PUROLITE®
ION EXCHANGE RESINS

ISO 9002 BSI REGISTERED FIRM FM 40352

A-520E

Macroporous Strong Base Anion Exchange Resin

(For the selective removal of nitrate)

Technical Data

PRODUCT DESCRIPTION

Purolite A-520E is a macroporous strong base anion resin which is specially designed for the removal of nitrates from water for potable processes. The macroporous matrix and special ion exchange group functionality imparts ideal nitrate selectivity to **Purolite A-520E** making this resin particularly suitable for nitrate removal even when moderate to high concentrations of sulphate are present. Hence this resin gives superior performance in nitrate removal applications when compared with standard exchange resins.

A requirement of the nitrate removal process is to produce potable water meeting the quality standard defined by the European Economic Community in the Directive No. 80/778 of July 1980. This directive limits the nitrates to a maximum admissable concentration (M.A.C.) of 50 mg NO_3/l. The U.S.A. drinking water regulations limit nitrates to 45 mg NO_3/l.

Typical Physical & Chemical Characteristics	
Polymer Matrix Structure	Macroporous Styrene-Divinylbenzene
Physical Form and Appearance	Opaque Cream Spherical Beads
Whole Bead Count	95% min.
Functional Groups	Quaternary Ammonium
Ionic Form, as shipped	Cl^-
Shipping Weight (approx.)	680 g/l (42.5 lb/ft^3)
Screen Size Range: - U.S. Standard Screen	 16 - 50 mesh, wet
Particle Size Range	+1200 mm <5%, -300 mm <1%
Moisture Retention, Cl^- form	50 - 56%
Reversible Swelling $Cl^- \rightarrow SO_4/NO_3$	negligible
Total Exchange Capacity, Cl^- form,	
wet, volumetric	0.9 meq/ml min.
dry, weight	2.8 meq/g min.
Operating Temperature, Cl^- Form	100ºC (212ºF) max.
pH Range, Stability	0 - 14
pH Range, operating	4.5 - 8.5

Standard Operating Conditions Nitrate Removal				
Operation	**Rate**	**Solution**	**Minutes**	**Amount**
Service	8 - 32 BV/h 1 - 4 gpm/ft^3	Influent water to be treated	per design	per design
Backwash	Refer to Fig. 2	Influent water 10 - 20ºC (50 - 68ºF)	5 - 20	1.5 - 4 BV 10 - 25 gal/ft^3
Regeneration	2 - 5 BV/h 0.25 - 0.6 gpm/ft^3	3 - 10% NaCl	20 - 60	90 - 250 g/l 7.8 - 15.6 lb/ft^3
Rinse, (slow)	2 - 5 BV/h 0.25 - 0.6 gpm/ft^3	Influent water	20 - 60	2 - 5 BV 15 - 40 gal/ft^3
Rinse, (fast)	8 - 32 BV/h 1 - 4 gpm/ft^3	Influent water	-	-
Backwash Expansion 50% to 75% Design Rising Space 100% "Gallons" refer to U.S. Gallon = 3.785 litres				

REGENERATION

Sodium chloride is generally preferred for regeneration for reasons of cost and efficiency. When available sea water can be used quite effectively. The use of softened water for make up of regenerant and rinse is often recommended to avoid the precipitation of calcium carbonate in and around the **Purolite A-520E** (or any other resin used in this application). Although the precipitation is not particularly detrimental in the short term, the long term effects may include increased resin attrition and leakage of nitrates.

PRECONDITIONING PROCEDURE

Purolite A-520E is processed to insure that it meets the requirements for use in the treatment of potable water.

On installation it is recommended that the resin be regenerated with two bed volumes of 6% NaCl followed by a rinse of four bed volumes of potable water, prior to use.

HYDRAULIC CHARACTERISTICS

The pressure drop or headloss across a properly classified bed of ion exchange resin depends on the particle size distribution, bed depth, and void volume of the exchange material as well as on the viscosity (and hence on the temperature) of the influent solution. Factors affecting any of these parameters, for example the presence of particulate matter filtered out by the bed, abnormal compressability of the resin, or the incomplete classification of the bed will have an adverse effect and result in an increased headloss.

Depending on the quality of the influent water, the application and the design of the plant, service flow rates may vary from 10 - 40 bed volumes/hour (1 - 5 gpm/ft^3). Typical pressure drop data is given in Fig. 1.

Fig. 1 PRESSURE DROP CHARACTERISTICS

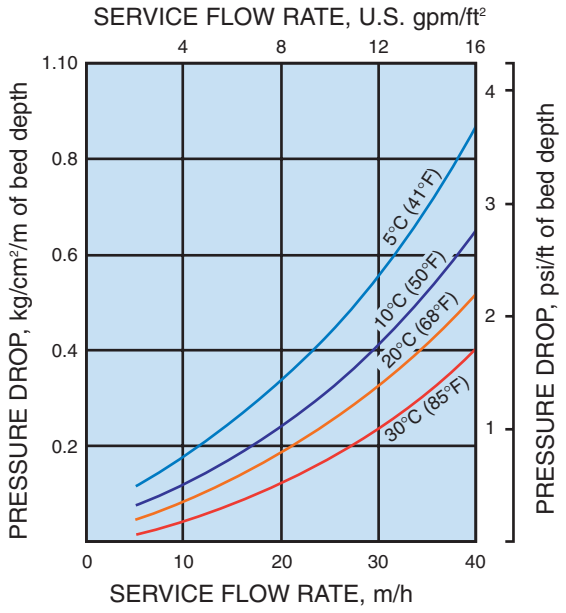
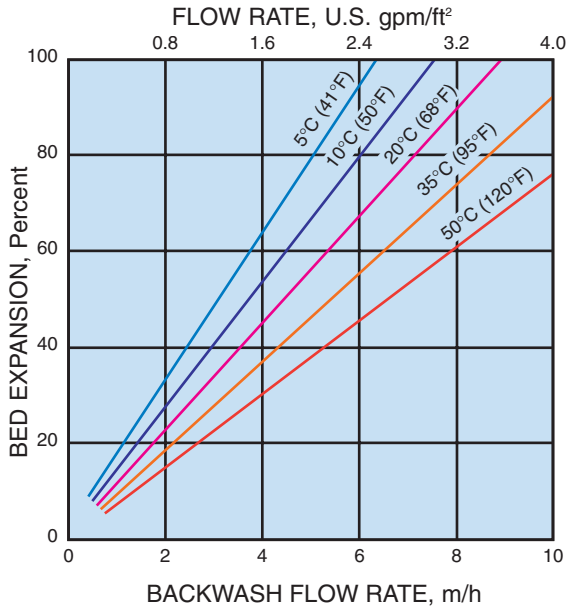


Fig. 2 BACKWASH EXPANSION



During upflow backwash, the resin bed should be expanded in volume by between 50 and 70%. This operation will free it from any particulate matter, clear the bed of bubbles and voids, and reclassify the resin particles, ensuring minimum resistance to flow. Bed expansion increases with flow rate and decreases with temperature, as shown in Fig. 2. Care should be taken to avoid over expansion of the bed.

Conversion of Units	
1 m/h (cubic meters per square meter per hour)	= 0.341 gpm/ft² = 0.409 U.S. gpm/ft²
1 kg/cm²/m (kilograms per square cm per meter of bed)	= 4.33 psi/ft = 1.03 atmos/m = 10 ft H_2O/ft

OPERATING PERFORMANCE

The high selectivity of **Purolite A-520E** for nitrate over sulphate ensures that any necessary reduction in nitrate levels can be achieved even in the presence of high influent sulphate concentration. Hence it so offers the advantage over standard strong base resins that its exchange capacity for nitrates is less affected by a high influent concentration of sulphate. For this reason, although **Purolite A-520E** has a lower total exchange capacity than standard strong base anion resin, its use can produce advantageously higher throughputs for the following reasons.

Both standard gel type or macroporous strong base resins are quite capable of effective nitrate removal where sulphate to total anion ratios are low. However, on account of the high selectivity for sulphate in dilute solutions which follows the order,

$$HCO_3^- < Cl^- < NO_3^- < SO_4^=$$

selective displacement of nitrate by sulphate results in the effective nitrate removal capacity being reduced by sulphate loading. Apart from the obvious disadvantage of the reduction of treated water obtained on cycling, the exchange of both nitrate and sulphate by chloride will result in a less palatable and sometimes less acceptable water than the influent supply, in that the treated water may be more corrosive and the limits for chloride concentration may be exceeded.

PUROLITE A-520E, CO-CURRENT REGENERATION

Fig. 3 OPERATING CAPACITY

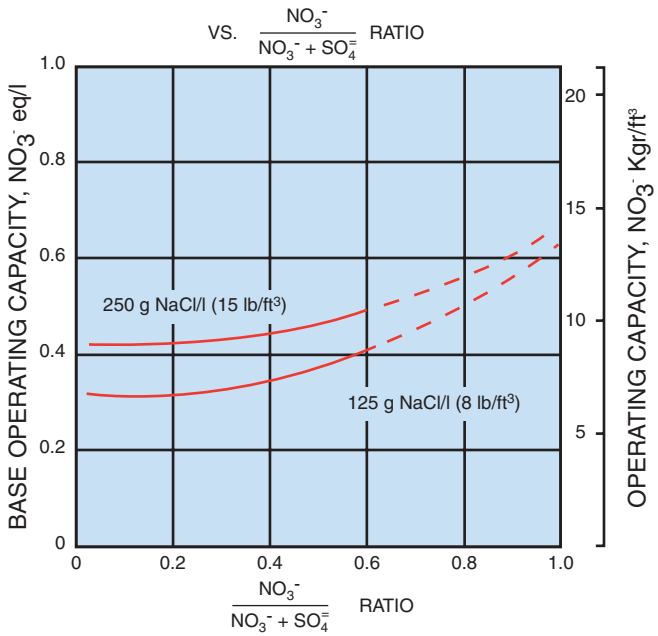


Fig. 4 NITRATE LEAKAGE

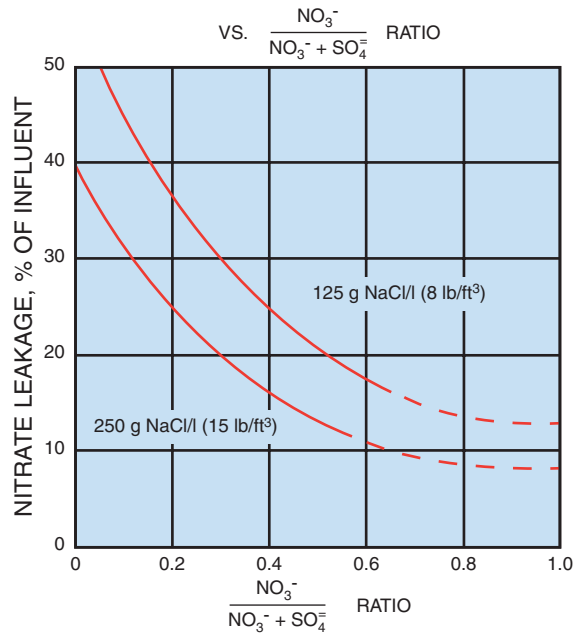


Fig. 3 and Fig. 4 give the operating capacity and nitrate leakage respectively which may be obtained using co-current regeneration at the given regeneration levels. Values obtained from Fig. 3 are expressed in terms of nitrate throughput, corrected for nitrate leakage, and hence may not be used directly to determine the throughput of water. All ion concentration values are either on a ppm or a meq/l basis for ratio determination.

Calculation for throughtput of treated water	
cyclic output (liters) $= \dfrac{V \times OC}{L - l_n} \times 10^3$	where V = resin volume (liters) OC = operating capacity (eq/l) L = nitrate load (meq/l) l_n = nitrate leakage (meq/l)
or cyclic output (U.S. gal) $= \dfrac{V_f \times OC_k \times 10^3}{0.058\,(L_p - l_{np})}$	where V_f = resin volume (ft^3) OC_k = operating capacity (kgr/ft^3) L_p = nitrate load (ppm as $CaCO_3$) np = nitrate leakage (ppm as $CaCO_3$)

Similarly Fig. 5 and Fig. 6 give the values for counter-current regeneration. It should be noted that in this case the nitrate leakage is lower for a given regeneration level. Hence the possibility to blend treated with untreated water on a 50% basis is a useful option which can make counter-current regeneration attractive. On the other hand the choice of co-current regeneration can result in the production of higher volumes of treated water of satisfactory quality for direct use. The higher leakage (l_n, l_{np}, in the equations above) so reduces the load on the ion exchange bed that for a given operating capacity greater throughputs per cycle are obtained. This latter effect can influence the throughput more than differences in basic operating capacity. It therefore follows that both capacity and leakage for alternative modes of regeneration should be evaluated before recommending specific design conditions.

PUROLITE A-520E, CO-CURRENT REGENERATION

Fig. 5 OPERATING CAPACITY

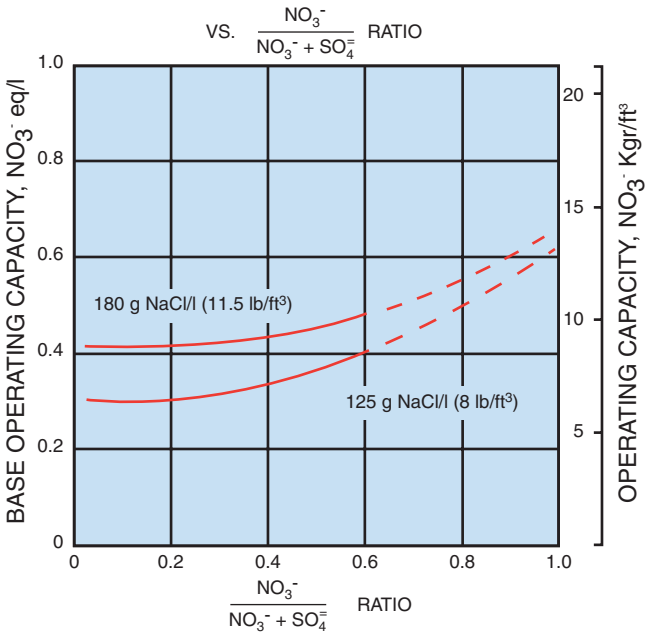
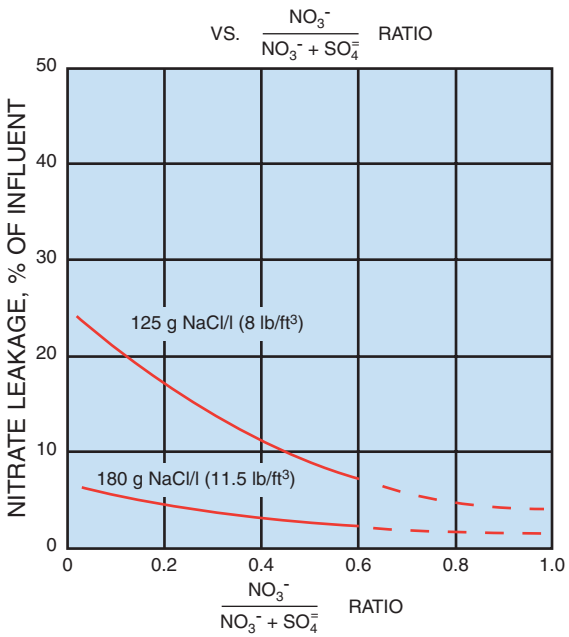


Fig. 6 NITRATE LEAKAGE



Presupposing that the objective of the nitrate removal treatment is to obtain potable water of a quality which meets the World Health Organization (WHO) limit, where the nitrate/(nitrate + sulphate) ratio is higher than 0.6, a nitrate selective resin is not necessary. A standard strong base resin can give higher throughputs as a result of its higher total capacity. It will be seen that up to the ratio of 0.6 the curves in Figs. 3 - 6 are continuous to show where **Purolite A-520E** is the recommended resin. The discontinuous curves are given so that comparisons may be made with alternative resins. Where lower leakages than the WHO limit are required, for example in the processing of certain foods, **Purolite A-520E** will often give a superior performance to the standard resins even where nitrate/(nitrate + sulphate) ratios are higher than 0.6. One particular advantage here is that there is no slug of highly concentrated nitrate at breakthrough as is found with standard resins, hence the possibility to excessively contaminate the food product by overrunning the bed is avoided.

EXAMPLE OF CALCULATION

How to use Figs. 3 through 6.

It is assumed that it is required to treat a well water of the following analysis to produce a nitrate concentration of less than 50 mg/l.

WATER ANALYSIS

Anions	ppm	meq/l	ppm as $CaCO_3$	Cations	ppm	meq/l
Nitrate	93	1.5(L)	76(L_p)	Calcium	90	4.5
Sulphate	98	2.0	100	Magnesium	18	1.5
Chloride	71	2.0	100	Sodium	30	1.3
[HCO_3*	122	2.0	100]	Potassium	8	0.2
Total Anions		7.5		Total Cations		7.5
Equivalent Mineral Acidity (EMA)		5.5				

$$\frac{\text{Nitrate}}{\text{Nitrate + Sulphate}} = \frac{NO_3^-}{NO_3^- + SO_4^=} = \frac{76}{76 + 100} = 0.43$$

*Note: Unless concentration of bicarbonates is well above average it does not affect the performance to a significant extent.

A regeneration level of 125 g NaCl/l has first been chosen, using co-current regeneration.

To calculate the cyclic throughput from the equations given above;

From Fig. 3, Base Capacity at 0.43 for $\frac{NO_3^-}{NO_3^- + SO_4^=} = 0.36$ eq/l

From Fig. 4, Leakage at $\frac{0.43\ NO_3^-}{NO_3^- + SO_4^=} = 23\%$

Hence for each litre of resin, throughput $= (0.36/1.15) \times 10^3$ liters

$= 313$ liters

And for each cubic foot of resin, $= [7.9/(0.058 \times 57.7)] \times 10^3$

$= 2360$ U.S. gal.

Depending upon the throughput requirement the resin volume is chosen so as to operate within the flow rate stipulations given in the standard operating conditions above. A design factor of 0.9 is also recommended as is customary. Hence throughput/liter of resin for design purposes will be 313 x 0.9 = 281.7 liters (2124 U.S. gal/ft^3).

In this example the leakage is 17.3 ppm as $CaCO_3$ (21.4 ppm as NO_3), hence the useful option to blend treated water with raw water on a 50% basis could be applied. It would be of no advantage to move to counter-current regeneration in this case. Reference to Fig. 5 will show that the basic capacity curve is very similar. However the throughput will be lower, because the reduced leakage increases the ion exchange load for a given throughput. When on the other hand nitrate concentrations or ratios are higher, it may be advantageous to operate counter-current rather than increase the regeneration level while operating co-current. In this way a suitable blend may be obtained with lower regenerant costs (and costs of disposal).

NOTES

PUROLITE®
ION EXCHANGE RESINS

WORLDWIDE OFFICES

USA: www.puroliteUSA.com
International: www.purolite.com

U.S.A.
The Purolite Company
150 Monument Road
Bala Cynwyd, PA 19004
Phone: (1) 610-668-9090
Toll Free: 800-343-1500
Telefax: (1) 610-668-8139
Email: sales@puroliteUSA.com

TEXAS
The Purolite Company
1700 West Loop South
Suite 740
Houston, TX 77027
Toll Free: 800-562-6488
Telefax: (1) 713-627-7890

CANADA
The Purolite Company
625 Wabanaki Drive
Unit #2
Kitchener, Ontario N2C 2G3
Toll Free: 800-461 -1500
or (1) 519-896-6674
Telefax: (1) 519-896-6679

UNITED KINGDOM
Purolite International Limited
Kershaw House
Great West Road
Junction with Lampton Road
Hounslow, TW5 OBU
Sales Phone: (44) 181 -570-4454
Telefax: (44) 181-572-7726

European Marketing
Phone: (44) 181-577-1222
Telefax (44) 181-577-1136

GERMANY
Purolite Deutschland GmbH
Harkort Strasse 25
40880 Ratingen
Phone: (49) 2102-46033
Telefax: (49) 2102-443663

FRANCE
Purolite International SARL
34 Avenue Matignon
75008 Paris
Phone: (33) 1-4256-4563
Telex: 648856
Telefax: (33) 1-4563-3826

SPAIN
Purolite Iberica S.A.
Parc Tecnologic del Valles
Centre Empreses Noves Tecnologies
08290 Cerdanyola del Valles (Barcelona)
Phone: (34) 3-582-0266
Telefax: (34) 3-582-0268

EGYPT
Purolite International Middle East
Cairo Liaison Office
12 Obour Gardens
Fifth Floor, App. No. 55
Salah Salem Street
Nasr City, Cairo
Phone: (20) 2-4021477
Telefax: (20) 2-4021478

ITALY
Purolite International S.r.l.
Viale Coni Zugna 29
20144 Milan
Phone: (39) 02-481-8145
Telefax: (39) 02-4801-2359

ROMANIA
Purolite Romania
International Business Center Modern
B-dul Carol I No. 34-36
5th Floor
Bucharest, Sector 2
Phone: (40) 1-250-5053/5028
Telefax: (40) 1-250-5999

POLAND
Head Office
Radus Spolka z o.o.
ul Przebendowskich 33
81-543 Gdynia
Phone/Fax (48) 58-6248118

GLIWICE
Radus Spolka z o.o.
ul Górnych Walów 25
44-100 Gliwice
Phone: (48) 32-315-931
Telefax: (48) 32-315-931

SLASK
Radus Spolka z o.o.
ul 3 Maja 3/33
32-600 Oswiecim
Phone: (48) 33-425-603
Telefax: (48) 33-425-603

CZECH & SLOVAK REPUBLICS
Purolite International
Nad Mazankou 17
182 00 Prague 8
Phone: (420) 2-688-1086
Telefax: (420) 2-688-1086

RUSSIA
Head Office
Purolite International
10th Floor
36 Lyusinovskaya Street
Moscow
Phone: (7) 095-564-8120
Telefax: (7) 095-564-8121

ST. PETERSBURG
Purolite International Limited
12 Building A Tambovskaya St.
St. Petersburg
192007 Russian Federation
Phone: (7) 812-327-8530
Telefax: (7) 812-327-9079

KAZAKHSTAN
Purolite RH Limited
Office 205
240 Dostyk AV.
Almaty 480051
Phone: (7) 3272-641-234
Telefax: (7) 3272-641-234

SINGAPORE
Purolite International (Singapore)
PTE Limited
32-04 The Concourse
300 Beach Road, 199555
Phone: (65) 297-0889
297-1453
Telefax: (65) 297-1986

CHINA
Head office
Purolite (China) Company, Ltd.
Chengguan Town
Deqing County
Zhejiang Province 313200
Phone: (86) 572-842-2908
Telefax: (86) 572-842-3954

TAIWAN
Purolite International
16F-2, No. 191
Fu-hsing N. Road,Taipei
Phone: (886) 2-546-7078
Telefax: (886) 2-546-7069

MEXICO
Purolite International, S.A. De C.V.
World Trade Center
Montecito 38, Piso 33,Oficina-19
Mexico D.F. 03810
Phone: (52) 5-488-0904
Telefax: (52) 5-488-0906

UKRAINE
Purolite International Limited
2 Korolenko Street.
Dnepropetrovsk 320070
Phone: (38) 0562-320-065
0562-320-066
Telefax: (38) 0562-320-067

KOREA
Purolite International (Korea) LLC
Dae Yeon Bldg., Suite 403
943-30 Daechi-dong
Kangnam-gu, Seoul
Phone: (82) 2-3453-7062/7063
Telefax: (82) 2-3453-7064

A-520E/1299/SOP