

**PFA-400**  
**Strong Base Anion  
Exchange Resin**

Uniformly Sized.  
For fast regeneration-efficient demineralization

**Technical Data**

**PRODUCT DESCRIPTION**

**Purofine PFA-400** is a gel type I strong base anion exchange resin which because of its *Special Narrow Size Distribution* has *High Operating Capacity* particularly at lower regeneration levels, where the effect of its *Superior Regeneration Efficiency* is most marked. It is also relatively less susceptible to organic fouling than are standard gel-type strong base anion resins. Consequently higher purity treatment waters can generally be obtained.

The *High Operating Capacity* may be used to obtain longer runs and higher throughputs, which can also be realized where small or shallow resin beds are required. These significant advantages result from improved optimum rates of ion exchange loading and regeneration. Hence operation at high flow rates which are normally detrimental to the performance of conventional anion exchange resins is perfectly satisfactory. Thus useful economies may be made both in operating and capital costs.

Typical Physical & Chemical Characteristics	
Polymer Matrix Structure	Crosslinked Gel Polystyrene
Physical Form and Appearance	Uniform Amber Spherical Beads
Whole Bead Count	95% min.
Functional Groups	R(CH <sub>3</sub> ) <sub>3</sub> N <sup>+</sup>
Ionic Form, as shipped	Cl <sup>-</sup>
Shipping Weight (approx.)	690 g/l (43 lb/ft <sup>3</sup> )
Screen Size Distribution: - Median Volume Diameter - Distribution	560 ±40 microns 90% within ± 100 microns
Screen Size Range: - U.S. Standard Screen	25 - 40 mesh, wet
Particle Size Range	+0.710 mm <1%, -0.425 mm <1%
Moisture Retention, Cl <sup>-</sup> form	48 - 54%
Swelling Cl <sup>-</sup> → OH <sup>-</sup>	20% max.
Specific Gravity, moist Cl <sup>-</sup> Form	1.08
Total Exchange Capacity, Cl <sup>-</sup> form, wet, volumetric dry, weight	1.3 eq/l min. 3.7 eq/kg min.
Operating Temperature, OH <sup>-</sup> Form Cl <sup>-</sup> Form	60°C (140°F) max. 100°C (212°F) max.
pH Range, Stability	No Limitations

Standard Operating Conditions (Two-Stage Demineralization, Co-Flow Regeneration)				
Operation	Rate	Solution	Minutes	Amount
Service	8 - 60 BV/h 1.0 - 7.5 gpm/ft <sup>3</sup>	Decationized water	per design	per design
Backwash	Refer to fig. 2	Decationized water 5° - 25°C (41° - 77°F)	5 - 20	1.5 - 3 BV 10 - 25 gal/ft <sup>3</sup>
Regeneration	2 - 4 BV/h 0.25 - 0.5 gpm/ft <sup>3</sup>	3 - 5% NaOH	30 - 60	48 - 128 g/l 3 - 8 lb/ft <sup>3</sup>
Rinse, (slow)	2 - 4 BV/h 0.25 - 0.5 gpm/ft <sup>3</sup>	Decationized water	30 approx.	1 - 2 BV 8 - 16 gal/ft <sup>3</sup>
Rinse, (fast)	8 - 40 BV/h 1.0 - 5.0 gpm/ft <sup>3</sup>	Decationized water	15 approx.	1 - 5 BV 8 - 40 gal/ft <sup>3</sup>
Backwash Expansion 50% to 75%				
Design Rising Space 100%				
"Gallons" refer to U.S. Gallon = 3.785 litres				

## REGENERATION

**Purofine PFA-400** 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 volume required for a fast rinse. In fact total rinse

volumes for **Purofine PFA-400** can often be reduced to values as low as 2 Bed Volumes (16 gal/ft<sup>3</sup>) depending on the quality of the feed water used for the rinse. Where hot sodium hydroxide is indicated, (where the ratio of silica to total anions is high), heating the resin bed prior to regeneration is recommended.

## OPERATING PERFORMANCE

**Purofine PFA-400** is especially recommended for a two-stage demineralization following a strong acid cation exchange resin, **Purofine PFC-100** or **Purolite C-100**. 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-400** is over 1.3 eq/l (≡ 28 kgr/ft<sup>3</sup>), normal operating capacities lie in the range between 0.5 and 0.9 eq/l (11 - 20 kgr/ft<sup>3</sup>).

The operating capacity obtained is dependent on:

- The regeneration level used.
- The ratio of sulphate plus carbon dioxide to total anions.
- 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 down-flow operation, the absence of larger beads 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 utilization of ion exchange sites within each bead, regeneration of **Purofine PFA-400** is significantly more efficient.

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 concentration is 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.

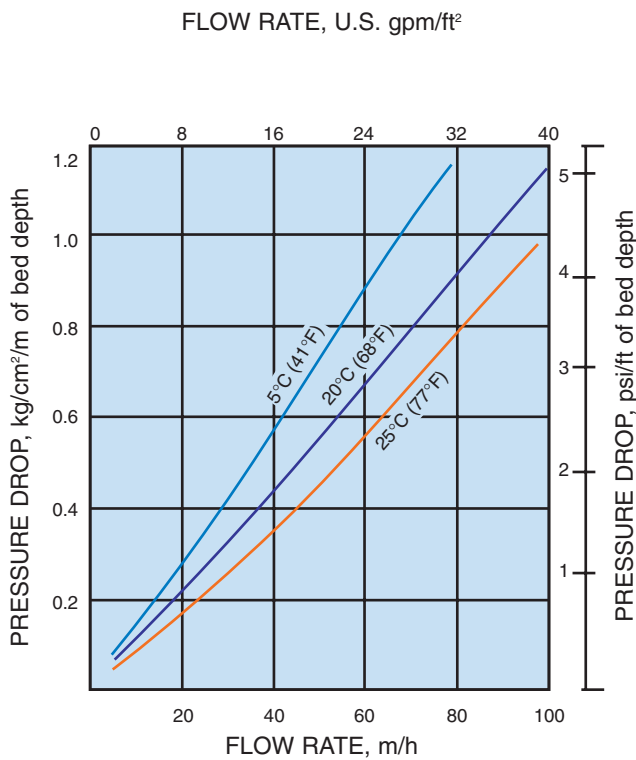
The elimination of that portion of beads, smallest in diameter and volume, increases the voids fraction and reduces the pressure drop, (See Section on “Hydraulic Characteristics”). These advantages also apply to counter-flow regeneration systems. However where regeneration is upflow, the smallest beads 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**'s resins are reduced to some degree.

## 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, and on the flowrate and viscosity (and hence on the temperature) of the influent solution. Anything affecting any of these parameters, for example the pres-

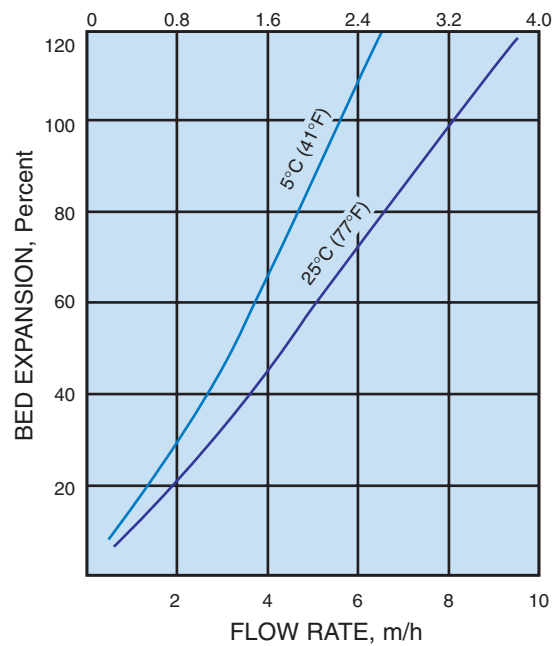
ence of particulate matter filtered out by the bed, abnormal compaction of the resin bed, or the incomplete classification of the resin spheres will have an adverse effect, and result in an increased headloss. Typical values of pressure drop across a bed of **Purofine PFA-400** are given in Fig. 1 below, for a range of operating flowrates.

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



**Fig. 2 BACKWASH EXPANSION**

AS A FUNCTION OF TEMPERATURE  
(EXHAUSTED AND REGENERATED FORMS)  
BACKWASH FLOW RATE, U.S. gpm/ft²



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 flow. Backwash should be com-

menced 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 <sup>2</sup> = 0.409 U.S. gpm/ft <sup>2</sup>
1 kg/cm <sup>2</sup> /m (kilograms per square cm per meter of bed)	= 4.33 psi/ft = 1.03 atmos/m = 10 ft H <sub>2</sub> O/ft

## CHEMICAL AND THERMAL STABILITY

**Purofine PFA-400** 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 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

60° C (140° F) breaks down by two parallel mechanisms. The first results in nitrogen loss (and hence loss of capacity), while the second and minor 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

## 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 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				TREATMENT	
	meq/l	ppm as CaCO <sub>3</sub>	Total Anions	%	
Cl	1.0	50	45		Regeneration with NaOH at : 64 g/l, (4 lb/ft <sup>3</sup> )
SO <sub>4</sub>	1.0	50	45		Co-flow rate at temperature : 30°C (86°F)
CO <sub>2</sub>	0.1	5	5		Flow rate : 40 BV/h, 5 gpm/ft <sup>3</sup>
SiO <sub>2</sub>	0.1	5	5		Sodium leakage : 40 ppb
Total	2.2	110	100		(ex cation bed)
					End point SiO <sub>2</sub> leakage : 200 ppb
CAPACITY CALCULATION				SILICA LEAKAGE	
<p>For a feed water with 45% sulphate and 5% CO<sub>2</sub>, divalent ions equals 50%. Fig. 3 shows base operating capacity for 64 g/l of NaOH and 50% divalent ions</p> $C_B = 0.61 \text{ eq/l, } 13.3 \text{ kgr/ft}^3$ <p>Correction factor for regeneration temperature of 30°C, (86°F) and 5% silica of total anions, (Fig. 5)</p> $C_1 = 0.96$ <p>Correction factor for SiO<sub>2</sub> end-point leakage of 200 ppb, (Fig. 7)</p> $C_2 = 1.03$ <p>Hence operating capacity</p> $= C_B \times C_1 \times C_2$ $0.61 \times 0.96 \times 1.03 = 0.60 \text{ eq/l, } 13.1 \text{ kgr/ft}^3$ <p>Applying the customary engineering design factor of 0.9, the operating capacity obtainable</p> $= 0.60 \times 0.9 = 0.54 \text{ eq/l,}$ $= 11.8 \text{ kgr/ft}^3$				<p>Base silica leakage Bs for 64 g NaOH/l at 5% SiO<sub>2</sub>/Total Anions</p> $= 18 \text{ ppb (Fig. 4)}$ <p>Correction factor* for Na leakage</p> $K_1 = 0.98 \text{ (Fig. 6)}$ <p>Correction factor* for regeneration temperature of 30°C (86°F) (Fig. 8)</p> $K_2 = 0.88$ <p>Operational silica leakage</p> $= Bs/K_1 \times K_2 = 18/0.98 \times 0.88$ $= 21 \text{ ppb}$	
				*Reciprocal correction factors in this example	

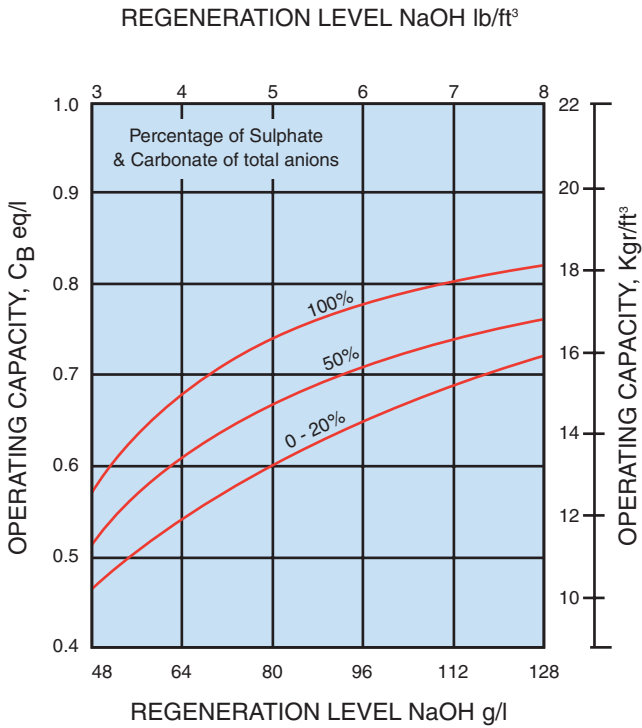
## PLANT DESIGN

If, as is often the case, the silica leakage is a prime requirement, the 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 Bs. Thus the regeneration level which gives Bs, is

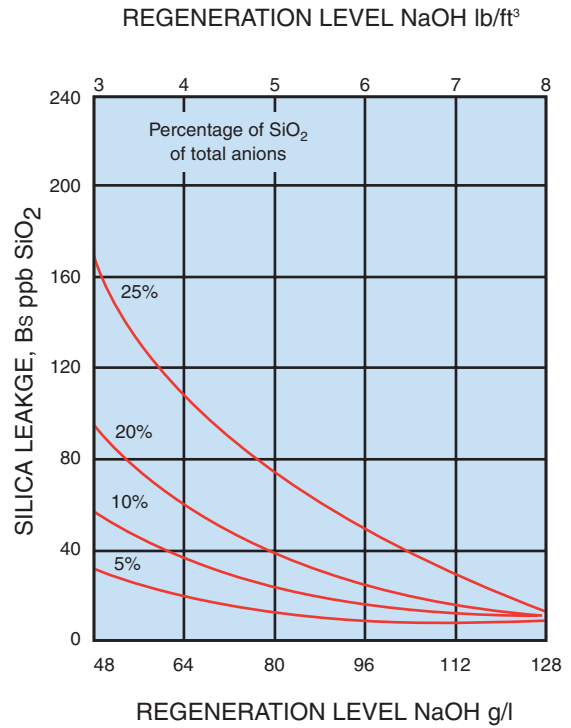
found from Fig. 4. The operating capacity is then calculated as given in the example above. It may of course be necessary to modify the first design calculation to take account of other factors as mentioned above: such as, flow rate should be within the required limits and there could be a need for neutral effluent, etc.

# PUROFINE PFA-400 (CO-FLOW REGENERATION)

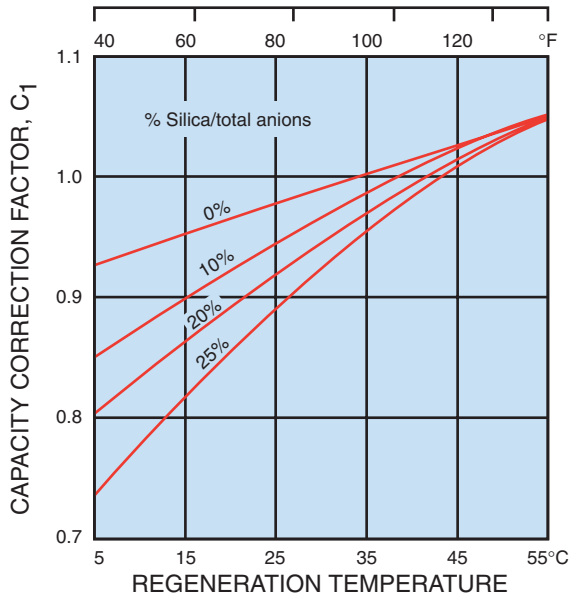
**Fig. 3 BASE OPERATING CAPACITY**



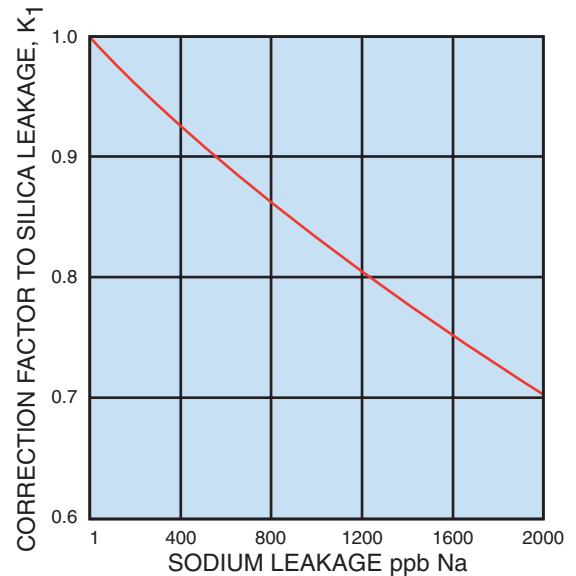
**Fig. 4 BASE SILICA LEAKAGE**



**Fig. 5 CAPACITY CORRECTION FACTOR FOR TEMPERATURE OF REGENERANT**

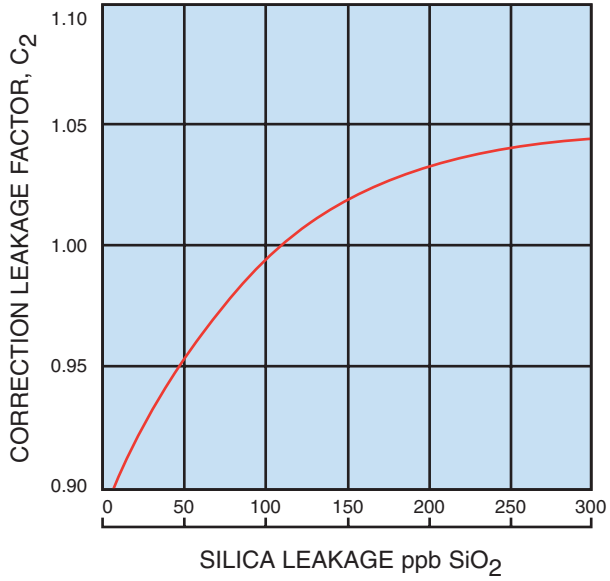


**Fig. 6 SILICA LEAKAGE CORRECTION FACTOR FOR SODIUM IN DECATONIZED WATER**

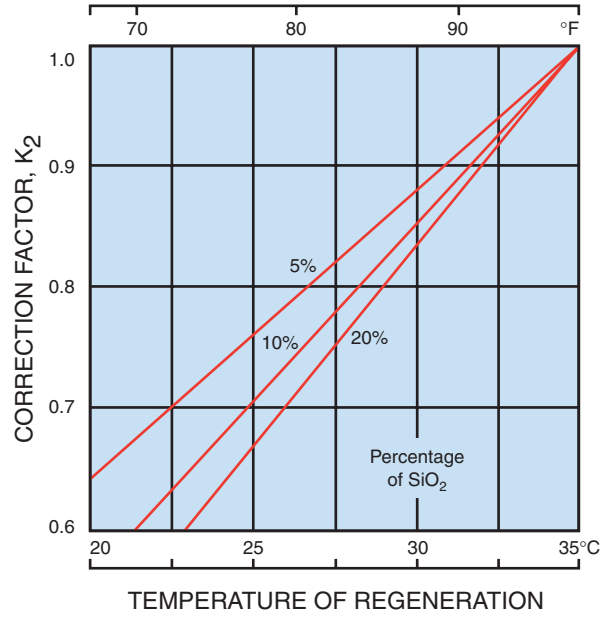


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**Fig. 7 CAPACITY CORRECTION  
RECIPROCAL FACTOR FOR SILICA  
END-POINT LEAKAGE**



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



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