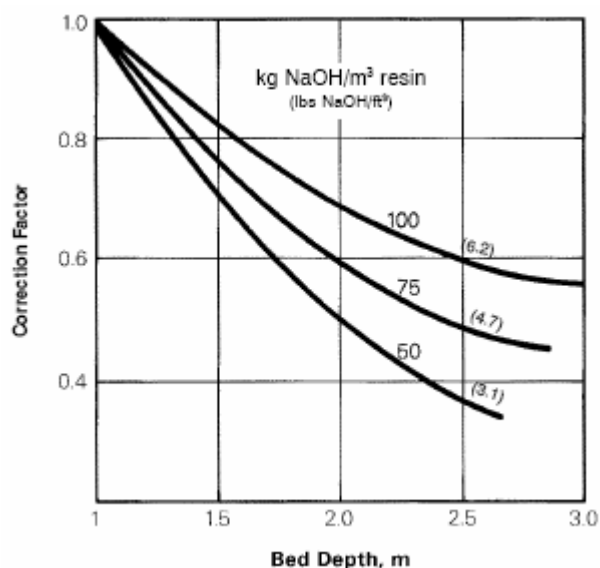


Figure 9. Correction factor for bed depth effect
in counter-current operation



Demineralized water is needed to dilute the regeneration chemicals and for the displacement rinse which has the same flow direction of the regeneration. The final rinse uses decationized water from the cation exchange unit in the flow direction of the service cycle.

The following steps are recommended to obtain low silica leakage with a type I strong base anion resin in counter-current operation:

1. Define bed depth and regeneration level from Figures 8 and 9 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 channeling.
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 SiO₂ per liter of resin.

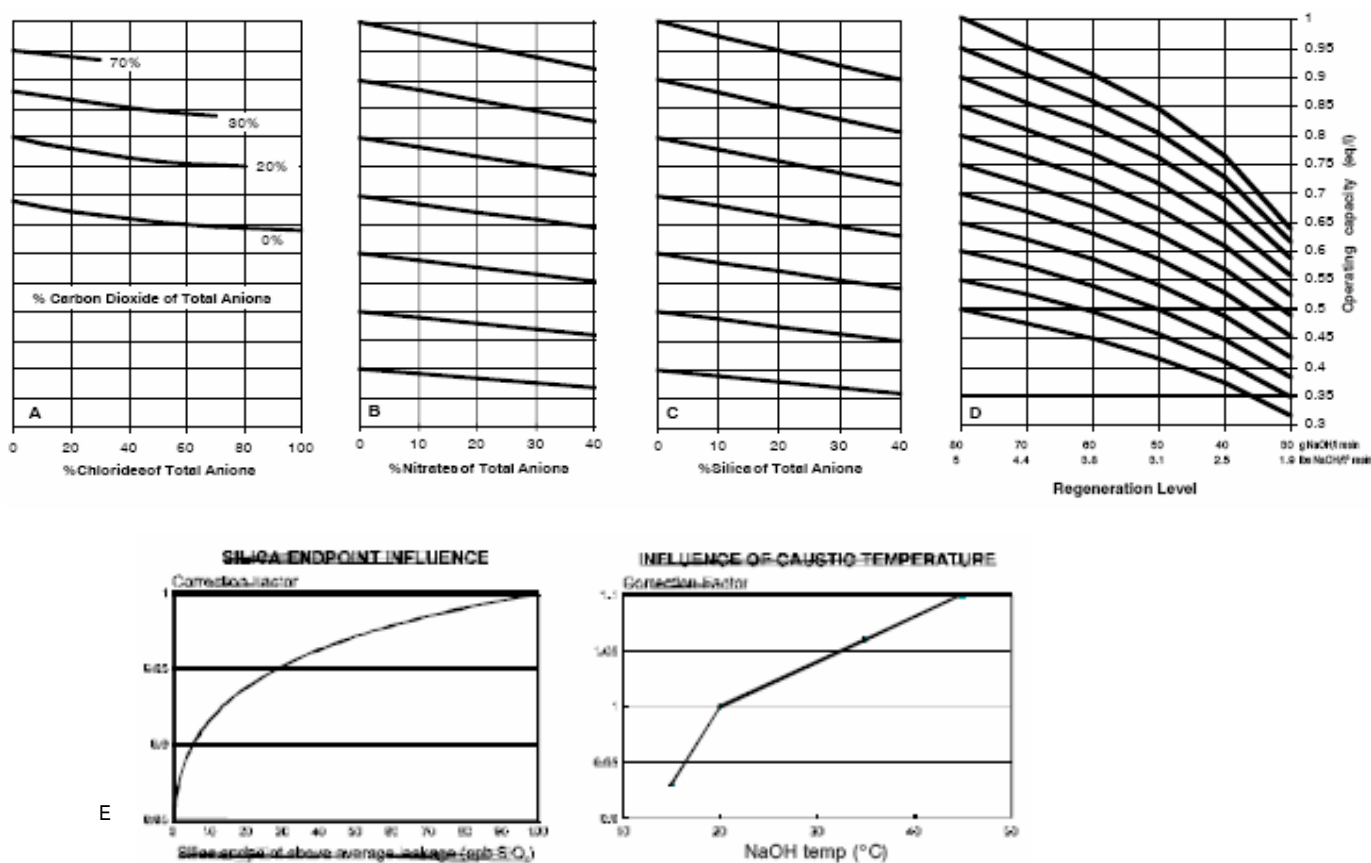
Data on counter-current operational capacities for DOWEX™ MARATHON™ 11 resin are presented in Figure 10.

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. Read off on the right hand side of the diagram the operational capacity corresponding to the ordinate point located on graph D.
6. Now for regeneration at different temperatures modify the abscissa point on graph D according to the guidelines given at the top of graph E.

Figure 10. Counter-current operational capacity data



DOWEX™ MARATHON™ 11 resin as an organic screen

When used as an organic screen ahead of a demineralization train, DOWEX MARATHON 11 is operated in the chloride form using alkaline brine as the regenerant (10% NaCl + 1% NaOH). It is common to run the organic screen as a co-flow unit. The recommended operating conditions are given in the table shown on page 3.

A regenerant dosage of 150 g NaCl with 15 g NaOH per liter resin (10 lbs/ft³ NaCl, 1 lb/ft³ NaOH) is recommended. The unit should be designed such that the maximum organic loading on the resin is 7 g/L organics (end-of cycle) expressed as KMnO₄ consumption. The capacity and leakage will depend on the nature and composition of the organics in the influent feedwater.

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 China

Dow Chemical (China) Investment Company Ltd.
Liquid Separations
23/F, One Corporate Avenue
No. 222, Hu Bin Road
Shanghai 200021
China
Tel. +86 21 2301 9000
Fax +86 21 5383 5505

Dow Pacific

Customer Information Group – Liquid Separations
All countries except Indonesia and Vietnam:
Toll free phone: +800 7776 7776
Toll free fax: +800 7779 7779

All countries:
Tel. +60 3 7958 3392
Fax +60 3 7958 5598
E-mail: dowcig@dow.com

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

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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. $\text{SiO}_2 + \text{CO}_2$ 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 ($\text{SiO}_2 + \text{CO}_2$) 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	1.2
	kgr/ft ³ as CaCO ₃	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 ⁻ → OH ⁻)	%	20
Particle density	g/ml	1.09
Shipping weight	g/l	690
	lbs/ft ³	43

Recommended Operating Conditions	
Maximum operating temperature:	
OH ⁻ form	35°C (95°F)
Cl ⁻ form	70°C (160°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 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. Its 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 channeling 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

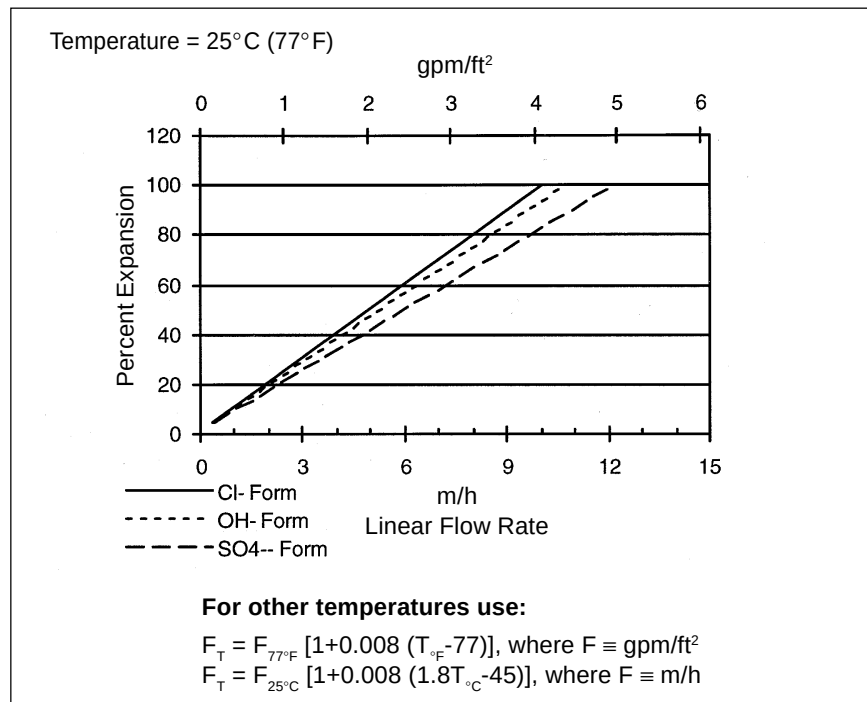
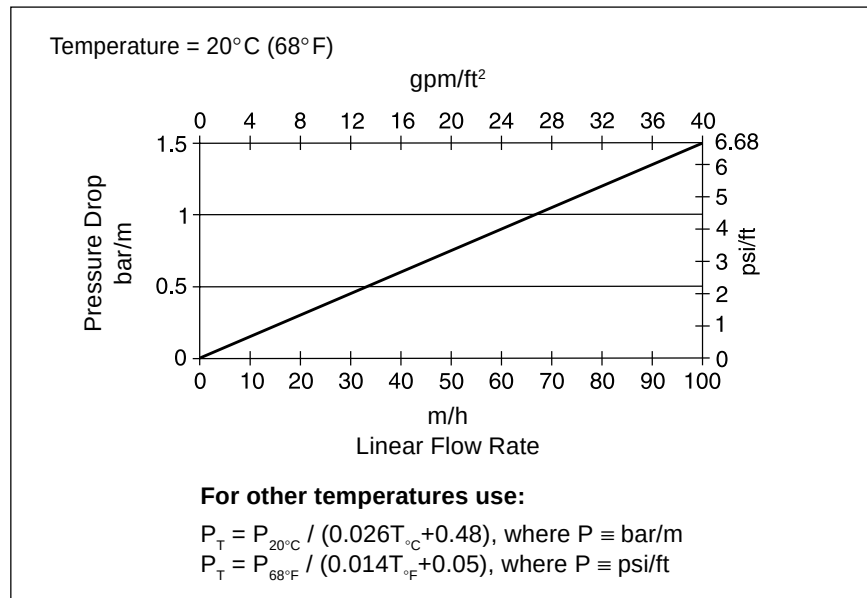


Figure 2. Pressure drop



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 consi-

dered 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.

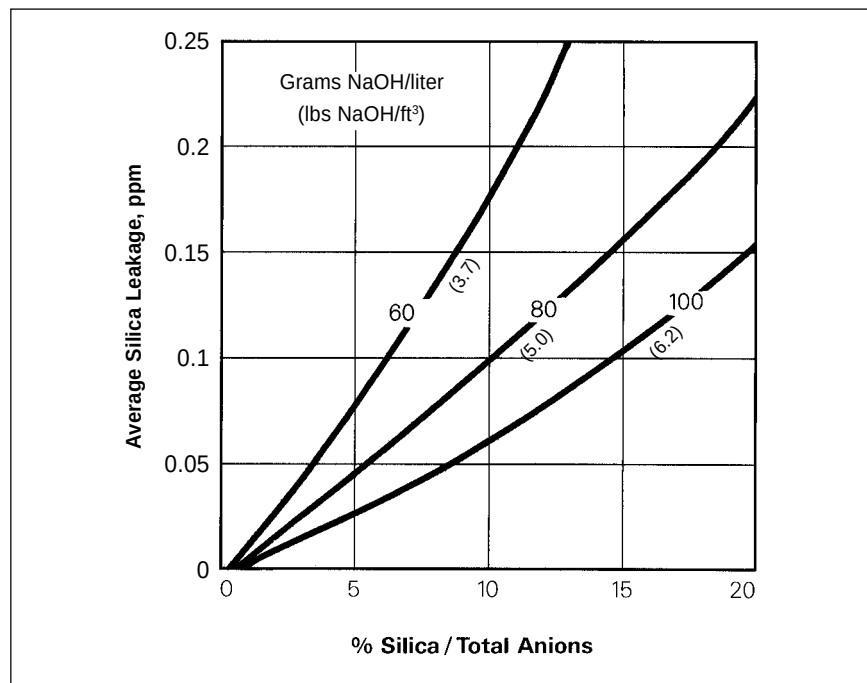
Operating Characteristics

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.

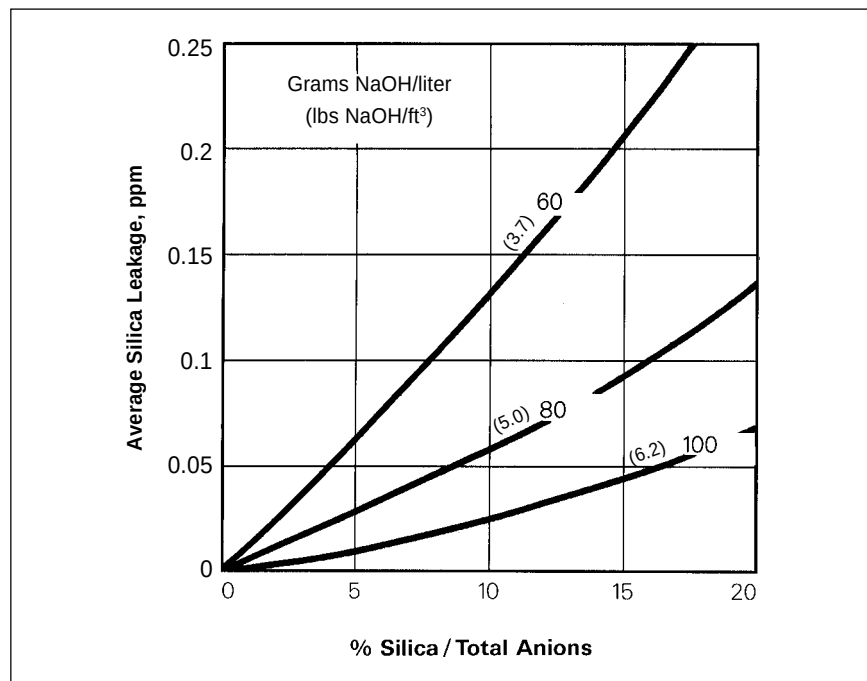
The recommended operating conditions in the table shown on page 3 are a guide and should not be restrictive. Excellent results in regeneration can be obtained when using NaOH in concentrations of 2% up to 8%.

A regenerant dosage rate of approximately 2 grams NaOH per liter of resin (0.1lb/ft³) 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 m³/h/m³ or 0.4 gpm/ft³). 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

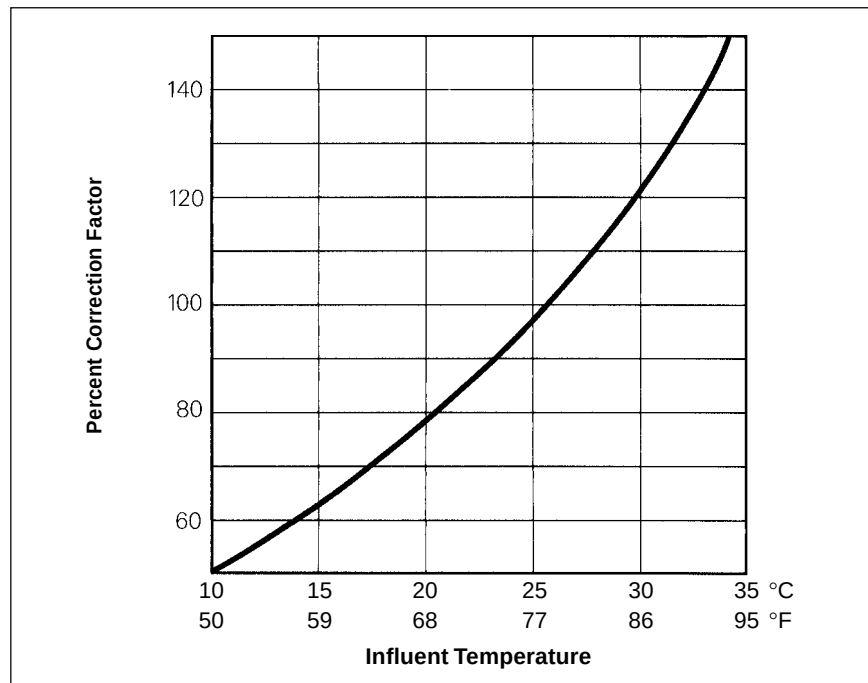
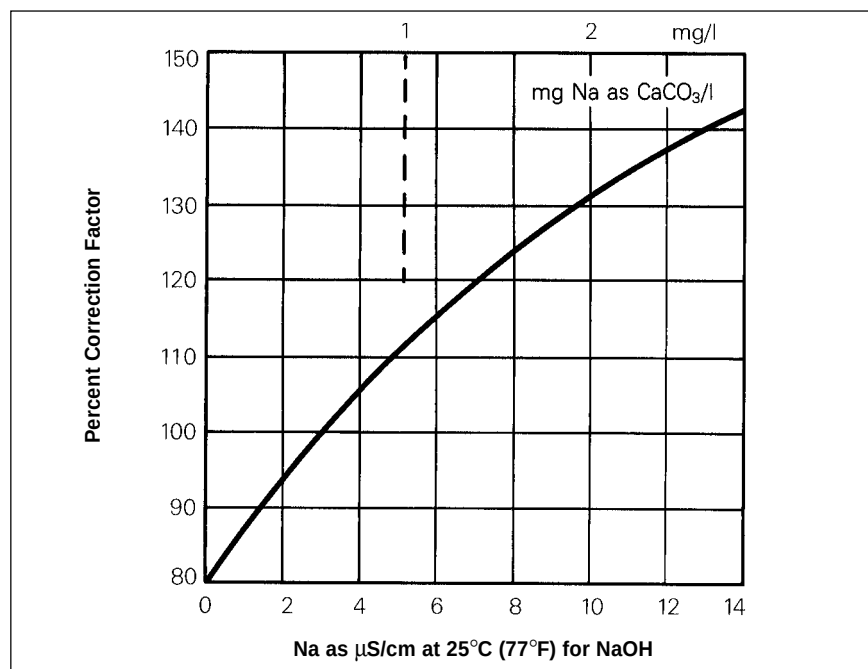


Figure 6. Sodium leakage correction for co-current operation



Co-current operational capacity data

Note: Use type 1 resin if $\text{CO}_2 + \text{SiO}_2$ 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: $\text{eq/l} \times 21.8 = \text{kg/ft}^3$ as CaCO_3 .

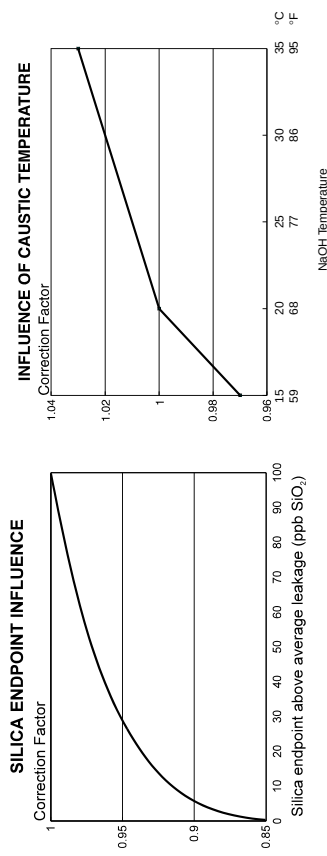
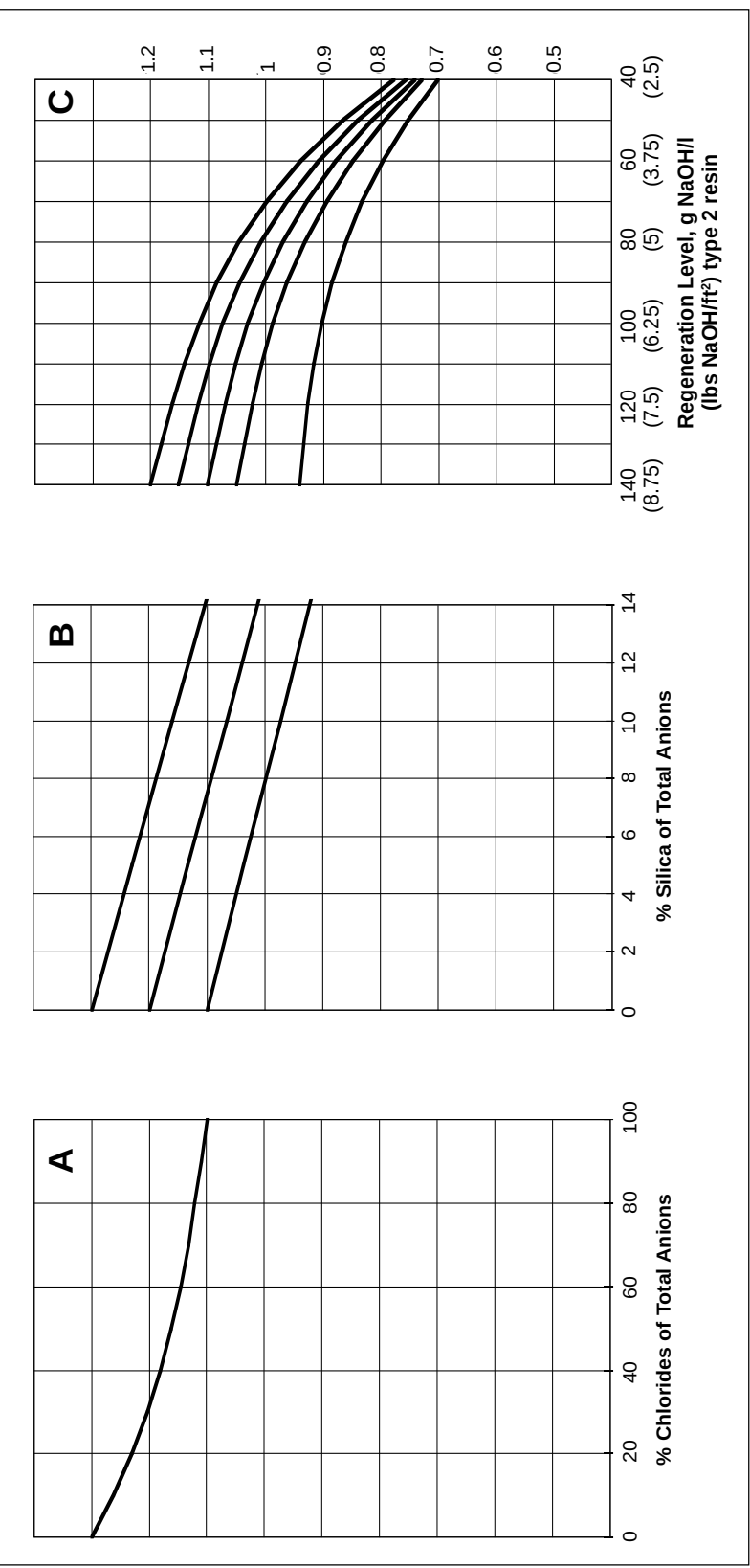


Figure 7. Co-current operational capacity data



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 $2 \text{ m}^3/\text{m}^3$ of resin ($0.25 \text{ gpm}/\text{ft}^3$). 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

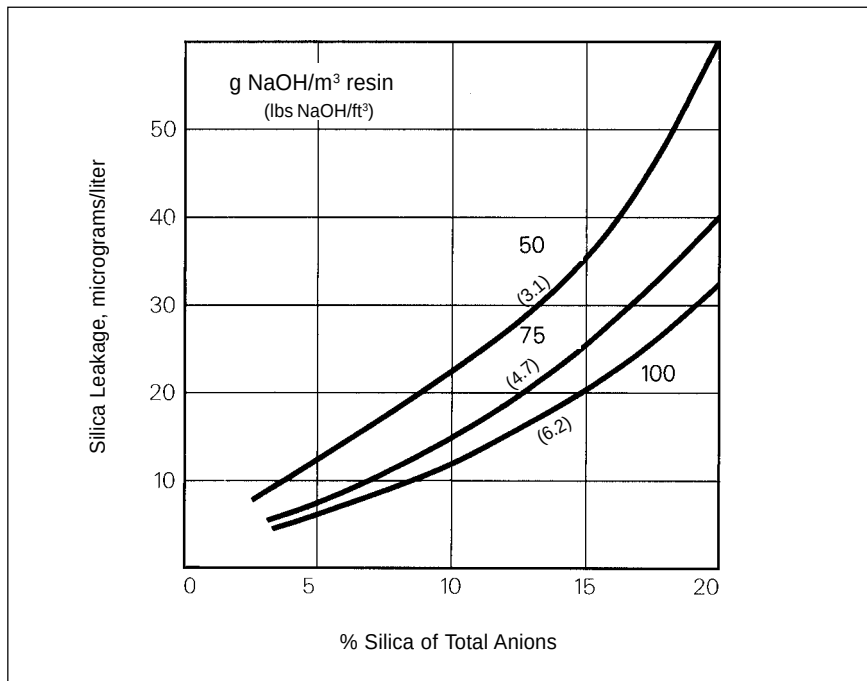
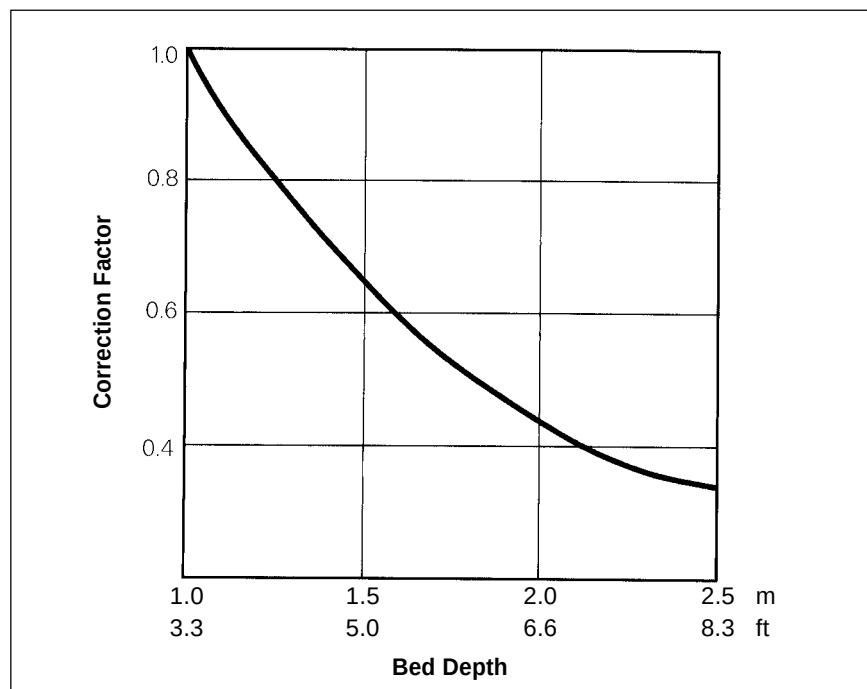


Figure 9. Correction factor bed depth for counter-current operation



Counter-current operational capacity data

Note: Use type 1 resin if $\text{CO}_2 + \text{SiO}_2$ 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.

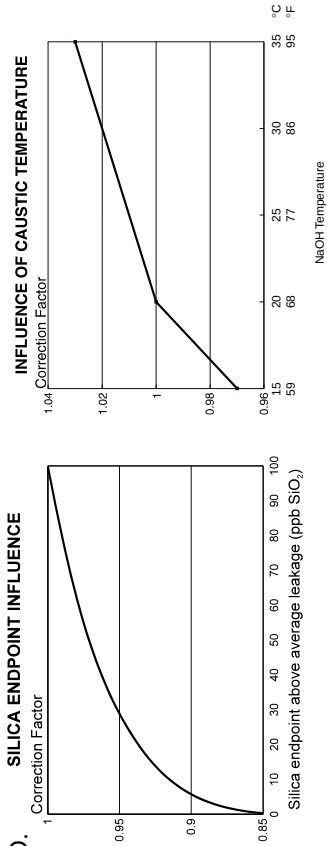
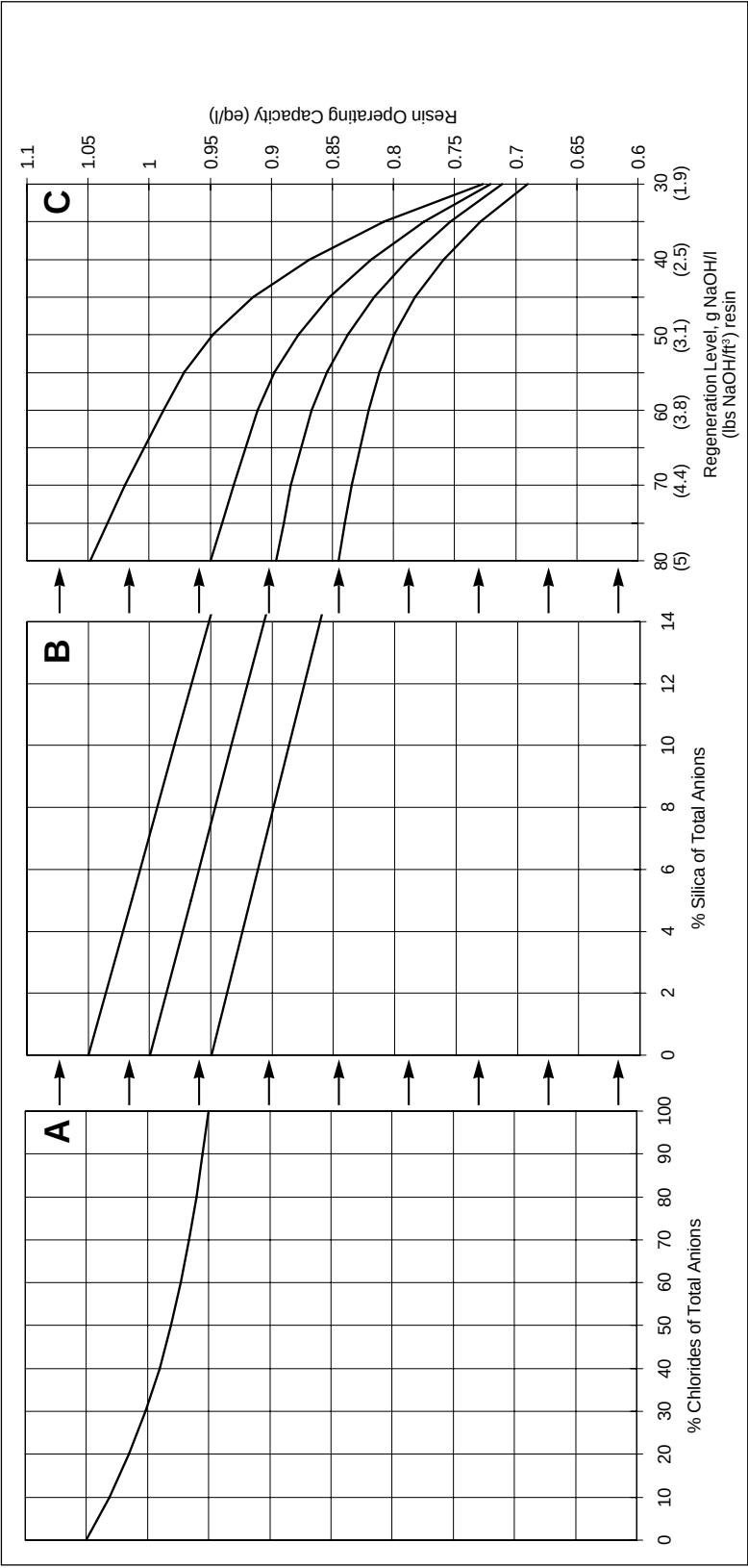


Figure 10. Counter-current operational capacity data



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For more information call Dow Liquid Separations:

LENNTECH

info@lennotech.com Tel. +31-152-610-900

www.lennotech.com Fax. +31-152-616-289

†

†

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CH 171-405-E-402R

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	1.3
	kgr/ft ³ as CaCO 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	640
	lbs/ft ³	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	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	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 its 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).

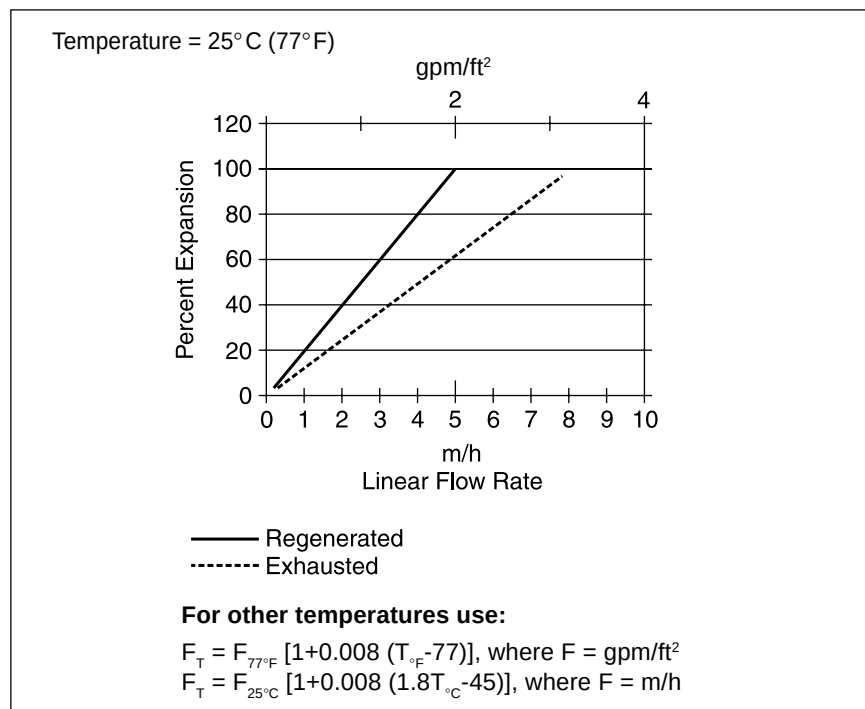
The target expansion of the exhausted resin is 100% relative to the free base form bed depth.

$$\{(3.0\text{m} - 1.5\text{m})/1.5\text{m}\} \times 100 = 100\%.$$

Using Figure 1, the flowrate required for 100% expansion in the regenerated form is determined to be 9.0 m/h (3.7 gpm/ft²) at 25°C (77°F). The temperature correction factor is then applied to determine the required flowrate at 15°C (60°F).

$$9.0 \text{ m/h} [1 + 0.008 \{(1.8 \times 15) - 45\}] = 7.7 \text{ m/h (3.1 gpm/ft}^2\text{)}.$$

Figure 1. Backwash expansion vs. flow rate



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.

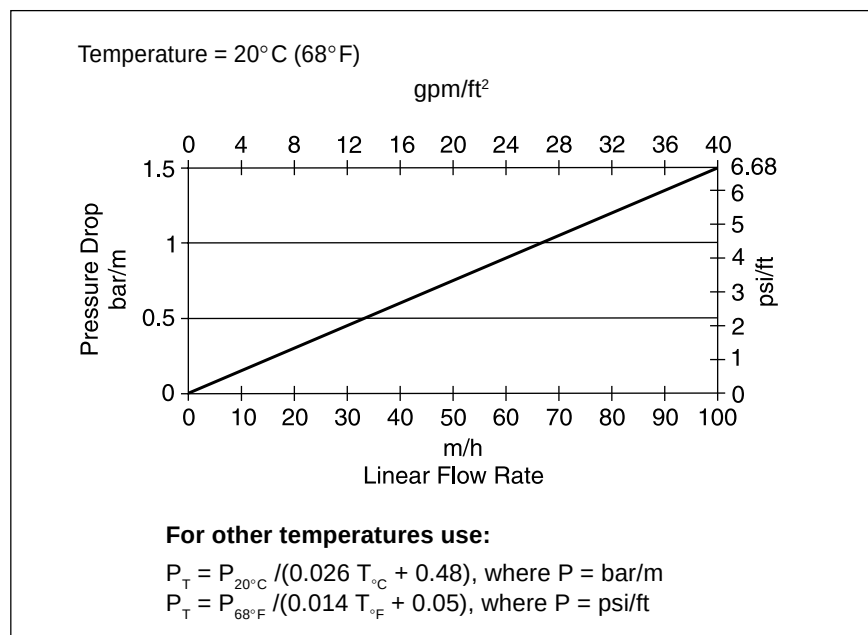
The data in Figure 2 shows the pressure drop per unit bed depth as a function of both flow velocity and water temperature for the resin. These figures refer to a new resin bed at the beginning of the operational cycle with the resin in the free amine form (i.e. regenerated) in a backwashed, settled condition 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.

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

Figure 2. Pressure drop



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.

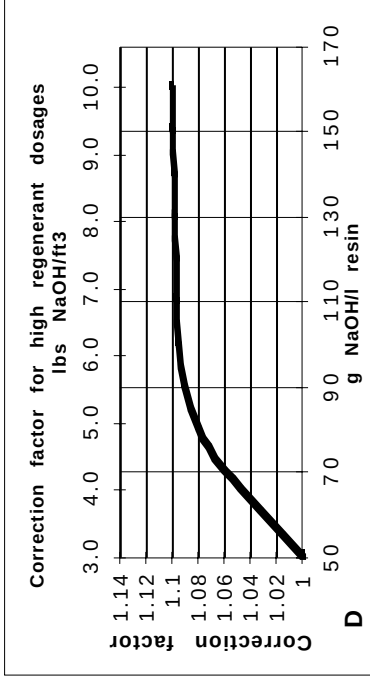
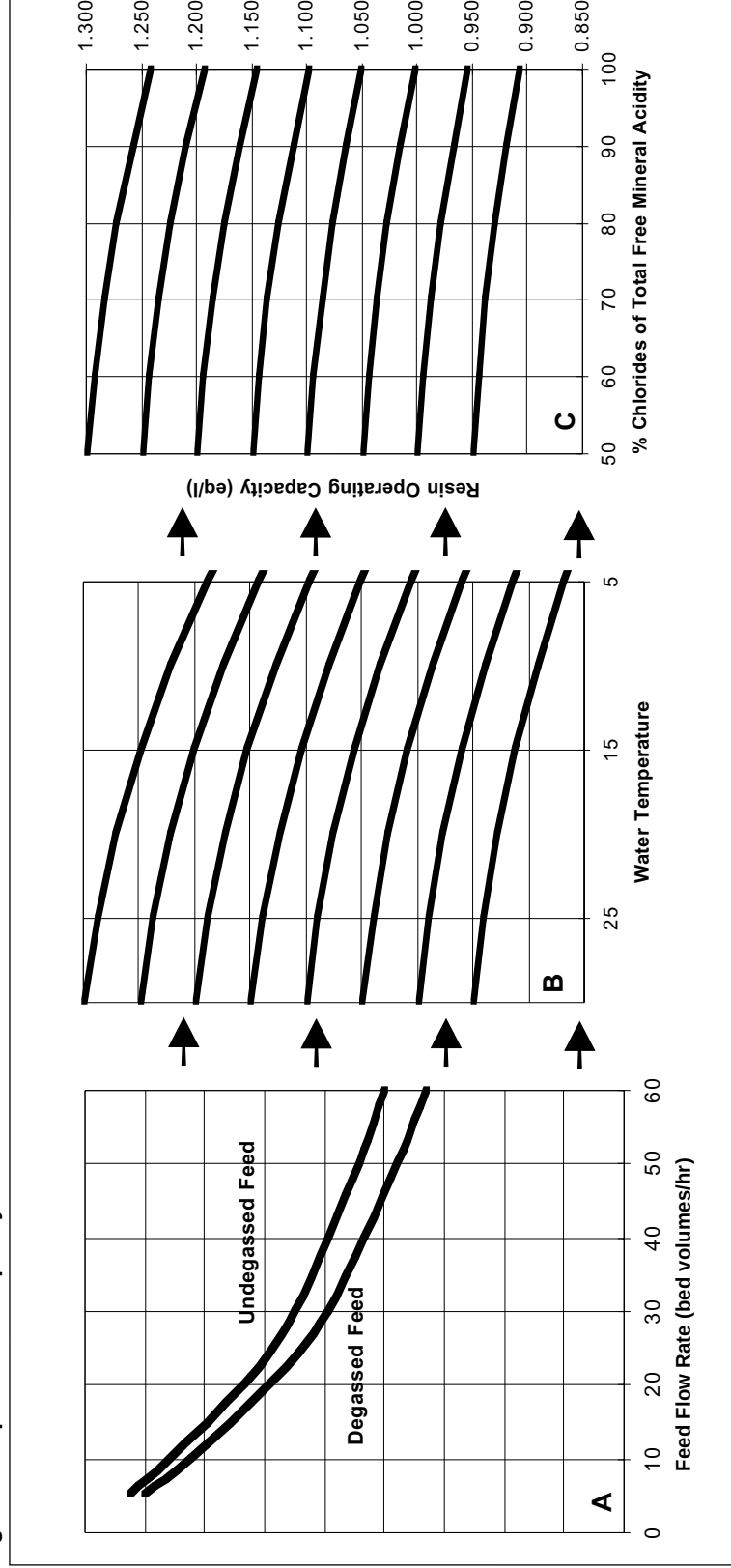


Figure 3. Operational capacity data



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.

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www.lennotech.com Fax. +31-152-616-289

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Form No. 177-01691-904

DOWEX™ Ion Exchange Resins

7. Other

- Softening Resins

- DOWEX MONOSPHERE™ C-350
- DOWEX MONOSPHERE C-400
- DOWEX HCR-S
- DOWEX HCR-S/S

- Ultrapure Water Resins

- DOWEX MONOSPHERE 650C UPW (H)
- DOWEX MONOSPHERE 550A UPW (OH)
- DOWEX MONOSPHERE MR-3 UPW
- DOWEX MONOSPHERE MR-575 UPW
- DOWEX MONOSPHERE MR-450 UPW



DOWEX™ MONOSPHERE™ C-350

Uniform Particle Size, Strong Acid Cation Exchange Resin for Residential Water Softening
Applications with High Salt Efficiency

Product	Type	Matrix	Functional group
DOWEX™ MONOSPHERE™ C-350	Strong acid cation	Polystyrene-DVB, gel	Sulfonic acid

Guaranteed Sales Specifications		Na ⁺ form	
Total exchange capacity, min.	eq/L	2.2	
	kgr/ft ³ as CaCO ₃	48.2	
Water content	%	38 – 45	
Bead size distribution			
Mean particle size	μm	350 ± 50	
Uniformity coefficient, max.		1.1	
< 200 μm, max.	%	0.5	

Typical Physical and Chemical Properties		Na ⁺ form	
Whole uncracked beads	%	95 - 100	
Particle density	g/mL	1.30	
Shipping weight	g/L	830	
	lbs/ft ³	51	
Total swelling (Ca ⁺⁺ → Na ⁺)	%	4	

Recommended Operating Conditions

- Maximum operating temperature 130°C (265°F)
- pH range 0 - 14
- Bed depth, min. 200 mm (0.7 ft)
- Flow rates:
 - Service/fast rinse 5 - 200 m/h (2 - 80 gpm/ft²)
 - Backwash See Figure 1
 - Regeneration/displacement rinse 5 - 20 m/h (2 - 8 gpm/ft²)
- Total rinse requirement 2 - 5 Bed volumes
- Regenerant:
 - Type 5 - 25% NaCl

Typical Properties and Applications

DOWEX™ MONOSPHERE™ C-350 resin is a uniform particle size gel cation resin designed for use in home water softening. The small beads yield an outstanding operating capacity, which in turn results in a high regeneration efficiency and a considerable saving in salt usage. The amount of waste salt passed on to the environment is far less than in the case of conventional resins.

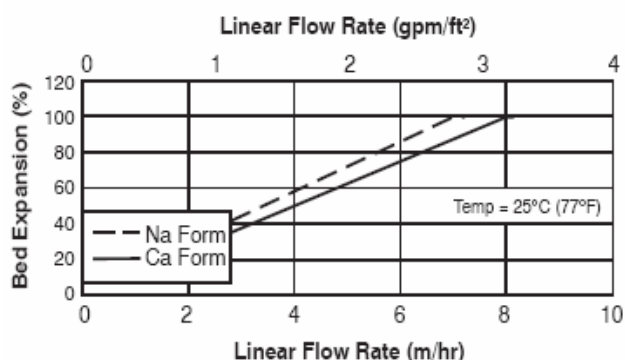
DOWEX MONOSPHERE C-350 resin has excellent mechanical strength and very good stability to oxidation.

Packaging

25 liter bags or other packaging upon request

Figure 1. Backwash Expansion Data

Temperature = 20° C (68° F)



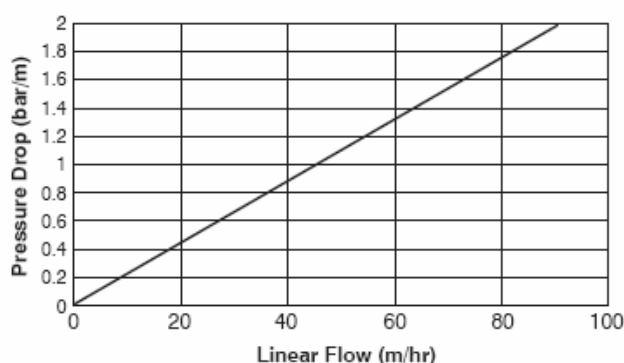
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

Note: These resins may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

DOWEX™ Ion Exchange Resins

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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DOWEX™ MONOSPHERE™ C-400

Uniform Particle Size, Strong Acid Cation Exchange Resin for Residential Water Softening
Applications with High Salt Efficiency

Product	Type	Matrix	Functional group
DOWEX™ MONOSPHERE™ C-400	Strong acid cation	Polystyrene-DVB, gel	Sulfonic acid

Guaranteed Sales Specifications		Na ⁺ form	
Total exchange capacity, min.	eq/L	2.2	
	kg/ft ³ as CaCO ₃	48.2	
Water content	%	38 - 45	
Bead size distribution			
Mean particle size	μm	400 ± 50	
Uniformity coefficient, max.		1.1	
< 200 μm, max.	%	0.5	

Typical Physical and Chemical Properties		Na ⁺ form	
Whole uncracked beads	%	95 - 100	
Particle density	g/mL	1.30	
Shipping weight	g/L	830	
	lbs/ft ³	51	
Total swelling (Ca ⁺⁺ → Na ⁺)	%	4	

Recommended Operating Conditions

- Maximum operating temperature 130°C (265°F)
- pH range 0 - 14
- Bed depth, min. 700 mm (2.4 ft)
- Flow rates:
 - Service/fast rinse 5 - 100 m/h (2 - 40 gpm/ft²)
 - Backwash 5 - 10 m/h (2 - 4 gpm/ft²)
 - Regeneration/displacement rinse 5 - 20 m/h (2 - 8 gpm/ft²)
- Total rinse requirement 2 - 5 Bed volumes
- Regenerant:
 - Type 5 - 25% NaCl

Typical Properties and Applications

DOWEX™ MONOSPHERE™ C-400 resin is a uniform particle size cation resin designed for use in home water softening in units up to a bed depth of 700 mm (2.4 ft). The small beads yield an outstanding operating capacity, which in turn results in a high regeneration efficiency and a considerable saving in salt usage. The amount of waste salt passed on to the environment is far less than in the case of conventional resins.

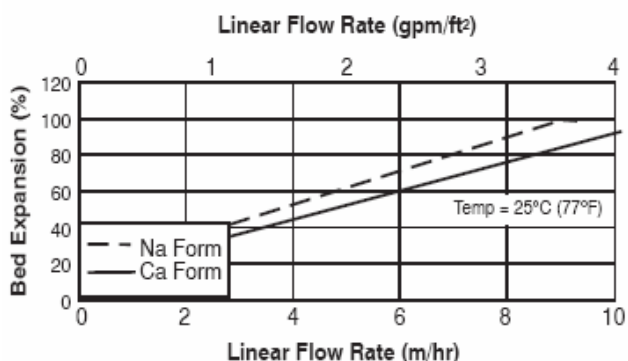
DOWEX MONOSPHERE C-400 resin has excellent mechanical strength and very good stability to oxidation.

Packaging

25 liter bags or other packaging upon request

Figure 1. Backwash Expansion Data

Temperature = 20° C (68° F)



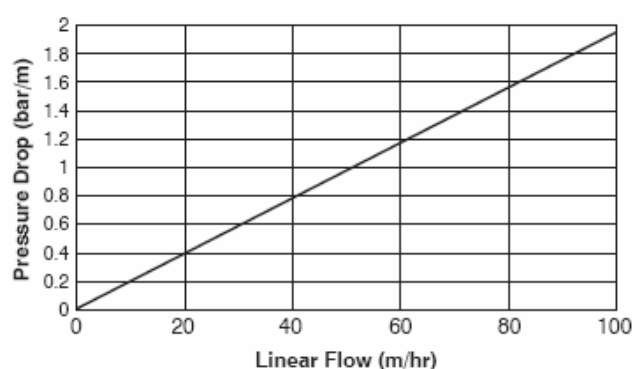
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20° C (68° F)



For other temperatures use:

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

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

Note: These resins may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

DOWEX™ Ion Exchange Resins

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DOWEX™ HCR-S

A High Capacity Cation Exchange Resin for Industrial Softening and Demineralization Applications

Product	Type	Matrix	Functional group
DOWEX™ HCR-S	Strong acid cation	Styrene-DVB gel	Sulfonic acid

Guaranteed Sales Specifications		Na ⁺ form	H ⁺ form
Total exchange capacity, min.	eq/L	2.0	1.8
	kgr/ft ³ as CaCO ₃	43.7	39.3
Bead size distribution range† 300 - 1,200 µm, min. (50 mesh - 16 mesh)	%	90	90
Acidity range	pH	7.0 - 10.5	—
Color throw, as packaged, max.	APHA	20	—

Typical Physical and Chemical Properties		Na ⁺ form	H ⁺ form
Water content	%	44 - 48	50 - 56
Whole uncracked beads	%	90 - 100	90 - 100
Total swelling (Na ⁺ → H ⁺)	%	8	8
Particle density	g/mL	1.28	1.22
Shipping weight	g/L	820	780
	lbs/ft ³	51	49

Recommended Operating Conditions

- Maximum operating temperature: 120°C (250°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/ft²)
 - Backwash: See figure 1
 - Co-current regeneration/displacement rinse: 1-10 m/h (0.4-4 gpm /ft²)
- Total rinse requirement: 3 - 6 Bed volumes
- Regenerant: 1-8% H₂SO₄, 4-8% HCl or 8-12% NaCl

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

Typical Properties and Applications

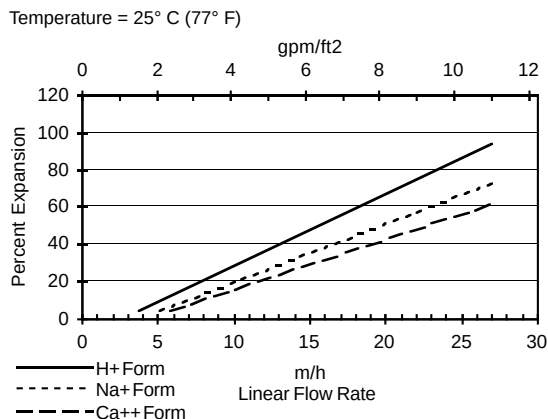
DOWEX™ HCR-S cation exchange resin is a high capacity resin with excellent kinetics and good physical, chemical and thermal stability.

DOWEX HCR-S cation exchange resin is well suited for industrial water softening and demineralization in the co-current mode of regeneration.

Packaging

25 liter bags or 5 cubic feet fiber drums

Figure 1. Backwash Expansion Data

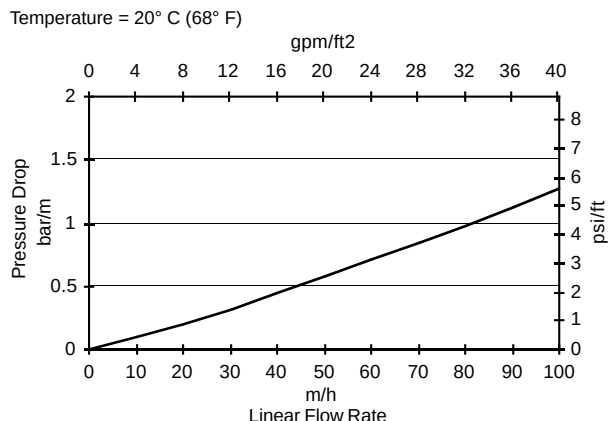


For other temperatures use:

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

$$F_T = F_{25^\circ\text{C}} [1 + 0.008 (1.8T_C - 45)], \text{ where } F = \text{m/h}$$

Figure 2. Pressure Drop Data



For other temperatures use:

$$P_T = P_{20^\circ\text{C}} / (0.026 T_C + 0.48), \text{ where } P = \text{bar/m}$$

$$P_T = P_{68^\circ\text{F}} / (0.014 T_F + 0.05), \text{ where } P = \text{psi/ft}$$

Note: These resins may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

DOWEX™ Ion Exchange Resins

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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DOWEX™ HCR-S/S

A High Capacity Cation Exchange Resin for Domestic Applications

Product	Type	Matrix	Functional group
DOWEX™ HCR-S/S	Strong acid cation	Styrene-DVB, gel	Sulfonic acid

Guaranteed Sales Specifications		Na ⁺ form
Total exchange capacity, min.	eq/L kgr/ft ³ as CaCO ₃	1.9 41.5
Bead size distribution range†		
300 - 1,200 µm, min.	%	90
< 300 µm, max.	%	1
Whole uncracked beads, min.	%	90
Color throw, as packaged, max.	APHA	20
Acidity range	pH	7.0 - 10.5

Typical Physical and Chemical Properties		Na ⁺ form
Water content	%	48 - 52
Total swelling (Ca ⁺⁺ → Na ⁺)	%	5
Particle density	g/mL	1.30
Shipping weight	g/L lbs/ft ³	800 50

Recommended Operating Conditions

- Maximum operating temperature 120°C (250°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/ft²)
 - Backwash See Figure 1
 - Co-current regeneration/displacement rinse 1 - 10 m/h (0.4 - 4 gpm /ft²)
- Total rinse requirement 3 - 6 Bed volumes
- Regenerant: 8 - 12% NaCl

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

Typical Properties and Applications

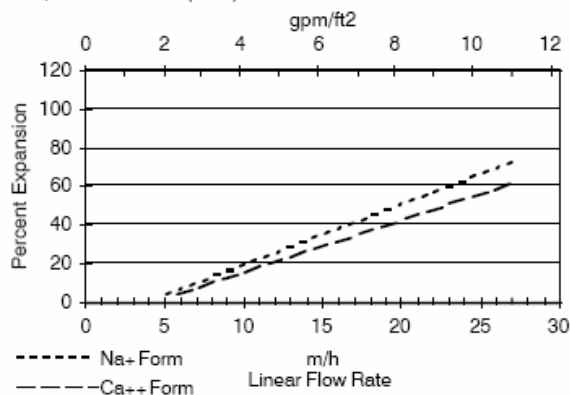
DOWEX™ HCR-S/S cation exchange resin is a high capacity resin with excellent kinetics and good physical, chemical and thermal stability. DOWEX HCR-S/S is used for domestic applications in the co-current mode of regeneration. For counter-current regeneration, DOWEX HCR-S/S CR is available.

Packaging

25 liter bags or 1 cubic foot bags

Figure 1. Backwash Expansion Data

Temperature = 25°C (77°F)



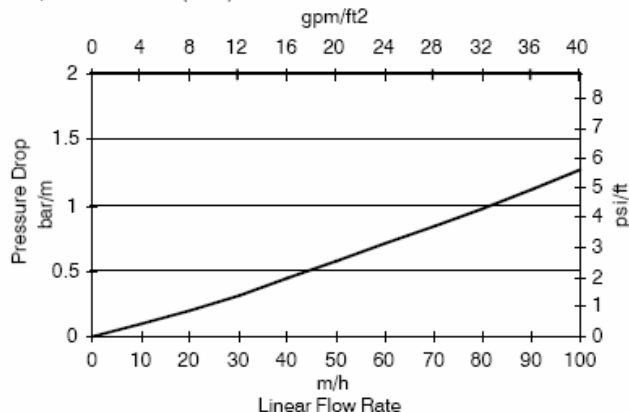
For other temperatures use:

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

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

Figure 2. Pressure Drop Data

Temperature = 20°C (68°F)



For other temperatures use:

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

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

Note: These resins may be subject to drinking water application restrictions in some countries: please check the application status before use and sale.

DOWEX™ Ion Exchange Resins

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DOWEX MONOSPHERE 650C UPW (H)

A Uniform Particle Size Strong Acid Cation Resin for Single or Mixed Bed Demineralization for Ultrapure Water Applications

Product	Type	Matrix	Functional group
DOWEX™ MONOSPHERE™ 650C UPW (H)	Strong acid cation	Styrene-DVB gel	Sulfonic acid
Guaranteed Sales Specifications			H ⁺ form
Total exchange capacity, min.	eq/L	1.9	
	kgr/ft ³ as CaCO ₃	41.5	
Water content	%	46 - 51	
Bead size distribution†			
Mean particle size	µm	650 ± 50	
Uniformity coefficient, max.		1.1	
Whole uncracked beads, min.	%	95	
Crush strength			
Average, min.	g/bead	500	
> 200 g/bead, min.	%	95	
Typical Physical and Chemical Properties			H ⁺ form
Particle density, approx.	g/mL	1.22	
Shipping weight, approx.	g/L	785	
	lbs/ft ³	49	

Recommended Operating Conditions

- Maximum operating temperature:
 - Single bed 120°C (250°F)
 - Mixed bed 60°C (140°F)
- Resin bed depth, min.:
 - Single bed 800 mm (2.6 ft)
 - Mixed bed 450 mm (1.5 ft)
- Flow rates:
 - Service/fast rinse 10 - 60 m/h (4 - 24 gpm/ft²)
 - Backwash see Figure 1
 - Regeneration/displacement 4 - 10 m/h (1.6 - 4 gpm /ft²)
- Total rinse requirement 2 - 5 Bed volumes
- Regenerant 1 - 8% H₂SO₄, 4 - 8% HCl

UPW Specific Properties

- Rinse characteristics:
 - UPW grade resins are rinsed with +17.5 Megaohm.cm water to meet stringent ionic and organic residuals
 - Ionic conductivity rinse down, max. as packaged 1 µS/cm
 - TOC rinse down to 5 ppb (+) (see Figure 3) 20 bed volumes

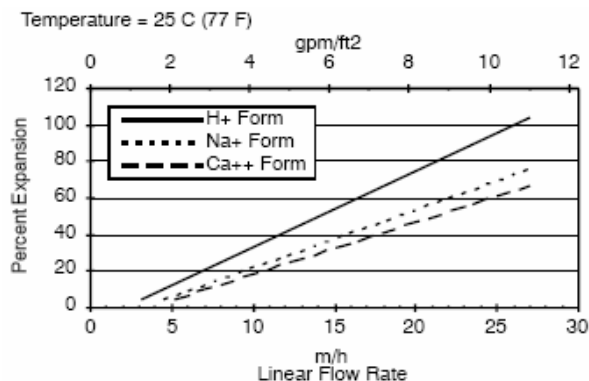
† For additional particle size information, please refer to Particle Size Distribution Cross Reference Chart (Form No. 177-01775).

(+) delta TOC ppb measured in/out

Typical Properties and Applications

DOWEX MONOSPHERE 650C UPW (H) strong acid cation exchange resin is recommended for the roughing ion exchange loop either in a two bed followed by a mixed bed or in a working mixed bed following reverse osmosis. The dark color of this resin is a visible differentiation from the light colored DOWEX MONOSPHERE 550A, and is therefore suited for regenerable mixed beds. UPW grade is characterized by its efficient rinse profile to a conductivity and (delta) TOC end points.

Figure 1. Backwash Expansion Data

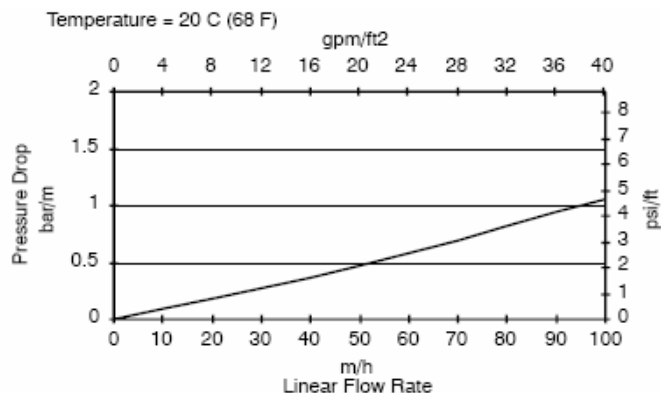


For other temperatures use:

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

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

Figure 2. Pressure Drop Data

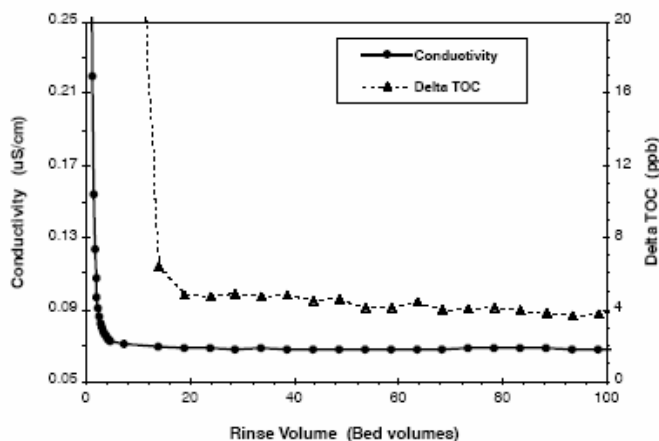


For other temperatures use:

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

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

Figure 3. Conductivity and TOC Rinsedown Curves



DOWEX Ion Exchange Resins

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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DOWEX MONOSPHERE 550A UPW (OH)

A Uniform Particle Size Strong Base Anion Resin for Single or Mixed Bed Demineralization for Ultrapure Water Applications

Product	Type	Matrix	Functional group
DOWEX™ MONOSPHERE™ 550A UPW (OH)	Strong base anion	Styrene-DVB gel	Quaternary ammonium
Guaranteed Sales Specifications			OH ⁻ form
Total exchange capacity, min.	eq/L kgr/ft ³ as CaCO ₃	1.0 21.9	
Water content	%	55 - 65	
Bead size distribution†			
Mean particle size	µm	590 ± 50	
Uniformity coefficient, max.		1.1	
Whole uncracked beads, min.	%	95	
Crush strength			
Average, min.	g/bead	350	
> 200 g/bead, min.	%	95	
Typical Physical and Chemical Properties			OH ⁻ form
Particle density, approx.	g/mL	1.08	
Shipping weight, approx.	g/L lbs/ft ³	657 41	

Recommended Operating Conditions

- Maximum operating temperature:
Single bed (OH⁻ form) 60°C (140°F)
Mixed bed (OH⁻ form) 60°C (140°F)
- Resin bed depth, min.:
Single bed 800 mm (2.6 ft)
Mixed bed 450 mm (1.5 ft)
- Flow rates:
Service/fast rinse 10 - 60 m/h (4 - 24 gpm/ft²)
Backwash See Figure 1
Regeneration/displacement 4 - 10 m/h (1.6 - 4 gpm /ft²)
- Total rinse requirement 2 - 5 Bed volumes
- Regenerant:
Type 4 - 8% NaOH
Temperature Ambient or up to 50°C (122°F) for silica removal

UPW Specific Properties

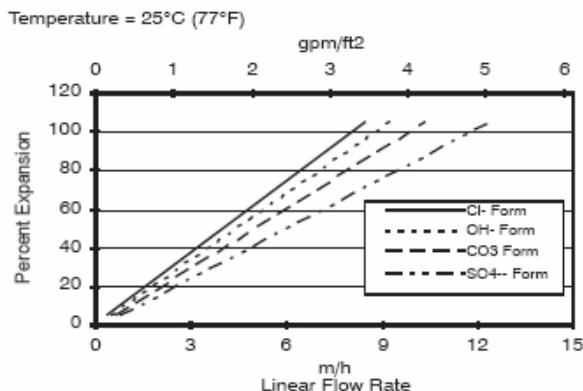
- Rinse characteristics:
UPW grade resins are rinsed with +17.5 Megaohm.cm water to meet stringent ionic and organic residuals
 - Ionic conductivity rinse down, max. as packaged 1 µS/cm
 - TOC rinse down to 4 ppb (+) (see Figure 3) 45 bed volumes

† For additional particle size information, please refer to Particle Size Distribution Cross Reference Chart (Form No. 177-01775).
(+) delta TOC ppb measured in/out

Typical Properties and Applications

DOWEX MONOSPHERE 550A UPW (OH) type I strong base anion exchange resin is recommended for the roughing, intermediate and polishing ion exchange loops either in a two bed system followed by a mixed bed or in a mixed bed following reverse osmosis (RO). Low TOC levels in the UPW grade are achieved by deliberate functionalization and rinsing as shown in Figure 3. UPW grade is characterized by its light color, superior crush strength and high (greater than 95%) conversion of exchange sites to the hydroxide (OH) form.

Figure 1. Backwash Expansion Data

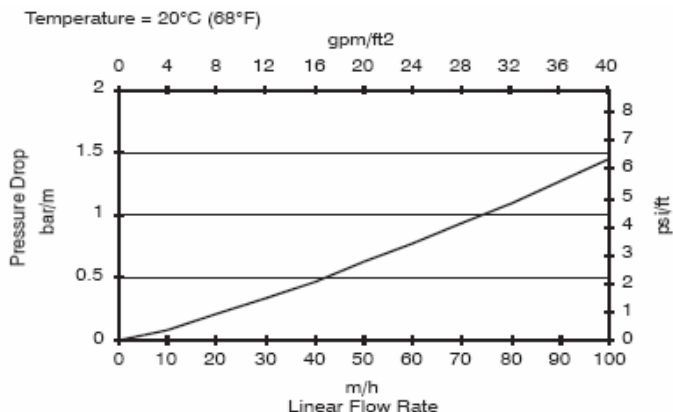


For other temperatures use:

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

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

Figure 2. Pressure Drop Data

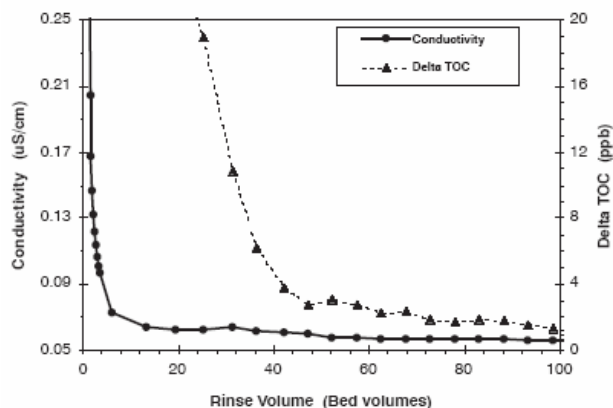


For other temperatures use:

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

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

Figure 3. Conductivity and TOC Rinsedown Curves



DOWEX Ion Exchange Resins

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DOWEX™ MONOSPHERE™ MR-3 UPW

A Separable Uniform Particle Size Mixed Bed Ion Exchange Resin for Ultrapure Water Production

Product	Resin ratio	Matrix	Functional group
DOWEX™ MONOSPHERE™ MR-3 UPW	Note**	Styrene-DVB, gel	Sulfonic acid and quaternary ammonium

Guaranteed Sales Specifications		H ⁺ form	OH ⁻ form
Total exchange capacity, min.	eq/L kgr/ft ³ as CaCO ₃	1.9 41.5	1.0 21.9
Water content	%	46 - 51	55 - 65
Bead size distribution†			
Mean particle size	µm	650 ± 50	590 ± 50
Uniformity coefficient, max.		1.1	1.1
Whole uncracked beads, min.	%	95	95
Crush strength			
Average, min.	g/bead	500	350
> 200 g/bead, min.	%	95	95

Typical Physical and Chemical Properties		H ⁺ form	OH ⁻ form
Particle density, approx.	g/mL	1.22	1.08
Shipping weight, approx.	g/L		689
	lbs/ft ³		43

Recommended Operating Conditions

- Maximum operating temperature 60°C (140°F)
- Resin bed depth, min. 800 mm (2.6 ft)
- Flow rates:
Service 10 - 60 m/h (4 - 24 gpm/ft²)
- Pressure drop see Figure 1

UPW Mixed Resin Specific Properties

- Cationic resin conversion to H 99.9% min.
- Anionic resin conversion to:
 - OH 95% min.
 - CO₃ 5% max.
 - Cl 0.1% max.
- Rinse characteristics:
 - UPW grade resins are rinsed with +17.5 Megaohm.cm water to meet stringent ionic and organic residuals
 - Ionic conductivity rinse down to 0.055 µS/cm (see Figure 2) 1 bed volume
 - TOC rinse down to 2 ppb (+) (see Figure 2) 50 bed volumes

Note** Resin ratio of anion to cation is volumetrically optimized to achieve maximum removal of boron and silica.

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

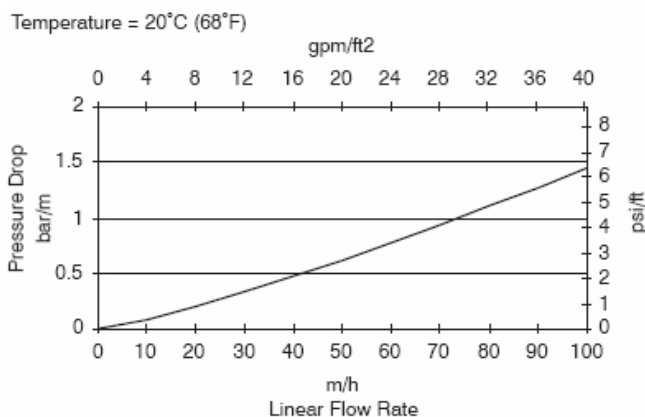
(+) delta TOC ppb measured in/out

Typical Properties and Applications

DOWEX™ MONOSPHERE™ MR-3 UPW grade resin is recommended as a working or polishing mixed bed to complement two bed ion exchange or reverse osmosis systems. It can be used as a regenerable mixed bed since the color difference and particle size difference will allow a visually good separation to achieve optimal regeneration. Very low ionic load to a regenerable mixed bed can occasionally lead to clumping, especially when the mixed bed is operated to a boron or silica break. An improvement in the manufacturing process of DOWEX MONOSPHERE 550A UPW grade will eliminate cation/anion clumping under normal regeneration conditions.

The UPW grade is characterized by the high conversion to ionic sites (95.0% min.) and a volumetric ratio that allows a higher exchange of boron and silica. As shown in Figure 2, the excellent rinse characteristics also allow a very efficient on-line operation.

Figure 1. Pressure Drop Data

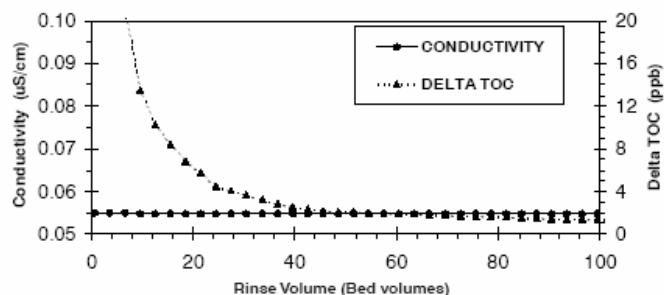


For other temperatures use:

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

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

Figure 2. Conductivity and TOC Rinsedown Curves



DOWEX Ion Exchange Resins

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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DOWEX MONOSPHERE MR-575 UPW

Uniform Particle Size Mixed Bed Resin for Ultrapure Water Applications

Product	Type	Matrix	Functional group
DOWEX* MONOSPHERE* MR-575 UPW	1.2:1 by equivalent cation:anion	Styrene-DVB, gel	Sulphonic acid Quaternary amine

Guaranteed Sales Specifications		OH ⁻ form	H ⁺ form	
Total capacity, min.	eq/l kgr/ft ³ as CaCO ₃	1.0 21.8	2.3 50.3	
Water content	%	55 – 65	41 – 46	
Bead size distribution				
Mean particle size	µm	590 ± 50	550 ± 50	
Uniformity coefficient, max.		1.1	1.1	
<0.3 mm, max.	%	0.5	0.2	
Whole uncracked beads, min.	%	95	95	
Crush strength				
Average, min.	g/bead	350	500	
> 200 g/bead, min.	%	95	95	
Ionic conversion				
Cation resin			H ⁺ 99.7% min.	
Anion resin	OH ⁻ 95% min.	Cl ⁻ 0.1% max.	CO ₃ ⁻ 5% max.	
			SO ₄ ²⁻ 0.1% max.	
Trace metals, ppm dry resin, max.				
	Na	Fe	Cu	Al
Cation	25	25	15	15
Anion	25	25	15	15

Typical Physical and Chemical Properties		OH ⁻ form	H ⁺ form
Particle density	g/ml	1.08	1.22
Shipping weight	g/l	705	705
	lbs/ft ³	44	44

Recommended Operating Conditions

- Maximum operating temperature 60°C (140°F)
- pH range 0-14
- Bed depth, min. 800 mm (2.6 ft)

Typical properties and applications

DOWEX MONOSPHERE MR-575 UPW uniform particle size mixed resin has outstanding purity to meet the requirements of high quality water applications such as for the electronics industry as a final polisher. It is a 1.2:1 stoichiometric mixture of DOWEX MONOSPHERE 575C UPW (H) and DOWEX MONOSPHERE 550A UPW (OH) resins. It also has excellent physical and chemical stability. Extremely low levels of residual metallic impurities, make this resin well suited for high purity water applications.

Packaging

5 cubic foot drums or 25 liter bags

DOWEX Ion Exchange Resins

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DOWEX MONOSPHERE MR-450 UPW

A Non-Separable Uniform Particle Size Mixed Bed Ion Exchange Resin for Ultrapure Water Production

Product	Resin ratio	Matrix	Functional group
DOWEX™ MONOSPHERE™ MR-450 UPW	Note**	Styrene-DVB, gel	Sulfonic acid and quaternary ammonium

Guaranteed Sales Specifications		H ⁺ form	OH form
Total exchange capacity, min.	eq/L kgr/ft ³ as CaCO ₃	1.9 41.5	1.0 21.9
Water content	%	46 - 53	55 - 65
Bead size distribution†			
Mean particle size	μm	360 ± 50	590 ± 50
Uniformity coefficient, max.		1.1	1.1
Whole uncracked beads, min.	%	95	95
Crush strength			
Average, min.	g/bead	350	350
> 200 g/bead, min.	%	95	95

Typical Physical and Chemical Properties		H ⁺ form	OH form
Particle density, approx.	g/mL	1.22	1.08
Shipping weight, approx.	g/L lbs/ft ³	704 44	704 44

Recommended Operating Conditions

- Maximum operating temperature 60°C (140°F)
- Resin bed depth, min. 800 mm (2.6 ft)
- Flow rates:
Service 10 - 60 m/h (4-24 gpm/ft²)
- Pressure drop see Figure 1

UPW Mixed Resin Specific Properties

- Cationic resin conversion to H 99.7% min.
- Anionic resin conversion to:
OH 95% min.
CO₃ 5% max.
Cl 0.1% max.
- Rinse characteristics:
UPW grade resins are rinsed to meet stringent ionic and organic residuals
 - Ionic conductivity rinse down to 0.055 μS/cm (see Figure 2) 2 bed volumes
 - TOC rinse down to 4 ppb (+) (see Figure 2) 45 bed volumes

Note** Resin ratio of anion to cation is volumetrically optimized to achieve maximum removal of boron, silica and other sensitive ions.

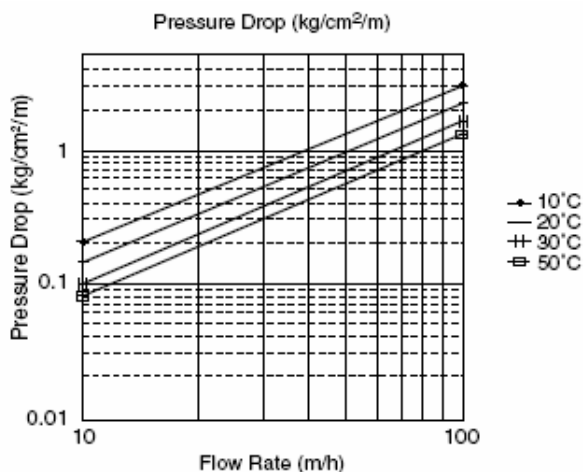
† For additional particle size information, please refer to Particle Size Distribution Cross Reference Chart (Form No. 177-01775).

(+) delta TOC ppb measured in/out

Typical Properties and Applications

DOWEX MONOSPHERE MR-450 UPW grade resin is a non-separable homogeneous mixed bed resin. It is recommended as a point of use or non-regenerable mixed bed in the polishing loop to achieve sub ppb levels of soluble silica, boron, sodium, potassium, sulfate, chloride, zinc, iron and aluminum. This non-regenerable mixed bed resin is used for two to three years before replacement. The UPW grade product is characterized by the very high conversion to ionic sites (95.0% min.), excellent rinse profiles for conductivity and (delta) TOC and superior crush strength. This homogeneous mixed bed contains 360 micron cation and a 590 micron anion (mean particle size) thus providing efficient kinetics to achieve a higher operating capacity.

Figure 1. Pressure Drop Data

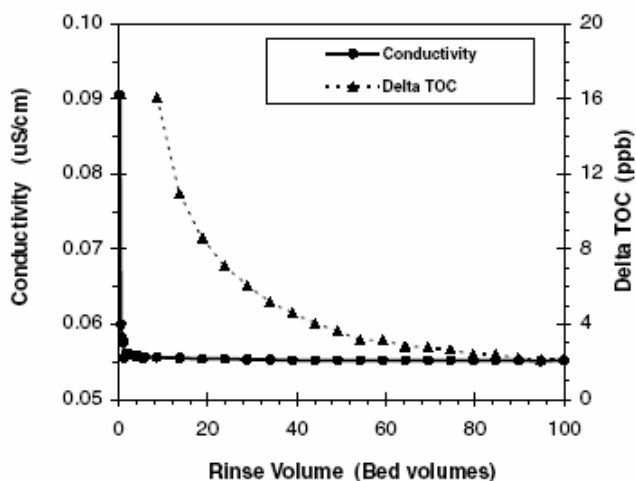


For other temperatures use:

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

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

Figure 2. Conductivity and TOC Rinsedown Curves



LENNTECH

info@lennotech.com Tel. +31-152-610-900

www.lennotech.com Fax. +31-152-616-289

DOWEX Ion Exchange Resins

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