

C-100EF
Strong Acid
Cation Exchange Resin
(For use in water softening)

Technical Data

PRODUCT DESCRIPTION

Purofine C-100EF is a specially produced, high quality cation exchange resin that has been designed specifically for use in both domestic and industrial softening where potable water is required. It is one of a range of **Purofine** products manufactured for modern day softening. It offers a number of advantages over the conventional range of softening resins.

Operating capacity is significantly greater at standard flow rates, and also relatively greater when flow rates are high, variable or intermittent. It is also useful where high quality water is required while using the minimum quantities of regenerant for effective operation.

Safe and effective disposal of waste regenerants is becoming an increasingly important environmental issue. It is in this area that the Purofine range offers considerable advantages. Regulations concerning the disposal of such regenerants will become increasingly strict in the next decade. Hence the efficient utilization of salt will be an increasingly important characteristic of the ion exchange softening process. Indeed it is to be expected that the current standard softening resins may be rendered unsuitable in certain “pollution sensitive” areas.

Purofine C-100EF is in compliance with the U.S. Food, Drug and Cosmetic Act, section 21, paragraph 173.25.

Typical Physical & Chemical Characteristics	
Polymer Matrix Structure	Crosslinked Gel Polystyrene
Physical Form and Appearance	Clear Amber Uniform Spherical beads
Whole Bead Count	95% min.
Functional Group	R-SO ₃
Ionic Form, as shipped	Na ⁺
Shipping Weight (approx.)	825 g/l (53 lb/ft ³)
Screen Size Range: - U.S. Standard Screen	30 - 40 mesh, wet
Particle Size Range Mean diameter	90% within 0.4 - 0.6 mm 0.475 - 0.525 mm
Moisture Retention, Na ⁺ form	44 - 48%
Reversible Swelling Ca ⁺⁺ → Na ⁺	8% max.
Specific Gravity, moist Na ⁺ Form	1.29
Total Exchange Capacity, Na ⁺ form, wet, volumetric	2.0 eq/l min.
Operating Temperature, Na ⁺ Form	140°C (285°F) max.
pH Range	no limitations

Standard Operating Conditions				
Operation	Rate	Solution	Minutes	Amount
Service	8 - 200 BV/h 1.0 - 25 gpm/ft ³	Influent water	per design	per design
Backwash	Refer to Fig. 2	Influent water 5°- 30°C (40° - 80°F)	5 - 20	1.5 - 4 BV 10 - 30 gal/ft ³
Regeneration	2 - 8 BV/h 0.25 - 1.0 gpm/ft ³	5 - 20% NaCl	12 - 60	50 - 320 g/l 4 -20 lb/ft ³
Rinse, (slow)	2 - 8 BV/h 0.25 - 1.0 gpm/ft ³	Influent water	30 approx.	2 - 4 BV 15 - 30 gal/ft ³
Rinse, (fast)	8 - 40 BV/h 1.0 - 5.0 gpm/ft ³	Influent water	30 approx.	3 - 10 BV 24 - 80 gal/ft ³
Backwash Expansion 50% to 75% Design Rising Space 100% (This is not necessary for small cartridges operating on a filtered water supply) "Gallons" refer to U.S. Gallon = 3.785 liters				

OPERATING PERFORMANCE

The operating performance of **Purofine C-100EF** in the sodium cycle depends upon:

- The amount and concentration of regenerant used.
- The flow rate of the influent water through the bed.
- The total hardness of the water to be treated, and its sodium content.

In respect of a), b) and c) **Purofine C-100EF** offers significant advantages compared with standard softening resins. The size distribution allows for easier diffusion within the resin beads, which greatly improves the efficiency of regeneration, and consequently reduces salt wastage and therefore, environmental pollution. The second major advantage of this **Purofine** resin is that the total bead surface area is increased by 20% approx. The elimination of the coarser beads typically found in standard softening resin produces faster kinetics and thus results in a significant relative improvement in capacity, especially at higher flow rates, and where hardness and/or sodium contents are high.

These advantages are particularly useful in small domestic softeners and in dishwasher softening, where bed depths in the smaller purpose-built units are much lower than those generally recommended. Whereas for standard softening, exhaustion cycles should be designed to last for at least 4h., it is possible to operate discontinuously, at higher flow rates up to 600BV/h, provided that leakage levels are not critical. The advantages over conventional softening resins are greater the higher operational flow rate, hence it is in the technologies of

intermittent domestic and dishwasher softening where the greatest relative advantages of Purofine resins lie. In order to achieve the best results, care must be taken to choose the optimum design conditions and those of operation. It is therefore preferable to consider these technologies separately. More data on this is given later.

Performance is usually assessed in terms of the residual hardness in the treated water (traditionally expressed as ppm of CaCO₃ where 1 ppm CaCO₃ corresponds to a divalent cation concentration of 0.02 meq/l). In municipal water softening, low regeneration levels and high efficiency of removal of the hardness are usually required. Acceptable water quality can be obtained by a split-stream operation in which a fully softened stream is blended with the raw water. For industrial use, a suitable treated water can be obtained with regeneration levels of 65-80kg salt per cubic meter, (or 4-5lb/ft³) of resin. In ordinary domestic and dishwasher softening, residual hardness at these comparatively low levels is not usually required. Consequently quite high flow rates are often in use with correspondingly less effect on the operating capacity.

Hardness leakage under the standard operating conditions is normally less than 1 % of the total hardness of the influent water, typically in the range of 1 - 10 ppm. Correction factors should be applied to both base operating capacities, see fig. 3, fig. 4 and leakage fig. 5, fig. 6 according to the flow rate and total dissolved solids (TDS) content of the raw water.

USE OF REGENERANT

Purofine C-100EF is of particular advantage in situations where disposal of waste regenerant is difficult. Waste regenerant will invariably be high in chloride, sodium and hardness ions. These waste chemicals will be delivered to sewerage and may not be efficiently removed in local treatment plants- After such treatment as it receives, water returned to aquifers will be higher in TDS and this will consequently cause a need for additional water treatment in the down stream plants. Hence ways to lesson the volume and bulk of the regenerant used for softening process offer widescale advantages, and their importance is becoming increasingly recognized.

Reference to Fig. 7, applicable to flow rates in the region of 25 BV/h, will show that, at low regeneration levels salt wastage may be reduced to less than 20%, compared with 30% for standard resins. Under ideal laboratory conditions even higher efficiencies are obtainable.

It is of course usual to introduce a contingency design factor of 0.9, (or 0.8 for certain small cartridges), in order to be confident of plant performance, and to limit throughput according to this. Hence practically, salt consumption values will be as quoted in Fig. 7 and given in the example towards the end of this bulletin. Naturally, the difference between resin types is reduced with increasing regeneration level.

Similarly reference to Fig. 8, applicable to flow rates in the region of 125 BV/h, shows that the **Purofine C- 100EF** will offer the same relative advantages in better efficiency at low regeneration levels. However, because the normal wastage (and hence pollution) is greater both at faster flow rates and higher regeneration levels, this represents a larger quantity of salt saved. Hence the attraction of reduced pollution, expressed, for example, in Kilograms of salt wasted over each 100 regenerations is greater.

DISCONTINUOUS SOFTENING

The discontinuous softening cycle used for instance in dishwashing has been designed to use flow rates of up to 600 BV/h for short periods, though flow rates of 80 - 400 BV/h are more usual. These high flow rates are only recommended for shallow beds of 0.1 - 0.4m approx. in order that pumping costs are kept to a minimum, and sufficient flow is regularly obtained.

Purofine C-100EF is ideal for this application. It can offer a 30% increase in capacity when high flow rates in the region of 300 BV/h are used. Fig. 9 compares the operating capacity of **Purofine C-100EF** with that of a conventional resin when using various quantities of regenerant at a flow rate of 300 BV/h, when treating water with a TDS of 500ppm (10meq/l).

It is because treated water for dishwashing is satisfactory with quite high levels of hardness, that operation at high flow rates is preferable. Indeed the presence of a small pro-

portion of hardness may make the water less aggressive in certain situations, thus reducing the possibility of attack of certain items being cleaned. The hardness leakage obtained depends on the rate of loading of ions on the exchanger.

To obtain the leakage figure, Fig. 10 gives the correction factor, K_2 by which the leakage given from Fig. 5 should be multiplied. This curve need only be broadly interpreted, since in this application very low leakage offers no special advantage. Many factors, both of a chemical and an engineering nature will influence the particular leakage obtained, hence exact prediction is, in any case difficult. For this reason the correction factor K_2 is given for lower combinations of flow rate and ionic concentration. Where operation is discontinuous, a notional flow rate based on an allowance for intervals between regenerations may sometimes be used. Where higher loadings are contemplated leakage will be less predictable, hence this information is not given.

CHEMICAL AND THERMAL STABILITY

Purofine C-100EF 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 long periods of time will eventually break down the crosslinking. This can cause the resin to swell as well as to

produce small amounts of extractable breakdown products. Like all conventional polystyrene sulphonated resins, it can be used at temperatures up to 150°C (300°F) in the sodium or calcium and magnesium forms. The acid (hydrogen) form tends to hydrolyze in water at temperatures appreciably higher than 120°C (250°F) thereby losing capacity.

HYDRAULIC CHARACTERISTICS

The pressure drop (headloss) across a properly classified bed of ion-exchange resin depends on the particle size distribution, bed depth, and on the voids volume of the bed. It also depends on the flow rate and viscosity (and hence on the temperature) of the influent solution. Anything affecting any of these parameters, for exam-

ple the presence of particulate matter filtered out by the bed, or abnormal compaction of the resin bed, will have an adverse effect, and result in an increased headloss. Typical values of pressure drop across a bed of **Purofine C- 100EF** are given for a range of operating flowrates in Fig. 1 .

Fig. 1 PRESSURE DROP VS FLOW RATE

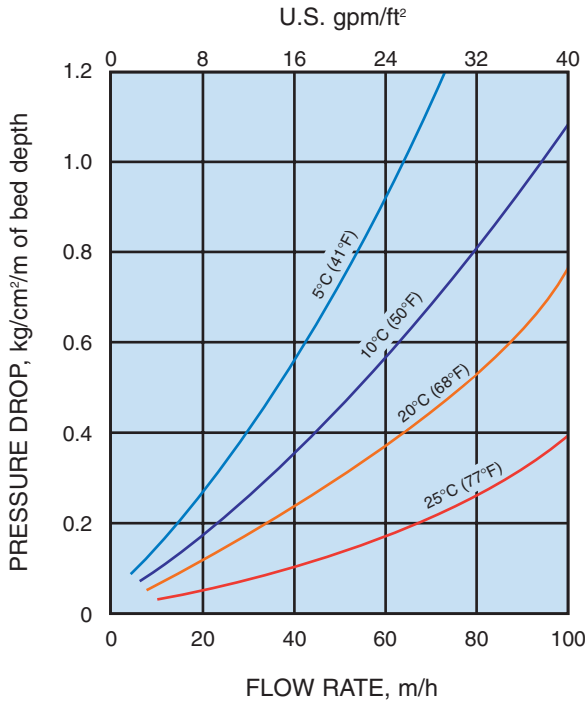
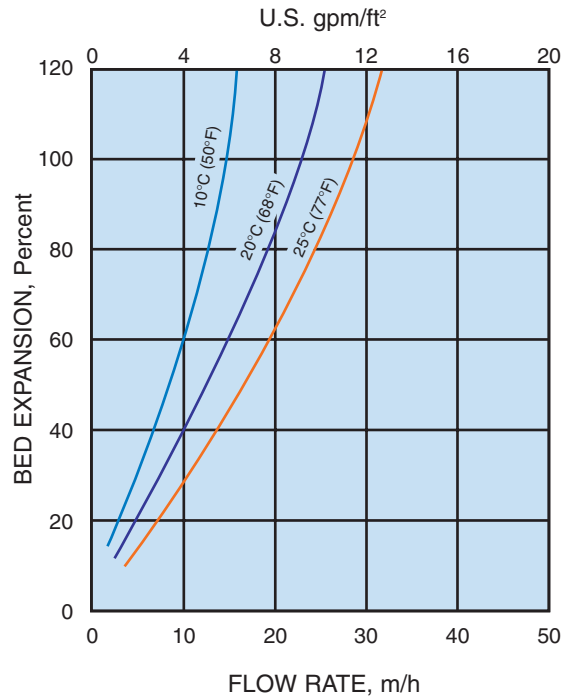


Fig. 2 BACKWASH EXPANSION (AS A FUNCTION OF TEMPERATURE)



During upflow backwash, the resin bed should be expanded in volume by between 50 and 75%, in order to free it from any particulate matter originating from the influent solution, to clear the bed of bubbles and voids, 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, as above. Care should always be taken to avoid resin loss by accidental overexpansion of the bed. This backwashing process is not usually necessary for small cartridges operating on a clean water supply.

Conversion of Units	
1 m/h (cubic meters per square meter per hour)	= 0.341 gpm/ft ² = 0.409 U.S. gpm/ft ²
1 kg/cm ² /m (kilograms per square cm per meter of bed)	= 4.33 psi/ft = 1.03 atmos/m = 10 ft H ₂ O/ft

PUROFINE C-100EF (SOFTENING)

Fig. 3 OPERATING CAPACITY, C_b

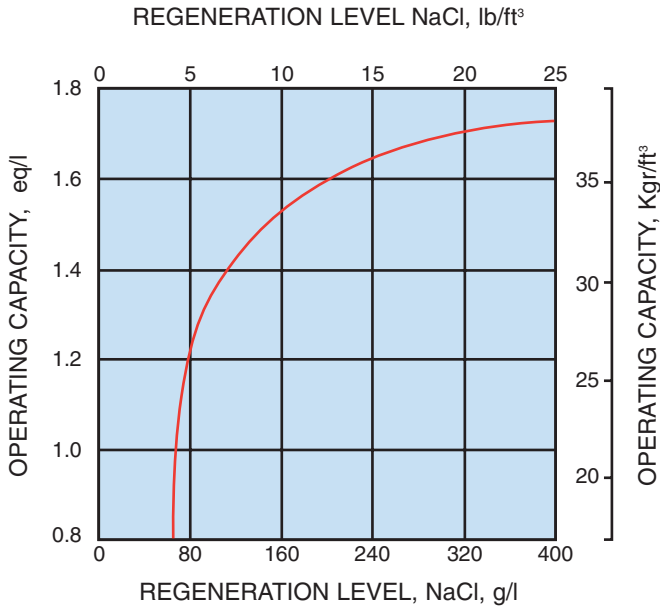


Fig. 4 EFFECT OF FLOW RATE & TDS ppm ON OPERATING CAPACITY

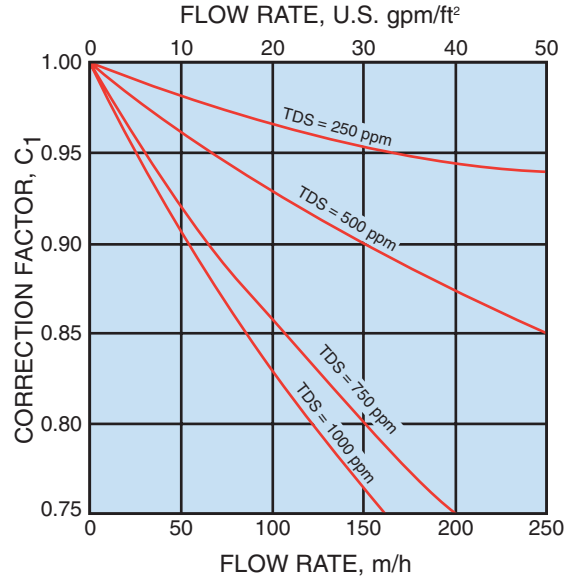


Fig. 5 HARDNESS LEAKAGE

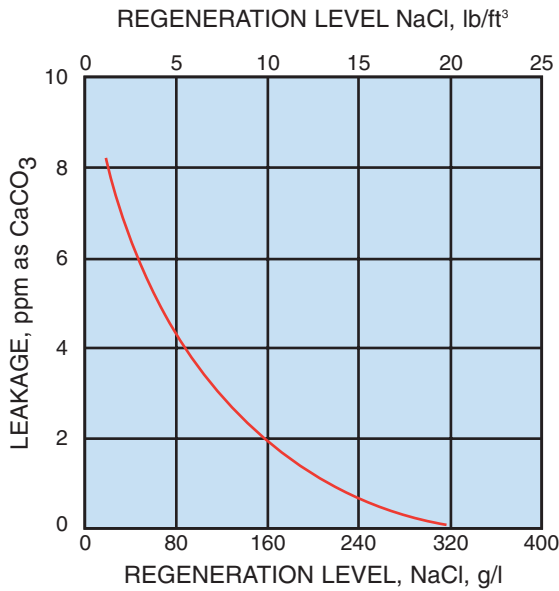
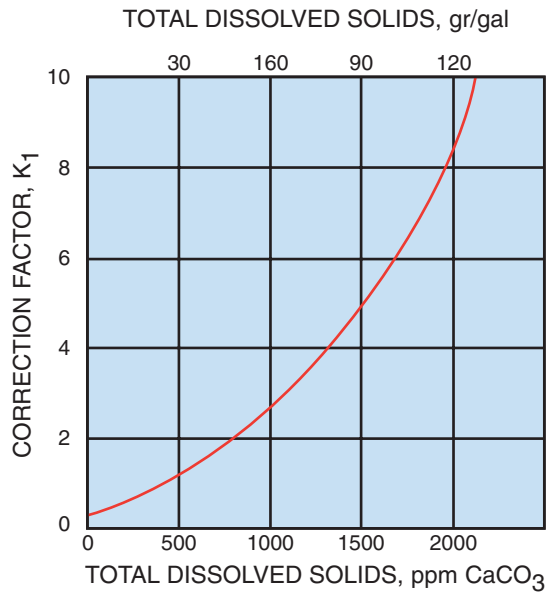


Fig. 6 CORRECTION FOR TDS



SOFTENING CAPACITY CALCULATION

If the regeneration level, influent water analysis, and service flowrate are known, the capacity and leakage curves may be used directly to determine the operating

capacity of the resin in the unit, and the residual hardness in the treated water. A specific example of the application of these curves is given below:

INFLUENT WATER			
Cation analysis in:	ppm CaCO₃	meq/l	gr/U.S. gal
Total hardness	400	8	23
Sodium (& univalents)	<u>100</u>	<u>2</u>	<u>5.8</u>
TDS (total dissolved solids)	500	10	28.8
TREATMENT			
Regeneration with: 80 g/l [5 lb/ft ³] of NaCl			
Service Flowrate: 25 m/h [10 U.S. gpm/ft ²]			
Leakage endpoint: 25 ppm above permanent leakage figure.			
CAPACITY is calculated as follows:			
Fig. 3 → Base Operating Capacity, C _b , @ 80 g/l (5 lb/ft ³) NaCl = 1.26 eq/l (27.6 kgr/ft ³)			
Fig. 4 → correction factor, C ₁ for 25 m/h & TDS 500 = 0.975			
Hence calculated Operating Capacity, C _b x C ₁ = 1.23 eq/l (26.9 kgr/ft ³).			
After applying the conventional 90% "design factor" the value of 1.11 eq/l may be quoted as a design operating capacity. This corresponds to a figure of 24.2 kgr/ft ³ (1.11 eq/l x 21.85 kgr/ft ³ per eq/l).			
LEAKAGE is calculated as follows:			
Fig. 5 → Base Leakage @ 80 g/l NaCl [or 5 lb/ft ³] = 4.5 ppm CaCO ₃			
Fig. 6 → correction factor, K ₁ , for a TDS value of 500 = 1.1			
Hence permanent (kinetic) leakage = 4.5 x 1.1 = 5 ppm CaCO ₃			
NOTES:			
i) The curves given are based on an endpoint of 25 ppm, over and above the observed kinetic leakage; operating capacities will differ somewhat if a different criterion is used.			
ii) The curves given are applicable only to influent monovalent ion contents less than or equal to the hardness content; if the water to be treated is atypical in this or other parameters, please contact your local sales office for assistance.			
SALT WASTAGE			
	Metric	U.S. Units	
Operating Capacity (Using NaCl of 80 g/l)	= 1.23 eq/l	26.9 Kgr/ft ³	
Limited throughput (according to design)	= 1.11 eq/l	24.2 Kgr/ft ³	
Direct Salt Usage (NaCl of mol. wt. 58.5)	= 1.11 x 58.5 = 64.9 g/l	24.2 x 0.1675 4.054 lb/ft ³	
Excess Salt Wastage	= 80 - 64.9 = 15.1 g/l	5 - 4.054 0.946 lb/ft ³	
% Wastage of salt used	= (15.1/80) x 100% = 18.9%	(0.946/5) x 100%	

PUROFINE C-100EF

Fig. 7 SALT WASTAGE AT STANDARD FLOW RATE OF 25 BV/h

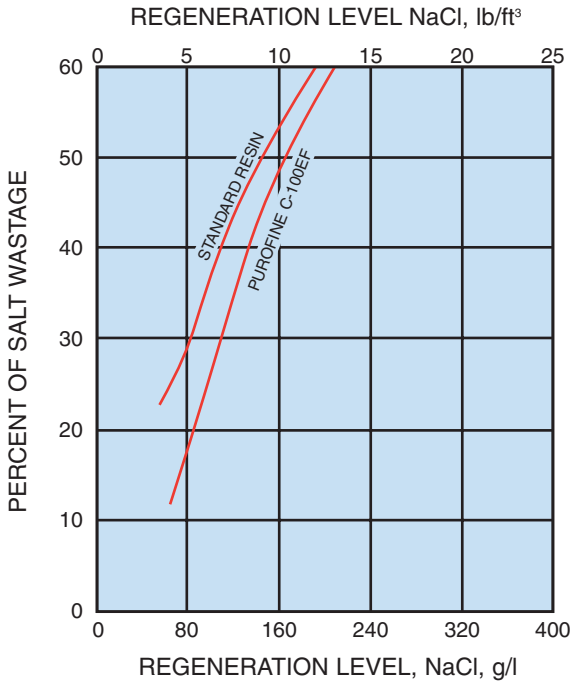
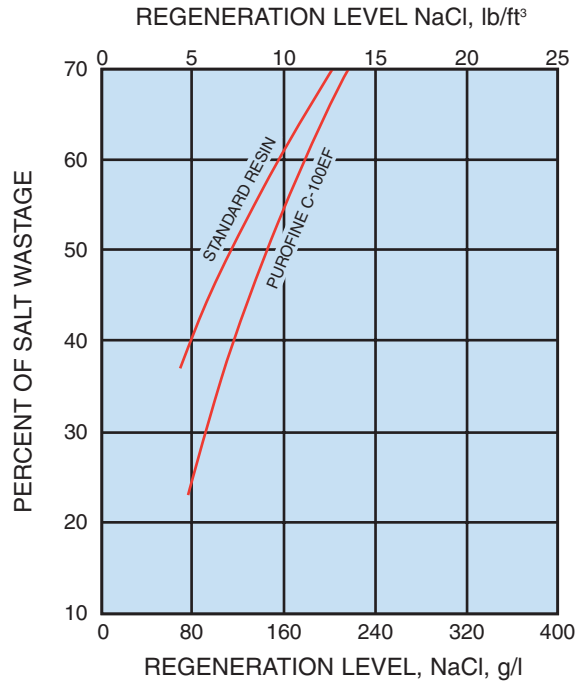


Fig. 8 SALT WASTAGE AT HIGHER FLOW RATE OF 125 BV/h



COMPARISON OF PUROFINE C-100EF AND PUROLITE C-100E FOR DISCONTINUOUS SOFTENING AT 300BV/h, SERVICE FLOWRATE 125 m/h (TDS = 500 ppm)

Fig. 9 OPERATING CAPACITY

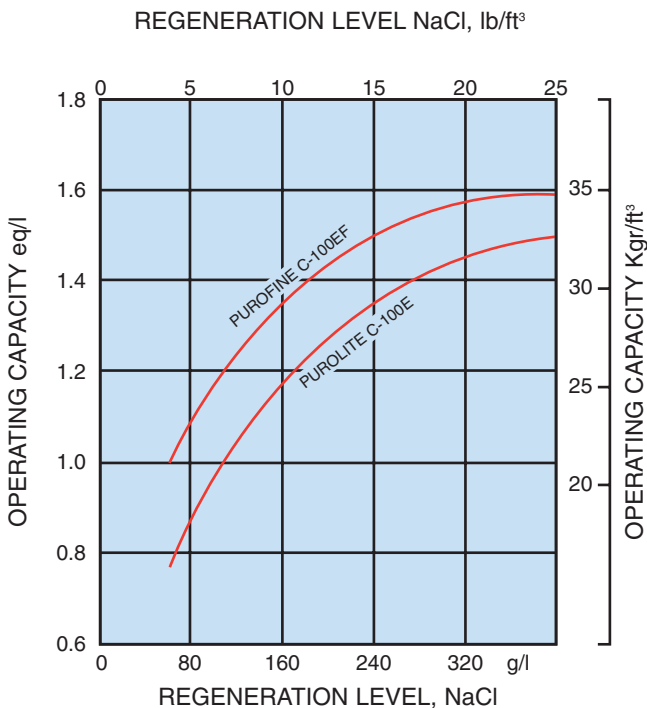
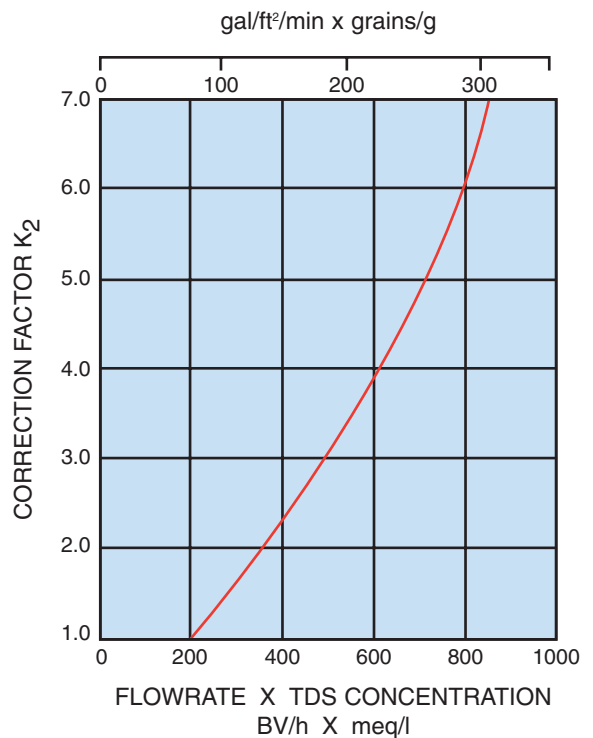


Fig. 10 LEAKAGE (Approx) CORRECTION FACTOR



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