# Nitrate III
# PRODUCT DATA SHEET

## Product Description

Nitrate III is a clear gel Type I strong-base anion exchanger with both high operating capacity and the ability to achieve low residual silica levels. IVlinimal quantities of caustic soda are required compared with those typical of the classical Type I quaternary ammonium structure based on polystyrene. It has a clear gel structure, showing excellent regeneration efficiency and rinse characteristics. Nitrate III functions well both in mixed bed and layered bed demineralizer systems, where specially tailored particle size ranges result in achieving or maintaining good separations. Nitrate III has exceptional physical stability for a conventional gel-type resin which permits a long life without the development of excessive pressure drop; it also shows good kinetics of exchange, enabling very low concentration levels of both strong and weak acid anions to be achieved at practical flowrates.

| Typical Physical & Chemical Characteristics | |
|---|---|
| Polymer Matrix Structure | Polystyrene cross-linked with Divinylbenzene |
| Physical Form and Appearance | Clear golden spherical beads |
| Whole Bead Count | 90% min. |
| Functional Groups | Type I Quaternary Ammonium |
| Ionic Form, as shipped | $Cl^-$ |
| Shipping Weight (approx.) | 680 - 695 g/l (42.5 -43.5 lb/ft$^3$) |
| Screen Size Range:<br>- US. Standard Screen | <br>16 - 50 mesh, wet |
| Particle Size Range | +1.2 mm <2%, 03 mm <1% |
| Moisture Retention, $Cl^-$ form | 48 - 54% |
| Reversible Swelling $Cl^- \rightarrow OH^-$ | 1.08 |
| Total Exchange Capacity, $Cl^-$ form,<br>wet, volumetric<br>dry, weight | <br>1.3 eq/l min.<br>3.7 eq/kg min. |
| Operating Temperature, $Cl^-$ Form | 100°C (212°F) max. |
| Operating Temperature, $OH^-$ Form | 30°C (140°F) max. |
| pH Range, Stability | 0 - 13 |
| pH Range, operating | 0 - 8 |

| Standard Operating Conditions<br>(Two-stage Demineralization, Co-flow Regeneration) | | | | |
|---|---|---|---|---|
| **Operation** | **Rate** | **Solution** | **Minutes** | **Amount** |
| Service | 8 - 32 BV/h<br>1.0 - 5.0 gpm/ft$^3$ | Decationized water | per design | per design |
| Backwash | 5 - 7.5 m/h<br>2.0 - 3.0 gpm/ft$^2$ | Decationized water<br>10 - 40°C<br>(50 - 105°F) | 5 - 20 | 1.5 - 3 BV<br>10 - 25 gal/ft$^3$ |
| Regeneration | 2 - 4 BV/h<br>0.25 - 0.50 gpm/ft$^3$ | 4 - 6% NaOH | 30 - 60 | 64 - 160 g/l<br>4 -10 lb/ft$^3$ |
| Rinse, (slow) | 2 - 7 BV/h<br>0.25 - 0.50 gpm/ft$^3$ | Decationized water | 30 approx. | 2 - 5 BV<br>15 - 40 gal/ft$^3$ |
| Rinse, (fast) | 8 - 32 BV/h<br>l - 4 gpm/ft$^3$ | Decationized water | 20 approx. | 3 - 6 BV<br>25 - 45 gal/ft$^3$ |
| Backwash Expansion 50% to 75%<br>Design Rising Space 100%<br>"Gallons" refer to U.S. Gallon = 3,785 liters | | | | |

# Operating Performance (Co-Flow Operation)

Although the total exchange capacity of Nitrate III is greater than 1.3 equivalents per liter (:284 Kgr/fts) of resin bed, normal operating capacities lie in the range between 0.5 and 0.9 equiv./l (10.9 and 19.7 kgr/fts respectively). The operating capacity actually obtained is dependent on:
a) The regeneration level used,
b) The ratio of sulphate + carbonate to total anions,
c) The ratio of silica to total anions, where the NaOH regenerant temperature is less than about 30°C, 86°F.

The data required to estimate base operating capacities under conditions a) & b) are given in Figs. 7 & 8. The operating capacity also depends upon the end point silica leakage as well as on c) above . Figs. 9 & 10 give correction factors to calculate the operating capacity obtainable. Base values for silica leakage are indicated in Fig. 3. The reciprocal correction factor for the effect of the influent sodium concentration on silica residuals is shown in Fig. 5, and that for the temperature of regenerant is shown in Fig. 6. (The base silica leakage should be divided by these factors to obtain the actual silica leakage.)

# Mixed Bed

While these graphs give a close approximation to the practical working of an individual column of Nitrate III, mixed-bed operation can produce near-zero residuals. High quality water with a conductivity of 0.055 HSCI'ILI (18 megohm water), or better, can be obtained, provided that the inlet has previously been treated either using an efficient reverse osmosis system, or a two stage deionizer. This quality can be obtained even where there are traces of residual organics in the deionized feed to the mixed bed. However, inefficiencies in separation of the cation and anion components, and consequent cross-contamination of the resins with traces of cations or anions respectively, may reduce the expected operating capacity by between 10 and 20%.

| Standard Operating Conditions<br>(Two-stage Demineralization, Counter-flow Regeneration) | | | | |
|---|---|---|---|---|
| **Operation** | **Rate** | **Solution** | **Minutes** | **Amount** |
| Service | 8 - 40 BV/h<br>1.0 - 5.0 gpm/ft$^3$ | Decationized water | per design | per design |
| Backwash | 5 - 7.5 m/h<br>2.0 - 3.0 gpm/ft$^2$ | Decationized water<br>10 - 40°C<br>(50 - 105°F) | 5 - 20 | 1.5 - 3 BV<br>11 - 22 gal/ft$^3$ |
| Regeneration | 2 - 4 BV/h<br>0.25 - 0.50 gpm/ft$^3$ | 3 - 6% NaOH | 30 - 60 | 48 - 160 g/l<br>3 -10 lb/ft$^3$ |
| Rinse, (slow) | 2 - 4 BV/h<br>0.25 - 0.50 gpm/ft$^3$ | Decationized water | 30 approx. | 2 - 4 BV<br>15 - 30 gal/ft$^3$ |
| Rinse, (fast) | 8 - 40 BV/h<br>1.0 - 5.0 gpm/ft$^3$ | Decationized water | 20 approx. | 3 - 6 BV<br>22 - 45 gal/ft$^3$ |
| Backwash expansion recommended (when reqd,) 50% to 75%. It is generally recommended that the bed is at least loosened and suspended solids (if any), removed every 5 » 20 cycles. Design rising space (according to design) 10% min. “Gallons” refer to US. Gallon = 3.785 liters | | | | |

# Operating Performance (Counter-Flow Operation)

Nitrate III is recommended where counter-flow operation is indicated - that is where low leakages and improved operating capacity are needed. Its high resistance to attrition under the recommended operation conditions ensures a treated water of the highest quality obtainable from this mode of operation. Such water can be low in both residual ions, and particulate matter. The treated water obtainable is especially suitable for further processing.

The data required to estimate operating capacities under a general range of conditions are given in Figs. 11 & 12. Correction factors for silica end point leakage, and silica to total anions ratio are given in Figs 13 & 14. Base values for silica leakage are indicated in Fig. 4 while the reciprocal factors for the influent sodium concentration on silica residuals is shown in Fig. 5, and that for temperature correction given in Fig. 6.

# Regeneration

Nitrate III is supplied in the chloride form and must be regenerated with a good grade of sodium hydroxide. Efficient completion ofthe regeneration with a displacement rinse at the same flow rate, will ensure that rinse volumes required to produce treated water of satisfactory quality during the subsequent fast rinse stage are extremely low. Where the ratio of silica to total anions in the feed solution is high, for example where the strong base anion unit is positioned afier a weak base anion unit, the use ofwarm caustic soda will reduce silica leakage, and will prevent build-up of silica in the resin. For maximum efficiency the resin bed should be preheated prior to regeneration. This is particularly important where the temperature differential between the influent water and the regenerant is large. Rinsing with warm water is also recommended.

# Hydraulic Characteristics

The pressure drop (headloss) across a properly classified bed of ion-exchange resin depends on the particle size distribution, bed depth, and void volume of the exchanger, as well as on the flowrate and viscosity (and hence on the temperature) of the influent solution. Anything affecting any of these parameters, for example the presence of particulate matter filtered out by the bed, abnormal compaction of the resin bed, or the incomplete classification of the resin spheres will have an adverse effect, and result in an increased headloss. Typical values of pressure drop across a bed of Nitrate III are given in Fig.1, below, for a range of operating flowrates.

**Fig. 1 PRESSURE DROP VS FLOW RATE**

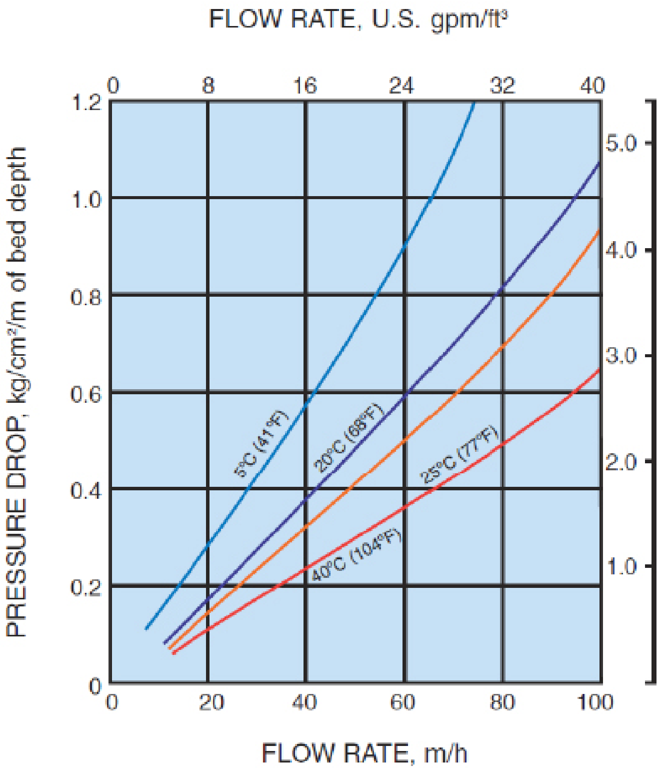
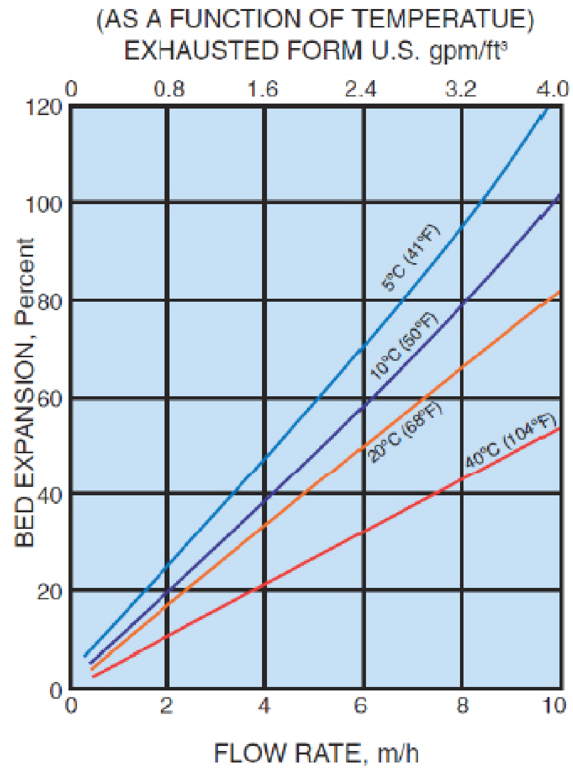



**Fig. 2 BACKWASH EXPANSION**




During backwash, the resin bed should be expanded in volume by 50 to 75%, at least, in order to free it from any particulate matter removed from the influent solution, to clear the bed of bubbles and irregular voids, and to reclassify the resin particles as much as possible, ensuring minimum resistance to flow. Backwash should be commenced gradually to avoid an initial surge with consequent carryover of resin particles. Bed expansion increases with flow rate and decreases with temperature, as shown in Fig.2. Care should always be taken to avoid resin loss by accidental over-expansion of the bed.

| Conversion of Units | |
|---|---|
| 1 m/h (cubic meters per square meter per hour) | = 0,341 gpm/ft$^2$<br>= 0,409 US. gpm/ft$^2$ |
| l kg/cm$^2$/m (kilograms per square cm per meter of bed) | = 4.33 psi/ft<br>= 1.03 atmos/m<br>= 10 ft $H_2O$/ft |

# Chemical and Thermal Stability

Nitrate III is insoluble in dilute or moderately concentrated acids, alkalies, and in all common solvents. However, exposure to significant amounts of free chlorine, “hypochlorite” ions, or other strong oxidizing agents over a period of time will degrade the resin and break down the crosslinking. This can reduce the ion exchange capacity or increase the moisture retention of the resin, decreasing its mechanical strength, and should be avoided. This resin, like all conventional polyvinybenzyl quatemary ammonium resins is thermally unstable in the hydroxide form under alkaline conditions, and at temperatures over about 70°C, 160°F, breaks down by two parallel mechanisms. The first results in nitrogen loss, (and hence loss of capacity), while the second path results in the formation of weak-base groups. The recommended maximum operating temperature per-mits an economic half-life without significant loss of capacity. The salt forms of the resin are at least two orders of magnitude more stable, but can still break down at higher temperatures with loss of strong-base capacity.

# Operating Capacity Calculation

If the influent water analysis is known, and service flow rate, regeneration level, the treated water quality/quantity are specified, the capacity and leakage curves may be used directly to determine the operating capacity of the resin. Hence the volume of resin required for the unit which is needed to produce the water quantity of the quality specified, may be calculated. Several factors may influence the choice of regeneration level and service flow rate such as the silica leakage requirement in the treated water, the need to balance the excess regenerant from cation and anion units to give a neutral effluent, the need to optimize capital and running costs, the availability of regenerants, choice of convenient intervals between regenerations, and so on. In the following example the use of the operating capacity and leakage curves is illustrated for a specified treatment including regeneration level and flow rate.

**INFLUENT WATER ANALYSIS**

| | ppm $CaCO_3$ | meq/l | Total Anions % |
|---|---|---|---|
| Cl | 45 | 0.9 | 41 |
| $SO_4$ | 50 | 1.0 | 45 |
| $SO_2$ | 5 | 0.1 | 5 |
| $SiO_2$ | 10 | 0.2 | 9 |
| Total | 110 | 2.0 | 100 |

**TREATMENT**

Regeneration with NaOH at : 80 g/l, (5 lb/ft³)
Co-flow, at Temp : 25°C, 77°F
Flow rate : 40 BV/h, 5 gpm/ft³
Sodium leakage : 0.40 ppm as $CaCO_3$
(ex-cation bed)
End Point $SiO_2$ leakage = 100 ppb
(above permanent leakage)

**CAPACITY CALCULATION**

For a feed with 45% sulphate and 5% $CO_2$, divalent ions equals 50%. Fig. 3 shows: Base operating capacity $C_B$ for 80g/l (5lb/ft³) of NaOH, for 50% divalent ions at 25°C, 77°F

= 0.58 eq/l, 12.7 Kgr/ft³.

Correction Factors for end point silica leakage of 100 ppb, (Fig. 9)

$C_1 = 0.94$

and 9% $SiO_2$ (Fig. 10)

$C_2 = 0.99$

Hence operating capacity

$= C_B \times C_1 \times C_2$

0.58 x 0.94 x 0.99 = 0.54 eq/l, 11.8 Kgr/ft³.

Applying the customary engineering design factor of 0.9, the operating capacity obtainable

= 0.54 x 0.9 = 0.49 eq/l,

= 10.6 Kgr/ft³

**SILICA LEAKAGE**

Base silica $B_s$ for 80g NaOH/1, (5lb/ft³) at 9% $SiO_2$/Total Anions

= 15 ppb (Fig. 3)

Correction factor* for Na leakage

$K_1 = 0.94$ (Fig. 5)

Correction factor* for NaOH Temp. at 9% $SiO_2$ (Fig. 6)

$K_2 = 0.72$

Operational silica leakage

$= B_s / K_1 \times K_2 = 15 / 0.94 \times 0.72$

= 22 ppb

**NOTE:**

In cases where an intermediate regeneration level and % silica of total anions is required, please interpolate.

* Reciprocal correction factors in this example