where science meets business

WTP Design by Computer

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Presentation Content

- Design brief + influent water
- Ground rules + introduction to the software
- Water analysis
- Plant layout
- Treated water specification
- The design
  - Resin choice and design margin
  - Flow rate and cycle time
  - Optimising rinse volumes and regeneration levels
  - Vessel sizing
  - Adjusting for neutral effluent
- Outputs
- Other design options + OPEX comparison

Design Brief

Client requires demineralised water sourced from deep borehole.

Plant design requirements are for 80 m3/h flow. Operators work an 8 hour shift pattern.

Proposed option is counter-current packed bed SAC – degasser – SBA with separate polishing MB

Outline treated water specification is:

	Conductivity (μScm^{-1})	Silica (ppb)
Average	1	20
End point	2	50

Influent Water

Cations (ppm $CaCO_3$)	Anions (ppm $CaCO_3$)	Other info
Ca^{2+}: 200	HCO_3^-: 150	SiO_2(reactive): 10 ppm
Mg^{2+}: 75	Cl^-: 50	TOC: 0.1 ppm
Na^+: 50	NO_3^-: 30	pH: 7.2
K^+: 5	SO_4^{2-}: 100	EC: 430 μScm^{-1}
Fe^{3+}: 0.1		
Total Cations: 330.1	**Total Anions: 330**	

Ground Rules – Plant Design

- SAC – WBA
  - For partially demineralised water 10 – 30 µScm^{-1} spec.
- SAC – SBA
  - Most common combination – can incorporate DG
- SAC – WBA - SBA
- WAC – SAC - WBA
- WAC – SAC – SBA
- WAC – SAC – WBA – SBA

  More complex, higher CAPEX systems but lower OPEX due to higher regeneration efficiency of WAC/WBA when high EMA
  - Resin can be housed in separate vessels or layered in the same vessel
- Degasser commonly used when alkalinity > 1 meq/l (50 ppm as $CaCO_3$)
- DG located before WBA for acrylic WBAS, and after for polystyrenic WBAs

Ground Rules – Resin Choice / Grade

Anion resin selection:

- Reactive silica level
  - T1 sty/acr > T2 sty/bif.
- Operating (working) capacity
  - Bif > T2 sty > acr > T1 sty
- Operating flow rate (BV/h)
  - poss. acr bead deformation
- Organics load
  - Acr/bif > T1 sty > T2 sty
- Operating temperature
  - T1 sty >T2 sty> bif. > acr

Cation resin selection:

- Usually 8 % xlinked gel SAC, either in Na or H form.
- Macro resins usually used only in demanding conditions

WAC/WBA resins

- Used in separate vessels or in layered (stratified) beds
- Std + graded products available
- Acr WAC, both sty+acr WBA available

Resin grades:

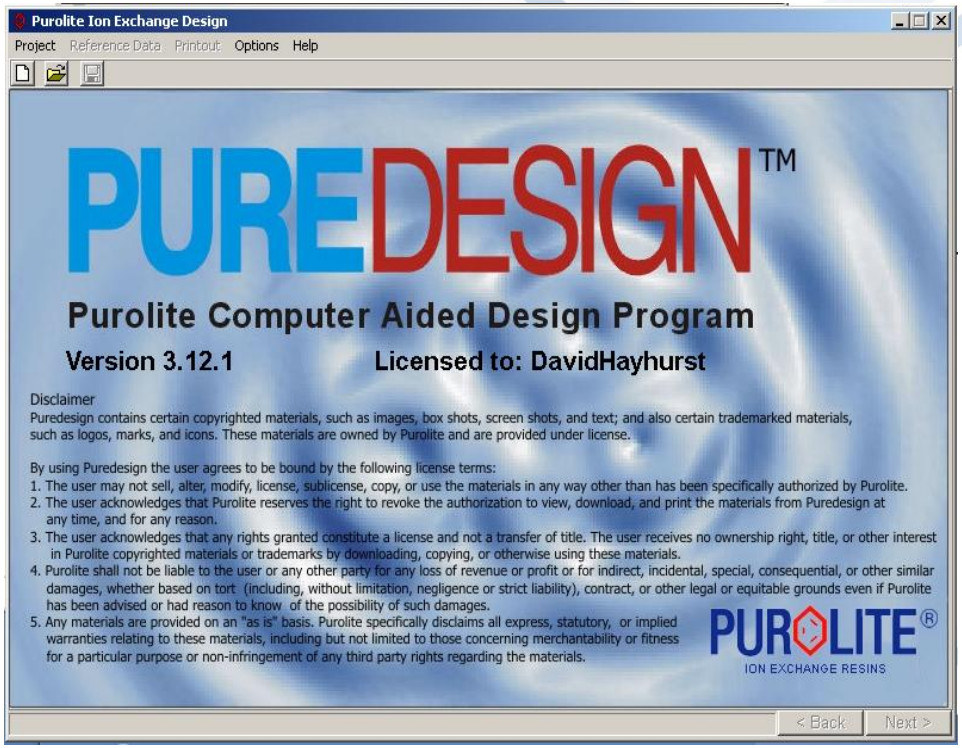
- Standard or Purofine for co-flow
- Puropack for counter-flow
- DL for stratified beds

Ground Rules – Regeneration

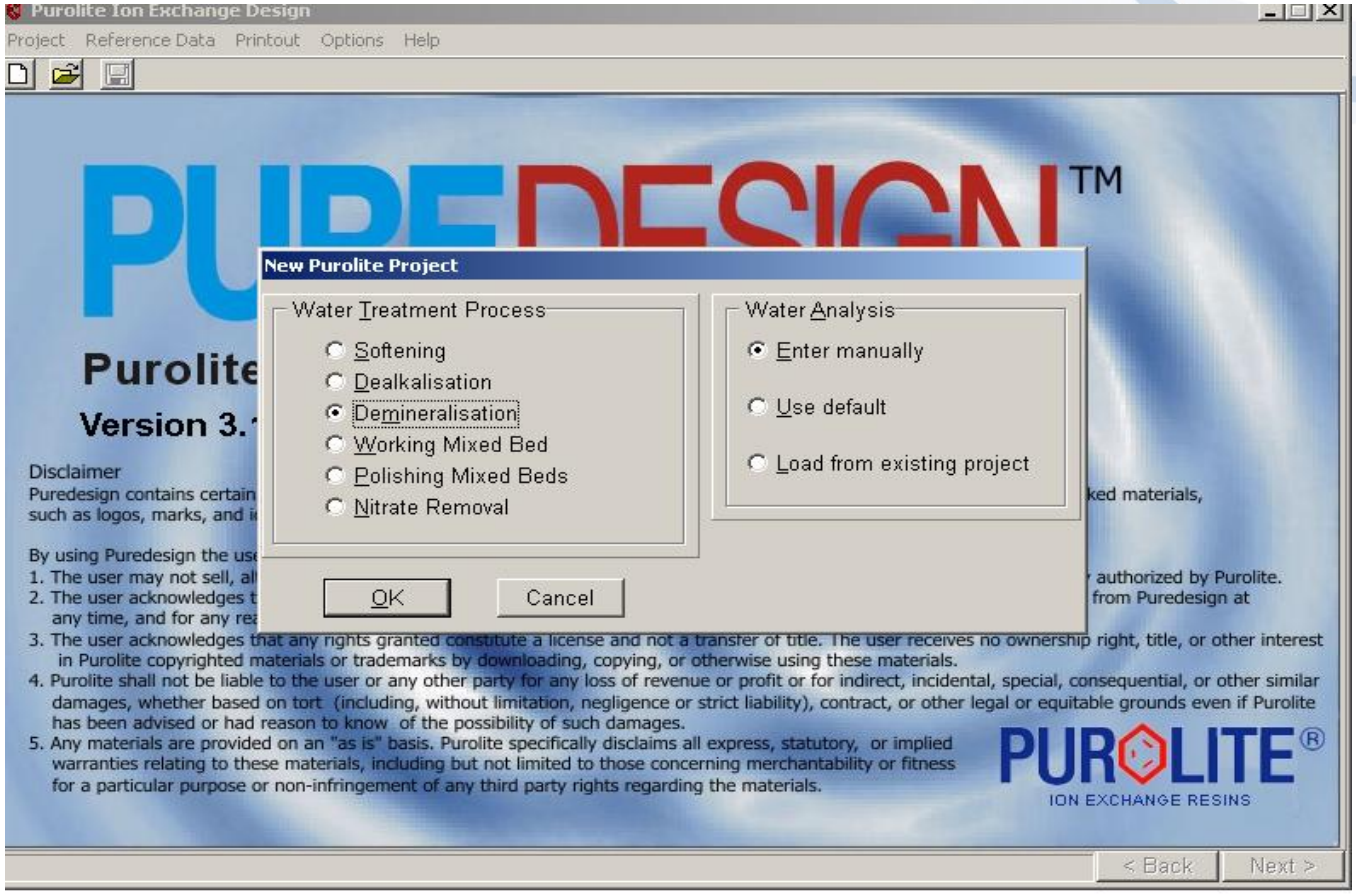
- WAC / SAC – HCl or H_2SO_4
  - Note Puredesign assumes 2-step regeneration with H_2SO_4 + displays average acid strength – if single addn., add 5 % to design margin
- WBA / SBA - NaOH
  - Minimum level of 65 g/l for organic fouling waters
- Options include co or counter flow regeneration, backwashed or packed bed
- Standard rinses:
  - co-flow 2 BV slow, 4-6 BV fast
  - counter-flow 2 BV slow, 2BV fast for cation, 3-4 BV fast for anion
- Neutral effluent achievable by balancing regen levels

Introduction to the Software

- Provides theoretical model of plant
- Enables optimisation of equipment, service and regeneration conditions for given raw water and treated water specification
- Allows system modification to mimic the effects of changed raw water/treated water specification

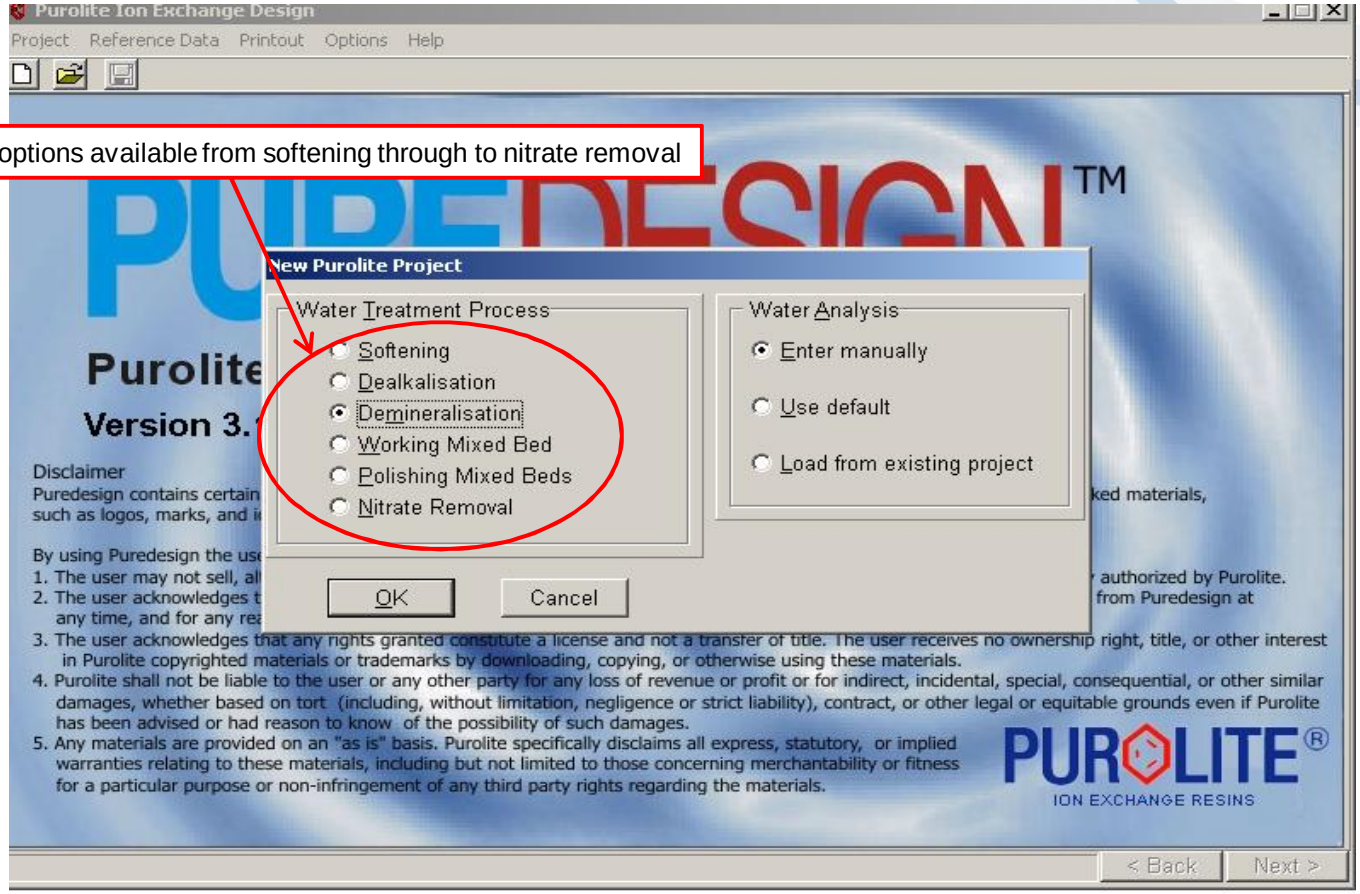


Introduction to the Software



Introduction to the Software

Choice of process options available from softening through to nitrate removal



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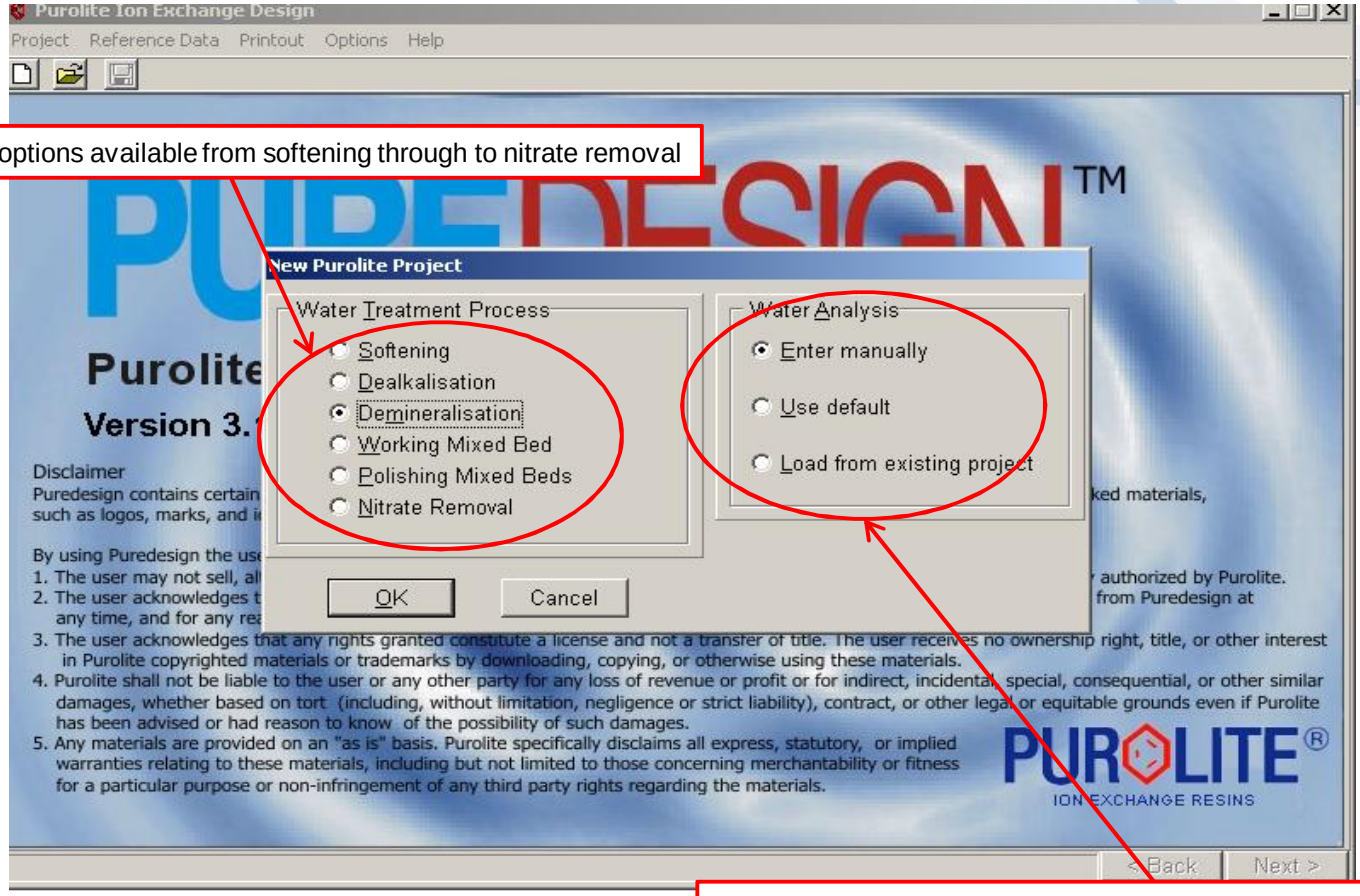
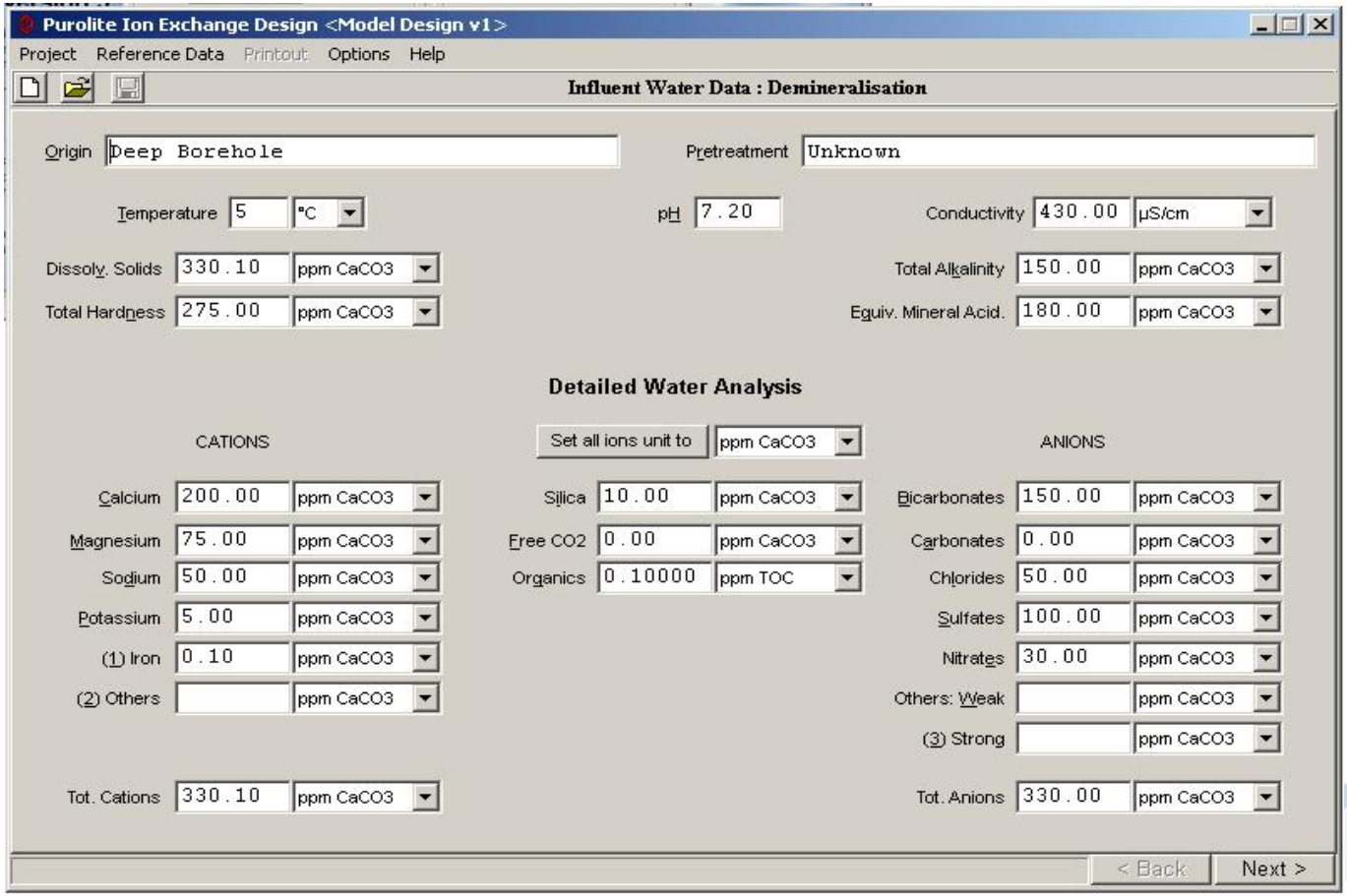


Water analysis option allow for both manual entry and load from memory to facilitate multiple iterations of design

Water Analysis On Screen



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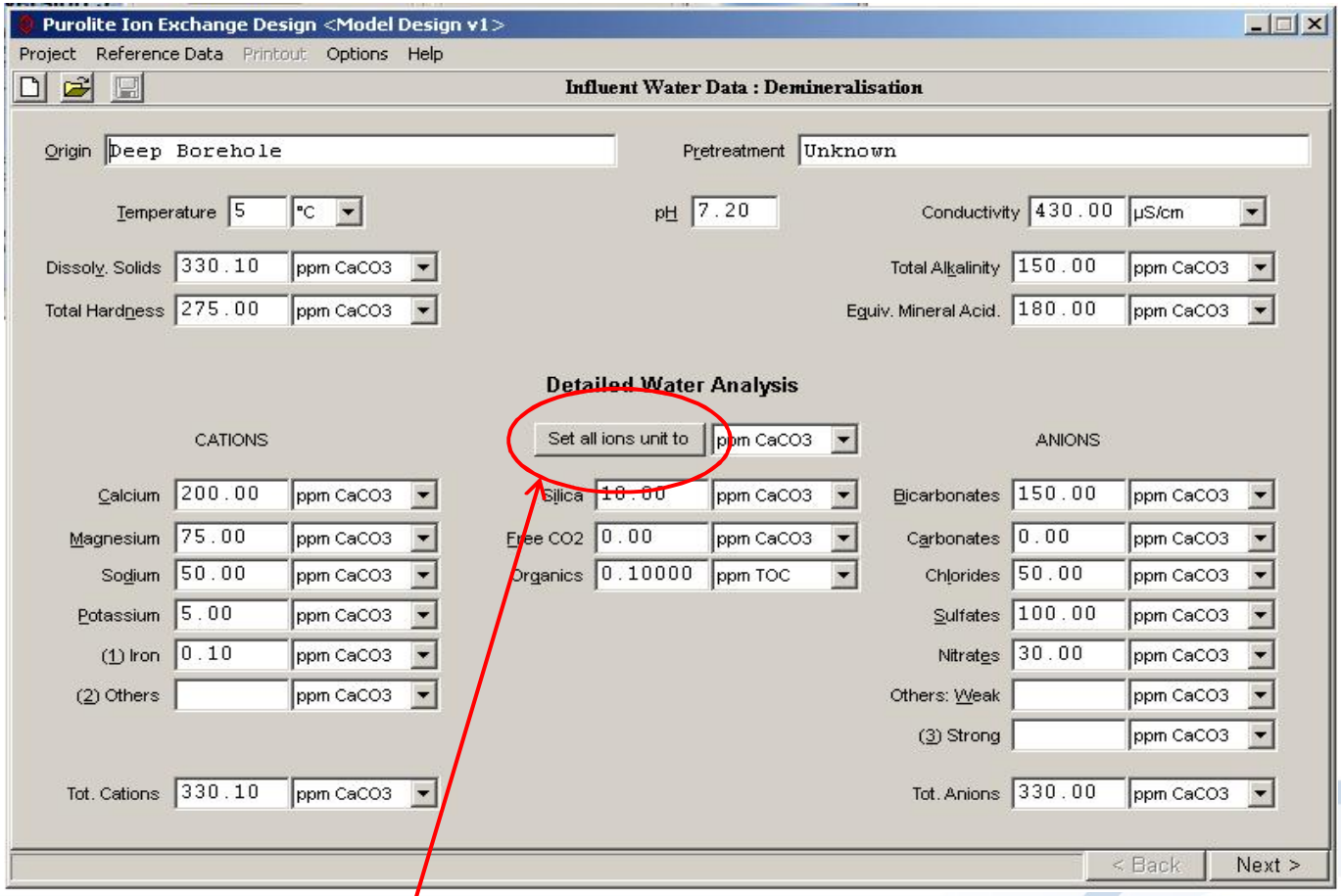
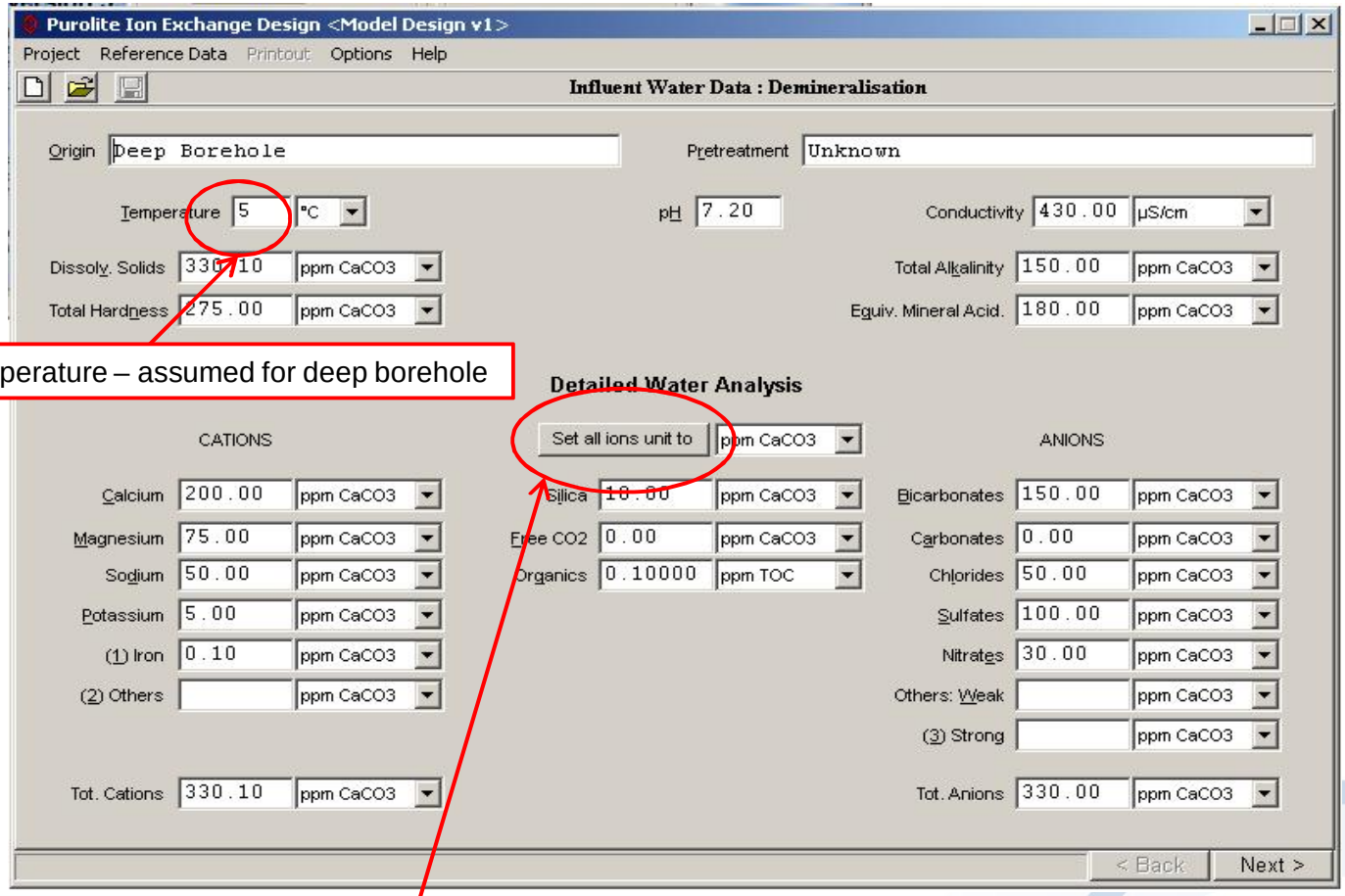


Several units available when entering water analysis, standardisable with ‘set all ions to’ button

Water Analysis On Screen



Note water temperature – assumed for deep borehole

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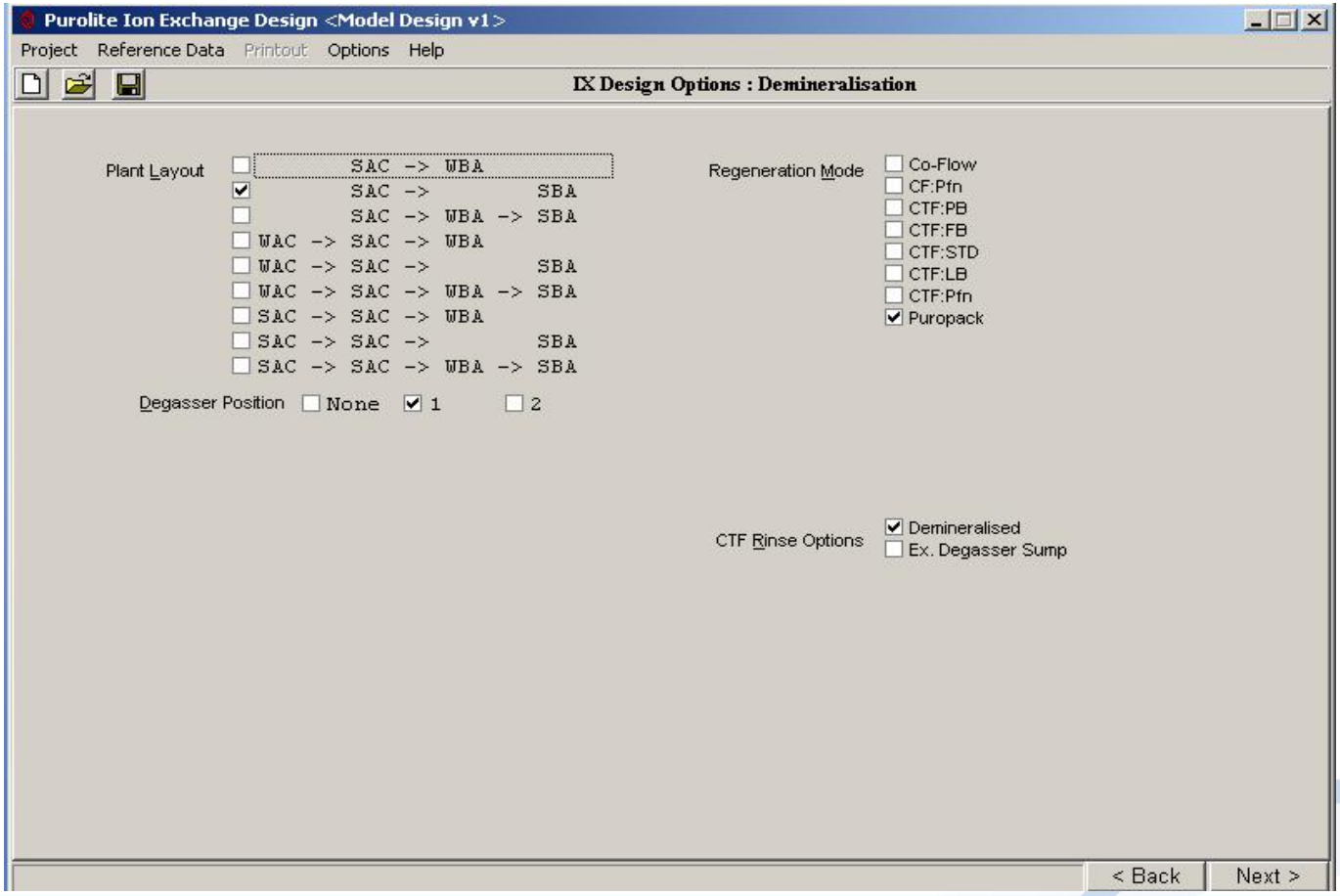
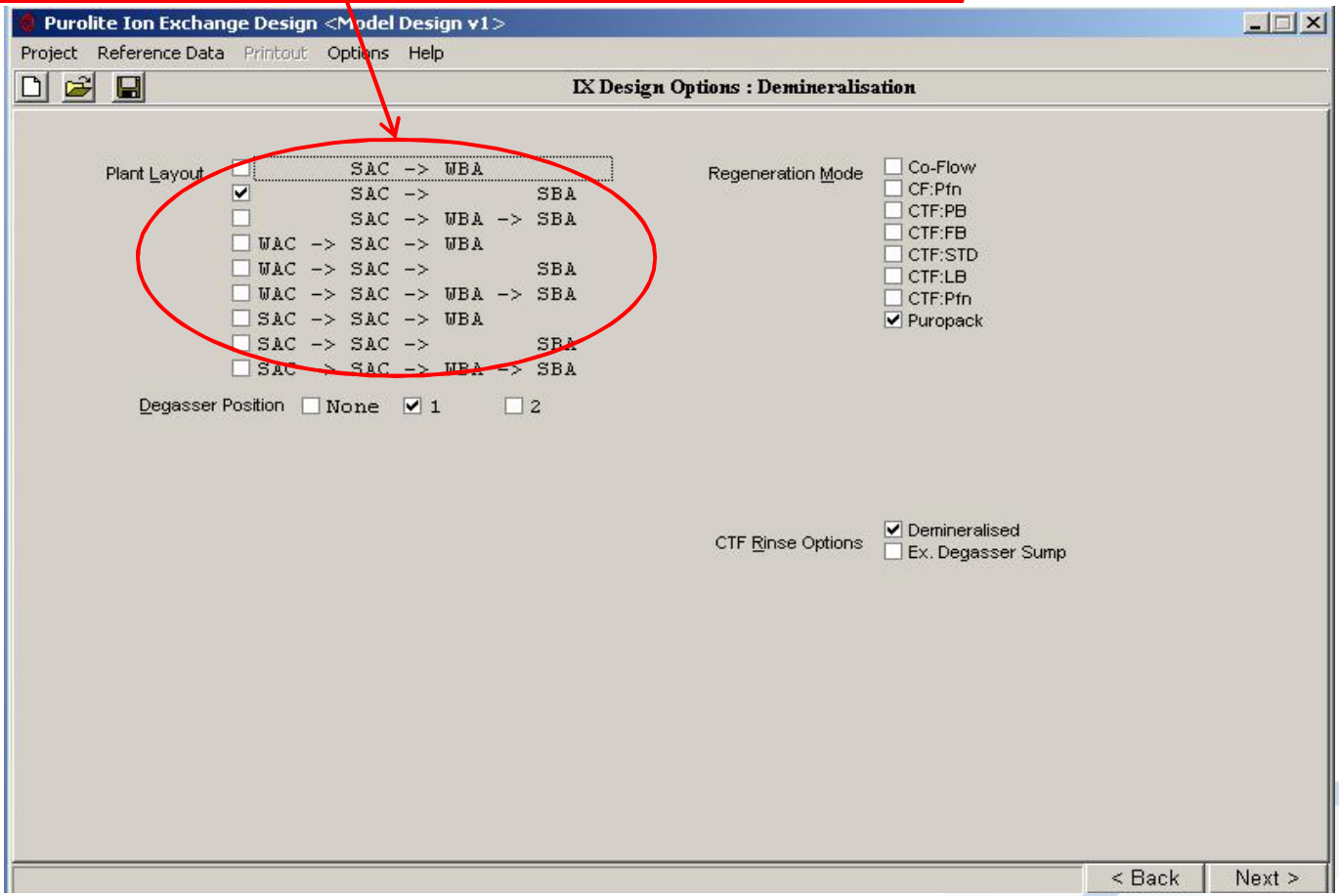
Plant Layout



Plant Layout

Plant layout can be specified with regard to CAPEX vs OPEX and treated water requirements



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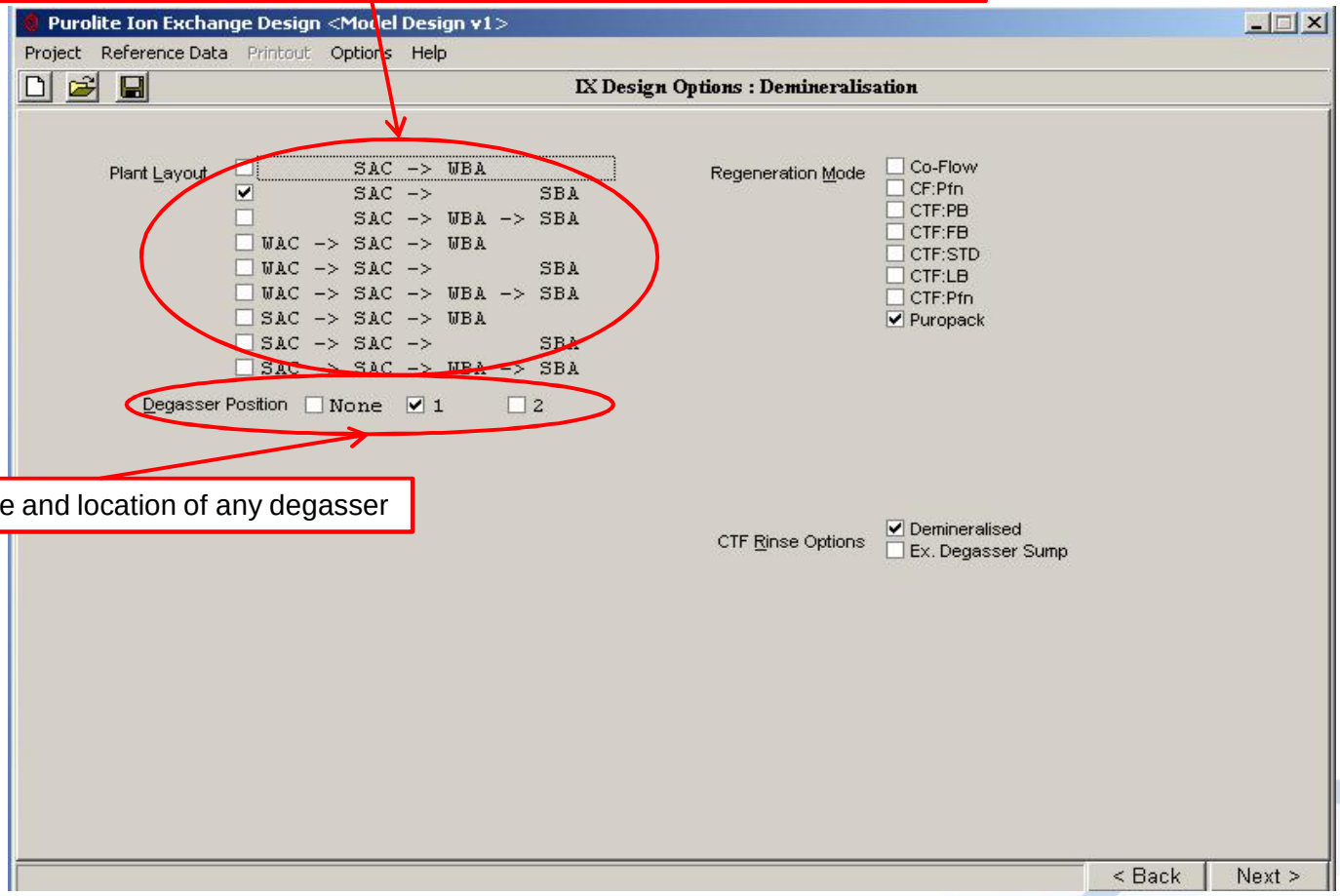

Define presence and location of any degasser

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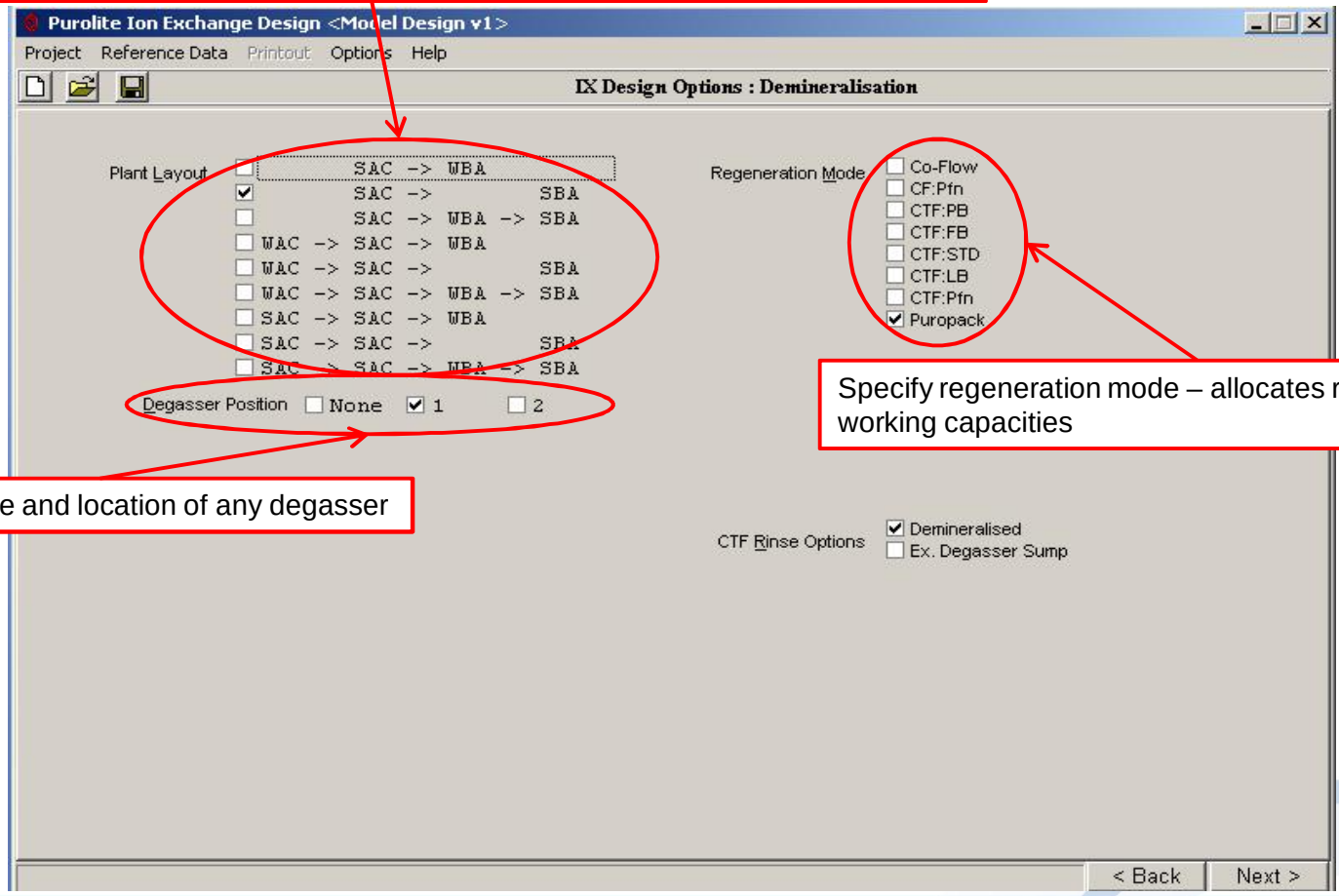

Specify regeneration mode – allocates resin choices and working capacities

Define presence and location of any degasser

Plant Layout

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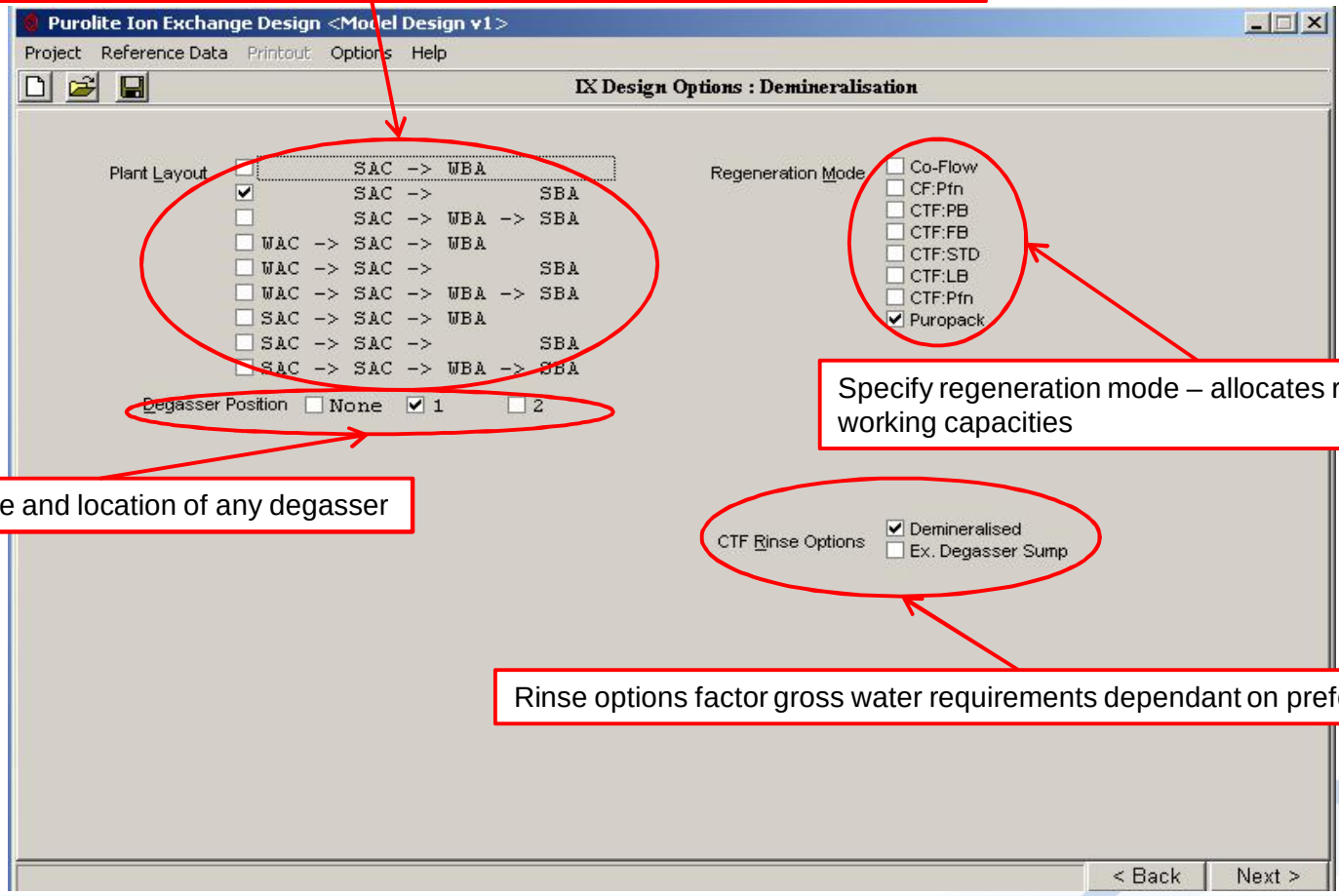
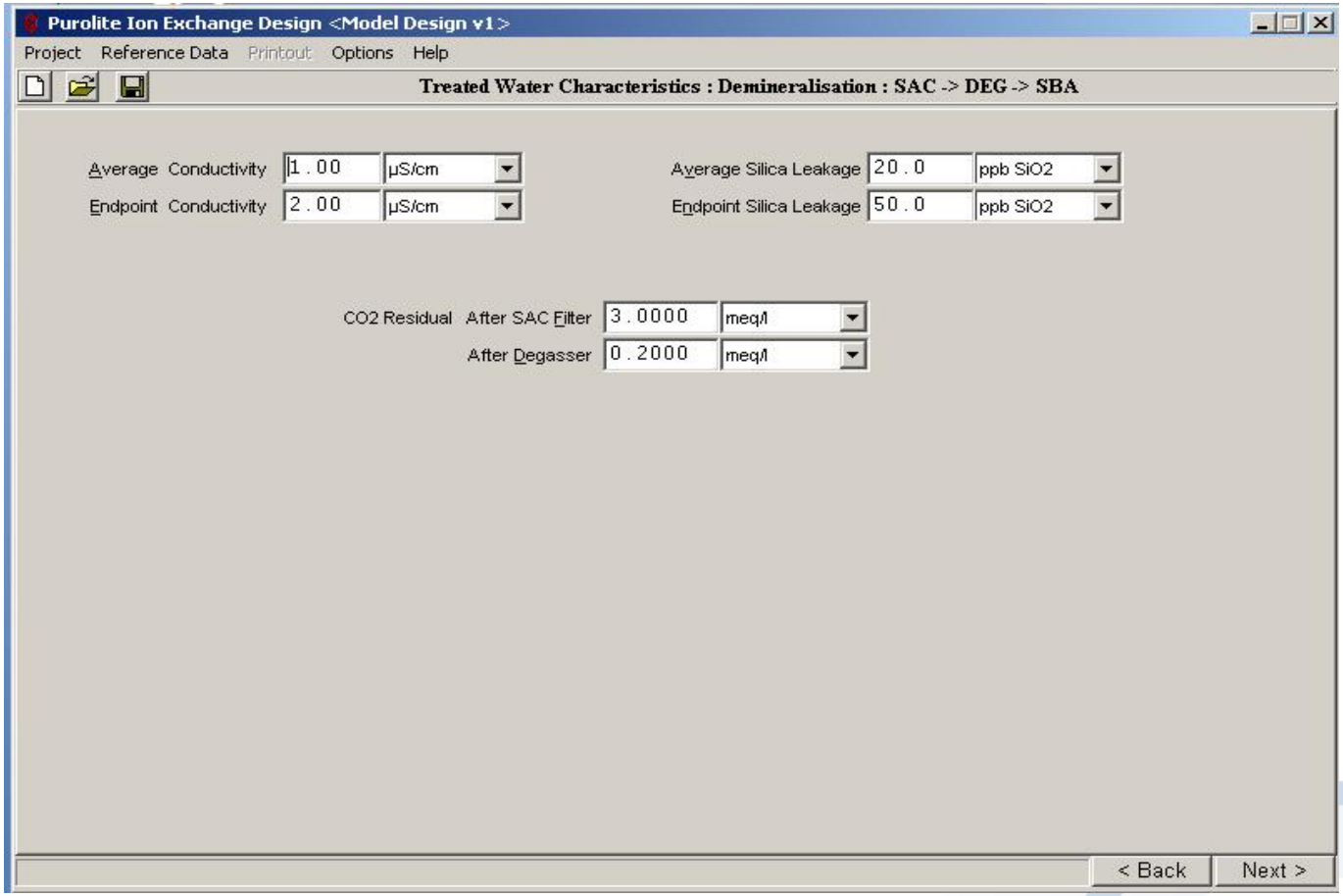


Specify regeneration mode – allocates resin choices and working capacities

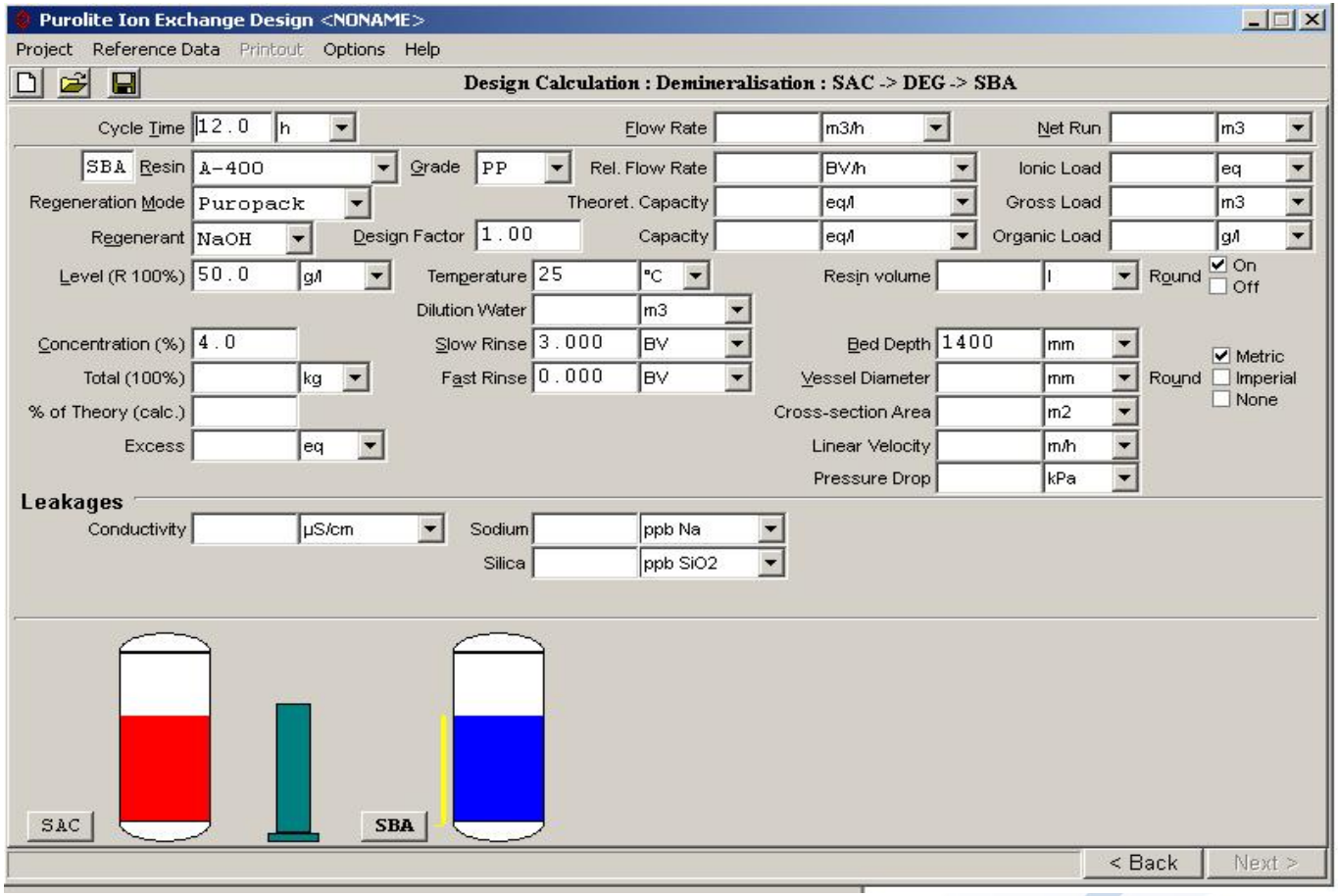
Define presence and location of any degasser

Rinse options factor gross water requirements dependant on preferred source

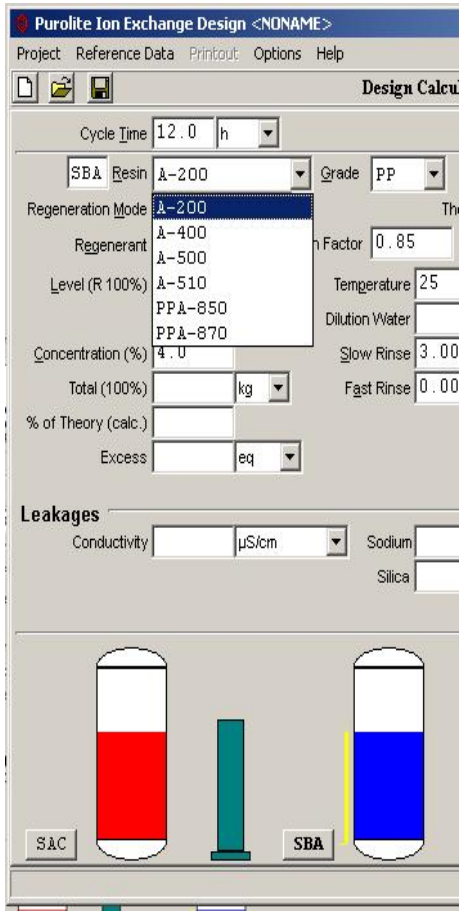
Treated Water Specification

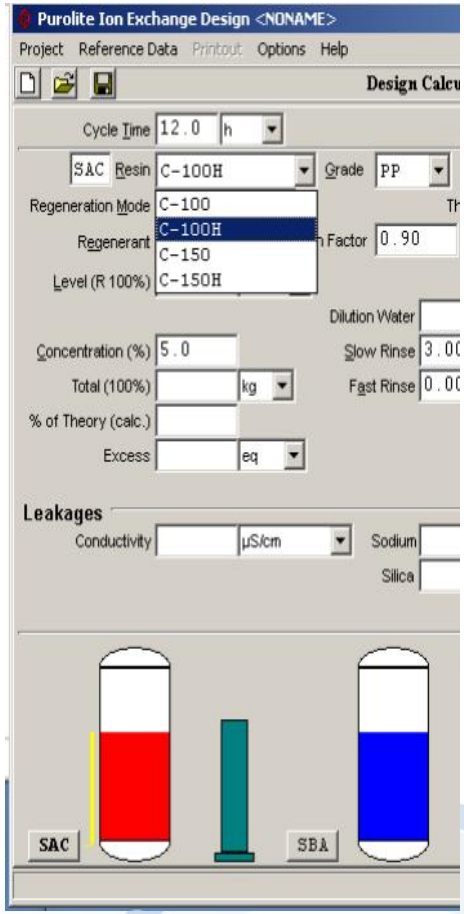


The Design


Purolite Ion Exchange Design <NONAME>
Project
Reference Data
Printout
Options
Help
Design Calculation : Demineralisation : SAC -> DEG -> SBA
Cycle Time
12.0
h
Flow Rate
m3/h
Net Run
m3
SBA Resin
A-400
Grade
PP
Rel. Flow Rate
BV/h
Ionic Load
eq
Regeneration Mode
Puropack
Theoret. Capacity
eq/l
Gross Load
m3
Regenerant
NaOH
Design Factor
1.00
Capacity
eq/l
Organic Load
g/l
Level (R 100%)
50.0
g/l
Temperature
25
°C
Resin volume
l
Round
On
Off
Dilution Water
m3
Concentration (%)
4.0
Slow Rinse
3.000
BV
Bed Depth
1400
mm
Total (100%)
kg
Fast Rinse
0.000
BV
Vessel Diameter
mm
Round
Metric
Imperial
None
% of Theory (calc.)
Cross-section Area
m2
Excess
eq
Linear Velocity
m/h
Pressure Drop
kPa
Leakages
Conductivity
µS/cm
Sodium
ppb Na
Silica
ppb SiO2
SAC
SBA
< Back
Next >

The Design – Resin Choice and Design Margin





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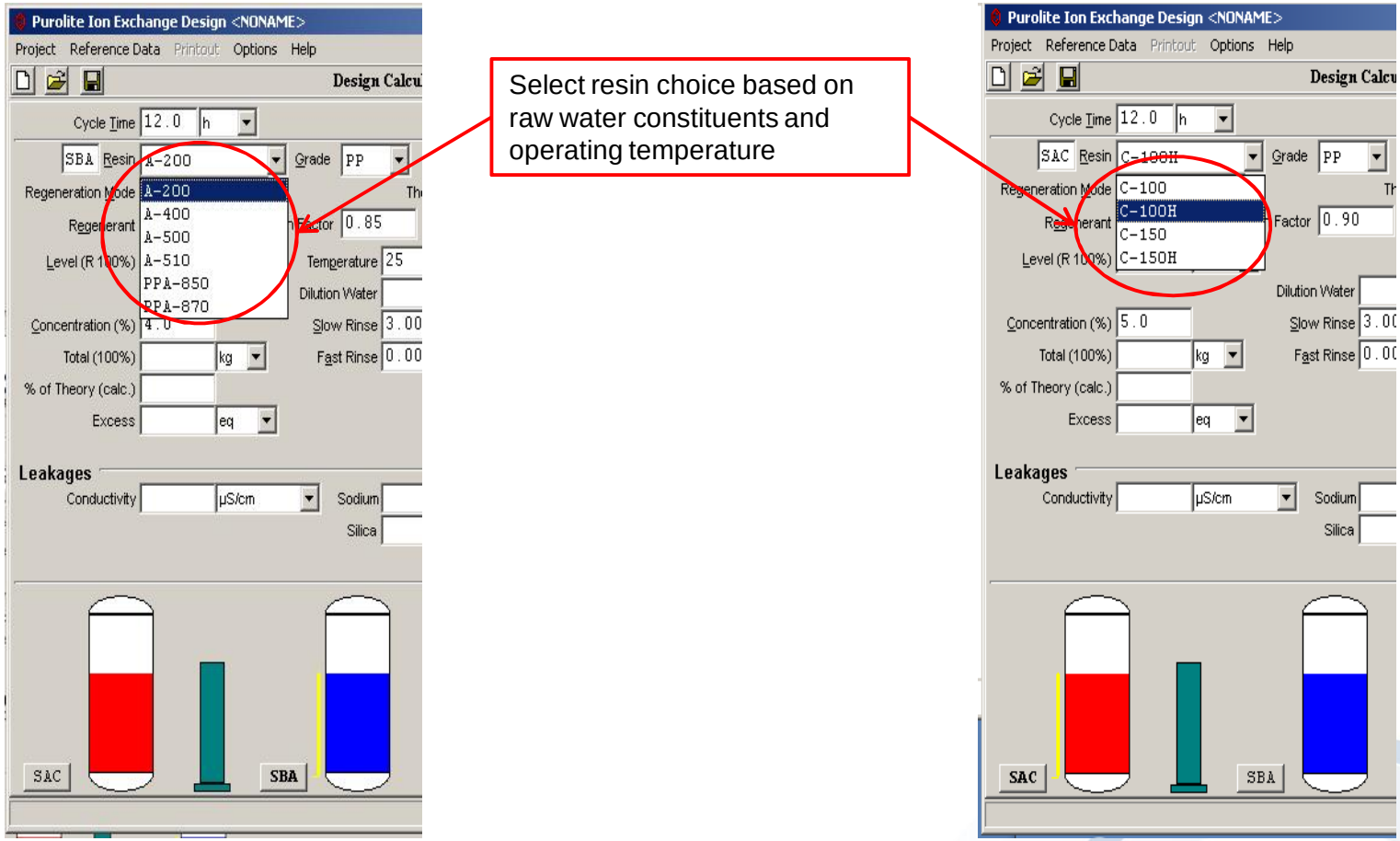

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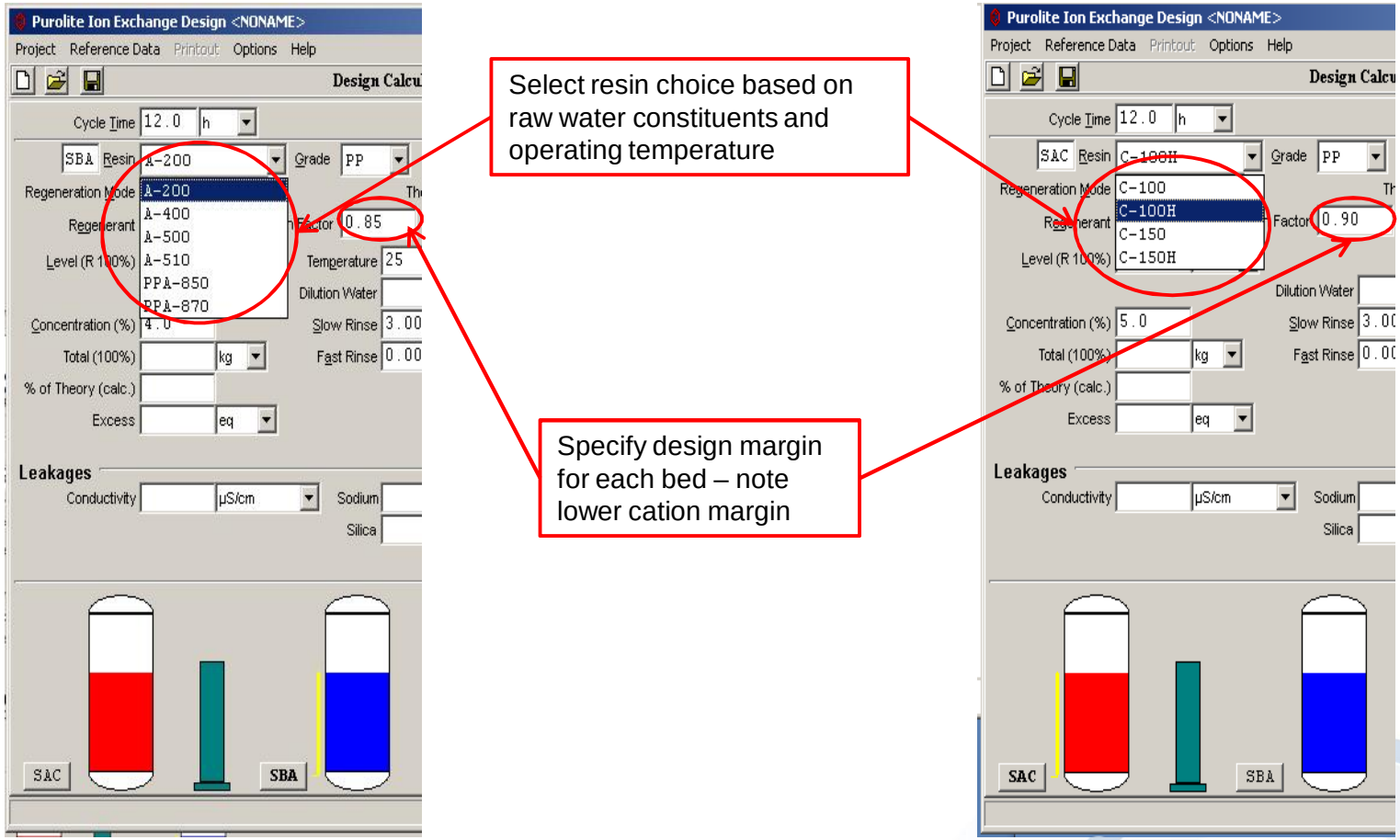
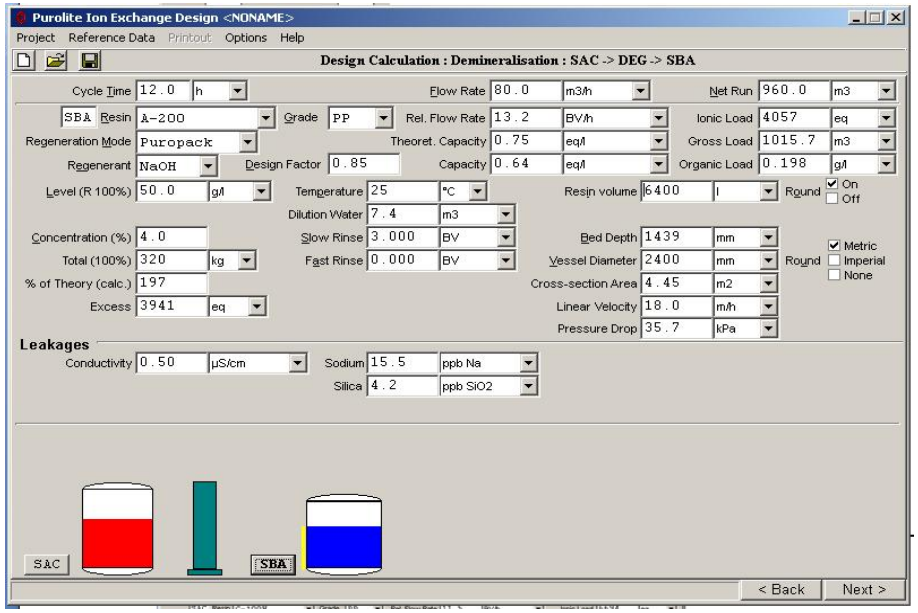
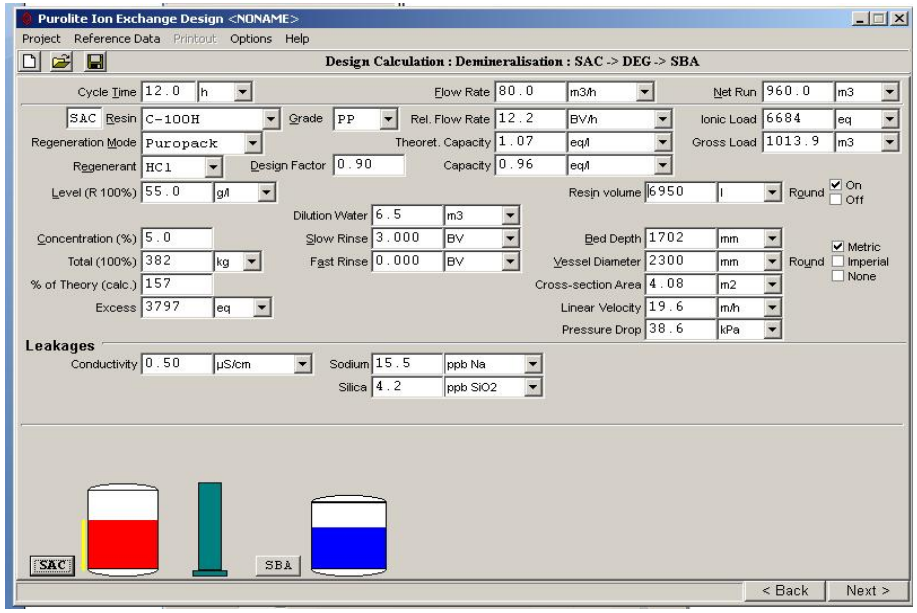


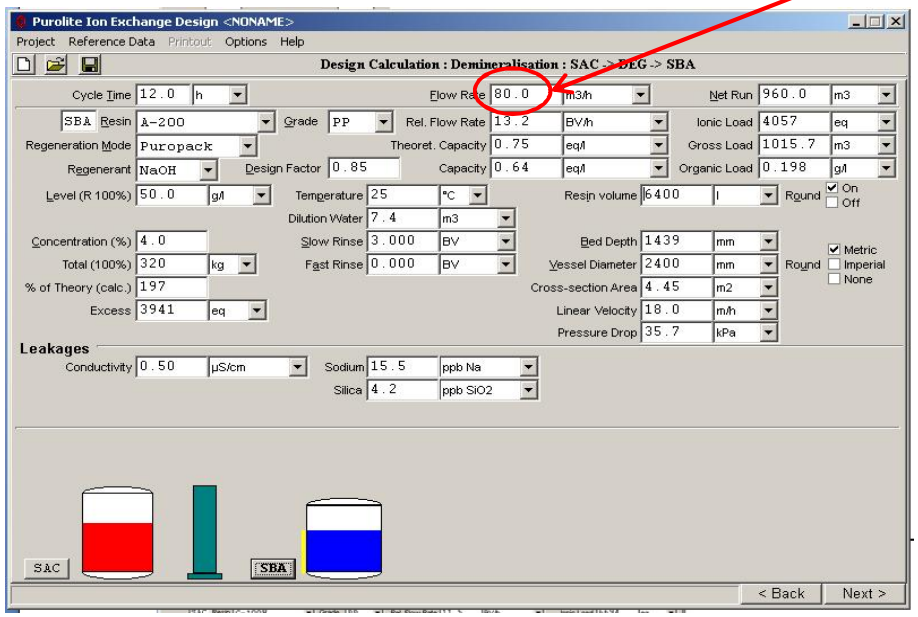
The Design –Flow Rate and Cycle Time

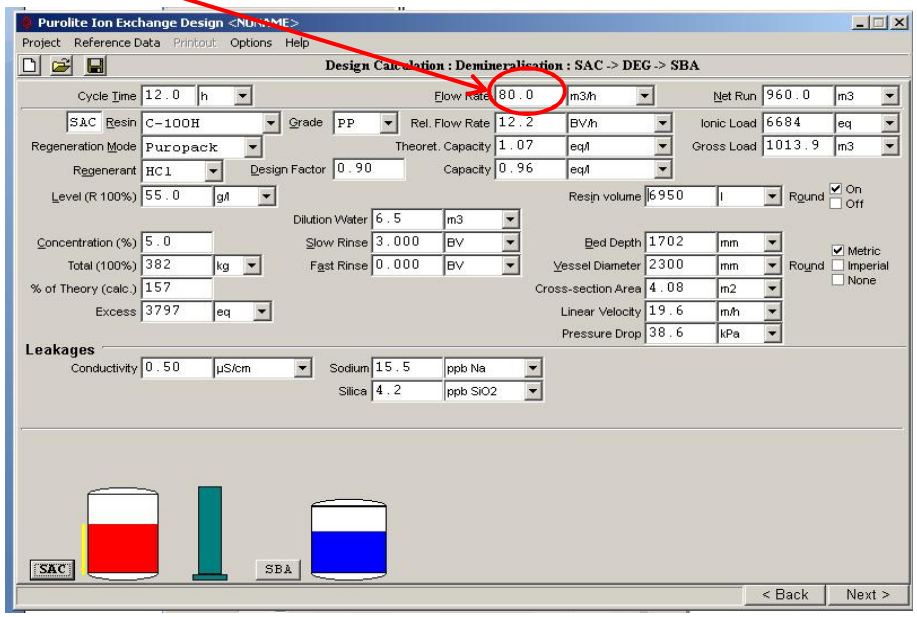




The Design –Flow Rate and Cycle Time

Introducing a cycle time generates a basic model with a series of default set points





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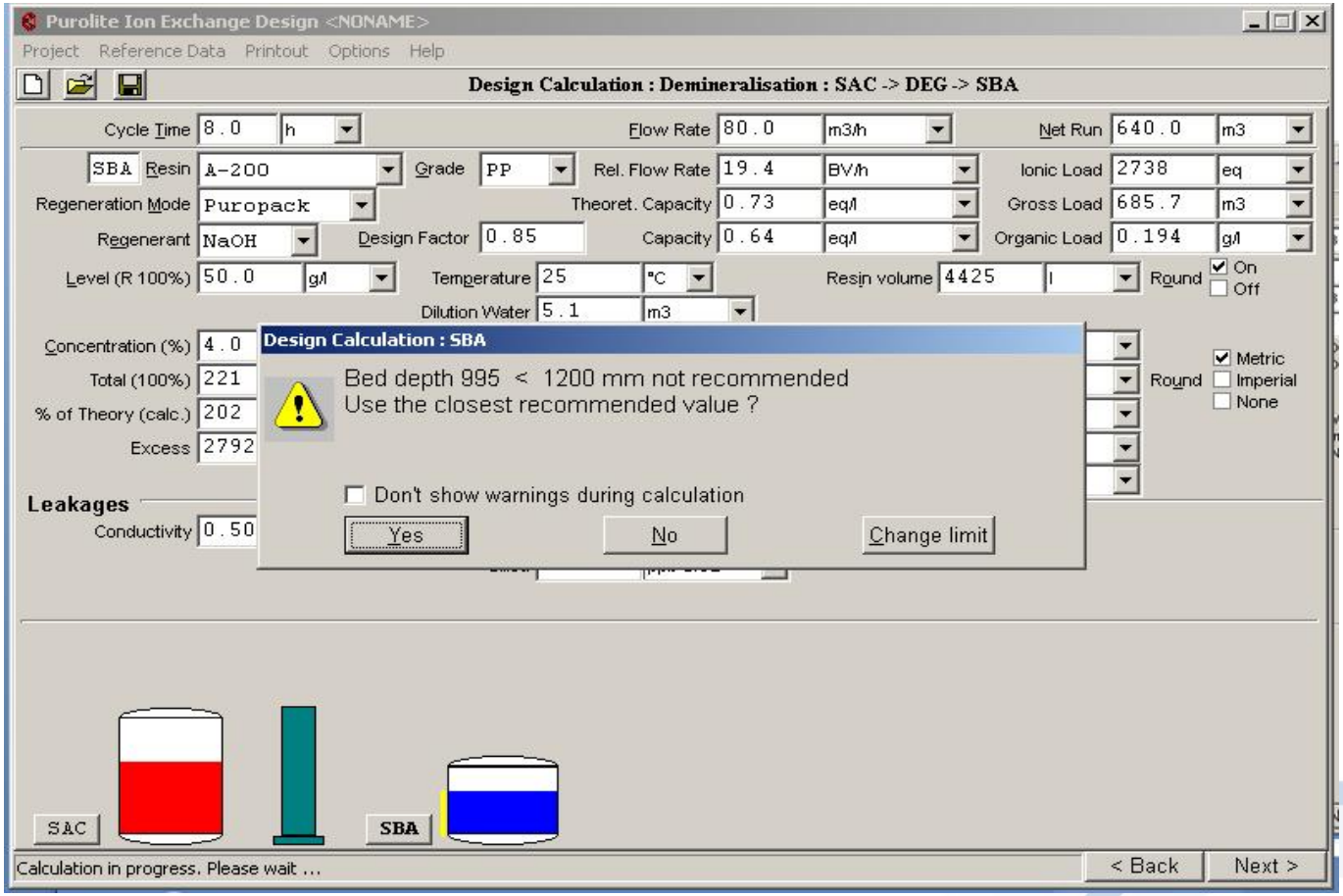

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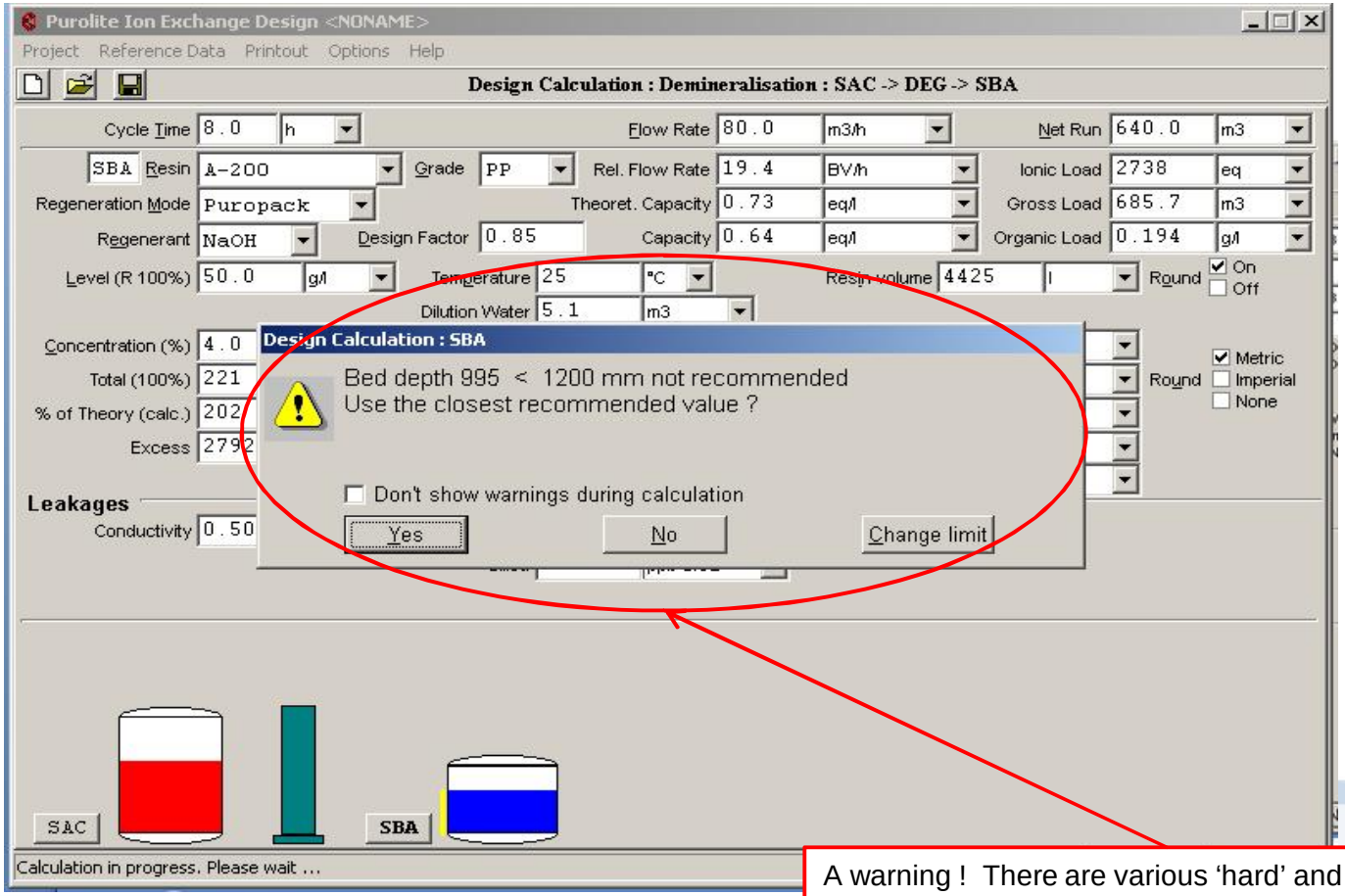
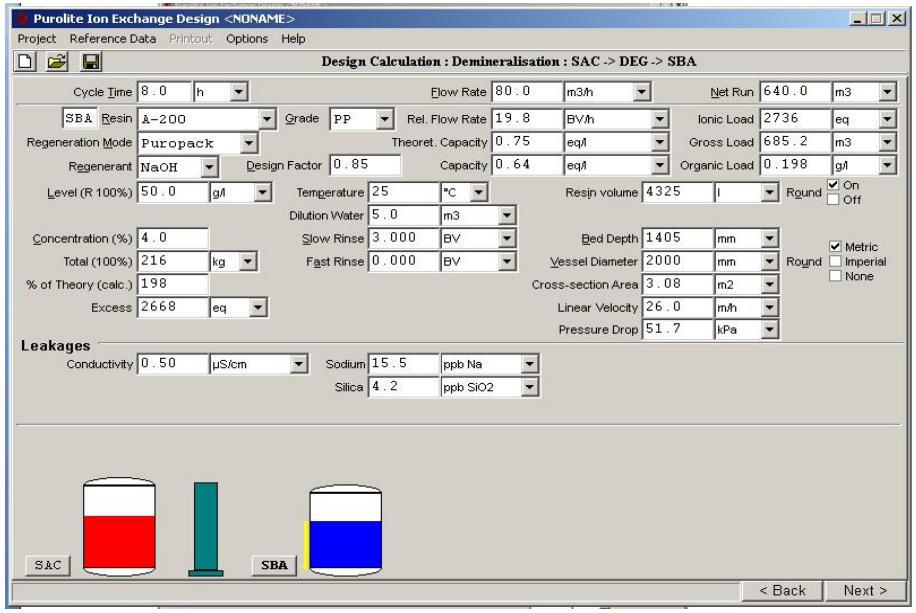
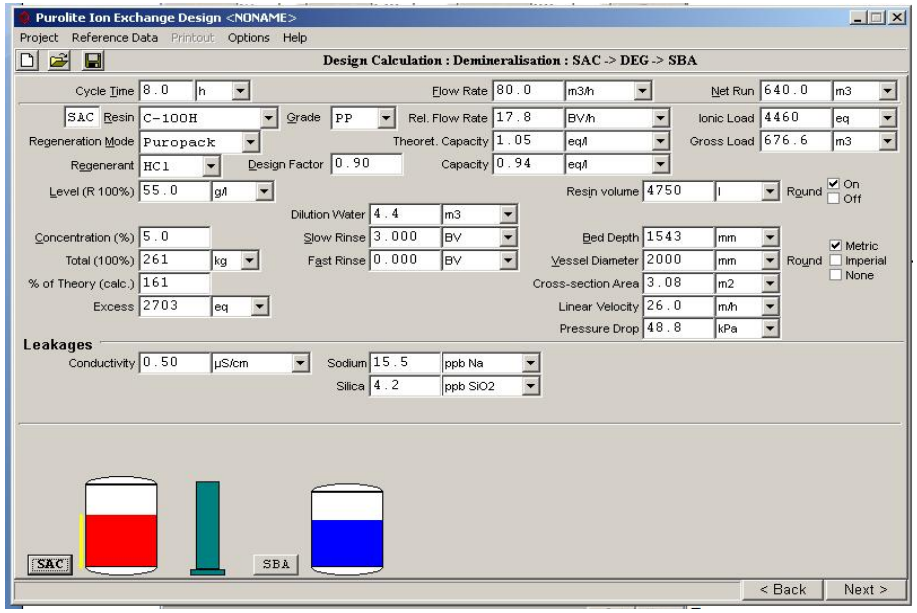


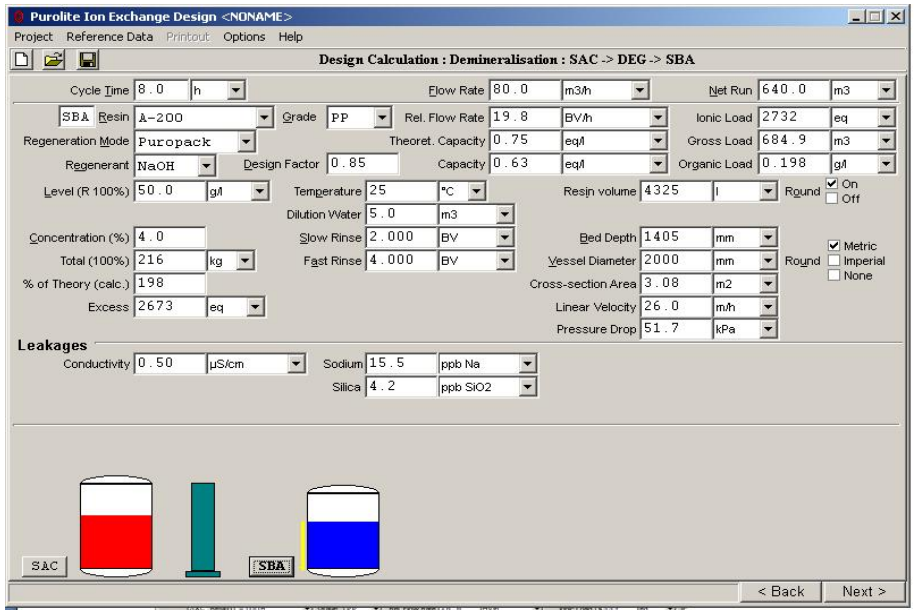
A warning ! There are various 'hard' and 'soft' limits built into the program. We would suggest increasing design margin if these warnings are overridden, as the program assumes operation within defined parameters

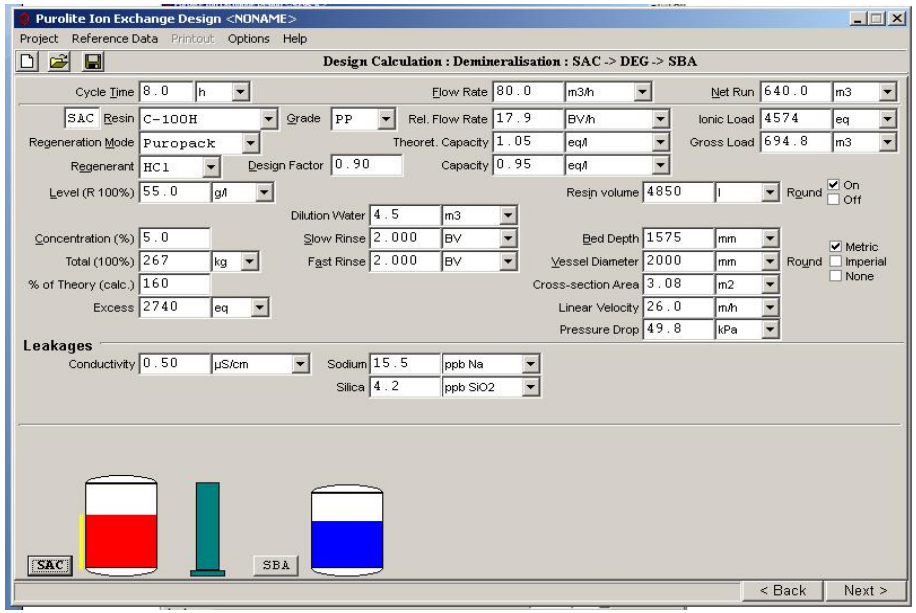
The Design – Flow Rate and Cycle Time





The Design – Optimising Rinse Volumes and Regeneration Levels





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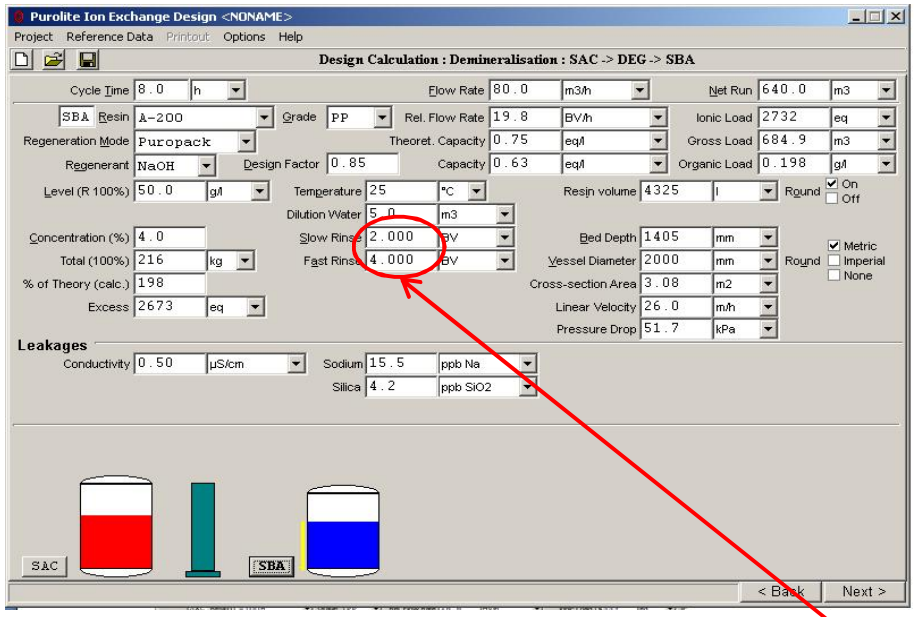
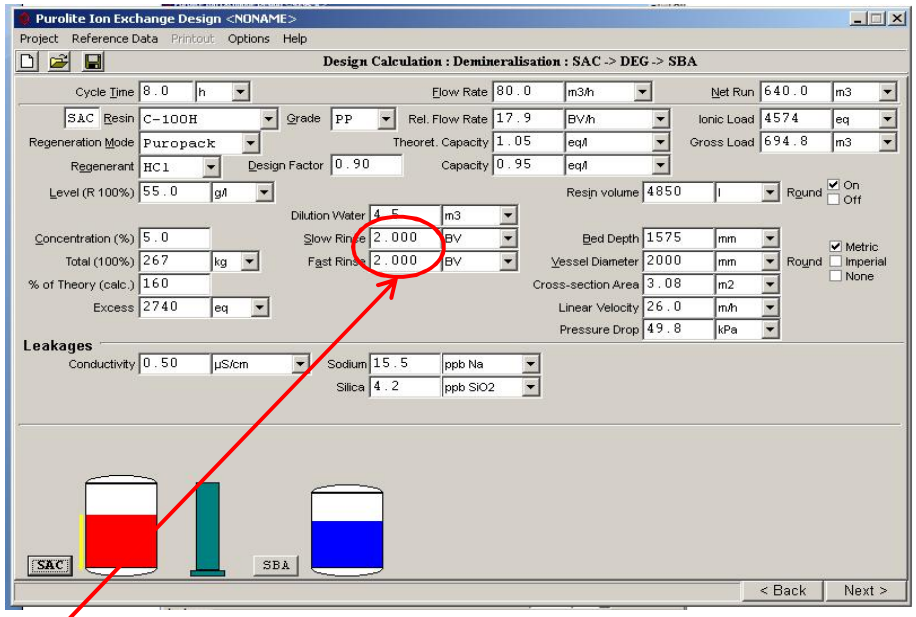
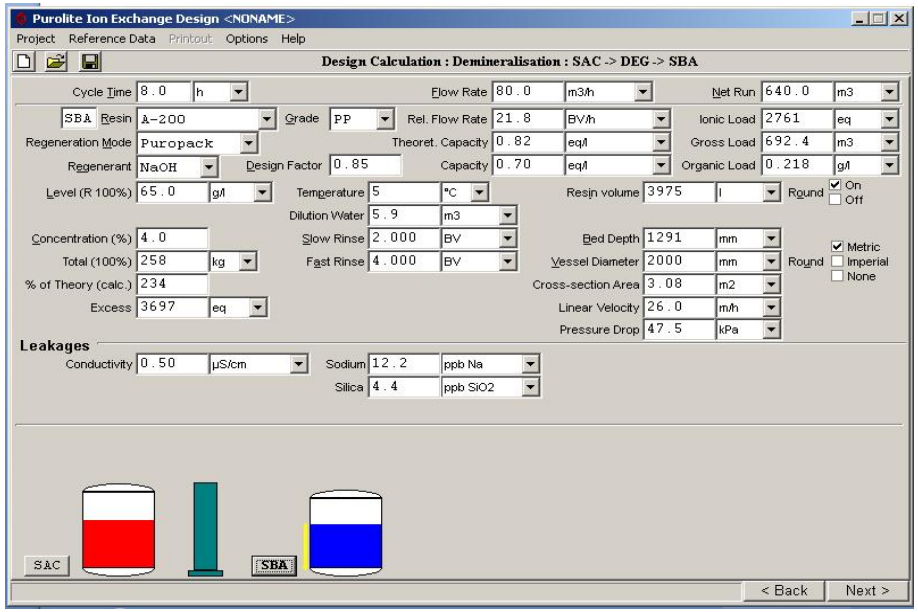
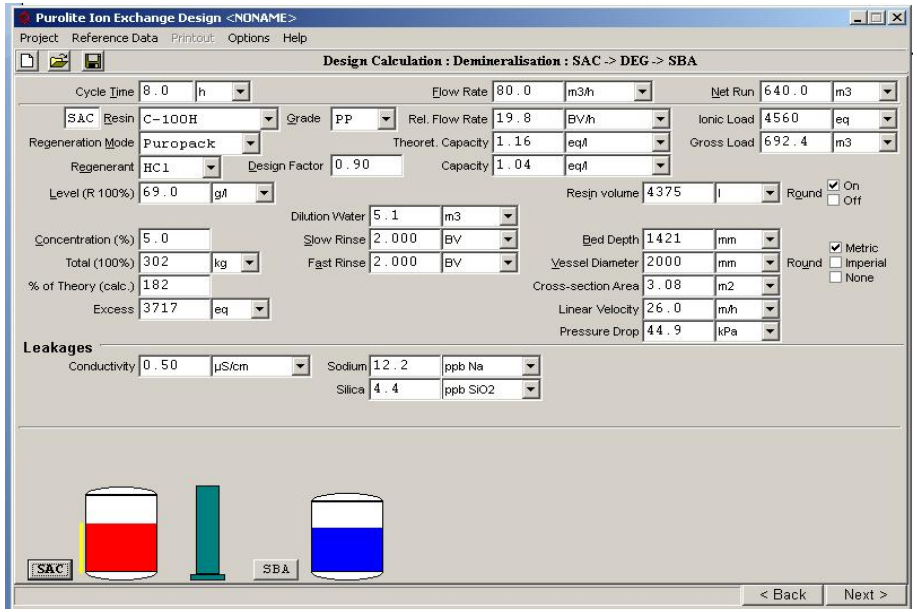




Typical rinse volumes for counter-flow systems

The Design – Optimising Rinse Volumes and Regeneration Levels





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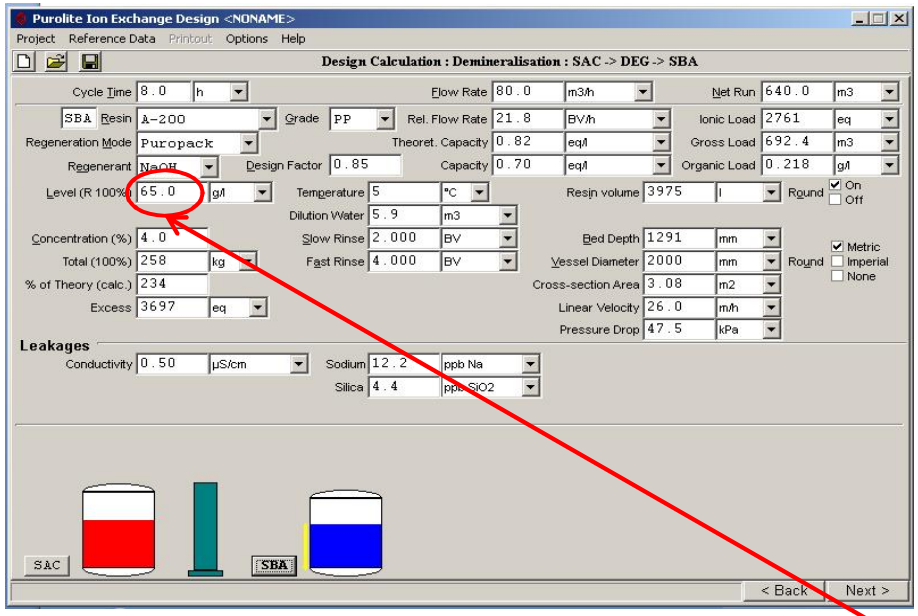
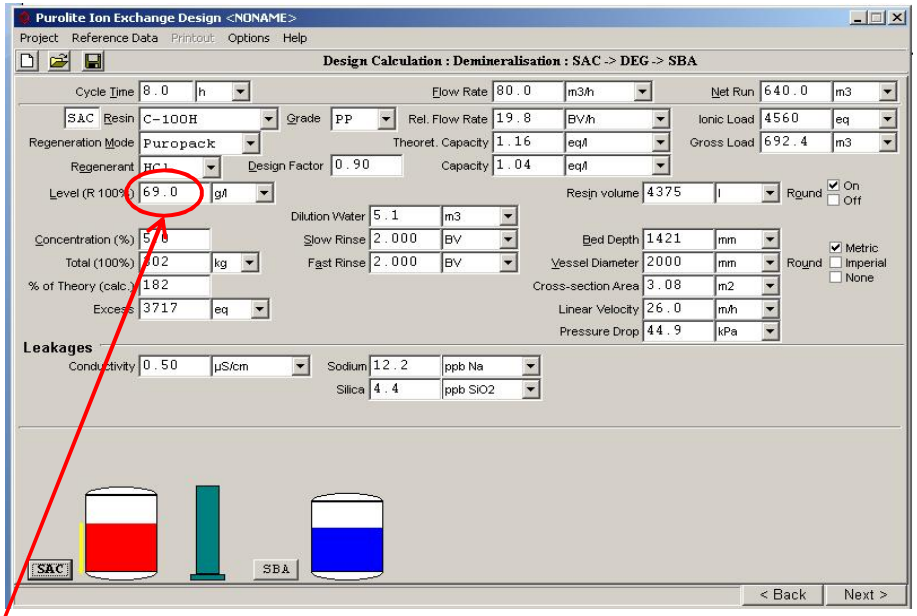
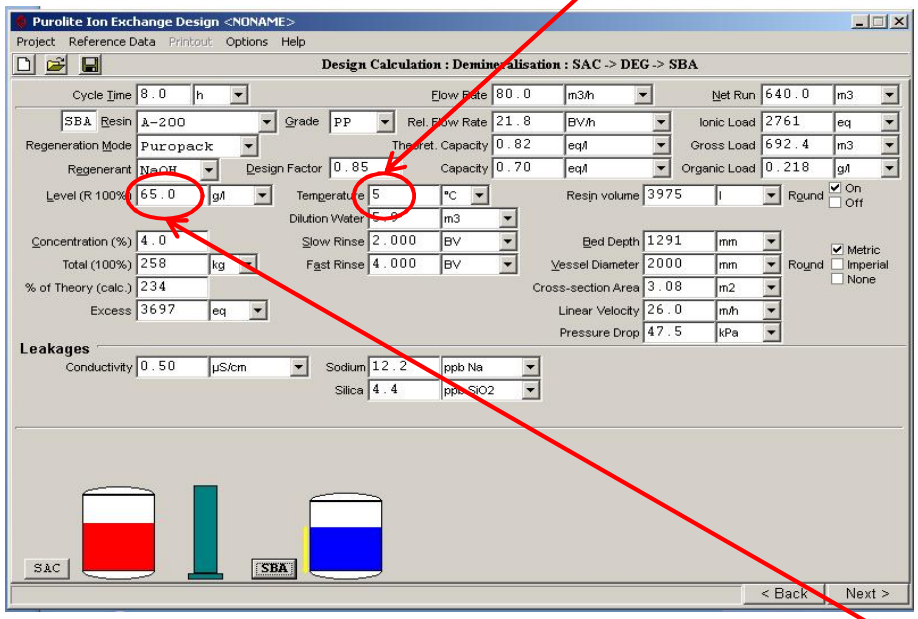


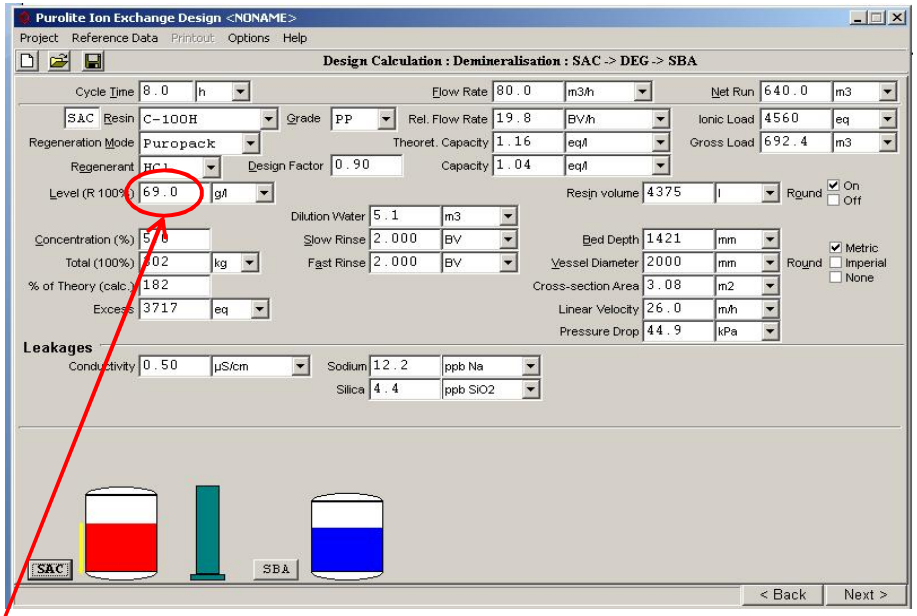


Regen. levels set to give approximately neutral effluent and manage the small quantity of organics in the influent water

The Design – Optimising Rinse Volumes and Regeneration Levels

Note temperature adjustment on anion – default is 25 ºC – not likely from deep borehole in UK



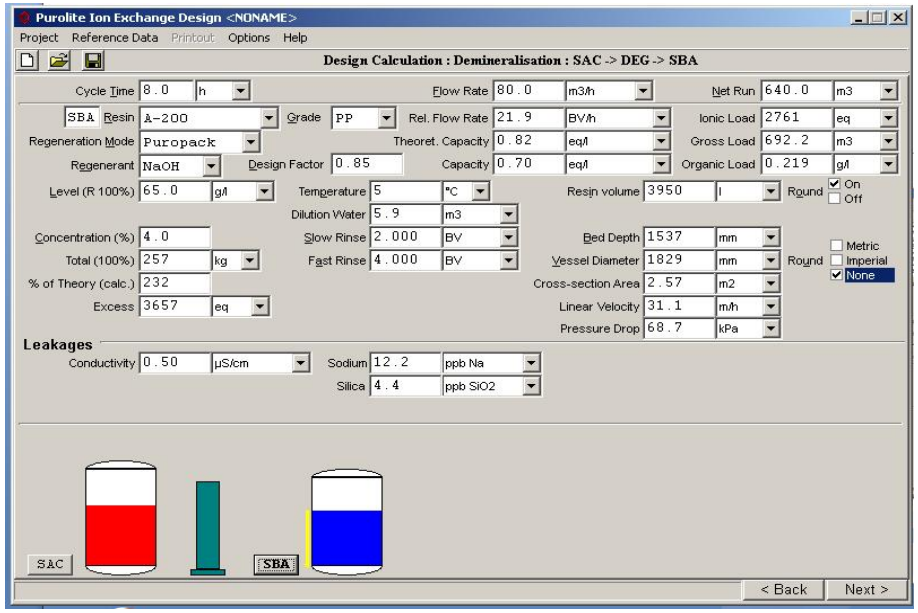


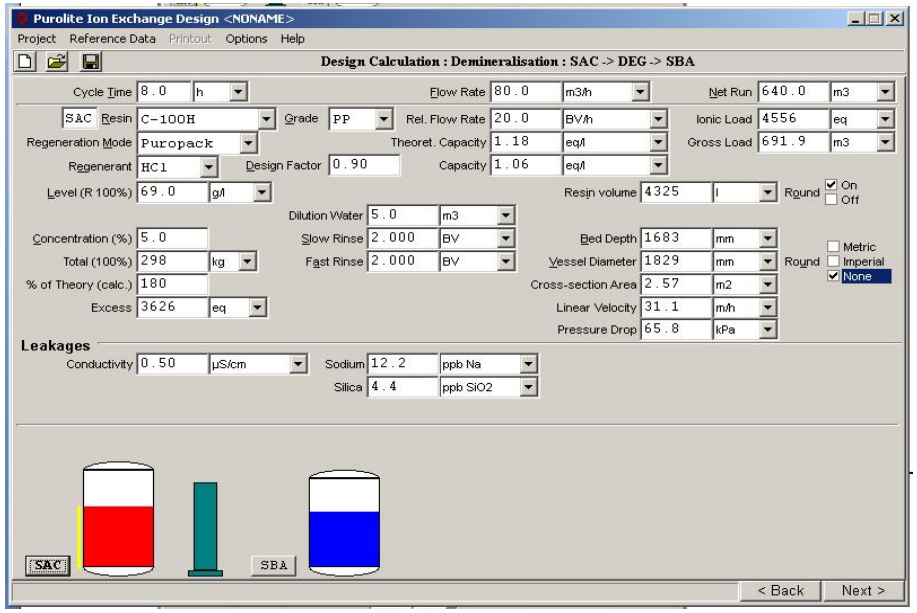
Regen. levels set to give approximately neutral effluent and manage the small quantity of organics in the influent water

The Design – Vessel Sizing

- Plant currently modeled assuming metric measurements
- In practice, vessels often sized on imperial measurements
- To minimise CAPEX, there is often merit in reducing vessel diameter, whilst factoring effect on bed depth and pressure drop
- Vessel dimensions influence distribution/flow and thus performance
- Watch out for changes to effluent levels if attempting to achieve neutral effluent !

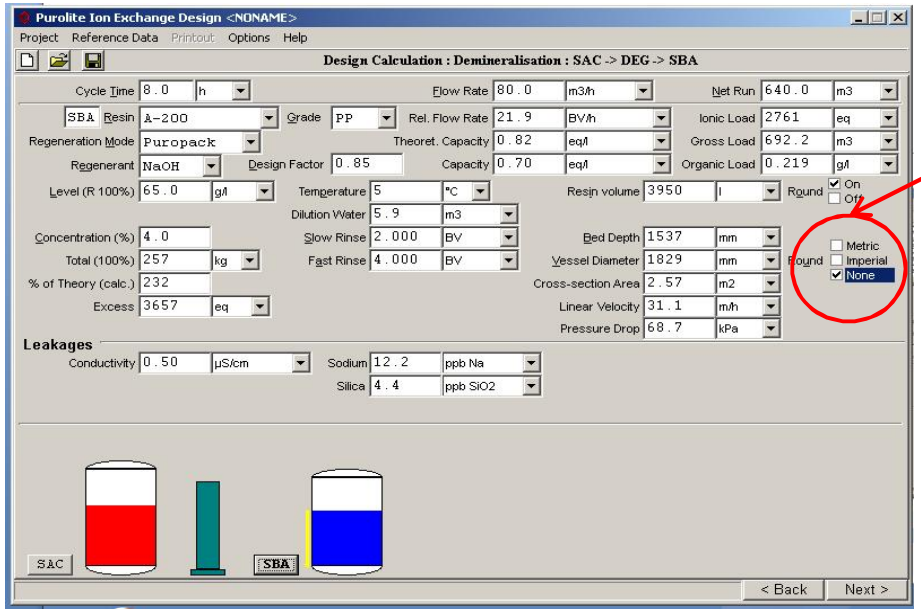
The Design – Vessel Sizing

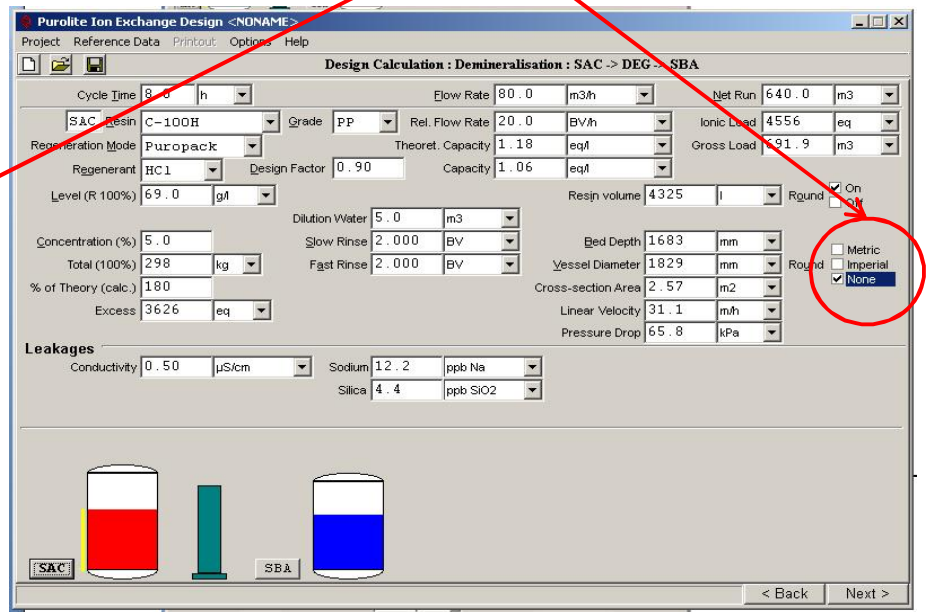




The Design – Vessel Sizing

Switching vessel rounding to ‘none’ enables metric or imperial values





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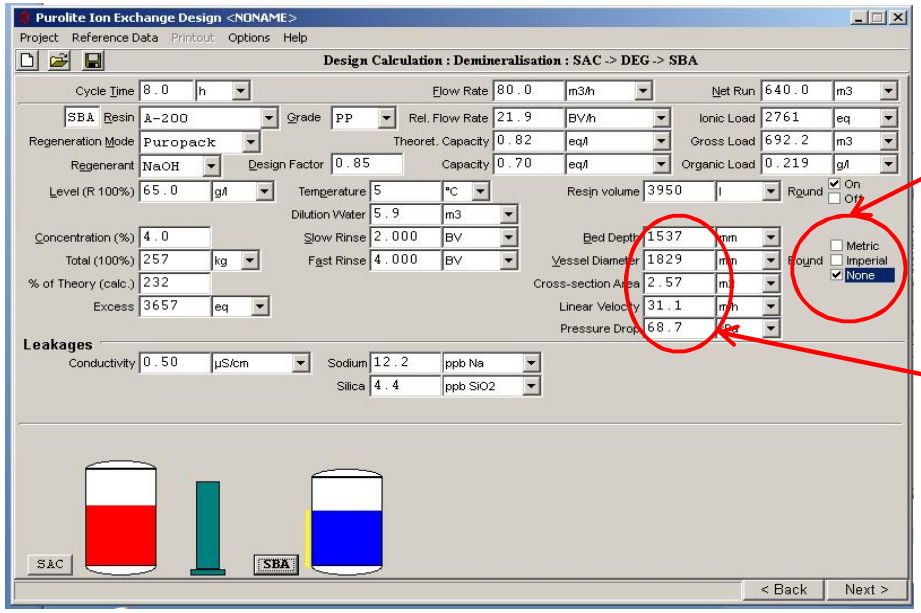

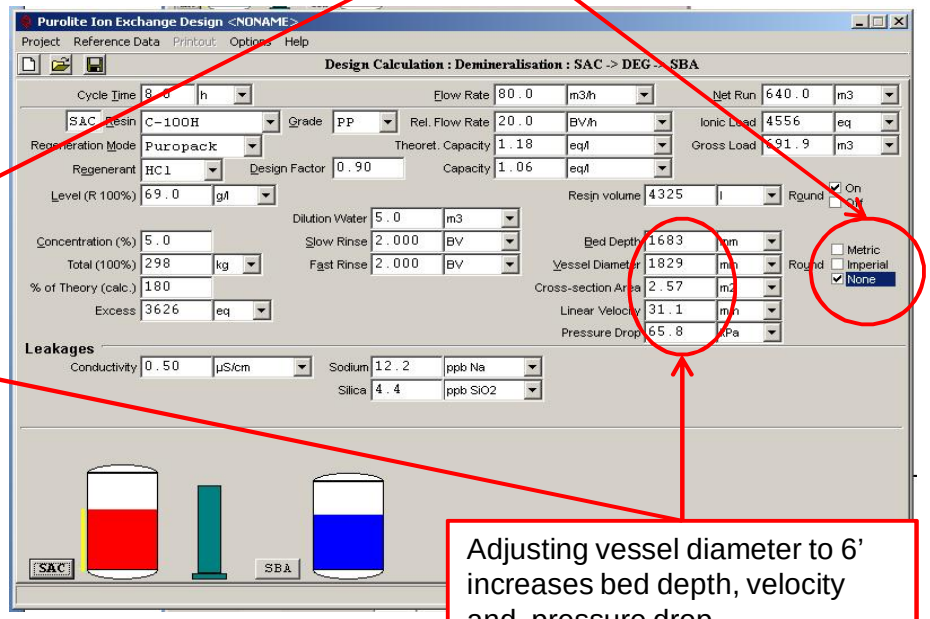

Adjusting vessel diameter to 6’ increases bed depth, velocity and pressure drop

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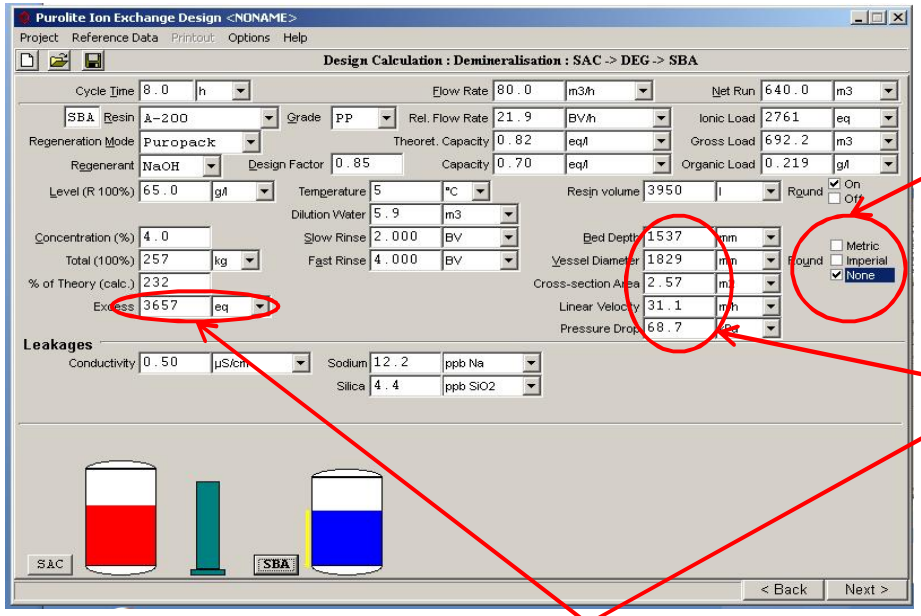
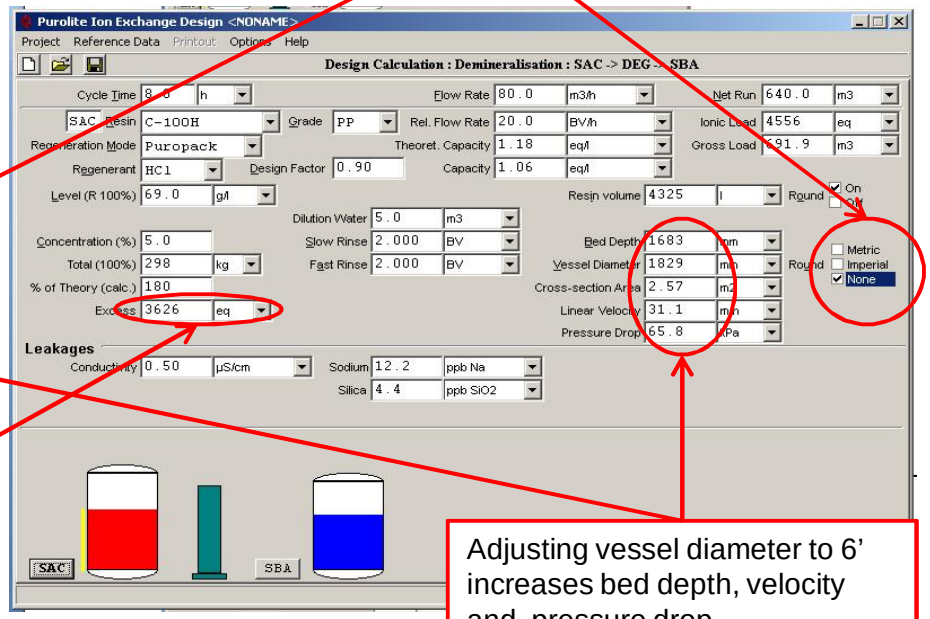
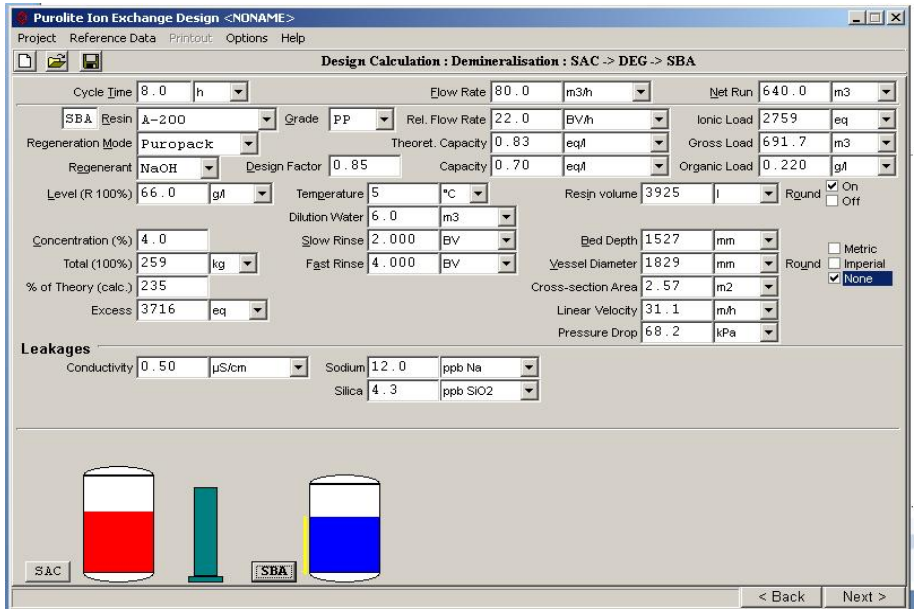


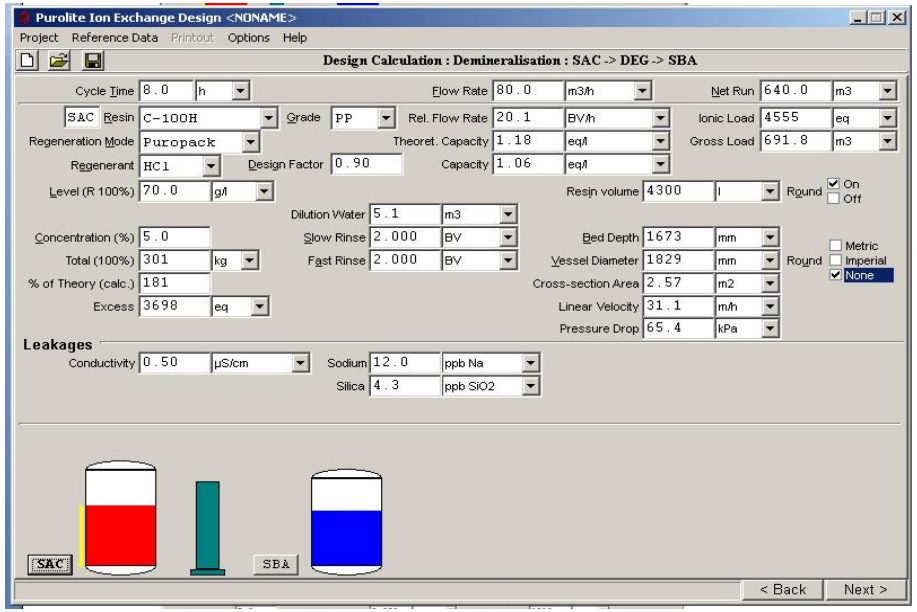


Adjusting vessel diameter to 6’ increases bed depth, velocity and pressure drop

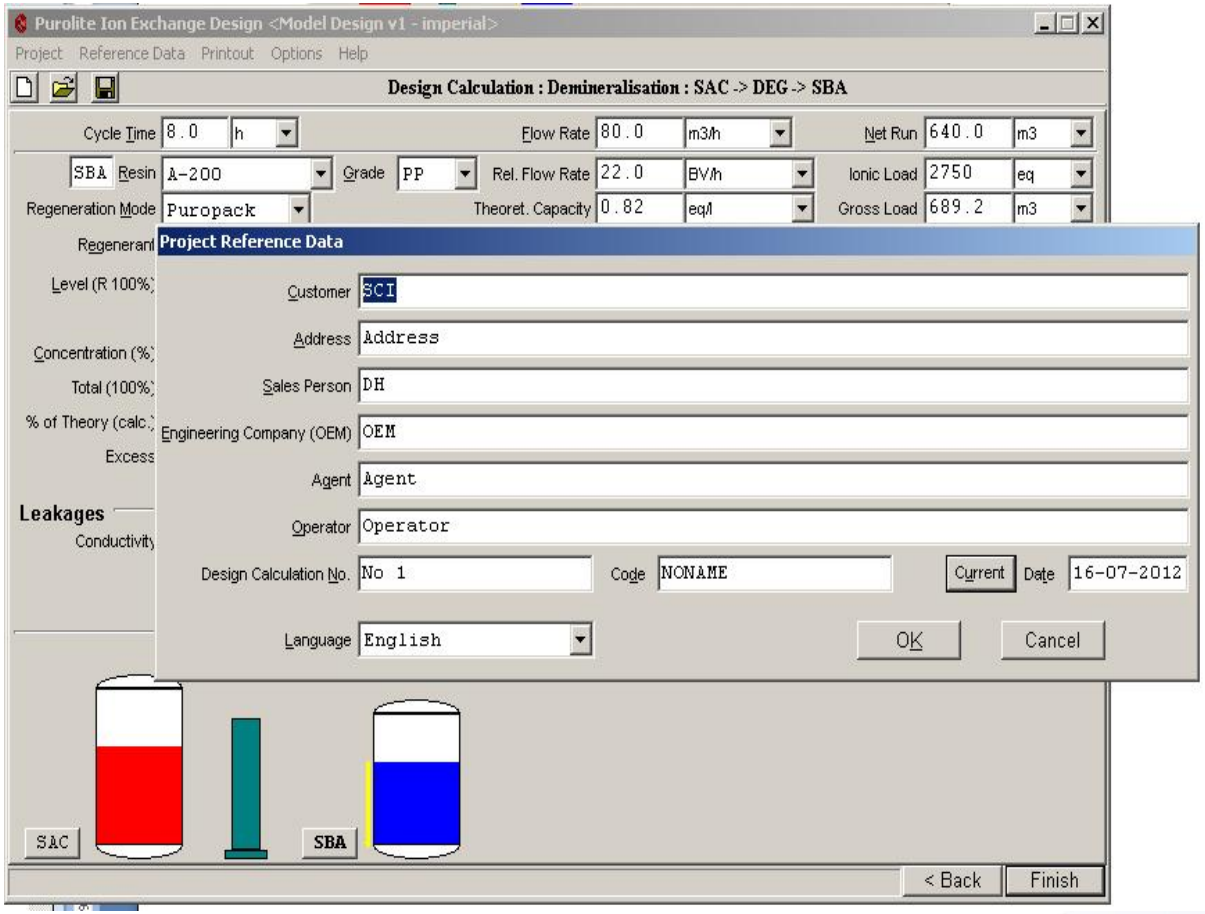
Resin volumes and consequently excess regenerant to drain also affected

The Design – Adjusting for Neutral Effluent





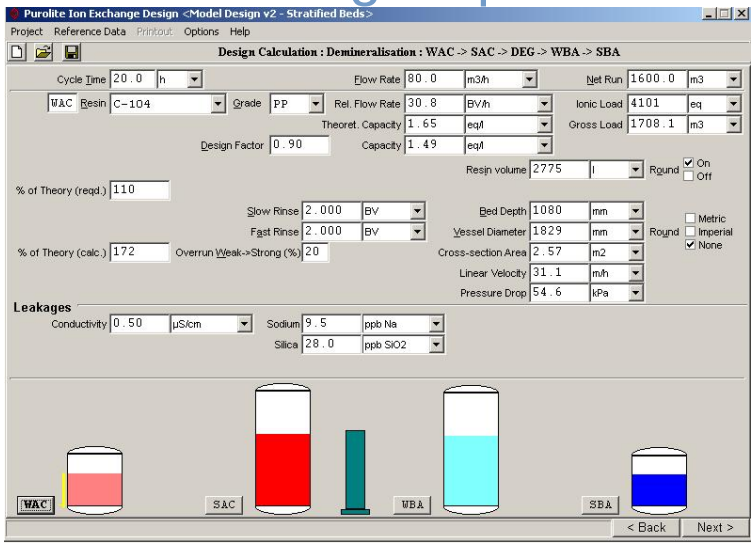
Outputs

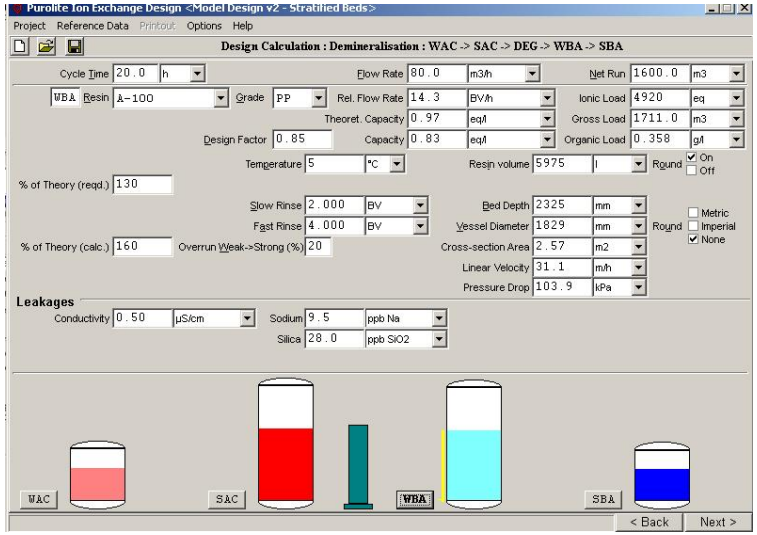

Purolite Ion Exchange Design <Model Design v1 - imperial>
Project Reference Data Printout Options Help
Design Calculation : Demineralisation : SAC -> DEG -> SBA
Cycle Time 8.0 h
Flow Rate 80.0 m3/h
Net Run 640.0 m3
SBA Resin A-200
Grade PP
Rel. Flow Rate 22.0 BV/h
Ionic Load 2750 eq
Regeneration Mode Puropack
Theoret. Capacity 0.82 eq/l
Gross Load 689.2 m3
Regenerant
Level (R 100%)
Concentration (%)
Total (100%)
% of Theory (calc.)
Excess
Leakages
Conductivity
Project Reference Data
Customer SCI
Address Address
Sales Person DH
Engineering Company (OEM) OEM
Agent Agent
Operator Operator
Design Calculation No. No 1
Code NONAME
Current
Date 16-07-2012
Language English
OK
Cancel
SAC
SBA
< Back
Finish

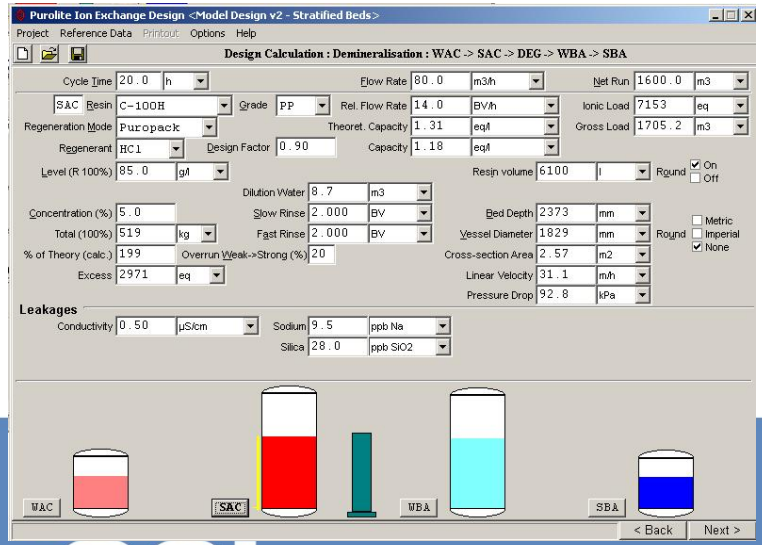
Outputs

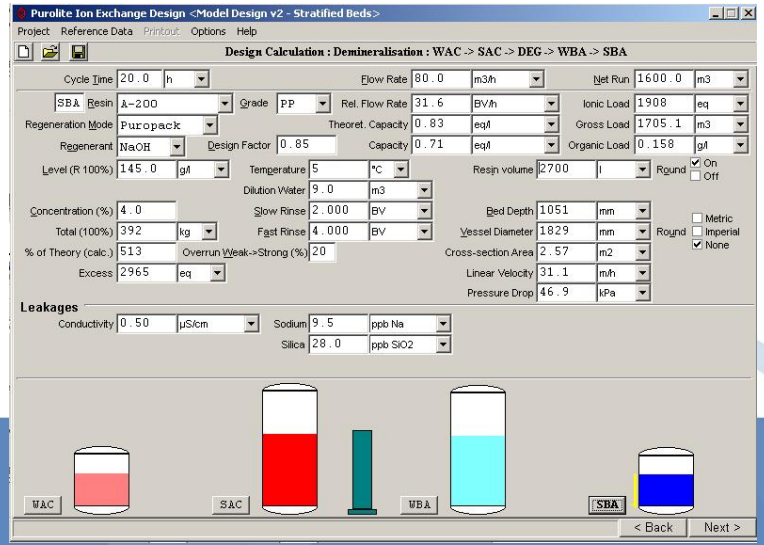
Design generated in MS Word, e.g. here

Other Design Options – Stratified Bed









OPEX Comparison – Packed Bed vs Stratified Bed

Operating costs per m^3 treated water produced:

- Counter current packed bed SAC – DG – SBA - £0.38
- Stratified WAC - SAC – DG – WBA – SBA - £0.24
  - Approximate 37 % reduction in cost

Costs based on chemical cost of £105/T of 32% HCl and £260/T of 46% NaOH
Information for costing kindly provided by Watercare International

Questions ?

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