

Technical Data

PRODUCT DESCRIPTION

Purofine PFA-300 is a gel type II strong base anion exchange resin which because of its **Special Narrow Size Distribution** has **Particularly High Operating Capacity** at lower regeneration levels, where its **Superior Regeneration Efficiency** is most marked. It is the resin of choice where the water to be treated contains a high proportion of mineral acids (as opposed to silica). It is also relatively less susceptible to organic fouling than are standard gel-type strong base anion resins. Consequently higher purity treatment waters (or other solution) can generally be obtained, and rinse volumes, and hence rinse times are

considerably reduced. However normal care should be taken that the maximum temperature of operation and regeneration applicable to type II resins (given below) is not exceeded.

The increased capacity which is available may be used to obtain longer runs and higher throughputs, which can also be realised where small or shallow resin beds are required. These significant advantages result from improved optimum rates of ion exchange loading and regeneration. Thus useful economies may be made both to operating and capital costs.

Typical Physical, Chemical & Operating Characteristics

Polymer Matrix Structure	Cross-linked Gel Polystyrene
Appearance	Uniform amber spherical beads
Whole Beads	95% min.
Functional Groups:	R-(CH ₃) ₂ (C ₂ H ₄ OH)N ⁺
Ionic Form (as shipped)	Cl ⁻
Shipping Weight	690 g/l (43 lb/ft ³)
Screen Size Distribution:	
Median Volume Diameter:	560 +/- 40 microns
Distribution:	90% +/- 100 microns
Screen Size: (British Standard Screen)	22-36 mesh wet
(U.S. Standard Screen)	25-40 mesh wet
Particle Size Range	+ 0.710mm < 1%: - 0.425mm < 1%
	(25 U.S. mesh) (40 U.S. mesh)
Moisture Retention: Cl ⁻ form	40-45%
Maximum Swelling, Cl ⁻ ->OH ⁻	10% max
Specific Gravity, Moist Cl ⁻ Form	1.10
Total Exchange Capacity, Cl ⁻ form, wet volumetric	1.4 eq/l min
dry weight	3.3 eq/kg min
Operating Temperature, OH ⁻ Form, max	40°C (104°F)
Cl ⁻ Form, max	85°C (212°F)
pH range	no limitations

STANDARD OPERATING CONDITIONS

(Two-stage Demineralisation, Co-flow Regeneration)

Operation	Rate	Solution	Minutes	Amount
Service	8 – 60 BV/h (1.0 – 7.5 gpm/ft ³)	Decationised Water	—	—
Backwash	3.75 – 7.5 m/h (1.5 – 3.0 gpm/ft ²)	Decationised Water 5°-25°C, 41°-77°F	5 – 20	1.5 – 3 BV (10 – 25 gal./ft ³)
Regeneration	2 – 4 BV/h (0.25 – 0.50 gpm/ft ³)	3 – 5% NaOH	30 – 60	48 – 128 g/l (3 – 8 lb/ft ³)
Rinse, (slow)	2 – 4 BV/h (0.25 – 0.50 gpm/ft ³)	Decationised Water	30 (approx)	1 – 3 BV (8 – 25 gal/ft ³)
Rinse, (fast)	8 – 40 BV/h (1.0 – 5.0 gpm/ft ³)	Decationised Water	30 (approx)	1 – 5 BV (8 – 40 gal/ft ³)
	Backwash expansion recommended		50% to 75%	
	Design rising space recommended		100%	
	“Gallons” refer to U.S. Gallon =		3.785 Litres	

REGENERATION

Purofine PFA-300 is supplied in the chloride form and must be regenerated with a good grade of sodium hydroxide before use. The slow rinse is used to complete the displacement of the regenerant. If this is carried out carefully at the recommended

flow rates, it will reduce the need for a fast rinse to a very low volume. In fact total rinse volumes for **Purofine PFA-300** can often be reduced to values as low as 2 Bed Volumes (15 gal/ft³) depending on the quality of the feed water used for the rinse.

OPERATING PERFORMANCE

Purofine PFA-300 is especially recommended for a two-stage demineralisation following a strong acid cation exchange resin, **Purofine PFC-100 type** or **Purolite C-100**. It is recommended especially where the proportion of silica to total anions is low (less than 30%). The optimum size distribution ensures that the **Purofine** system offers advantages in lower regenerant costs, reduced rinse volumes, and greater flexibility in obtaining a neutral effluent in plant design. Although the total exchange capacity of **Purofine PFA-300** is over 1.4 eq/l (30.5Kgr/ft³), normal operating capacities lie in the range between 0.7 and 1.1 eq/l (15 – 24 Kgr/ft³).

The operating capacity obtained is dependent on:

a) The regeneration level used, and its temperature.

- b) The ratio of sulphate plus carbon dioxide to total anions.
- c) The ratio of silica to total anions.

The data required to estimate operating capacities under these conditions are given in Figs. 3, 5 & 7. Average values for silica leakage are indicated in Fig. 4 while the effect of the influent sodium concentration on silica residuals is shown in Fig. 6, and the effect of regeneration temperature is shown in Fig. 8. Particularly in downflow operation, the absence of larger beads normally present in the standard resins ensures a sharper exhaustion profile, which can result in lower leakage prior to breakthrough. Also there exists the possibility of operation at higher flow rates, and because of better utilisation of ion exchange sites within each bead, **Purofine PFA-300** undergoes better regeneration and rinse.

The efficiency of regeneration is also improved for additional reasons. Diffusion from larger beads is the limiting factor in both the extent of regeneration, and the rinse volume required to remove excess regenerant containing the ions responsible for exhaustion. This is particularly true where these ions are divalent (sulphate and carbonate). Both these ions are easily removed during regeneration where ionic concentrations are highest. However all anion resins selectively hold divalent ions in dilute solution. Hence once the displacement rinse is applied, these ions diffusing out of the beads towards the end of the regeneration, will selectively displace regenerant ions as the ionic concentration within the bead is reduced. In beads of smaller diameter, the diffusion path is shorter, hence a larger proportion of these ions will have diffused out of the beads and consequently cannot return to previously regenerated sites. Hence not only is the efficiency of regeneration improved, but also rinse volumes are significantly reduced. This latter advantage is partly applicable to **Purofine PFA-300**. This is because type II resins in lifetime use, can undergo well known chemical changes in which a proportion of ion exchange sites are

converted to weak base functionality, especially where operation is at or near maximum recommended temperature. Indeed this can increase regeneration efficiency. However silica removal capability is often reduced, and rinse volumes are extended, bringing forward the decision on resin replacement. It follows that a resin with superior rinse characteristics can offer better performance over an extended lifetime.

The elimination of that fraction of beads, smallest in diameter and volume, increases the voids fraction and reduces the pressure drop, (See Section on "Hydraulic Characteristics"). These advantages also apply to counter-flow regeneration systems. However where regeneration is upflow, the smaller beads of the distribution are to be found at the outlet, hence the efficiency is good for the **Purolite** range, and the advantages of the **Purofine** resins are reduced in gross terms.

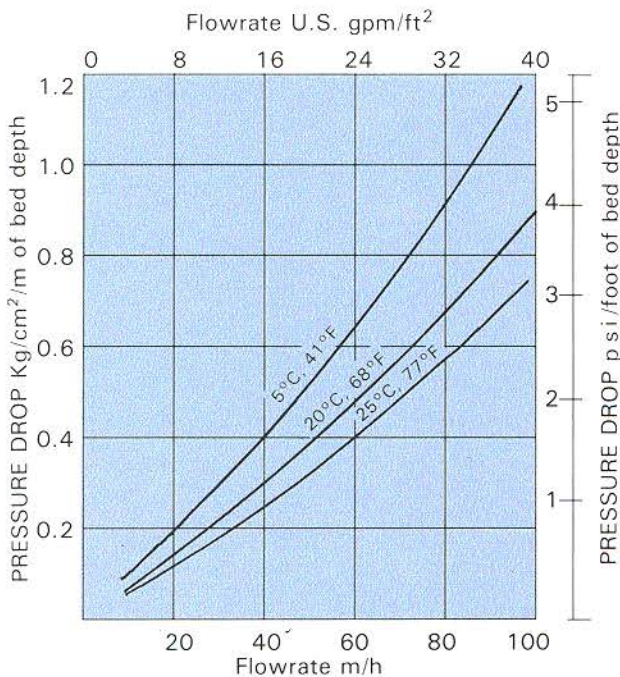
Nevertheless where the treated water quality needs to be of high purity, the capability to achieve a superior chromatographic profile throughout the bed results in a lower silica leakage at the bed outlet, which can be of benefit in a number of applications, particularly in high technology systems.

HYDRAULIC CHARACTERISTICS

The pressure drop (headloss) across a properly classified bed of ion-exchange resin depends on the particle size distribution, bed depth, and voids volume of the exchanger, and 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

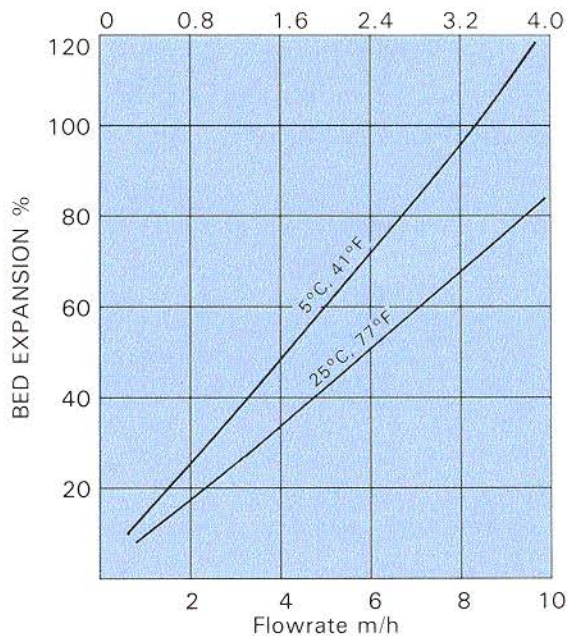
matter filtered out by the bed, abnormal compaction of the resin bed, or the incomplete classification of the resin spheres will have an adverse effect, and result in an increased headloss. Typical values of pressure drop across a bed of **Purofine PFA-300** are given in Fig. 1 below, for a range of operating flowrates.

Fig. 1 PRESSURE DROP Vs FLOWRATE



During upflow backwash, the resin bed should be expanded in volume between 50 and 75%, in order to free it from any particulate matter from the influent solution, to clear the bed of bubbles and voids, and to reclassify the resin particles as much as possible, ensuring minimum resistance to

Fig. 2 BACKWASH EXPANSION (as a function of temperature) (Exhausted and regenerated forms) Flowrate U.S. gpm/ft²



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 metres per square metre per hour)
 - = 0.341 gpm/ft²
 - = 0.409 U.S. gpm/ft²
- 1 Kg/cm²/m (kilograms per square cm per metre of bed)
 - = 4.33 p.s.i./ft.
 - = 1.03 atmos/m
 - = 10 ft.H₂O/ft

CHEMICAL AND THERMAL STABILITY

Purofine PFA-300 is insoluble in dilute or moderately concentrated acids, alkalis, and in all common solvents. However, exposure to significant amounts of free chlorine, "hypochlorite" ions, or other strong oxidising agents over a period of time will break down the crosslinking. This could increase significantly the moisture retention of the resin, decreasing its mechanical strength and

total capacity, and should be avoided. This resin like all conventional poly(vinylbenzyl) quaternary ammonium resins is thermally unstable in the hydroxide form under alkaline conditions, and at temperatures over about 40°C, 105°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 permits 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, and hence ability to remove silica from solution.

OPERATING CAPACITY CALCULATION

If the influent water analysis is known, and service flowrate, 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 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 optimise 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

	meq/l	ppm as CaCO ₃	Total Anions %
Cl	1.0	50	45
SO ₄	1.0	50	45
CO ₂	0.1	5	5
SiO ₂	0.1	5	5
Total	2.2	110	100

TREATMENT (Specified)

Regeneration with NaOH at 64g/l, 4lb/ft³
 Co-flow, at temperature = 25°C, 77°F
 Flow rate = 40BV/h, 5gpm/ft²
 Sodium leakage = 100ppb.
 (ex cation bed)
 End point SiO₂ leakage above
 permanent leakage = 200ppb

CAPACITY Calculation

For a feed water with 45% sulphate and 5% CO₂, divalent ions equals 50%.

Reference to Fig. 3 shows base operating capacity for 64g/l of NaOH and 50% divalent ions

$$= 0.83 \text{ eq/l, } 18.1 \text{ Kgr/ft}^3$$

Correction factor for regeneration temperature of 25°C, 77°F and 5% silica of total anions, (Fig. 5) $C_1 = 0.98$

Correction factor fo SiO₂ end-point leakage of 200ppb, (Fig. 7) $C_2 = 0.97$

Hence operating capacity = $C_b \times C_1 \times C_2$

$$0.83 \times 0.98 \times 0.97 = 0.79 \text{ eq/l, } 17.2 \text{ Kgr/ft}^3$$

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

$$0.79 \times 0.9 = 0.71 \text{ eq/l, } 15.5 \text{ Kgr/ft}^3$$

SILICA LEAKAGE

Base silica leakage B_s for 64g NaOH/l at 5% SiO₂/Total Anions = 50ppb (Fig. 4).

Reciprocal Correction factor for Na leakage $K_1 = 0.96$ (Fig. 6).

Reciprocal Correction factor for regeneration temperature of 25°C, 77°F K_2 (Fig. 8)

$$= 0.85$$

Operational silica leakage

$$= B_s / K_1 \times K_2 = 50 / 0.96 \times 0.85 = 61 \text{ ppb}$$

PLANT DESIGN

If the silica leakage is a prime requirement, the maximum operating silica leakage specified should be corrected by multiplying by K_1 (correction for sodium) and K_2 (correction for temperature of regenerant to be considered) to derive the necessary base leakage B_s . Thus the regeneration level which gives B_s is found from Fig. 4. The operating capacity is then calculated as given in the example above. Where the treated water requirement specifies a conductivity, several options are possible. Generally the practical convenience of the operation is a major factor. Considerations such as intervals between regenerations, size of plant, need for continuous flow are as important as

chemical consideration. Hence It may be necessary to modify the design calculation to take account of other factors as mentioned above, and additionally to ensure that flowrates are within the required limits and that any need for neutral influent is met, etc. Where there is no specification for silica, conductivity leakage under $10\mu\text{Scm}^{-1}$ is obtainable using Figs. 3 & 5 at zero SiO_2 . Conductivity of less than $2\mu\text{Scm}^{-1}$ is generally obtainable using counter-flow regeneration incorporating a short recycle rinse prior to service. The use of **Purofine PFA-300 in place of standard type II resins will substantially reduce the recycle rinse volume.**

PUROFINE PFA-300

(Co-flow Regeneration)

Fig. 3 BASE OPERATING CAPACITY

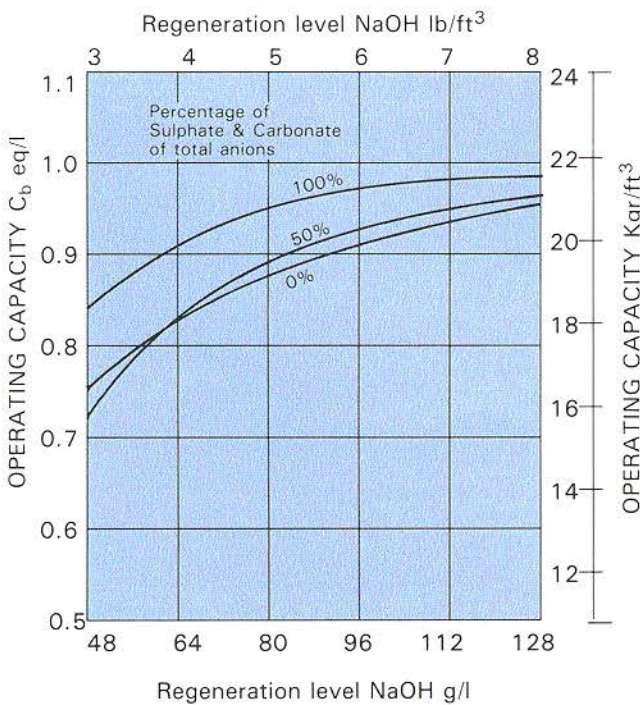
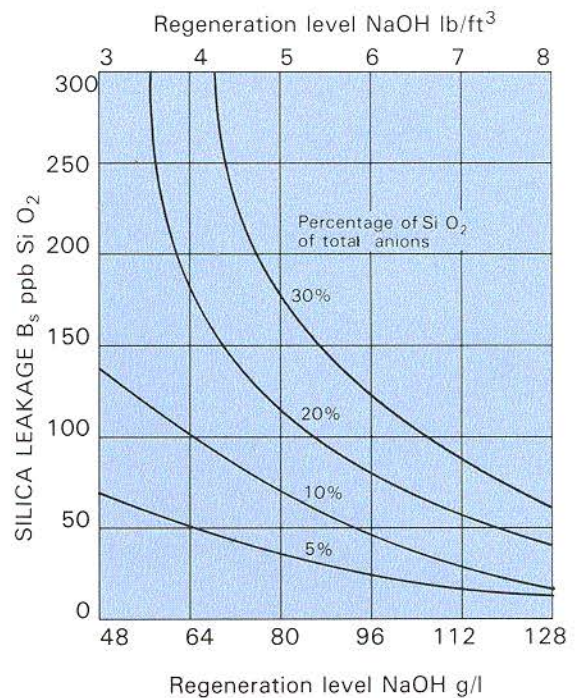


Fig. 4 BASE SILICA LEAKAGE



PUROFINE PFA-300

Fig. 5 CAPACITY CORRECTION FACTOR FOR TEMPERATURE OF REGENERANT

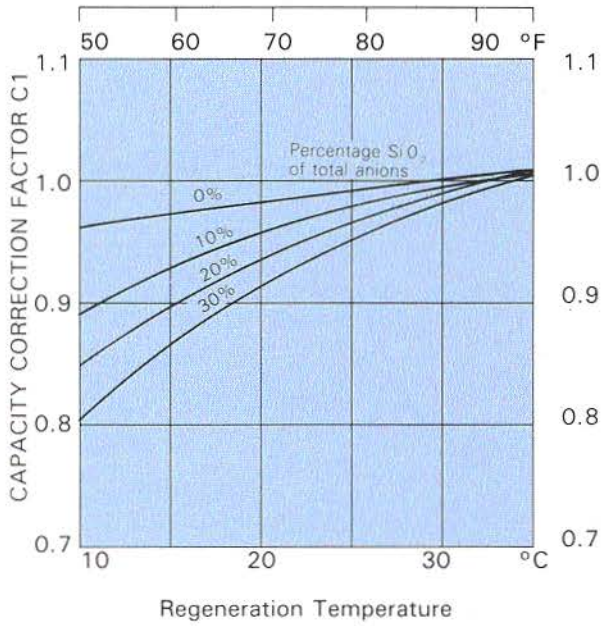


Fig. 6 SILICA LEAKAGE RECIPROCAL CORRECTION FACTOR FOR SODIUM IN DECATONISED WATER

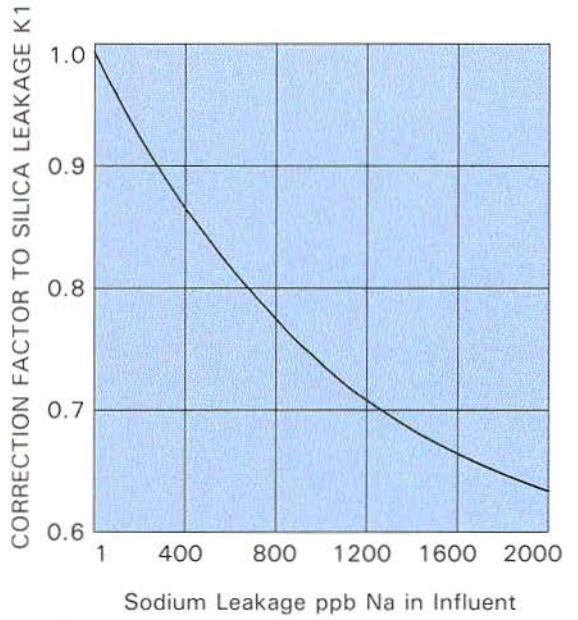


Fig. 7 CAPACITY CORRECTION FACTOR FOR SILICA END-POINT LEAKAGE (Above Permanent Leakage)

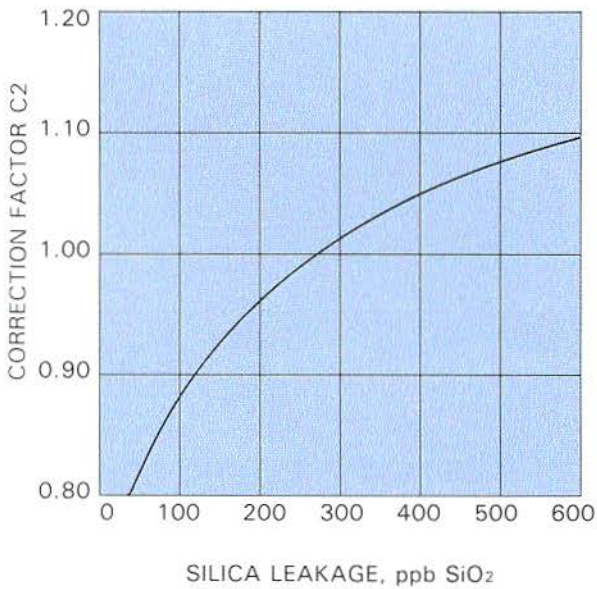


Fig. 8 SILICA LEAKAGE CORRECTION RECIPROCAL FACTOR FOR TEMPERATURE OF REGENERANT

