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NanotechROCAD

Calculation program for membrane systems
Version 1.0

Operating Manual

JSC RM Nanotech
Technical Assistance Center
2020

Contents

1 Introduction

1.1 Purpose and structure of the document

This Manual is intended for users of the **NanotechROCAD** program.

The document consists of 5 sections:

1. **General information on NanotechROCAD**

   Briefly describes the purpose and principles of the program use.

2. **Program installation**

   Describes the step by step process of the program installation.

3. **Overview of program use**

   Briefly describes the main steps of the program operation and the screens with links to the detailed information given in the following sections. New users are recommended to study the program from this section.

4. **Program description**

   Provides a systematized detailed description of all program functions and screens.

5. **Additional information**

   This section contains additional information that may be useful for understanding the program features. A glossary is also provided here.

1.2 Used fonts and symbols

The following fonts and symbols are used herein:

File names and paths thereto

Names of graphical interface elements

Links to the document sections or Internet sites

Information supplementing or clarifying the above material.

Description of the procedure for calling the described program function.

2 General information on NanotechROCAD

2.1 Purpose of the program

The **NanotechROCAD** program (hereinafter referred to as the program) is intended to assess the characteristics of the designed reverse osmosis plants using filter elements manufactured by JSC RM Nanotech. The range of the reverse osmosis filter elements produced by Nanotech can be used in water treatment plants for drinking needs, water treatment for technical needs, treatment or concentration of industrial effluents.

The program allows to identify and analyze deviations of the design plant characteristics from the recommended values and select the plant optimal design under the given conditions.

2.2 The program logic

Working with the program includes the following sequence of basic steps:

1) description of the properties of the inlet water supplied to the reverse osmosis plant;
2) description of the design features of the plant;
3) calculation of the hydraulic characteristics of the plant and the properties of the output water flows; at this step, the program generates a list of characteristics that have unacceptable values;
4) assessment of the compliance of the values of the plant calculated characteristics with the expected values, analysis of the causes of deviations and the choice of methods for their correction.

If, according to the results of step 4, the current design of the plant does not meet the requirements, return to step 2, make changes to the design and repeat steps 3, 4. The process ends when the optimum plant design is reached.

The program stores all data describing the plant (including those specified by the user and those obtained during the calculation) in a special format files called the plant project files. Multiple plant options can be stored in a single project file, differing in design details and inlet water properties. The characteristics of the plant options can be compared directly in the program, as well as generate reports on the selected options.

2.3 Program versions

New program versions are posted in the Technical Support / program section on www.membranium.com.

In addition to functional improvements, new versions of the program may include refinements of design parameters for Nanotech filter elements, as well as reflect changes in the company's product line.

3 Program Installation

3.1 System requirements

The program can be installed on a computer with a Windows 7 SP1 64 bits or later.

Microsoft .NET Framework 4.7 or higher shall be installed on the computer.

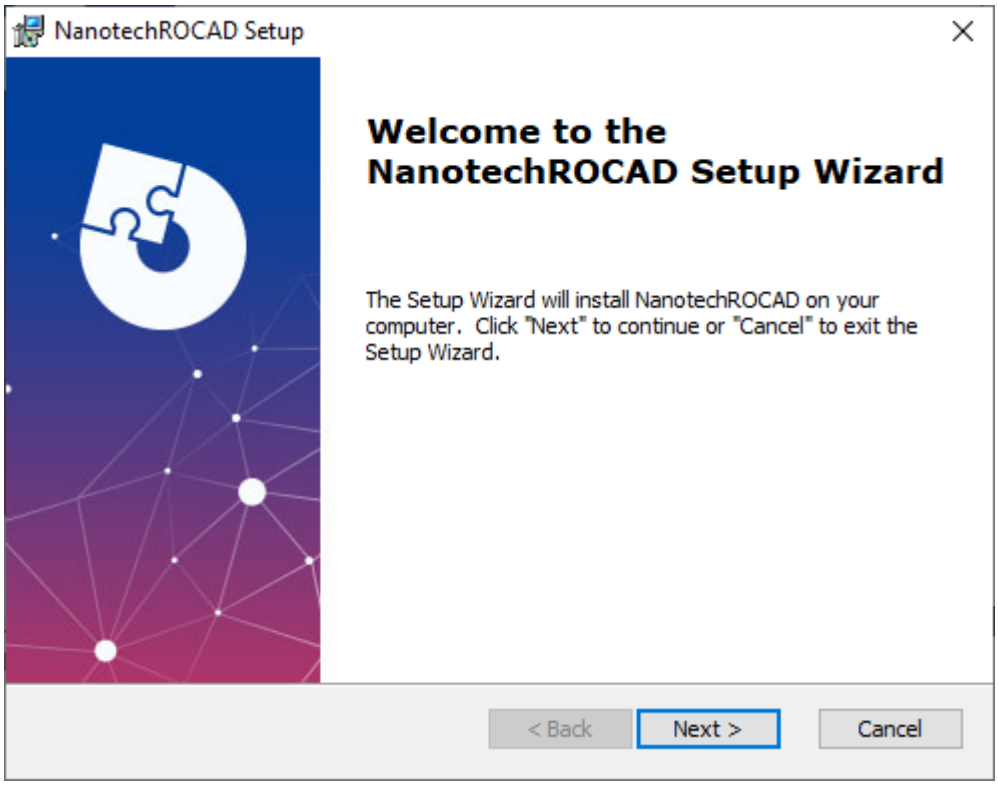
Required hard disk space: not less than 150 MB.

3.2 Installation procedure

Download the latest version of the program installation file from the Technical Support / program section on https://www.membranium.com.

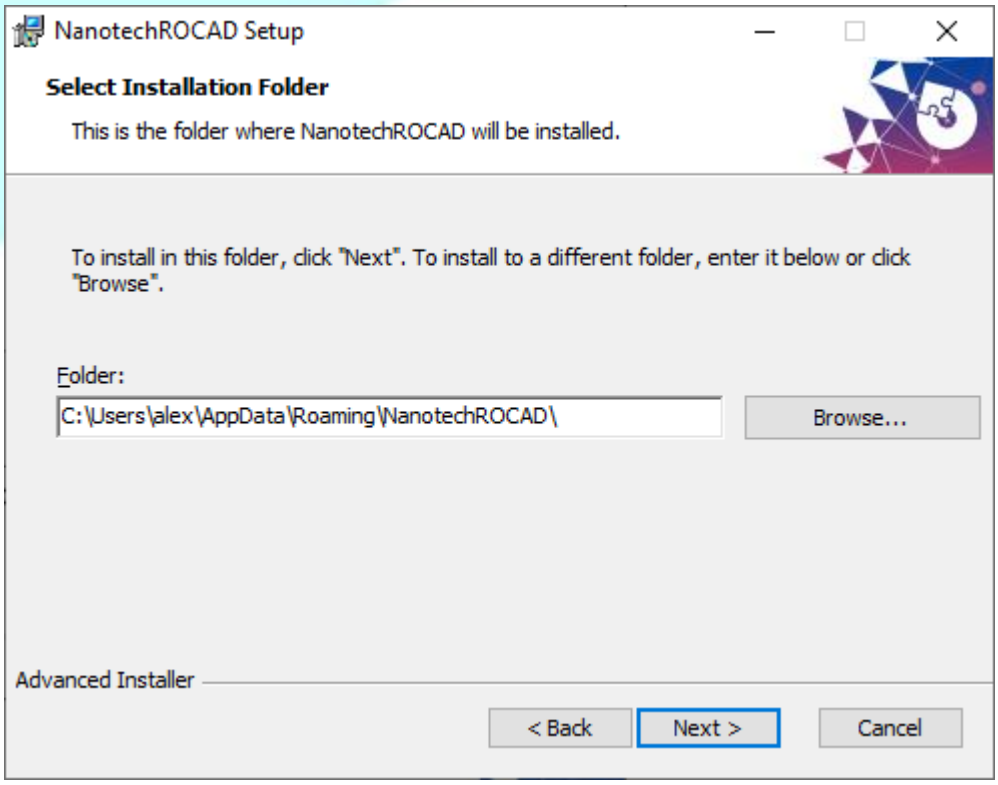
Open Explorer and double-click the icon of the installation file **NanotechROCAD_<version number>.msi** to start the installation procedure.

In the first step, a welcome screen will be displayed:



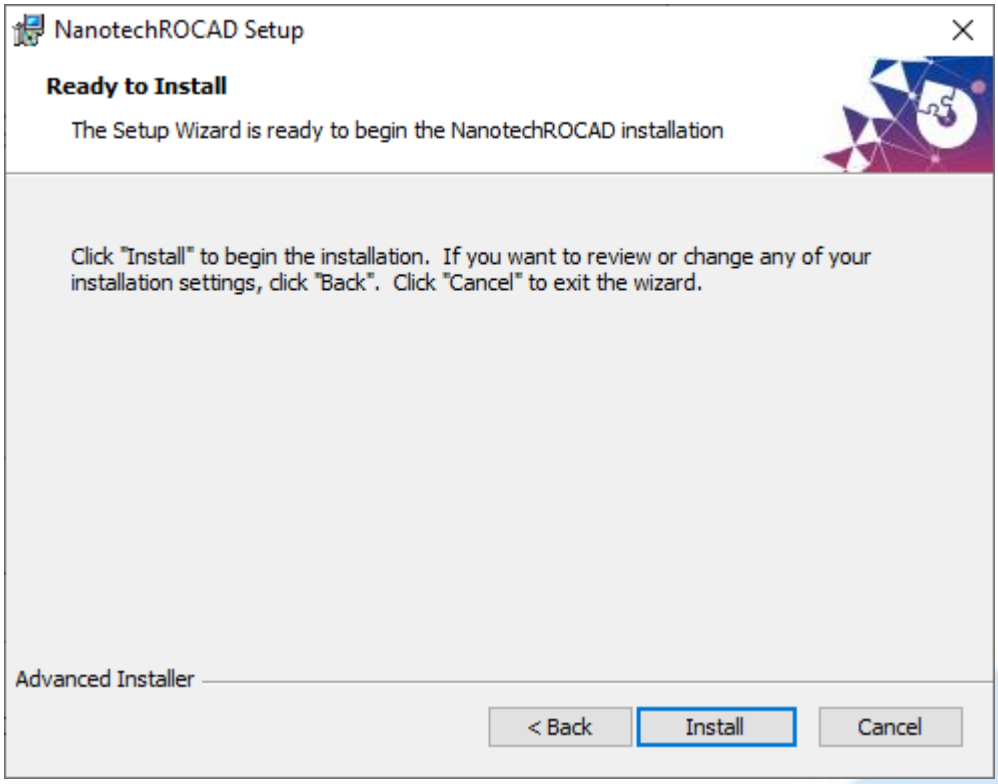
Click the **Next** button to proceed to the next step.

At the next step, select the folder where the program will be installed:

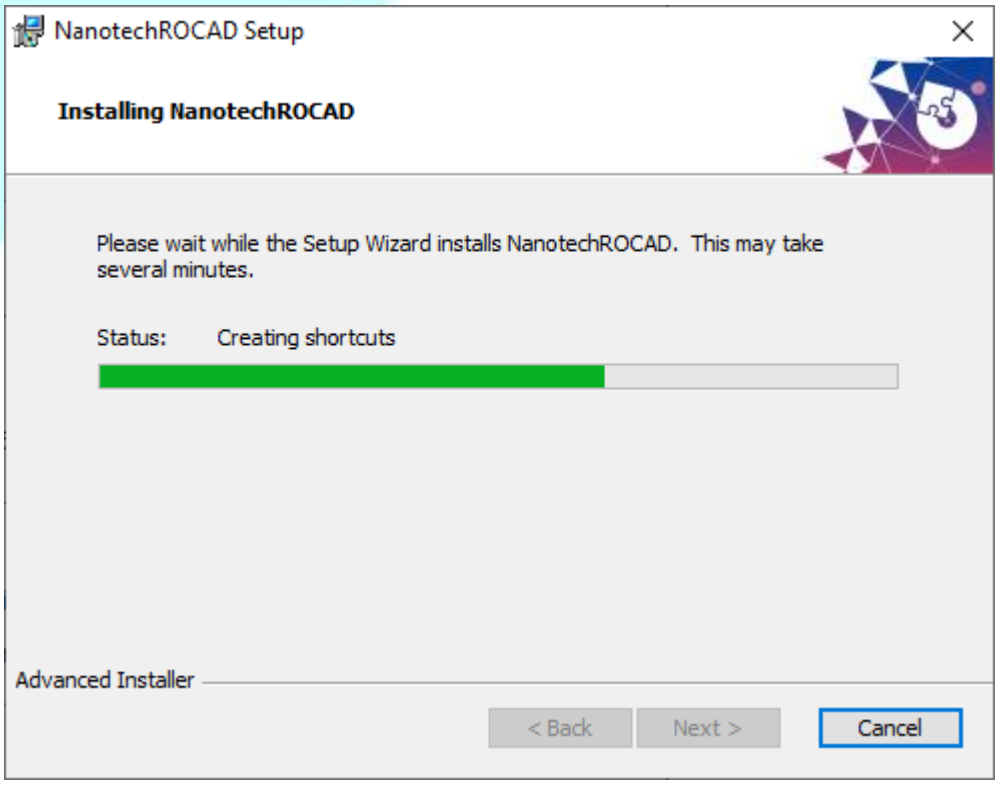


By default, it is proposed to install the program into the **NanotechROCAD** folder located in the current user profile. It is recommended to leave the default value. Installation to this folder does not require administrator rights.

Click the **Next** button to proceed with the installation. A screen will be displayed confirming the readiness to start copying the files. Click the **Install** button:

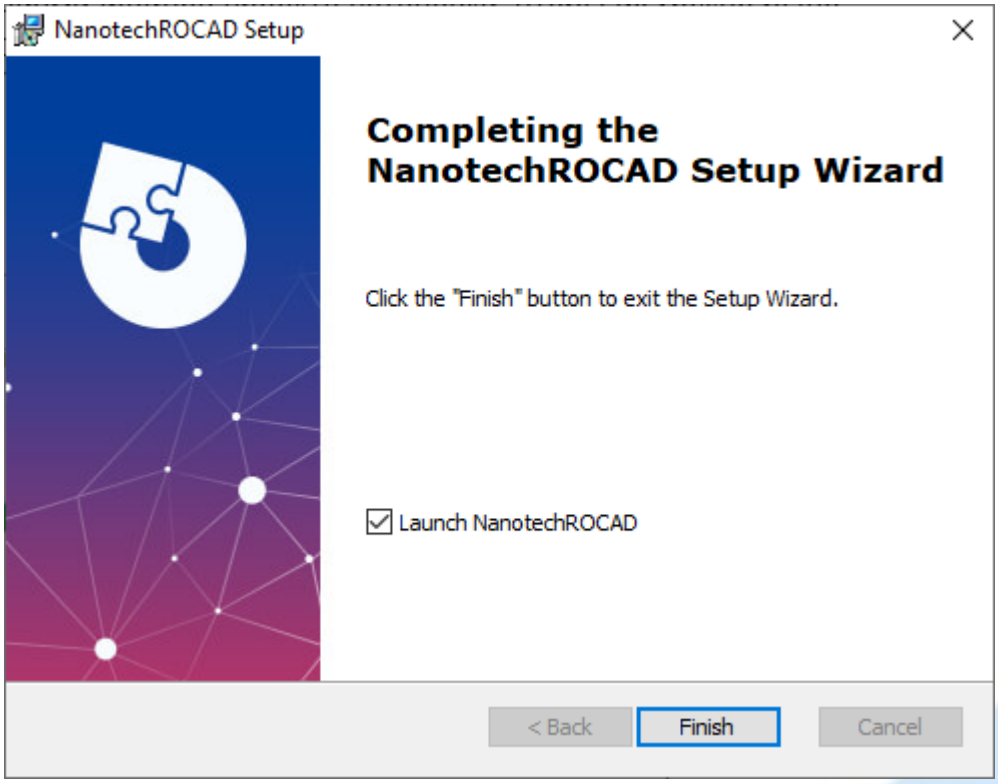


The next screen shows the progress of the program installation on the computer.



During the program installation the necessary files will be copied to your computer, a shortcut will be added to the Start menu to launch the program, and associations of the program with the extensions of the plant project files (**.roprj**, **.roprjxml**) will be created. To open its double click Explorer in Windows.

When the installation is complete, the following screen appears:



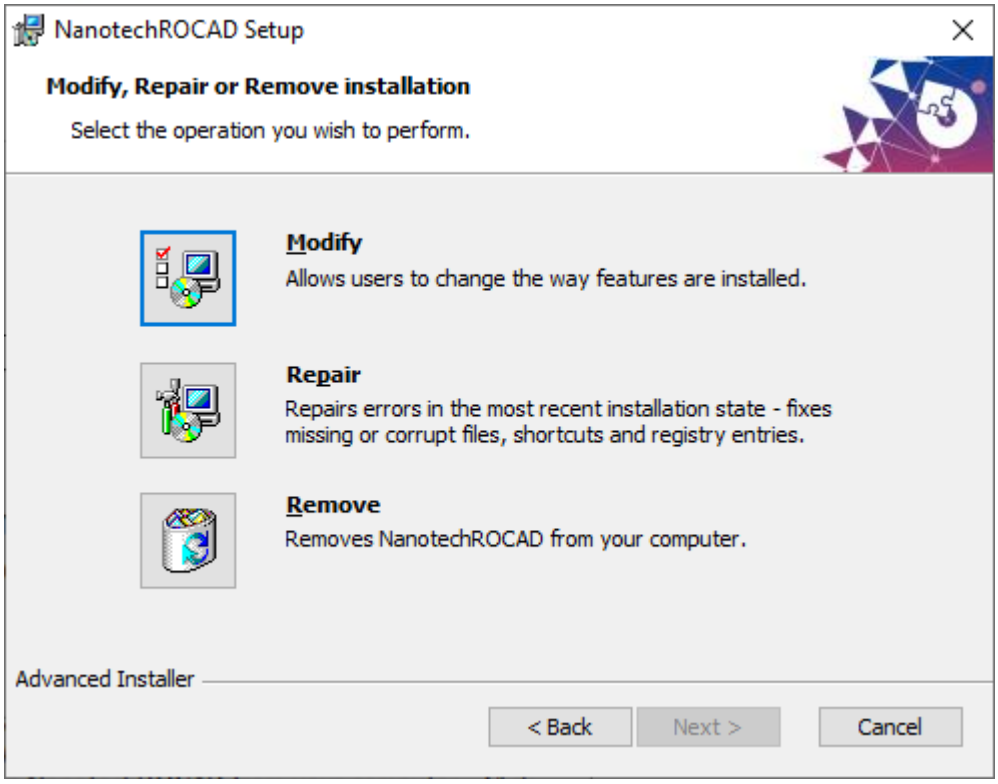
Click **Finish** to complete the installation. If you leave the **Launch NanotechROCAD** checkbox checked, the program will be launched automatically immediately after the installation is complete.

In the future, to launch the program, use the “NanotechROCAD.exe” shortcuts and the icon located on the desktop and in the Start menu.

3.3 Procedure for updating / recovering / removing the program

If on the computer there is a previously installed program of one of the previous versions, the installation of the new version is carried out in the same way as described above. The old version will be automatically overwritten with the new one.

Restarting the installation also allows to recover a damaged copy of the program or remove the previously installed program from your computer. In this case, after the welcome screen, you will be offered the following options:



Click **Modify** or **Repair** to reinstall the program.

Click **Remove** to remove the program from your computer.

You can also use the **Uninstall NanotechROCAD <version number>** shortcut in the Start menu to remove the program.

The program removal does not delete the plant project files created with it.

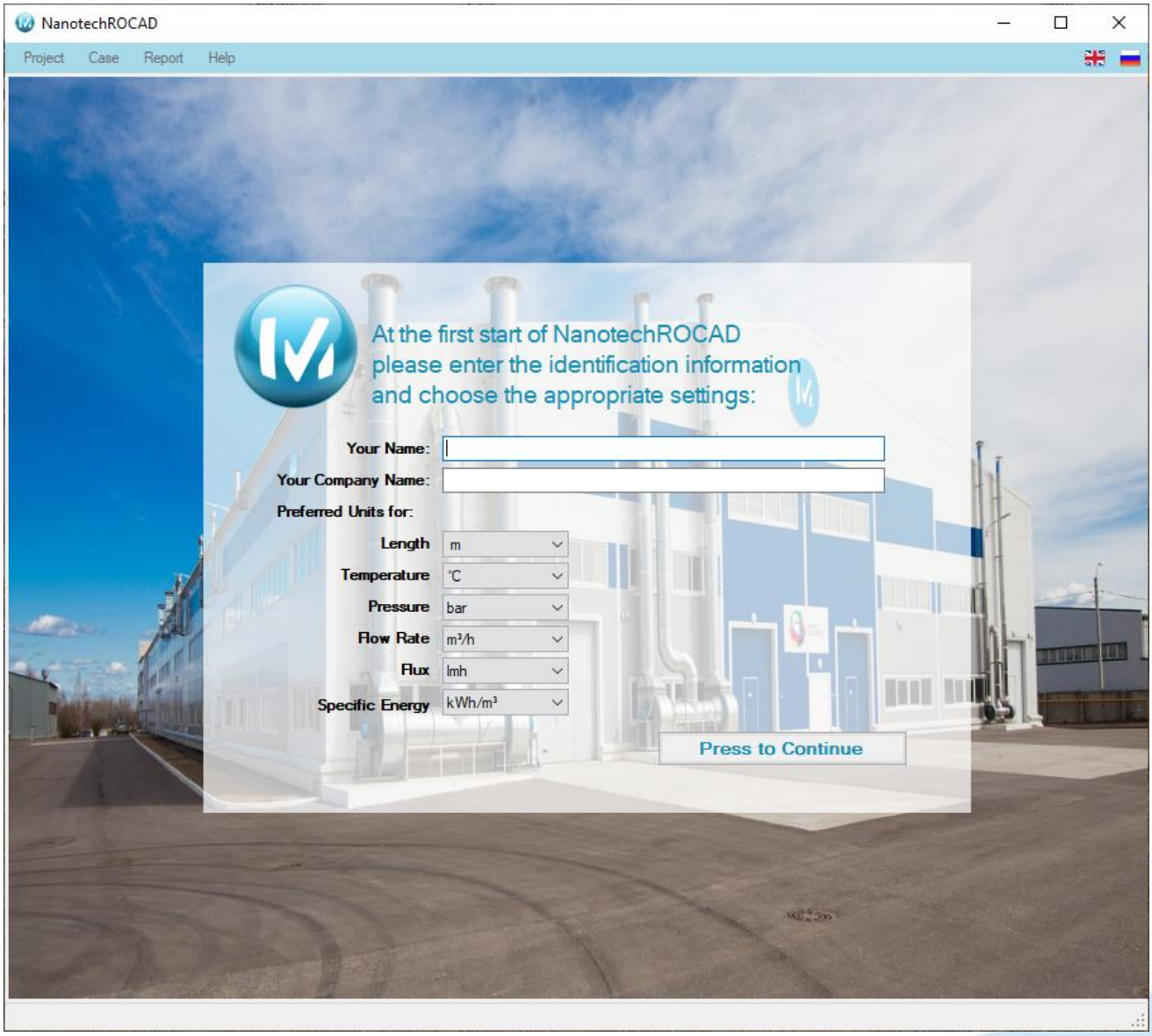
4 Program Overview

Below is a brief description of the main steps of the program operation and the screens with links to the detailed information given in the following sections.

4.1 First launch of the program

When starting the program for the first time, select the interface language using the button located in the upper right corner of the program window: - Russian; - English.

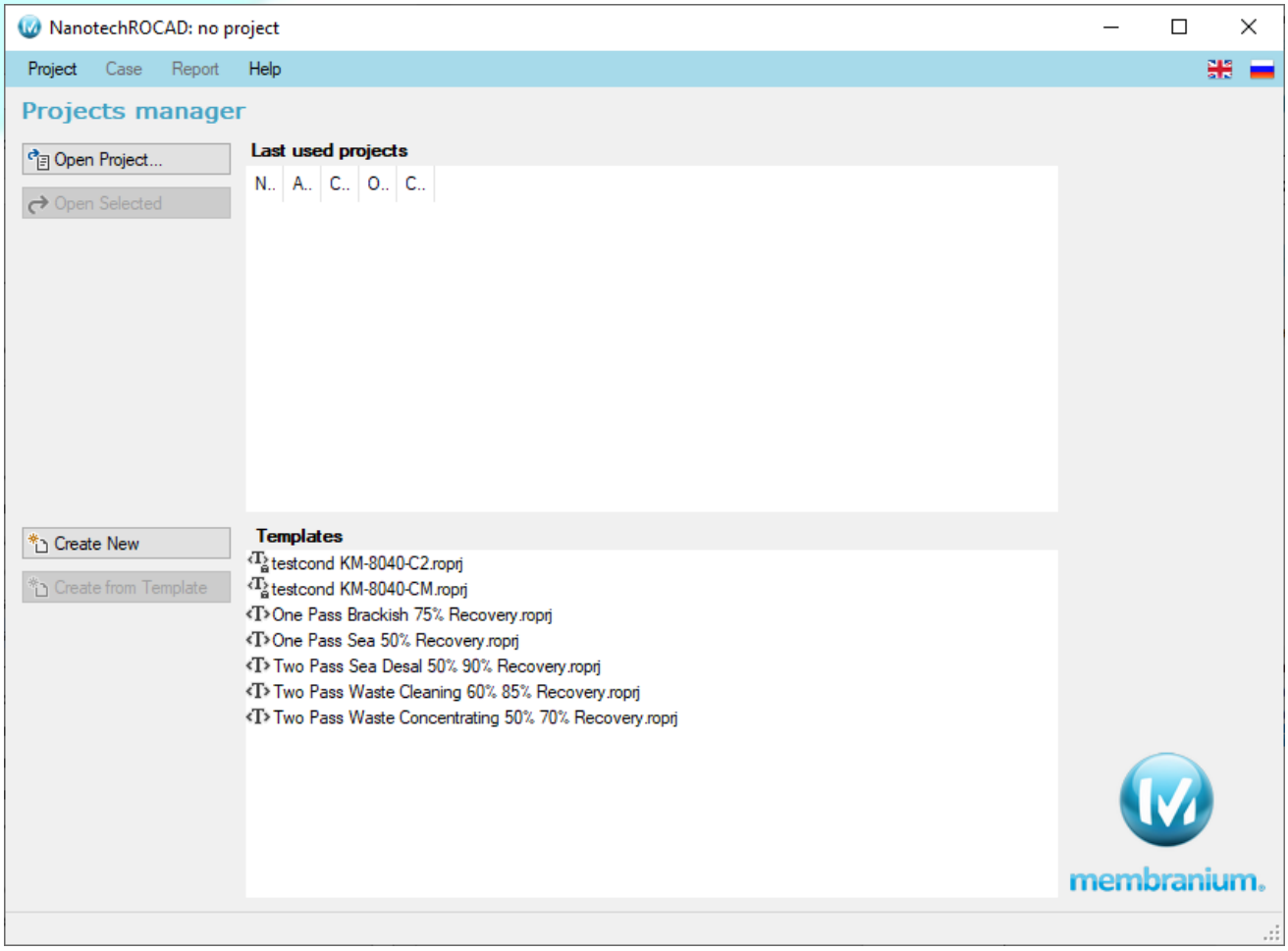
Then fill in your identification data and select preferred units for the performance values of the reverse osmosis plant. The specified identification data are used when creating new plant projects (saved in the project file) and also displayed in reports.



The screen shown above is displayed only at the first program start. All values entered here can subsequently be changed using the Program settings dialog.

4.2 Creating the plant project

After completing the input of the initial data (or when you restart the program), the “Projects Manager” form is displayed:



To create a new plant project, click the button Create New. Also, you can select one of the templates provided with the program and listed in the **Templates** list, and create a new project by clicking the button Create from Template.

Immediately after creating a new project, the program will offer to enter a description of the project, then edit the composition of the inlet water of the plant, and then edit the configuration of the plant, as described below in the sections

- Editing inlet water properties
- 4.5 Plant Editing

For more information on using the Project Manager, see section:
5.4.2 *Projects Manager*

4.3 Loading a previously created plant project

To open a previously created plant project file, use the button Open Project... . Next, in the open file selection window, select the required project file (project files have the **roprj** or **roprjxml** extension).

If the required project is in the **Last used projects** list, you can open it by clicking on its name in the list.

See also:
5.4.2.3 *View information for existing projects*.

When opening an existing project, the form for viewing the plant characteristics will be displayed: see below 4.6 Plant calculation and analysis of its results.

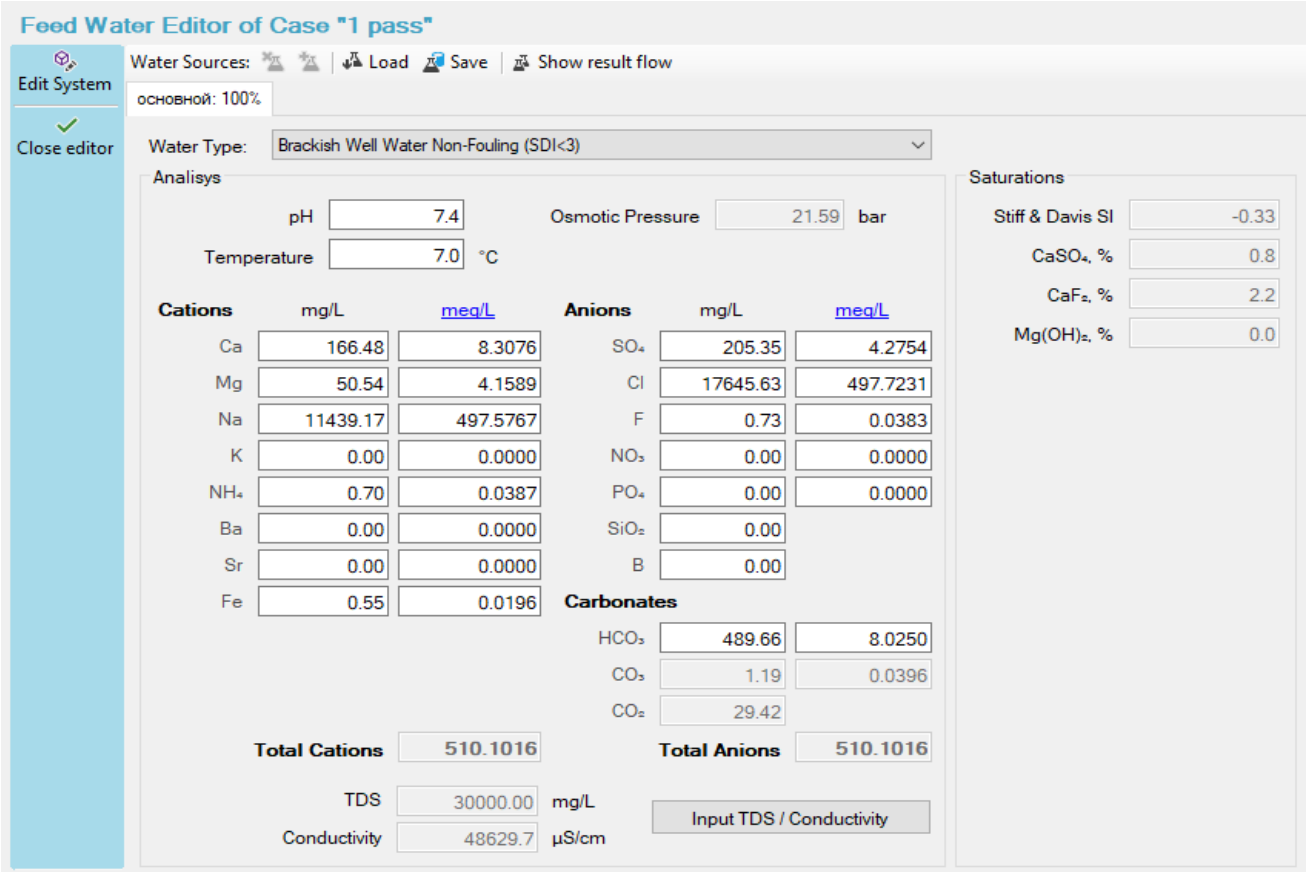
The characteristics are displayed only for the plant for which the calculation was previously performed (before saving the project). If errors occurred during the calculation of the plant, you will need to make changes to its configuration and perform the calculation again; see:

- 4.4 Editing feed water properties
- 4.5 Plant Editing

4.4 Editing feed water properties

If you have created a new plant project, the program will immediately open the "Feed Water Editor" form. To edit the feed water properties for the existing project, click the **Edit Feed** button on the toolbar:

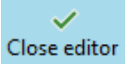
The "Feed Water Editor" form» looks as follows:



The "Feed Water Editor" form allows:

- to set one or more water sources, which when mixed generate a flow supplied to the inlet of the reverse osmosis plant;
- load water source data from a file (or save the data of the selected source to a file for later use);
- describe the physical and chemical properties of water sources.

Detailed information on working with the "Feed Water Editor" form is given in section 5.4.4 Editing feed water properties below.

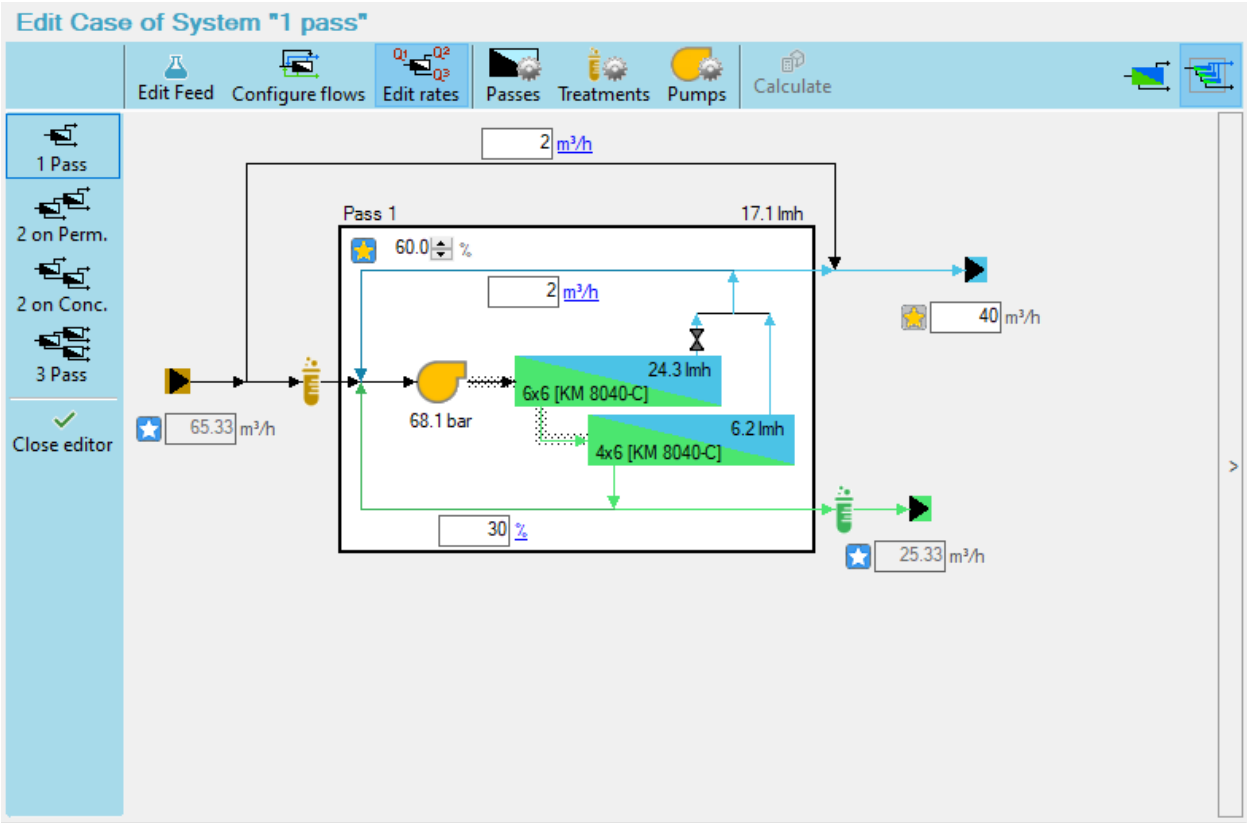
Click the button 

to exit the water editor mode. If you have created and edited a new project, the program will then automatically switch to the Plant Editing mode.

4.5 Plant editing

If you have created a new plant project, the program will open the plant editing form immediately after finishing editing the feed water. To edit a plant for an existing project, click the **Edit System** button on the toolbar:

The plant editor form looks as follows:



Using the toolbar buttons and controls located on the plant diagram, you can do the following:

- select the number of plant stages and the method of their connection; the following plant configurations are available:
  - "1 Pass";
  - "2 on Perm." – two passes of treatment, the permeate from the first pass is supplied for additional treatment to the second pass;
  - "2 on Conc." – two passes of concentration, the concentrate from the first pass is fed for additional concentration to the second pass;

- "3 Pass" – a combined circuit with the supply of the output flows of the first pass to additional second and third passes and the possibility of water circulation between them.

- configure bypass of inlet water, internal and external recycles and water outlets of the installation;
- configure reagent water treatment of inlet and outlet flows of the passes;
- set the values of flow rates and recoveries of the passes;
- indicate the type and number of SWFE (spiral wound filter element) and other parameters of the passes and stages;
- set the efficiency of the plant pumps (for calculating energy costs).

For details on plant editing, see section 5.4.5 Plant design editing below.

As changes are made to the plant design, the program allows to quickly perform a rough estimate of the plant and evaluate the impact of changes on its performance.

See also:

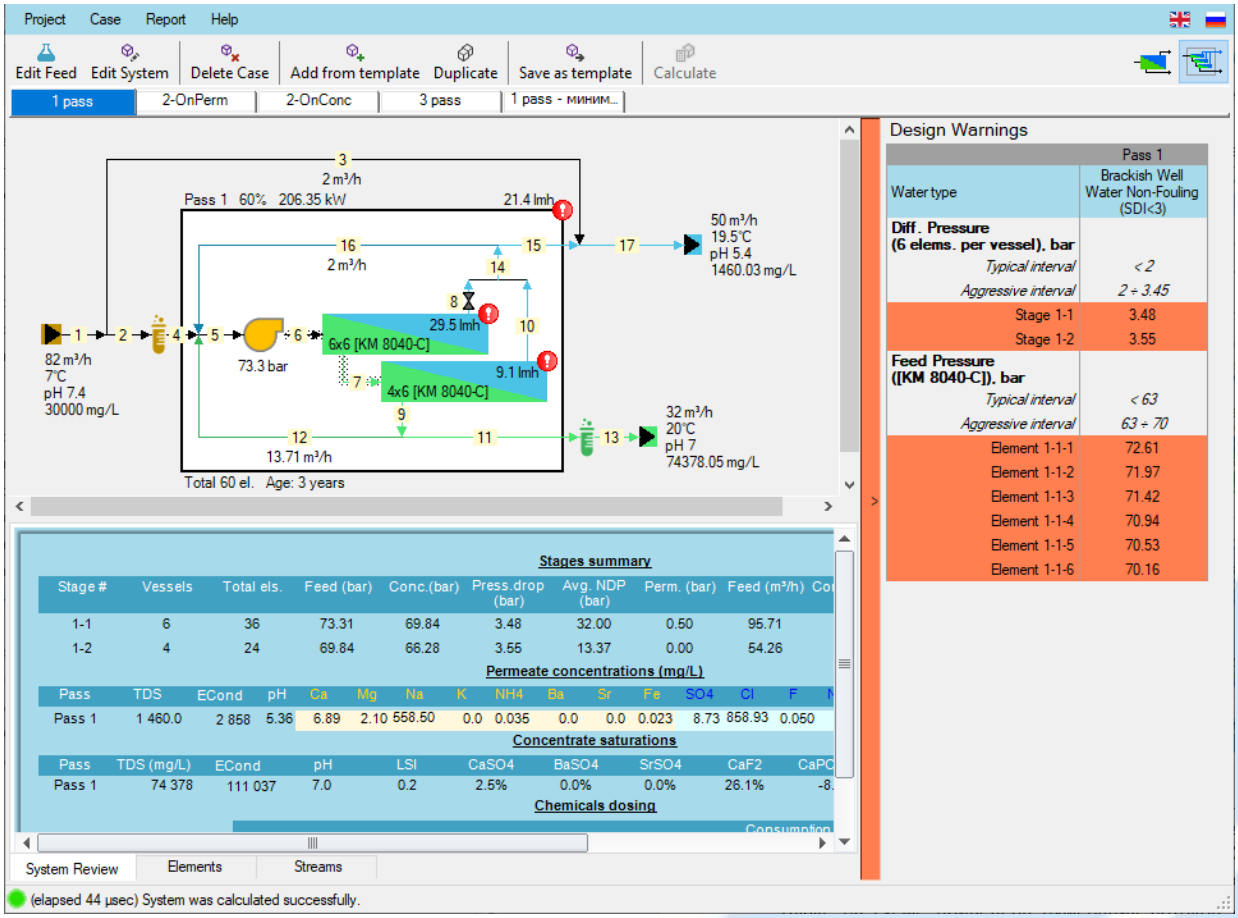
- *Types of calculations performed by the program.*
- *Viewing and analyzing warnings generated by the calculation.*

Click the button Close editor to exit the plant editor mode. If there are changes in the design, the plant will be calculated and its characteristics will be updated on the information tabs (see next section).

4.6 Plant calculation and analysis of its results

The calculation of the plant is performed automatically after making changes to its design or the properties of the feed water.

The general view of the program window in the mode of viewing the plant characteristics after calculation is shown below:



Above-left is the plant diagram. The most important characteristics (for inlet / outlet flows: flow rate, temperature and concentration, for passes: pump pressure, recovery, average permeate flux and also bypass and recycles rates) are shown directly in the diagram.

The diagram also shows the numbering of the plant flows. If you hover the cursor over a flow number, a pop-up window appears showing the characteristics of the flow.

Below-left, under the diagram, there is a set of tabs containing tables of characteristics:

- **System Review** – shows a summary of the most significant characteristics of the plant as a whole;
- **Elements** – shows characteristics for individual SWFE;
- **Streams** – shows the characteristics of the plant flows.

To switch quickly to the characteristics of the plant element of interest (stage, phase, flow), select it in the diagram by clicking the mouse button.

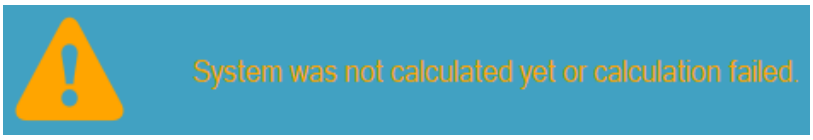
If select flow on the diagram by mouse clicking, on the tab **Elements** the column will be highlighted which displays characteristics of the selected flow. When pass or stage is selected on the diagram the all elements of selected pass or stage are highlighted on the tab **Elements**.

The design warnings sidebar is on the **right**. It contains warnings on the overrun of the calculated plant characteristics beyond the recommended and permissible limits. Based on the warnings presence or absence conclusions can be made about the design quality and the required design changes.

See also:

- 5.4.1 *Program Settings*
- 5.4.3 *Plant Cases*
- *Viewing and analyzing warnings generated by the calculation*

Some plant configurations lead to errors when trying to make calculations. Most often, these are the configurations with a poorly selected number of stages and number of elements in the pressure vessel, too high values of pass recoveries and recycle rates, with an inappropriate choice of the SWFE model for the type and concentration of feed water used. If an error occurred while calculating the plant, the following message will be displayed at the bottom of the program window, instead of the tabs with characteristics tables:



In this case, it will be necessary to change the plant design, trying to eliminate the causes leading to the error.

4.7 Summary report generation

Being in the view of plant calculated characteristics, you can generate a summary report suitable for printing or saving in the selected file format (PDF, Microsoft Word, Microsoft Excel, etc.)

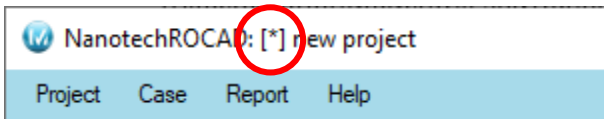
To do this, select an item in the main menu: **Reports – Active case**.

For more information on the report see section 5.4.7 Report generation on a plant case.

4.8 Saving plant project changes

After making changes to the composition of the inlet water and (or) the plant design, do not forget to save the project file before completing the work with the program.

If there are unsaved changes, an asterisk is displayed in the program header in front of the project name:

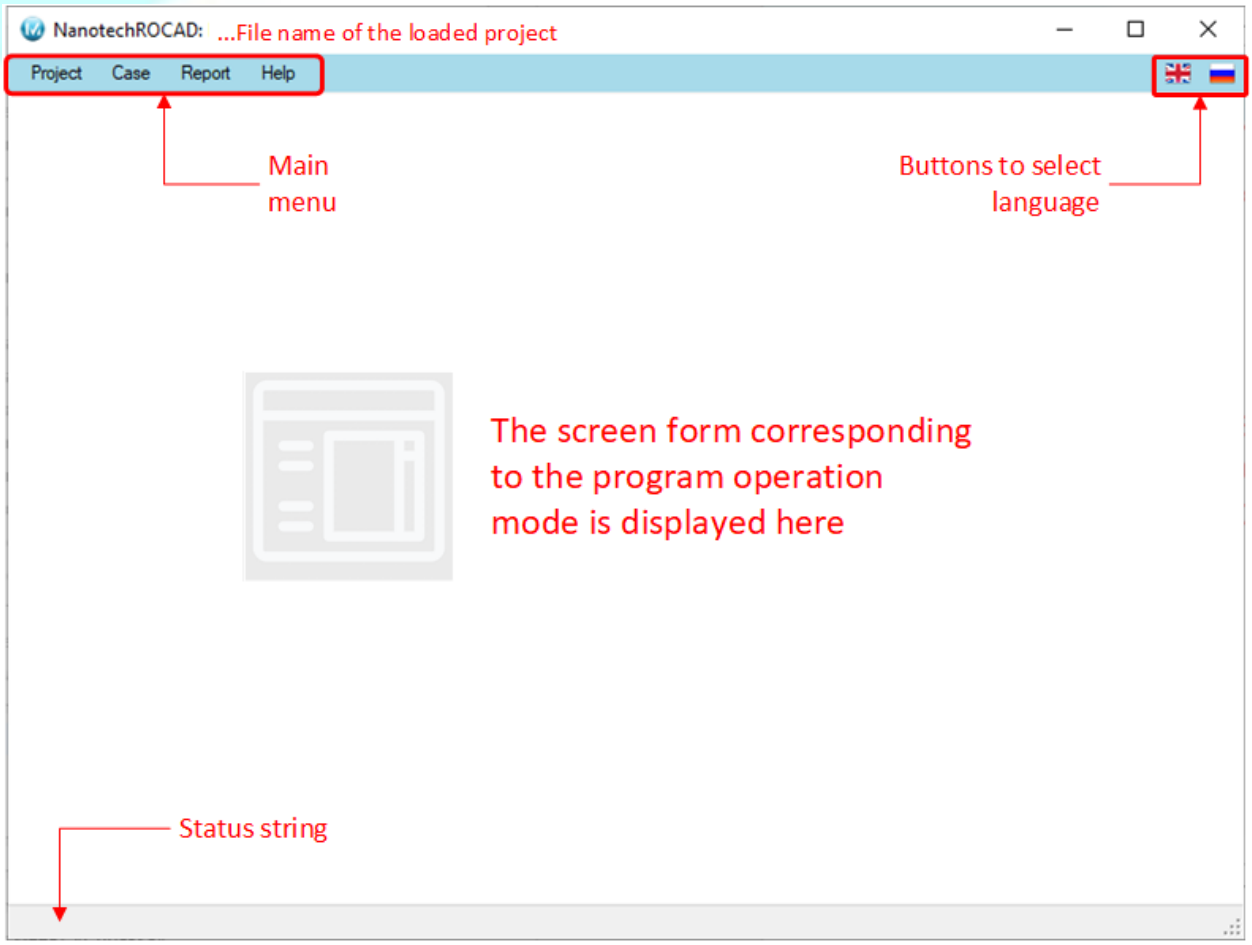


To save, use the menu item **Project – Save**.

5 Program Details

5.1 The structure of the program window and the purpose of the controls

The structure of the program window is shown in the figure below:



The **window heading** displays the name of the loaded plant project file. If there are unsaved changes in the project, the symbol "[*]" is displayed in front of the project name.

The **main menu** bar is located immediately under the heading. On the right side of the menu bar there are buttons for switching the interface language: English / Russian.

At the bottom of the program window there is a **status line**, in which additional information is displayed corresponding to the context of the operation being performed.

The rest of the window displays one of the forms that correspond to the current operating mode (actions being performed):

- **Initial screen** – see. 4.1 First launch of the program;
- **Projects manager** – see 5.4.2 Projects Manager;
- **Feed water editor**– see 5.4.4 Editing feed water properties;
- **Plant case editor** – see 5.4.5 Plant design editing;
- **Cases** – see 5.4.3 Plant Cases and 5.4.6 Plant case calculation.

5.2 List of dialog forms

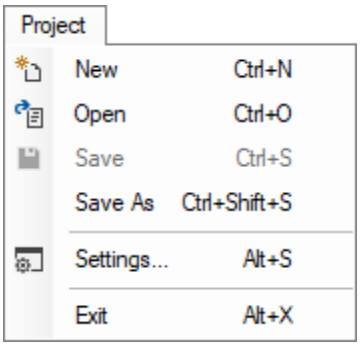
The program uses the following dialog forms:

- **Program settings** – see section 5.4.1 Program Settings;
- **Case description** – see 5.4.3.6 Editing case name and description;
- **Water sources names & ratios** – see Editing water sources names and ratios;
- **Passes and stages configuration** – see 5.4.5.6 Passes and stages details configuration;
- **Stages autoconfiguration options** – see Automatic pass sectioning;
- **Membrane elements catalog** – see Stage configuration;
- **Water treatment** – see 5.4.5.7 Editing water treatment settings;
- **Pumps efficiency configuration** – see 5.4.5.8 Setting pump efficiency;
- **About program** – see 5.3.4 "Help" menu .

5.3 Main menu structure

5.3.1 “Project” menu item

Contains commands for managing the program and the active project:



Create a new plant project	❶
Open an existing plant project	❷
Save changes to the active project	❸
Save a copy of the active project to a new file	❹
Edit program / project settings	❺
Exit the program	❻

Notes:

❶, ❷ – see 5.4.2 Projects Manager;

❸ – writes changes to the project file;

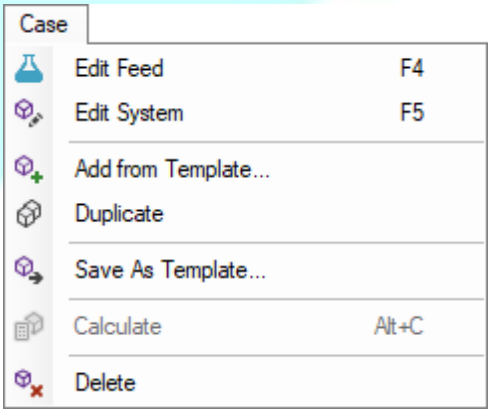
❹ – creates a new project file and writes the contents of the active project there; the file of the active project is not changed;

❺ – see 5.4.1 Program Settings;

❻ – if the active project contains unsaved changes you will be requested to save them before exiting.

5.3.2 “Case” menu item

Contains commands for managing the plant cases of the active project:



Switch to feed water editing mode	❶
Switch to plant editing mode of the active case	❷
Add new case from template file	❸
Duplicate the active case	❹
Save the active case as a template	❺
Calculate the plant	❻
Remove active case from the project	❼

Notes:

❶ – see 5.4.4 Editing feed water properties;

❷ – see 5.4.5 Plant design editing;

❸, ❹ – see 5.4.3.3 Adding new case into the project;

❺ – see 5.4.3.4 Saving case as template;

❻ – used to start manual plant calculation of the active case; see Accurate calculation;

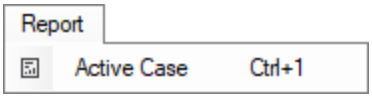
❼ – see 5.4.3.5 Deleting case.

See alse:

5.4.3.2 *General information about plant cases*

5.3.3 “Report” menu item

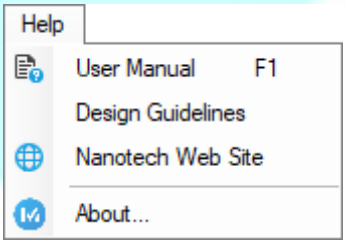
Contains command for generating report:



see 5.4.7 Report generation on a plant case

5.3.4 "Help" menu item

Contains commands for getting help information:



Show contextual section of help system	❶
Display design guidelines	❷
Open Nanotech website	❸
Show program general information	❹

Notes:

❶ – when this item clicked it shows the home page of the built-in help system; when F1 is pressed, it shows a context-sensitive section of help system;

❷ – displays on the screen the design guidelines for plants using Nanotech filter elements;

❸ – opens the home page of www.membranium.com;

❹ – opens a dialog box containing general information on the program version used; the window looks as follows:

5.4 Description of program functions

5.4.1 Program Settings

The "Program settings" dialog is used to view and change the settings for the current user, as well as to edit the settings of the active plant project.

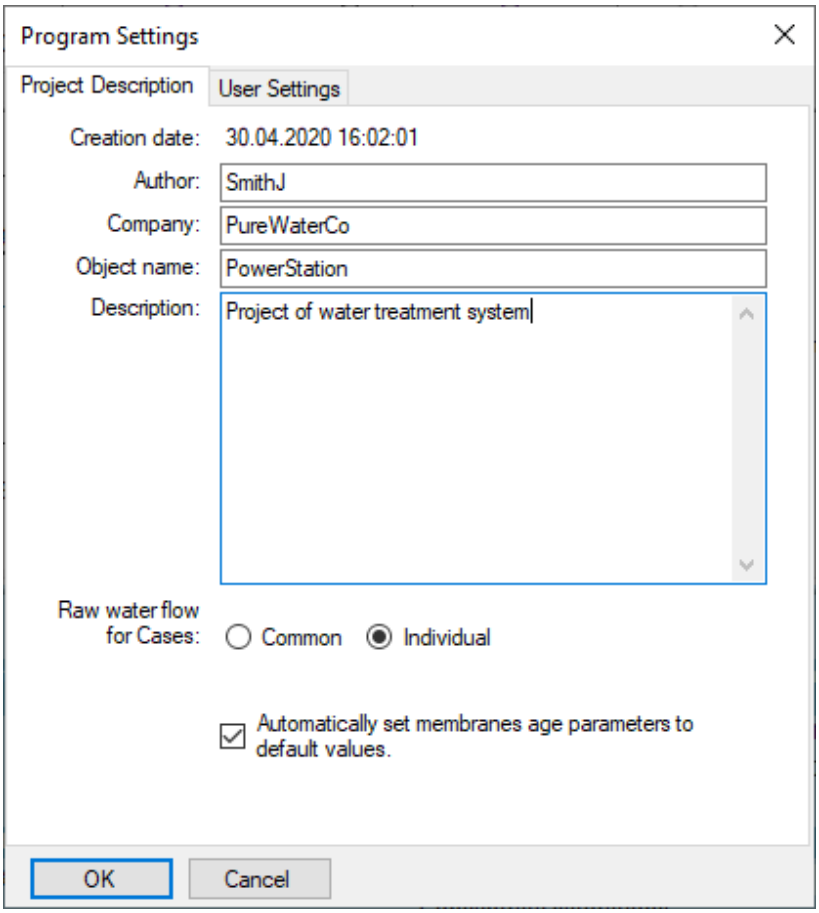
To open the dialog, use the menu **Project - Settings...**
or the keys combination **Alt+S**

The dialog window contains two tabs.

5.4.1.1 Plant project description and settings

The **Project Description** tab allows to edit general information related to the active project and set some of its properties. All data displayed on the tab is stored in the plant project file.

The tab is not displayed if no project is open.



Project creation date

Name of the project author and company.

Name of the object for which the plant is designed.

Free-form description of the project.

See description below.

See description below.

Values in fields **Creation date**, **Author**, **Company**, **Object name** can be used for sorting the projects list in "Projects Manager" (see 5.4.2.3 View information for existing projects). They are also used when generating reports.

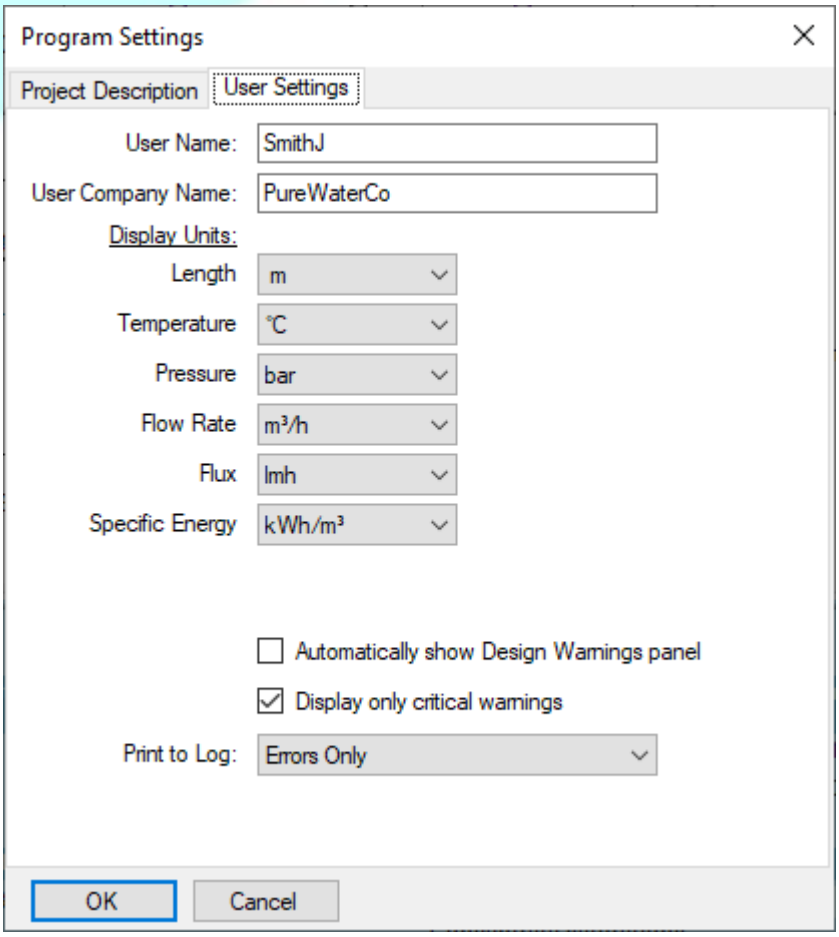
By default, the name of the project author and company is taken from the user settings, but for the active project they can be changed here.

The switch **Raw water flow for Cases** determines whether the plant cases in the project will use a common water source or have individual inlet water properties. For details, see Cases water source mode setting.

If option **Automatically set membranes age parameters to default values** is on the values of parameters "Flux decline" and "SP increase" will be automatically set by the program to the default values depending on the pass feed water type; in this case, the values of the parameters cannot be changed in the Passes and stages configuration dialog. To set different values of the membrane age parameters, first deselect this option. For details, see Setting the age of membrane elements.

5.4.1.2 User settings

The **User Settings** tab is intended for setting the program parameters, individual for each user. The data displayed on the tab is stored in the user's personal settings file (see 6.1.1.2 The directory structure of the program on the hard disk).



User name

Company name

Units in which values will be entered and displayed in the program for the current user

See descriptions below.

Values of fields **User Name** and **User Company Name** are used when creating new projects (are copied to the project properties).

The units selected in the settings are applied for input / output values of the plant characteristics.

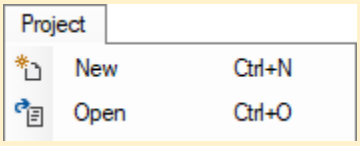
The options **Automatically show Design Warnings panel** and **Display only critical warnings** relate to behavior and contents of Design warnings sidebar. For details see Design warnings sidebar.

The **Print to Log** list allows to select the level of verbosity of messages collected into a log file during the program operation. The messages contain technical information, which, in some cases, may be required by the support service to solve the user problems. The **NanotechROCAD.log** log file is located in the **NanotechROCAD** subfolder of the current user's **My Documents** folder.

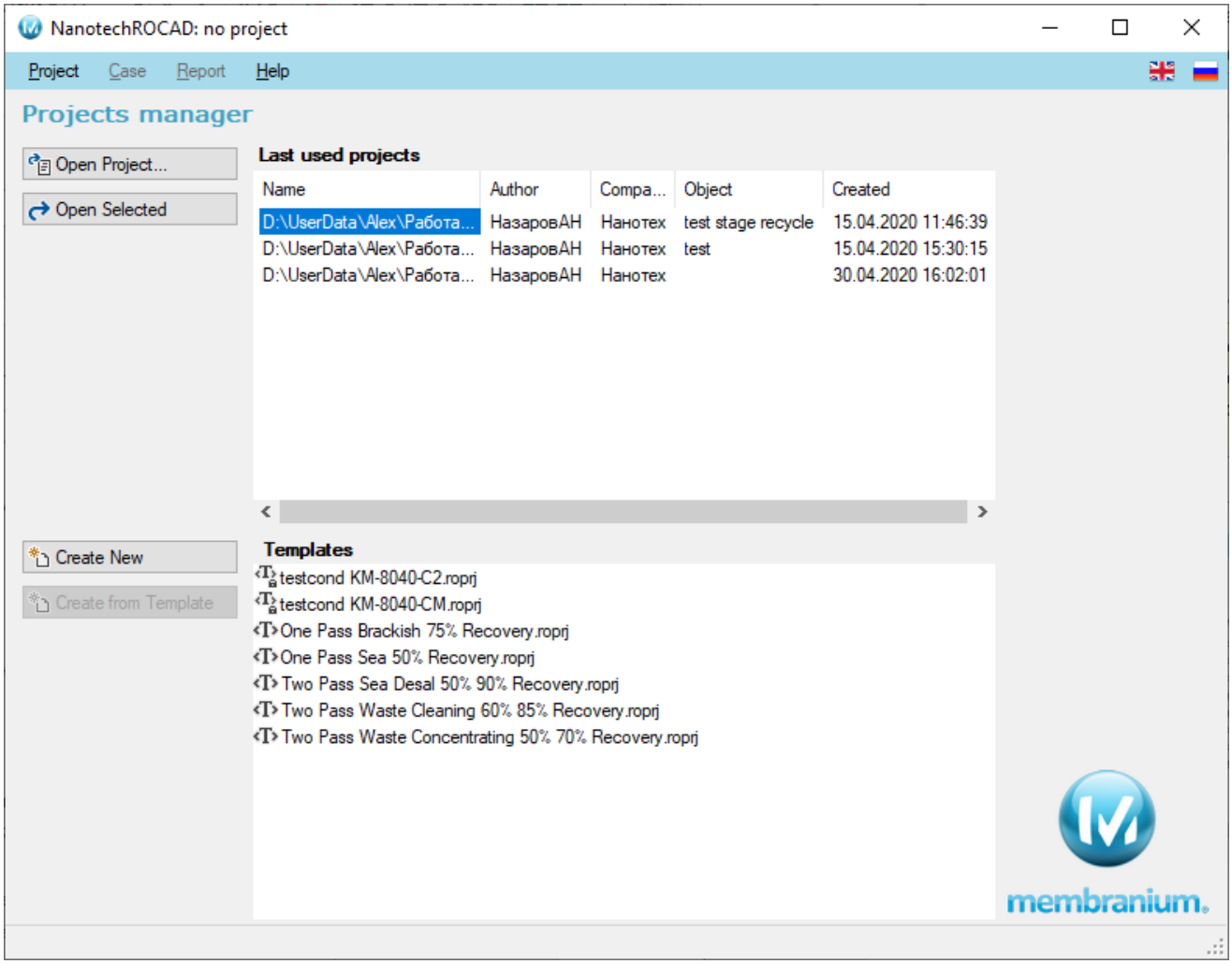
5.4.2 Projects Manager

5.4.2.1 Overview of the “Projects Manager” form

The form “Project Manager” is displayed when the program is started or when the menu item **Project-New** or **Project-Open** is called.



The “Projects manager” form looks as follows:



The **upper part** of the window, including the **Last used projects** list, is intended for selecting and opening previously created projects. The upper part is not visible if the Projects Manager was opened by the "Project-New" command.

The **lower part** of the window, including the **Templates** list, is used to create a new project. The bottom part is not visible if the Projects Manager was opened by the command "Project-Open".

5.4.2.2 Location of project files

The program stores the data of the plant projects in files. These files have the **roprj** or **roprjxml** extension.

Project files created by program users can be located in any accessible location in the file system. However, the program uses two folders in a special way, considering all project files placed therein as templates that can be used to create new projects:

- The **Templates** folder located in the directory where the program is installed (by default **<UserProfile>\AppData\Roaming\NanotechROCAD**) contains preinstalled project templates included in the installation package.
- The **<UserProfile>\Documents\NanotechROCAD\Templates** folder contains project templates created by the user.

A project template file is essentially the same as a project file. Only the fact that this file is located in a special folder allows the program to use it as a template when creating new projects – see 5.4.2.5 Creating a new project using template.

5.4.2.3 View information for existing projects

You can open an existing project:

1) by clicking button Open Project... and then selecting the required file using the standard file open dialog;
2) by selecting one of the files in the **Last used projects** list (place the cursor on the required line in the list and click once, or click button Open Selected).

Columns of **Last used projects** list display:

- "Name" – indicates the path to the project file;
- "Author", "Company", "Object", "Created" – contain general information on the project (if it was filled in by the author).

Click on the column heading of the list to sort it by the selected field.

If the project has a description, it will be shown in a pop-up window when you hover on a row in the list.

After the project file has been selected and loaded, the program will switch to the mode of viewing the characteristics of the plant and display the form "Cases" – see 5.4.3 Plant Cases.

See also:

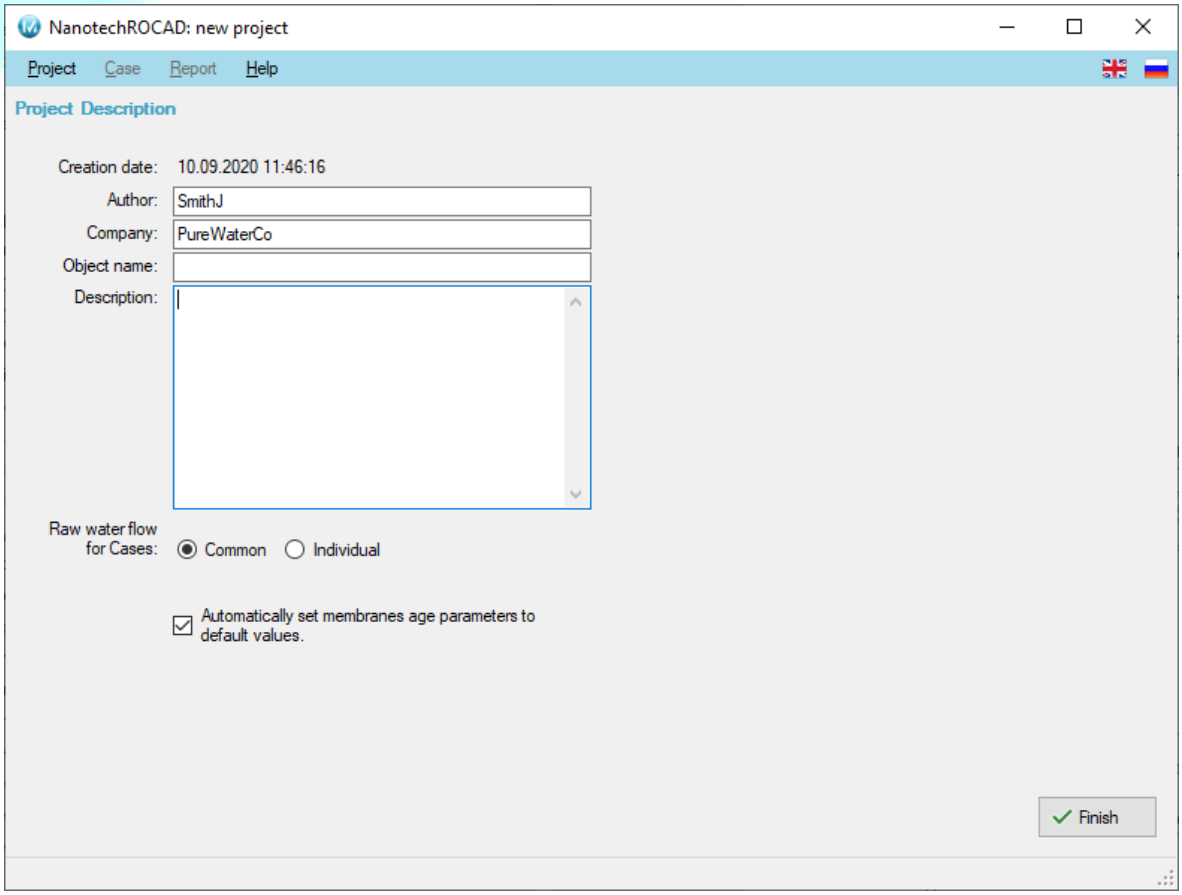
5.4.1.1 Plant project description and settings

5.4.2.4 Creating a new project "from scratch"

To create a new project with default settings, click the button Create New.

Creating a new project involves the following steps:

1. **Filling in the project description and properties.**



The entered parameters are similar to those described in 5.4.1.1 Plant project description and settings. Subsequently, they can be changed using the Program Settings dialog.

Click the button Finish to go to step 2.

2. **Specifying of the properties of the source water supplied to the plant.**

   At this step, all actions are performed in the "Feed water editor" form.

   For details see 5.4.4 Editing feed water properties.

3. **Choice of configuration and specifying details of the plant design.**

   Operations are performed in the "Edit case" form.

   For details see 5.4.5 Plant design editing

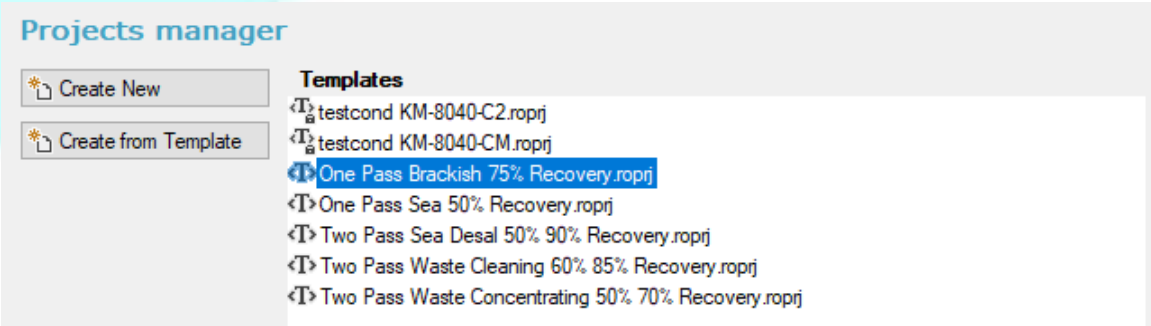
4. **Final plant calculation.**

   Upon completion of this step, the program will switch to the mode of viewing the characteristics of the plant and display the “Cases” form – see 5.4.3 Plant Cases.

   At this step it is recommended to save the created project.

5.4.2.5 Creating a new project using template

To create a new project using a template, select one of the templates listed in the **Templates** list (hover the cursor over the required line of the list and click once, or click button Create from Template):



Templates preinstalled with the program are marked in the **Templates** list with an icon, templates created by the user – with an icon.

Creating a new project using a template includes the same steps as creating a new project from scratch. However, the project created from the template already contains the specification of the inlet water and all the plant cases defined in the template.

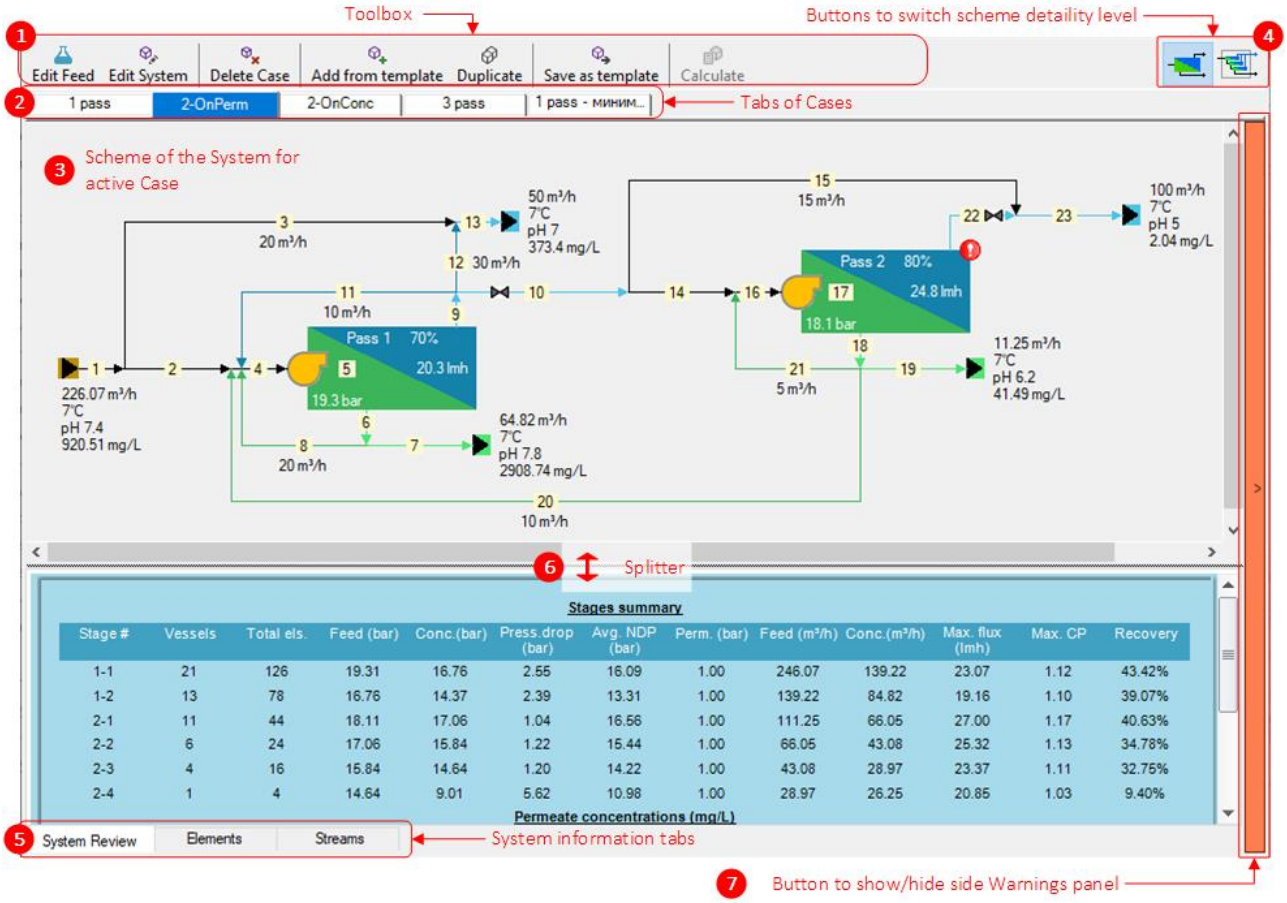
5.4.3 Plant Cases

5.4.3.1 Overview of the “Cases” form

The form “Cases” is dispalyed:

- when opening an existing plant project;
- upon completion of data entry for a new project;
- after clicking the **Close editor** button in the "Feed water editor" or the "Case editor" form.

The structure and purpose of the controls of the form “Cases” is shown in the figure:



Toolbar

At the top of the form there is a toolbar ❶ with the following buttons:

Edit Feed	Opens the “Feed water editor” form (see 5.4.4 Editing feed water properties). Depending on the project settings, a common water source for all cases or an individual water source of the active case will be edited.
Edit System	Opens the “Case editor” form for active case (see 5.4.5 Plant design editing).
Delete Case	see 5.4.3.5 Deleting case
Add from template	see 5.4.3.3 Adding new case into the project - Adding from template
Duplicate	see 5.4.3.3 Adding new case into the project - Duplicating
Save as template	see 5.4.3.4 Saving case as template
Calculate	Calculates the active plant case. See Accurate calculation.

Cases tabs

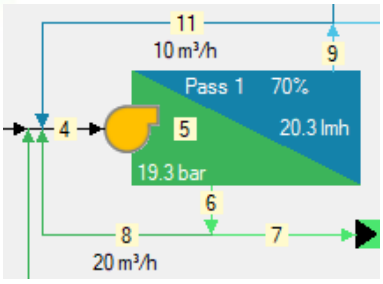
Below the toolbar there are the cases tabs ❷. The tab for the active case is highlighted. General information on cases is given below.

Plant diagram

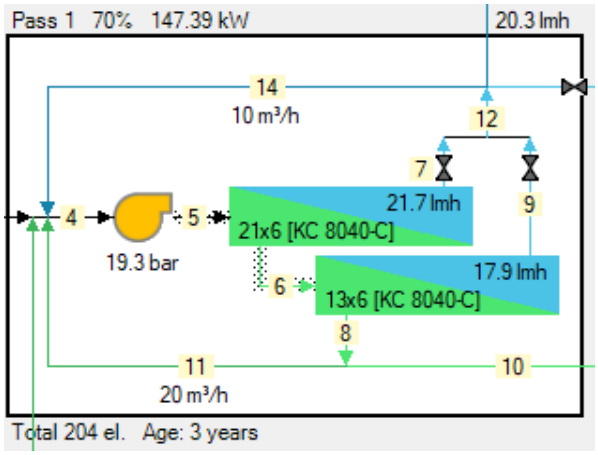
The diagram❸ shows the configuration and key features of the plant for the selected case.

Using the buttons for switching the detaility ❹ the visibility of stages can be turned on or off on the diagram:

pass view when stages visibility is off



pass view when stages visibility is on

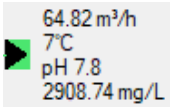


The diagram shows the following types of plant assemblies:


Inlet water supply node


Permeate outlet node


Concentrate outlet node



For inlet and outlet nodes the water properties are inscribed:

- rate
- temperature
- pH
- TDS

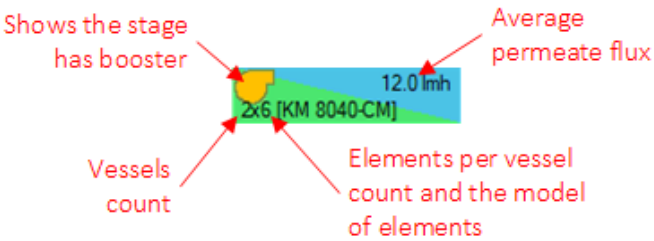

Pass feed water pretreatment node


Pass permeate post-treatment node


Pass concentrate post-treatment node

Main pump. Pressure is inscribed.

Pass



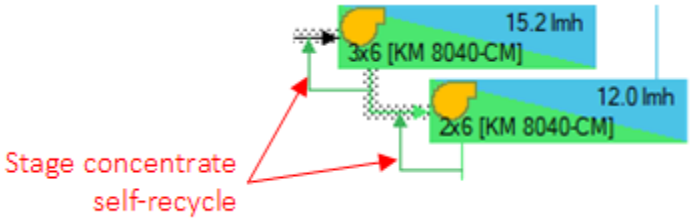
Stage

For passes and stages the icons may be displayed on the diagram indicating the presence of design warnings For more details, see Design warnings indication on the plant diagram.

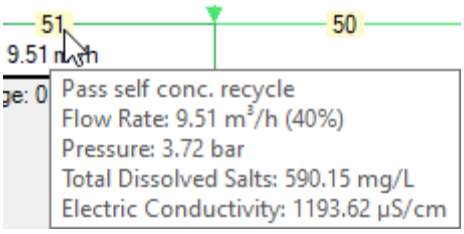
The diagram shows the following types of flows in the plant:

- feed or bypass flow
- permeate flow
- concentrate flow
- permeate recycle
- concentrate recycle
- valve at the end of the permeate flow line indicates the positive permeate back pressure
- shaded flow indicates the non-zero pressure drop due to resistance in the stage supply fittings

For stages, the concentrate self recycle is shown (if specified).



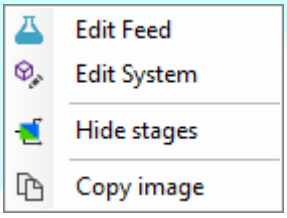
All flows in the plant diagram are numbered. If you hover over a number, a pop-up window will show the characteristics of the flow:



The diagram is linked with the dashboards below it. When an object (pass, stage, flow, water treatment unit) is selected in the diagram, the dashboard corresponding to the selected object opens and the data of the object selected in the diagram is highlighted on it.

Diagram context menu

If you right-click on the diagram, the context menu will open:



The **Edit Feed** and **Edit System** menu items perform the same actions as the buttons on the toolbar with the same name.

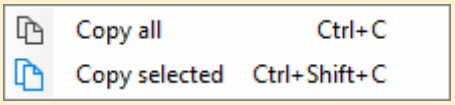
The **Hide stages (Show stages)** item toggles the detaility level of the diagram.

The **Copy image** item is used to copy a graphic image of the diagram to the clipboard.

Dashboards

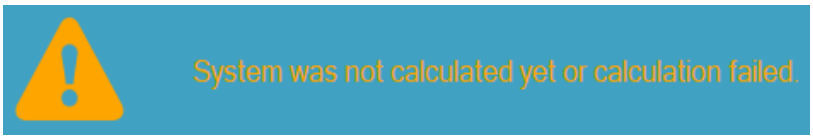
Below the plant diagram there are tabs of the dashboards❺. The dashboard displays the calculated values of the plant characteristics.

To copy the contents of the dashboard to the clipboard, use the context menu:



The **Copy all** menu item will copy the entire property sheet, including the row and column headers. The **Copy selected** item will copy only the selected columns.

The dashboards are not displayed if the plant has not been calculated or if there are errors in the calculation. In this case, the following message will be displayed instead of the dashboards:



The “System Review” dashboard

The dashboard contains a summary of the key features of the plant:

Stages summary

Stage #	Vessels	Total els.	Feed (bar)	Conc.(bar)	Press.drop (bar)	Avg. NDP (bar)	Perm. (bar)	Feed (m³/h)	Conc.(m³/h)	Max. flux (lmh)	Max. CP	Recovery
1-1	21	126	19.31	16.76	2.55	16.09	1.00	246.07	139.22	23.07	1.12	43.42%
1-2	13	78	16.76	14.37	2.39	13.31	1.00	139.22	84.82	19.16	1.10	39.07%
2-1	11	44	18.11	17.06	1.04	16.56	1.00	111.25	66.05	27.00	1.17	40.63%
2-2	6	24	17.06	15.84	1.22	15.44	1.00	66.05	43.08	25.32	1.13	34.78%
2-3	4	16	15.84	14.64	1.20	14.22	1.00	43.08	28.97	23.37	1.11	32.75%
2-4	1	4	14.64	9.01	5.62	10.98	1.00	28.97	26.25	20.85	1.03	9.40%

Permeate concentrations (mg/L)

Pass	TDS	ECond	pH	Ca	Mg	Na	K	NH4	Ba	Sr	Fe	SO4	Cl	F	NO3	PO4	HCO3	CO3	SiO2	B	CO2
Pass 1	8.59	18.2	5.57	1.39	0.464	0.0	0.0	0.023	0.0	0.0	0.005	0.207	0.041	0.016	0.0	0.0	6.44	0.0	0.0	0.0	38.56
Pass 2	2.04	4.2	4.99	0.230	0.077	0.0	0.0	0.005	0.0	0.0	0.001	0.032	0.007	0.003	0.0	0.0	1.67	0.0	0.0	0.0	38.23

Concentrate saturations

Pass	TDS (mg/L)	ECond	pH	LSI	CaSO4	BaSO4	SrSO4	CaF2	CaPO4 SI	SiO2	MgOH	Osm.press.(bar)
Pass 1	2 908.7	5 524	7.8	1.8	39.9%	0.0%	0.0%	149.1%	-7.2	0.0%	0.0%	1.0
Pass 2	41.49	88.2	6.2	-3.0	0.0%	0.0%	0.0%	0.0%	-8.8	0.0%	0.0%	0.0

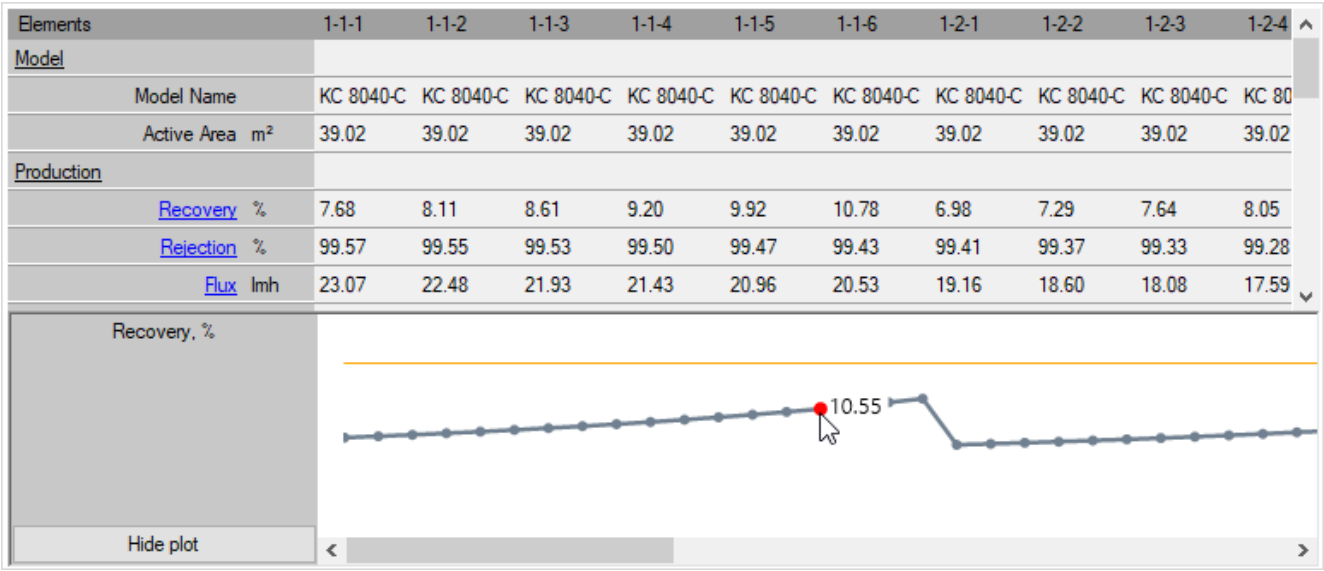
The “Elements” dashboard

The dashboard shows the characteristics of the membrane elements. The element numbers in the table consist of three parts: the first part denotes the number of the pass, the second – the number of the stage on the pass, the third – the ordinal number of the element in the stage pressure vessel.

Elements	1-1-1	1-1-2	1-1-3	1-1-4	1-1-5	1-1-6	1-2-1	1-2-2	1-2-3	1-2-4	1-2-5	1-2-6
Model												
Model Name	KM 8040-C	KM 8040-C	KM 8040-C	KM 8040-C	KM 8040-C	KM 8040-C	KM 8040-C	KM 8040-C	KM 8040-C	KM 8040-C	KM 8040-C	KM 8040-C
Active Area m²	39.02	39.02	39.02	39.02	39.02	39.02	39.02	39.02	39.02	39.02	39.02	39.02
Production												
Recovery %	11.77	11.19	10.28	9.10	7.76	6.43	3.60	3.05	2.57	2.16	1.82	1.53
Rejection %	99.71	99.65	99.58	99.48	99.35	99.15	98.96	98.74	98.45	98.11	97.73	97.29
Flux lmh	38.30	32.13	26.21	20.81	16.15	12.34	9.70	7.92	6.47	5.30	4.36	3.60
Diff. Pressure bar	0.47	0.39	0.33	0.29	0.25	0.23	0.37	0.35	0.34	0.33	0.32	0.31
NDP bar	37.28	32.93	28.46	24.07	19.93	16.24	13.48	11.41	9.65	8.14	6.88	5.82
CP level	1.05	1.05	1.04	1.04	1.03	1.03	1.01	1.01	1.01	1.01	1.01	1.01
Flow Velocity cm/s	11.96	10.57	9.42	8.48	7.75	7.18	10.18	9.83	9.55	9.32	9.13	8.97
Permeate												
Perm. Flow Rate m³/h	1.49	1.25	1.02	0.81	0.63	0.48	0.38	0.31	0.25	0.21	0.17	0.14
Perm. Pressure bar	0.50	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00
Perm. pH	4.55	4.60	4.67	4.75	4.85	4.97	5.07	5.16	5.25	5.34	5.42	5.49
Perm. Electric Conductivity µS/cm	218.86	290.74	393.60	540.52	742.81	1028.80	1341.80	1675.59	2102.39	2604.06	3176.86	3826.20
Perm. Total Dissolved Salts mg/L	103.89	138.65	188.83	261.21	361.98	506.23	666.03	838.28	1060.87	1325.35	1630.54	1980.09

If you select a pass or a stage in the diagram, all its elements will be highlighted in the table.

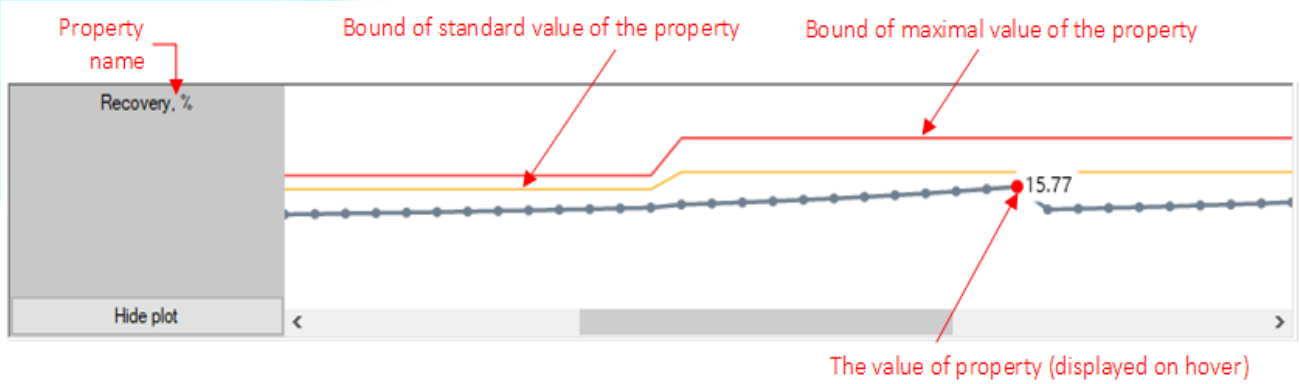
The names of certain characteristics in the element table are underlined and colored in blue. Clicking on the name opens the panel, which shows a plot of the values of the selected characteristic over the entire array of the elements:



The plot panel can be controlled:

- by pressing and holding the left mouse button, you can move the chart up and down along the vertical axis;
- holding the Shift key on the keyboard, using the mouse wheel, you can change the vertical scale of the chart;
- if you move the cursor over a node point, the value of the characteristic at that point will be shown.

For a number of characteristics, in addition to their own characteristic plot, the limits of the recommended and acceptable values will be shown:



To collapse the plot panel, click the **Hide plot** button.

The “Streams” dashboard

The dashboard shows the characteristics of the plant flows. The numbering of flows in the table and in the diagram is the same.

Streams	1	2	3	4	5	6	7	8	9
Base Info									
Flow Rate m³/h	226.07	206.07	20.00	246.07	246.07	139.22	106.85	84.82	54.40
Pressure bar	0.00	0.00	0.00	1.57	19.31	16.76	1.00	14.37	1.00
pH	7.40	7.40	7.40	7.44	7.44	7.66	5.40	7.84	5.78
Total Dissolved Salts mg/L	920.51	920.51	920.51	1009.60	1009.60	1779.28	5.69	2908.74	14.38
Electric Conductivity µS/cm	1833.80	1833.80	1833.80	2004.49	2004.49	3453.97	11.98	5523.89	30.56
Osmotic Pressure bar	0.35	0.35	0.35	0.38	0.38	0.65	0.00	1.03	0.01

The “Treatment” dashboard

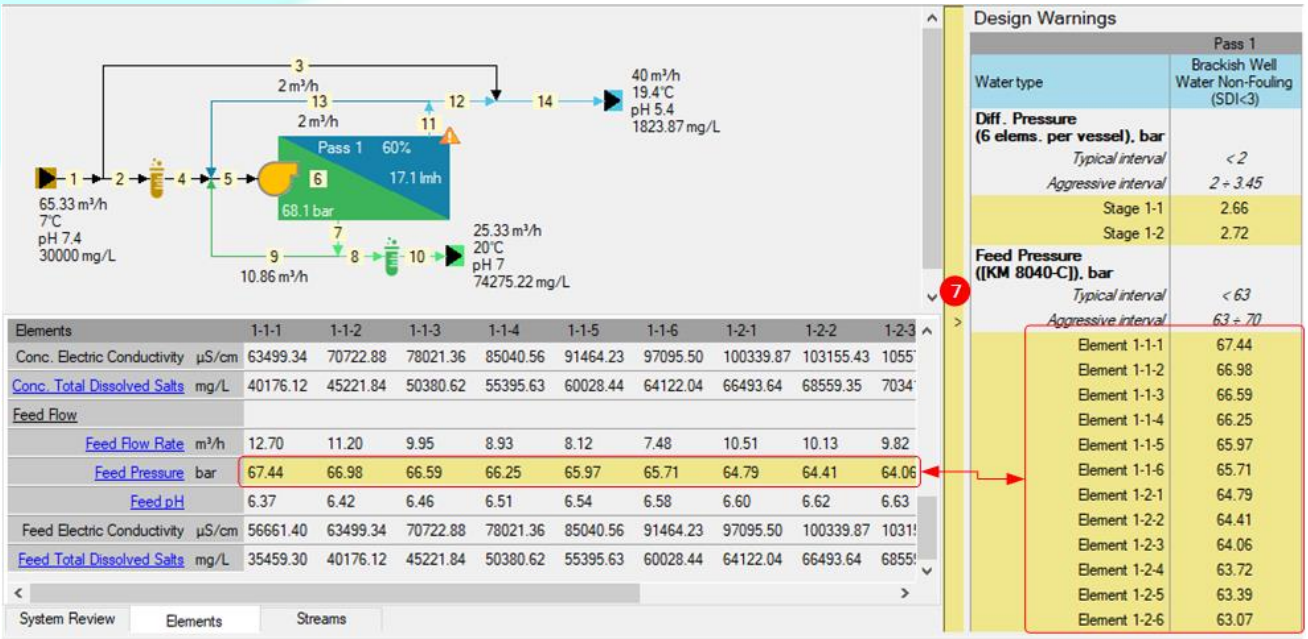
The dashboard is displayed when the water treatment node is selected in the plant diagram. The panel shows dosages and consumption of the chemicals for the selected treatment node:

Input water pretreatment of pass 1	Hydrocloric acid: HCl
Concentration %	40.00
Specific gravity	1.20
Specific dose (vol.) mL/m³	245.77
Consumption (vol.) L/d	373.57
Specific dose (mass) g/m³	294.44
Consumption (mass) kg/d	447.53

System Review | Elements | Streams | Treatment

Design warnings sidebar

If calculated values of some plant characteristics go beyond the recommended or permissible limits, the list of warnings will be prepared on the right side of the program window:



Along with the warnings on the right bar, the warnings are also displayed on the dashboard, and alert icons are displayed in the plant diagram.

To hide or expand the design warnings sidebar, click on the vertical bar ❼.

To copy the contents of design warnings sidebar to the clipboard, use the panel's context menu item: Copy Ctrl+C

See also:

Plant designing rules and principles

Viewing and analyzing warnings generated by the calculation

5.4.3.2 General information about plant cases

Overview of cases usage

Several plant cases can be stored in a single project file, differing in design details and possibly in the inlet water properties (see below Cases water source mode setting).

When creating a new project from scratch, it contains only one case. In future, you can add other cases into the project (see 5.4.3.3 Adding new case into the project) or delete unnecessary ones (see 5.4.3.5 Deleting case).

The selected case can be saved as a template (see 5.4.3.4 Saving case as template). This will allow to create new projects based on this case (see 5.4.2.5 Creating a new project using template) or add it to existing projects.

The following data is associated with each case in the project:

- name and description;
- plant design;
- properties of the inlet water supplied to the plant;
- status and results of the latest plant characteristics calculation.

Cases water source mode setting

Depending on the value of **Raw water flow for Cases** parameter (see 5.4.1.1 Plant project description and settings), all cases in the project will either use the common water source of the project, or they will have individual properties of the inlet water.

When creating a new project, the water source mode for cases is set to “Common” then properties of the inlet water are identical for all cases. The “Common” source mode is used when it is necessary to compare the calculation results of several plant design cases at the given properties of the inlet water.

In “Individual” mode, each case has its own water source, the properties of which can be adjusted independently from other cases. This makes it possible to store in project the calculation results of one plant design case at different temperatures or compositions of the inlet water.

The “Individual” mode has limitations – the properties of the resulting water source cannot be obtained by mixing several flows, as in the “Common” mode.

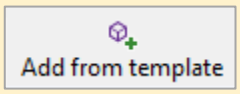
For a project with multiple plant options, changing the **Raw water flow for Cases** is done as follows:

- when switching the mode from “Common” to “Individual” – all cases receive a copy of the resulting flow from the common water source of the project;
- when switching the mode from “Individual” to “Common” – the common water source of the project is created as a copy of the inlet water of the first case in the order from those available in the project.

5.4.3.3 Adding new case into the project

Adding from template

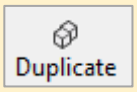
To copy a case from another project (template) to the active project, use:

- Menu item **Case – Add from Template**
- Button **Add from template** on the toolbar: 

Specify the template file in the standard file selection dialog. The first case from the specified template will be added to the active project.

Duplicating

To create a copy of the active case in the project, use:

- Menu item **Case – Duplicate**
- Button **Duplicate** on the toolbar: 

5.4.3.4 Saving case as template

To save the active case to a template file, use:

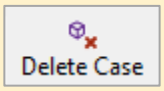
- Menu item **Case – Save as template**
- Button **Save as template** on the toolbar:

The created template file can later be used to create new projects or add the case to existing projects.

5.4.3.5 Deleting case

To remove the active case from the project, use:

- Menu item **Case – Delete**
- Button **Delete Case** on the toolbar:



If the case is the only one in the project, it cannot be deleted.

5.4.3.6 Editing case name and description

Each case can have a name and description. The name is displayed on the case tab. The description is displayed in a pop-up window when you hover over the case tab.

When a new project is created, its only case is unnamed.

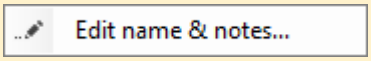
To edit the name or description of case, click on its tab:

- once – right click

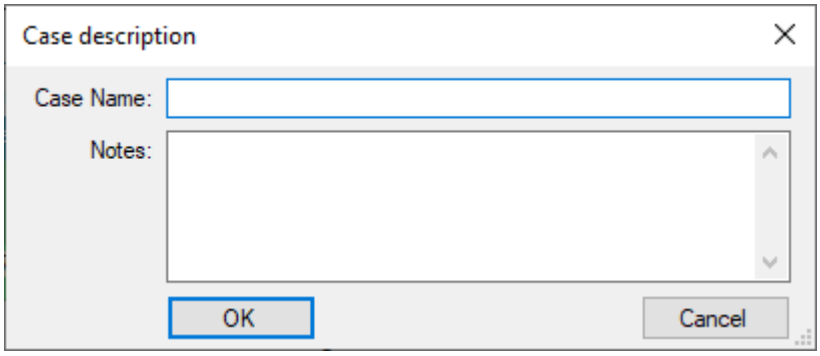
or

- twice – with the left mouse button

then click on the expanded context menu



Fill in or edit the required fields in the dialog box and click **OK** to accept the changes:



5.4.4 Editing feed water properties

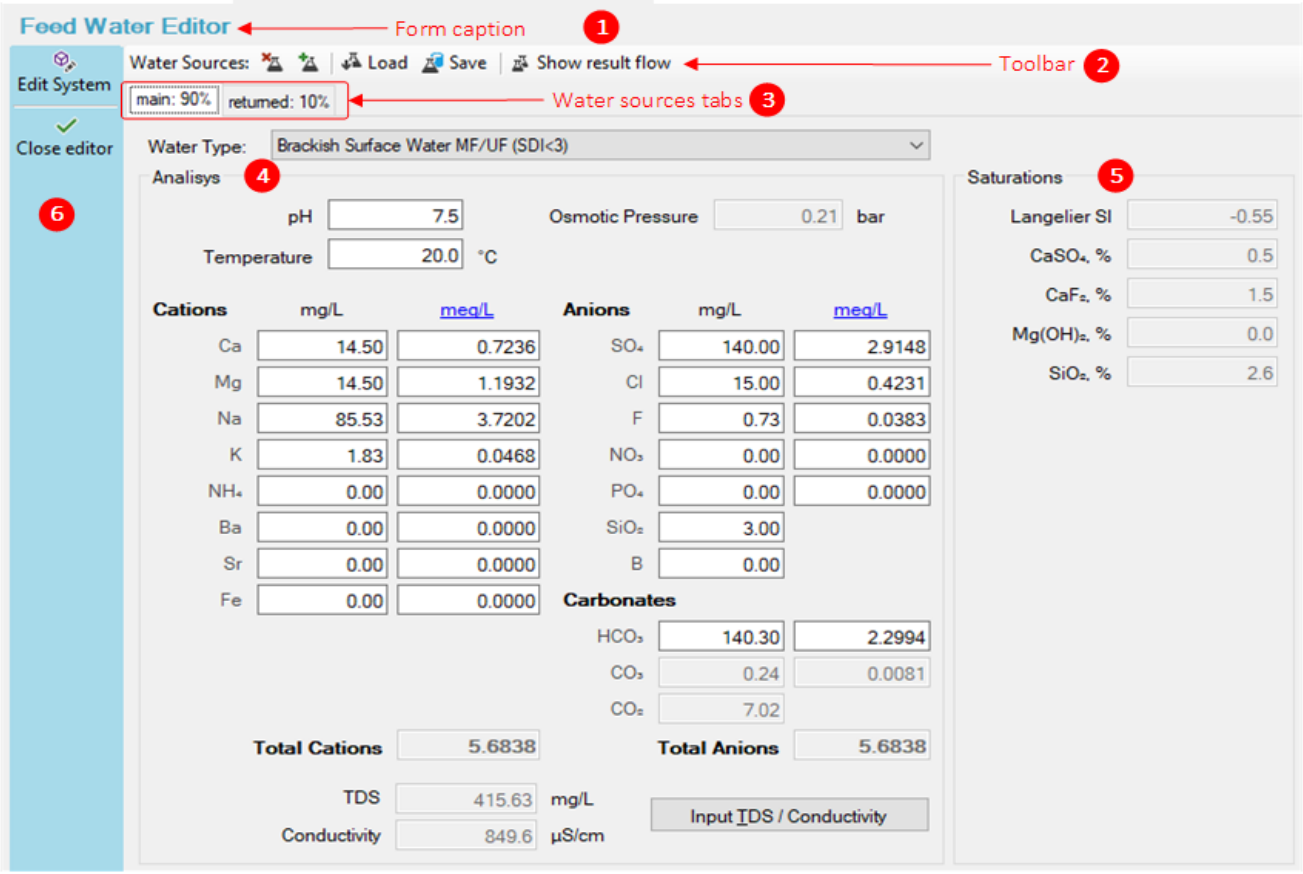
5.4.4.1 Overview of the form “Feed Water Editor”

The form is intended for editing the properties of the inlet water of the active case.

The form “Feed Water Editor” is displayed:

- on step 2 of creating a new plant project;
- from the “Cases” form:
  - menu item **Case – Edit Feed**
  - button **Edit Feed** on the toolbar
  - diagram context menu item **Edit Feed**
  - **F4** key
- from the “Edit case” form:
  - button **Edit Feed** on the toolbar
  - diagram context menu item **Edit Feed**
  - **F4** key

The structure and purpose of the controls of the “Feed Water Editor” form are shown in the figure:



The caption of the form ❶ indicate the current cases water source mode. If the source mode is set to “Common”, the form caption contains text:

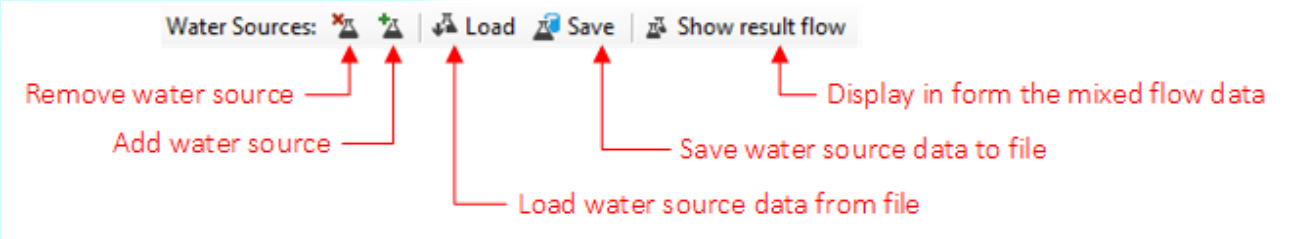
Feed Water Editor (common to all options)

If the source mode is set to “Individual”, the form caption looks as follows:

Feed Water Editor of Case "<case name>"

The toolbar ❷ allows to manage water sources (flows):

- add and remove water sources (see 5.4.4.4 Working with multiple water sources);
- save water source data to a file and load them from previously created files;
- view the properties of the resulting flow, supplied to the plant, formed by mixing water from all primary sources.



The function of mixing multiple flows into a resulting flow is only available in the "Common" water source mode. In the "Individual" mode, the buttons for adding and removing water sources on the toolbar will be inactive.

The water properties of each primary source are displayed on a separate tab ❸. The names and ratios of the sources can be edited.

The **Water type** list and the **Analysis** field group ❹ on the active tab are intended to describe the properties of the water of the selected source.

The **Saturations** panel ❺ displays the water saturation indices for the edited water source.

After finishing editing the water properties, you can:

- return to the mode of viewing data for plant options by clicking the **Close editor** button on the panel❻;
- switch to the plant editor of the active option by clicking the **Edit system** button on the panel❻.

Immediately before exiting the form, the entered data are checked. If there are errors, a message will be displayed and the form will remain open until data are corrected.

See 5.4.4.5 Possible errors when editing water properties below.

When exiting the form, if the water properties have changed, the related plant cases will be automatically calculated.

See alse: 5.4.6 Plant case calculation

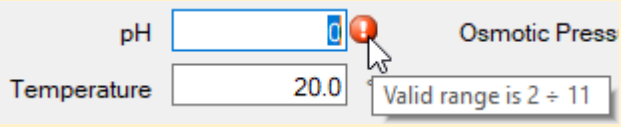
5.4.4.2 Editing water source properties

The properties listed below shall be determined for the water source.

To move between form fields, in addition to the mouse, you can use the following keys:

- **Tab / Shift+Tab**
- **Down arrow / Up arrow**
- **Enter / Shit+Enter**

If an invalid value was entered in any field, an error icon appears next to the input field. Hover over the icon to read the error message:



To continue, correct the erroneous value.

Water type

Select the appropriate type of water from the list of the same name:

- RO Permeate (SDI<1)
- Brackish Well Water Non-Fouling (SDI<3)
- Brackish Well Water High-Fouling (SDI<5)
- Brackish Surface Water MF/UF (SDI<3)
- Brackish Surface Water Conv. (SDI<5)
- See Well Water (SDI<3)

- See Open Intake Water MF/UF (SDI<3)
- See Open Intake Water Conv. (SDI<5)
- Wastewater MF/UF (SDI<3)
- Wastewater Conv.(SDI<5)

The water types in the list are ordered according to the upward trend in total water salinity and suspended solids content. For each type of water, the program defines the permissible limits. The overrun of the plant characteristics beyond such limits is undesirable.

pH

The valid pH range is 2 – 11.

At pH values less than 4 or higher than 9, the plant calculation may give less accurate results.

Temperature

The permissible temperature range is 4 – 45°C.

Dissolved solids concentration

Concentrations can be entered in **mg/L** or equivalent values. When entering equivalent concentrations, you can select the units: **meq/L** or **mg/L CaCO3**. To switch the units, click the blue-colored heading:

Cations	mg/L	mg/L $CaCO_3$	meq/L
Ca	14.50	36.1791	0.7236
Mg	14.50	59.6585	1.1932
Na	85.53	186.0114	3.7202
K	1.83	2.3403	0.0468
NH_4	0.00	0.0000	0.0000

On entering concentrations, the program calculates the total equivalent concentration of cations and anions (in the selected units), the total salts content in **mg/L** and estimates the value of the specific conductivity of the solution.

The calculation of total ion concentrations takes into account the contents of H and OH ions, which are expressed by the pH value, but are not explicitly present in the list of cations and anions. Therefore, the calculated values of the total ion concentrations may differ from the values obtained by simply adding the contents of cations and anions shown in the form window.

If the bicarbonate ion (HCO_3) concentration is set, the carbonate ion (CO_3) and dissolved carbon dioxide content is calculated from the set pH value and solution temperature.

Balancing cations and anions

Based on the principle of electroneutrality, the total equivalent concentrations of cations and anions in a solution must coincide. If an imbalance occurs during the entry of concentrations or pH, it shall be corrected. The program emphasizes the names of the most common cations or anions (depending on which type of ions is less in the solution). Click on the name of an ion to increase its amount by the amount needed to achieve the electroneutrality:

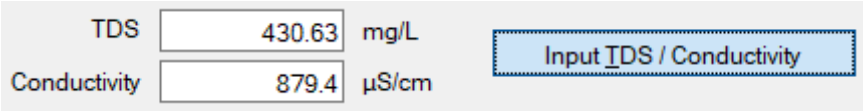
Cations	mg/L	meq/L
Ca	14.50	0.7236
Mg	14.50	1.1932
Na	85.53	3.7202
K	1.83	0.0468
NH_4	0.00	0.0000

Fast input of TDS

The program allows to enter the total dissolved salts value in **mg/L** (or the corresponding value of the specific conductivity in **µS/cm**). The program will automatically calculate the amount of Na and Cl ions in the solution in order to achieve the specified salt content.

If, in addition to Na and Cl, other ions are present in the solution, such an amount of Na and Cl will be selected so that the solution is electrically neutral while the concentration of other ions remains unchanged. Since the calculated amount of Na and Cl cannot be negative, the total salt content of such solution can be higher than the that specified.

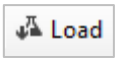
To start entering TDS or specific conductivity, click the **Input TDS/Conductivity** button. In this case, the fields for entering ion concentrations will become unavailable, but it will be possible to edit the fields to the left of the button:



After entering the desired value, click the **Input TDS/Conductivity** button for the second time. The calculation of the ion content will be performed and the program will return to the normal mode for the ion concentration input.

5.4.4.3 Using water source data files

Loading water source properties from a file

To load the properties of an active water source from a file click the button  on the toolbar – a standard file open dialog will be shown. Specify the location of the desired water source data file (it has the **.wsrc** extension).

The properties of the active water source will be loaded from the selected file. The previous values will be overwritten.

Saving water source properties to a file

To save the properties of an active water source click the button  on the toolbar and enter a name for the file to be created. Water source data files have the **.wsrc** extension.

5.4.4.4 Working with multiple water sources

If the **Raw water flow for Cases** option is configured so that all cases share a common inlet water source, it is possible to describe this input source as a result of mixing water from several primary sources (flows).

Adding a water source to a project

To add a primary water source to the project, click the  button on the toolbar. A tab will be added for the new "untitled" source.

Removing the water source

To remove an active water source from a project click the  button on the toolbar.

After confirmation, the source will be deleted, and its tab will be closed.

The last remaining water source in the project cannot be deleted.

Editing water sources names and ratios

Water sources can be easily named.

When calculating the properties of the resulting flow, water from the primary sources is mixed in proportion to the ratio of each source.

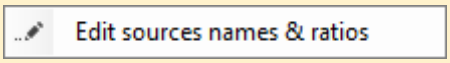
To edit the names and ratios of the primary flows, click on the tab of any of the sources:

- once – right click

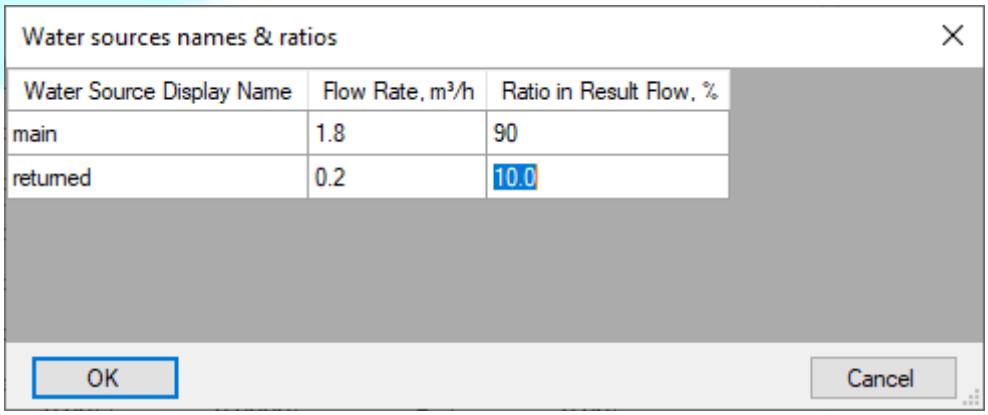
or

- twice – with the left mouse button

then click context menu item



In the open dialog box, the data for each source is indicated on a separate line:



The source name is entered in the first column and can be edited.

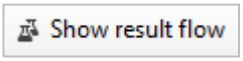
There are two ways to assign source ratio:

i. by editing the values in the column “Flow Rate”; values can be entered in any order; ratios in % are calculated automatically relative to the sum of rates;

ii. specifying percentage values in the column “Ratio in Result Flow"; it is recommended to enter values from top to bottom, from the first source to the last one – the percentage of the last source is calculated automatically based on the fact that the sum of the ratios is 100%.

Click **OK** to save the changes.

Viewing the resulting flow properties

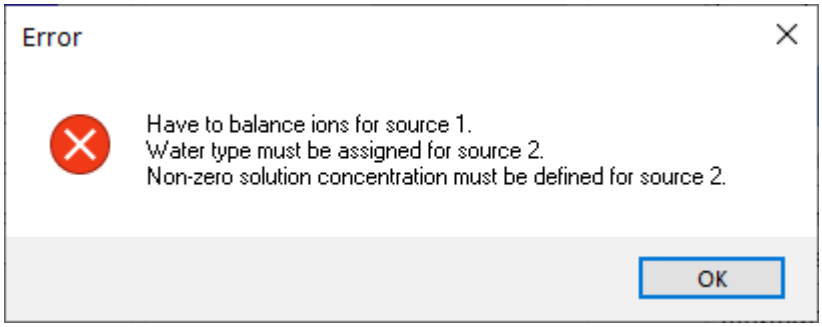
To see the properties of the resulting flow obtained by mixing the water of all the described sources in a given proportion, click the button 

on the toolbar. The button will be fixed, the flow properties will be shown on the current tab.

To continue entering data, you need to release the **Show result flow** button by clicking it again.

5.4.4.5 Possible errors when editing water properties

Before exiting the “Feed Water Editor” form, the entered data are checked for each of the primary water sources. If there are errors, a list of them is displayed in a dialog box, for example:



Water sources with errors are numbered in the order of their tabs.

Possible types of errors are shown in the table:

Error message	Reason
Water type must be assigned for source	The water type has not been set for the specified source.

Non-zero solution concentration must be defined for source	Zero concentrations of all dissolved components are indicated for the specified source.
Have to balance ions for source	The sums of equivalent concentrations of cations and anions do not coincide – the requirement for electroneutrality of the solution is violated.
Water sources total rate must be not zero	Flow rate for each of the sources is zero – it is impossible to calculate the ratios of the sources.

5.4.5 Plant design editing

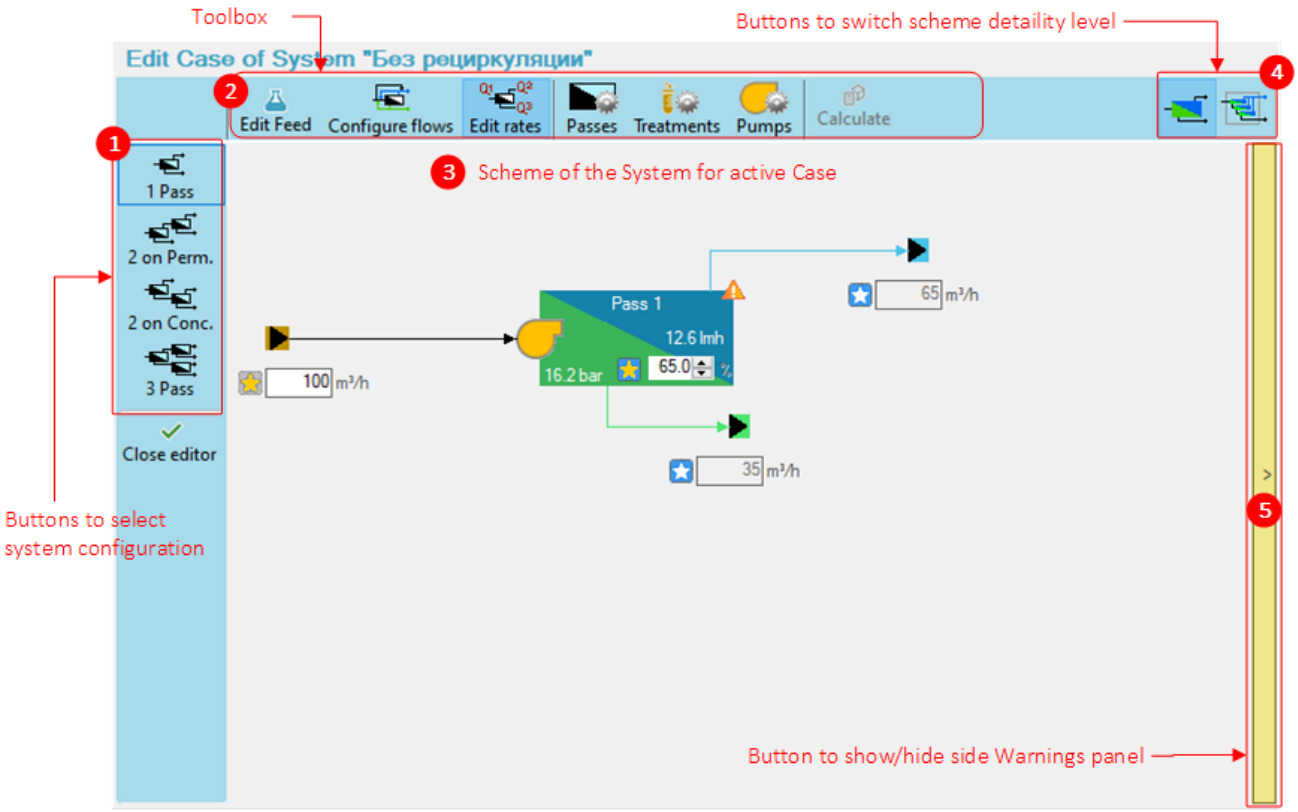
5.4.5.1 Overview of the “Edit Case” form

The form is intended to select a configuration, edit details of the design and hydraulic scheme of the active plant case.

The form “Edit case” is displayed:

- on step 3 of creating a new plant project;
- from the “Cases” form:
  - menu item **Case – Edit System**
  - **Edit System** button on the toolbar
  - diagram context menu item **Edit System**
  - **F5** key
- from the: “Feed Water Editor” form:
  - **Edit System** button on the left panel
- **F5** key

The structure and purpose of the controls of the “Edit case” form are shown in the figure:



On the left panel there are buttons for selecting one of the four typical plant configurations ❶ (see 5.4.5.3 Selecting typical configuration).

The toolbar❷ is located at the top of the form. The following buttons are located on it:

Edit Feed	when clicking the button, an attempt is made to save the changes in the plant design and go to the Feed Water Editor form;
Configure flows / Edit rates	the buttons switch the form to the Mode of configuring flow scheme and treatment nodes or to the Mode of configuring the plant hydraulic characteristics, respectively;
Passes	opens the dialog Passes and stages configuration;
Treatments	opens the dialog Water treatment;
Pumps	opens the dialog Pumps efficiency configuration;

Calculate performs an approximate calculation of the plant, considering changes in flow rates.

See section 5.4.6 *Types of calculations performed by the program*

In the central part of the form there is a plant diagram ❸. Using the buttons for switching the detaility ❹ the visibility of stages can be turned on or off on the diagram.

Depending on the selected editor mode (**Configure flows** or **Edit rates**), the diagram is used either to configure flow scheme in the installation (bypasses, recycles, strips), or to specify flow rates and recoveries on passes.

The vertical button ❺ collapses and expands the design warnings sidebar. The warnings are updated every time the plant is calculated. The calculation is performed while editing the plant.

5.4.5.2 General information on the plant design

Plant design elements

The table lists the plant design elements, which are operated by the program.

Design element	Description
Membrane element	Spiral wound filter membrane element. A flow of pressurized water enters the element inlet. Part of the flow is filtered through a membrane fabric and generates an outlet flow of treated water (permeate). The rest of the flow, containing an increased concentration of impurities (concentrate), passes through the pressure channel of the element and leaves it. The outlet pressure of the concentrate is lower than the inlet pressure due to the hydraulic resistance of the element. Main features related to element: ▪ model (determines the purpose and size of the element); ▪ recovery; ▪ permeate flux; ▪ inlet pressure; ▪ pressure drop; ▪ concentration polarization (CP) level.
Pressure vessel	The pressure vessel is a robust housing with a pressurized flow inlet. Inside the housing, filter membrane elements are installed in series, so that the concentrate output flow from the previous element enters the inlet of the next one. The permeate from all elements of the vessel is combined and generates the output flow of permeate from the vessel. Main features related to vessel: ▪ number and models of elements in the housing; ▪ pressure drop.

Design element	Description
Stage	The stage consists of a set of pressure vessels connected in parallel. All vessels are considered identical in terms of the number and models of membrane elements installed therein. The inlet water flow entering the stage is divided into parts in proportion to the number of vessels. The permeate and concentrate flows discharged from the vessels are combined into the stage concentrate and permeate outlet flows. A portion of the combined concentrate flow can be recycled back to the stage inlet (self recycle of concentrate). The stage inlet pressure is maintained by a main pump installed in the pass. An additional pump (booster) can be configured for the stage, providing pressure rise by a predetermined value. Main features related to stage: ▪ number of pressure vessels; ▪ number and models of elements in the vessel; ▪ hydraulic resistance of the fittings; ▪ booster pressure; ▪ pressure drop.
Pass	The largest structural unit of the plant. The water flow entering the pass can be pre-treated. Part of the inlet flow can be bypassed and connected to the outlet flow of the post-treated permeate of the pass. The water remaining after the bypass is fed to the pump and then passes under pressure through the pressure vessels of the stages of the pass. The pump pressure shall be such that the specified recovery on the pass is ensured. A pass can have one or more stages connected in series, so that the concentrate output from each previous stage enters the inlet of the next. The concentrate flow from the last stage generates the "internal" pass concentrate flow. Part of this flow can be removed from the plant to the outside, or returned to the pass inlet. The concentrate flow leaving the pass can be post-treated. Permeate flows from all stages of the pass are combined to generate the "internal" permeate flow of the pass. Part of the combined permeate flow can be removed from the plant to the outside, or returned to the pass inlet. The final pass permeate flow can also be post-treated. The passes, in turn, can also be connected in series over permeate or concentrate to achieve a high degree of water treatment or concentration. The program supports configurations of plant with one, two and three passes (see Acceptable configurations). Main features related to pass: ▪ recovery; ▪ pump pressure; ▪ average permeate flux; ▪ number of stages and SWFE; ▪ pump power and specific energy consumption; ▪ consumption of chemicals.

Design element	Description
Flow	Water flow inside the installation. Main features related to flow: ▪ flow type (see below); ▪ type of water (corresponds to one of the water types used in the "Feed Water Editor" form); ▪ volumetric flow rate; ▪ pressure; ▪ pH; ▪ total dissolved salts content (TDS) / specific conductivity; ▪ dissolved solutes concentrations; ▪ saturation indices. The flow type can be as follows: ▪ **Feed flow**: the flow of water entering the inlet of the plant / pass / stage / membrane element. ▪ **Permeat**: outlet water flow from the plant / pass / stage / membrane element, passed through the membrane filters; the salinity of the permeate is lower than that of the inlet flow. ▪ **Concentrate**: outlet water flow from the plant / pass / stage / membrane element, remaining after separation of the permeate; the salinity of the concentrate is higher than that of the inlet flow. ▪ **Bypass**: strip from the inlet flow to the pass, connected to the outlet permeate flow from the pass. ▪ **Permeate strip**: flow diverting a part of the outlet permeate from the pass to the outlet node. ▪ **Concentrate strip:** flow diverting part of the outlet concentrate from the pass to the outlet node. ▪ **Permeate recycle:** flow that returns a portion of the outlet permeate of a pass back to the inlet of the same pass (self recycle of permeate) or to the inlet of another pass (external recycle of permeate). ▪ **Concentrate recycle:** flow returning part of the output concentrate of a pass back to the inlet of the same pass (self recycle of concentrate) or to the inlet of another pass (external recycle of concentrate); self-recycle of concentrate can also be configured for a stage.
Water treatment node	The water treatment node specifies a number of physical-and-chemical treatment methods that are consistently applied to the input flow. As a result the required characteristics of the output flow (pH, temperature, content of some solutes) are achieved. The program allows to configure water treatment nodes for the inlet and outlet flows of the pass and, according to the specified conditions, calculate the dosage and consumption of chemicals.
Pump	The program considers the following types of pumps: ▪ main pass high pressure pump; ▪ pump for stage pressure increase (booster). The features related to pump: ▪ efficiency; ▪ pressure (for the main pump); ▪ pressure increase (for booster).

Design element	Description
Split node	A plant unit that divides the input flow into several parts. It is used to originate bypasses, recycles and branches. The unit outlet flow rates can be specified in absolute values or as a percentage of the inlet flow rate. Apart from the flow rate, all other features of the output flows are the same as those of the inlet flow of the unit.
Blend node	A plant unit where multiple input flows are mixed into one output flow. It is used to combine bypasses and recycles with the main flow. The calculation of the involvement of the input flows features in that output is carried out in proportion to their flow rates.
Inlet/outlet node	Inlet/outlet nodes are: ▪ **inlet plant unit**, for which the flow rate and properties of the raw water are known; ▪ **permeate / concentrate outlet unit of the pass** not connected to another pass; ▪ **unit, on which the strip flow** of pass permeate or concentrate ends. The features of the inlet/outlet nodes are the properties of its water.

Plant design procedure

At the initial stage of the plant design, it is recommended to adhere to the following procedure:

1) Select a typical plant configuration from the set of acceptable configurations.
2) Determine what additional flows and what water treatment units shall be available in the plant (see 5.4.5.4 Configuring flow scheme and treatment nodes).
3) Set the values of recoveries on the passes, flow rates on inlet/outlet nodes and all additional flows (see 5.4.5.5 Configuring the plant hydraulic characteristics).
4) Set the detailed configuration of stages and phases (see 5.4.5.6 Passes and stages details configuration).
5) Configure treatment methods at water treatment nodes (see 5.4.5.7 Editing water treatment settings).
6) Set the pumps efficiency for the correct calculation of energy consumption (see 5.4.5.8 Setting pumps efficiency).
7) Ensure that the calculated plant characteristics comply with the design rules.

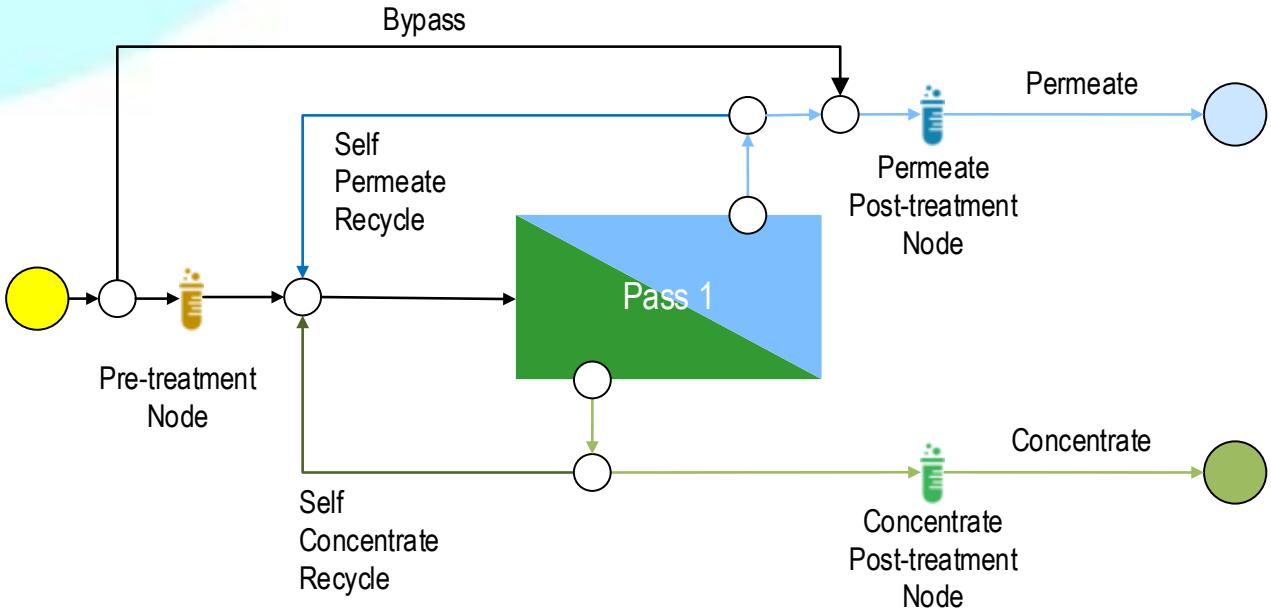
Optimize the design if necessary. The optimization process in most cases comes to repeating steps 2 – 4 (making changes to the plant design), followed by calculation and analysis of the results – until the design rules are met.

Acceptable configurations

The program supports the following typical plant configurations.

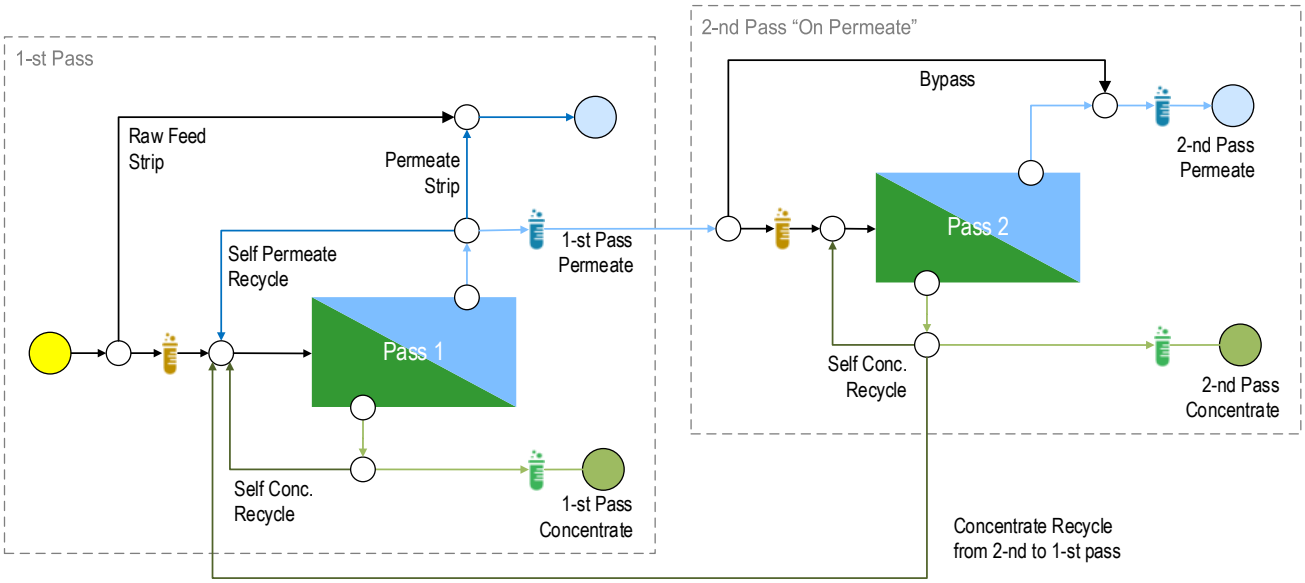
One-pass plant

Possible types of flows and water treatment nodes for a one-pass plant are shown in the figure.



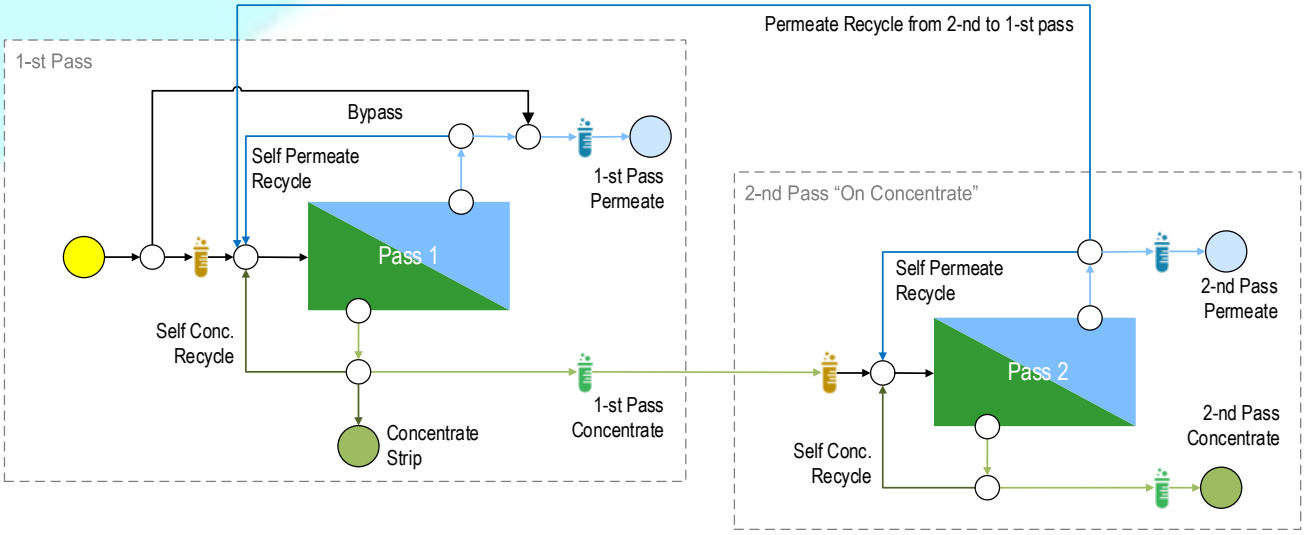
Two-pass plant for water cleaning

The plant includes two passes. The permeate from the first pass enters the inlet of the second pass. Possible types of flows and water treatment nodes for this type of plant are shown in the figure.



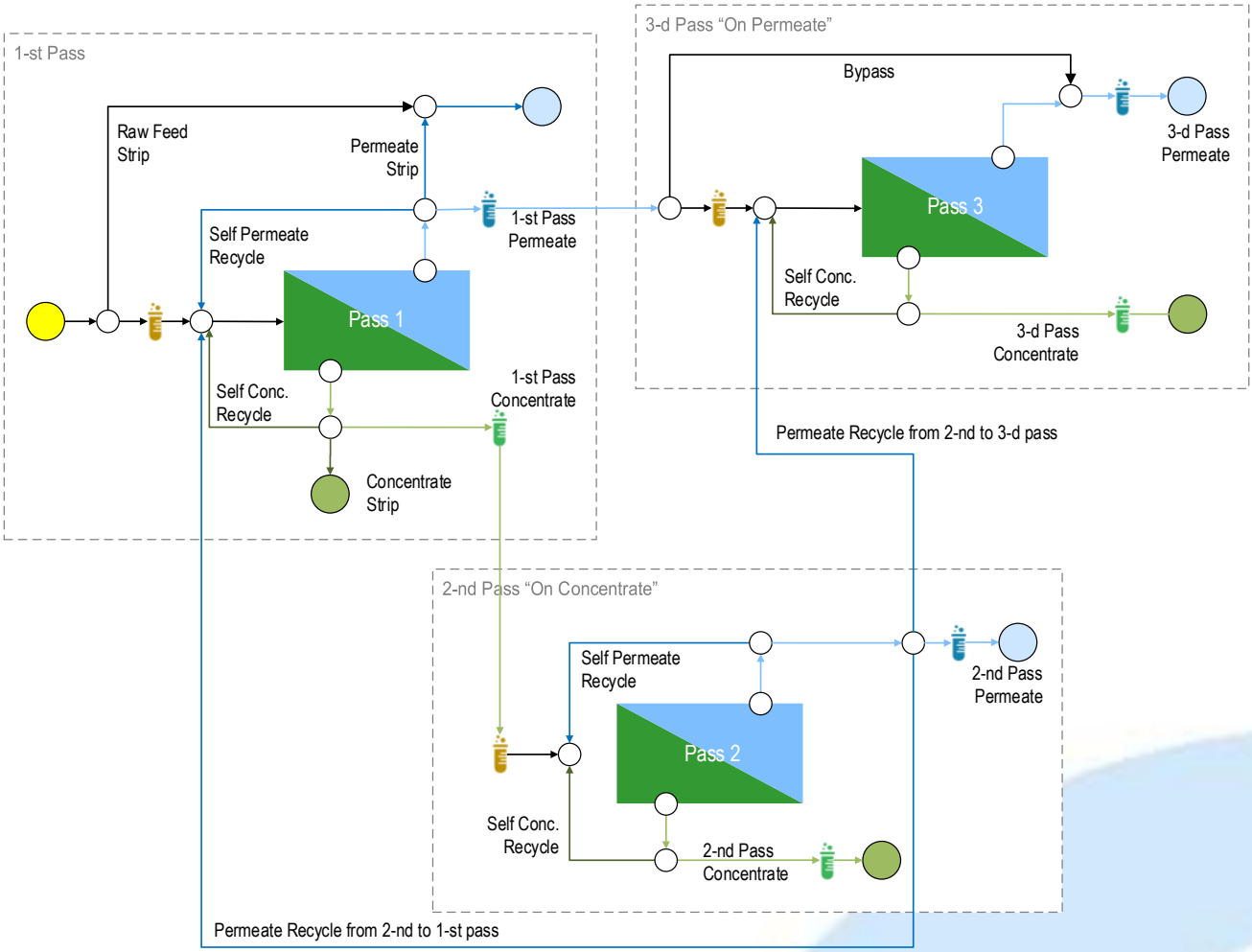
Two-pass plant for waste concentration

The plant includes two passes. The concentrate from the first pass enters the inlet of the second pass. Possible types of flows and water treatment nodes for this type of plant are shown in the figure.



Three-pass plant

This type of plant is a combination of the previous two ones. The plant consists of three passes. The concentrate from the first pass enters the inlet of pass 2, and the permeate enters the inlet of pass 3. Possible types of flows and water treatment units in a three-pass plant are shown in the figure.



Plant designing rules and principles

A well-designed plant shall follow the guidelines listed in the table below.

Item No.	Rule	Comment
1	The average permeate flux from a pass shall not be too high.	The parameters are interrelated. With an increase of recovery the flux and the CP level increase. An increase in the values of these parameters leads to accelerated wear of the membrane and to increase in the rate of deposits growth in the element pressure channel. The limiting values of the parameters depend on the type of the feed water: the higher the content of dissolved salts and suspended particles in it, the lower the allowable value of the parameter.
2	The permeate flux from the membrane element shall not be too high.	
3	The concentration polarization level in the pressure channel of the membrane element shall not be too high.	
4	The recovery of the membrane element shall not be too high.	
5	The feed rate of the membrane element shall not exceed the permissible value.	The permissible value is defined in the data sheet of the SWFE model.
6	The flow rate of the membrane element concentrate shall not be too low.	The permissible value of the parameter depends on the diameter of the element and on the type of water. If the parameter values are too small, the correct flow mode in the pressure channel is violated and the risk of salt deposition increases.
7	The differential pressure across the membrane element shall not exceed the specified value.	The requirement is due to the design of the element. High pressure drop can damage the element. The maximum allowable pressure drop is set in the data sheet of the SWFE model.
8	The pressure drop across the pressure vessel of the stage shall not exceed a given value.	In fact, the requirement is similar to the previous one, but this parameter is easier to control in practice. The permissible value depends on the number of elements in the pressure vessel; additionally, it is taken into account that the pressure drop across the elements located at the beginning of the housing is higher than on those subsequent. For the inlet water with a high level of contamination, lower limit values are used to consider the increased rate of the elements contamination leading to an increase in the pressure drop across the pressure channel.
9	The inlet pressure on the membrane element shall not be too high.	The requirement is due to the design of the element. High pressure can destroy the element. The limiting value is set in the data sheet of the SWFE model.
10	The salinity of the concentrate for poorly soluble salts (calcium, barium, strontium sulfates; calcium phosphates and fluorides; silicates, etc.) shall not be too high.	With an increase in water saturation with poorly soluble salts, the probability of their deposition in membrane elements increases. Allowable parameter values depend on the quality of the water used and the applied reagent treatment methods.

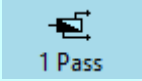
The limit values of the parameters indicated in the table are checked by the program when calculating the plant. The program alerts when the plant characteristics are out of the range.

When optimizing the performance of the plant, the following principles shall be considered:

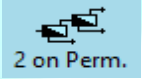
Item No.	Trouble	Reason	Required changes in a plant design
1	Too high permeate flux. Too high element recovery. Too high concentration polarization	The recovery on the pass is too high for the current salt content of the inlet water.	Decrease in the target recovery of the pass.
		Insufficient membrane area.	Adding membrane elements (increasing the number of elements in the vessel of the stages / increasing the number of stages).
2	Feed flow rate of element is too high	There are not enough vessels at the stage.	Reducing the feed flow rate for a vessel by increasing the number of vessels on a stage.
3	Too low yield of concentrate from elements	Usually observed for elements located in the “tail” of the vessel or at the last stages of the pass, with low values of the feed rate at these elements.	Reducing the number of elements in the vessel. Reducing the number of stages (redistribution of elements from the last stage to the previous ones).
4	Too high pressure drop across the vessel or the element	High feed rate (flow speed).	Reducing the feed rate to the vessel by increasing the number of vessels on a stage.
5	Permissible element inlet pressure exceeded	An unsuitable SWFE model for the given type of water and salinity was selected.	Selection of the appropriate type of SWFE.
		The permissible permeate flux has been exceeded.	See item 1
6	The permissible limits of salt saturation of the concentrate are exceeded	High degree of concentration.	Reducing the degree of concentration by reducing the target pass recovery.
		Water chemistry + plant operating conditions.	Preliminary chemical treatment of water to eliminate the scale formation.

5.4.5.3 Selecting typical configuration

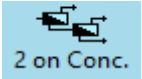
To change the configuration of the plant, use the group of buttons ❶ on the "Edit Case" form:



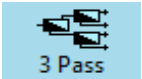
One-pass configuration;



Two-pass configuration for water cleaning;



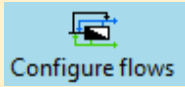
Two-pass configuration for waste concentration;



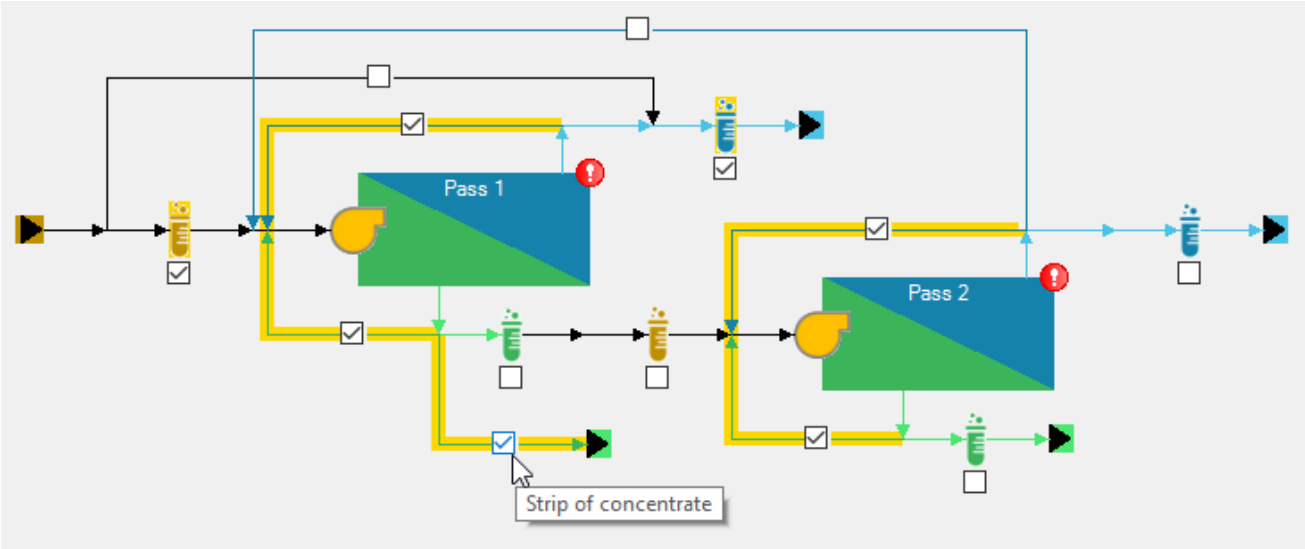
Three-pass configuration.

5.4.5.4 Configuring flow scheme and treatment nodes

Click button **Configure flows**
on the toolbar ❷ of the "Edit Case" form,
to switch to the mode of configuring flow scheme and treatment nodes.



In the mode of configuring flow scheme and treatment nodes, the plant diagram shows all allowed types of flows and treatment nodes for the selected typical plant configuration. To add a flow or treatment node to the plant, check the box located on the flow line or below the node; to remove a flow or a node from the plant – uncheck the box:



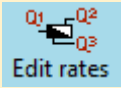
The flows and nodes marked on the diagram are highlighted with a yellow background.

When you hover the cursor over the checkbox, a pop-up tip appears with the name of the flow or treatment node.

After finishing editing the configuration, it is necessary to set the flow rates of all newly added flows by switching to the "Edit rates" mode.

5.4.5.5 Configuring the plant hydraulic characteristics

Click the button **Edit rates** on the toolbar ❷ of the "Edit Case" form to switch to flow rates editing mode.



Flow rates and pass recoveries (hereinafter referred to as hydraulic characteristics) are specified in the input fields directly on the plant diagram. When the value of one of the hydraulic characteristics changes, the rest are recalculated automatically. Press **Tab** or **Enter** to finish entering values in a numeric field and move to the next field.

If you locate cursor to the flow line, a pop-up window will show the flow rate (and if the plant has been calculated, the pressure and salinity estimates are also displayed).

Specifying the inlet / outlet flows rate and pass recoveries

The input fields for inlet / outlet flows rate and pass recoveries are equipped with pin buttons.

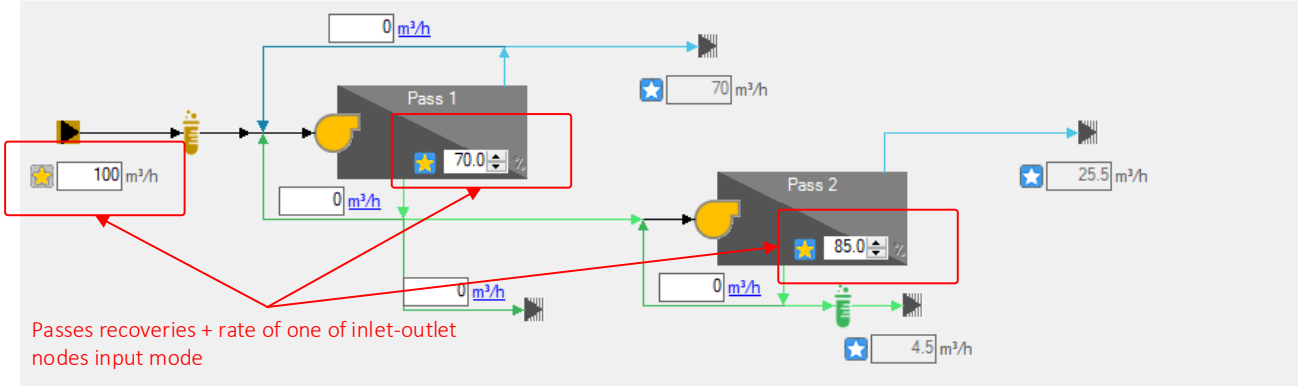
An asterisk is located in the center of the pin, its golden color indicates that the adjacent field is editable (active):

If the background of the pin is blue, you can select it with a click. A pin with a gray background is not selectable. Selecting pins toggles the availability for entering the associated data fields.

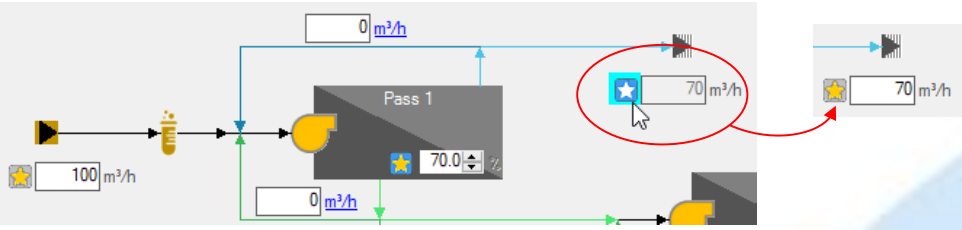
The input of inlet / outlet flows rate and pass recoveries can be entered in one of two modes:

1) <u>Entering the recoveries on all passes and one of the inlet / outlet flow rate</u>

The mode is switched on by activating any of the pass pins.



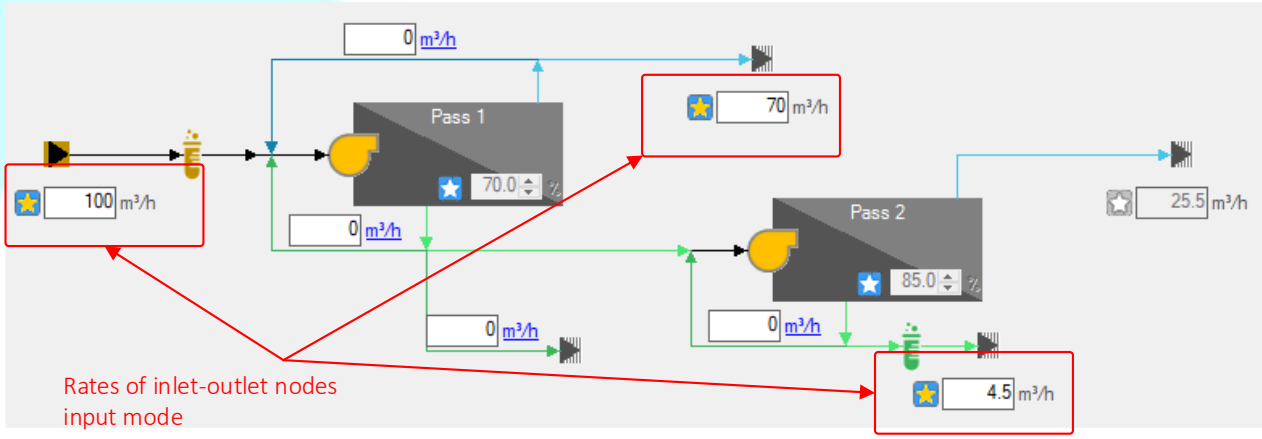
By default, input flow rate is checked for input. To select a different node for input, click its pin:



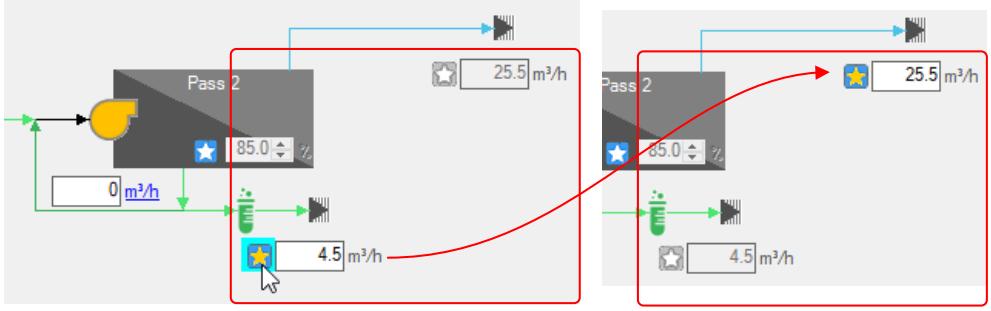
When any of the recoveries or flow rates value changes, the values of all other inlet / outlet flow rates are recalculated automatically.

2) Entering inlet / outlet flow rates (except the one selected)

The mode is turned on by deactivating any of the pass pins.



It is necessary to set the flow rates of all inlet / outlet nodes except for one which pin is inactive. To make another node inactive, click its pin:

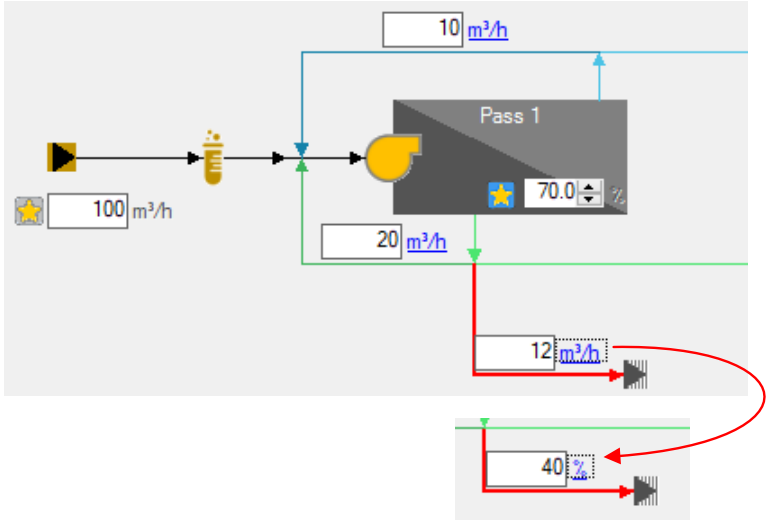


Changing any of the flow rates available for input will result in recalculation of the pass recoveries and the flow rate of the node excluded from the input.

Specifying the flow rates of recycles, bypasses and strips

Bypass, recycle and strip flow rates shall be entered in the fields adjacent to the corresponding flow line in the diagram. When the cursor is placed in the input field, the corresponding flow is highlighted in the diagram.

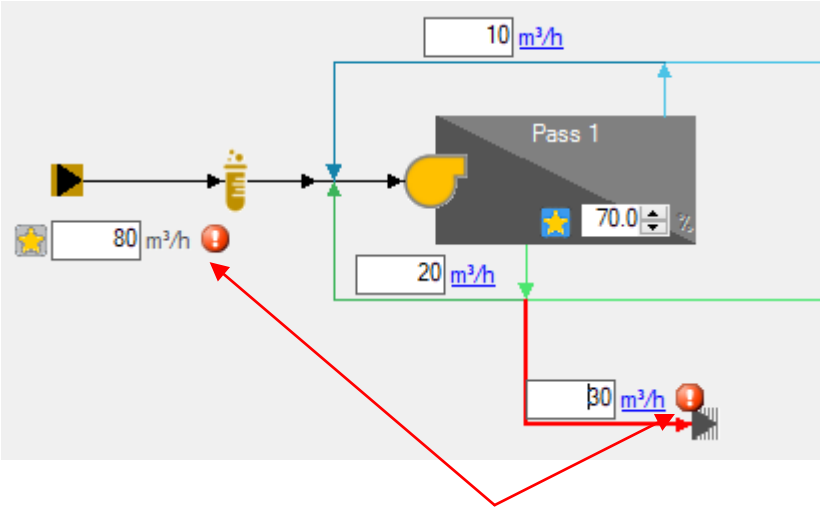
The flow rate can be set in absolute units or as a percentage of the flow rate entering the split node (for strips and external recycles – the flow rate of the incoming flow is calculated excluding the internal recycle). To switch the units, click on their name:



Possible errors when editing the plant hydraulic scheme

If the plant has bypasses, recycles or strips, not all combinations of inlet - outlet flow rates and pass recoveries that can be entered are acceptable. For example, an attempt to set the absolute value of the strip flow rate to be greater than the input flow rate to the split node will result in an error. An error will also occur if the input flow rate to the plant is reduced to such a value that it cannot provide the flow rate of the strip flow, which was corrected for the previous value of the plant input flow rate.

If, after entering the value of one of the plant hydraulic characteristics, an error occurs when calculating the flow rates, an error icon is displayed next to the input field:



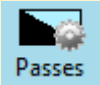
Errors indicators

Change the value in this or other fields to eliminate the error.

If there are errors in the diagram, the toolbar of the “Case Edit” form will be unavailable. If you exit the case editor with errors presence, the flow rate changes that caused the errors will be discarded.

5.4.5.6 Passes and stages details configuration

To open the dialog for passes and stages details configuration, proceed with one of the following actions:

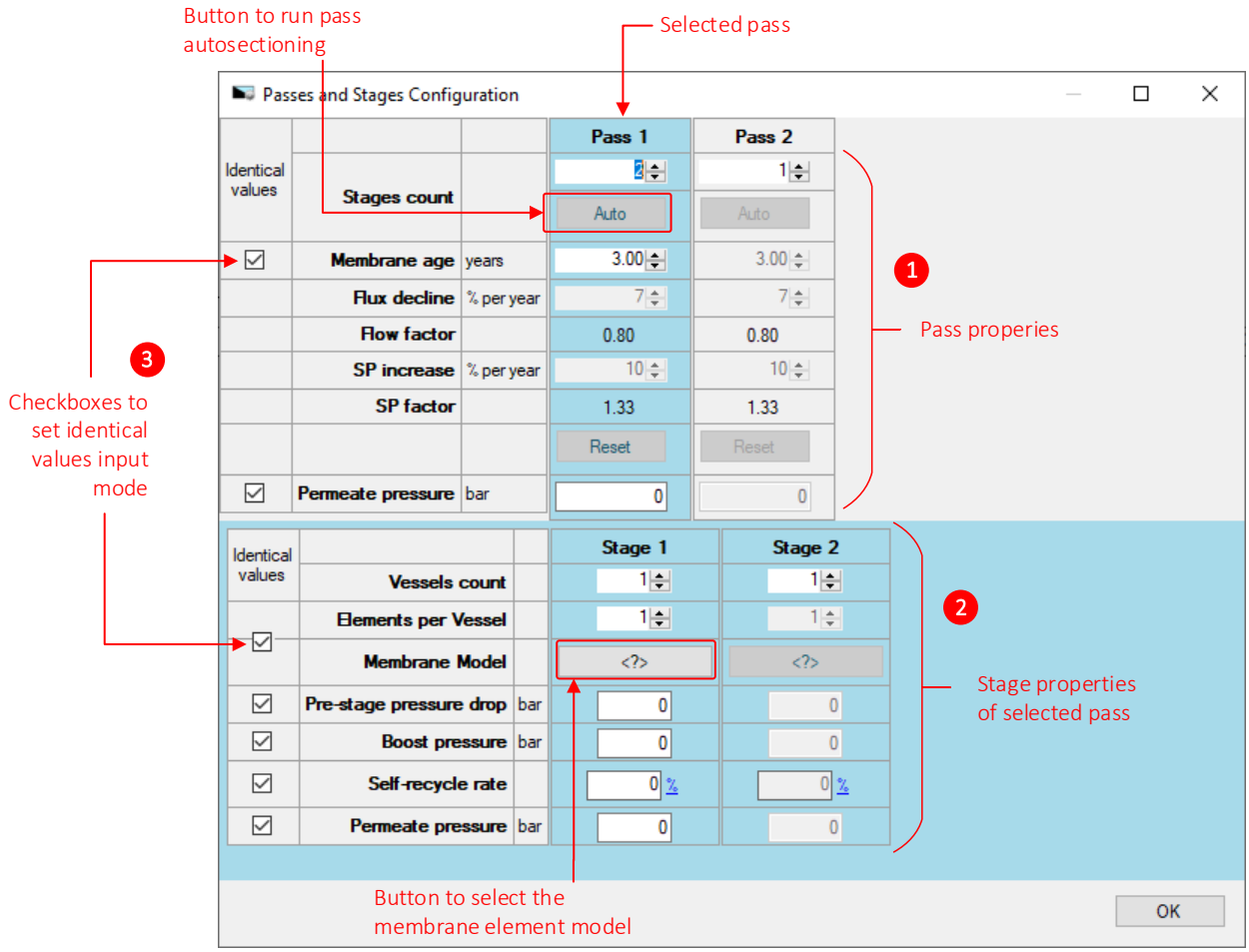
1. Click the **Passes** button on the toolbar: 

2. Select diagram context menu item **Edit passes & stages configuration**;
3. Double-click the left mouse button on the image of a pass or stage in the diagram.

When using method 1 or 2, if a pass or its stage was previously selected on the diagram, the corresponding pass will be selected in the dialog as well.

If you use method 3, the double-clicked pass will be selected in the dialog.

The structure of the dialog for passes and stages details configuration is shown in the figure:



The upper half of the dialog window is occupied by the characteristics of the passes ❶. The data column of the selected (edited) pass is highlighted. The lower half is occupied by the characteristics of the stages of the selected pass ❷.

The "Identical values" checkboxes are to the left of the characteristics names ❸. The checkbox is automatically set if the values of the corresponding characteristic match in all columns. If you set the checkbox manually, the value from the first column will be copied to all the others, and in future its changes will be synchronously applied to all columns. If you uncheck the box, you will be able to enter different values.

The characteristics of the passes and stages are displayed in the plant diagram: see Plant diagram.

Pass configuration

For a pass, you can specify the number of stages, the age of the membranes (it is assumed to be the same for all membrane elements) and permeate back pressure.

The number of stages is selected in the field of the same name. The number of stages cannot be zero.

Use the **Auto** button to start the automatic pass sectioning procedure.

Setting the age of membrane elements

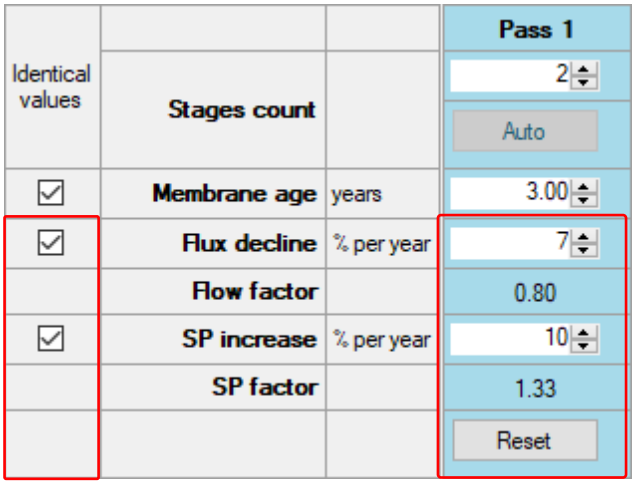
The productivity and selectivity of the new membrane elements are close to the data sheet values. Their productivity and selectivity decrease over time. Deterioration can occur due to the gradual growth of deposits in the elements (not completely eliminated by periodic chemical treatment) and degradation of the membrane fabric. Depending on the type of the inlet water and the mode of operation of the plant, the degradation of performance over the time can be more or less significant.

A decrease in the performance of the elements leads to an increase in the pressure required to ensure the required performance of the plant. A decrease in their selectivity leads to a deterioration in the quality (increase in salinity) of the permeate.

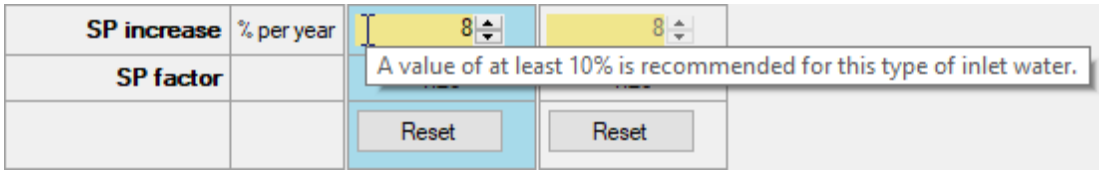
At the pass level, you can set the conditional age of the membrane elements. Depending on the value of the established flux decline and salt passage increase (% per year), the program finds the coefficients of the flux decline and salt passage increase and applies them to the calculation of the plant.

The value of the set flux decline and salt passage increase for elements can be selected automatically or set manually, depending on the parameter **Automatically set membranes age parameters to default values** (see 5.4.1.1 Plant project description and settings). Automatic mode is selected by default for new projects.

In manual mode, you can change the age parameters in the dialog form:



If the specified value of the parameter is lower than that recommended, the input field will be highlighted in yellow. If you hover over a field, a pop-up window will show the recommended value:



The **Reset** button allows to return the membrane age parameters to the recommended values.

Permeate back pressure

The permeate back pressure can be set per pass or per stage. When calculating the plant, the maximum of the set values is used.

Stage configuration

For each stage set the number of SWFE in the pressure vessel, select the SWFE model, and set the total number of pressure vessels. The number of pressure vessels and elements in the housing cannot be zero. The automatic sectioning procedure calculates the required number of vessels and stages for the selected pass.

Optionally for a stage, you can also define:

- the value of pressure loss at the inlet (due to resistance of the fittings);
- the value of pressure increase by an additional pump (booster);
- flow rate of concentrate self-recycle of the stage;
- permeate back pressure at the stage exit.

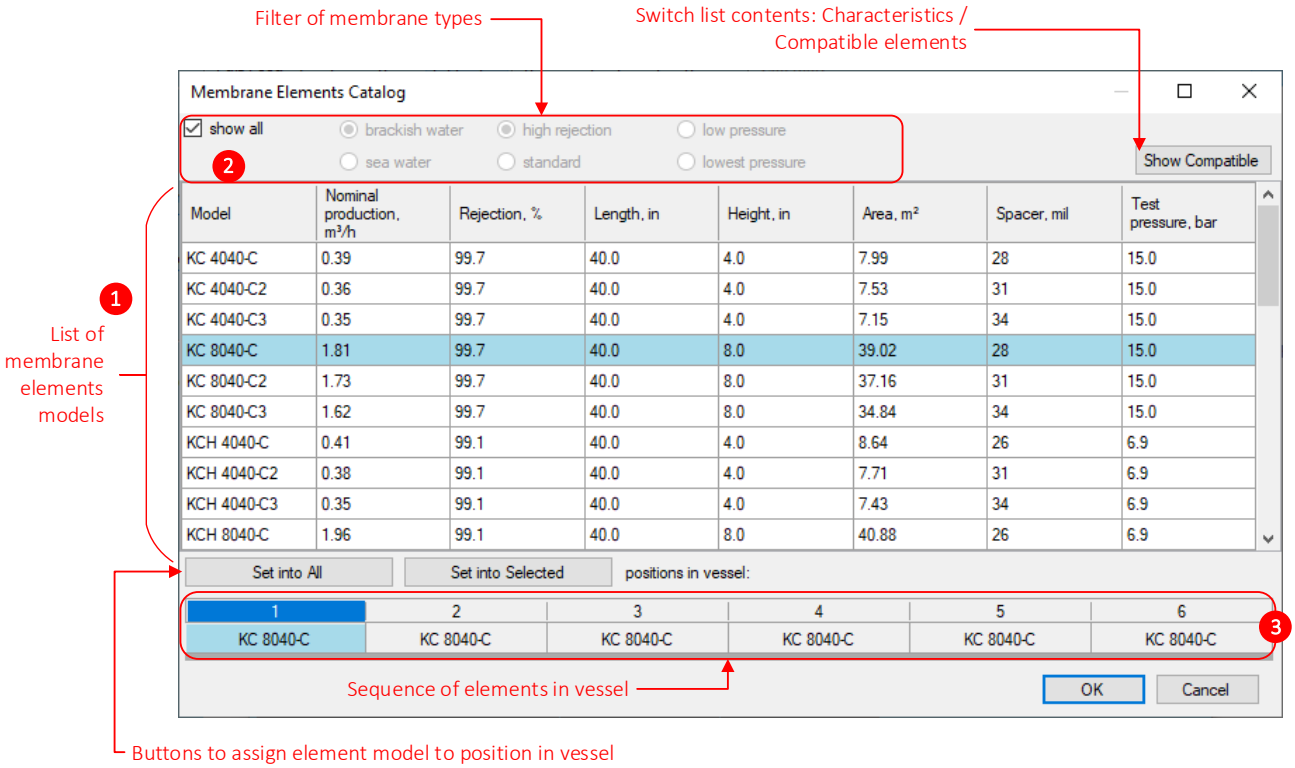
Selecting an SWFE model

To select an SWFE model, use the **Membrane Model** button of the corresponding stage.

The caption of the button displays:

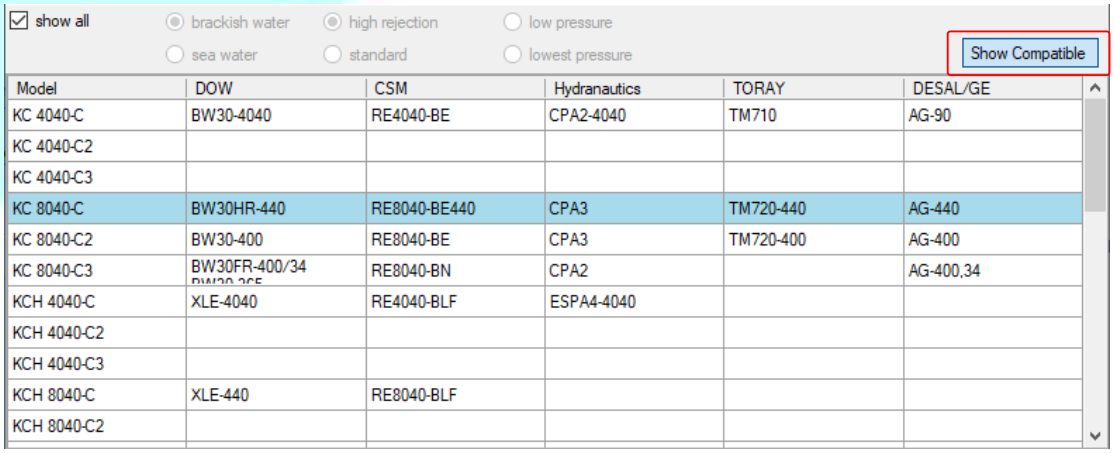
- **<?>** – if the SWFE model has not been selected yet;
- **model name** – if the SWFE model is selected and is the same for all elements in the vessel;
- **{MIXED}** – if elements of different models are mixed in the phase housing.

Clicking on the button will open the “Membrane Elements Catalog”" dialog box:



In the central part of the dialog there is a list of available SWFE models manufactured by Nanotech ❶. By default, the list columns show the data sheet characteristics of the elements.

Using the **Show Compatible** button, the list switches to the mode of displaying elements of other manufacturers that are similar in purpose and characteristics:



Model	DOW	CSM	Hydranautics	TORAY	DESAL/GE
KC 4040-C	BW30-4040	RE4040-BE	CPA2-4040	TM710	AG-90
KC 4040-C2					
KC 4040-C3					
KC 8040-C	BW30HR-440	RE8040-BE440	CPA3	TM720-440	AG-440
KC 8040-C2	BW30-400	RE8040-BE	CPA3	TM720-400	AG-400
KC 8040-C3	BW30FR-400/34	RE8040-BN	CPA2		AG-400,34
KCH 4040-C	XLE-4040	RE4040-BLF	ESPA4-4040		
KCH 4040-C2					
KCH 4040-C3					
KCH 8040-C	XLE-440	RE8040-BLF			
KCH 8040-C2					

Above the list of element models there is a **show all** checkbox and a set of membrane types filter buttons. If the **show all** checkbox is selected, a complete list of the SWFE models is displayed. Uncheck the box and select the water type radio button (**brackish water** or **sea water**) and the membrane type radio button (**high rejection,** or **standard**, or **low pressure**, or**lowest pressure**) – the available models of the selected type remain in the list.

Below the list of models there is a ruler ❸ showing the sequence of element models in the stage vessel and having buttons for assigning the element selected in the list to positions in the vessel.

To assign the same SWFE model to all positions in the vessel:

1) select an SWFE model from the list ❶;
2) **double-click** the selected row in the list, or click the **Set into all** button.

To change the SWFE model for individual positions in the vessel:

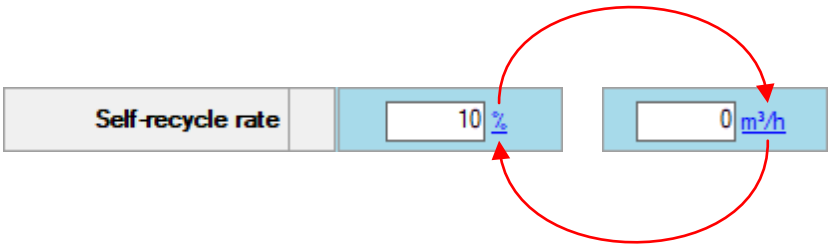
1) select the required SWFE model in the list ❶;
2) mark the required positions in the vessel (to select several positions, left-click on them while holding down the **Ctrl** or **Shift** key);
3) click the **Set into Selected** button*.

* The **Set into Selected** button will be unavailable if the selected SWFE model differs in diameter from other elements in the vessel.

To save the choice made, close the dialog clicking the **OK** button.

Self-recycle of concentrate

The self-recycle of the concentrate at the stage can be specified as a percentage of the output flow rate of the concentrate of the stage or in absolute values. To switch the units, click on their name:



Automatic pass sectioning

The pass sectioning procedure calculates the optimal sequence of pass stages with vessels count based on the following conditions:

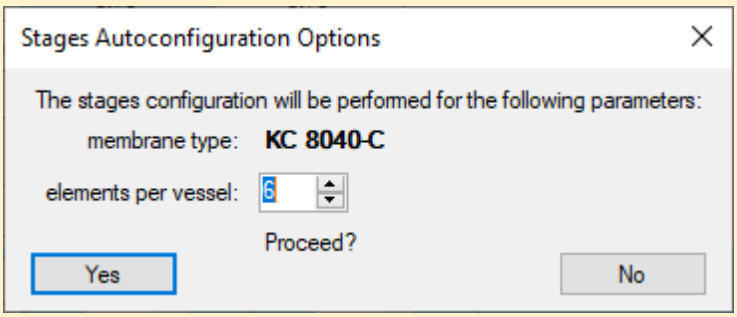
- all stages use one predetermined SWFE model;
- the elements count in the vessels is defined and is the same for all stages.

The initial data for the calculation are the feed flow rate per pass and the pass recovery. The restrictions are: maximum allowable feed flow rate per element and maximum allowable (for a given type of water) average permeate flux per a pass.

For automatic sectioning of a pass:

1) make sure the SWFE model is selected for the first stage of the pass; it will be used as the target model when performing sectioning;
2) click the **Auto** button for the pass;

in the dialog box that opens, check the parameters and set the required number of elements per vessel:



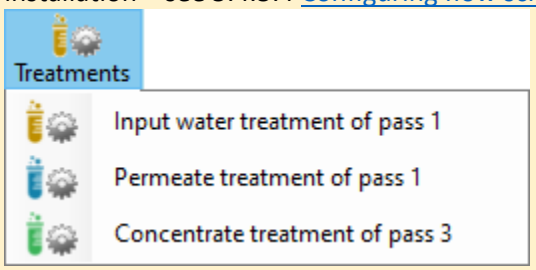
3) click **Yes** to execute the sectioning procedure.

As a result of sectioning, the number and characteristics of the stages of the pass will be updated.

5.4.5.7 Editing water treatment settings

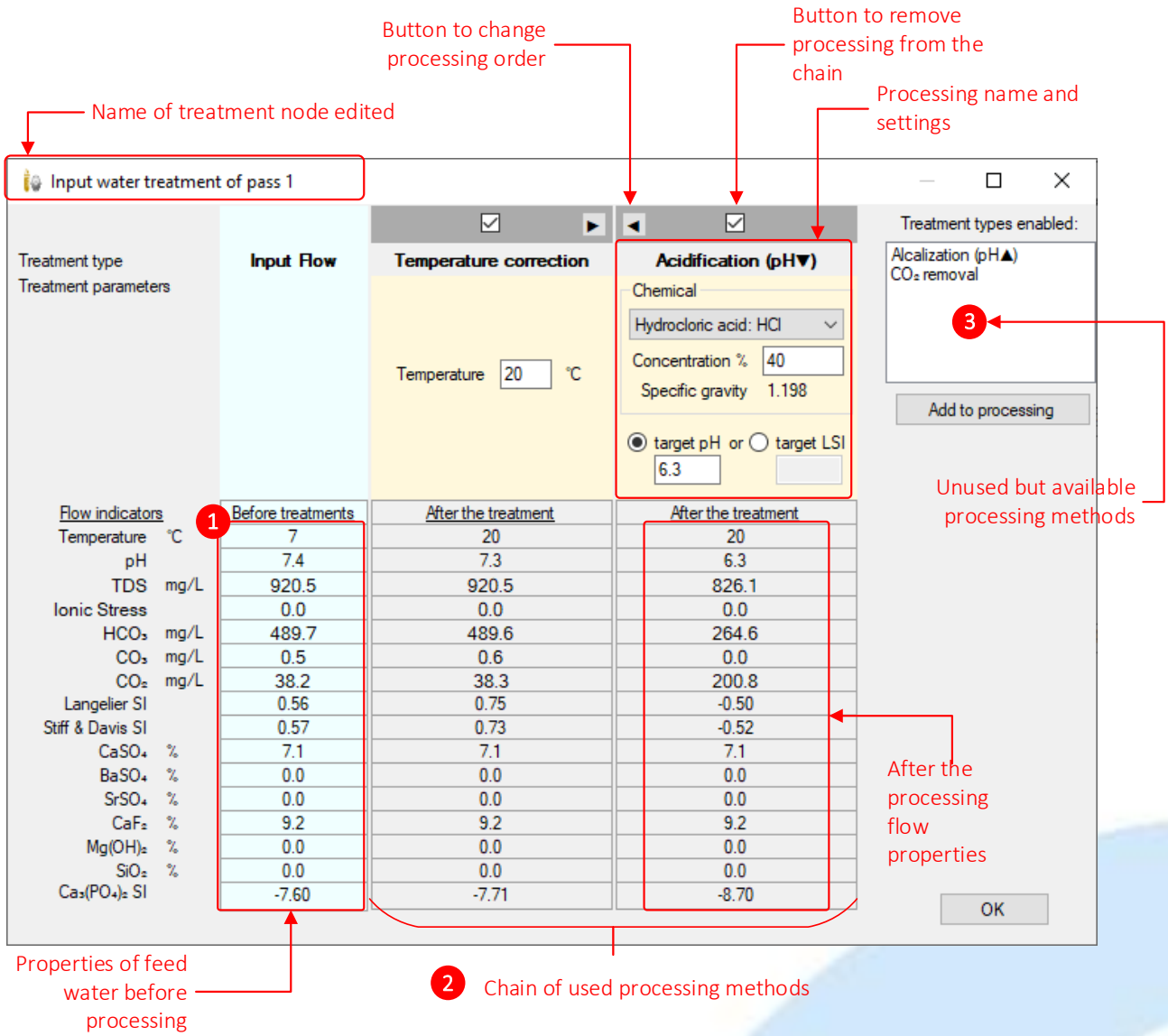
To open the dialog for setting the properties of the water treatment node, proceed as follows:

1. Click **Treatments** button on the toolbar and then select the required water treatment node from the drop-down list (the list contains all nodes that have been added to the installation – see 5.4.5.4 Configuring flow scheme and treatment nodes):



2. Select the **Edit treatment configuration** item from the context menu of the diagram and then select the required water treatment node from the drop-down list.
3. Double-click the left mouse button on the image of the required water treatment node in the diagram.

The water treatment settings dialog looks as follows:



For a water treatment node, a sequential water treatment chain can be configured using several of the available treatment methods.

The first column of the dialog shows the properties of the feed water prior to treatment ❶.

Each water treatment method used is described in a separate column. The methods are applied in the specified order ❷.

The methods available for adding to the processing chain are there in the list ❸.

- To add a processing method to the chain, select it from the list ❸ and click the **Add to processing** button below. Several methods can be selected simultaneously.
- To change the order of treatments, use the arrow buttons located in the header of the treatment method columns: ◄ ►
- To exclude an unnecessary treatment method from the chain, click the checkbox in the column heading: ☑; the method will be moved to the list ❸.

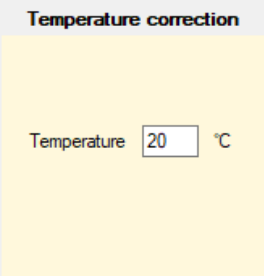
The following treatment methods are available for the **pre-treatment node** of the pass:

- temperature correction;
- acidification (lowering the pH to a given level);
- alkalization (increasing the pH to a given level);
- CO_2 removal.

The following treatment methods are available for the **post-treatment node for concentrate or permeate:**

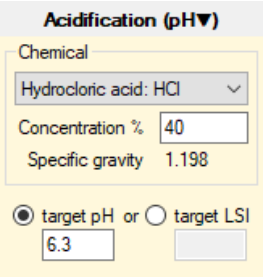
- temperature correction;
- pH correction (bringing the pH to a given value by dosing acid or base);
- CO_2 removal.

Temperature correction



The effect is to bring the temperature of the output flow to the specified value.

Acidification

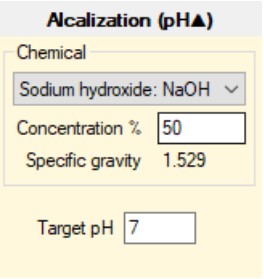


As a result of applying this method, the pH of the flow decreases until the target value of the selected parameter is reached.

The pH itself or the Langelier index (LSI) can be selected as the target parameter.

In the settings, you can select the chemical used and specify its concentration.

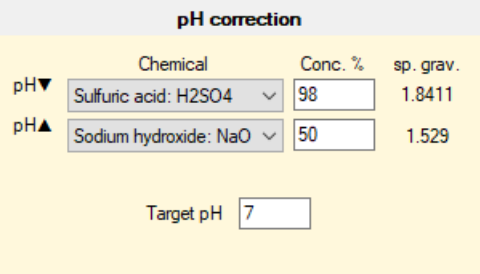
Alkalization



As a result of this method, the pH of the flow increases to a specified target value.

In the settings, you can select the chemical used and specify its concentration.

pH correction

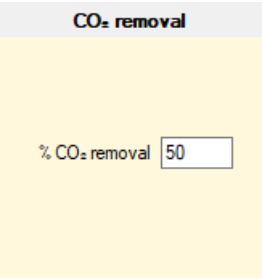


This method is designed to bring the pH of the output flow to a specified value.

If the pH of the input flow is higher than the set one, acid will be dosed, if the pH of the input flow is lower, the base will be dosed.

In the settings, you can select the chemicals used and specify their concentration.

CO_2 removal



This method describes the removal of dissolved carbon dioxide from the input flow. The concentration of carbon dioxide in the output flow will be less by a given value.

5.4.5.8 Setting pump efficiency

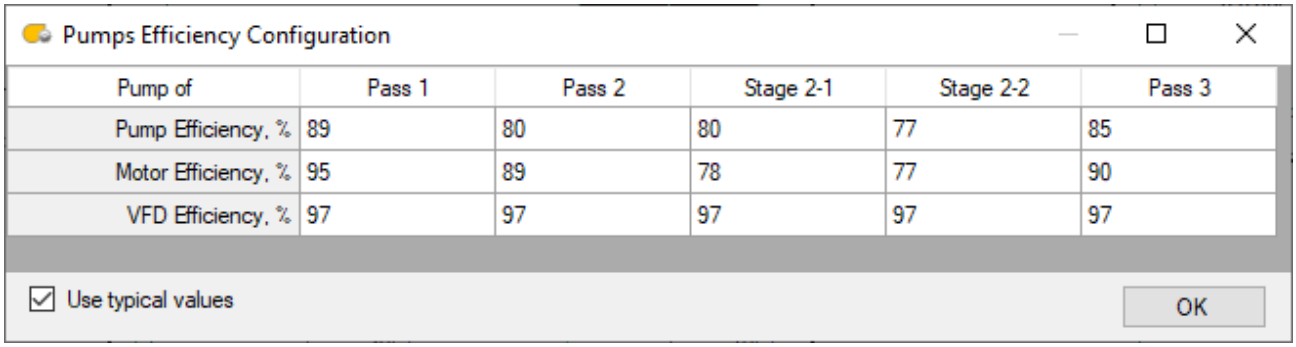
The efficiency of the pumps is used when calculating the energy consumption of the plant.

To open the pumps efficiency configuration dialog, proceed as follows:

1. Click **Pumps** button on the toolbar:

2. Select item **Edit pumps efficiency** of the diagram context menu;
3. Double-click the left mouse button on the pass pump in the diagram.

The pumps efficiency configuration dialog looks as follows:



Pump of	Pass 1	Pass 2	Stage 2-1	Stage 2-2	Pass 3
Pump Efficiency, %	89	80	80	77	85
Motor Efficiency, %	95	89	78	77	90
VFD Efficiency, %	97	97	97	97	97

The columns list all the pumps in the installation, including the high pressure pass pumps as well as the auxiliary stage pumps for which the pressure boost is configured (stage number has two parts: <pass number> – <stage number in a pass>).

The final efficiency of each unit is determined as the product:

- **Pump efficiency** – defines the efficiency of energy consumption for pumping liquid (this efficiency takes into account leaks through seals and clearances, head losses during the movement of the pumped medium inside the pump and friction losses between moving parts of the pump, such as bearings and glands);
- **Motor efficiency** – defines the efficiency of energy transfer from the engine to the pump;
- **Regulator efficiency** – for frequency regulated systems, defines the efficiency of the engine speed control system.

If the **Use typical values** check box is selected, the efficiency values will be automatically selected for all pumps. When the checkbox is unchecked, the efficiency values can be set manually.

5.4.6 Plant case calculation

Types of calculations performed by the program

For any plant case, an **approximate** or **accurate** calculation can be performed. An approximate calculation takes less time, but gives a much rougher estimate of the salt content in the outlet flows of the plant.

After completing the calculations of any type the design warnings list is updated. The time and status of the calculation are displayed in the status line of the program.

An example of a message in the status line on the successful completion of the calculation:

(elapsed 1528 µsec) System was calculated successfully.

An example of a calculation error message:

(elapsed 160 µsec) Calculation impossible. Check the System configuration.

Approximate calculation

An approximate calculation is carried out in the process of editing the plant configuration and allows to quickly estimate the effect of design changes on pressures, permeate fluxes and total salinity in the output flows.

In cases listed below, the approximate calculation of the plant is performed automatically:

- after closing the "Passes and Stages Configuration" dialog box;
- after closing the "Water treatment" dialog box;
- before moving from the "Case editor" to the "Feed water editor" form.

For other actions in the "Case editor" form (changing the configuration of flows, editing flow rates), you can run an approximate calculation using the **Calculate** button located on the toolbar.

Accurate calculation

The accurate calculation of the active plant option is performed automatically when exiting the "Edit Case" or "Feed water editor" form by clicking **Close editor** button, with subsequent transition to the "Cases" form.

If the project cases use a common water source and it has been changed, after exiting the "Feed water editor" form, all cases will be automatically calculated.

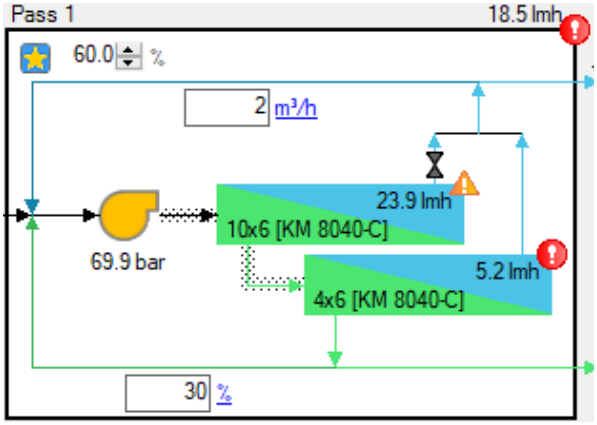
Viewing and analyzing warnings generated by the calculation

After each calculation, the program checks the characteristics of the plant for compliance with the designing rules. If there are violations, the information about it is displayed:

- in the plant diagram;
- on the **Elements** dashboard;
- on the design warnings sidebar.

Design warnings indication on the plant diagram

Alert icons are displayed in the upper-right corner of the pass and stage:



The icon alerts that some plant characteristics are out of the permissible range.

The icon alerts on the presence of characteristics running out the recommended range.

The indicator at the pass level is displayed if there are problematic characteristics of the pass and/or at least one of its stages (the maximum warning level is displayed).

The indicator at the stage level is displayed if there are problematic characteristics of the stage and/or at least one of its membrane elements (the maximum alert level is displayed).

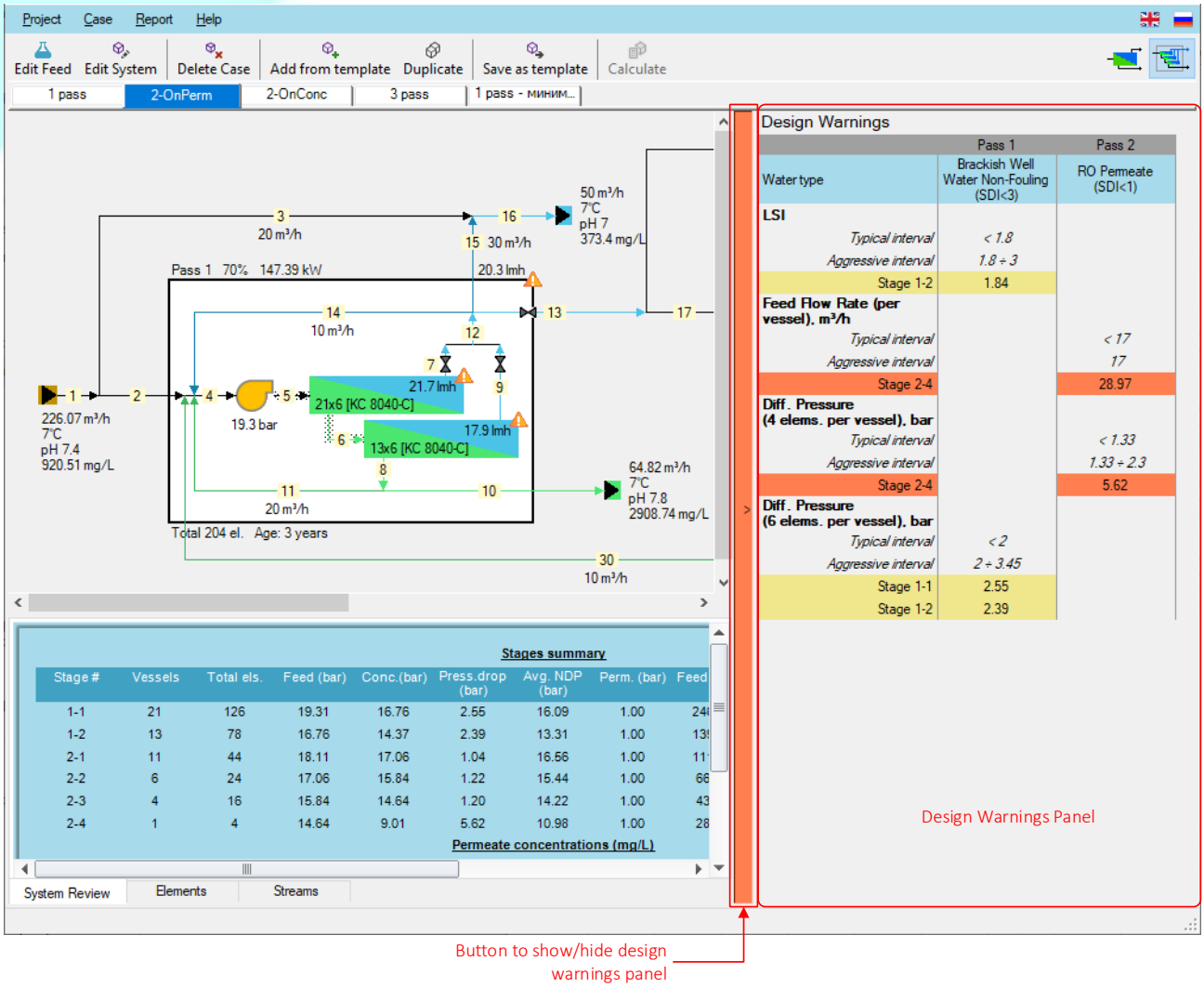
Design warnings indication on “Elements” dashboard

If there are alerts, an indication is displayed on the **Satges**, **Phases** and **Elements** dashboards : the background color marks the values of the characteristics that are outside the permissible or recommended ranges. If you hover over a value, a pop-up window will show the corresponding range:

Elements	1-1-1	1-1-2	1-1-3	1-1-4	1-1-5	1-1-6
Model						
Model Name	KC 8040-C	KC 8040-C	KC 8040-C	KC 8040-C	KC 8040-C	KC 8040-C
Active Area m²	39.02	39.02	39.02	39.02	39.02	39.02
Production						
Recovery %	12.07	13.46	15.20	17.43	20.31	24.02
Rejection %	98.84	98.72	98.55	Typical value: 15 %		97.27
Flux lmh	7.99	7.83	7.66	7.45	7.16	6.75

Design warnings sidebar

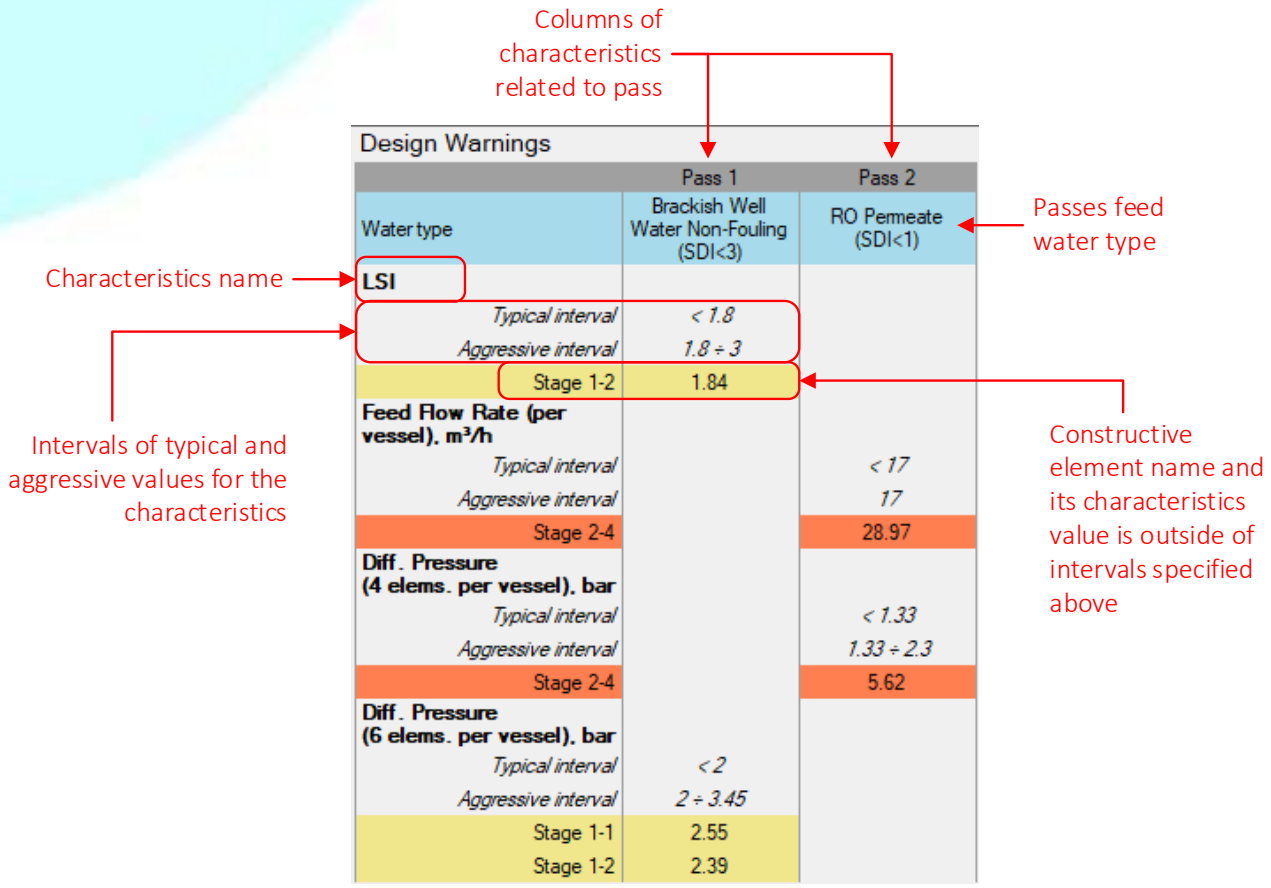
The summary information on the calculated characteristics of the plant that overrun the recommended and permissible limits is displayed on the design warnings sidebar located in the right part of the program window:



Immediatelly after calculation is finished, if warnings are there, the vertical button of the sidebar is highlighted with color, corresponded to the top warnings level for the plant characteristics that overrun the permissible or recommended ranges.

To don't show the warnings on the characteristics that overrun the recommended range but are still permissible, switch on the option **Display only critical warnings** in User settings.

The figure below shows how the information displayed on the warnings sidebar is arranged:



To show/hide the design warnings sidebar use the vertical button to the left of the panel.

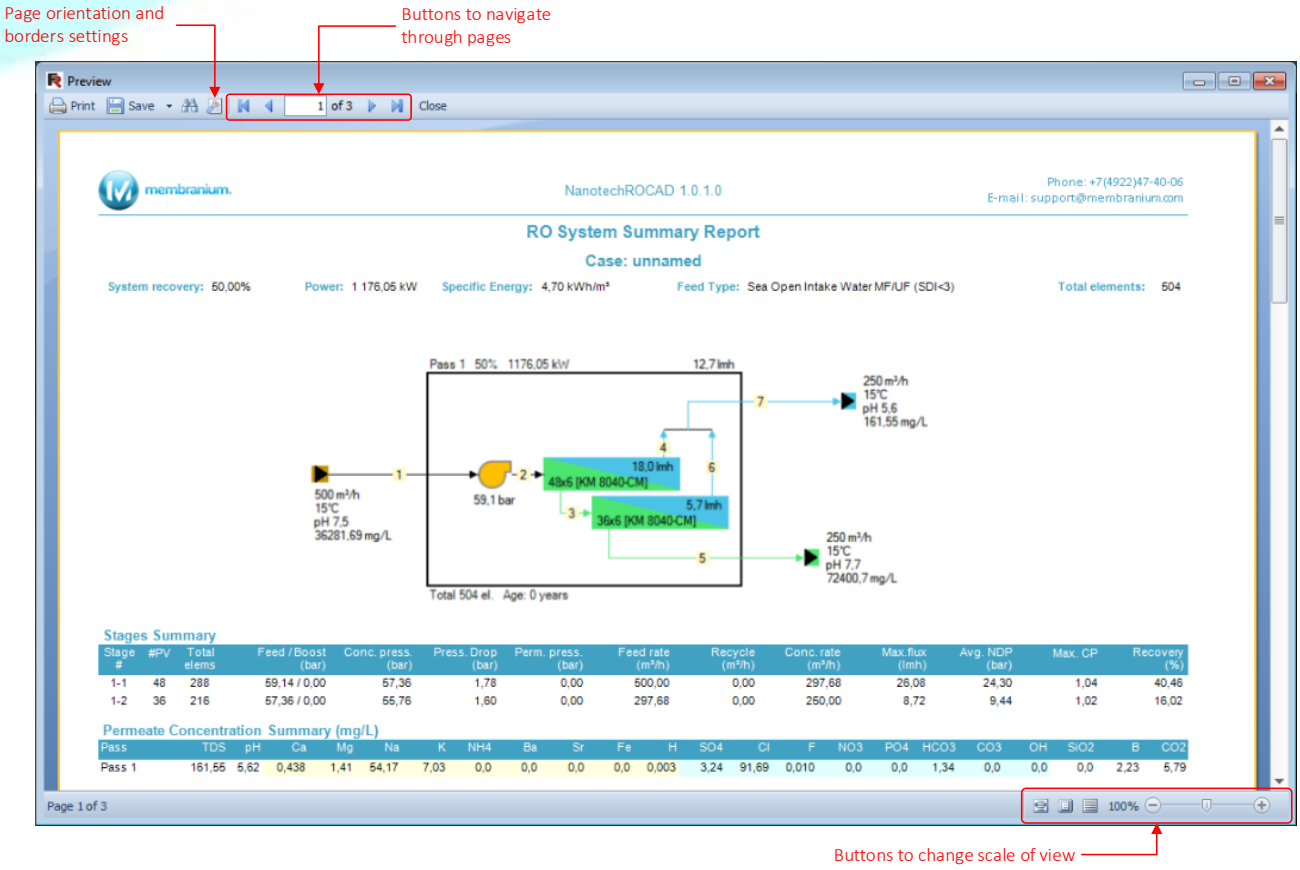
The design warnings sidebar will be expanded automatically on the finishing calculation, if the option **Automatically show Design Warnings panel** is enabled in the User settings.

5.4.7 Report generation on a plant case

To create a report, use menu item **Report – Active Case** or press **Ctrl+1**.

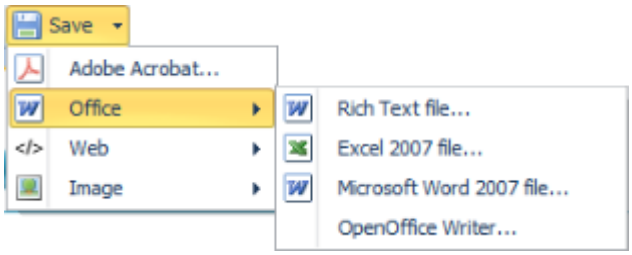
If the case has not been calculated, the menu item will not be available.

The generated report opens in the preview window:



To print the report use **Print** button.

The **Save** button allows to save the report file in one of the selected formats:



6 Additional information

6.1 Program details

6.1.1.1 Command line format

NanotechROCAD.exe [path to a project file]

When starting the program from the command line, the path to the project file can be passed as a parameter. Example:

NanotechROCAD.exe C:\Data\test.roprj

If the specified file exists, it will be loaded and immediately after starting the program will show the "Cases" form.

When launched without parameters, after starting the program, the "Projects Manager" form is displayed.

6.1.1.2 The directory structure of the program on the hard disk

The executable files and program settings are located in the directory specified during the installation (hereinafter **ROCAD_ProgPath**).

The default directory is **<UserProfilePath>\AppData\Roaming\NanotechROCAD**.

The **ROCAD_ProgPath** directory includes:

- the program settings file **app.settings** and the database of properties of membrane elements **Db\stor.sqlite** (changing these settings will most likely lead to incorrect operation of the program);
- localized resources (including the online help file) in the **en**, **ru** folders, etc.;
- pre-installed project templates in the **Templates** folder;
- main executable module **NanotechROCAD.exe**

User data and settings are located in the **<UserProfilePath>\Documents\NanotechROCAD** directory:

- user settings file **user.settings**;
- custom project templates in the **Templates** folder;
- runtime log of the program **NanotechROCAD.log**

6.1.1.3 Supported plant project file formats

The program allows to save and open project files in the following formats, differing in the file name extension:

File extension	Description
.roprj	plant project file in binary format
.roprjxml	plant project file in XML format

Files in binary format take up less disk space and are processed faster.

6.2 Terms and abbreviations

Active case	The plant case which tab was selected in the "Cases" form.
Active project	Plant project opened in **NanotechROCAD**.
Blend node	A plant unit where multiple input flows are mixed into one output flow. It is used when combining bypasses and recycles with the main flow.
Booster	An additional pump used to increase the pressure of the input flow entering the stage by a predetermined amount.
Bypass	A branch flow from the pass inlet flow, connected to the pass outlet permeate flow.
Case	Description of the plant design and the properties of the inlet water stored in the plant project. Multiple cases can be stored in one project.
Concentrate	Outlet water flow from the unit of the plant, remaining after separation of permeate; the salinity of the concentrate is higher than that of the inlet flow.
Concentration polarization	The effect of an increase in the concentration of solutes near the surface of the filtering membrane in a reverse osmosis unit, which leads to an increase in osmotic pressure on the membrane and a decrease in permeate flux.
Flow (inside the plant)	The flow of water supplied to the inlet and/or removed from the outlet of one of the plant units.
Flux (of permeate)	The volume of water passing through the unit of area of the membrane filter per unit of time.
Inlet (feed) water	The flow of water supplied to the inlet of the unit of the plant – pass, stage, membrane element, etc.
Inlet / outlet node	A unit through which water is introduced from the outside into the plant or removed from the plant to the outside.
LSI	Langelier Saturation Index; an indicator of water saturation with calcium carbonate.
Membrane element	Spiral wound filter membrane element, SWFE.
Node (of the plant)	Constructive part of the plant that converts input flows into outputs.
Pass	Plant design element. May include one or more stages connected in series. It can also include nodes for preliminary and post-treatment of water.
Permeate	Outlet water flow from the unit of the plant that has passed through membrane filters; the salinity of the permeate is lower than that of the inlet flow.
Plant	Installation of membrane water filtration using the principle of reverse osmosis.
Plant calculation	The procedure performed by the program for determining the characteristics of the plant (pressure, salinity of the output flows, energy consumption, etc.) for a given design and properties of the source water.
Plant configuration	Description of the plant design in terms of nodes, flows and their characteristics.
Plant project	A special format file that contains information on one or more plant cases that the program recognizes.
Post-treatment node	Unit for water treatment of the output flow (permeate or concentrate) of a pass.
Pressure vessel	Stage construction element. Robust housing with pressurized flow inlet. Filtering membrane elements are installed in series inside the housing.

Pre-treatment node	Unit for treatment of inlet water of a pass.
Program	The **NanotechROCAD**
Project template	The plant project used by the program as a pattern for creating new projects.
Pump	The unit of the installation that increases the pressure of the inlet flow.
Raw water	Inlet water entering the first pass of the plant.
Reagent treatment	Correction of water flow properties by dosing chemicals.
Recovery	The ratio of the volumetric flow rate of the outlet permeate flow from a plant unit to the flow rate of the inlet flow, expressed as a percentage.
Recycle	A flow that diverts a part of the output flow of a unit (pass, stage) back to the inlet.
Reverse osmosis	The process of water treatment, in which the flow of source water under pressure passes through membrane filter elements and is ultimately divided into “clean” water (permeate) and “dirty” water (concentrate).
Sectioning (of a pass)	The procedure for selecting the optimal stage configuration for a pass.
Split node	A plant unit that divides the input flow into several parts. It is used to originate bypasses, recycles and strips.
Stage	Structural element of a Pass. It consists of a set of pressure vessels connected in parallel.
Strip	A flow that diverts some of the water from the input flow to the outlet node.
SWFE	Spiral wound filter membrane element.
TDS	Total dissolved solutes
Treatment node	The unit of the plant, where the physical-and-chemical treatment of the inlet water is carried out in order to bring its properties to the required values.
Water source	A named set of water flow properties that can mix with water from other sources, eventually forming an inlet flow to the plant.
Water type	Characterization of the composition of water, in general (as a category), reflecting the level of content of dissolved salts and suspended particles in it.

7 Subject index