



## **DOW WATER SOLUTIONS**



***Computer Assisted Design for Ion eXchange systems***

**A Practical Guide for Operating the Program**

**Version 6**

## 1 - CADIX PROGRAM OVERVIEW

**CADIX** ("Computer Assisted Design for Ion eXchange") is a comprehensive ion exchange engineering tool for designing new water treatment systems and evaluating an existing plant performance with DOWEX™ ion exchange resins. CADIX allows design of both co-flow and counter-flow regenerated systems for a range of applications. It is designed for Windows® and is an easy program to use, but it does assume that the user has some knowledge of ion exchange resin technology and terminology. Further information on using CADIX is available in the *CADIX Help file* inside the program.

The program is divided into three main operations for plant design:

1. Design an ion exchange plant (new or existing for retrofit)
2. Predict existing plant performance
3. Compare economics and savings from any current installed systems

To obtain optimum display, the screen definition should be set at either a minimum 800 x 600 pixels with small fonts or any higher definition with any font size.

## 2 – INSTALLING THE PROGRAM

Full instructions are given in the installation guide on the Dow Water Solutions internet website at [www.dowwatersolutions.com](http://www.dowwatersolutions.com).

The CADIX program is available on CD-Rom or as a download directly from the website. In order to run the program, it should be installed onto your computer hard drive.

If you already have CADIX installed on your hard drive, please start at step 1 below. For a first installation, proceed directly to step 2.

1. Remove the previously installed version of CADIX using the *Add/Remove* procedure from Windows® (*Settings / control panel / add/remove program*). To avoid losing your existing design files, do not delete the CADIX folder or the files that remain after uninstall.
2. Close all applications.
3. Insert the CD-Rom into the driver. If you obtain your program from the website, proceed directly to step 5.
4. Perform the installation following the instructions on the CD-Rom
5. Run *setup.exe*
6. Follow the instructions displayed on the screen.

### Registration

A registration key protects the use of this software. The first time that you start the program after installation, you are requested to enter a registration key. You can operate the basic design for water demineralization and water softening without a key by clicking "Continue unregistered".

If you require more access, please ask Dow for a registration code (this can be done through the website). Then start CADIX, click "Register now" and enter the code in the registration box as displayed on the screen below. If you entered the key correctly, a message "Identity saved" appears and the program will start.


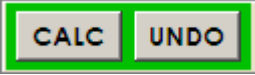




### Uninstalling CADIX

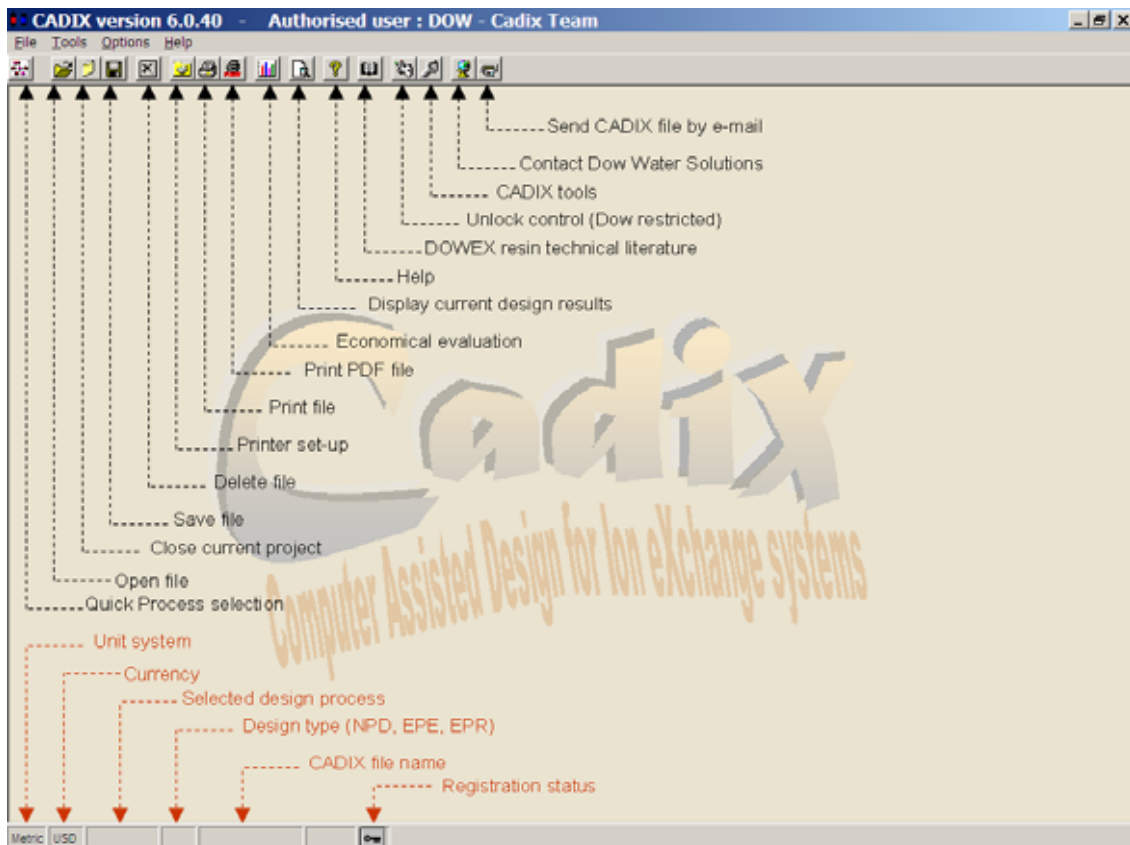
The User may uninstall CADIX using Windows® by accessing *Control Panel: Add/Remove Programs*. Click *Add or Remove Programs* and select CADIX60. Choose *Remove*.

### 3 – CADIX FEATURES

CADIX has a number of useful features to help in designing an ion exchange resin plant, including:

- **Metric and US unit systems.**
- **Default parameters:** Clicking the yellow light bulb icon (or Alt + x) on the top right corner of most screens inserts default values into the input cells. These default values can be customized as desired by clicking on the menu bar *Options / Change default parameters*. Check the *Save at exit* box when the changes are made. Please be aware that CADIX does not control changes made in the values. 
- **Customizing design results (green cells):** Some design result screens contain values displayed in green. These values can be modified. Enter the preferred value when the input box appears and click the "CALC" button. "Undo" reverts the values back to the original CADIX design. 
- **Custom vessel line:** In addition to single vessel packages already available, CADIX will support demin packages (cation + anion vessels), as well as vessels with pre-determined resin volumes.
- **Default waters:** a database containing current composition of the most known rivers and lakes is available and can be downloaded. Water analyses can also be inputted and recalled by the user.
- **CADIX tools:** CADIX offers a calculator, a unit converter and a function restorer that allows to restore some functions that have been deactivated. The Vessel sizer is available for Existing plant performance evaluation (EPE) at the size parameters entry stage. To open the tool selection, click this icon or Tools/CADIX tools on the menu bar. 

- **Multi-feed water sources:** CADIX provides the possibility to enter up to 5 different water sources as feed water to the ion exchange plant.
- **Comparative cost evaluation (economics):** CADIX offers a comparative cost evaluation that helps you make the best choice between different design alternatives you have made. Up to 5 different alternatives can be compared to identify the lowest cost to produce one m<sup>3</sup> (or 1,000 gallons) of demineralized water. The evaluation can be started from the menu bar under *Tools/Comparative cost evaluation/Start cost evaluation*, or by clicking the  icon.
- **Menu tool bar structure:** The definition of the different symbols on the top and bottom tool bars are shown in the diagram:



- Navigation side bar:** This is a new feature that allows simple navigation through the design steps. The navigation side bar appears on the right of the screen as soon as you enter data into CADIX or if you open a file saved in the memory. The navigation buttons become active (turning from grey to black) after the corresponding screen is displayed or the corresponding level of the program is reached. It is then possible to navigate through the design at will. For customization of the final design, it is recommended to follow the steps in the order given on the final Display Results page. The side bar consists of the three tabs: Feed data INPUT, Design RESULTS and CALC & CUSTOMIZE sections that are described below:

Navigation menu bar - Feed data input section

These items are the header of the eight pages where you input the feed data and proceed to the selections that will allow CADIX to perform a design. All first seven items are used for « New plant design » as well as for « Existing plant evaluation » and « Existing plant retrofit ». The last item is used only to feed CADIX with the vessel sizes of an existing plant, which will allow Cadix to evaluate the capacity of the existing plant or to optimize an existing plant for retrofit. Clicking one of these buttons will bring the program back to the corresponding level of feed data entry.

Navigation menu	
Feed water analysis	INPUT
Regeneration system & layout	
Plant capacity & degasifier	
Outlet water quality requirements	RESULTS
Regeneration parameters	
DOWEX resins selection	CALC & CUSTOMIZE
Polishing stage parameters	
Existing plant parameters	

Navigation menu bar - Design results section

These items are the header of the seven pages results that CADIX can display when a design has been completed. Click one of these buttons to open the corresponding page. Some of them contain green cells. These cells correspond to items that can be customized by the plant designer. Please note, however, that we strongly recommend to run through the whole result process edition, before starting any result customization.

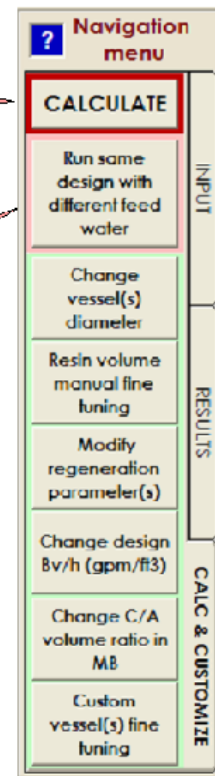
This item is made available when you open a file saved in the CADIX memory. Clicking this button will display the results of the design as it was saved. This step is inactive; CADIX displays an image like a printout. You cannot change anything. You can use this step, for example, when you want a printout of the results.

Navigation menu	
Plant diagram	INPUT
Performance design results	
Mechanical design results	
Regeneration flow sheet	RESULTS
H/OH effluents balance	
Polishing design results	CALC & CUSTOMIZE
Polishing regeneration flow sheet	
<b>Edit saved results</b>	

Navigation menu bar - Calculate section

Click "CALCULATE" and CADIX will open the cation/anion design parameters screen containing the regeneration dosages and safety factors which were used in the current design. Either modify the values or click the right arrow button to run the calculation process.

Once your design has been completed and you believe everything is right, you may be willing to know what will happen with the plant if something changes in the feed water. First think to save your current design. CADIX will consider this design as the "master". Then click this button and the feed water screens will be edited. When the analysis has been completed, click the right arrow button. CADIX will evaluate the performance using every parameter (resin volumes, vessel sizes, regeneration dosages, etc.) saved in the "master design". When saved, this evaluation will be marked as "child" with a link to the master.



Navigation menu bar - CUSTOMIZE section

This is a Condensate Polishing Plant reserved item. You may change the specific flow rate (Bv/h or gpm/ft3) used by CADIX to evaluate the volume of resins. Click this button to open the appropriate screen and follow the indications.

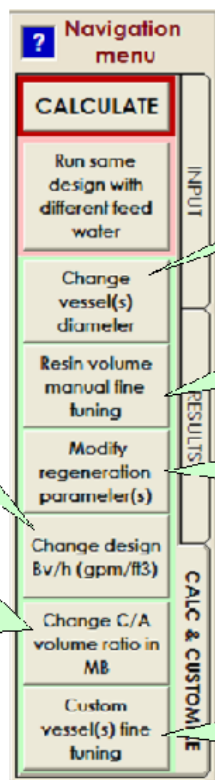
This is a Condensate Polishing Plant reserved item. You may change the Cation/Anion volume ratio used by CADIX to evaluate the proportion of both resins in a mixed bed. Click this button to open the appropriate screen and follow the indications. Note that changing Bv/h or gpm/ft3, if required, should be done before ratio modification.

If you do not agree, for any reason, with the vessel sizing by CADIX, you have the possibility to change. Click this button to open the appropriate screen. CADIX will calculate the plant with your figures, but keeps the right to modification if limits are exceeded.

You may adjust the final resin volume(s) to deal with any of your design parameters. Click this button to open the appropriate screen and follow the indications. Note that changing diameters, if required, must be done before volume tuning.

Some regeneration parameters may be customized. Click this button to open the regeneration screen. Modification can be done on values in green cells. Click one of these cells and follow the indications. Note that this step should be the last one.

Click this button if you are not satisfied with the vessel selection proposed by CADIX. You will be given the possibility to set the vessel selection to different criteria. Note that this item only applies to "Custom vessel(s) utilization" with "CADIX automatic vessel selection".




## 4 – HOW TO USE CADIX: A WATER DEMINERALIZATION EXAMPLE

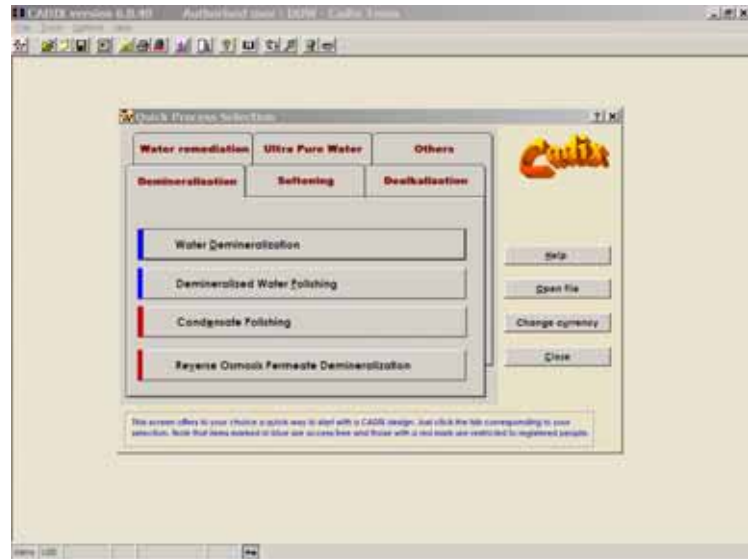
This section steps through the program to make a water demineralization design.

### 1. Quick Process Selection

This screen comes up automatically when CADIX is started. It can also be called up from the menu

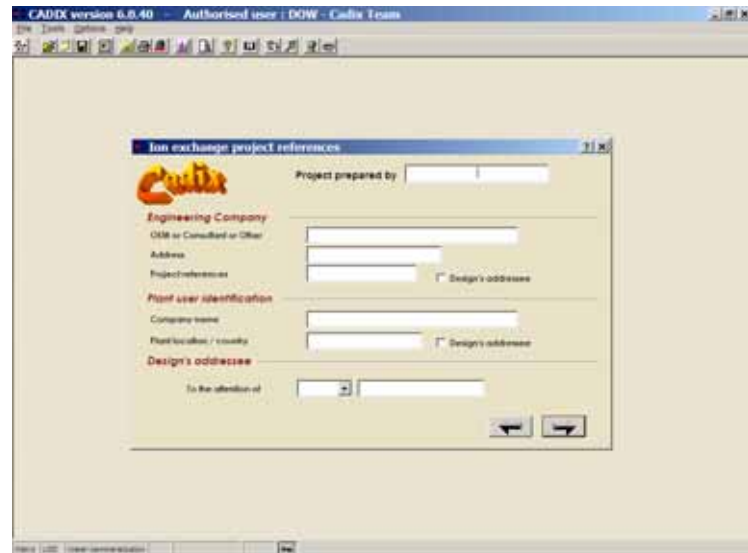
bar using the icon  or *File/New Project*. It offers a choice of the available applications for a new project or to open an existing project file.

Select “Water Demineralization”.



### 2. Project reference

The first input screen is a Project Reference. General project information is entered, including project name, user name, customer name and company.



### 3. Design type selection

The next screen is to choose if the design is for a new, existing or retrofit plant. The sequence of input screens is the same for each, except that "existing" and "retrofit" options have additional input screens for vessel sizes.



### 4. Feed water analysis input

Two screens are used to input feed water analysis data. There is a choice of units (meq/l, German/French degrees, ppm as ion or  $\text{CaCO}_3$  and  $\text{kg/ft}^3$ ) and possibility to manually or automatically balance the analysis (with  $\text{Na}^+$  or  $\text{Cl}^-$ ). The yellow bulb at the top right hand corner of the screen can be used to display and choose default water analyses in the memory.



The navigation bar appears on the right hand side of the screen at this point to allow easy navigation through the input, results and calculate screens during the design.





## 5. Regeneration System and Layout Selection.

This screen provides choices of regeneration system (co-flow, block systems...), floating inert resins (where appropriate) and resin vessel lay-out (WAC, SAC, single vessels, layered bed...). The option to choose an upstream organic scavenger or downstream polisher is also available. If a polishing stage is required, the regeneration system and resin vessel lay-out is inputted in this screen.



## 6. Plant Capacity Parameters

The plant capacity parameters are entered in this screen (flow rate, number of lines, time between regenerations). Also if a degasifier is to be included (a warning will appear if recommended).



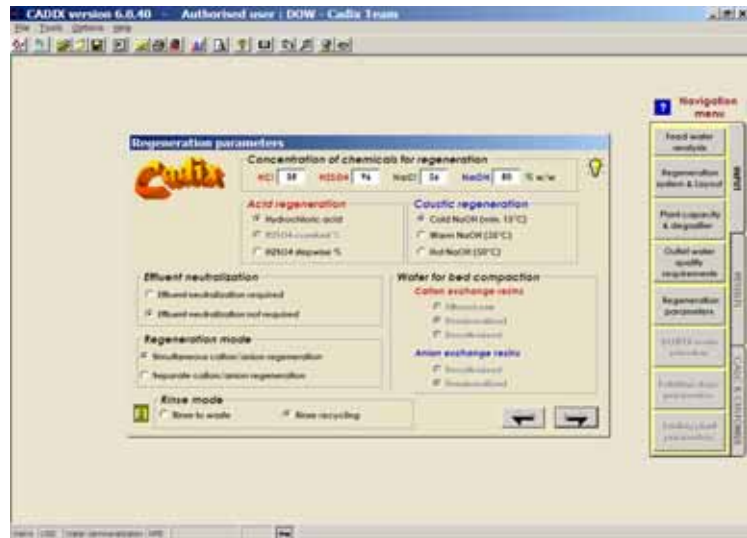
## 7. Water quality

The desired product water quality is entered in this screen (again, a default yellow bulb is available). CADIX will warn if the required water quality cannot be achieved during the design phase.



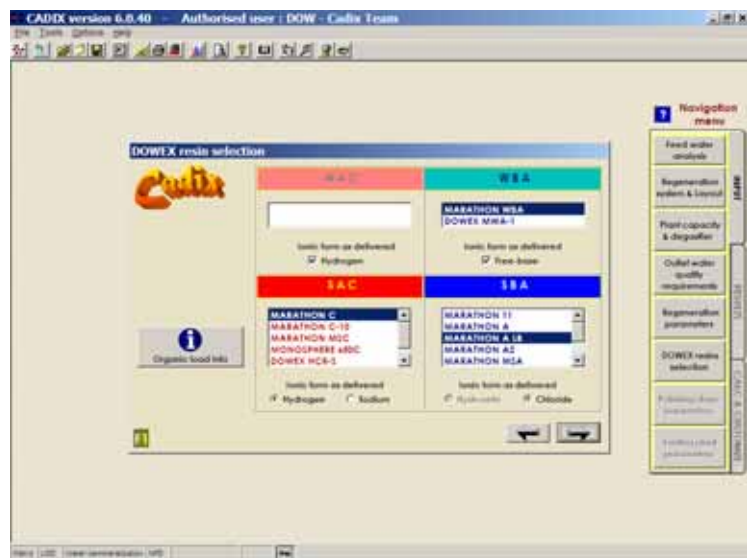
## 8. Regeneration Parameters

The type of regenerant chemical and service water, step-wise regeneration (for sulfuric acid), caustic temperature, effluent neutralization and regeneration mode are entered at this point.



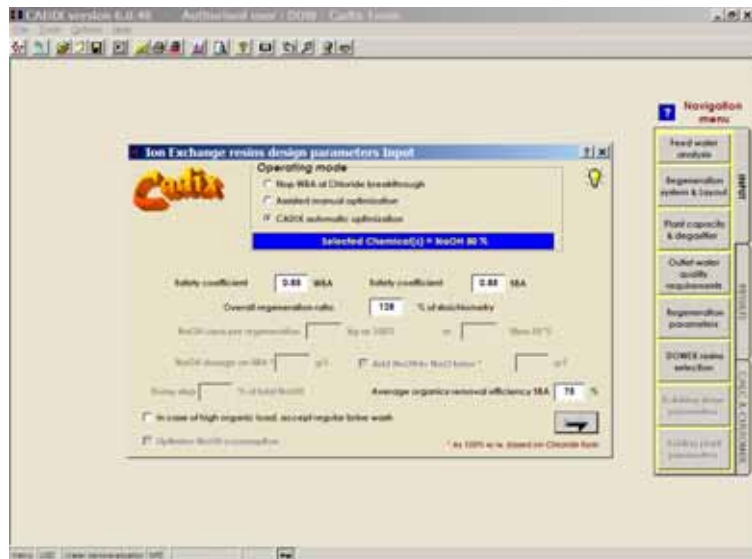
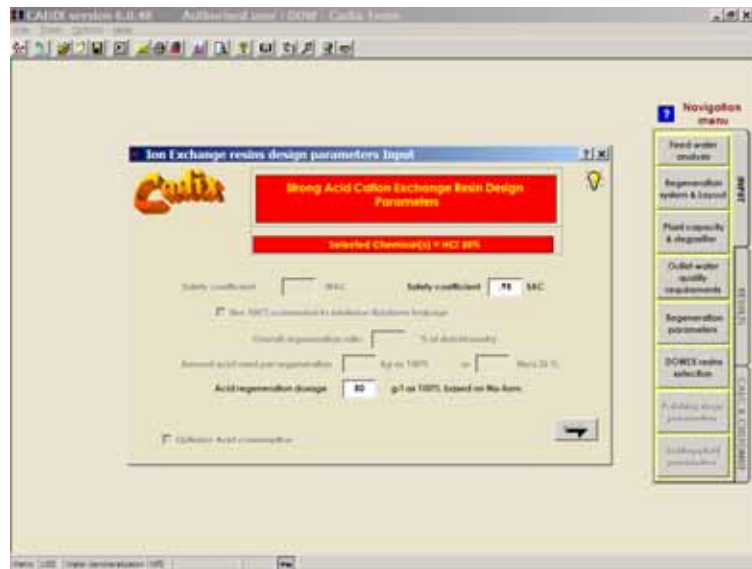
## 9. Resin selection

The DOWEX™ resin options available for the chosen regeneration system and lay-out can be chosen here.



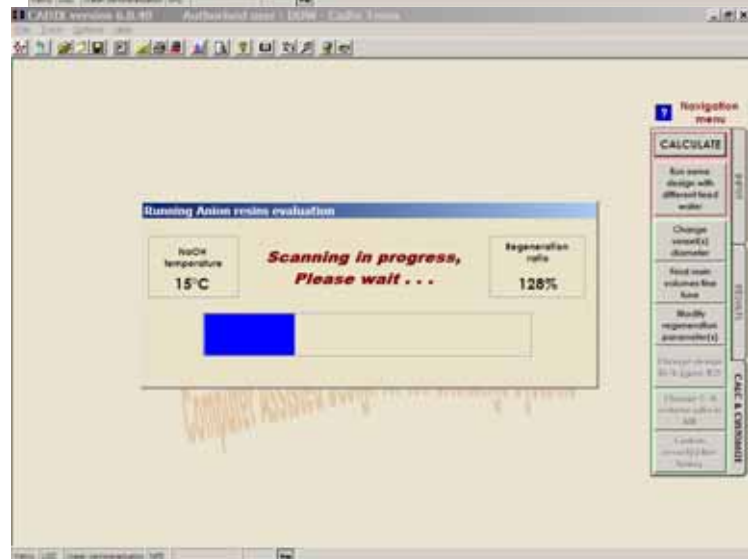
## 10. Design parameters

The cation and anion regenerant dosages and safety factors for the resin capacity are inputted in the next 2 screens. Default values are available (yellow bulb) and *Help* for guidance. Safety factors can be applied to account for non-ideal conditions (e.g. non-uniform flow distribution, resin fouling...). A safety factor of 0.95 means the design operating capacity is 95% of the maximum possible capacity under those conditions.



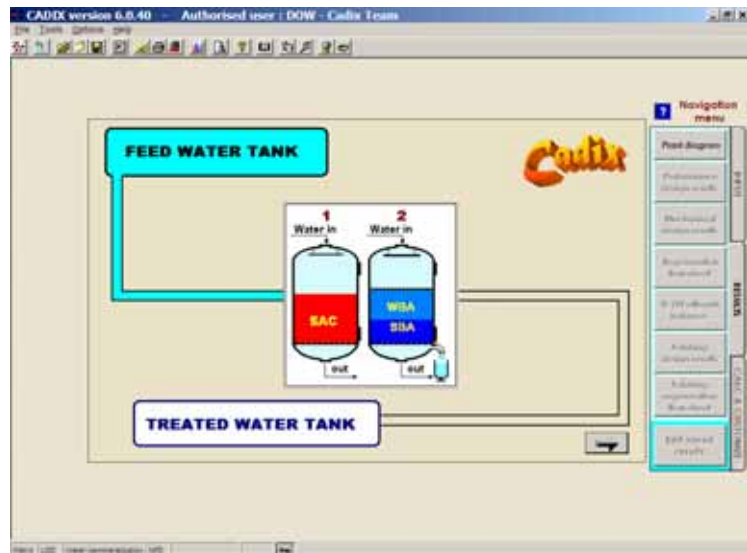
## 11. Design Calculation

CADIX will now start to calculate the design and a screen showing optimization of parameters may appear as shown.



## 12. Design Summary

The graphic shows the design layout. Information on individual vessels (dimensions, resin type and volume), feed and treated water quality can be obtained by clicking on the diagram.



## 13. Display Results

Once the design is complete, a series of screens show the results of the plant design.

The 1st screen has information on the resins (volume, type, regeneration conditions, capacities, throughputs....).

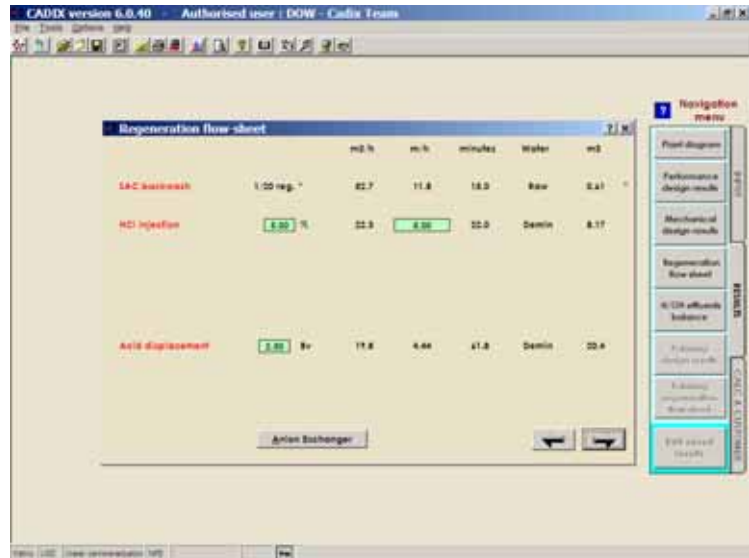
DOWEX Resins	Unit	Resin 1			Resin 2			Resin 3		
		DOWEX MAAKTON C	DOWEX MAAKTON WSA	DOWEX MAAKTON A 18	DOWEX MAAKTON WSA	DOWEX MAAKTON A 18	DOWEX MAAKTON WSA	DOWEX MAAKTON A 18	DOWEX MAAKTON WSA	DOWEX MAAKTON A 18
Volume as delivered	liters	8,822	4,880	7,423	4,880	7,423	4,880	7,423	4,880	7,423
Net flow rate	m <sup>3</sup> /h	390	390	390	390	390	390	390	390	390
Net throughput	m <sup>3</sup>	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506
Gross flow rate	m <sup>3</sup> /h	507	507	507	507	507	507	507	507	507
Gross throughput	m <sup>3</sup>	1,972	1,972	1,972	1,972	1,972	1,972	1,972	1,972	1,972
Time between 2 reg.	hours	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Operating capacity	mg/g	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283	1,283
Inlet form as delivered	mg	8,848	4,880	4,880	4,880	4,880	4,880	4,880	4,880	4,880
Organic load (MnO <sub>4</sub> )	g/l	Hydrogen	Free base	Chloride	0.75	0.24	0.75	0.24	0.75	0.24
Worst load on NO <sub>2</sub>	g/l		NaOH	NaOH	40.1	44.3	40.1	44.3	40.1	44.3
Regeneration chemical	g/l	802	NaOH	NaOH						
Regeneration dosage	g/l	80.0			40.1	44.3	40.1	44.3	40.1	44.3
Chemical amount 100%	kg	408			471	513	471	513	471	513
Reg. rate to sludge	%	124	40 Sludge	40 Sludge	128	128	128	128	128	128
Regeneration system										

The 2nd results screen gives information on the plant mechanical design (vessel dimensions, velocities and pressure drops).

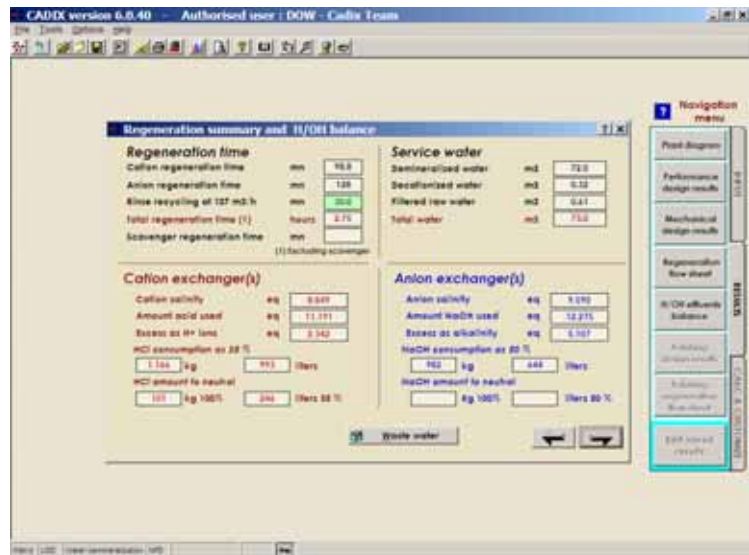
DOWEX Resins	Unit	Resin 1			Resin 2			Resin 3		
		DOWEX MAAKTON C	DOWEX MAAKTON WSA	DOWEX MAAKTON A 18	DOWEX MAAKTON WSA	DOWEX MAAKTON A 18	DOWEX MAAKTON WSA	DOWEX MAAKTON A 18	DOWEX MAAKTON WSA	DOWEX MAAKTON A 18
Volume as delivered	liters	8,822	4,880	7,423	4,880	7,423	4,880	7,423	4,880	7,423
Vessel diameter	mm	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400
Internal vessel area	m <sup>2</sup>	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46
Resin height as delivered	mm	1,977	1,977	1,977	776	2,518	1,220	776	2,518	1,220
Resin height regenerated	mm	1,977	1,977	1,977	823	2,287	1,460	823	2,287	1,460
Resin height as bed	mm	1,876	1,876	1,876	873	2,334	1,311	873	2,334	1,311
Bed resin top layer flow	mm	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Bed resin height	mm	300	300	300	300	300	300	300	300	300
Bed resin volume	liters	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338
Vessel cylindrical height	mm	3,475	3,475	3,475	4,850	4,850	4,850	4,850	4,850	4,850
Feedstock (swollen form)	mm	1,156	1,156	1,156	2,134	2,134	2,134	2,134	2,134	2,134
Linear velocity	m/h	22.5	22.5	22.5	11.5	11.5	11.5	11.5	11.5	11.5
Pressure drop at 15°C (-)	kPa	48.2	48.2	48.2	15.8	38.9	15.8	15.8	38.9	15.8
Filtered material load	kg/m <sup>3</sup>	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

## 14. Regeneration Conditions

The next screens detail regeneration conditions (concentrations, service water flow rates and volumes, times...)



This screen shows the regenerant effluent composition and amount required to neutralize the effluent.

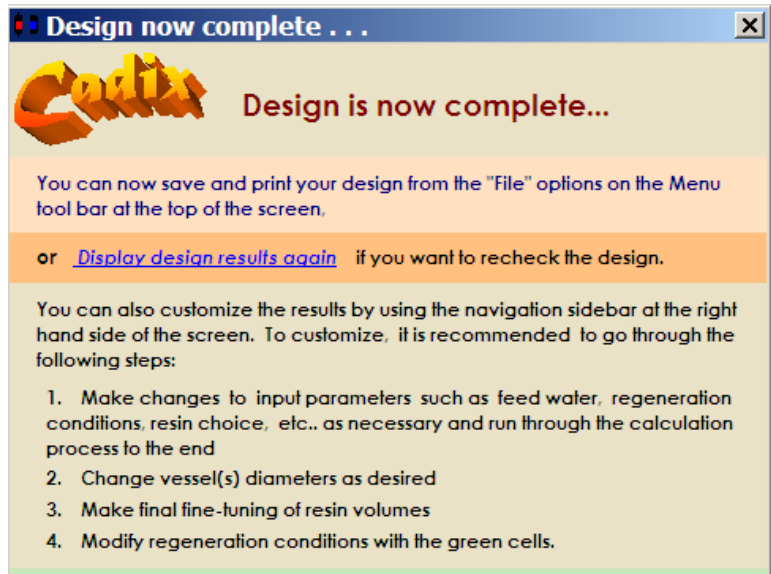


## 15. Design complete

The final screen has a link to display the design results again, in addition to information on how to customize the results.

Standard file management (file save, close project, print...), is available on the top menu bar. The print-out is a summary of the design results screens and is available in 6 languages.

Navigation back to any steps in the design can be made by using the navigation side bar.



## 16. Exit the CADIX program

Select *File / Exit CADIX* from the menu bar or click "X" at the top right corner of the screen to close the CADIX program.

## 5 – CONCLUSIONS

We hope that you find the CADIX computer program to be a useful tool to help you design ion exchange resin plants with DOWEX™ resins. The engineers of the DOW WATER SOLUTIONS technical department are available for consultation if you need help with the use of this software. Contact your local Dow representative.

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