where science meets business

Design by Computer Program

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Outline

- **Design tools**
- **Differentiation**
- **Approach & Attitude**
- **Design tools Handling**
- **General Considerations**
- **Example : regeneration chemicals**
- **Summary**

Available design tools

- **DOW**
  - IXCalc (Amberlite – Amberjet)
  - CADIX (DOWEX)
  - 2013 integrated technologies
- **Purolite**
  - Puredesign
- **Lanxess**
  - Lewaplus

A design program is an addition to the technical design manual

Other tools :

Boron removal
Arsenic removal
Nitrate removal
UPW polishing
...and more....

Differentiation to application

- Each program serves you at a range of different applications for which you can run a design. Each application will have its specific additional design rules in the program.
  - Demineralization
  - Demineralized water polishing
  - Softening / dealkalization
  - Post RO mixed beds
  - Scavenging
  - Condensate polishing
  - UPW polishing
  - Electro plating

Differentiation to system

- There is a large range of different systems all with their specific design details.
  - Co flow or co current systems
  - Mixed beds systems (demineralized water, post RO, condensate, UPW polishing)
  - Counter flow or counter current systems
    - Packed beds like UPCORE, Schwebebett, Amberpack, etc.
    - Blocked beds like air or water block

Differentiation general

- Most software includes specific water chemistry information
  - Carbon dioxide equilibrium
  - pH/amines relation for condensate polishing
  - Conductivity/TDS relation

- Operational details are not always included in the software output but do influence the performance of the design
  - Regeneration sequence
  - Blend and mix for feed water quality and for product quality
  - Waste water composition

- User options can be offered to widen the range of software use
  - New plant design (for engineers)
  - Evaluation of existing plant performance (end users and service suppliers)
  - Retrofit of a co-flow operated plant to a counter current technology (for engineers and end users)

The common rule

- Remember that fundament between all detailed differences the one thing all software tools MUST have in common is:

  1 eq for 1 eq 1 ppm $CaCO_3$ for 1 ppm $CaCO_3$

- When the fundamental principle for an ion exchange design tool is the same the most relevant parameter for a design is the designer and not the tool

Design Approach & Attitude

Gather your data

- Water analysis
- Application
- Preferences
- Operational circumstances

STOP!
USE YOUR BRAINS

Design Approach & Attitude

- Evaluate your water specification:
  - Water specification should be ionic balanced and consistent
  - Identify strange species that could influence system performance (Fe, TSS, ClO_3^-, TOC, T)
  - Identify the source of the feed water in order to understand the specification

- Evaluate the application
  - What is the required water quality and is it feasible
  - Identify application related design details that you might have to consider

- Evaluate the preferences
  - What preferences does your customer have (system, resins, runtime, etc.)
  - Are the preferences technically feasible and logical

Design Approach & Attitude

- System choice:
  - How to deal with suspended solids
  - Regeneration limitations are linked to the system (contact time, recovery, operational downtime)

- Resin sizing by load of impurities
  - Sizing by ionic load: operating capacity / ionic load
  - Sizing by organic load: organic load limitations (contact time, regenerant ratio
  - Sizing by silica load: silica load limitations (temperature, caustic concentration)
  - Sizing by crud load : high suspended solids and for condensate polishing

- Resin sizing by hydraulic factors (low TDS/High TDS):
  - If the TDS is high, increasing cycle length might decrease Bv/h and exceed the lower limit. If the TDS is low cycle length must be long enough not to exceed the upper limit.

Design tools “handling”

Design tools handling

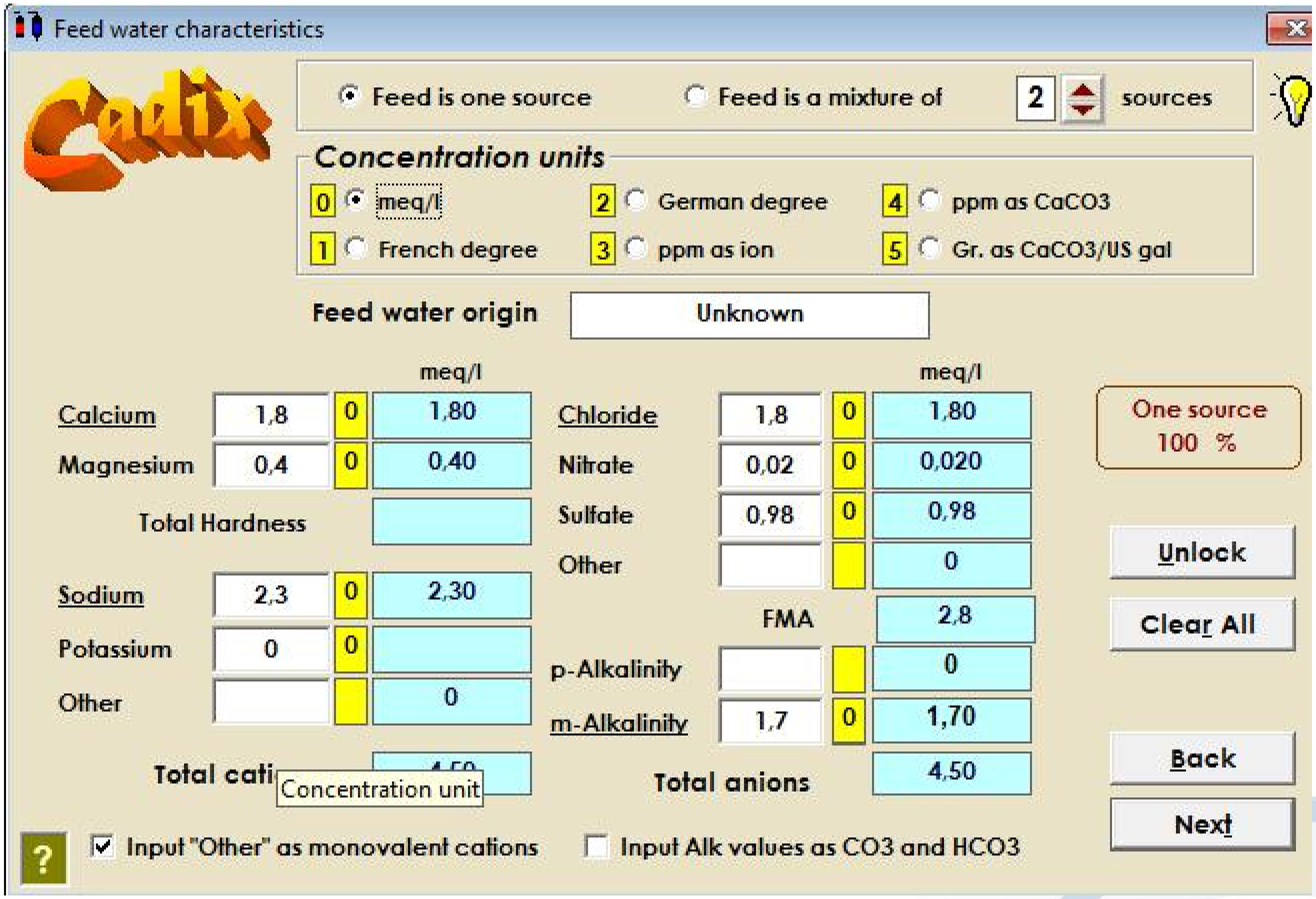
- Software is a tool which can help you utilize your skills; The program is not smart, YOU ARE!

- Each software tool is a box and set by boundaries and rules and limit the compatibility of the software with your project

- Make sure you are aware of the bounderies and rules of the tool in order to use the software correctly.
  - How are the chemicals calculated
  - How is the program dealing with silica
  - How is the program calculating overrun
  - How is the conductivity calculated (NaOH vs NaCl)

Let the technical support specialist of the resin manufacturer help you. He is there to help and will make his wide range of experience available for you

Example : Understanding of Chemicals



Example continue

Ionic load WAC : 2770 eq
Ionic load SAC 4673 eq

110% of 7443 eq = 8187 eq
~ 298,8 kg

CADIX - Design performance results

DOWEX Resins

		Vessel 1		
		DOWEX UPCORE MAC-3		DOWEX UPCORE Mono C-600
Volume as delivered	liters	2.075		3.525
Net flow-rate	m3/h	100		100
Net throughput	m3	1.600		1.600
Gross flow-rate	m3/h	103		103
Gross throughput	m3	1.654		1.654
Time between 2 reg.	hours	16,0		16,0
Operating capacity	meq/l	1.340	1.399	1.436
Ionic load	eq	2.770		4.673
Ionic form as delivered		Hydrogen		Hydrogen
Organic load KMnO4	g/l			
Silica load as SiO2	g/l			
Regenerant chemical		HCl		HCl
Regenerant dosage	g/l		56,2	91,9
Chemical amount 100%	kg		299	299
Reg. ratio to stoichio.	%		110	
Regeneration system		UPCORE		UPCORE

Example continue

Same regeneration ratio?

Ionic load WAC : 2782 eq
Ionic load SAC : 4583 eq

110% of 7365 eq = 8101 eq
~ 295 kg

110% of 2782 + 4583 eq
= 7644 eq.

Overall ratio:
7365/7644 * 100% ~ 104%!

Resin choice	Amberlite IRC86RF	Amberjet 1000 H
Resin volume [litres]	2250	3850
Running time [h]	16,0	16,0
Gross throughput [m3]	1637	1637
Ionic load [eq]	2782	4583
Organic load [g/L R as KMnO4]		
Operating capacity [eq/l R]	1,24	1,19
Flow-rate [BV/h]	45,5	26,6
Regenerant mode	Amberpack	Amberpack
Leakage (overrun) [%]	0	
Regenerant type		HCl
Concentration [%]		5,0
Regenerant ratio [% theory]	110	167
Regenerant Level [g/L R]		72
Total regen. [kg 100%]		279
Consumption [g/m3 water]		174,4
Excess of regenerant [eq]		278
Dilution water [m3]		4,7
Regen. displacement [m3]		9,1
Fast rinse [m3]	0,0	0,0
Backwash water [m3]	0,0	0,0
Total waste water [m3]	37,7	
TDS of waste [meq/L]	358	
Safety factors	0,95	0,95
Leakage		< 0,8 µS/cm

Example continue

There is nothing wrong in both projections, both calculations are correct.

The difference is only about understanding.

You need to know the boudaries and rules of the program and make yourself familiar with what is “in the box”

SUMMARY

- The program is a “tool” only. What you make with it strongly depends on the user
- Make use of the tool when you are ready evaluating all the input parameters and not the other way around
- Be critical to the input parameters and make sure they are consistent. They can be the source of design disaster
- If using the program is not a day-to-day job, use the support of the resin supplier

SUMMARY

- It is important to understand the **P**rogram-**D**esigners-**D**esign-**A**pproach (Program logic).

  - How is the regeneration ratio calculated?
  - When does the program correct automatically?
  - When does the program give a warning only and depend on the user?
  - How is the program calculating leakage overrun?
  - Etc.
  - Do not forget the manual function!

Remember that fundament between all detailed differences the one thing all software tools MUST have in common is:

1 eq for 1 eq

1 ppm $CaCO_3$ for 1 ppm $CaCO_3$

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