

Getting started with ProSec® in ProSimPlus® environment

Use Case 1: Main features overview

Software & Services In Process Simulation

We guide You to efficiency



ProSim

Introduction

This document presents a general overview of ProSec, ProSim's CAPE-OPEN compliant unit operation dedicated to the simulation of brazed plate-fin heat exchangers. In this document, ProSec is used in ProSimPlus, ProSim's steady state simulation software.

This step by step guide describes the different functions that are used to build a simulation of a brazed plate-fin heat exchanger with ProSec. It is based on a simple heat exchanger with two fluids.



For more information about the use of ProSimPlus environment, please consult "Getting started with ProSimPlus" documents.

Before we start: ProSimPlus interface

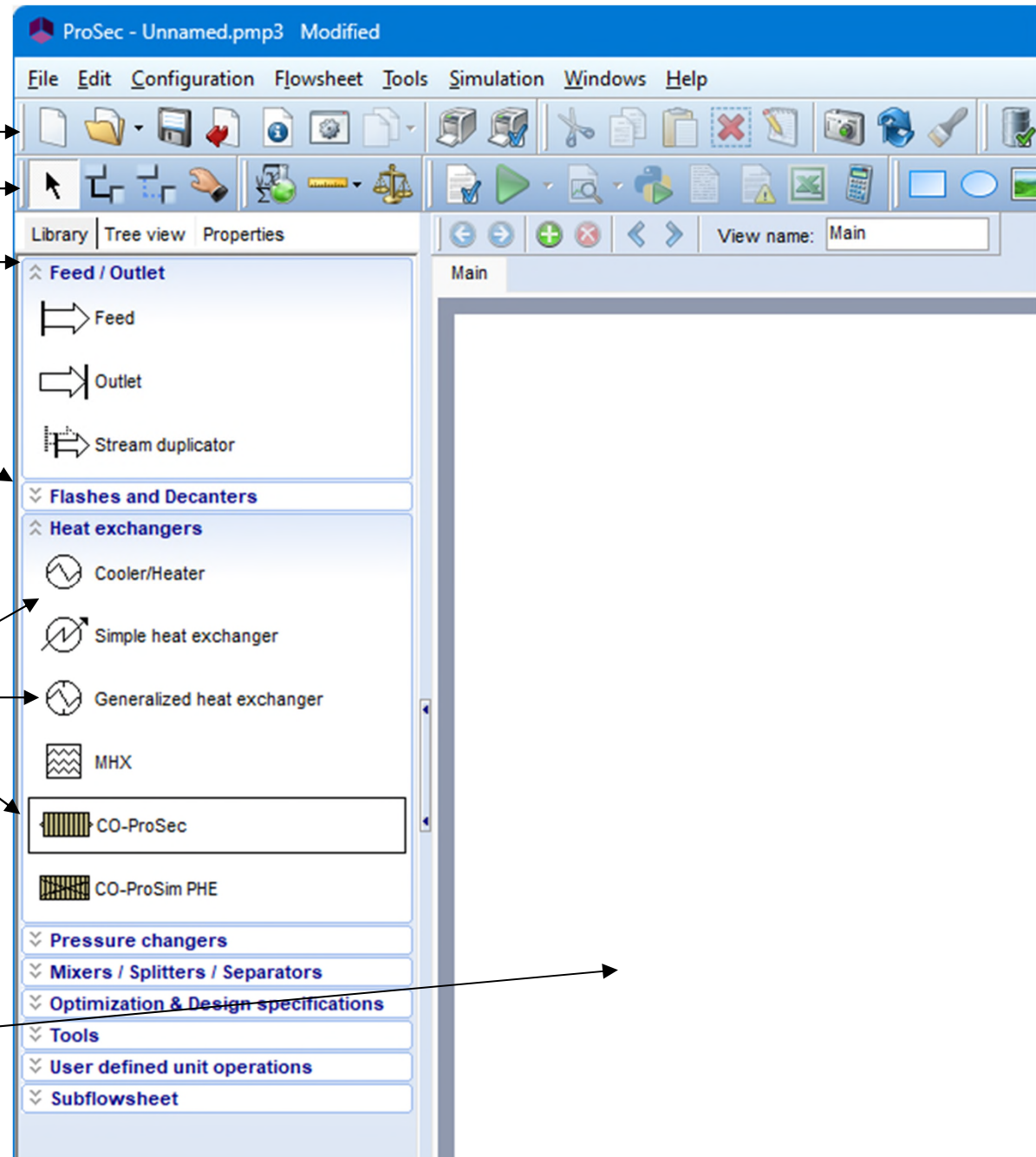
Project management menu

Project building menu

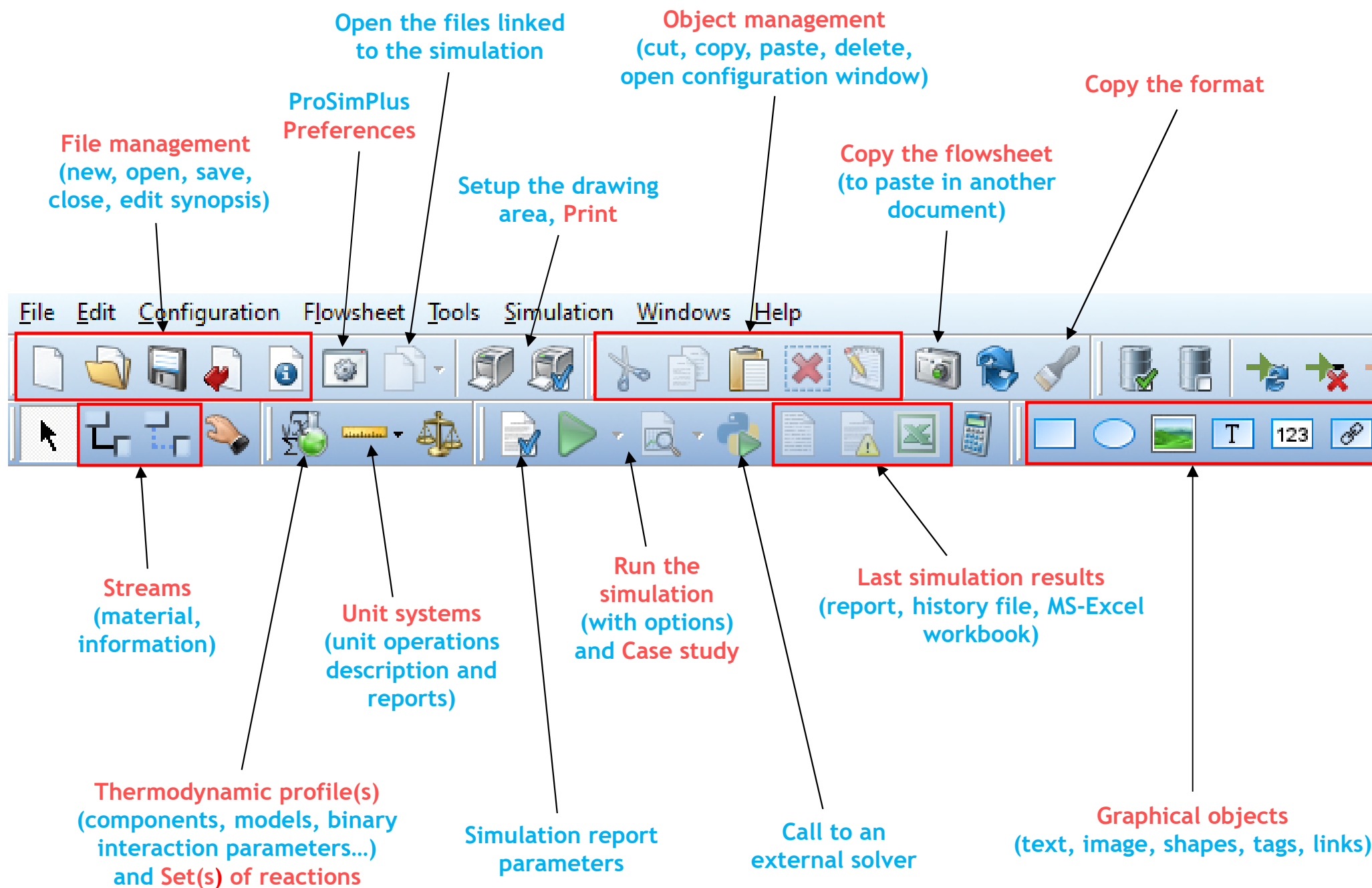
Categories list

Unit operations, within the selected categories

Drawing area



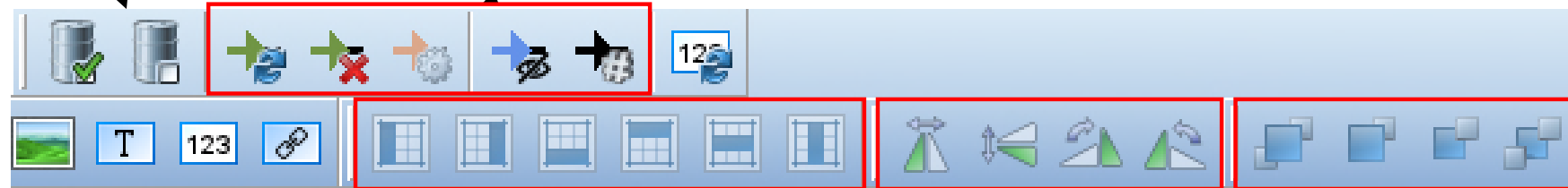
Before we start: ProSimPlus interface



Before we start: ProSimPlus interface

TBP/ASTM Assay curves of material streams (select, deselect)

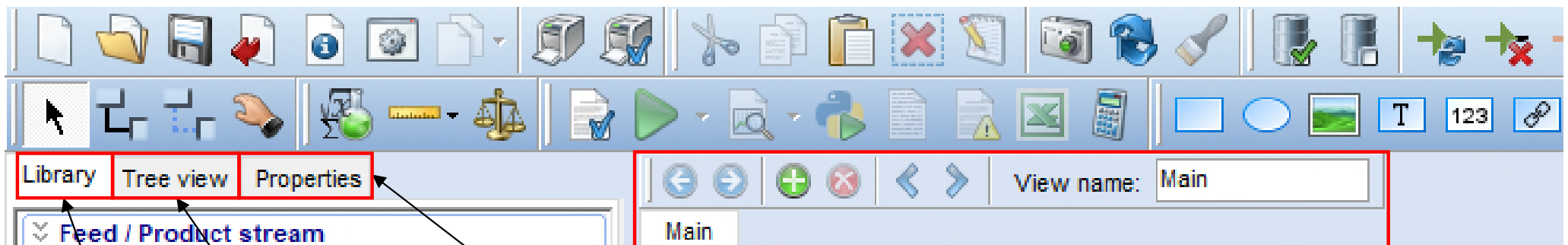
Streams management (link, initialization, number...)



Arrange the graphical objects on the flowsheet (**align, center...**)

Objects position (mirror, inverse, rotate...)

Arrange the objects **layout** in the flowsheet (front, back...)



Access to the library of unit operations

Access to the graphical properties and the name of the selected object

Access to the existing object on the flowsheet

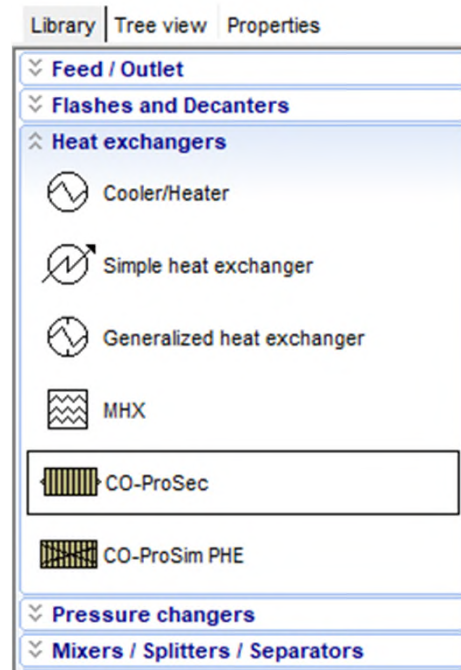
Management of the views of the flowsheet (creating, moving, renaming...)

Before we start: ProSimPlus interface

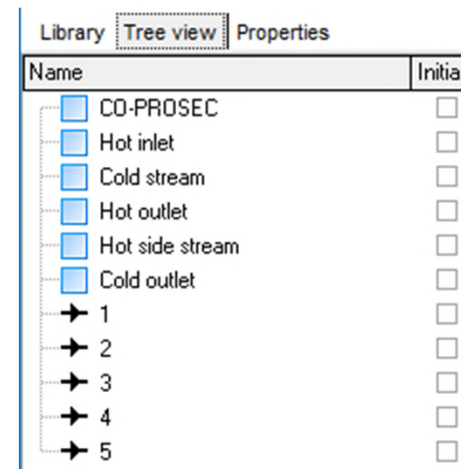
■ Unit operations library, tree view or properties

Beside the Library View, which presents the unit operations available in ProSimPlus within categories, the Tree View lists the items (streams and unit operations) used in the flowsheet. Selecting one (or several with the Ctrl button) item in the list selects the corresponding item in the flowsheet. Double clicking on the item in the list opens its configuration window.

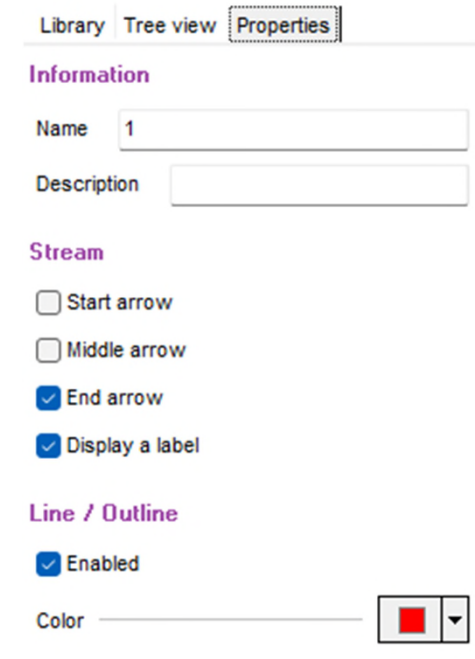
The Properties tabs allows to modify the graphical aspect of any selected items of the flowsheet.



Library view



Tree view

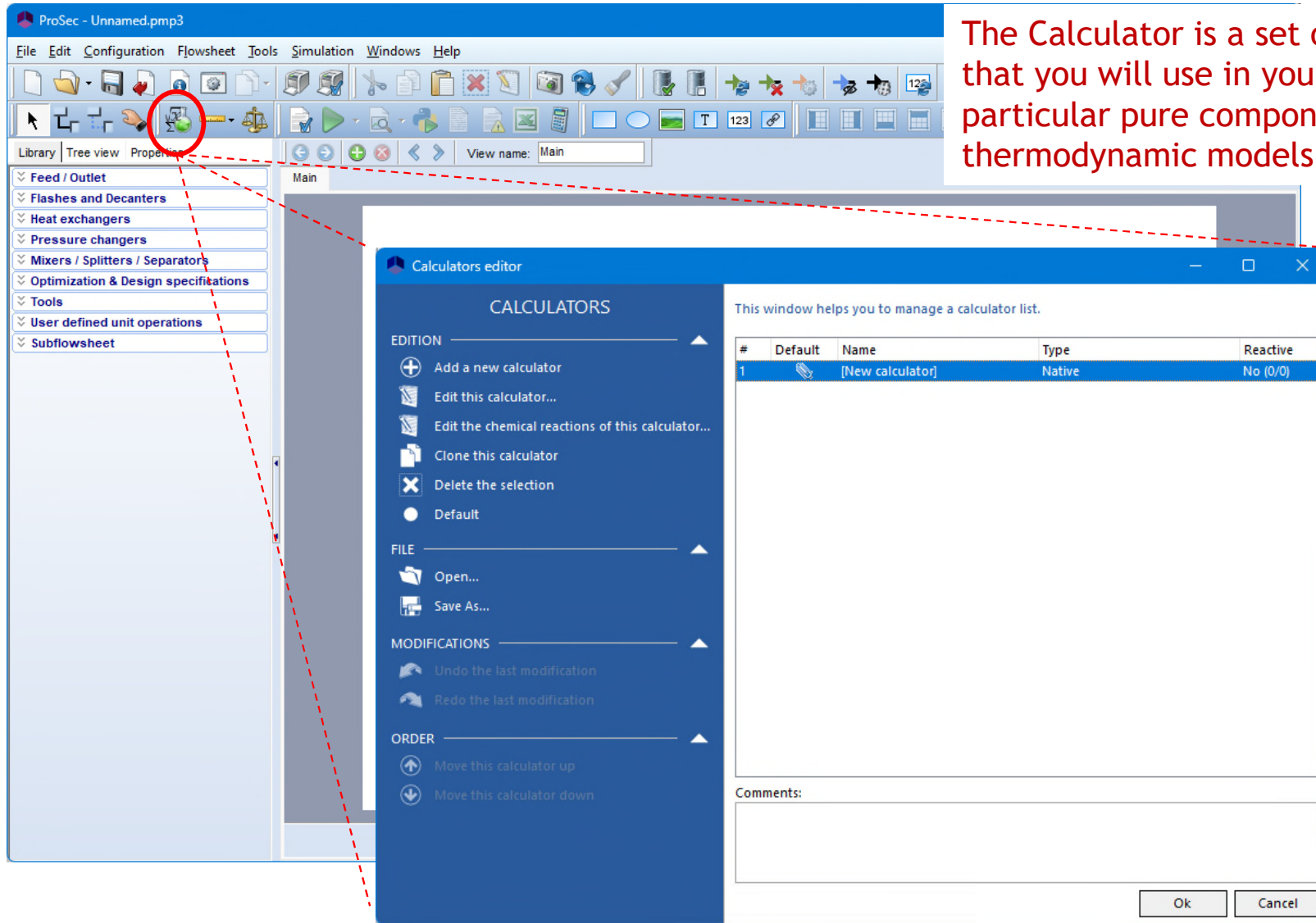


Properties

Building the flowsheet

- The steps are the following:
 - ✓ Step 1: Select your components
 - ✓ Step 2: Select your thermodynamic model
 - ✓ Step 3: Create your flowsheet
 - ✓ Step 4: Run the simulation
 - ✓ Step 5: Reports generated
 - ✓ Step 6: Analyze the results from the flowsheet
 - ✓ Step 7: Share the simulation

Step 1: Select your components



The Calculator is a set of thermodynamic data that you will use in your process. It includes in particular pure components and thermodynamic models.

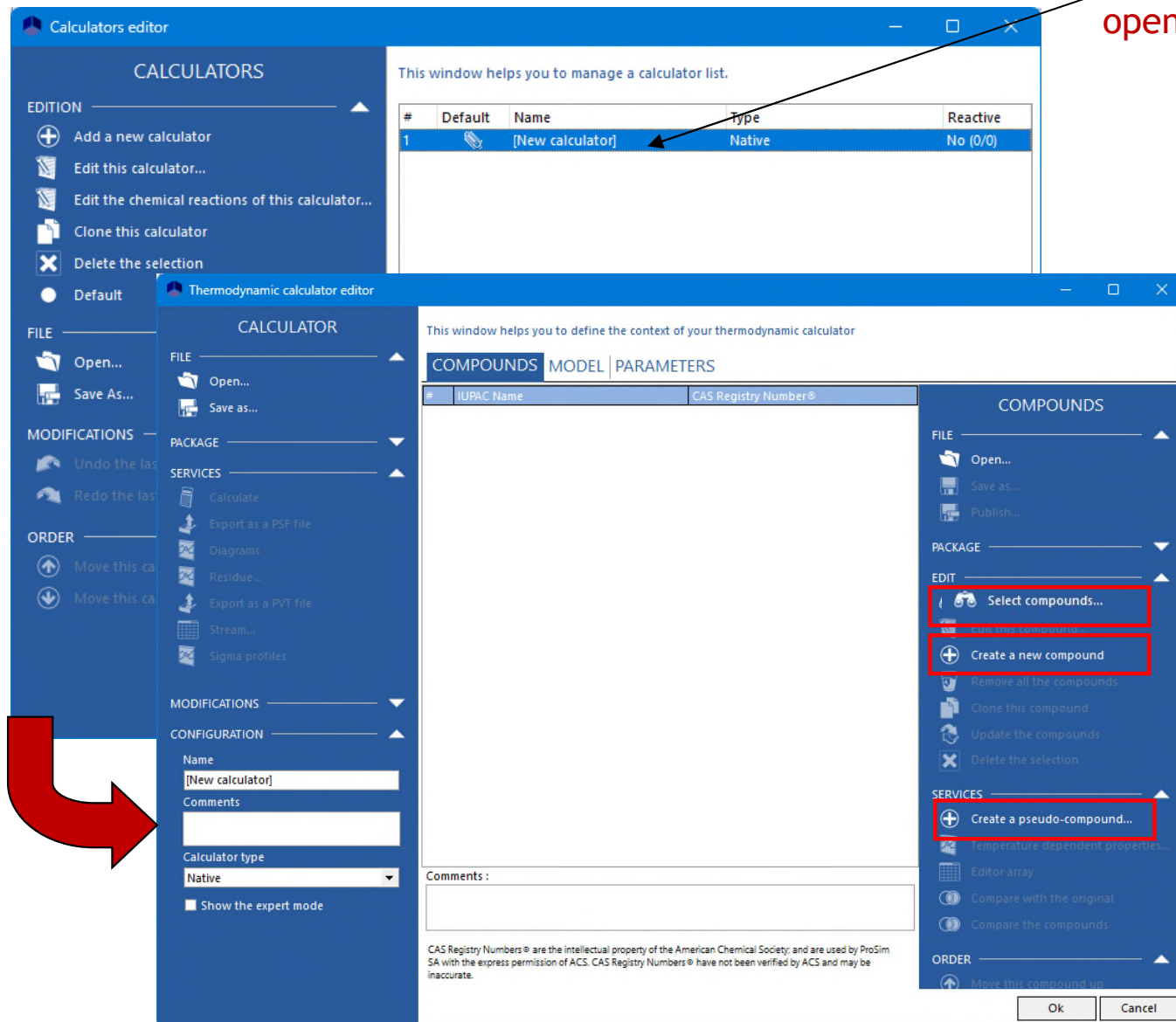
#	Default	Name	Type	Reactive
1		[New calculator]	Native	No (0/0)

Click on the Thermodynamics and Compounds icon to open the calculators editor.



You can use several calculators in the same flowsheet.

Step 1: Select your components



Double click on the “New calculator” to open the calculator environment window.

To search for a component in one of the databases, click on “Select compounds”

To create a component “from scratch” with the properties that you have, click on “Create a new compound”

To create pseudo compounds, without lights ends, click on “Create a pseudo-compound”

Step 1: Select your components

Enter the name of the compound you are looking for or select another criteria. Once entered, press "Search"

Check this box to clear previous results

The databases registered on your computer are listed here. Select the last one (in date)

The screenshot shows the 'Search results' window in ProSim. On the left, the 'COMPOUNDS' sidebar has a 'Search' button highlighted with a red box. Below it, the search criteria are set to 'Name or synonym' with 'methane' entered. The 'Exact name' checkbox is checked. Under 'OPTIONS', the 'Clear previous results' checkbox is also checked. The 'SEARCH IN' section shows a tree of databases, with 'Standard 2023' selected under 'Simulis® SQLite Databases'. The main window displays search results for 'METHANE', including its location, CAS Registry Number (74-82-8), and Specific ID. A table below shows the search results with columns for IUPAC name, Chemical formula, CAS Regi..., Molecular wei..., Bubble temper..., and Chemical family. The first result is 'METHANE' with formula 'CH4'. On the right, the 'Selected compounds:' list shows 'METHANE'.

Search results are displayed in central window.

Double click on the compound you require to select it. The selection will be displayed on the right window.

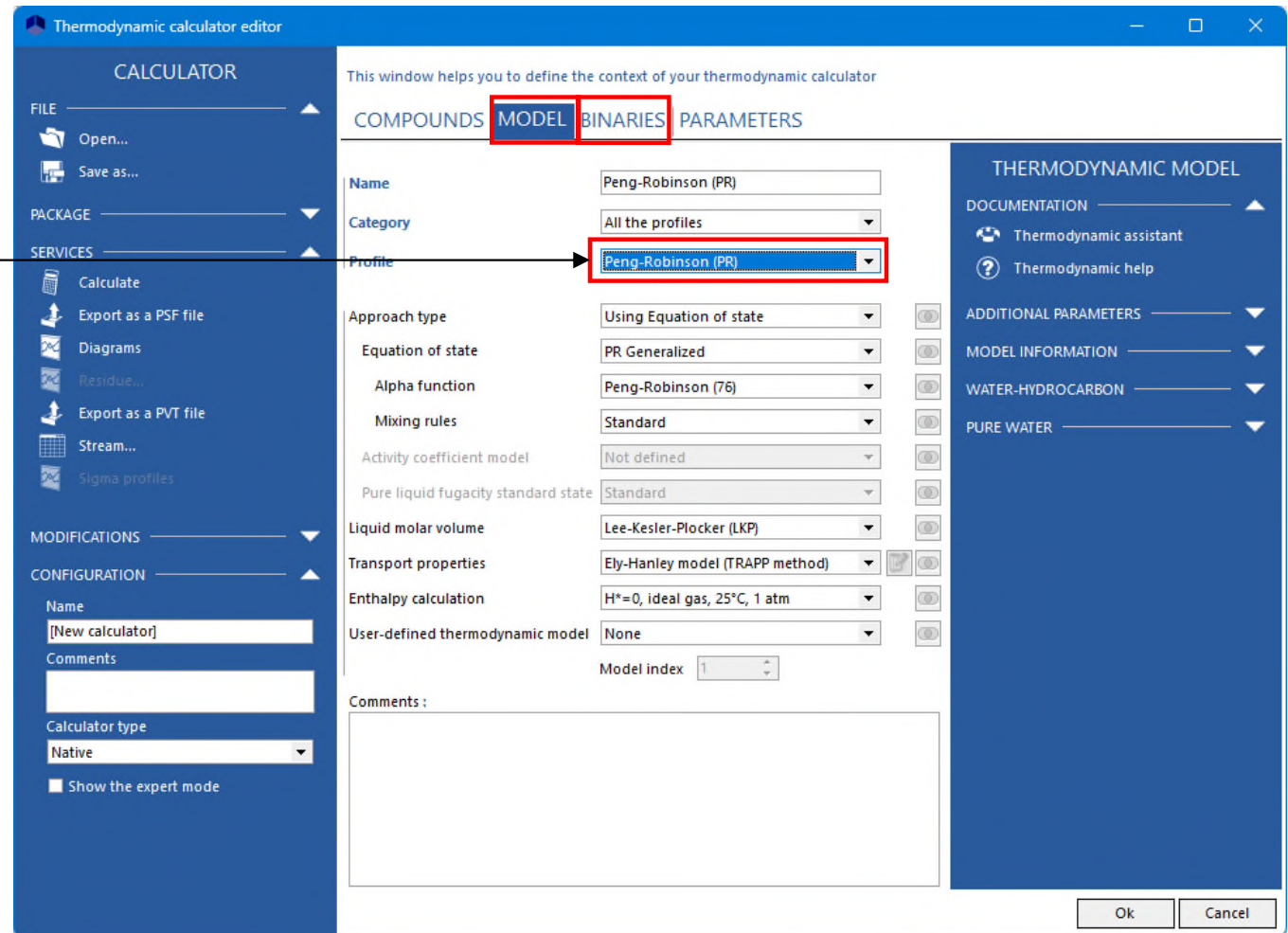
Repeat the operation to select all the components that you need. For this simulation you will need methane and ethane.

Step 2: Select your thermodynamic model

Once all components are selected, close the component search window to return to the Calculator edition environment.

Click on the “Model” tab to enter the thermodynamic selection environment.

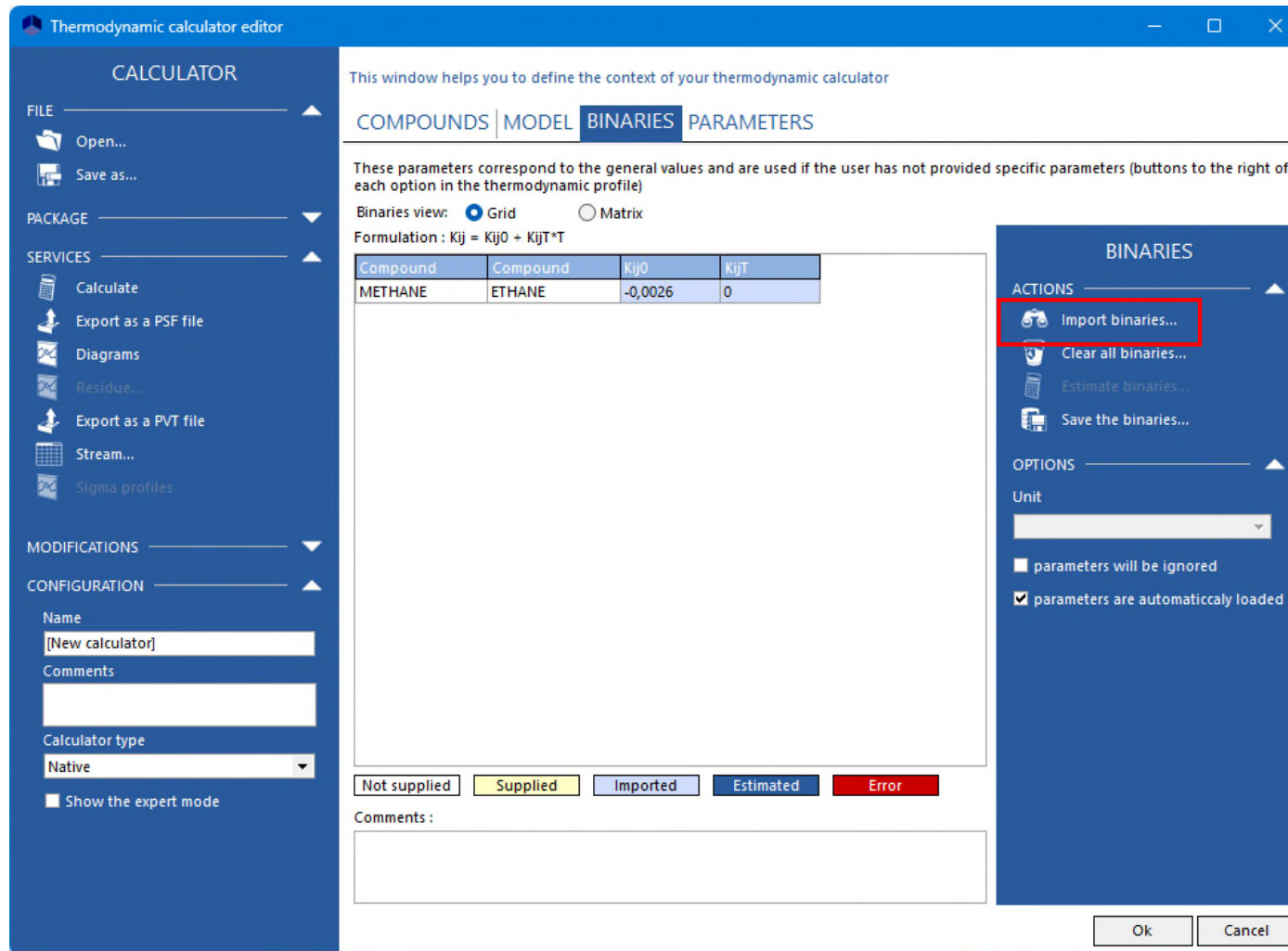
Select an appropriate thermodynamic model using the pull down menu.
Here we use Peng-Robinson.



When the selected thermodynamic model requires binary interaction parameters, the “Binaries” tab appears.

Step 2: Select your thermodynamic model

By default, for a new calculator, the available binaries are automatically loaded.



Now that your thermodynamic profile is completed click on “OK” to validate and close the window.

Step 3: Create the flowsheet

- A. ProSec unit operation
- B. Feed (inlet) and product (outlet)
- C. Connect all the unit operations with streams

Step 3: Create the flowsheet

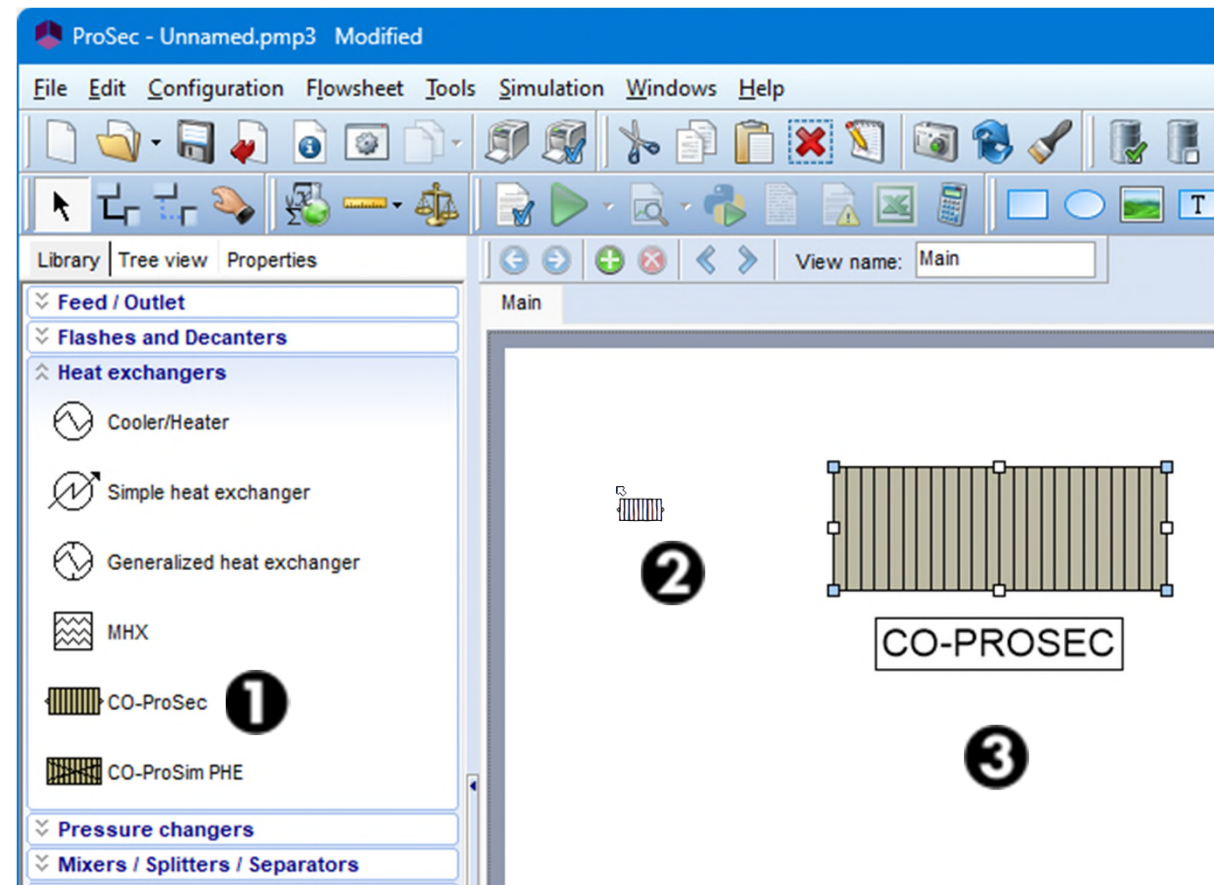
A- ProSec unit operation

14

1- Click on “CO-ProSec” icon in the library category “Heat exchangers” to select ProSec unit operation.

2- Move the mouse onto the drawing sheet to where you want to place the unit operation.

3- Click again, to release the unit.



A comprehensive set of features allows you to resize, rotate, reposition, align, etc. the element on the drawing area.

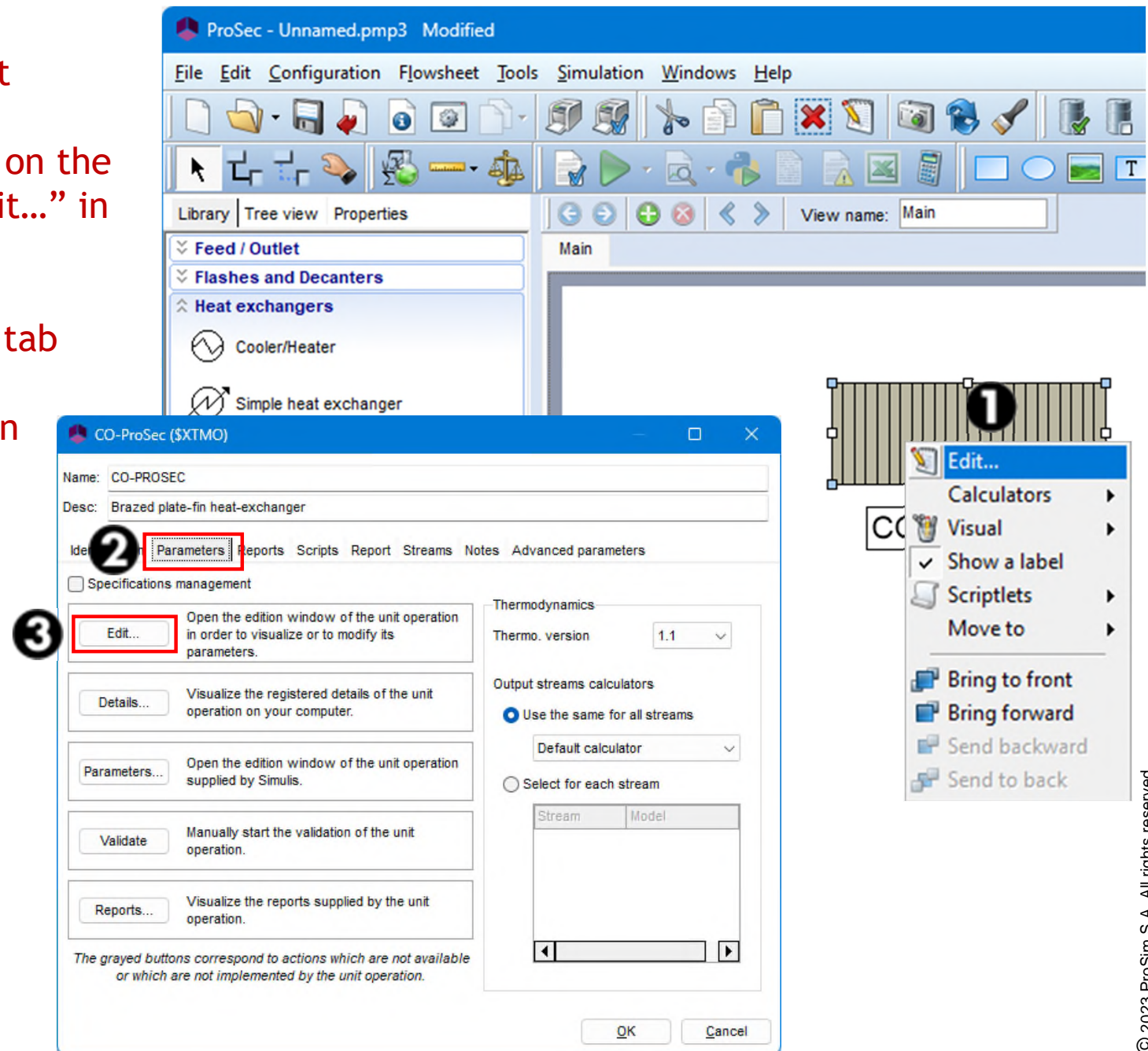
Step 3: Create the flowsheet

A- ProSec unit operation

15

To configure the ProSec unit operations:

1. Double-click on its icon on the flowsheet or select “Edit...” in the contextual menu
2. Press the “Parameters” tab
3. Press the “Edit...” button

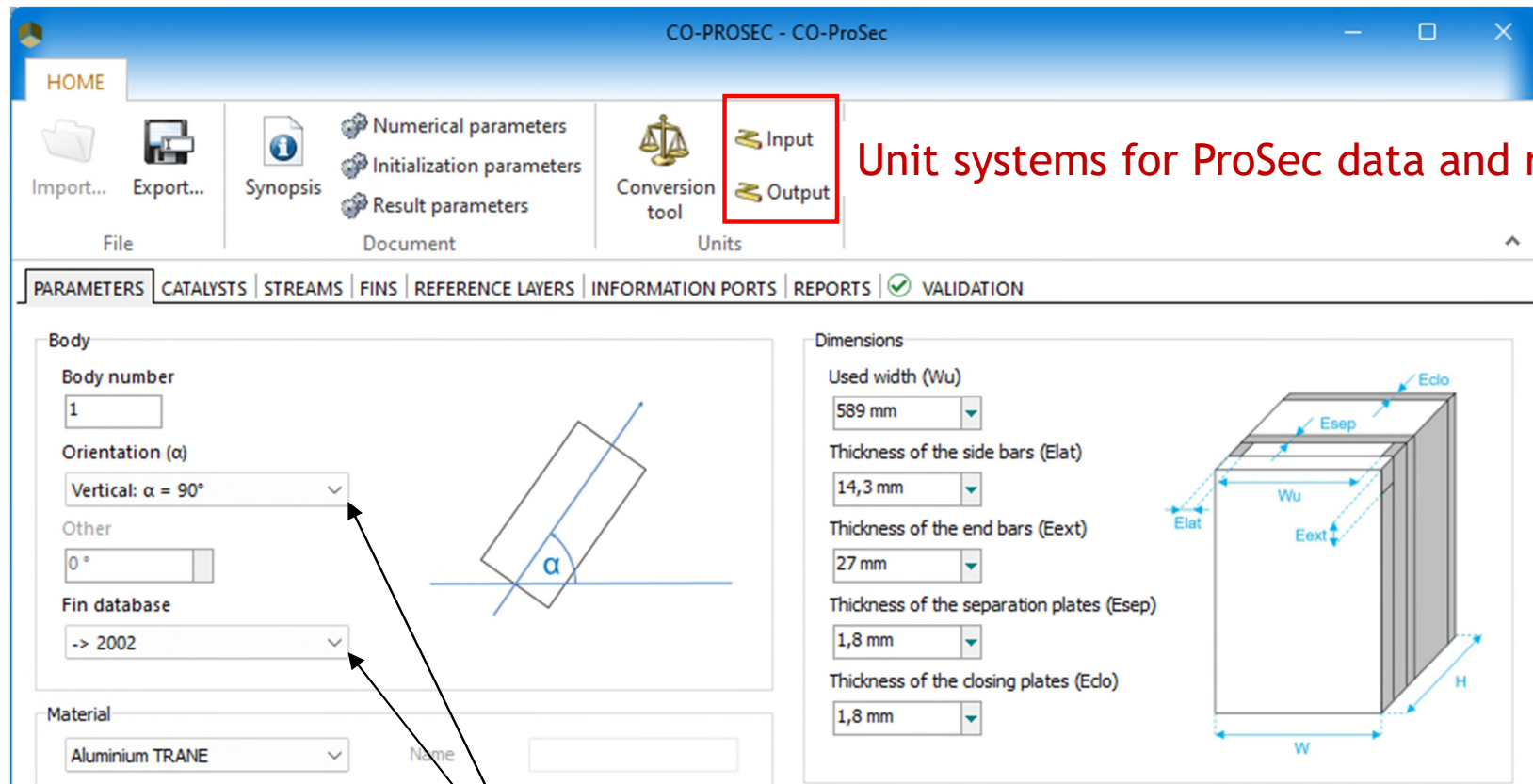


Step 3: Create the flowsheet

A- ProSec unit operation

16

- “Parameters” tab
 - ✓ Fill in the general characteristics of the heat exchanger as shown on the figure below



Change the default selection for the orientation and the fin database

Step 3: Create the flowsheet

A- ProSec unit operation

■ “Streams” tab

- ✓ Describe the two streams of the heat exchanger: a hot stream with a side stream and a cold stream

1. Click on “Add a stream” to add the hot stream

The screenshot shows the CO-PROSEC - CO-ProSec software interface. The top bar includes 'HOME' and 'LIST' tabs. Below them, the 'STREAMS TOOLS' section contains buttons for 'Add a stream', 'Add a feed', 'Add a side stream', 'Duplicate', and 'Delete'. A red box highlights the 'Add a stream' button, which is also marked with a circled '1'. A red arrow points from the text 'Management of the stream list' to the 'Delete' button. The main window shows the 'STREAMS' tab selected, with a list of streams including 'Hot'. The 'Hot' stream is selected, and its properties are displayed in the right pane, including Name, Color, Flow rate, and various specifications.

Management of the stream list

Stream	Name	Color	Flow rate	Specification
Hot	Hot	dRed	0 kg/s	From top to bottom

Step 3: Create the flowsheet

A- ProSec unit operation

18

- “Streams” tab
 2. Describe the stream “Hot” characteristics

PARAMETERS | CATALYSTS | **STREAMS** | FINS | REFERENCE LAYERS | INFORMATION PORTS | REPORTS | VALIDATION

Hot

Name dRed Hot

Cross flow ☐

Continuous thermodynamic ☐

Reactive ☐

A catalyst is taken into account ☐

Enthalpic factor 0 kg/s

Direction of circulation From top to bottom

Oversizing ratio on flowrate (%) 0

Fouling factor 0 W/m²/K

Correlation used to calculate the exchange coefficient HTFS 85

Threshold where the mixture is dealt as pure (%) 99,99

Generation of physico-chemical properties ... tabulated ☐

☐ Supercritical fluid

Number of tabulated points -

Extrapolation (DT) 5 K

Diphasic zone

Minimum number of diphasic points -

Option of diphasic tabulation Difference of enthalpy

Pressure drop is taken into account ☐

Initial pressure drop 0 bar

Maximum pressure drop 0,2 bar

Safety margin (DT) 5 K

Output temperature (UA calculation) 0 K

Give a name and select a color to easily identify the stream in the further steps

Change the default correlation for the heat transfer coefficient calculation

Step 3: Create the flowsheet

A- ProSec unit operation

19

- “Streams” tab
 3. Click on “Add a side stream” to add the stream “Hot” side stream
 4. Fill in the characteristics of this side stream

CO-PROSEC - CO-ProSec

STREAMS TOOLS

3 LIST

HOME

Add a stream Add a feed Add a side stream Duplicate Delete Specifications

Streams edit

PARAMETERS CATALYSTS STREAMS FINS REFERENCE LAYERS INFORMATION PORTS REPORTS VALIDATION

Hot

Side_Hot

Name Side_Hot

Splitting ratio of flowrate (%) 10

Give a name to easily identify the stream in the further steps

Enter the percentage of the stream leaving the heat exchanger by this side stream

Step 3: Create the flowsheet

A- ProSec unit operation

20

■ “Streams” tab

5. Click on “Add a stream” to add the cold stream

6. Describe the stream “Cold” characteristics

5

The screenshot shows the 'Streams' tab in the ProSim S.A. software. The 'Add a stream' button is highlighted with a red box. The stream name is 'Cold', and the direction of circulation is set to 'From bottom to top'. The correlation used is 'HTFS 85'. The stream is currently set to 'Cold'.

Parameter	Value
Name	Cold
Enthalpic factor	0 kg/s
Direction of circulation	From bottom to top
Oversizing ratio on flowrate (%)	0
Fouling factor	0 W/m ² /K
Correlation used to calculate the exchange coefficient	HTFS 85
Threshold where the mixture is dealt as pure (%)	99,99
Generation of physico-chemical properties	... tabulated
Supercritical fluid	<input type="checkbox"/>
Number of tabulated points	5 K
Extrapolation (DT)	5 K
Diphasic zone	<input type="checkbox"/>
Minimum number of diphasic points	5 K
Option of diphasic tabulation	Difference of enthalpy
Pressure drop is taken into account	<input type="checkbox"/>
Initial pressure drop	0 bar
Maximum pressure drop	0,2 bar
Safety margin (DT)	5 K
Output temperature (UA calculation)	0 K

Give a name to easily identify the stream in the further steps

Change the default direction of circulation and the default correlation for the heat transfer coefficient calculation

Step 3: Create the flowsheet

A- ProSec unit operation

■ “Fins” tab

- ✓ Describe the two fins used in the heat exchanger
- ✓ Fin #1 (for heat exchange zones) is a user-defined, for which performance data are given
- ✓ Fin #2 (for distributors) is a user-defined, for which performance data are calculated from correlations

1. Click on “Add a fin”

CO-PROSEC - CO-ProSec

HOME LIST

1 Add a fin Duplicate the selected fin Move up the selected fin Move down the selected fin Delete the selected fin Import user fin

Management of the fin list

PARAMETERS CATALYSTS STREAMS FINS REFERENCE LAYERS INFORMATION PORTS REPORTS VALIDATION

Name	Reference #	Origin
	0	Standard database

Calculation mode

☒ From geometry

☐ Performance data provided

Step 3: Create the flowsheet

A- ProSec unit operation

■ “Fins” tab

- ✓ Fin #1 description
- 2. Give a name
- 3. Select the “Origin” (Standard database or User)
- 4. Give a reference number
- 5. Fill in the characteristics

PARAMETERS | CATALYSTS | STREAMS | **FINS** | REFERENCE LAYERS | INFORMATION PORTS | REPORTS | VALIDATION

Name	Reference #	Origin
Fin #1	1001	User

2 4 3

Calculation mode

☐ From geometry

☒ Performance data provided

Type: Right fin

Height: 7,13 mm

Thickness: 0,4 mm

Fins number per meter: 673,2

Perforation porosity (%): 0

Serration length: 0 mm

Metal section correction: 0

Global efficiency: 1

☒ Fin efficiency is taken into account

Duct diameter: 0 mm

Duct absolute rugosity: 0 mm

Duct wet perimeter: 0 mm

Duct section: 0 m²

Ducts number per meter: 0

HTC correlations:

☐ User code (VBScript) on the whole area

Laminar flow: In-house correlation

Turbulent flow: In-house correlation

Friction factor correlations:

☐ User code (VBScript) on the whole area

Laminar flow: In-house correlation

Turbulent flow: In-house correlation

Reynolds numbers	Fanning coefficient	Colburn coefficient
46	0,98874	0,06258
122	0,39326	0,04122
200	0,26355	0,03266
538	0,14066	0,02048
881	0,113	0,01643
1442	0,09665	0,01337
2363	0,08753	0,01106
6338	0,0818	0,00797
17003	0,08171	0,00604
45614	0,0726	0,00462

Step 3: Create the flowsheet

A- ProSec unit operation

- “Fins” tab
 - ✓ Fin #2 description

1 Add a fin

Duplicate the selected fin

Move up the selected fin

Move down the selected fin

Delete the selected fin

Import a user fin

Edit

NAME	LIST	PARAMETERS	CATALYSTS	STREAMS	FINS	REFERENCE LAYERS	INFORMATION PORTS	REPORTS	VALIDATION
Fin #1	1001	User							
Fin #2	7844	User							

2 **4** **3**

Calculation mode

☒ From geometry

☐ Performance data provided

Type: Right fin

Height: 7,13 mm

Thickness: 0,4 mm

Fins number per meter: 200

Perforation porosity (%): 0

Serration length: 0 mm

Metal section correction: 0

Global efficiency: 1

☒ Fin efficiency is taken into account

Duct diameter: 0 mm

Duct absolute rugosity: 0 mm

Duct wet perimeter: 0 mm

Duct section: 0 m2

Ducts number per meter: 0

HTC correlations:

☐ User code (VBScript) on the whole area

Laminar flow: In-house correlation

Turbulent flow: In-house correlation

Friction factor correlations:

☐ User code (VBScript) on the whole area

Laminar flow: In-house correlation

Turbulent flow: In-house correlation

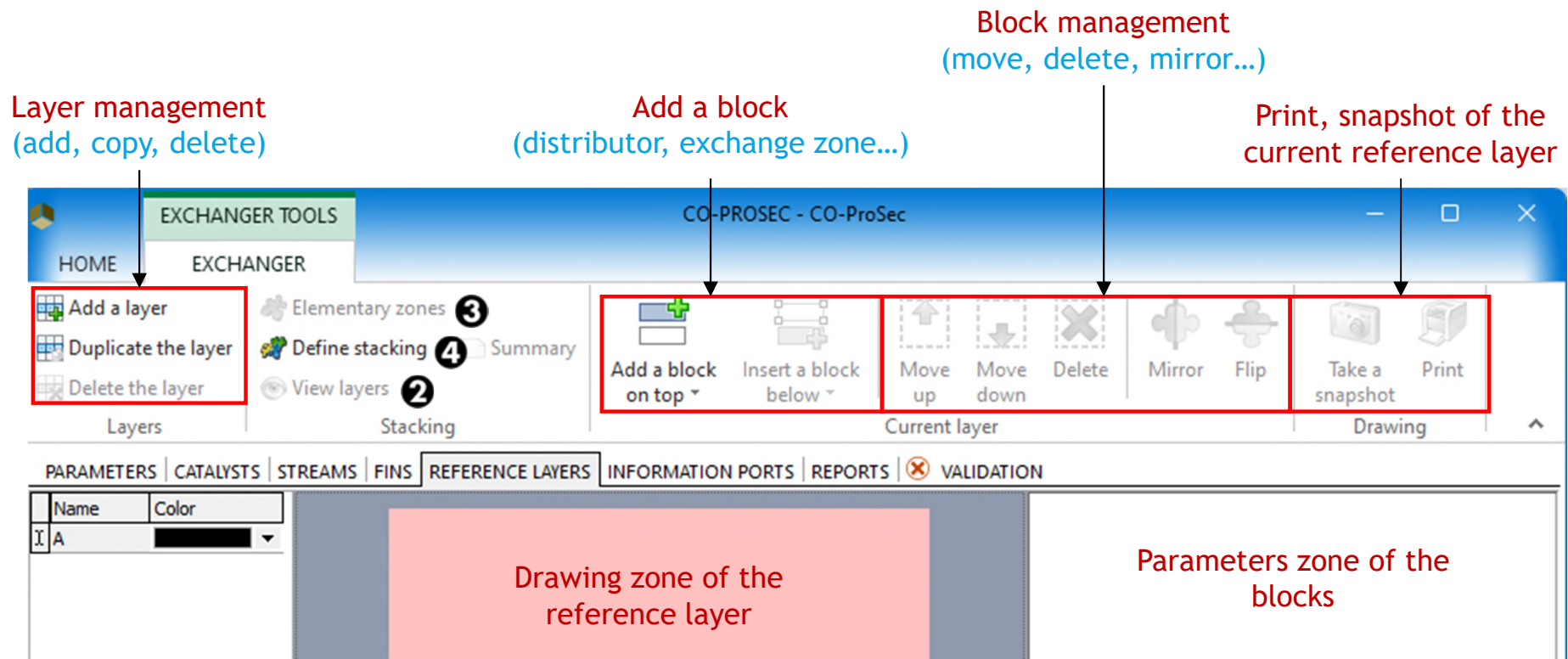
1. Click on “Add a fin”
2. Give a name
3. Select the “Origin” (Standard database or User)
4. Select the reference “7844”
5. Fill in the characteristics

Step 3: Create the flowsheet

A- ProSec unit operation

■ “Reference layer” tab

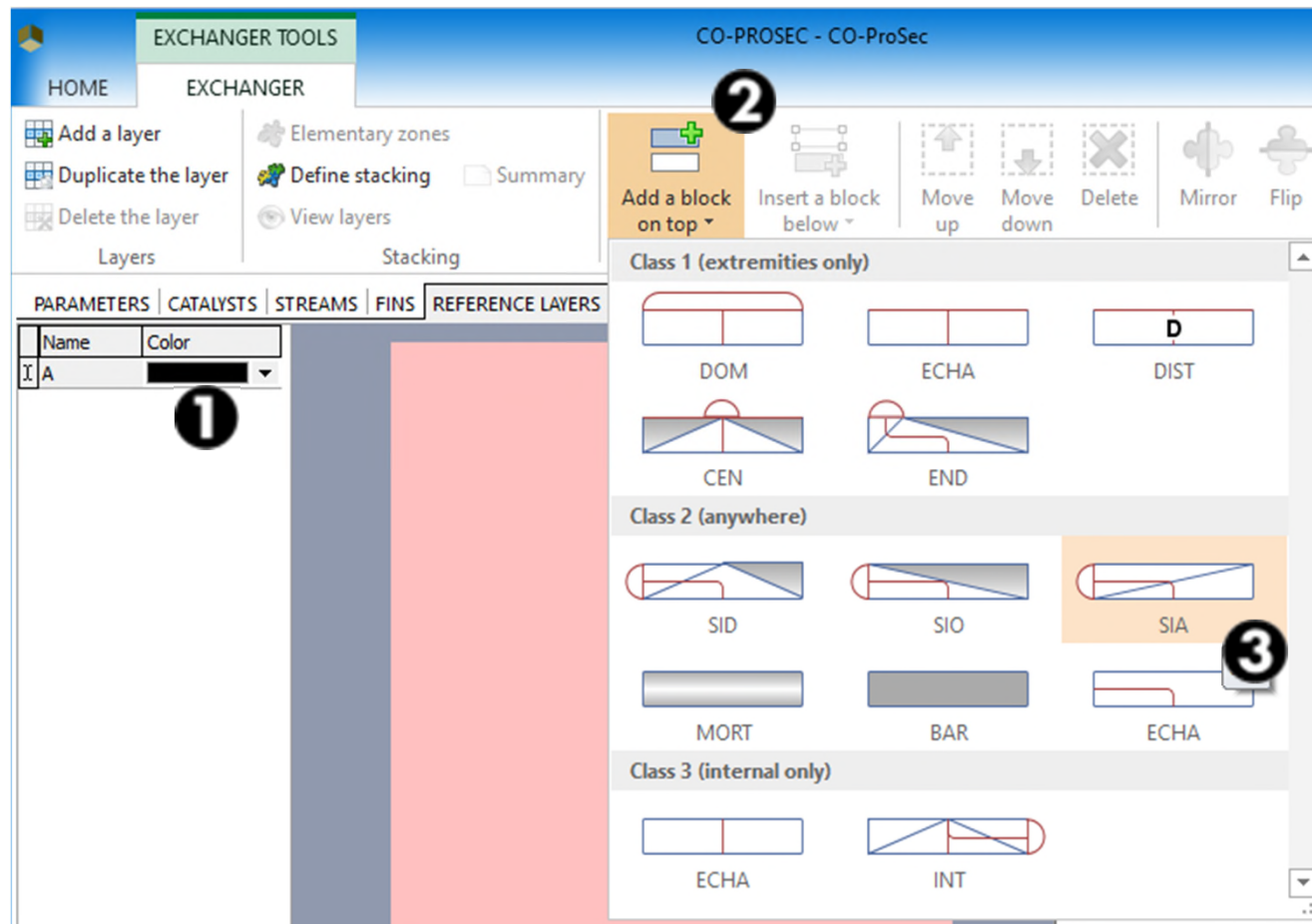
- ✓ Describe the reference layer, the meshing and the stacking
- 1. Describe the reference layers
- 2. Visualize the layers
- 3. Adjust the number of discretization cells
- 4. Define the stacking



Step 3: Create the flowsheet

A- ProSec unit operation

- “Reference layer” tab
 - ✓ Describe the reference layer “A” (hot stream reference layer)
 1. Select a color to easily identify this layer in the stacking description
 2. Click on “Add a block on top”
 3. Select the first block to add a “SIA” distributor



Step 3: Create the flowsheet

A- ProSec unit operation

26

- “Reference layer” tab

4. Click on the block to select it

5. Click on “Mirror” to change the position of its head

PARAMETERS | CATALYSTS | STREAMS | FINS | **REFERENCE LAYERS** | INFORMATION PORTS | REPORTS | VALIDATION

Layers: Add a layer, Duplicate the layer, Delete the layer

Stacking: Elementary zones, Define stacking, Summary, View layers

Current layer: Add a block on top, Insert a block below, Move up, Move down, Delete, **Mirror**

4

TOP

BOTTOM

SIA

500

200

200

Nun

Numt

Distributor

Distribut

Nozzle

Hea

Surface con

Volume correct

SIA

500

200

200

(*) used when the str

Step 3: Create the flowsheet

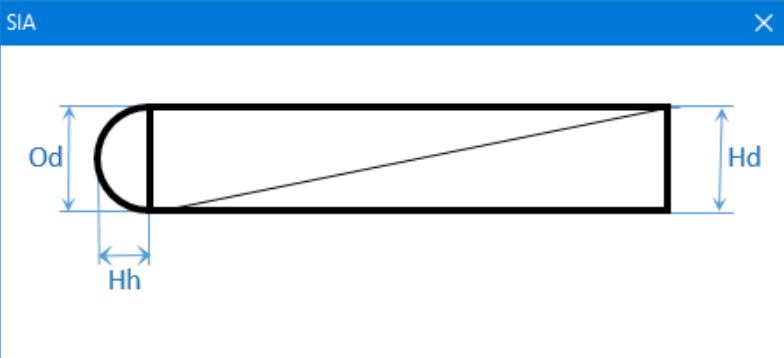
A- ProSec unit operation

- “Reference layer” tab
 6. Fill in its parameters

To identify the sizing dimensions

SIA (class 2) ?

Block height	200 mm
Main fin	Fin #1
PORT fin	Fin #1
TURN fin	Fin #1
SIO fin	Fin #1
Number of heads	1
Number of nozzles	1
Distributor opening (Od)	200 mm
Distributor height (Hd)	200 mm
Nozzle diameter (Dp)	0 mm
Head height (Hh)	100 mm
Surface correction factor	1
Volume correction factor (*)	1
Stream #1	Hot



The diagram shows a cross-section of the SIA unit operation. It is a horizontal cylinder with a semi-circular head on the left. The distributor opening (Od) is the width of the head. The distributor height (Hd) is the height of the cylinder. The head height (Hh) is the height of the head. A diagonal line represents the internal structure of the head.

Step 3: Create the flowsheet

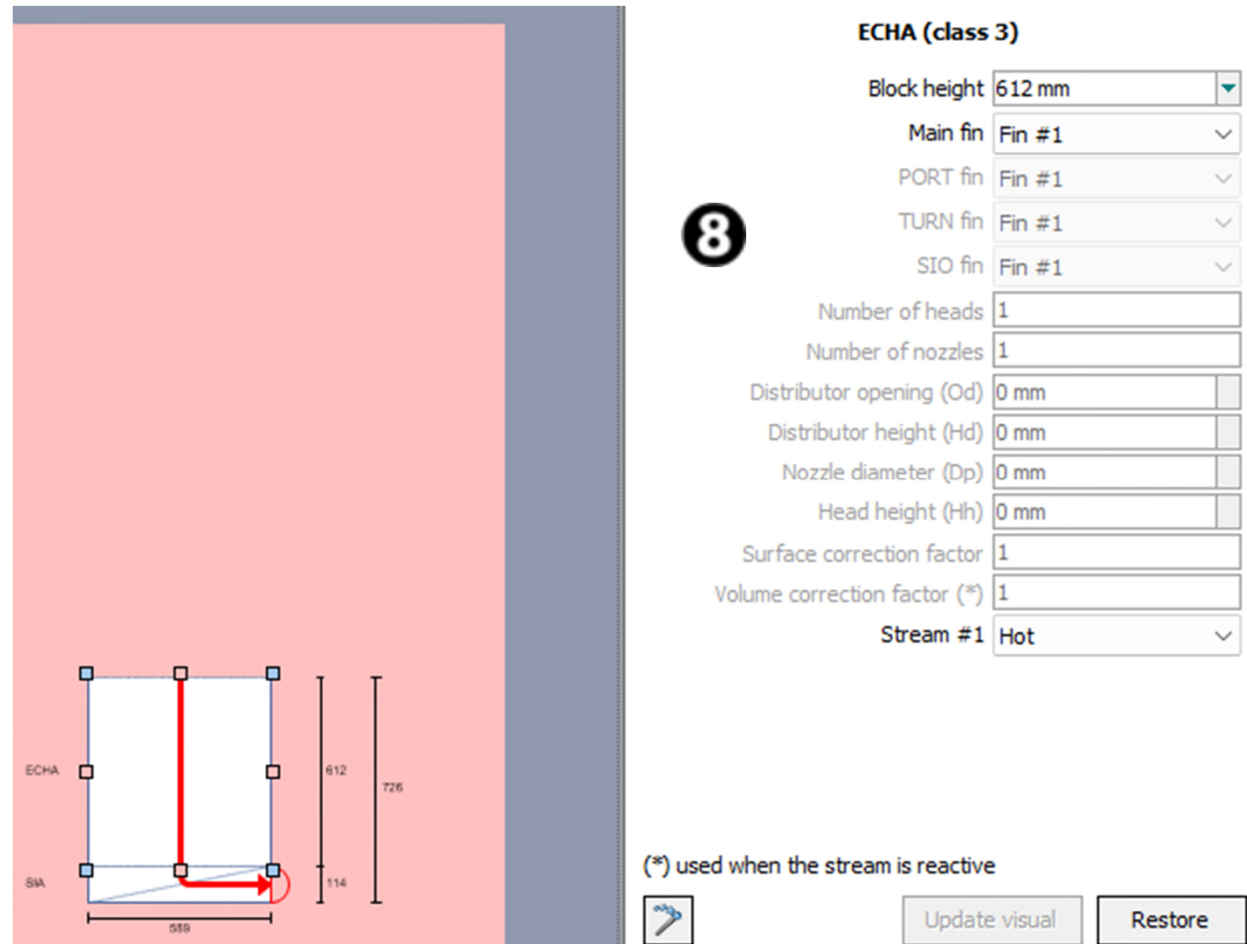
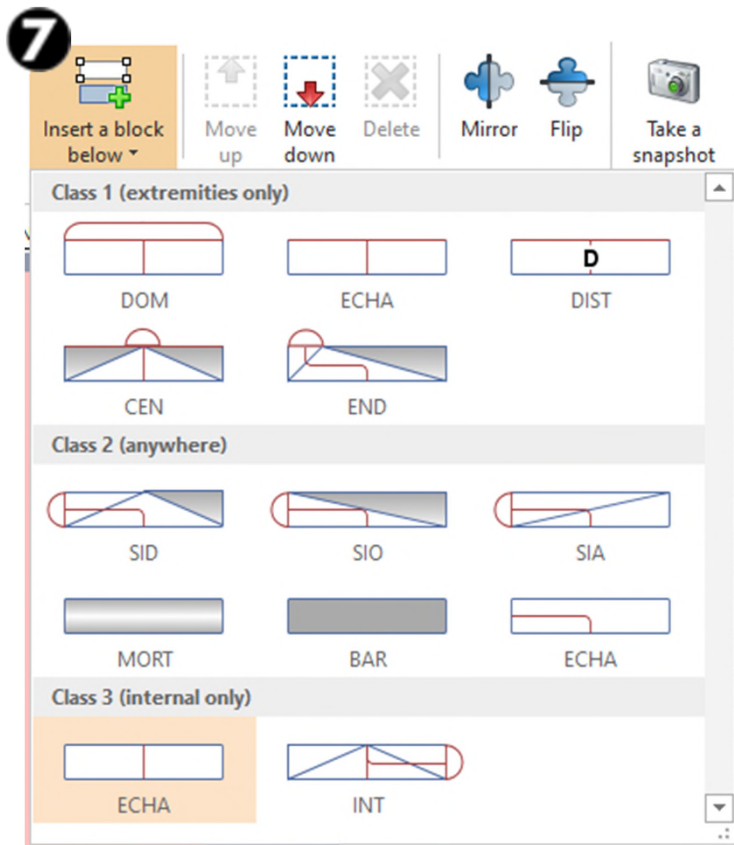
A- ProSec unit operation

28

- “Reference layer” tab

7. Click on “Add a block on top” and select a heat exchange zone “ECHA”

8. Select this block and enter its parameters



Step 3: Create the flowsheet

A- ProSec unit operation

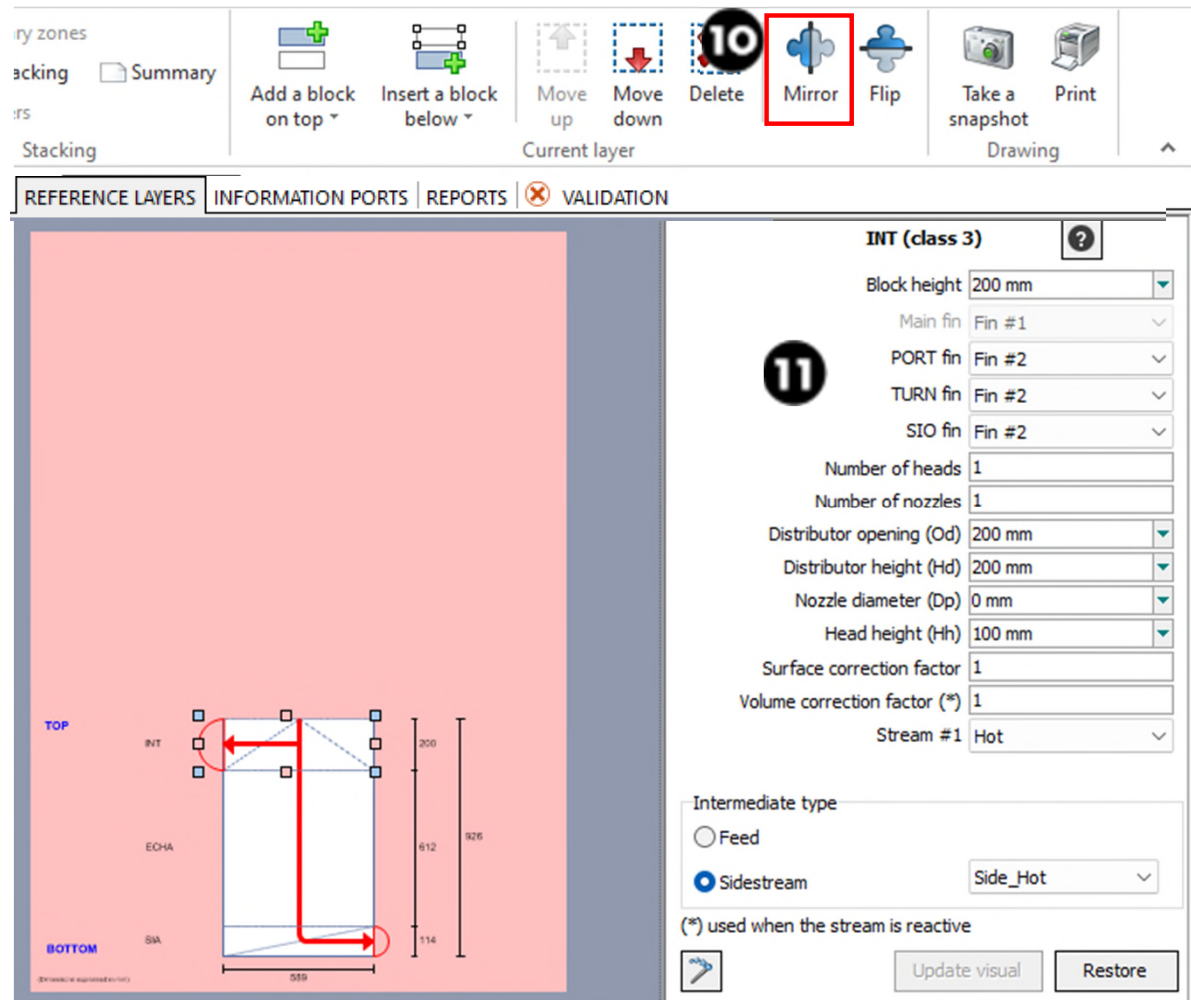
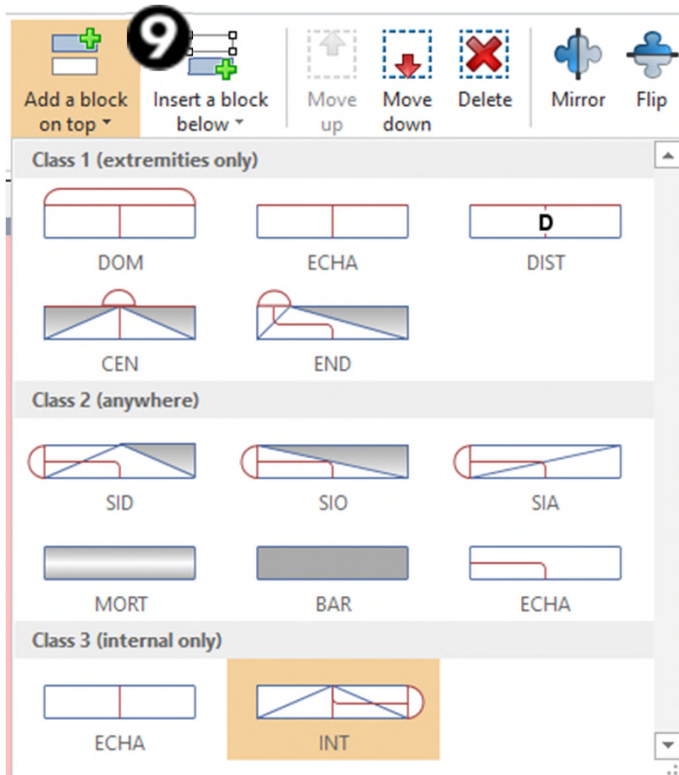
29

- “Reference layer” tab

9. Click on “Add a block on top” and select an “INT” distributor

10. Click on “Mirror” to change the position of its head

11. Select this block and enter its parameters



Step 3: Create the flowsheet

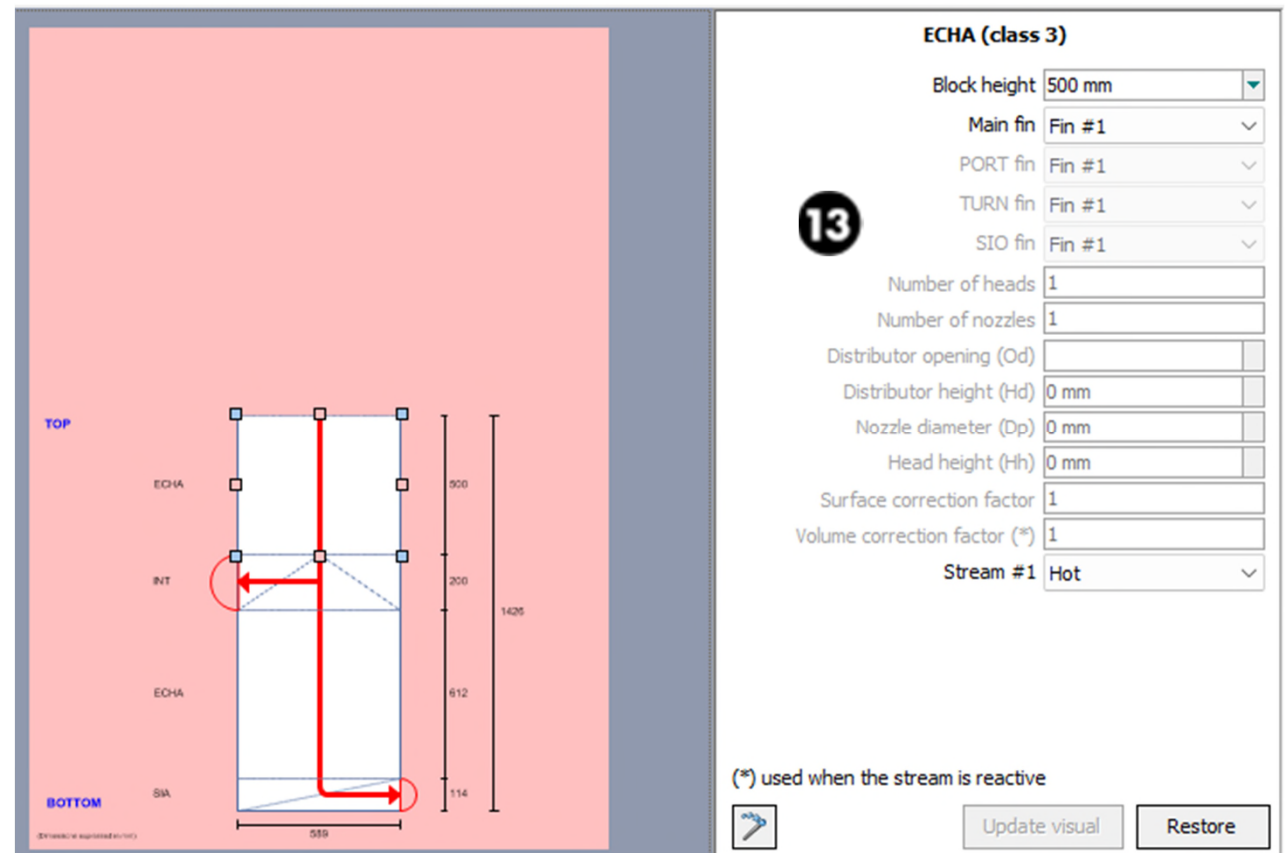
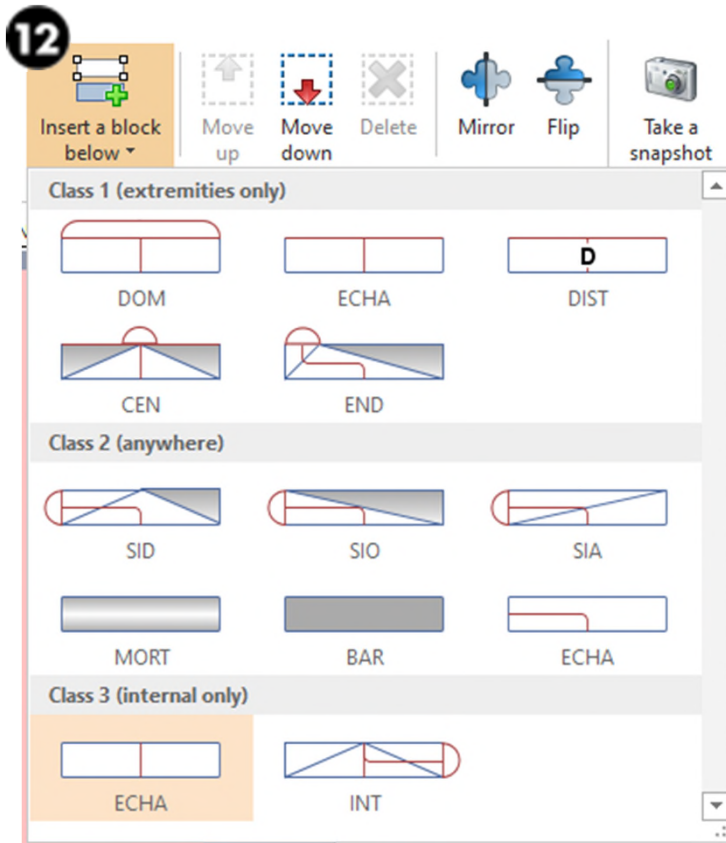
A- ProSec unit operation

30

- “Reference layer” tab

12. Click on “Add a block on top” and select a heat exchange zone “ECHA”

13. Select this block and enter its parameters



Step 3: Create the flowsheet

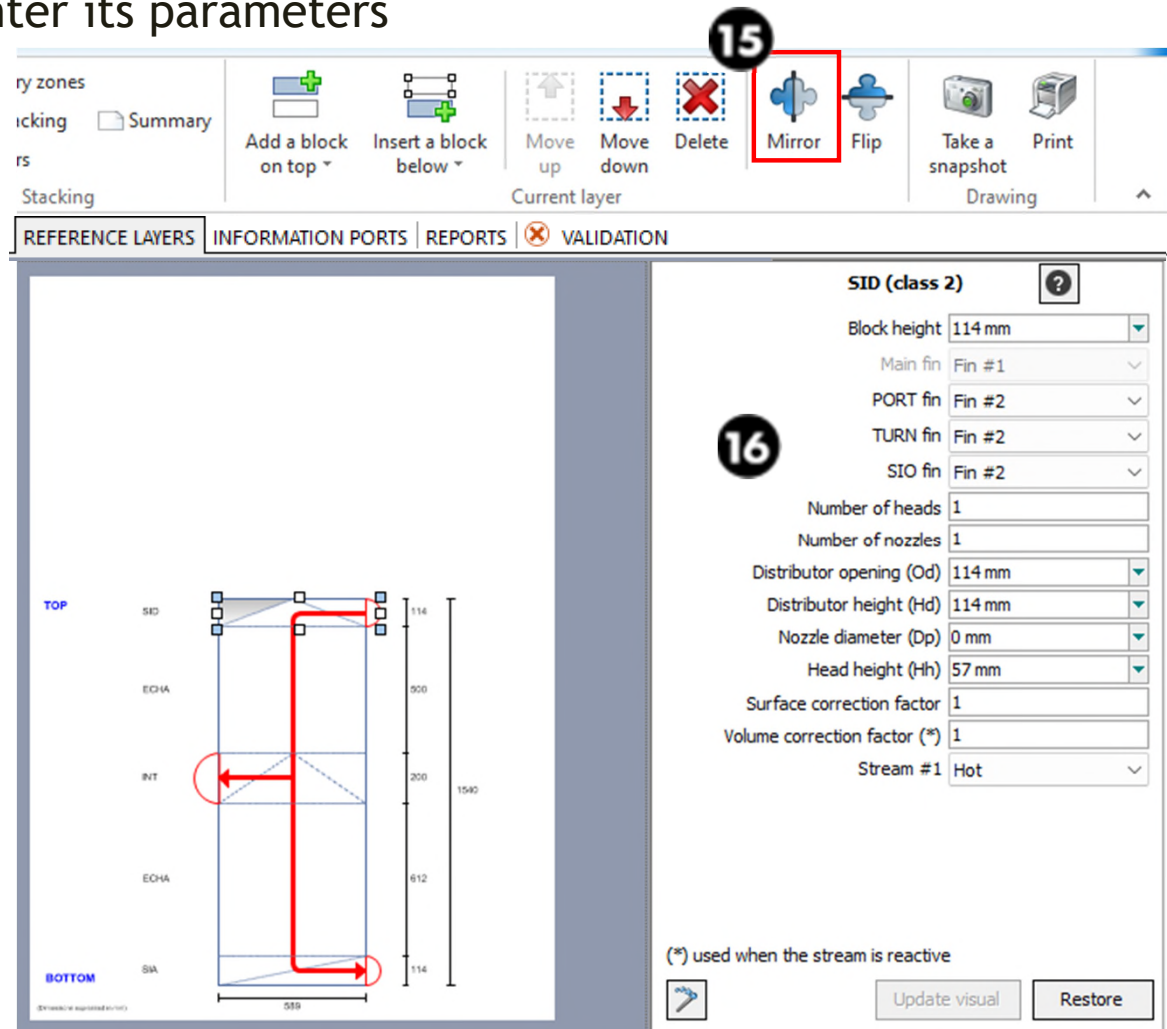
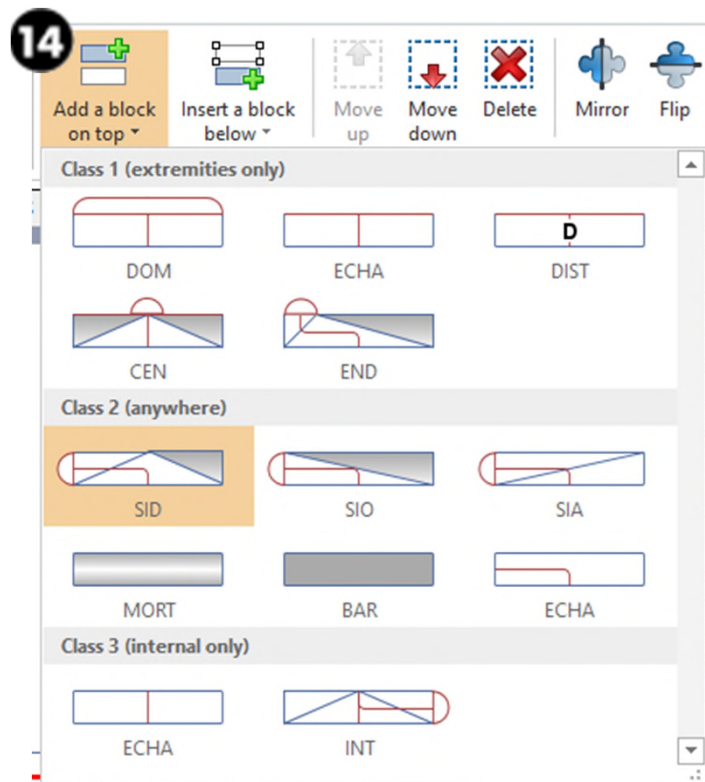
A- ProSec unit operation

■ “Reference layer” tab

14. Click on “Add a block on top” and select an “SID” distributor

15. Click on “Mirror” to change the position of its head

16. Select this block and enter its parameters



Step 3: Create the flowsheet

A- ProSec unit operation

- “Reference layer” tab
 - ✓ Describe the reference layer “B” (cold stream reference layer)
 1. Click on “Add a layer” to add a new reference layer
 2. Select a color to easily identify this layer in stacking description

The screenshot shows the CO-PROSEC - CO-ProSec software interface. The top navigation bar includes tabs for HOME, EXCHANGER, and EXCHANGER TOOLS. The EXCHANGER TOOLS tab is active, displaying a toolbar with icons for adding, duplicating, and deleting layers, as well as stacking and moving blocks. A red box highlights the 'Add a layer' icon, which is also indicated by a large black circle with the number '1'. Below the toolbar, the 'REFERENCE LAYERS' section is visible, showing a table with two layers: 'A' (red) and 'B' (blue). A large black circle with the number '2' is placed over the 'B' layer's color selection area. The main workspace area is currently empty, showing a large red rectangular area.

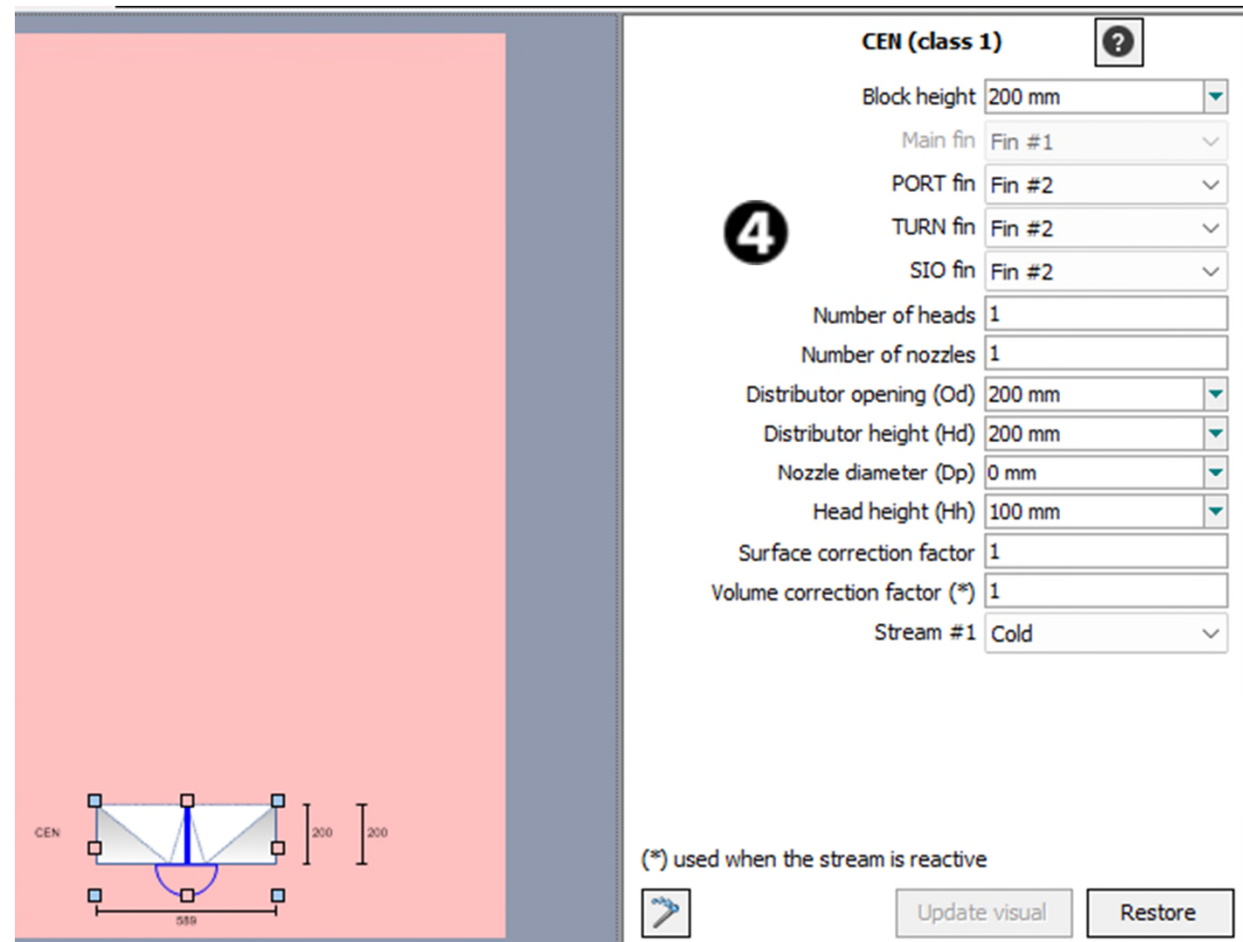
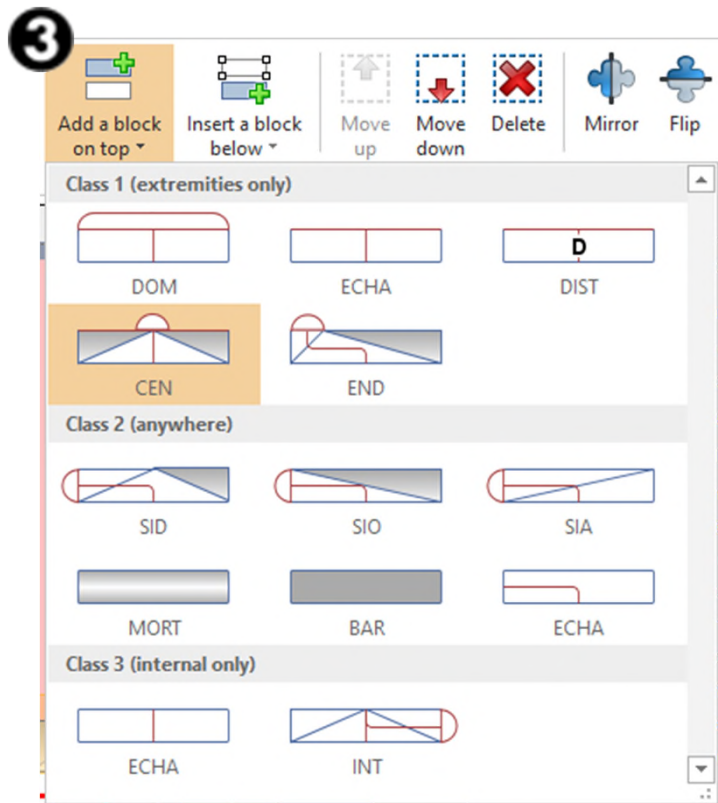
Name	Color
A	Red
B	Blue

Step 3: Create the flowsheet

A- ProSec unit operation

- “Reference layer” tab

3. Click on “Add a block on top” and select a “CEN” distributor
4. Select this block and enter its parameters



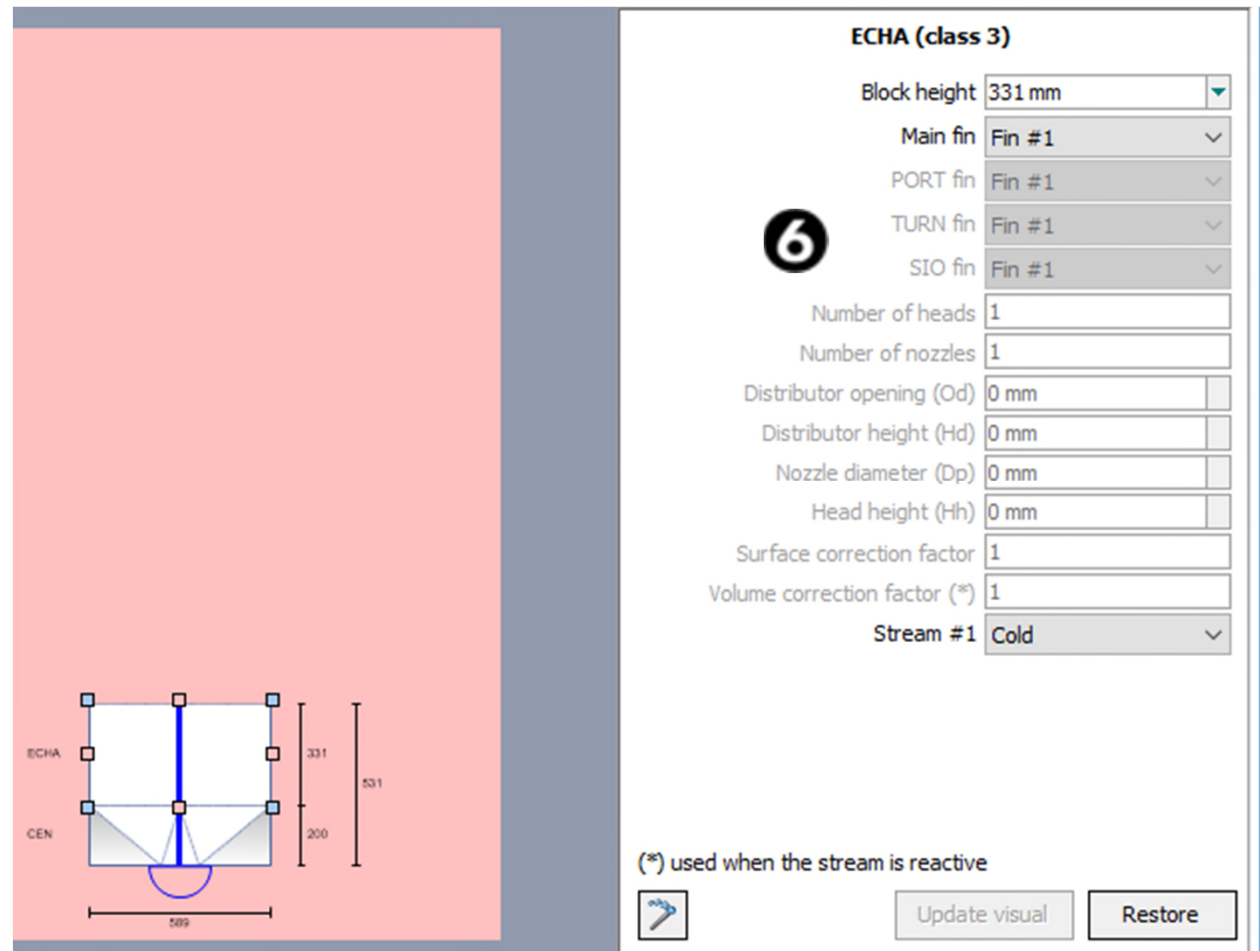
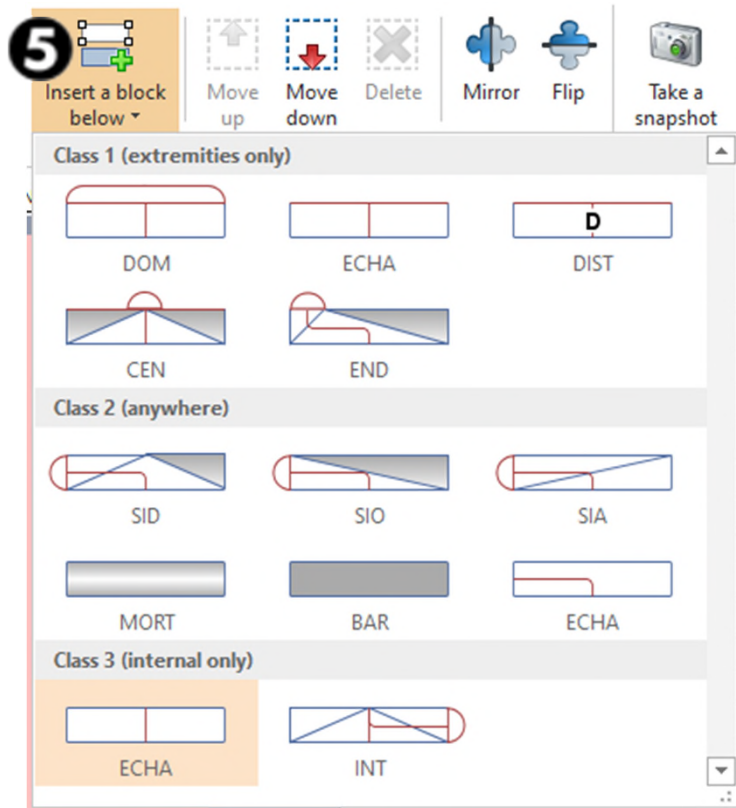
Step 3: Create the flowsheet

A- ProSec unit operation

34

- “Reference layer” tab

5. Click on “Add a block on top” and select a heat exchange zone “ECHA”
6. Select this block and enter its parameters

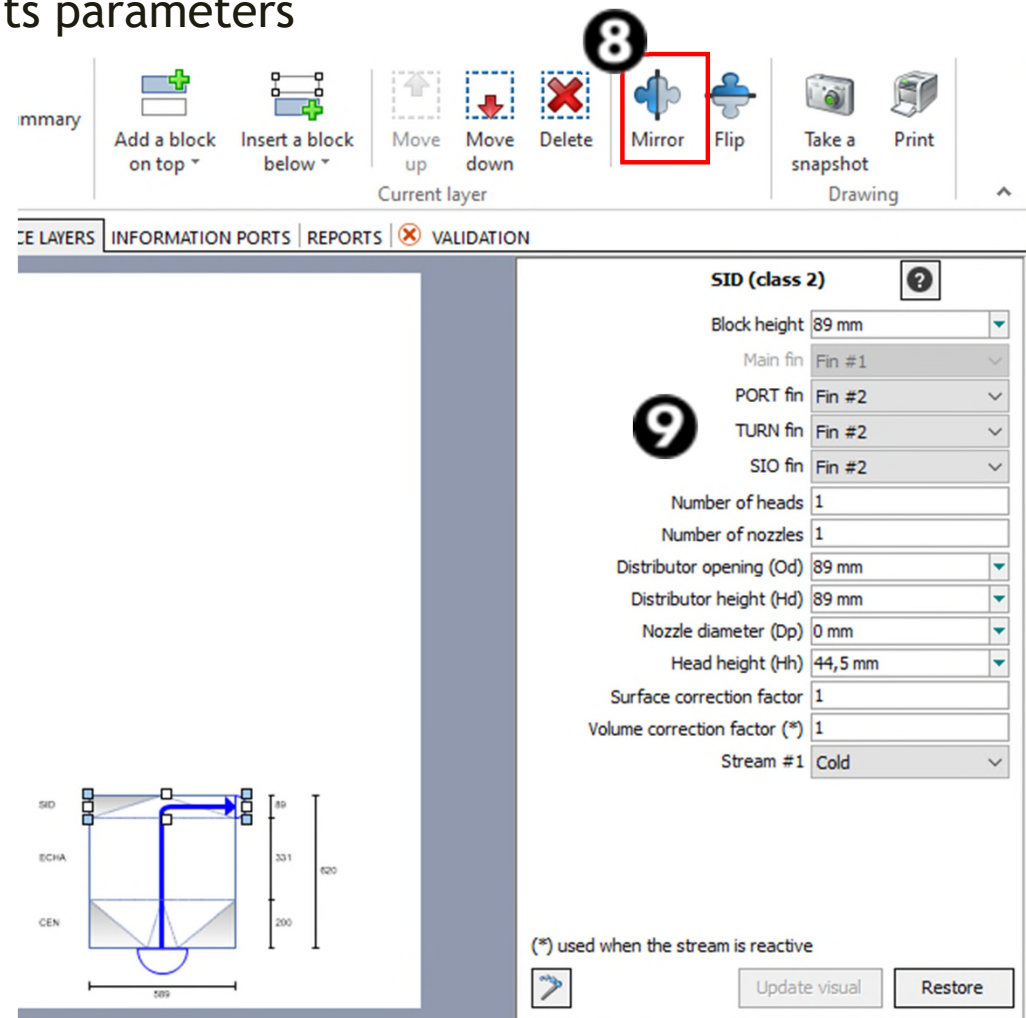
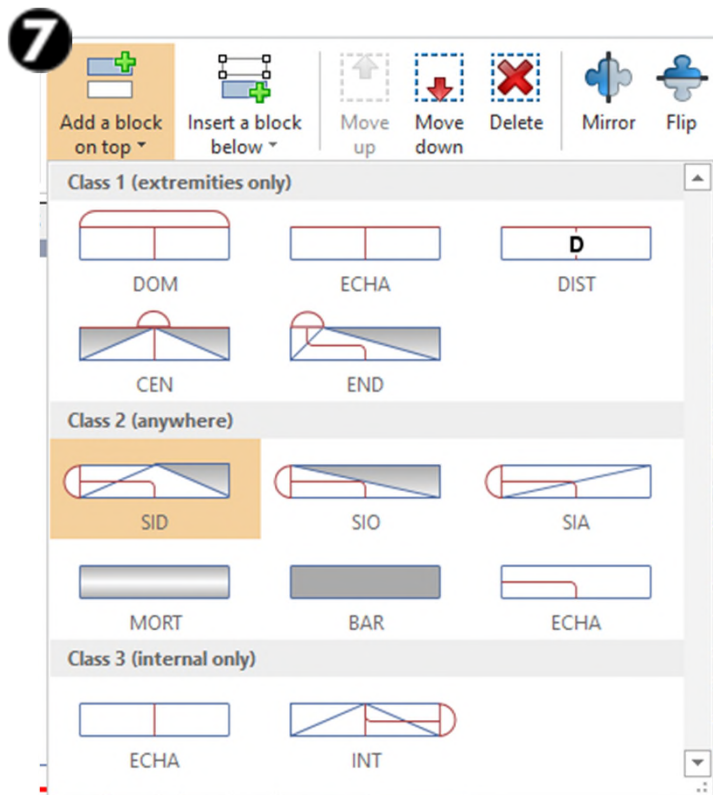


Step 3: Create the flowsheet

A- ProSec unit operation

■ “Reference layer” tab

7. Click on “Add a block on top” and select a “SID” distributor
8. Click on “Mirror” to change the position of its head
9. Select this block and enter its parameters

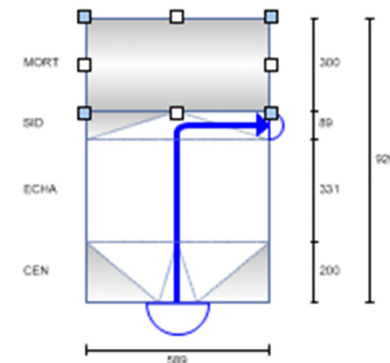
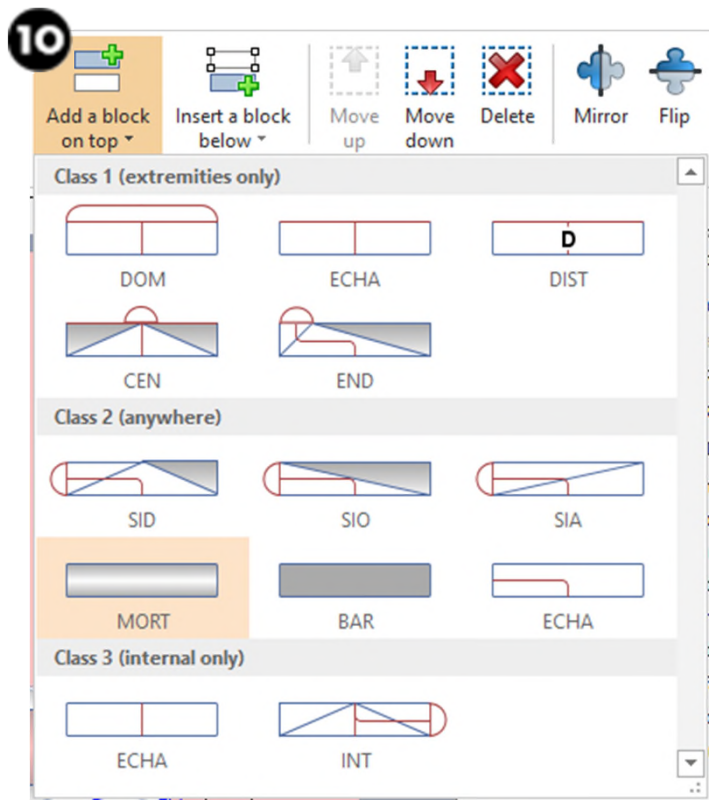


Step 3: Create the flowsheet

A- ProSec unit operation

- “Reference layer” tab

10. Click on “Add a block on top” and select a “MORT” zone, i.e. a zone in which no fluid flows (only conduction occurs)
11. Select this block and enter its parameters



MORT (class 2)

Block height 300 mm

Main fin Fin #1

PORT fin Fin #1

TURN fin Fin #1

SIO fin Fin #1

Number of heads 1

Number of nozzles 1

Distributor opening (Od) 0 mm

Distributor height (Hd) 0 mm

Nozzle diameter (Dp) 0 mm

Head height (Hh) 0 mm

Surface correction factor 1

Volume correction factor (*) 1

Stream #1 Hot

(*) used when the stream is reactive

Update visual

Restore

11

Step 3: Create the flowsheet

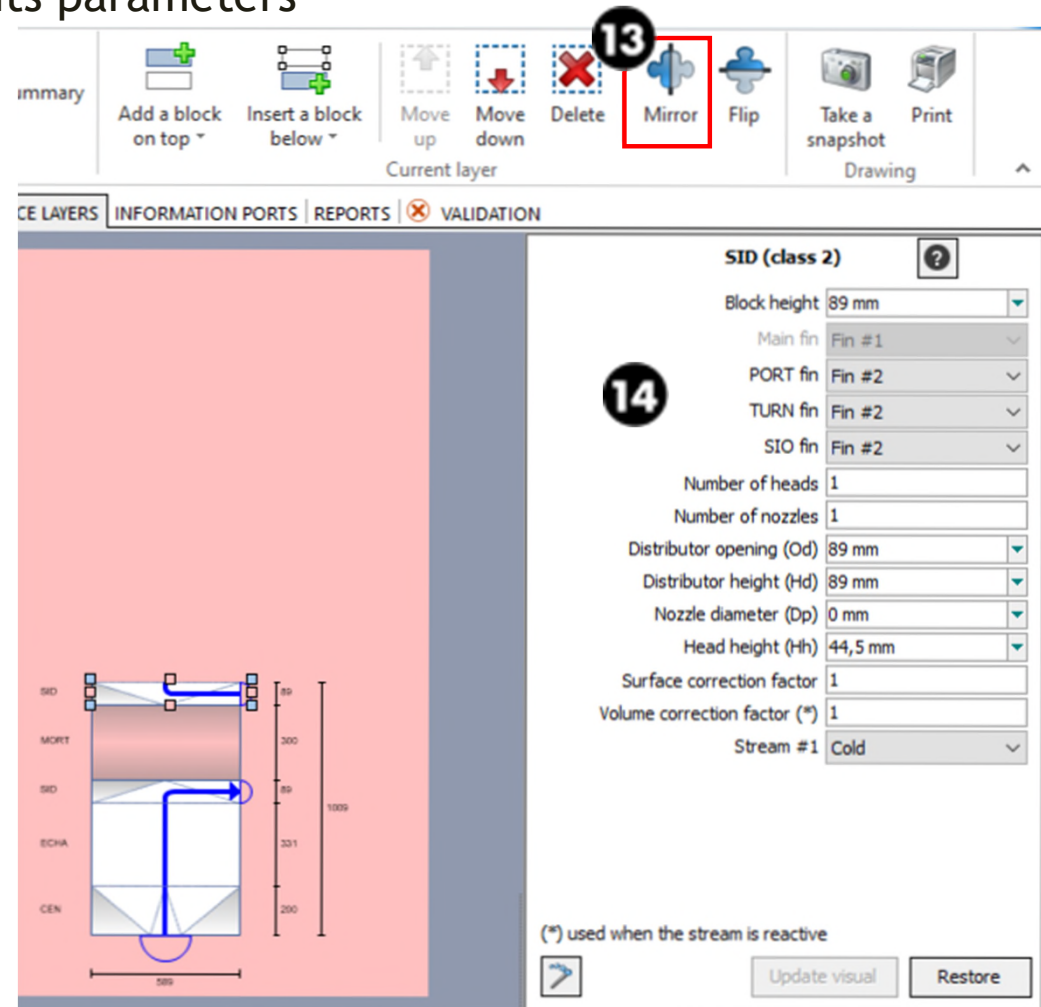
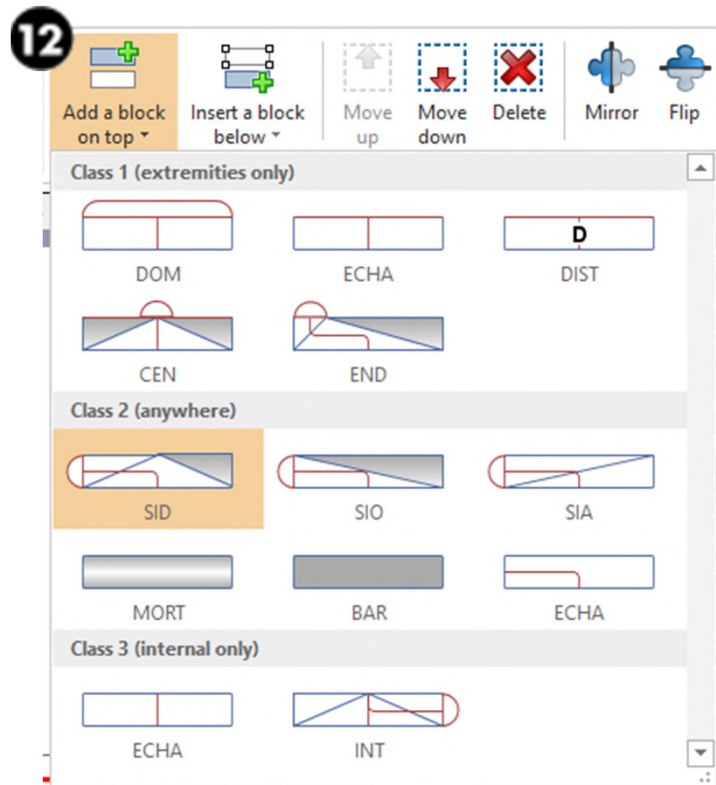
A- ProSec unit operation

- “Reference layer” tab

12. Click on “Add a block on top” and select a “SID” distributor

13. Click on “Mirror” to change the position of its head

14. Select this block and enter its parameters



Step 3: Create the flowsheet

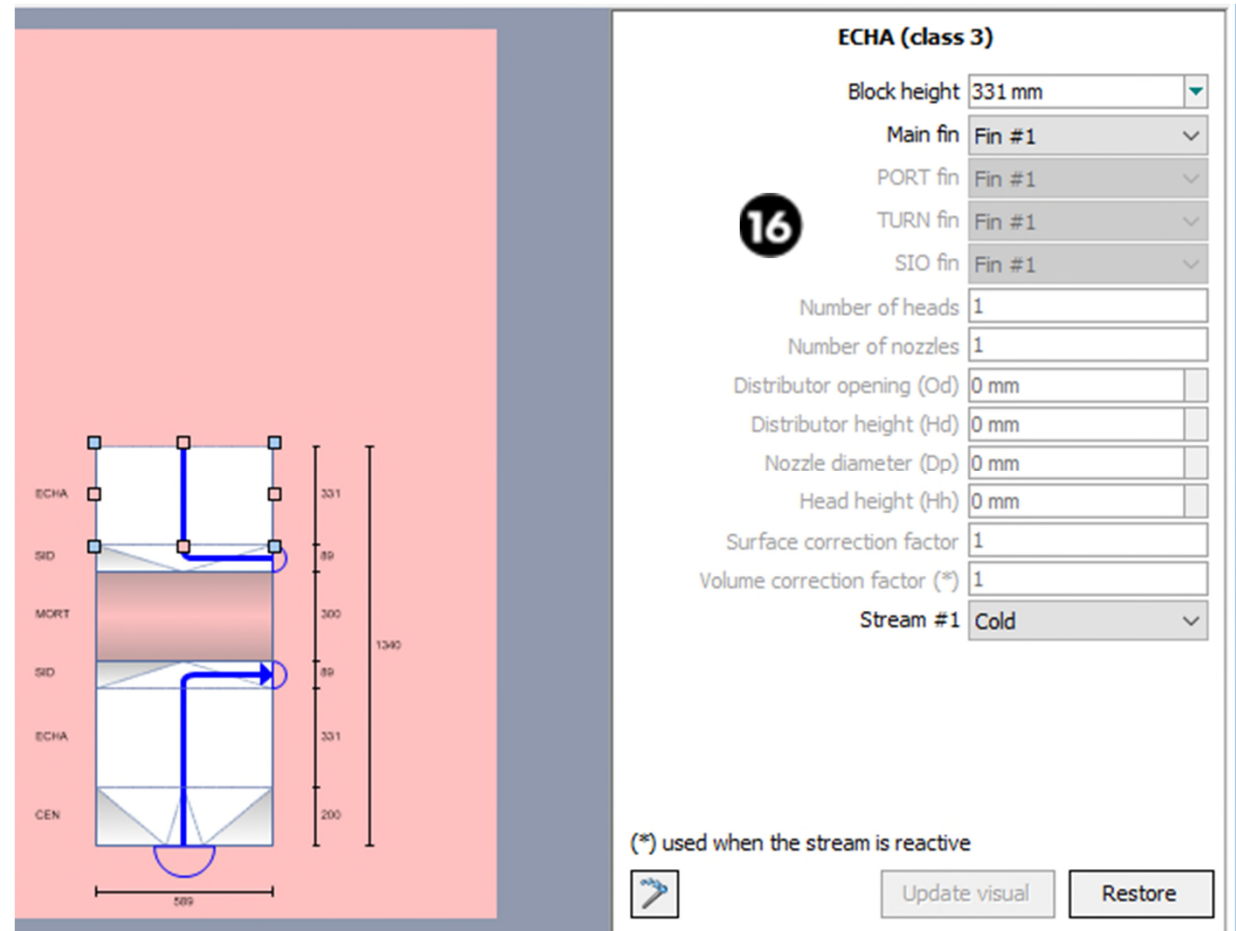
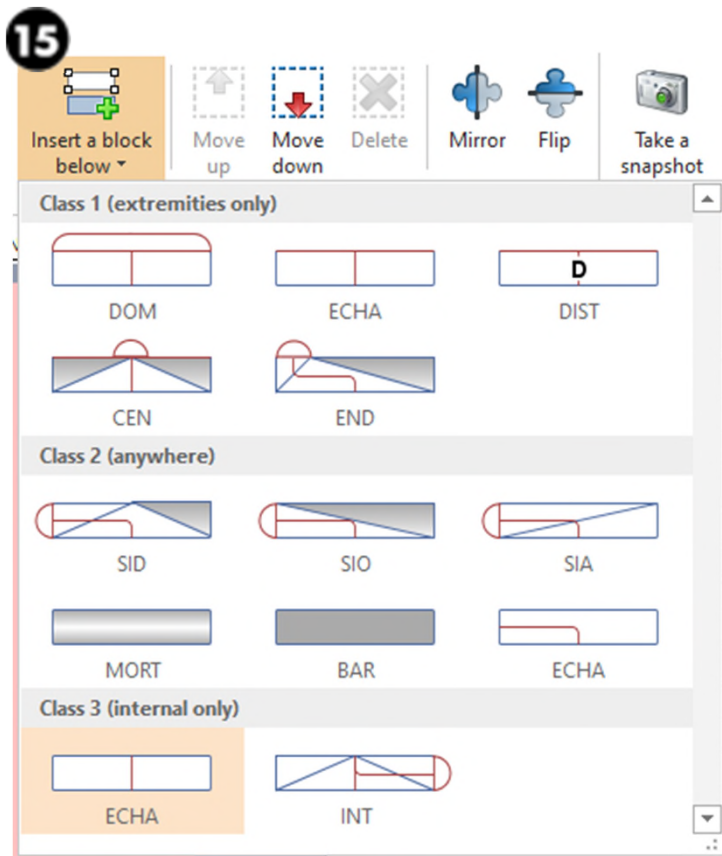
A- ProSec unit operation

38

- “Reference layer” tab

15. Click on “Add a block on top” and select a heat exchange zone “ECHA”

16. Select this block and enter its parameters



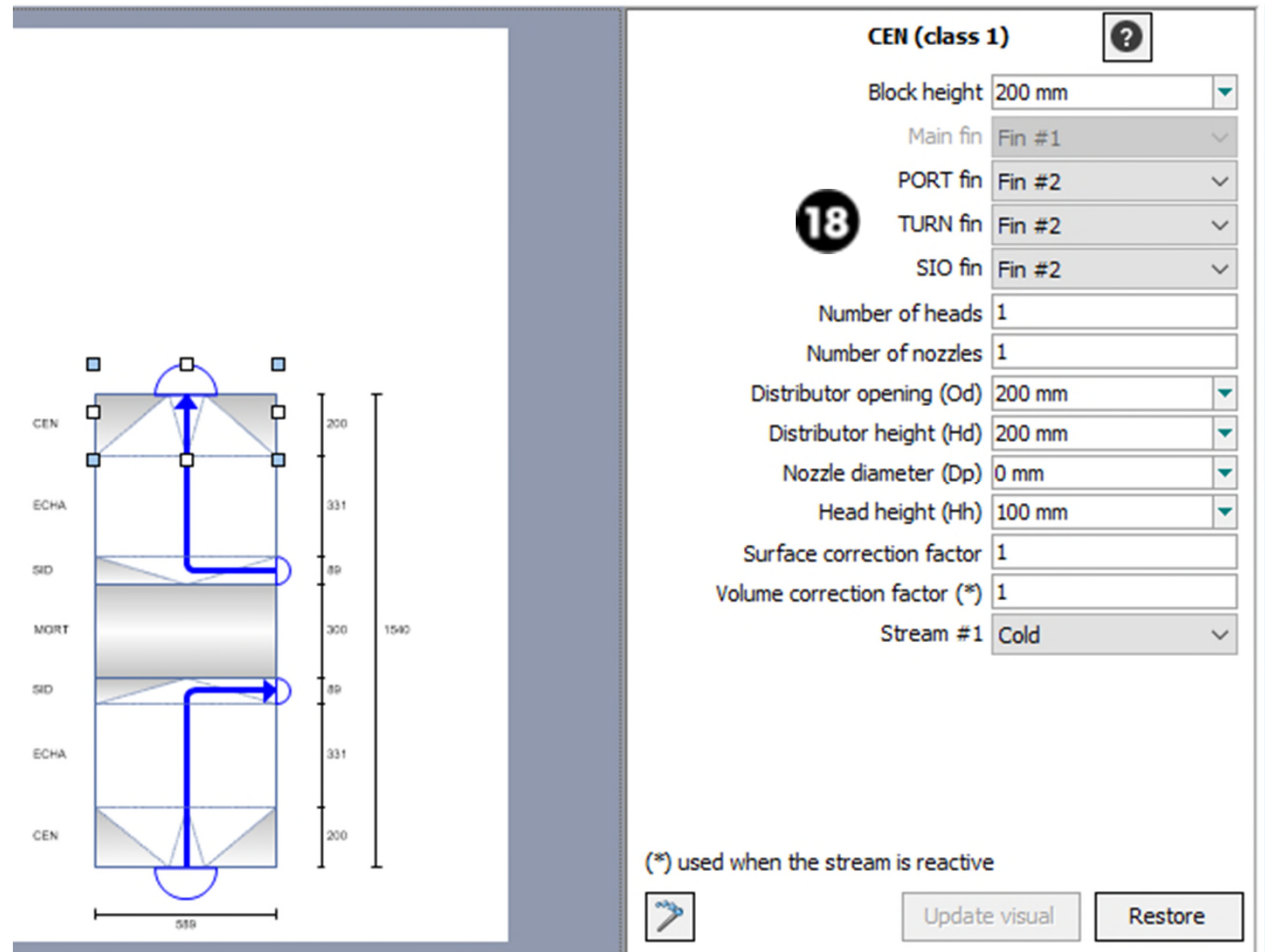
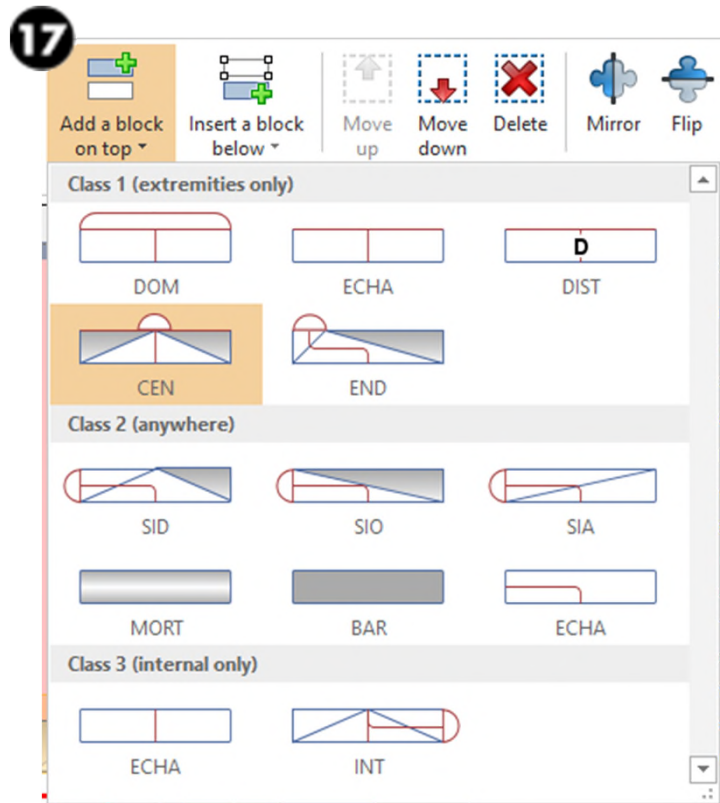
Step 3: Create the flowsheet

A- ProSec unit operation

- “Reference layer” tab

17. Click on “Add a block on top” and select a “CEN” distributor

18. Select this block and enter its parameters

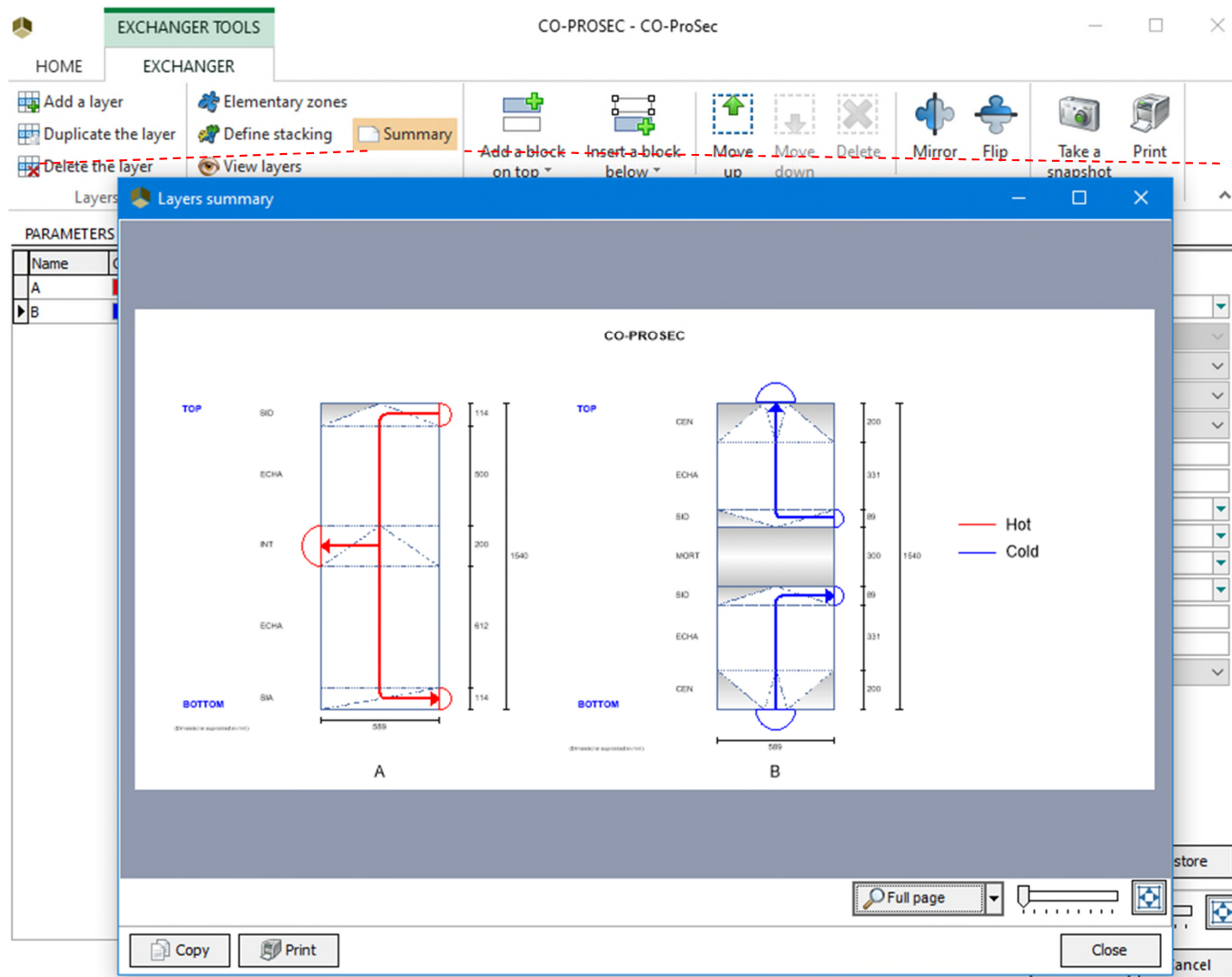


Step 3: Create the flowsheet

A- ProSec unit operation

40

- “Reference layer” tab
 - ✓ Click on “Summary” to visualize the whole reference layers



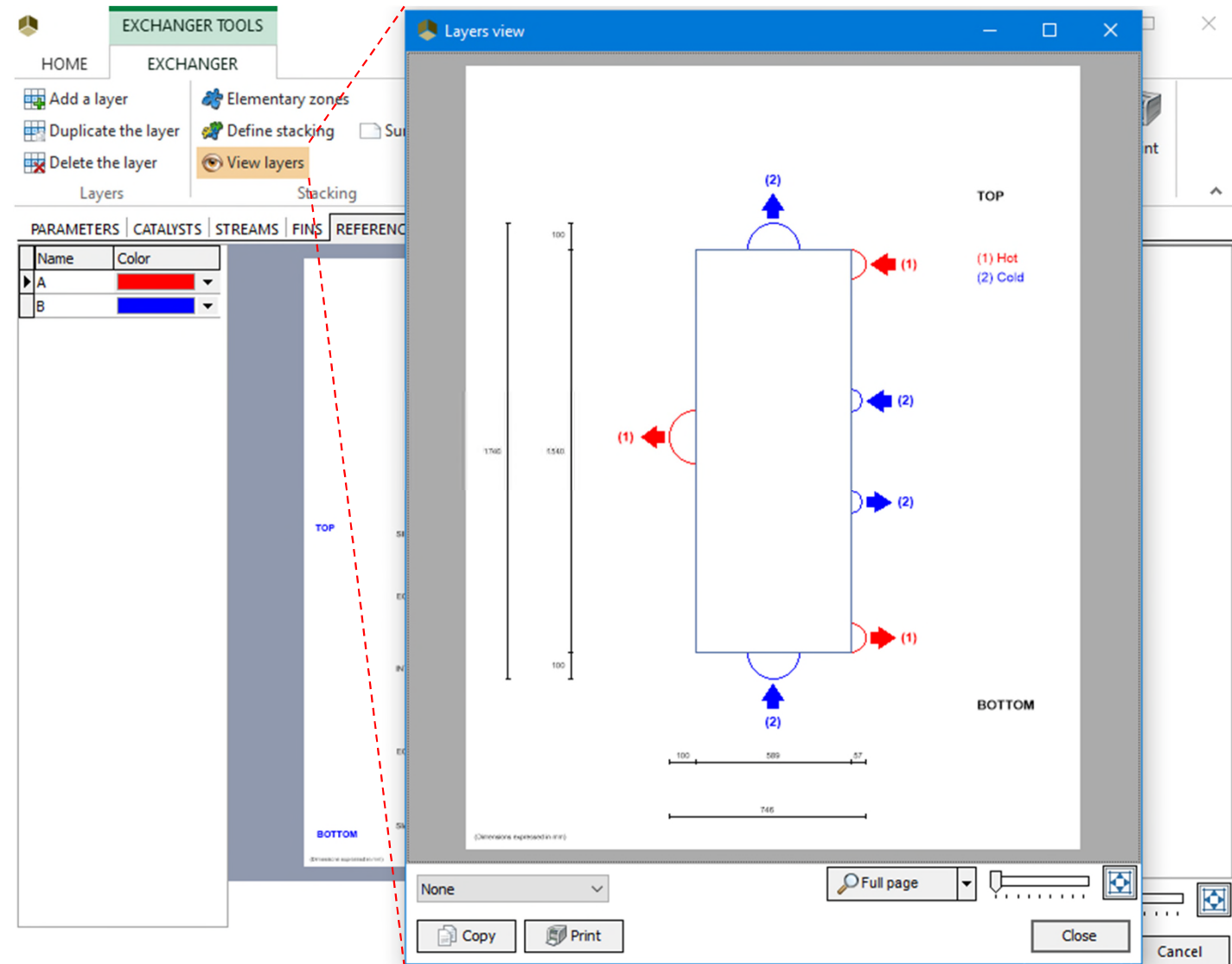
Step 3: Create the flowsheet

A- ProSec unit operation

41

- “Reference layer” tab

- ✓ Click on “View layers” to visualize the sketch of the heat exchanger (head position...)

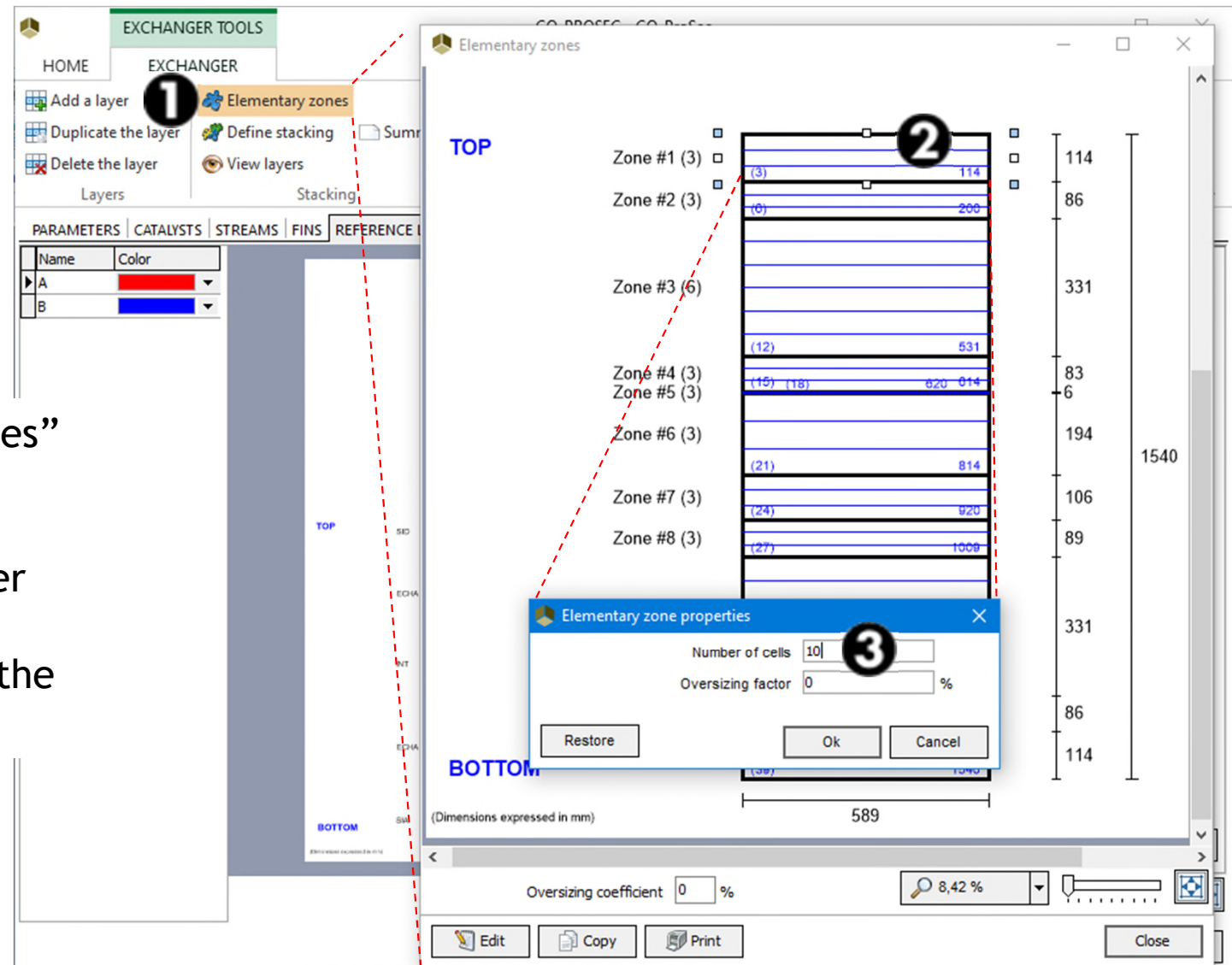


Step 3: Create the flowsheet

A- ProSec unit operation

- “Reference layer” tab
 - ✓ Adjust the number of discretization cells

1. Click on “Elementary zones”
2. Double-click on the first elementary zone
3. Modify the default number of cells
4. Repeat point 2 and 3 for the other elementary zones

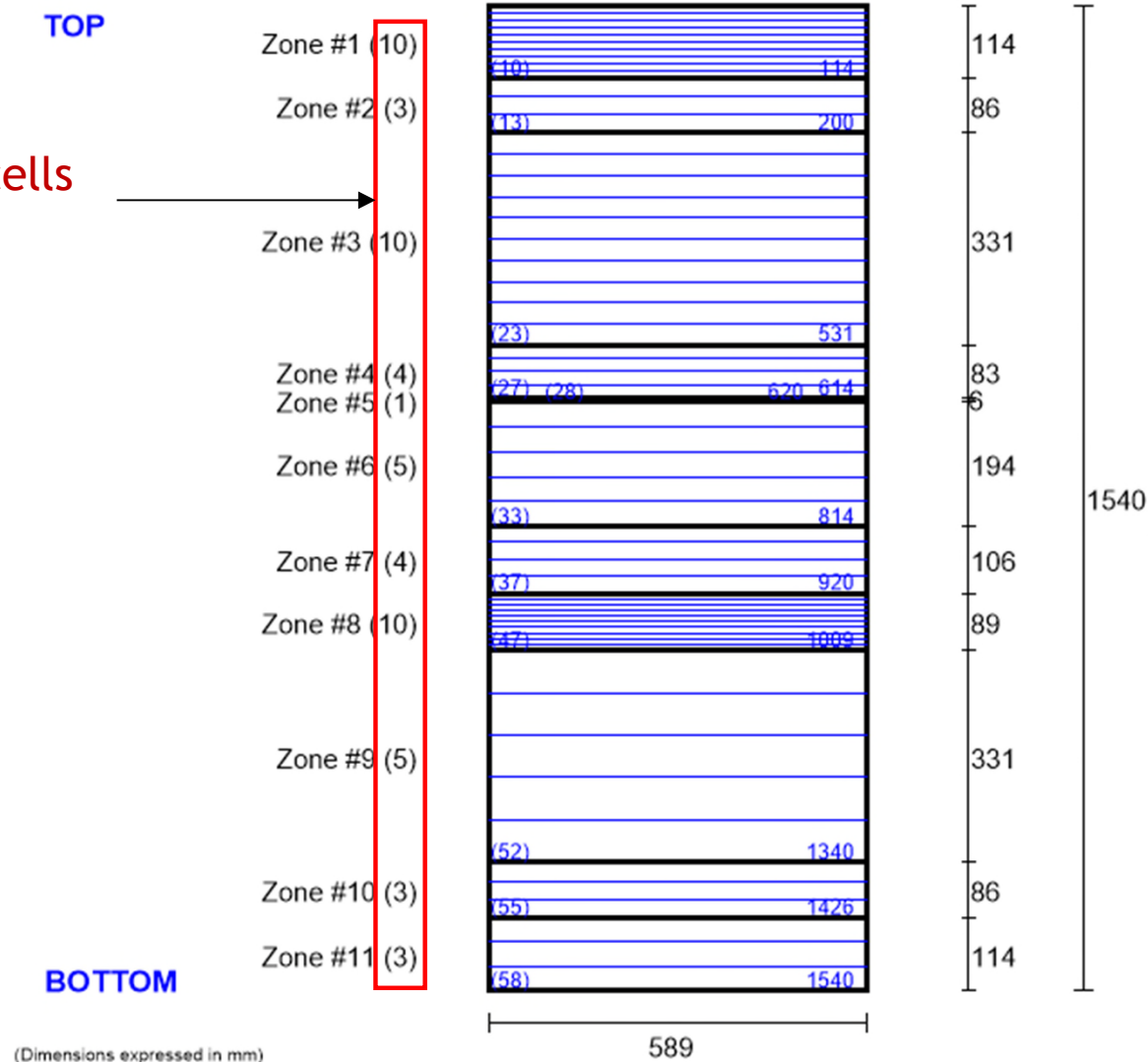


Step 3: Create the flowsheet

A- ProSec unit operation

- “Reference layer” tab
 - ✓ Adjust the number of discretization cells

Number of discretization cells
for each elementary zone



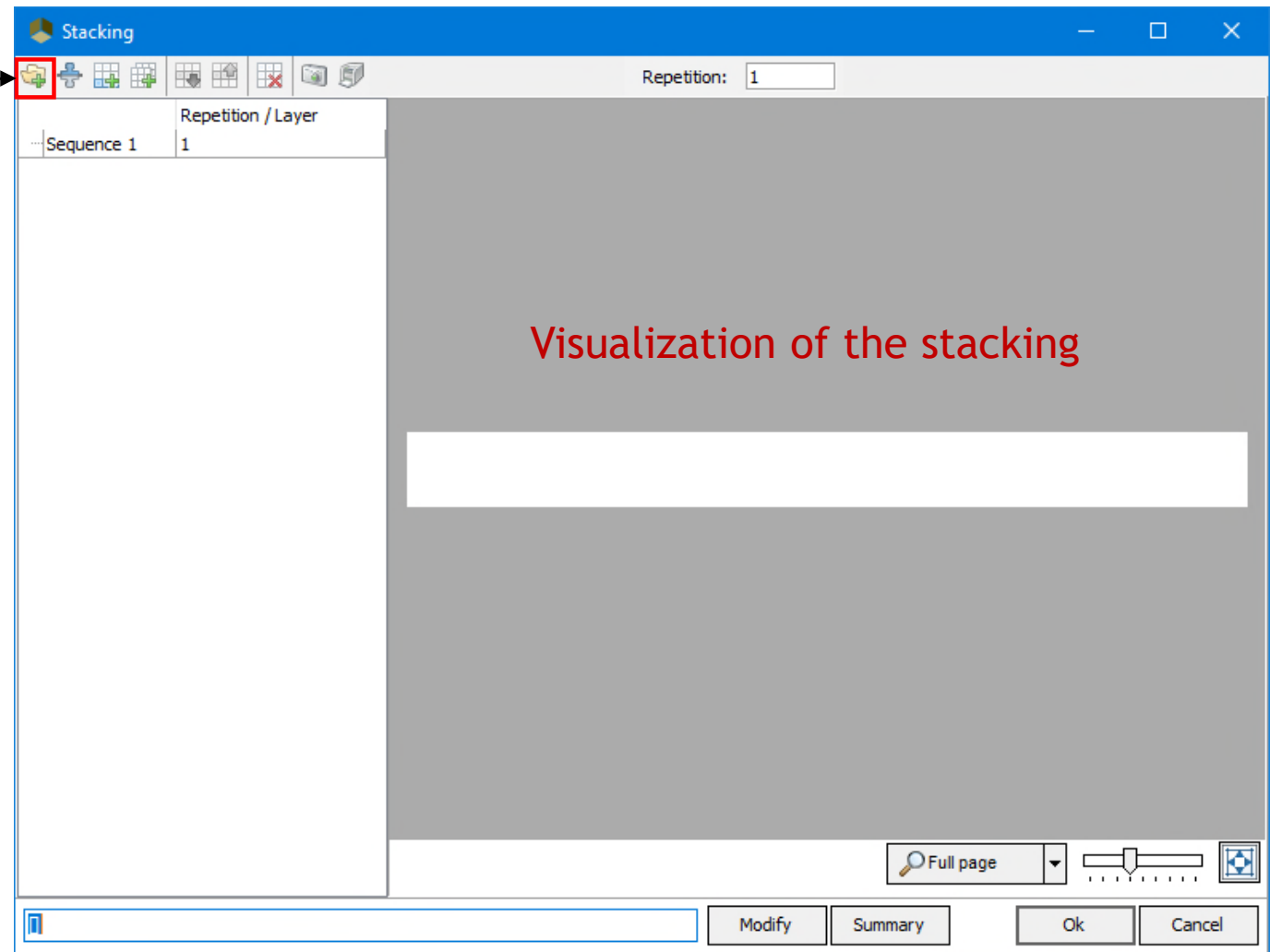
Step 3: Create the flowsheet

A- ProSec unit operation

44

- “Reference layer” tab
 - ✓ Define the stacking: A B A B A B (6 layers)
 - 1. Click on “Add a new sequence”

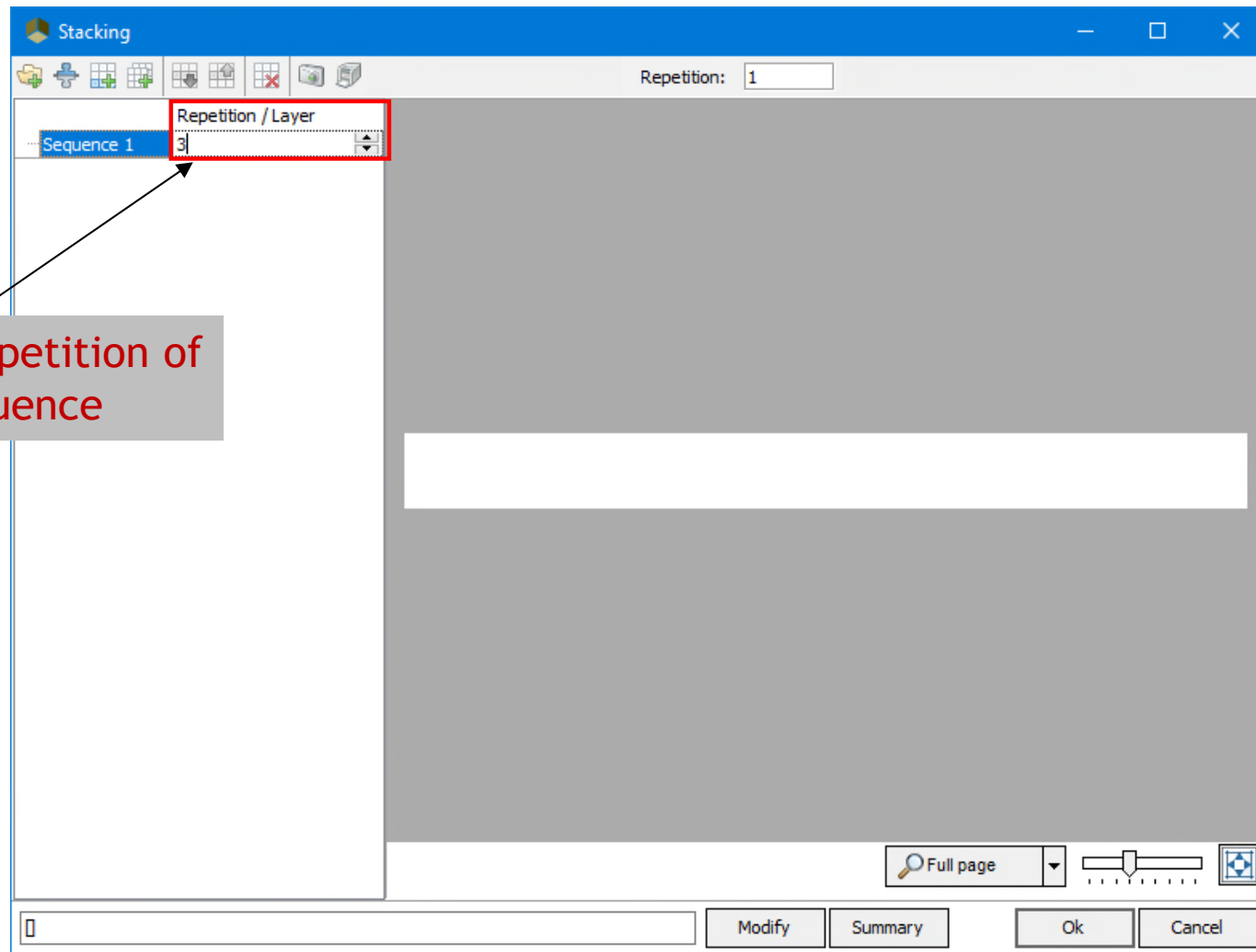
Add a sequence



Step 3: Create the flowsheet

A- ProSec unit operation

- “Reference layer” tab
 - ✓ Define the stacking: A B A B A B (6 layers)
 - 2. Specify 3 repetition for the “Sequence 1”



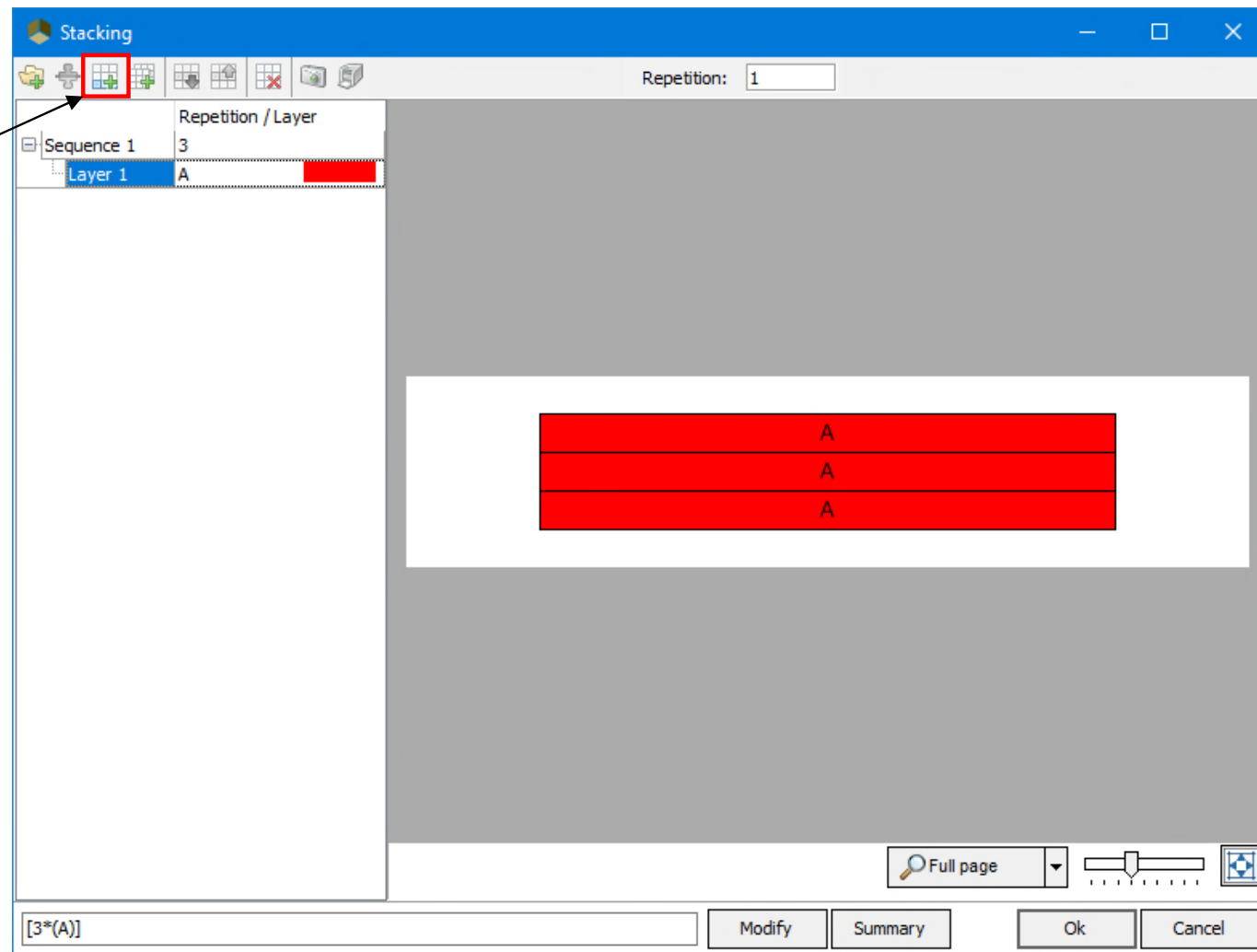
Step 3: Create the flowsheet

A- ProSec unit operation

46

- “Reference layer” tab
 - ✓ Define the stacking: A B A B A B (6 layers)
 - 3. Click on “Add a new layer in the selected sequence”

Add a layer
in a sequence



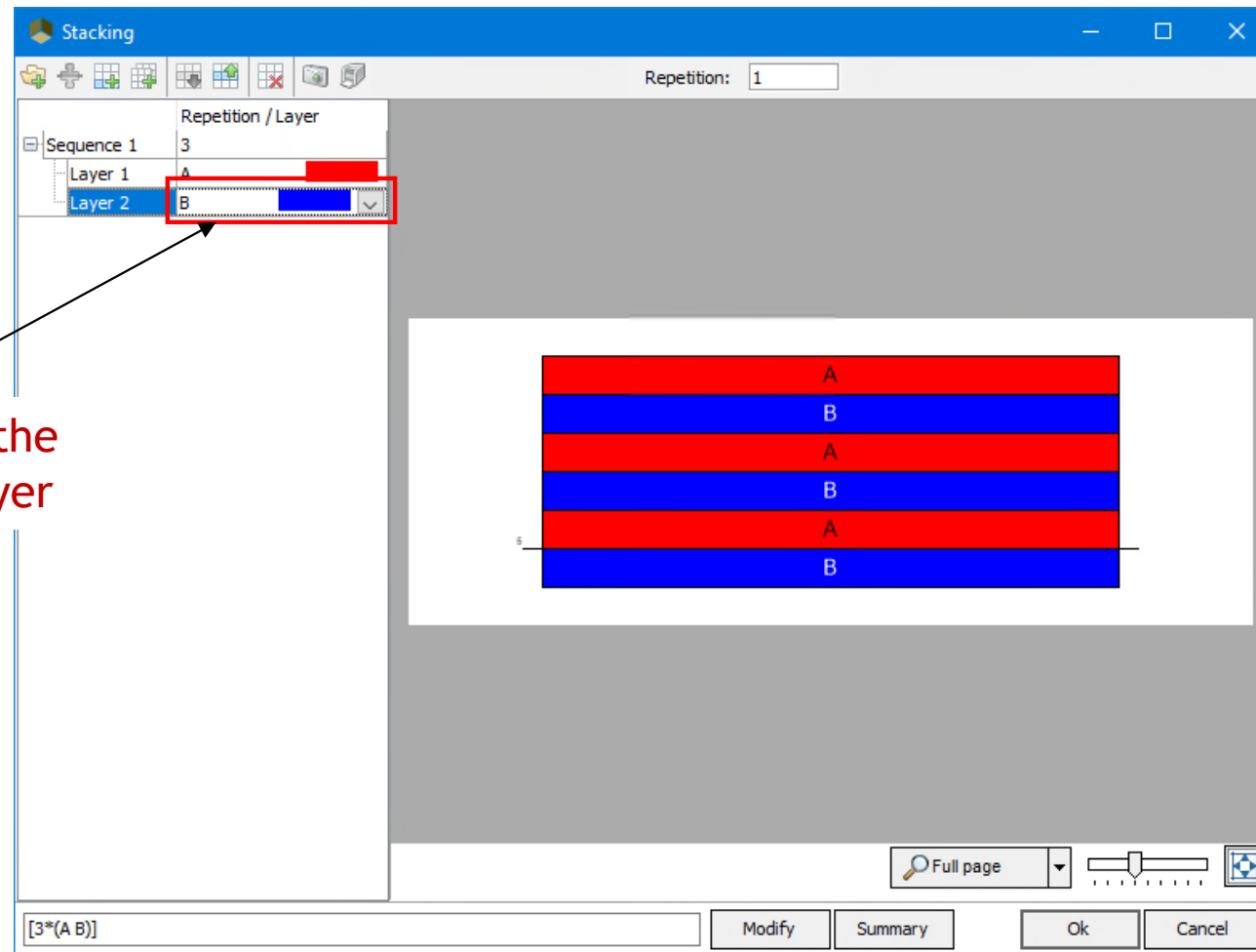
Step 3: Create the flowsheet

A- ProSec unit operation

47

- “Reference layer” tab
 - ✓ Define the stacking: A B A B A B (6 layers)
 - 4. Click a second time on “Add a new layer in the selected sequence”
 - 5. With the menu of the “Layer 2”, select the reference layer “B”

Selection of the
reference layer



Step 3: Create the flowsheet

A- ProSec unit operation

48

- “Information ports” tab
 - ✓ Add inlet/outlet information ports
 - 1. Click “Add an inlet port”

CO-PROSEC - CO-ProSec

HOME PORTS

1 Add an inlet port Add an outlet port Duplicate the selected port Delete the selected port

Edit ports

PARAMETERS CATALYSTS STREAMS FINS REFERENCE LAYERS INFORMATION PORTS REPORTS RESULTS VALIDATION

Inlet information ports Outlet information ports

#	Imported parameter	Stream	Sidestream	Zon...	Name
---	--------------------	--------	------------	--------	------

#	Exported parameter	Stream	Sidestream	Name
---	--------------------	--------	------------	------

Step 3: Create the flowsheet

A- ProSec unit operation

- “Information ports” tab
2. Select the parameter to import from another unit operation of the simulation for the inlet information port: the imported value will replace the value defined in the interface

The screenshot shows the 'CO-PROSEC - CO-ProSec' software window. The 'INFORMATION PORTS' tab is active. The 'Inlet information ports' table is displayed with the following columns: #, Imported parameter, Stream, Sidestream, Zon..., and Name. A dropdown menu is open for the 'Imported parameter' column, showing a list of parameters: 'Splitting ratio of flowrate (%)', 'Used width (Wu)', 'Global oversizing factor', 'Oversizing factor', 'Fouling factor', and 'Enthalpic factor'. The 'Splitting ratio of flowrate (%)' option is highlighted. A red box highlights the dropdown menu, and a black circle with the number '2' is next to the 'Imported parameter' header.

Inlet information ports						Outlet information ports				
#	Imported parameter	Stream	Sidestream	Zon...	Name	#	Exported parameter	Stream	Sidestream	Name
1	Splitting ratio of flowrate (%)	Hot	Side_Hot		Splitting ratio of flowrate (%)					

Step 3: Create the flowsheet

A- ProSec unit operation

50

- “Information ports” tab
3. Click “Add an outlet port”

CO-PROSEC - CO-ProSec

HOME PORTS

Add an inlet port Add an outlet port Duplicate the selected port Delete the selected port

Edit ports

PARAMETERS CATALYSTS STREAMS FINS REFERENCE LAYERS INFORMATION PORTS REPORTS RESULTS VALIDATION

Inlet information ports

#	Imported parameter	Stream	Sidestream	Zon...	Name
1	Splitting ratio of flowrate	Hot	Side_Hot		Splitting ratio of flowrate (%)

Outlet information ports

#	Exported parameter	Stream	Sidestream	Name
---	--------------------	--------	------------	------

Step 3: Create the flowsheet

A- ProSec unit operation

51

- “Information ports” tab
4. Select the parameter to export

CO-PROSEC - CO-ProSec

HOME PORTS

Add an inlet port Add an outlet port Duplicate the selected port Delete the selected port

Edit ports

PARAMETERS CATALYSTS STREAMS FINS REFERENCE LAYERS INFORMATION PORTS REPORTS RESULTS VALIDATION

Inlet information ports

#	Imported parameter	Stream	Sidestream	Zon...	Name
1	Splitting ratio of flowrate	Hot	Side_Hot		Splitting ratio of flowrate (%)

Outlet information ports

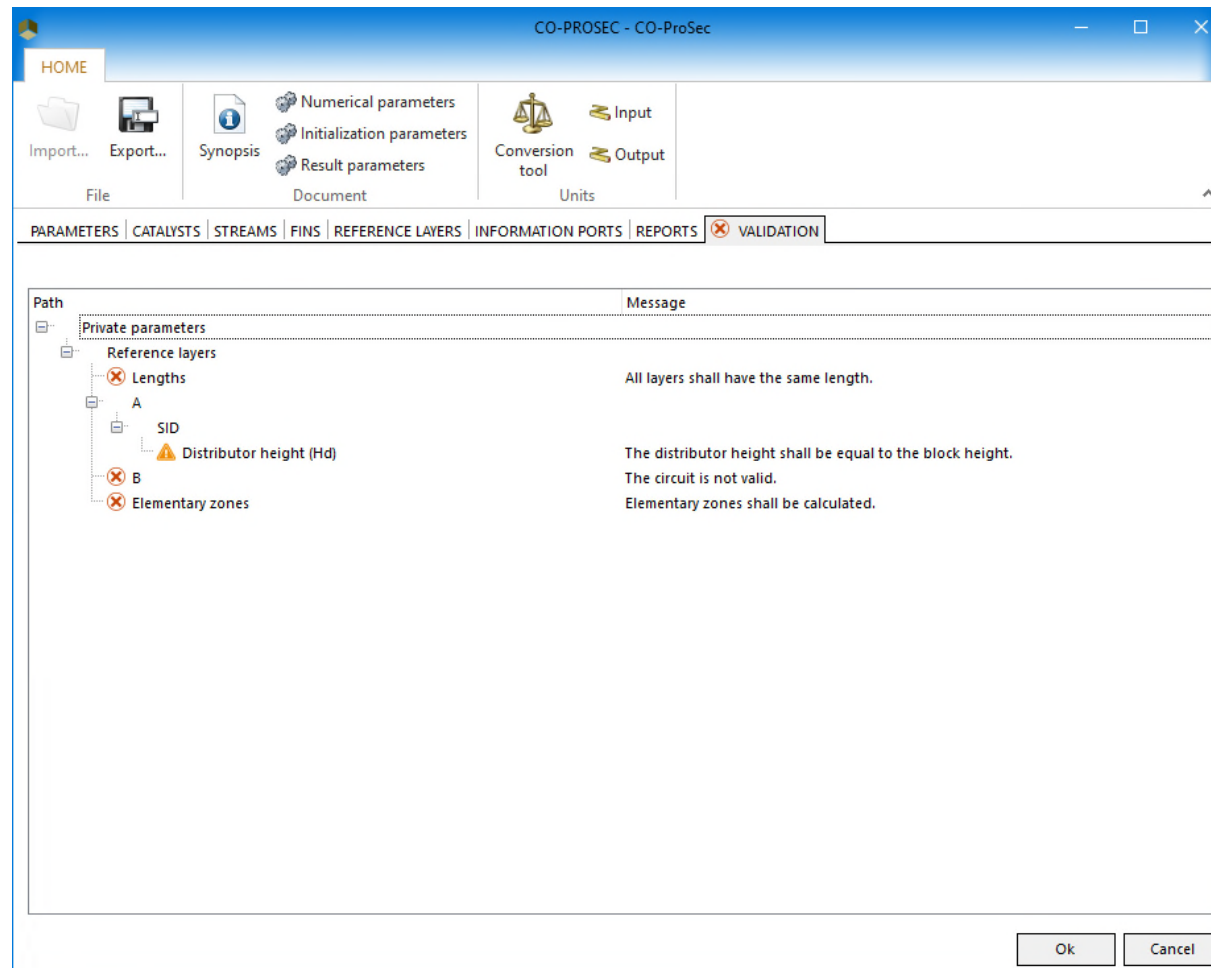
#	Exported parameter	Stream	Sidestream	Name
2	Heat duty for hot streams			Heat duty for hot streams

Heat duty (CWT)
Heat duty for hot streams (CWT)
Heat duty for cold streams (CWT)
Heat duty
Heat duty for hot streams
Heat duty for cold streams
Global pressure drop
Maximal DT between walls

Step 3: Create the flowsheet

A- ProSec unit operation

- “Validation” tab
 - ✓ The validation tab lists the eventual errors. At this point, errors are present due to the lack of material connections. To solve this problem, close all ProSec windows by clicking on “Ok” button.



Step 3: Create the flowsheet

B- Inlets and outlets

53

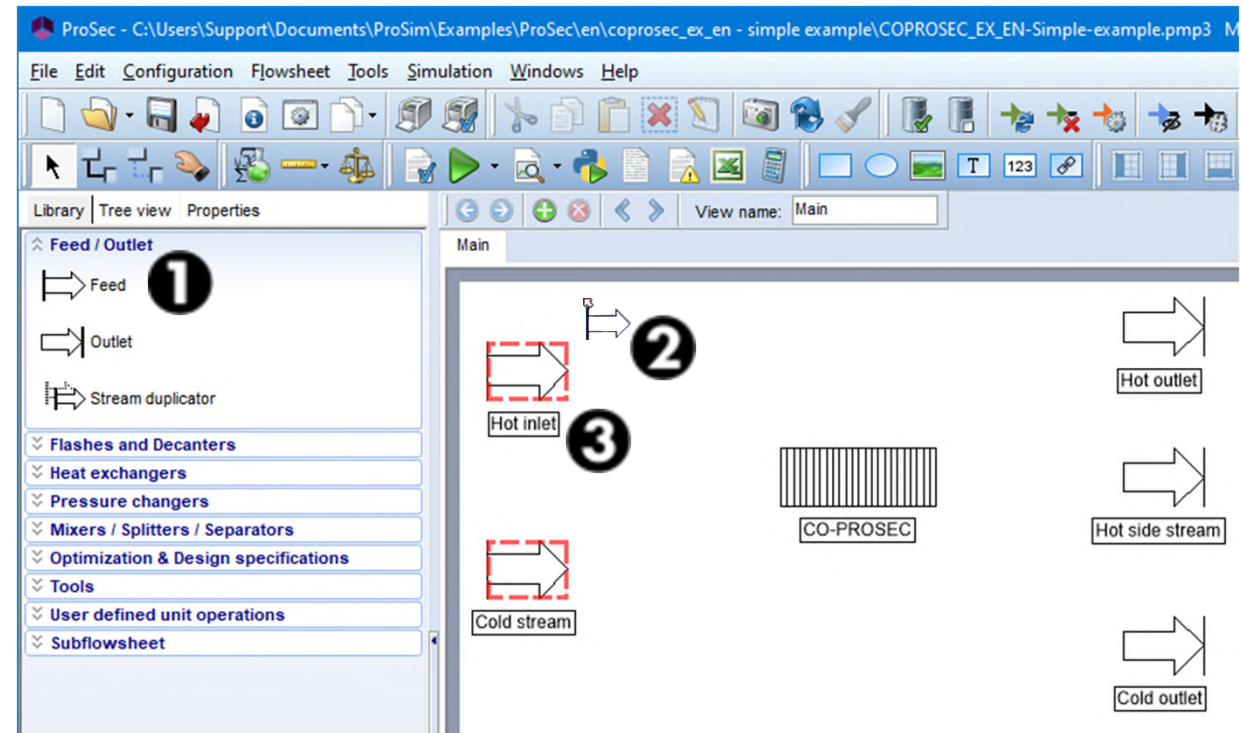
Two process feeds and three process outlets are needed for this example.

1- Click on “Process feed” icon in the library category “Feed / Product stream” to select a process feed unit operation.

2- Move the mouse onto the drawing sheet and reach the desired position.

3- Click again, to release the unit.

4- Repeat to add the second process feed and the three process outlets



Step 3: Create the flowsheet

B- Inlets and outlets

54

To configure a process feed:

1. Double-click on its icon on the flowsheet or select “Edit...” in the contextual menu.
2. Press the “Parameters” tab.

The screenshot displays the ProSim software interface. The main window shows a flowsheet with two inlet streams labeled 'Hot inlet' and 'Cold stream', both highlighted with red dashed boxes. A contextual menu is open for the 'Hot inlet' stream, with the 'Edit...' option selected, indicated by a red circle with the number 1. The 'Process feed (\$ALIM)' dialog box is open, showing the 'Parameters' tab, which is highlighted with a red box and a red circle with the number 2. The dialog box contains the following information:

Name: Hot inlet
Desc:
Parameters Scripts Report Streams Notes Advanced parameters
Copy Paste
Flowrates and fractions Thermal state Options
Flowrate specification Mole fractions
Mole fractions

#	Components	Mole fractions
1	METHANE	0
2	ETHANE	0

Sum: 0,0000 1 - sum: 1,0000
Fractions will be normalized because the sum is not equal to 1
Total flowrate Mass flowrate
Total mass flowrate 0 kg/h
Data link:
OK Cancel

Step 3: Create the flowsheet

B- Inlets and outlets

- Hot stream inlet characteristics

Process feed (\$ALIM)

Name: Hot inlet

Desc:

Identification Parameters Scripts Report Streams Notes Advanced parameters

Copy Paste

Flowrates and fractions Thermal state Options

Flowrate specification

Mass fractions

#	Components	Mass fractions
1	METHANE	0,5
2	ETHANE	0,5

Sum: 1,0000 1 - sum: 0,0000

Total flowrate

Mass flowrate

Total mass flowrate 4790,0000000 kg/h

Data link:

OK Cancel

Change the default name (option)

Select "Mass fraction"

Fill in the mass fractions

Select "Mass flowrate"

Fill in the mass flow rate

Step 3: Create the flowsheet

B- Inlets and outlets

56

- Hot stream inlet characteristics

Process feed (\$ALIM)

Name: Hot inlet

Desc:

Identification Parameters Scripts Report Streams Notes Advanced parameters

Copy Paste

Flowrates and fractions **Thermal state** Options

Data type

Temperature and pressure

Temperature specification

☒ Supplied

☐ Bubble point temperature at specified pressure

☐ Dew point temperature at specified pressure

Temperature 299 K

Pressure specification

☒ Supplied

☐ Bubble point pressure at specified temperature

☐ Dew point pressure at specified temperature

Pressure 69,4 bar

Data link: ...

OK Cancel

Specify the temperature

Specify the pressure

Step 3: Create the flowsheet

B- Inlets and outlets

57

- Cold stream inlet characteristics
 - ✓ Same characteristics as the hot stream except the temperature

Process feed (\$ALIM1)

Name: Cold stream

Desc:

Identification Parameters Scripts Report Streams Notes Advanced parameters

Copy Paste

Flowrates and fractions Thermal state Options

Data type

Temperature and pressure

Temperature specification

☒ Supplied

☐ Bubble point temperature at specified pressure

☐ Dew point temperature at specified pressure

Temperature 267 K

Pressure specification

☒ Supplied

☐ Bubble point pressure at specified temperature

☐ Dew point pressure at specified temperature

Pressure 69,4 bar

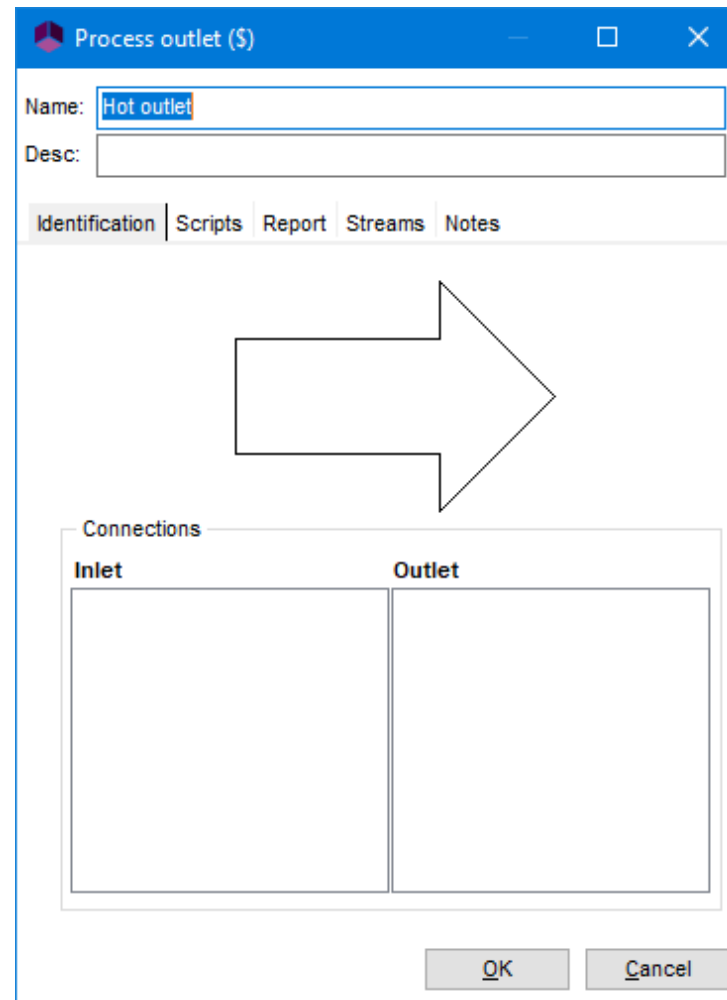
Data link:

OK Cancel

Step 3: Create the flowsheet B- Inlets and outlets

58

- Process outlets
 - ✓ No parameters are needed for process outlets

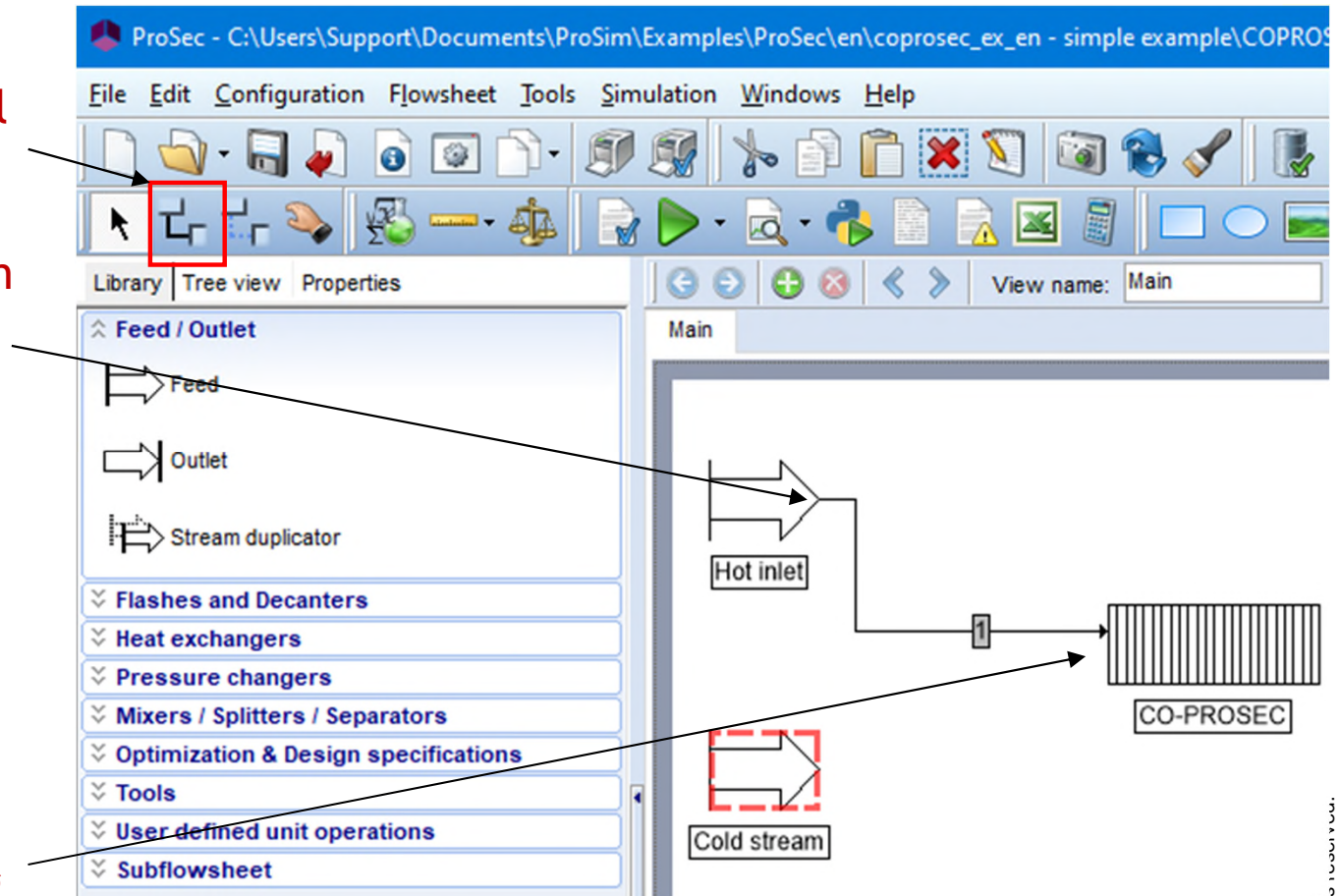


Step 3: Create the flowsheet

C- Connect unit operations

59

1. Select the “Create a material stream” icon
2. Select the first unit operation (source) by clicking on it
3. Select the connected unit operation (target) by clicking on it as well

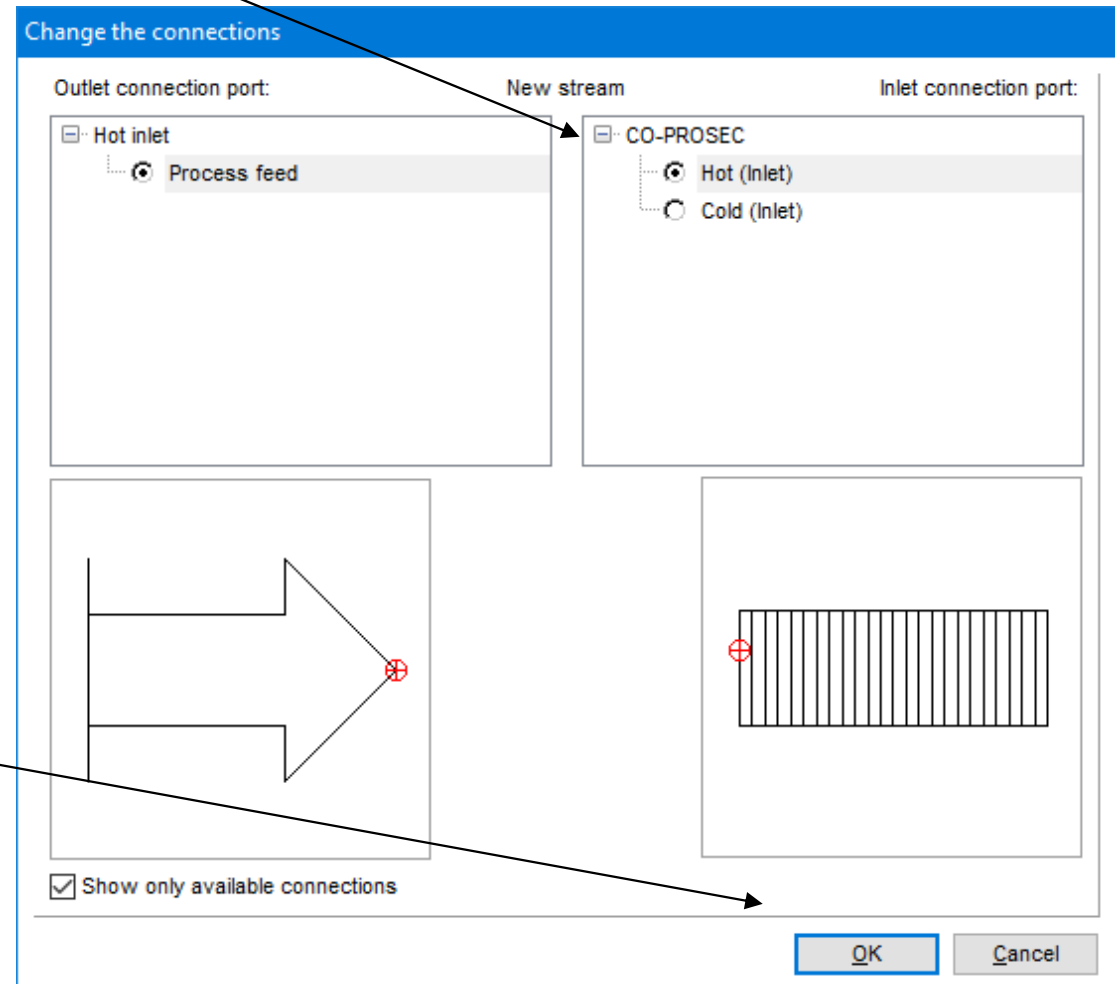


Step 3: Create the flowsheet

C- Connect unit operations

60

1. Select to which stream described in ProSec unit operation you want to connect the process feed. Here we connect the hot inlet to the hot stream described in ProSec unit operation.

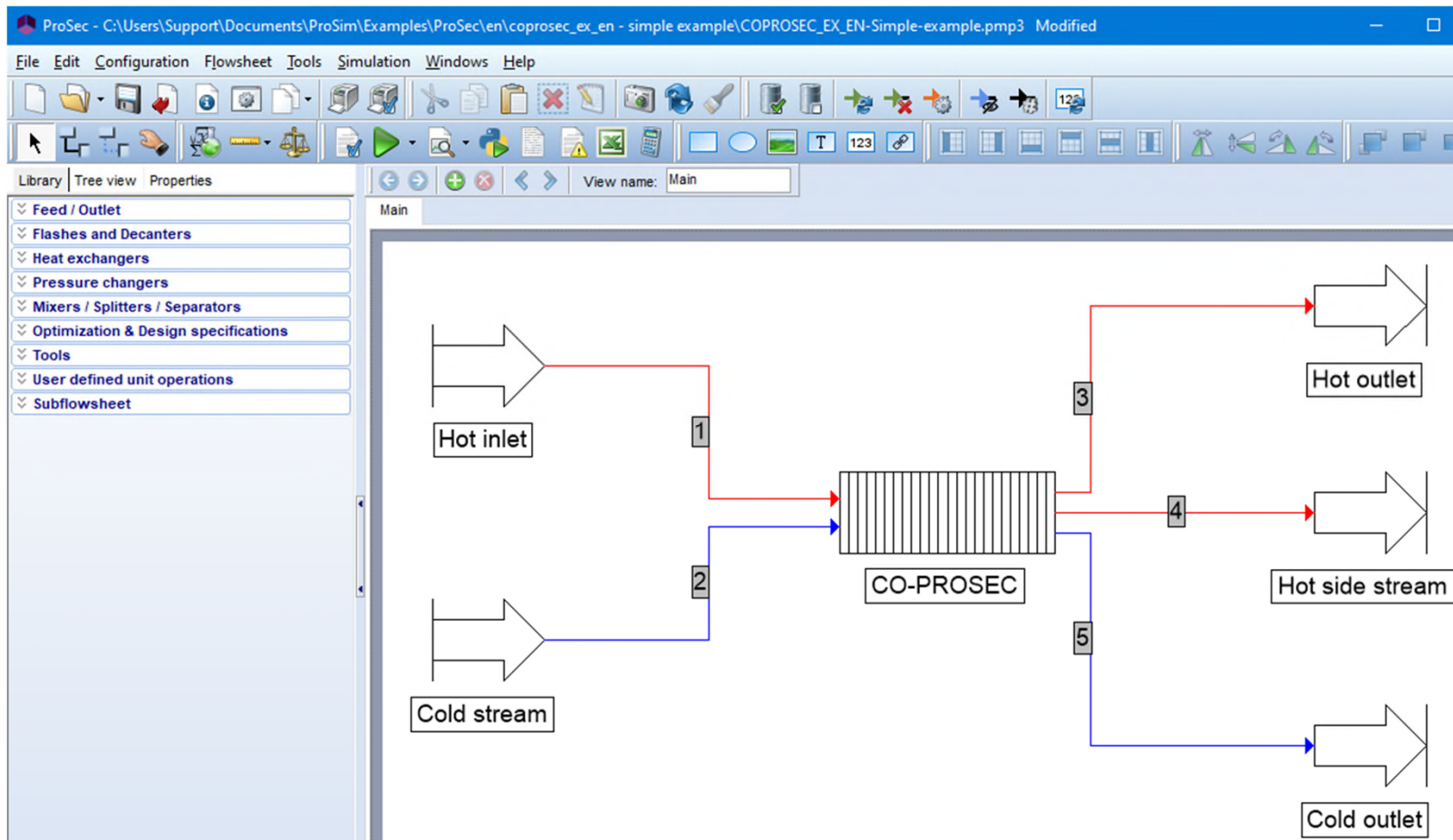


2. Confirm by clicking on "OK"
3. Repeat for the different material streams needed (5 streams)

Step 3: Create the flowsheet

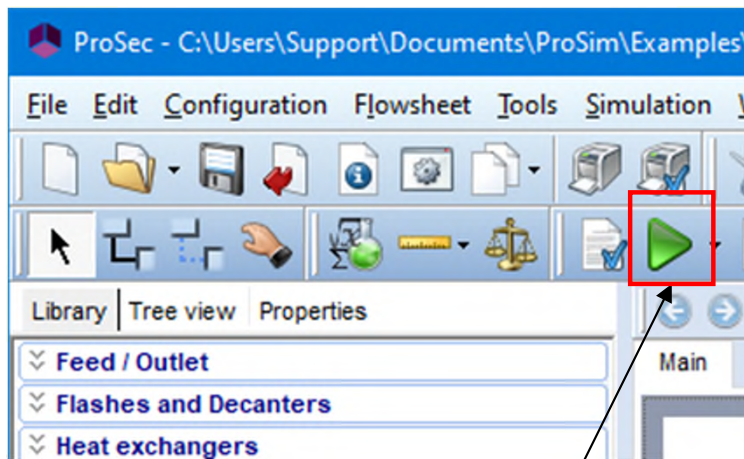
C- Connect unit operations

61



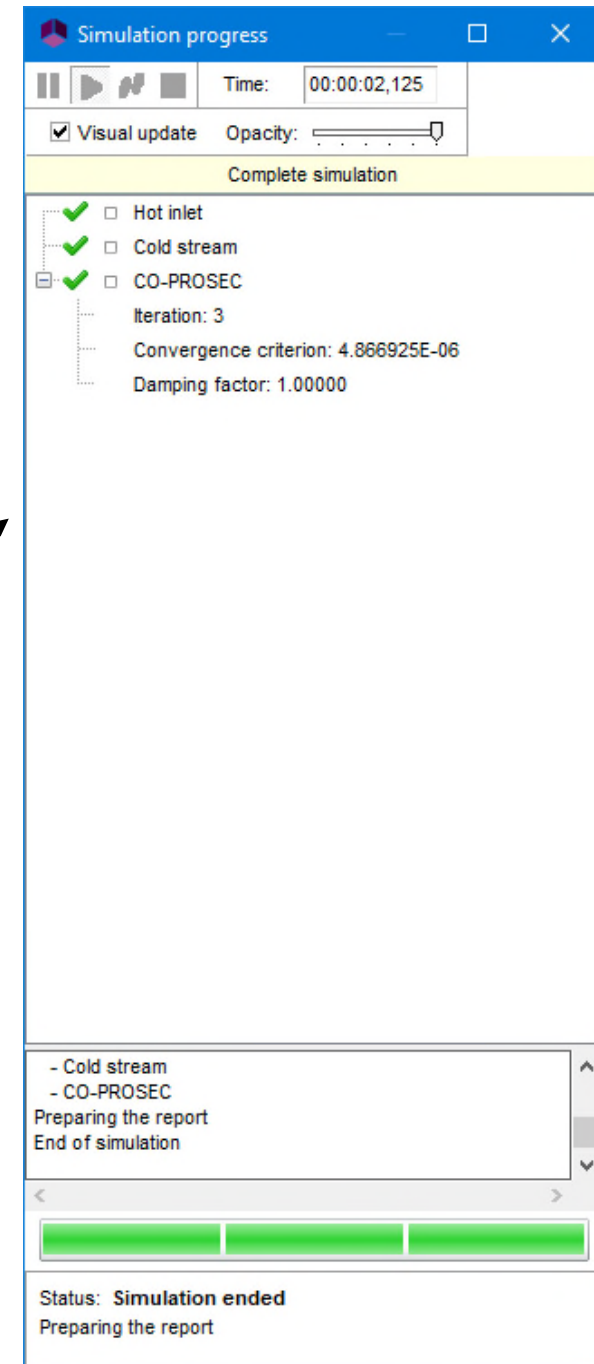
Material streams can be colored in order to ease the reading of the flowsheet. Simply right click on the stream to access the option.

Step 4: Running the simulation







Click on the green arrow to start the simulation

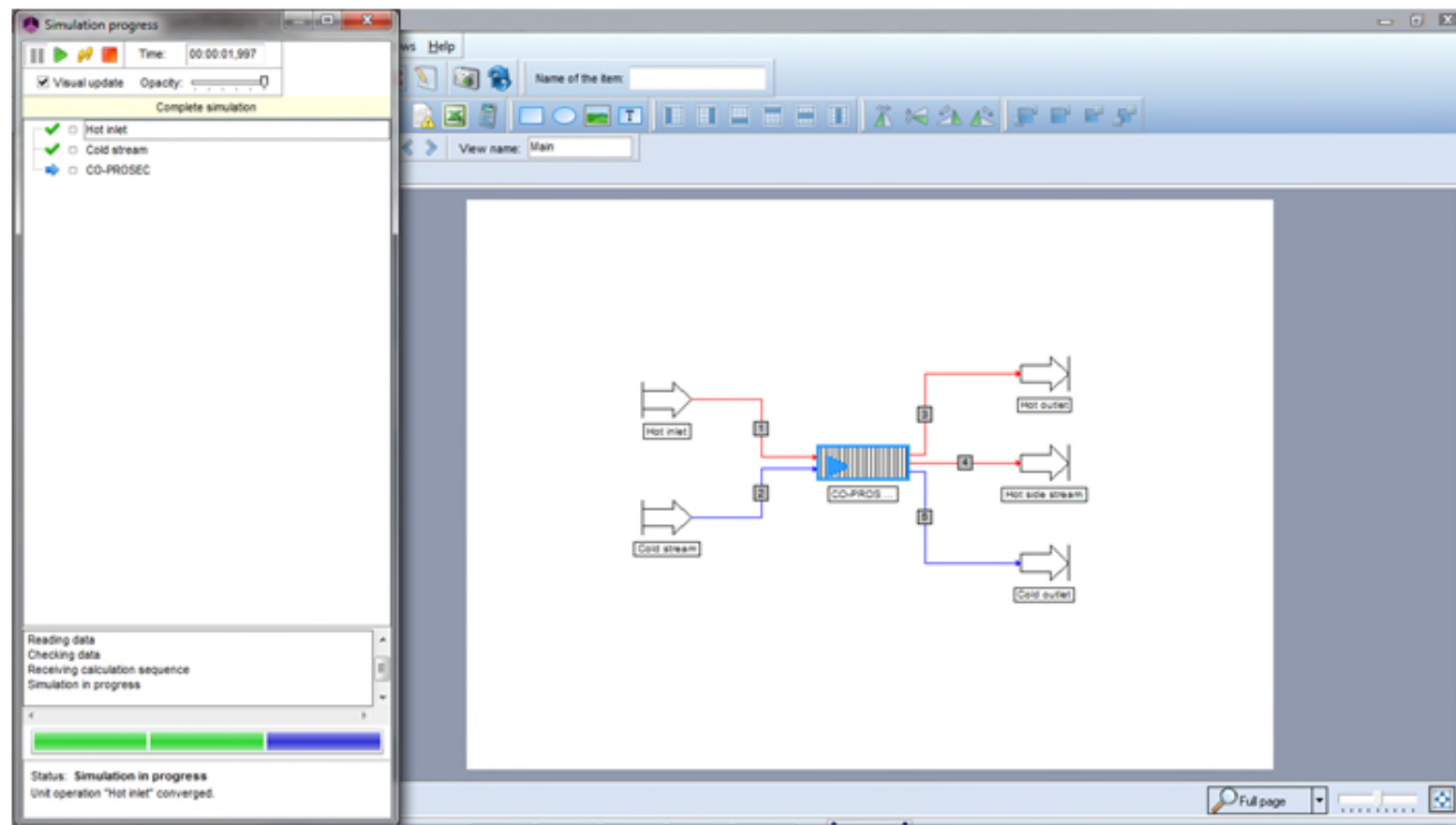
When the simulation starts,
the “Simulation progress” window
opens.



Step 4: Running the simulation

During the calculation, different symbols and indications will appear and disappear in the “Simulation progress” window and in the drawing area.

-  A green validation mark indicates that the module has been correctly calculated
-  A blue arrow indicates that calculation is in progress
-  A blue question mark indicates that the module has not been calculated yet
-  A red cross indicates a convergence error

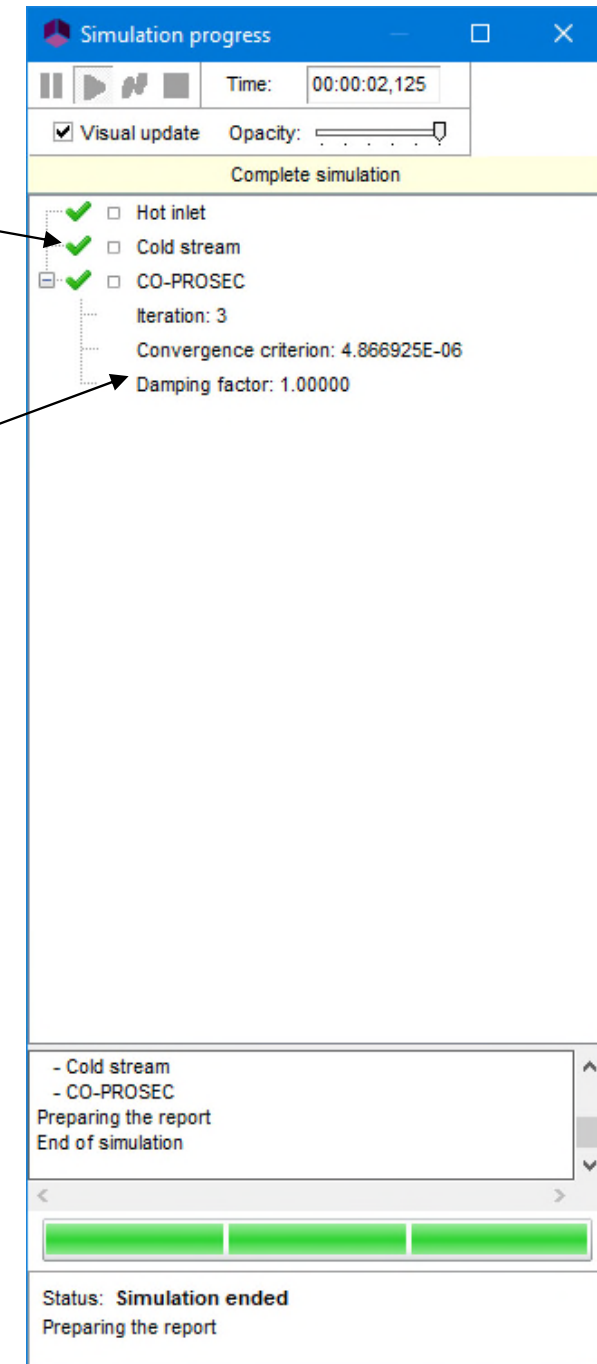


Step 4: Running the simulation

When all the modules have been properly calculated, all the marks are in green. Your simulation is successful.

Check that all the criteria for convergence have been reached.

Closing the “Simulation progress” window will, by default, automatically open the simulation report.



Step 5: Reports generated

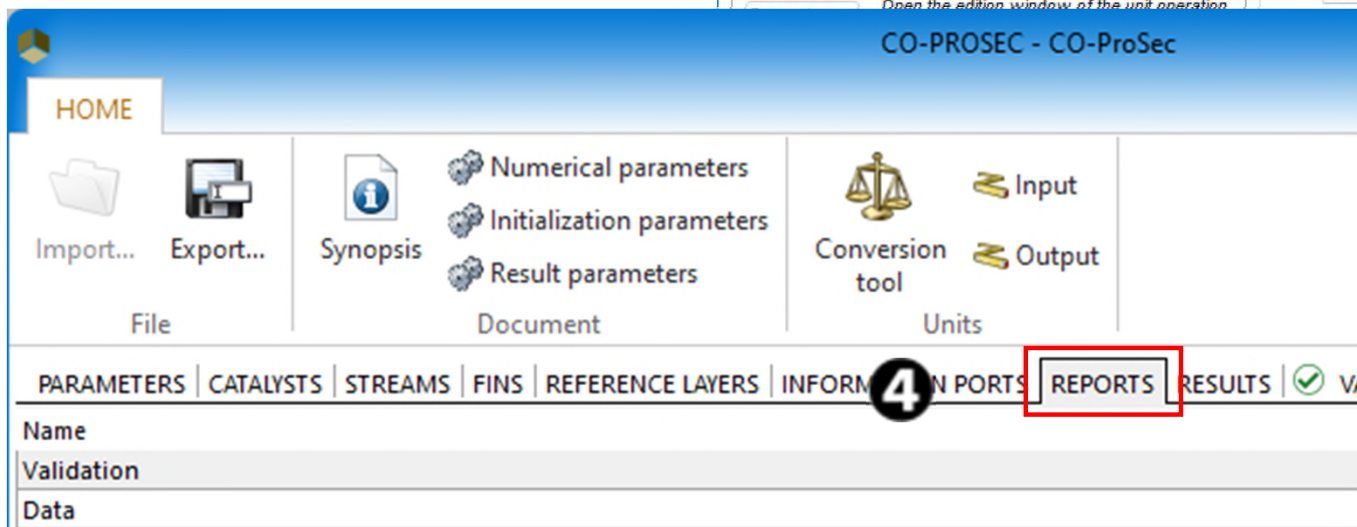
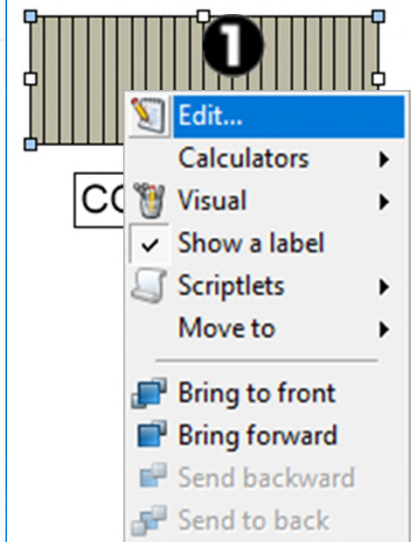
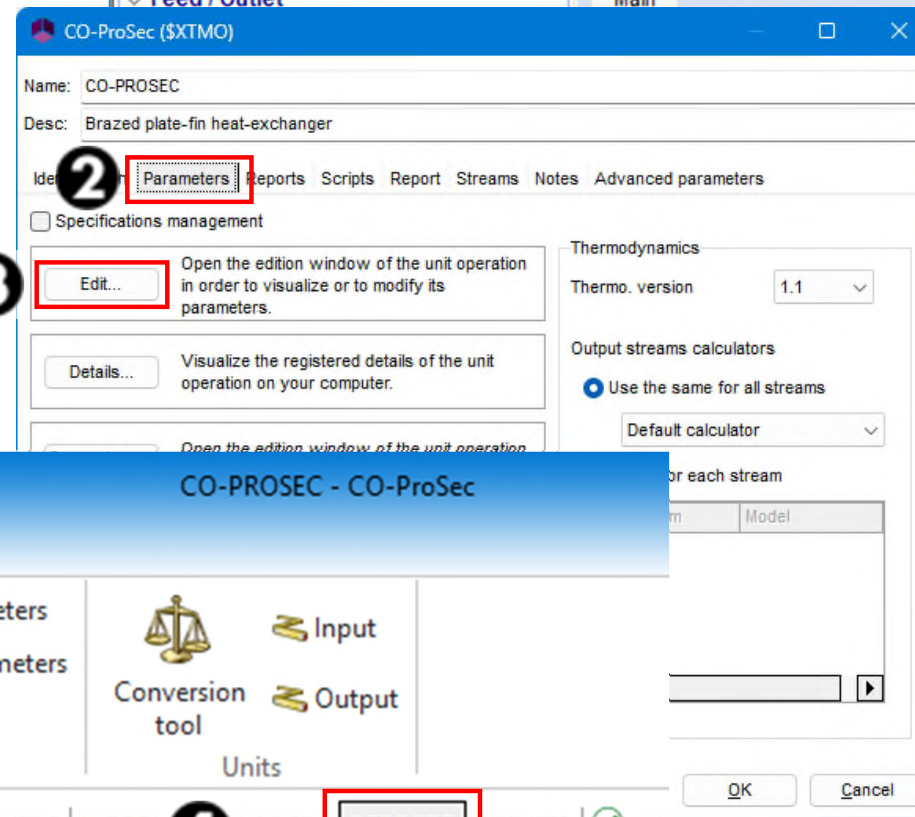
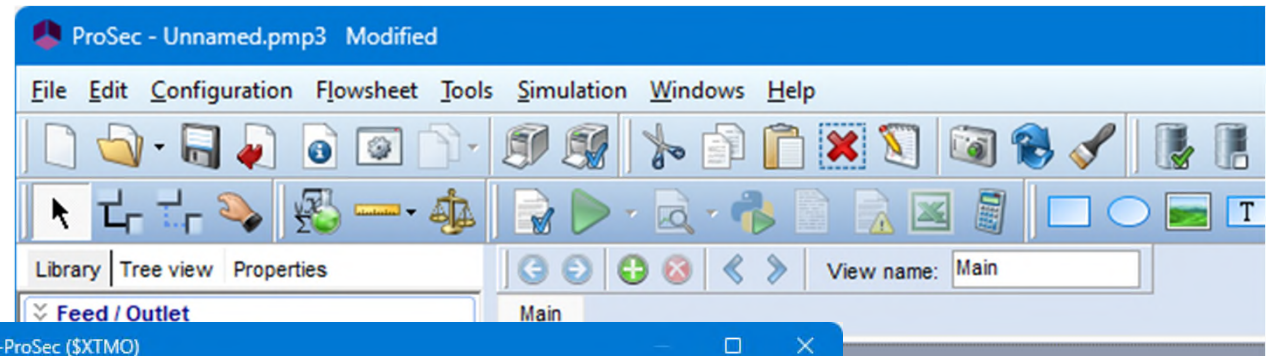
- A. ProSec unit operation tabulated results
- B. ProSec unit operation graphical results
- C. ProSimPlus general reports

Step 5: Reports generated

A- ProSec tabulated results

To consult the reports generated by ProSec unit operation:

1. Double-click on its icon on the flowsheet or select “Edit...” in the contextual menu
2. Press the “Parameters” tab
3. Press the “Edit...” button
4. Press the “Reports” tab



Step 5: Reports generated

A- ProSec tabulated results

- “Simulation” contains the main results:
 - ✓ Report on the input data
 - ✓ Results for the “Common Wall Temperature” calculation mode (initialization of ProSec rigorous calculations): inlet & outlet temperatures & vapor fraction, heat duty exchanged
 - ✓ ProSec results: inlet & outlet temperatures & vapor fraction, heat duty exchanged
 - ✓ Pressure drops calculation
 - ✓ ...

PARAMETERS CATALYSTS STREAMS FINS REFERENCE LAYERS INFORMATION PORTS REPORTS RESULTS <input checked="" type="checkbox"/> VALIDATION									
Name									
Validation									
Data									
Medistributions									
Simulation									
Historic									
Convergence									
Classes of criteria									
ZONE 11 -423.630 528.415									
<div> <div>RESULTS ABSTRACT</div> <div>RIGOROUS</div> </div>									
STREAM NAME	FLOW RATE (kg/s)	VAPOUR FRACTION		TEMPERATURE		HEAT DUTY			
		INLET	OUTLET	A	B	(J/s)	(kW)		
! Hot	1.3	1.0000	1.0000	299.00 >>	285.11	-57051.	-57.1	!	!
! >>SO	0.1				285.11	-16.	-0.0	!	!
! Hot	1.2	1.0000	1.0000	285.11 >>	274.17	-45617.	-45.6	!	!
! Cold	1.3	1.0000	1.0000	275.60 <<	267.00	45621.	45.6	!	!
! Cold	1.3	1.0000	1.0000	288.24 <<	275.60	57064.	57.1	!	!
HEAT DUTY EXCHANGED BY THE HOT FLUIDS = -102684.71 J/s									

Step 5: Reports generated

A- ProSec tabulated results

- “Classes of criteria” shows the number of equations which have a convergence criterion belonging to the class:

$$10^{\text{Class}+i} < \text{Criterion value} < 10^{\text{Class}}$$

- This indicates the level of convergence of ProSec.

PARAMETERS	CATALYSTS	STREAMS	FINs	REFERENCE LAYERS	INFORMATION PORTS	REPORTS	RESULTS	VALIDATION
Name								
Validation								
Data								
Misdisturbations								
Simulation								
Historic								
Convergence								
Classes of criteria								
Flowrate repartition								

CLASSES OF THE RESIDUALS	
CLASS	NUMBER OF EQUATIONS BELONGING TO THE CLASS
-6	662
-5	65
-4	0
-3	0
-2	0
-1	0
0	0
1	0
2	0

Step 5: Reports generated

A- ProSec tabulated results

- “Historic” contains information about the errors (with help if any errors are present) and the topology analysis of the inlet data by the unit operation.

PARAMETERS	CATALYSTS	STREAMS	FINs	REFERENCE LAYERS	INFORMATION PORTS	REPORTS	RESULTS	VALIDATION
Name								
Validation								
Data								
Misdisturbations								
Simulation								
Historic								
Convergence								
Classes of criteria								
Flowrate repartition								

**** DATA TEST OF THE 2 STREAMS ****					
**** TEST OF THE STACKING *****					
** ABSTRACT TABLE OF PASSAGE NUMBERS BY ZONES					
=====					
Z	D	R		T	
O	E	E		O	
N	A	D		T	
E	D	I		A	
		S		L	
STREAM	-1	0	1	2	
=====					
1	0	0	3	3	6
2	0	0	3	3	6
3	0	0	3	3	6
4	0	0	3	3	6
5	0	0	3	3	6
6	3	0	3	0	6

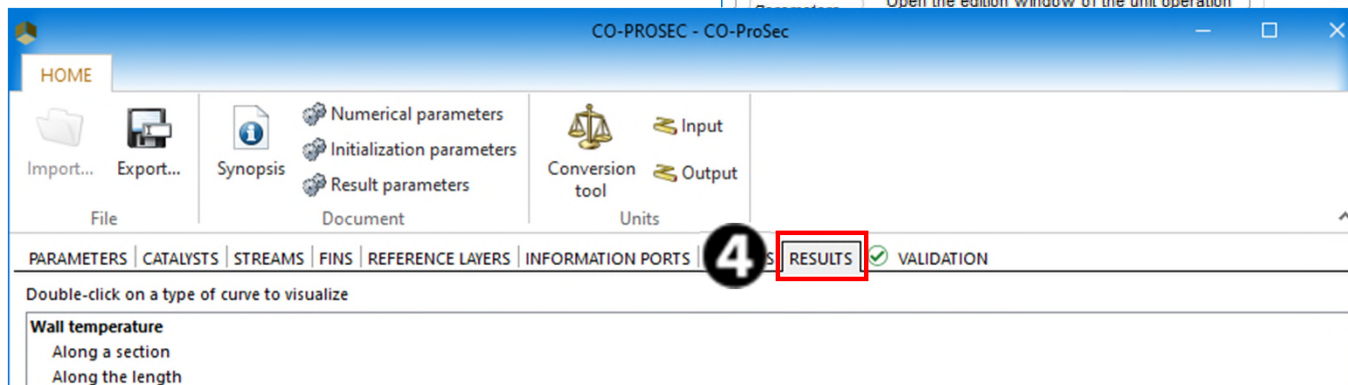
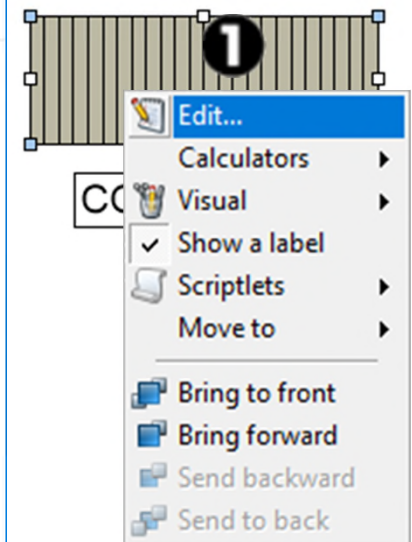
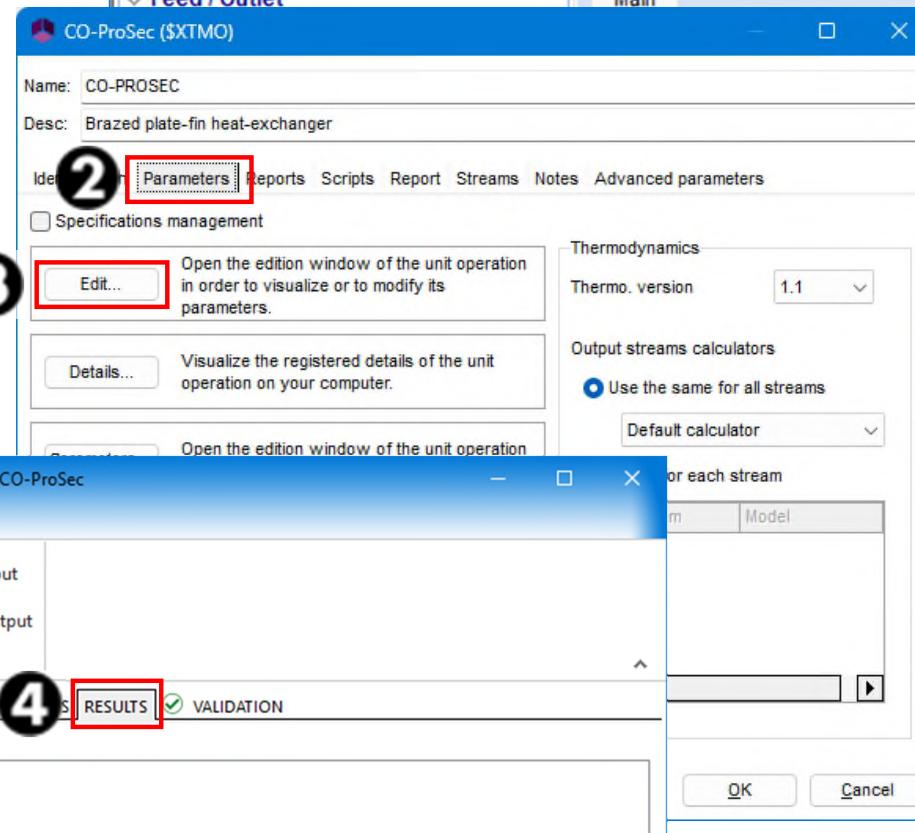
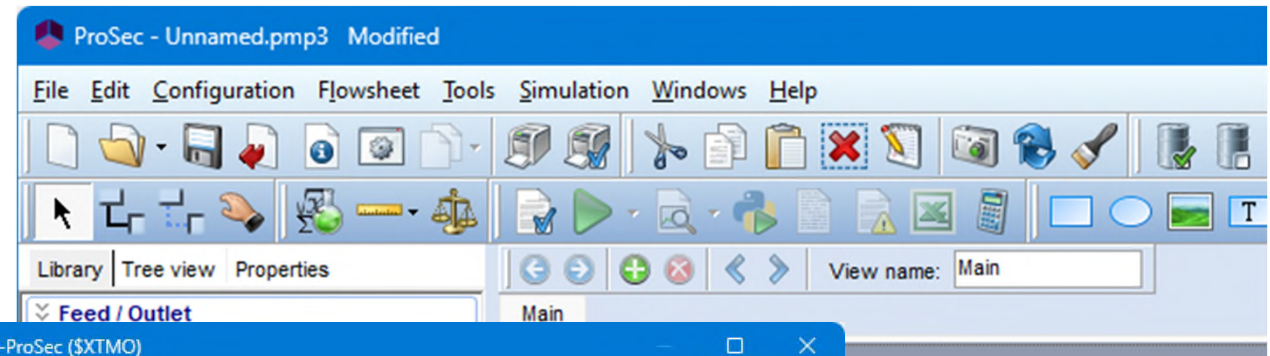
Step 5: Reports generated

B- ProSec graphical results

70

To consult the reports generated by ProSec unit operation:


1. Double-click on its icon on the flowsheet or select “Edit...” in the contextual menu
2. Press the “Parameters” tab
3. Press the “Edit...” button
4. Press the “Results” tab



Step 5: Reports generated

B- ProSec graphical results

- “Results” tab
 - Graphical results

PARAMETERS | CATALYSTS | STREAMS | FINS | REFERENCE LAYERS | INFORMATION PORTS | REPORTS | **RESULTS** |  VALIDATION

Double-click on a type of curve to visualize

Wall temperature
Along a section
Along the length

Fluid temperature
Along a section
Along the length

Fluid pressure
Along a section
Along the length
Related to the temperature

Heat transfer coefficients
Along a section
Along the length

Normal efficiency
Along a section
Along the length

Enthalpy
Along a section
Along the length

Vaporization ratio
Along a section
Along the length

Holdup
Along a section
Along the length

Flowrate
Along a section
Along the length

Double-click on a curve to visualize it

Step 5: Reports generated

B- ProSec graphical results

- “Results” tab
 - If at least one stream is vapor-liquid, the properties are displayed, if possible, for the vapor, the liquid and the global physical phase.
 - In green, available only for ProSec Reaction
 - In Prosec Reaction, the properties are displayed, if possible, in molar, mass and volume scale.

Wall temperature	Friction factors
Along a section	Along a section
Along the length	Along the length
Fluid temperature	By-pass efficiency
Along a section	Along a section
Along the length	Along the length
Fluid pressure	Reactions
Along a section	Vapor rates along the length
Along the length	Vapor extents along the length
Related to the temperature	
Heat transfer coefficients	Exchanged heats
Along a section	Along a section
Along the length	Along the length
Normal efficiency	
Along a section	
Along the length	
Enthalpy	
Along a section	
Along the length	
Vaporization ratio	
Along a section	
Along the length	
Holdup	
Along a section	
Along the length	
Flowrate	
Along a section	
Along the length	
Fractions	
Along the length	
Velocity	
Along a section	
Along the length	
Density	
Along a section	
Along the length	
Dynamic viscosity	
Along a section	
Along the length	
Thermal conductivity	
Along a section	
Along the length	
Reynolds number	
Along a section	
Along the length	

Step 5: Reports generated

B- ProSec graphical results

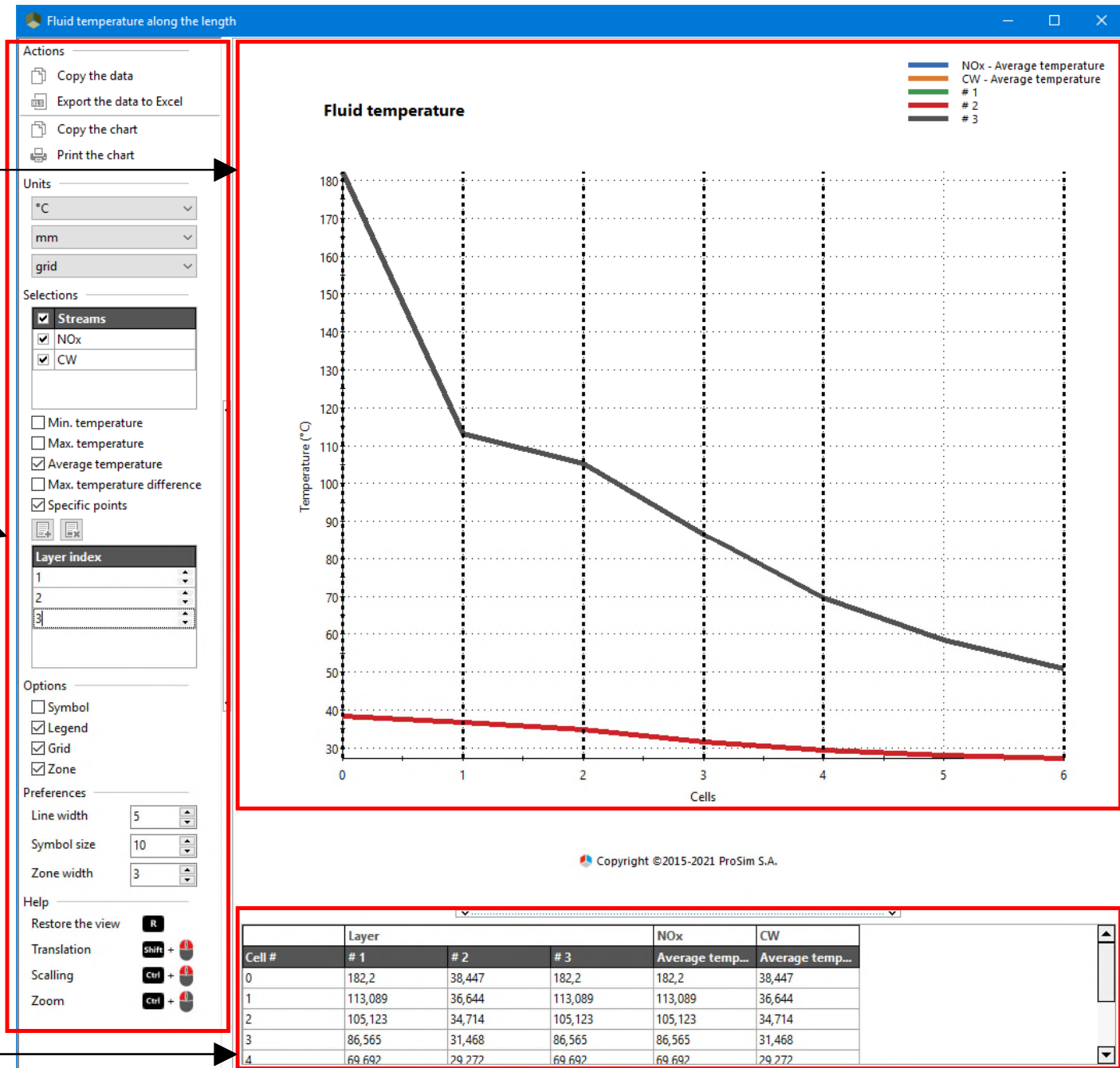
73

■ “Results” tab

Graph visualization zone

Control panel

Corresponding tabulated values



Step 5: Reports generated

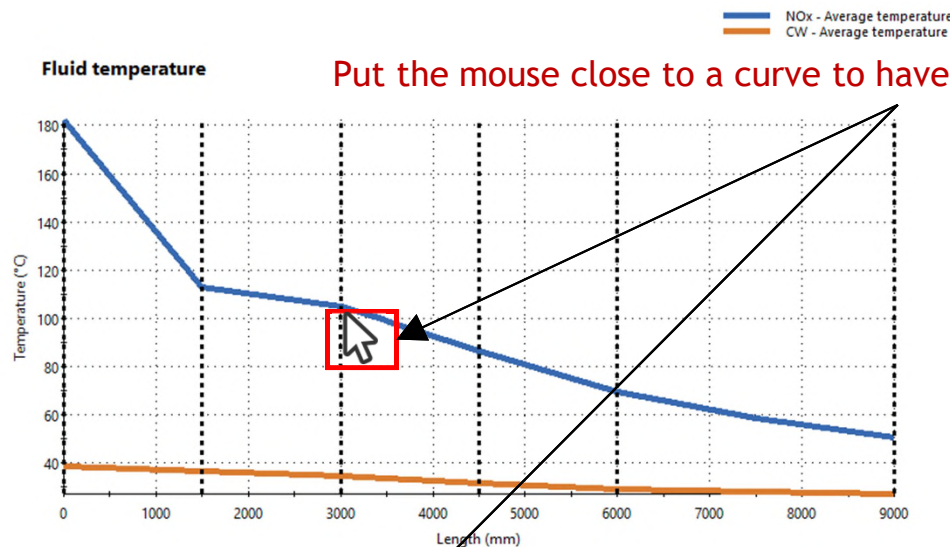
B- ProSec graphical results

■ “Results” tab

Copy/Export the values or the graph (e.g. in Excel)

Selection of the units of the axis, the X axis type (grid or length) and depending the curve: the physical state (vapor, liquid, global), the scale (molar, mass, volume).

Selection of the type of curves to plot (several selection possible)



Put the mouse close to a curve to have the corresponding coordinates

(X,Y) = (3000,00, 105,123)

NOx - Average temperature

Copyright ©2015-2021 ProSim S.A.

Graphical option of the graph

Actions

- Copy the data
- Export the data to Excel
- Copy the chart
- Print the chart

Units

- °C
- mm
- grid

Selections

- ☒ Streams
- ☒ NOx
- ☒ CW
- ☐ Min. temperature
- ☐ Max. temperature
- ☒ Average temperature
- ☐ Max. temperature difference
- ☒ Specific points

Layer index
1
2
3

Options

- ☐ Symbol
- ☒ Legend
- ☒ Grid
- ☒ Zone

Preferences

- Line width: 5
- Symbol size: 10
- Zone width: 3

Help

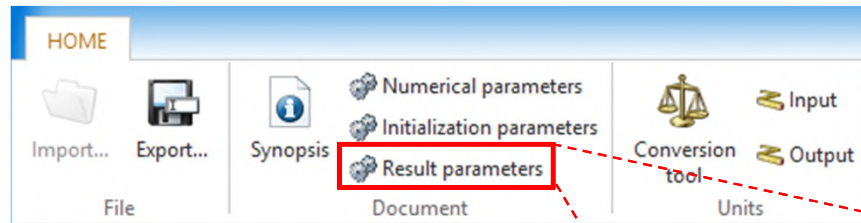
- Restore the view: R
- Translation: Shift + [Left/Right Arrow]
- Scalling: Ctrl + [Left/Right Arrow]
- Zoom: Ctrl + [Up/Down Arrow]

Step 5: Reports generated

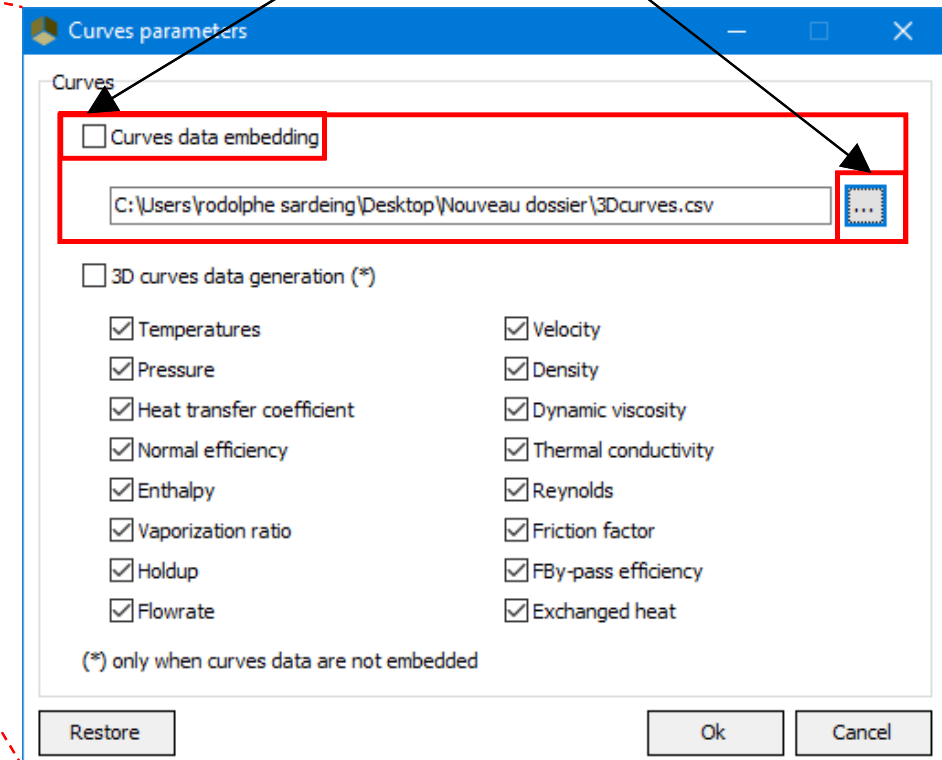
B- ProSec graphical results

75

- “Results” tab
 - Display of 3D curves



Deactivate the “Curves data embedding” (in the simulation file) to have access to the 3D curves. All the data will be saved in the “csv” file you will specify.



For simulations with a high number of streams and/or meshes, the curves could be not displayed. In that case, just decrease the number of 3D curves.

Step 5: Reports generated

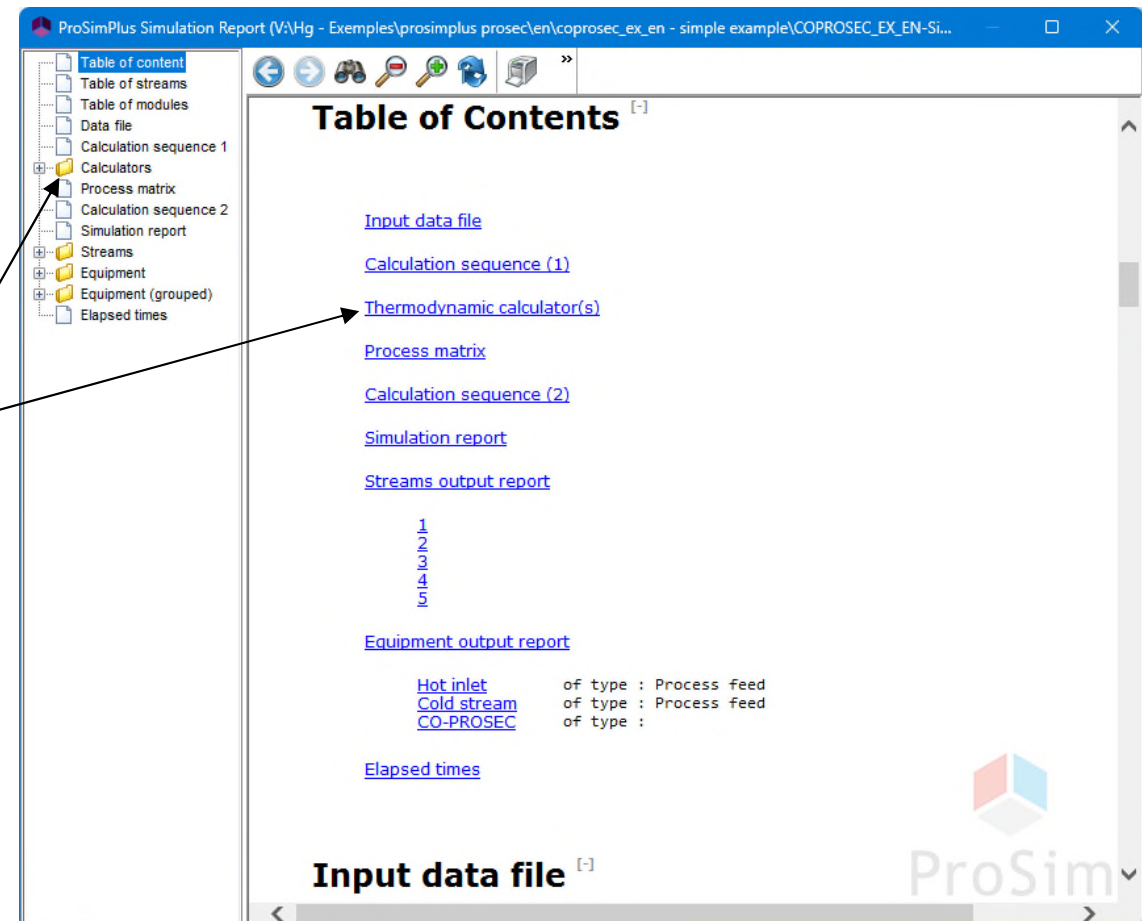
C- ProSimPlus general reports

The HTML report is by default automatically displayed after each run.

It provides information about:

- Pure component properties and thermodynamic models
- List of equipment calculation
- Process streams characteristics
- Results for each process equipment
- Convergence and constraints

Hyperlinks give you direct access to detailed information on initial configuration, unit operations, calculation sequence and results.




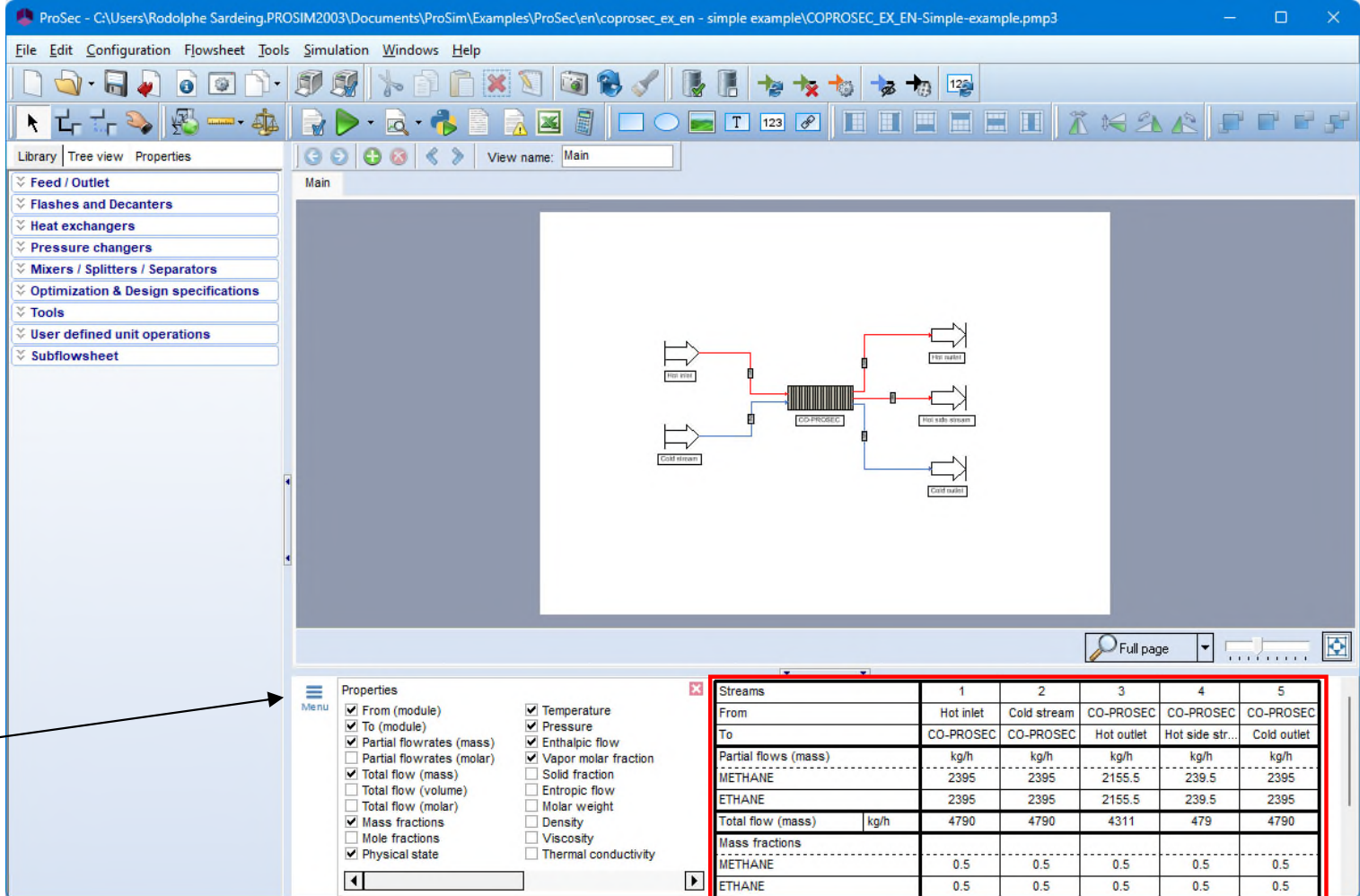
All the reports are created in the folder where you saved your project.

Step 6: Analyze simulation results from the flowsheet

77

A table with selected results is automatically generated and located below the flowsheet.

Click on  to configure the streams properties for the display and the export in MS-Excel



The screenshot shows the ProSim S.A. software interface. The main window displays a flowsheet with a central CO-PROSEC unit. The left sidebar contains a library of components. The bottom panel shows the 'Properties' section with various checkboxes for stream properties. A table of simulation results is displayed at the bottom right, showing mass flows and mass fractions for different streams.

Streams	1	2	3	4	5	
From	Hot inlet	Cold stream	CO-PROSEC	CO-PROSEC	CO-PROSEC	
To	CO-PROSEC	CO-PROSEC	Hot outlet	Hot side str...	Cold outlet	
Partial flows (mass)	kg/h	kg/h	kg/h	kg/h	kg/h	
METHANE	2395	2395	2155.5	239.5	2395	
ETHANE	2395	2395	2155.5	239.5	2395	
Total flow (mass)	kg/h	4790	4790	4311	479	4790
Mass fractions						
METHANE	0.5	0.5	0.5	0.5	0.5	
ETHANE	0.5	0.5	0.5	0.5	0.5	

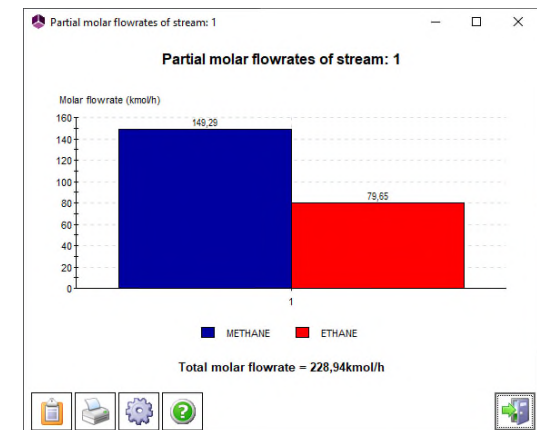
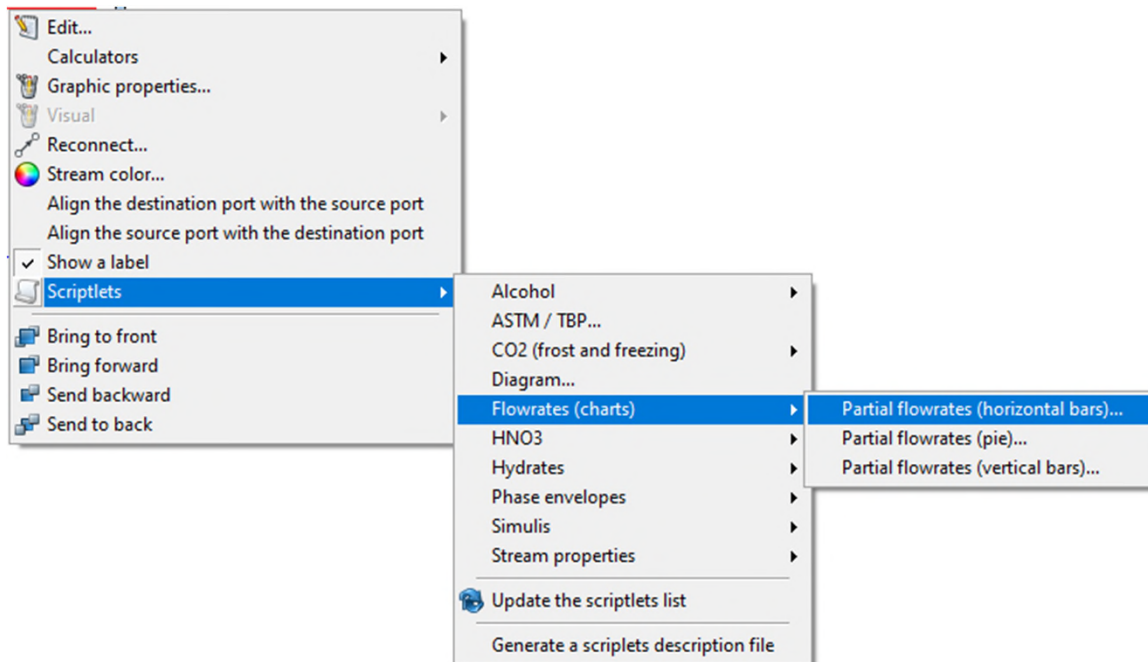
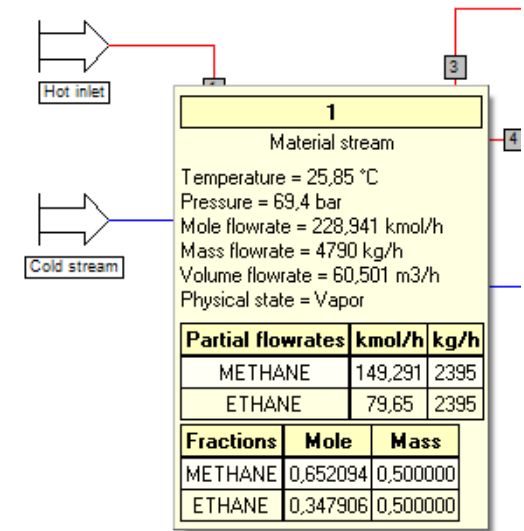
You can copy the grid to paste it in other documents or directly export it to an Excel file.

Step 6: Analyze simulation results from the flowsheet

78

In the drawing area, positioning the mouse on a stream displays its characteristics

Right click on a stream to access the contextual menu.
With Scriptlets, you can analyze results through different types of charts.



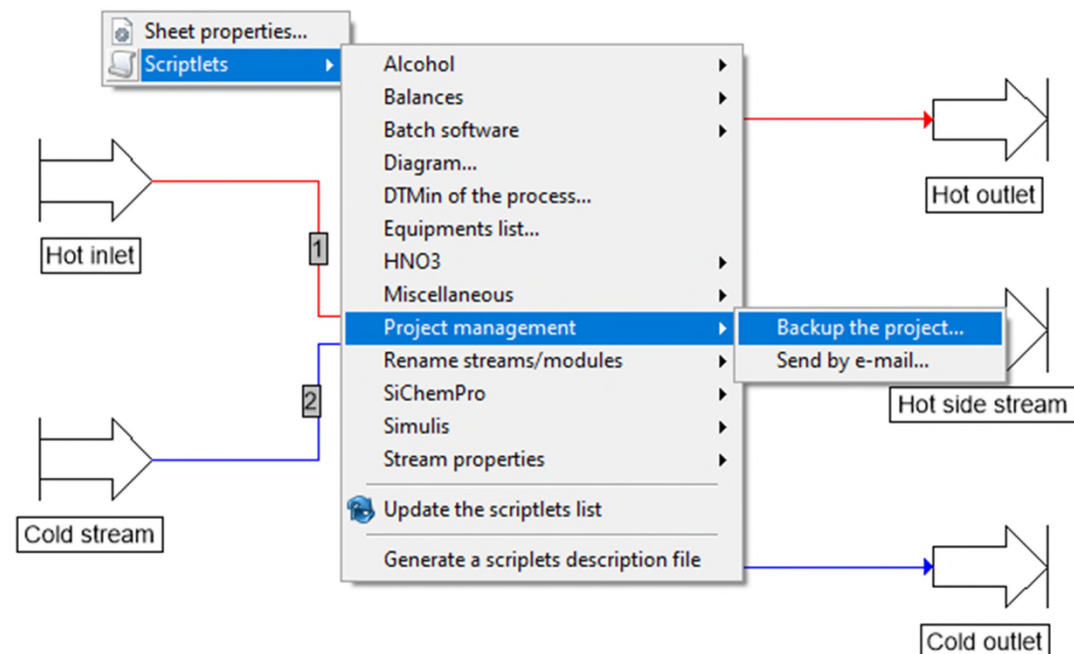
These charts can be copied and pasted in other documents

Step 7: Sharing the simulation

When you need to send the simulation to someone else, simply right click anywhere on the flowsheet, and select the Scriptlet “Send by e-mail...”.

This action will automatically create a zip file that will include among other:

- ✓ The “.pmp3” file (ProSimPlus file)
- ✓ The History file



**ProSim SA**

51, rue Ampère
Immeuble Stratège A
F-31670 Labège
France

☎: +33 (0) 5 62 88 24 30



Software & Services In Process Simulation

www.prosim.net
info@prosim.net

**ProSim, Inc.**

325 Chestnut Street, Suite 800
Philadelphia, PA 19106
U.S.A.

☎: +1 215 600 3759