

HTRI heat-exchanger (Xace) within ProSimPlus®

Use Case 5: Use of HTRI air cooler heat-exchanger (Xace) within ProSimPlus

Software & Services In Process Simulation

We guide You to efficiency



ProSim

Introduction

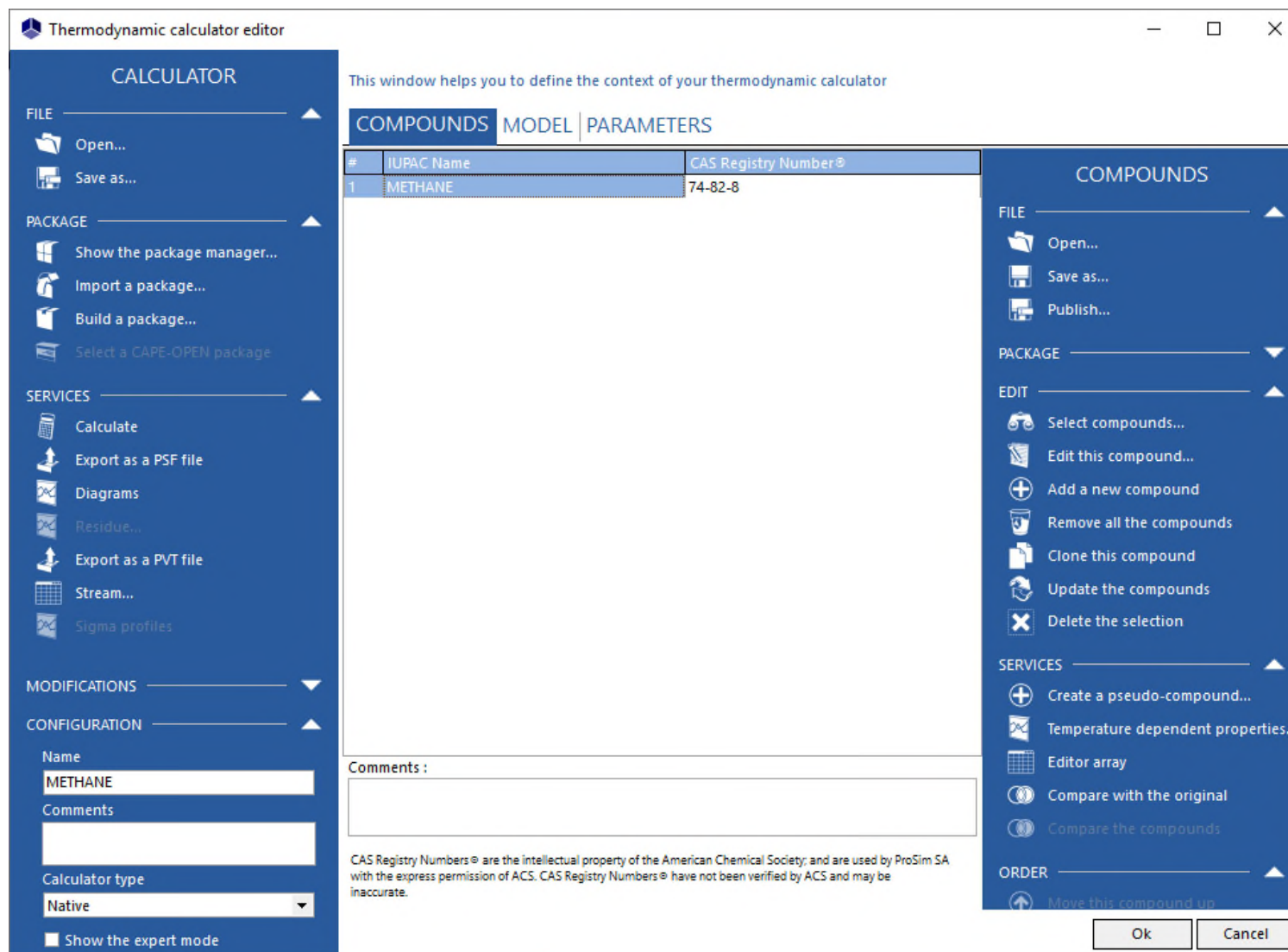
ProSimPlus® is a process engineering software that performs rigorous mass and energy balance calculations for a wide range of industrial steady-state processes. It is used in design as well as in operation of existing plants for process optimization, units troubleshooting or debottlenecking, plants revamping or performing front-end engineering analysis.

This document gives an example of use of HTRI (Heat Transfer Research, Inc.) air cooler heat-exchanger (Xace) within ProSimPlus®.

Note: as a prerequisite for a better understanding of this document, the user should know the general use of ProSimPlus®.

STEP #1: Select your compounds

Select your compounds like for any usual case:



STEP #2: Select your thermodynamic model

Select your thermodynamic model like for any usual case:

Thermodynamic calculator editor

— □ ×

CALCULATOR

FILE —▲

- Open...
- Save as...

PACKAGE —▲

- Show the package manager...
- Import a package...
- Build a package...
- Select a CAPE-OPEN package

SERVICES —▲

- Calculate
- Export as a PSF file
- Diagrams
- Residue...
- Export as a PVT file
- Stream...
- Sigma profiles

MODIFICATIONS —▼

CONFIGURATION —▲

Name
METHANE

Comments

Calculator type
Native

☐ Show the expert mode

This window helps you to define the context of your thermodynamic calculator

COMPOUNDS **MODEL** PARAMETERS

Name
Soave-Redlich-Kwong (SRK)

Category
All the profiles

Profile

Approach type
Using Equation of state

Equation of state
RK Generalized

Alpha function
Soave

Mixing rules
Standard

Activity coefficient model
Not defined

Pure liquid fugacity standard state
Standard

Liquid molar volume
Lee-Kesler-Plocker (LKP)

Transport properties
Classic methods

Enthalpy calculation
H*=0, ideal gas, 25°C, 1 atm

User-defined thermodynamic model
None

Model index
1

Comments :

THERMODYNAMIC MODEL

CONFIGURATION —

- Parameters
- Thermodynamic assistant
- Thermodynamic help
- ☐ Use a specific model for pure water

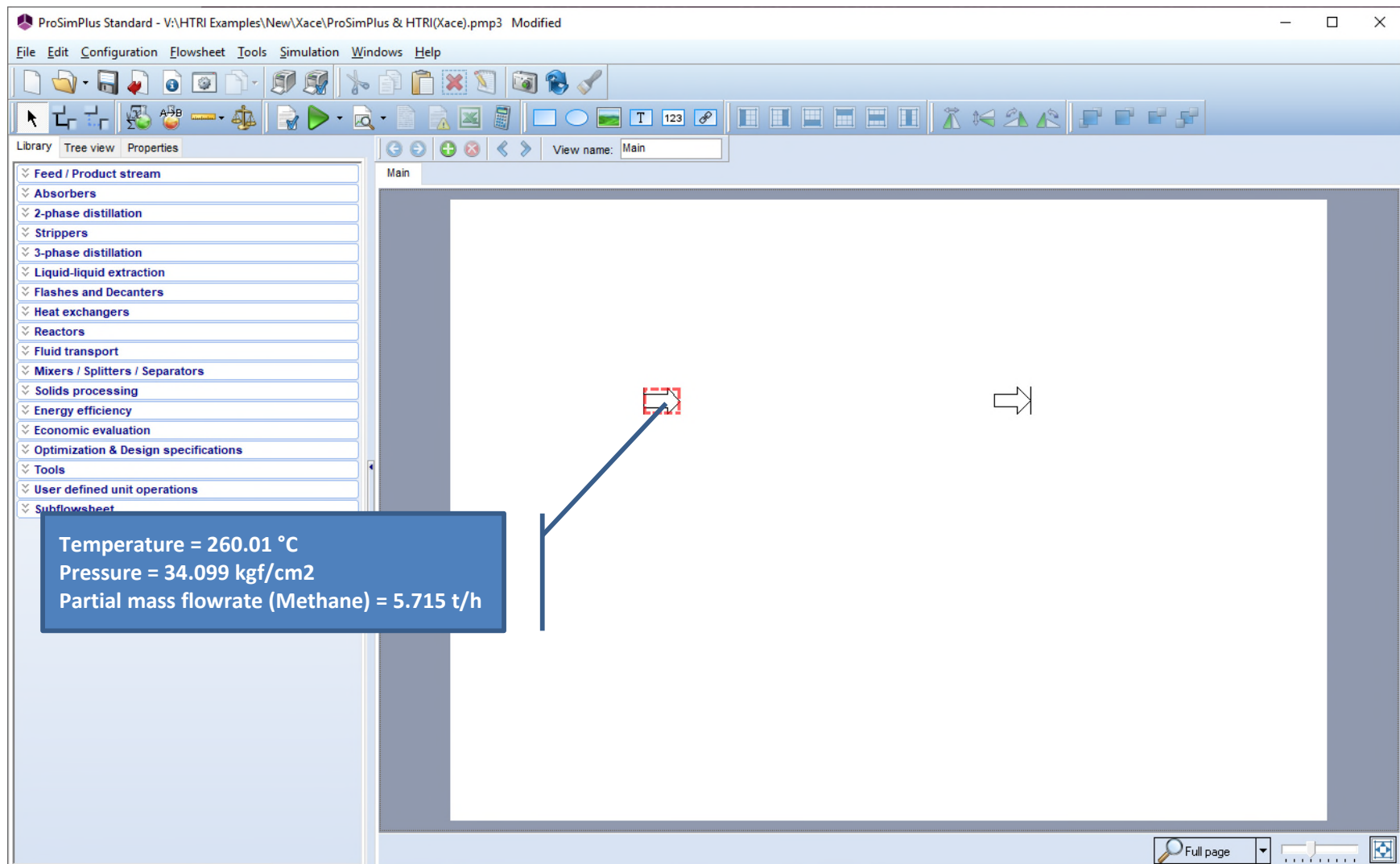
Advanced

- ☒ Water-hydrocarbons model
- Sol A 6,25043
- Sol B 4015,3
- ☐ The liquid phase splitting is taken into account
- Predictive model parameters...
- ☐ True species model
- Reactive model parameters...

Ok Cancel

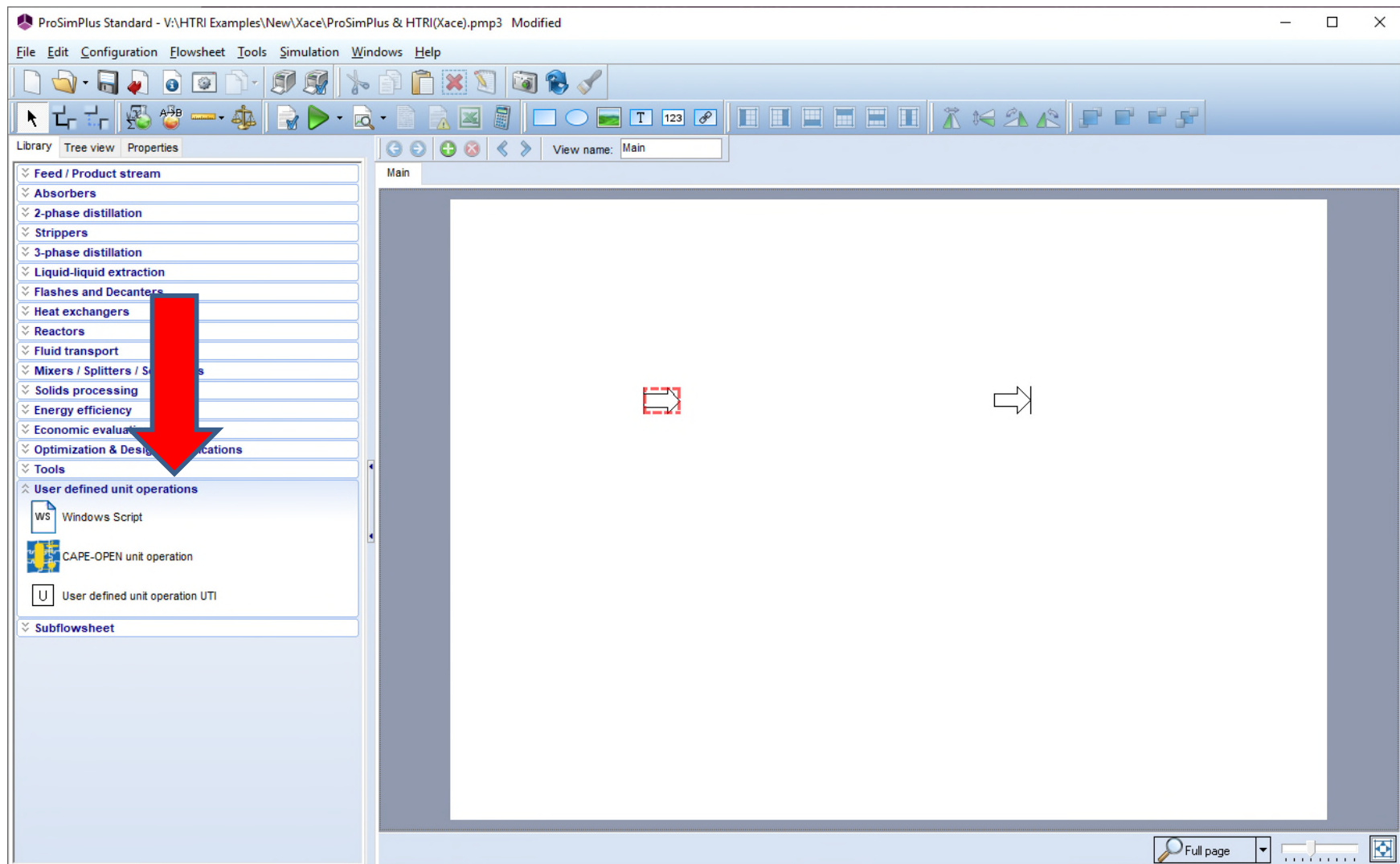
STEP #3: Create your flowsheet

Like for any usual case, add the feed and the product stream needed for your flowsheet, then edit the parameters (temperature, pressure, partial flowrates) for the feed:



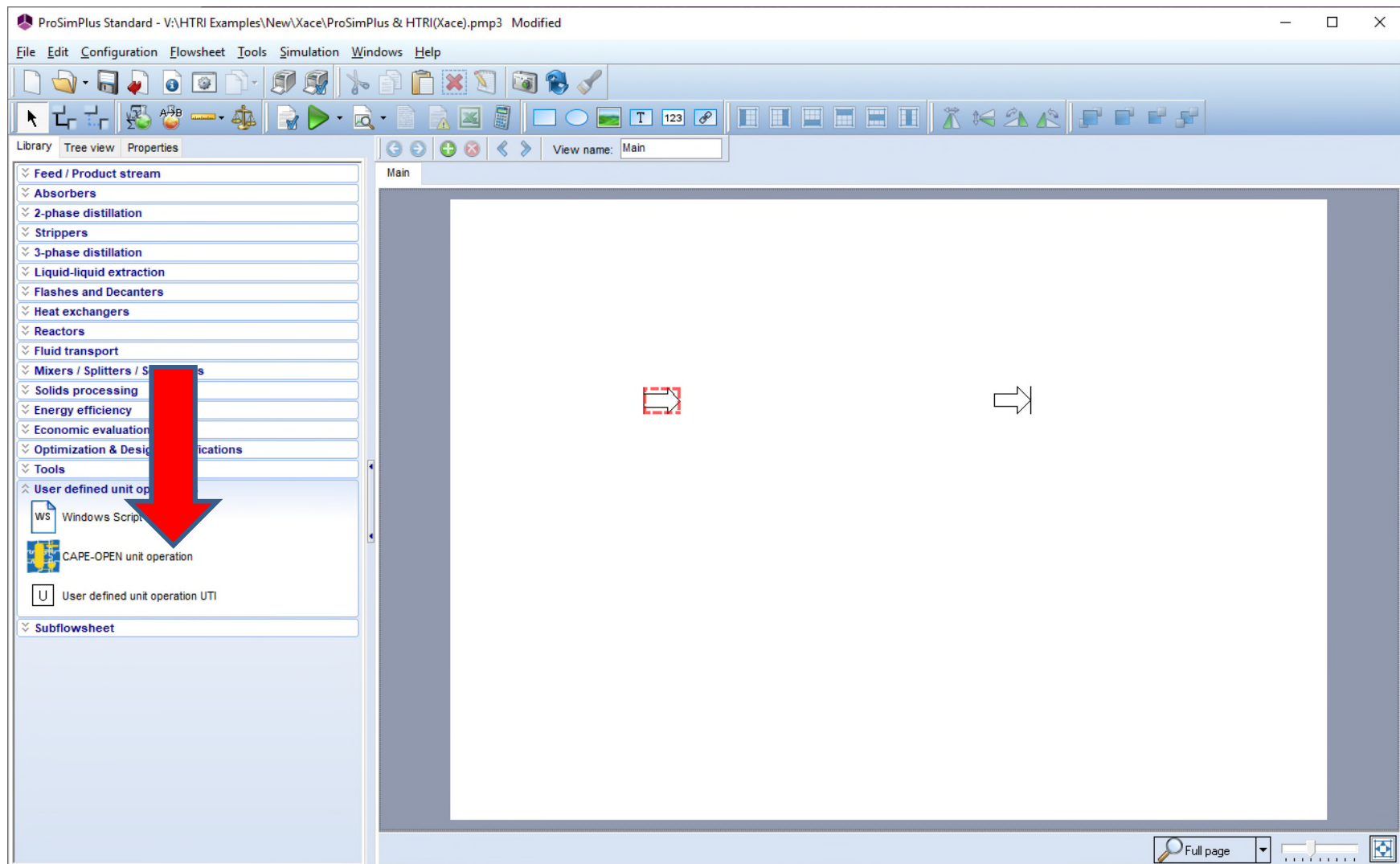
STEP #3: Create your flowsheet

To add a Xace heat-exchanger (air cooler), click on the category “User defined operations” in the “Library” of unit operations:



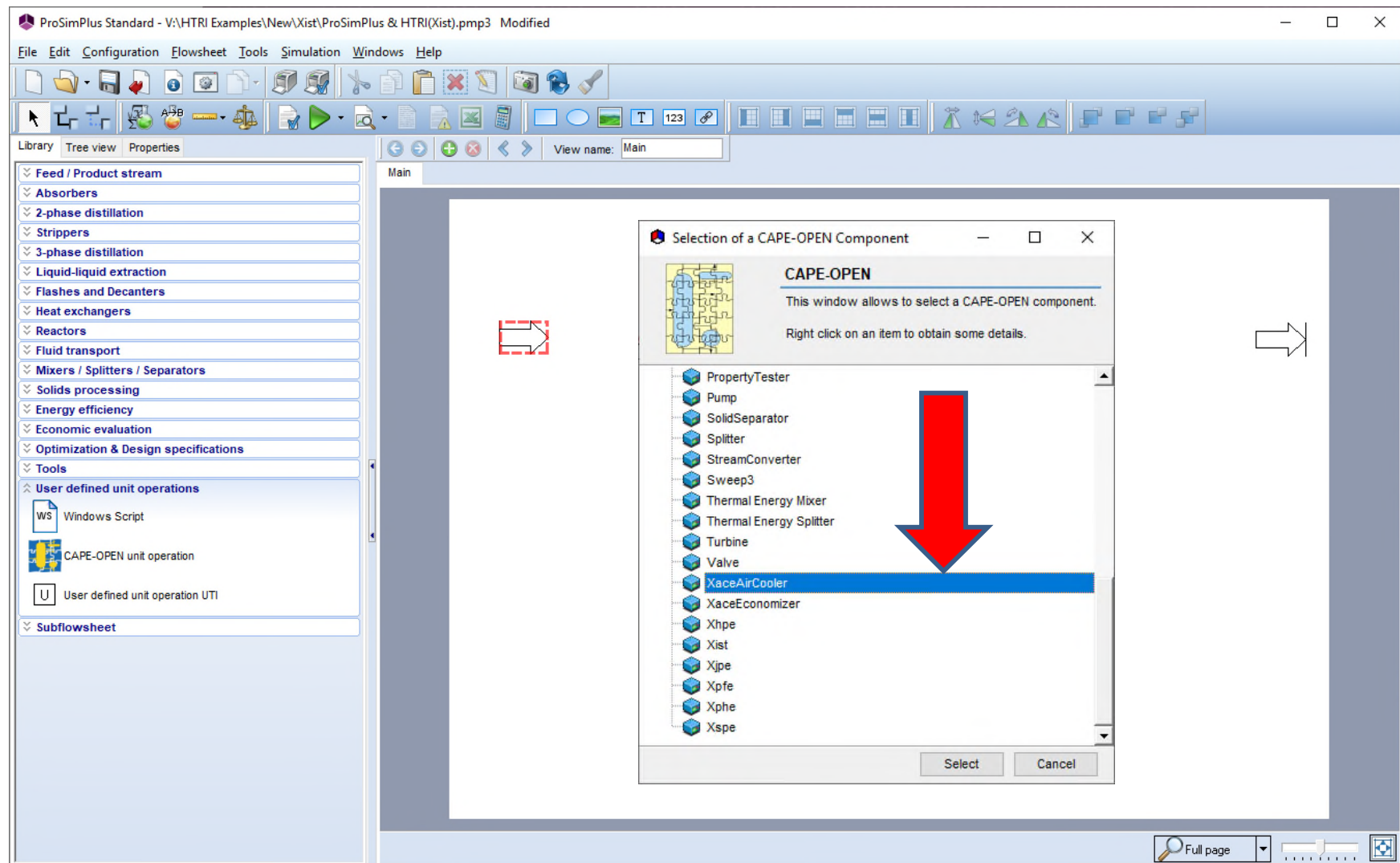
STEP #3: Create your flowsheet

Then click on “CAPE-OPEN unit operation”, then click on the flowsheet to add it:



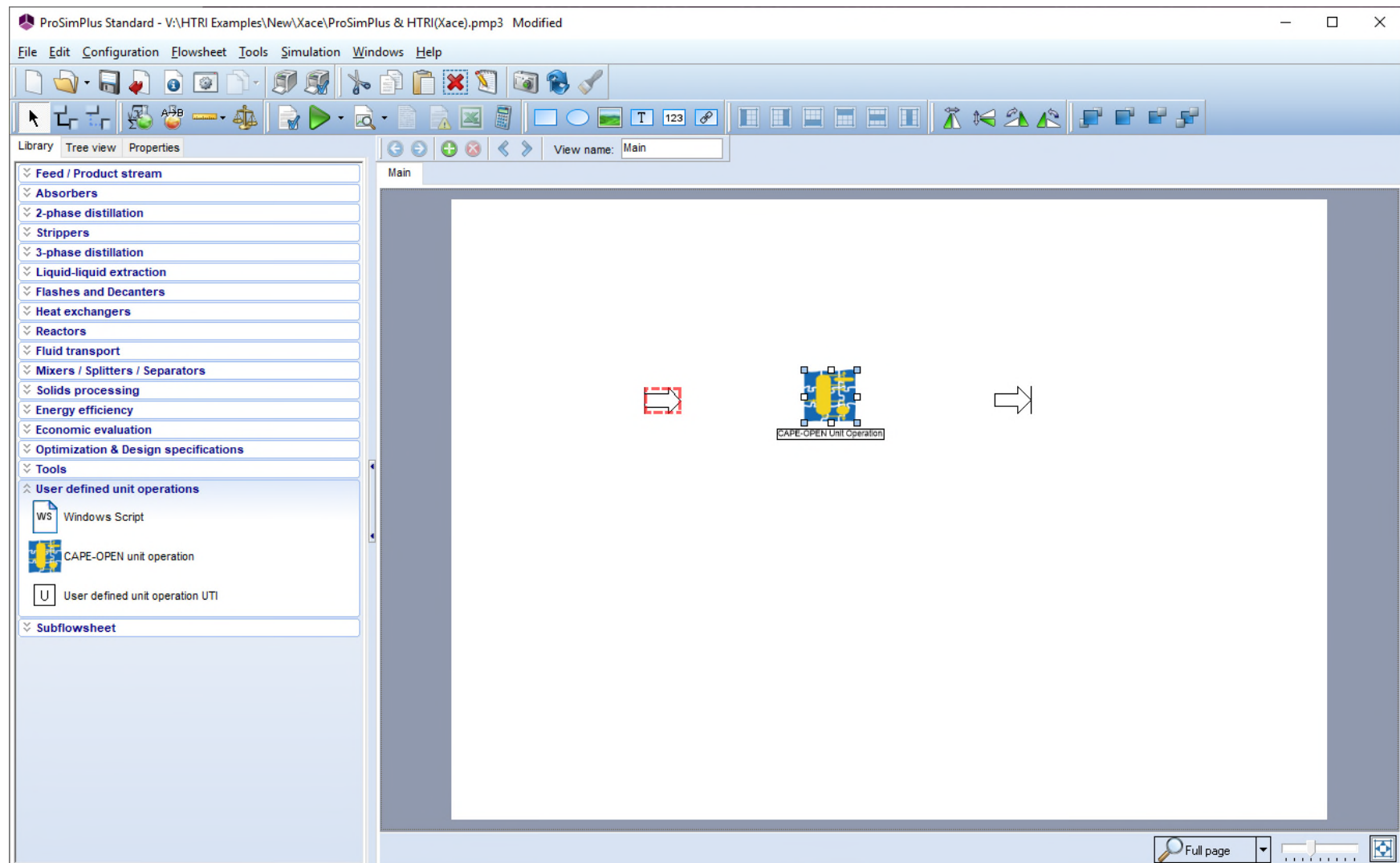
STEP #3: Create your flowsheet

The list of CAPE-OPEN unit operations available on your computer is displayed, select “XaceAirCooler” and then click on the button “Select” to validate your choice:



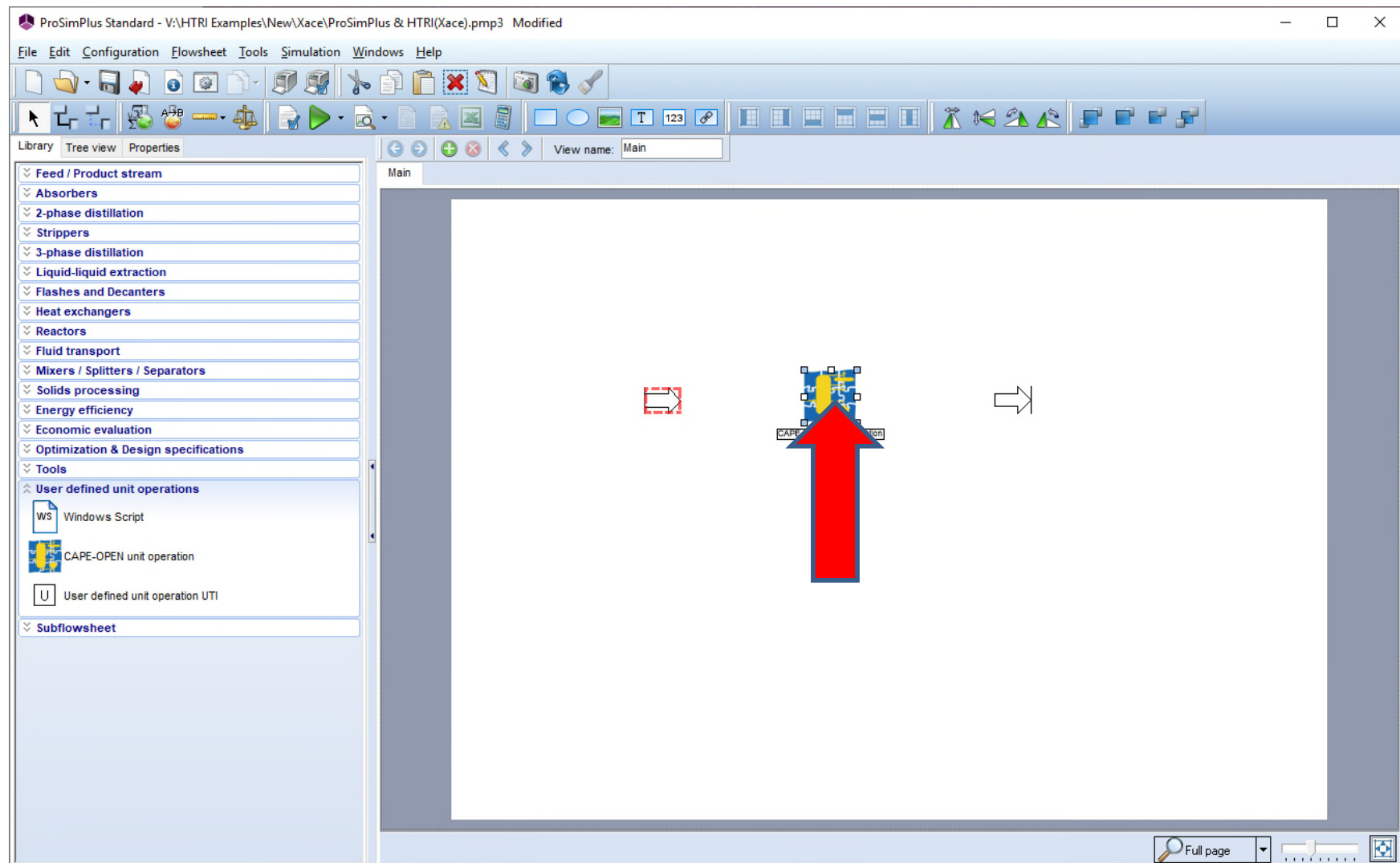
STEP #3: Create your flowsheet

The Xace heat-exchanger icon is added:



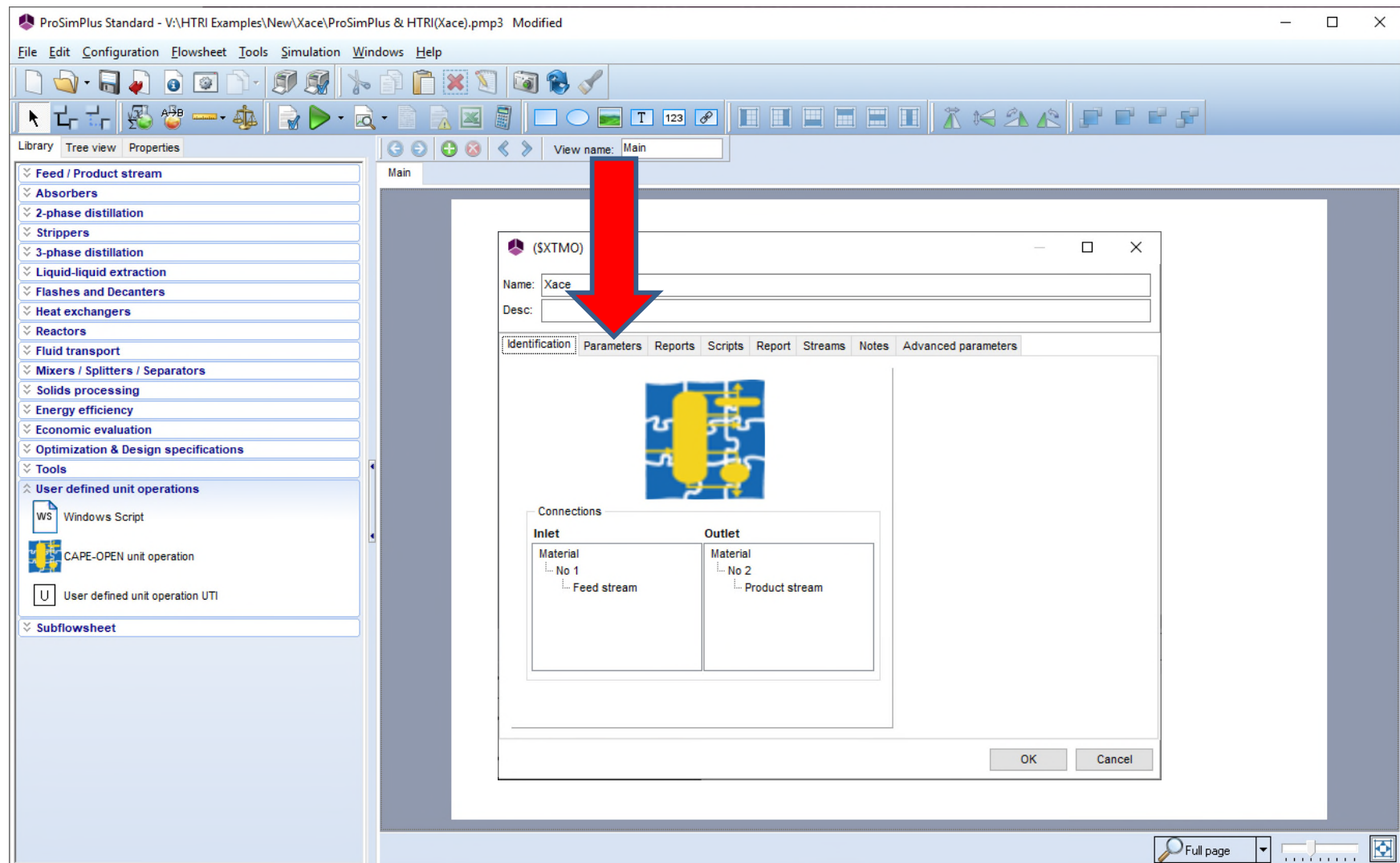
STEP #3: Create your flowsheet

Edit the parameters with a double-click on the selected unit operation:



STEP #3: Create your flowsheet

Select the “Parameters” tab:



STEP #3: Create your flowsheet

Then click on the “Edit...” button to open the specific dialog of a Xace heat-exchanger:

You can obtain some details about the unit operation

You can edit the public parameters of the unit operation

You can manually validate the unit operation

You can access to the standard textual reports

You can select a different thermodynamic model for each input material stream

**You can select the version of the CAPE-OPEN Thermodynamic specifications:
Select 1.0 for this case
(BEFORE CONNECTING MATERIAL STREAMS)**

The grayed buttons correspond to actions which are not available or which are not implemented by the unit operation.

Stream	Model
No 4	Global model
No 2	Global model

STEP #3: Create your flowsheet

Then enter the parameters of the heat-exchanger (see HTRI user guides):

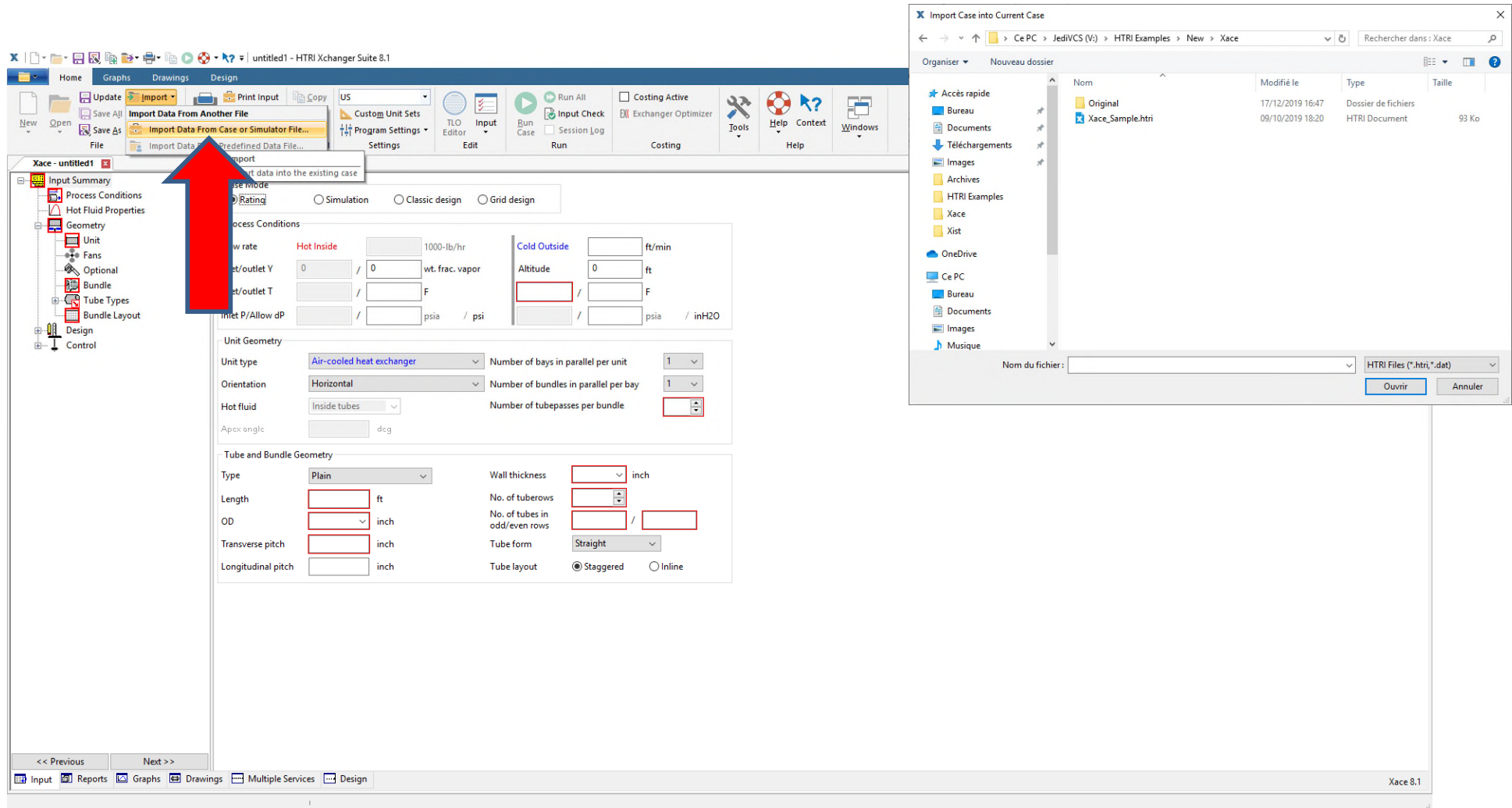
The screenshot displays the HTRI Xchanger Suite 8.1 software interface. The left sidebar shows a tree view with categories: Input Summary, Process Conditions, Hot Fluid Properties, Geometry, Unit, Fans, Optional, Bundle, Tube Types, Bundle Layout, Design, and Control. The main window is titled 'Xace - untitled1' and contains the following sections:

- Case Mode:** Radio buttons for Rating (selected), Simulation, Classic design, and Grid design.
- Process Conditions:**
 - Flow rate: Hot Inside (1000-lb/hr) and Cold Outside (ft/min).
 - Inlet/outlet Y: 0 / 0 wt. frac. vapor.
 - Altitude: 0 ft.
 - Inlet/outlet T: / F.
 - Inlet P/Allow dP: / psia / psi.
- Unit Geometry:**
 - Unit type: Air-cooled heat exchanger.
 - Orientation: Horizontal.
 - Hot fluid: Inside tubes.
 - Apex angle: deg.
 - Number of bays in parallel per unit: 1.
 - Number of bundles in parallel per bay: 1.
 - Number of tubepasses per bundle: 1.
- Tube and Bundle Geometry:**
 - Type: Plain.
 - Length: ft.
 - OD: inch.
 - Transverse pitch: inch.
 - Longitudinal pitch: inch.
 - Wall thickness: inch.
 - No. of tuberoses: .
 - No. of tubes in odd/even rows: / .
 - Tube form: Straight.
 - Tube layout: Staggered (selected) or Inline.

At the bottom, there are navigation buttons: << Previous, Next >>, and a status bar showing 'Caption: Xace 8.1'.

STEP #3: Create your flowsheet

Or import data from an existing Xace case:



STEP #3: Create your flowsheet

Data for the heat-exchanger (summary)

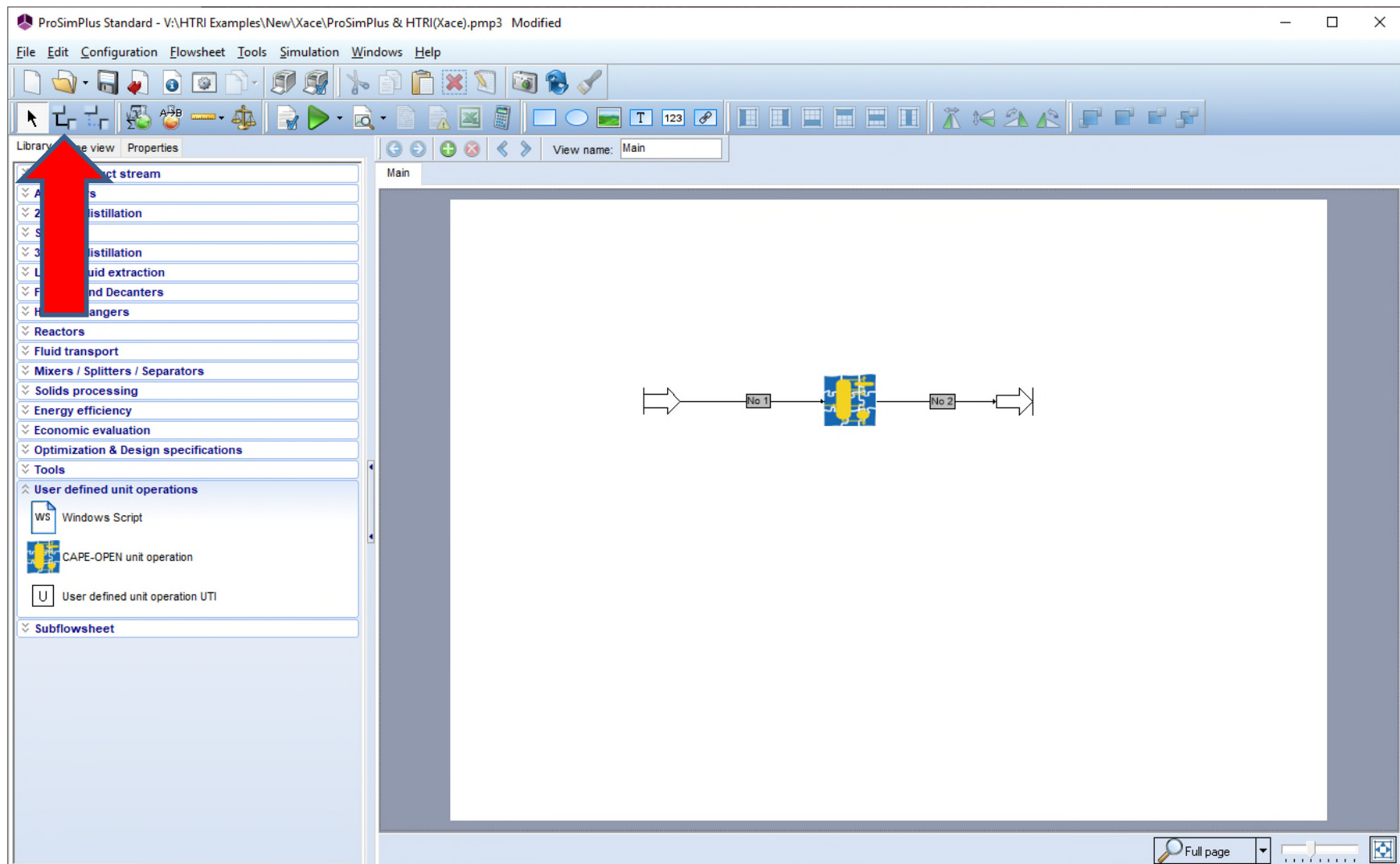
The screenshot displays the HTRI Xchanger Suite 8.1 software interface. The left sidebar shows a tree view with the following items: Input Summary, Process Conditions, Hot Fluid Properties, Geometry, Unit, Fans, Optional, Bundle, Tube Types, Bundle Layout, Design, and Control. The main window is titled "Xace - untitled1*" and contains the following sections:

- Case Mode:** Rating (selected), Simulation, Classic design, Grid design.
- Process Conditions:**
 - Flow rate: Hot Inside 12,6001 1000-lb/hr; Cold Outside 36950 ft³/min.
 - Inlet/outlet Y: 1 / 1 wt. frac. vapor; Altitude 0 ft.
 - Inlet/outlet T: 500,02 / 120,02 F; 100,02 F.
 - Inlet P/Allow dP: 485 / 5 psia / psi; 2 psia / inH₂O.
- Unit Geometry:**
 - Unit type: Air-cooled heat exchanger; Number of bays in parallel per unit: 1.
 - Orientation: Horizontal; Number of bundles in parallel per bay: 1.
 - Hot fluid: Inside tubes; Number of tubepasses per bundle: 4.
 - Apex angle: deg.
- Tube and Bundle Geometry:**
 - Type: High Fin; Wall thickness: 0,109 inch.
 - Length: 16 ft; No. of tubes: 4.
 - OD: 1 inch; No. of tubes in odd/even rows: 28 / 28.
 - Transverse pitch: 2,35 inch; Tube form: Straight.
 - Longitudinal pitch: 1,9485 inch; Tube layout: Staggered (selected), Inline.

At the bottom, there are navigation buttons: << Previous, Next >>, and a status bar showing "Run Completed" and "Modified".

STEP #3: Create your flowsheet

Like for any usual case, connect your material streams between unit operations:



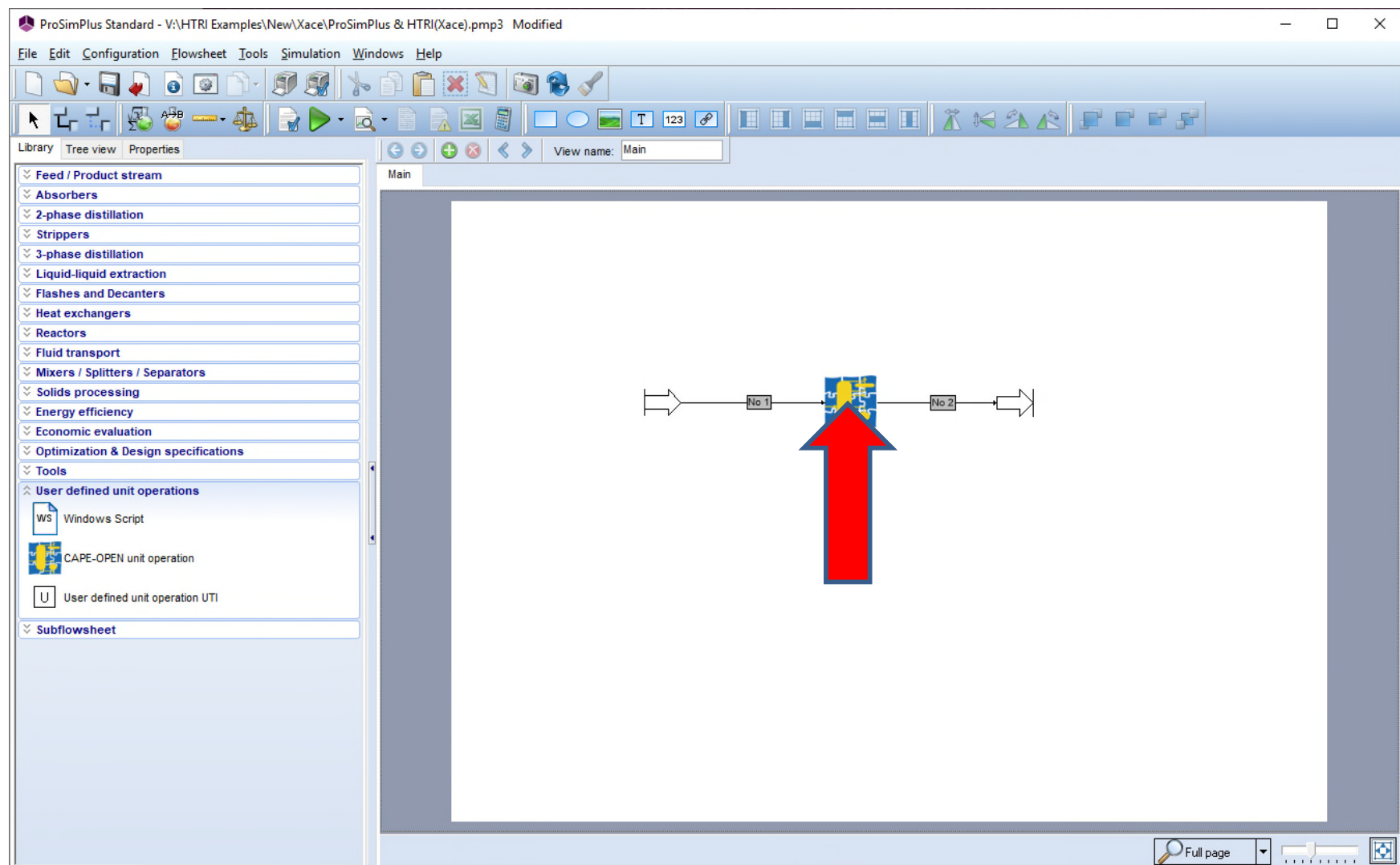
STEP #4: Run the simulation

When the input data is complete, click on the icon to run the simulation:

The screenshot displays the ProSimPlus Standard software interface. The main window shows a process flow diagram with a central unit operation (a blue square with a yellow lightning bolt) connected to two rectangular units labeled 'No 1' and 'No 2'. A red arrow points to the 'Run' button (a green play icon) in the toolbar. The left sidebar contains a library of unit operations, including 'Feed / Product stream', 'Absorbers', '2-phase distillation', 'Strippers', '3-phase distillation', 'Liquid-liquid extraction', 'Flashes and Decanters', 'Heat exchangers', 'Reactors', 'Fluid transport', 'Mixers / Splitters / Separators', 'Solids processing', 'Energy efficiency', 'Economic evaluation', 'Optimization & Design specifications', 'Tools', 'User defined unit operations', and 'Subflowsheet'. The right sidebar shows the 'Simulation progress' window, which indicates that the simulation is based on previous results and lists the following steps: 'Alimentation du procédé' (checked) and 'Xace' (checked). The status bar at the bottom right of the simulation progress window shows 'Status: Simulation ended' and 'Unit operation "Alimentation du procédé" converged.'.

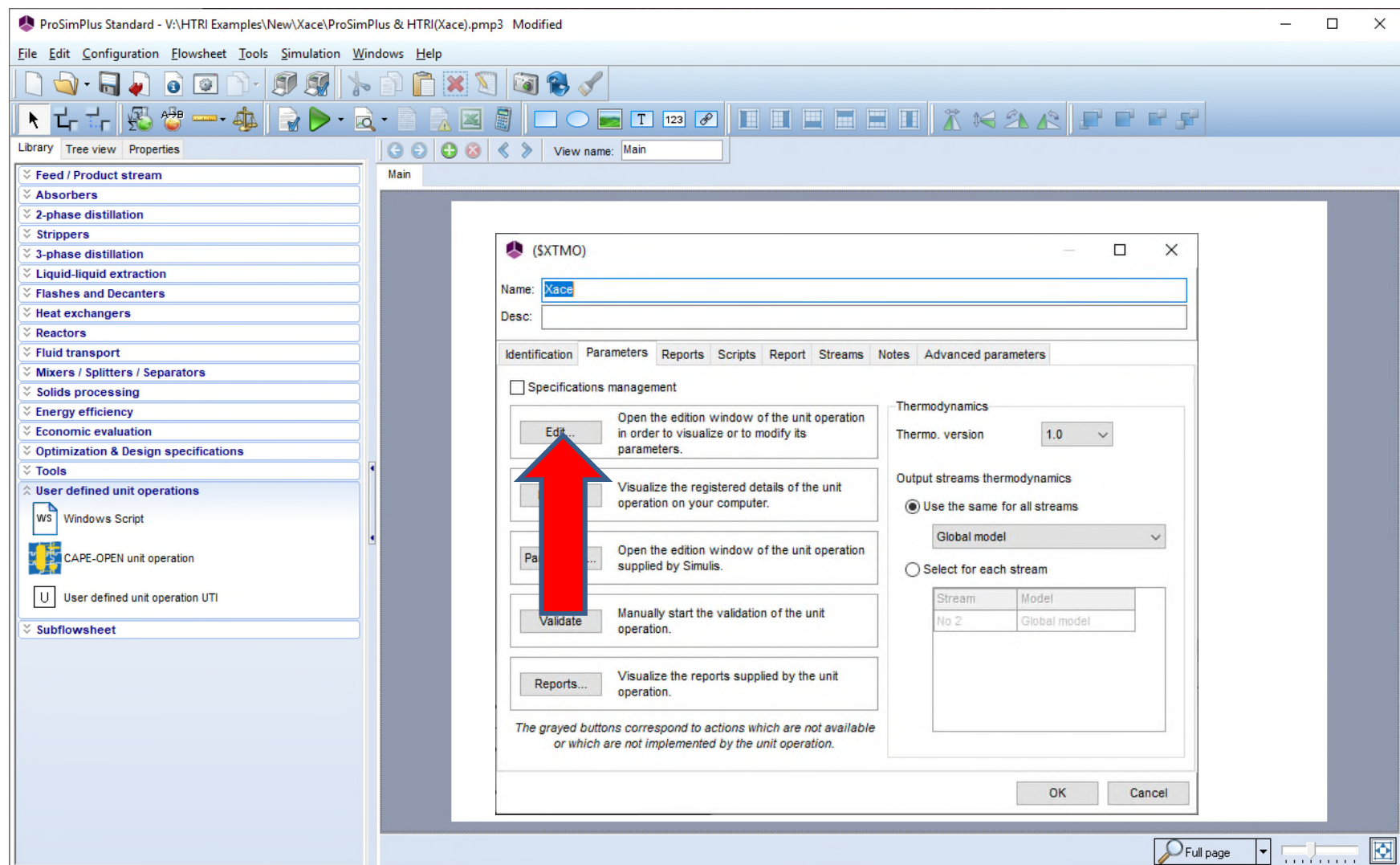
STEP #5: Analyze the results

When the simulation is complete, you can edit the reports of the Xace heat-exchanger with a double-click on the corresponding icon:



STEP #5: Analyze the results

Then click on the “Edit...” button to access to the various specific reports of the Xace heat-exchanger:



STEP #5: Analyze the results

Analyze the reports of your heat-exchanger (see HTRI user guides):

Results (output summary)

The screenshot displays the HTRI Xchanger Suite 8.1 software interface. The main window shows the 'Output Summary' report for a heat exchanger design. The report is titled 'Output Summary' and is released to the following HTRI Member Company: MKH Units. The report includes a table of process conditions, exchanger performance, unit geometry, fan geometry, and airside velocities.

Process Conditions

Outside		Tubeside	
No 1 / No 2		No 1 / No 2	
Fluid name	Sens. Gas		Sens. Gas
Fluid condition	75.421		5.715
Total flow rate (1000-kg/hr)	1.0000	1.0000	1.0000
Weight fraction vapor, In/Out			
Temperature, In/Out (Deg C)	37.79	260.01	48.90
Skin temperature, Min/Max (Deg C)	42.42	146.65	44.30
Pressure, Inlet/Outlet (kgf/cm2A)	1.033	34.099	33.823
Pressure drop, Total/Allow (mmH2O) (kgf/cm2)	8.416	50.800	0.276
Midpoint velocity (m/s)	4.92		9.70
- In/Out (m/s)		15.21	8.86
Heat transfer safety factor	1.0000		1.0000
Fouling (m2-hr-C/kcal)	0.000000		0.000410

Exchanger Performance

Outside		Tubeside	
Outside film coef (kcal/m2-hr-C)	38.03	Actual U (kcal/m2-hr-C)	14.002
Tubeside film coef (kcal/m2-hr-C)	859.67	Required U (kcal/m2-hr-C)	13.760
Clean coef (kcal/m2-hr-C)	16.628	Area (m2)	917.93
Hot regime	Sens. Gas	Overdesign (%)	1.76
Cold regime	Sens. Gas		
EMTD (Deg C)	62.5		
Duty (MM kcal/hr)	0.789		

Unit Geometry

Unit Geometry		Tube Geometry	
Bays in parallel per unit	1	Tube type	High-finned
Bundles parallel per bay	1	Tube OD (mm)	25.400
Extended area (m2)	917.93	Tube ID (mm)	19.863
Bare area (m2)	42.620	Length (mm)	4876.800
Bundle width (mm)	1718	Area ratio(out/in)	27.542
Number	2	Layout	Staggered
Diameter (mm)	101.60	Trans pitch (mm)	59.690
Velocity (m/s)	8.14	Long pitch (mm)	49.492
R-V-SQ (kg/m-s2)	796.68	Number of passes	4
Pressure drop (kgf/cm2)	4.47e-3	Number of rows	4
		Tube count	112
		Tube count Odd/Even	28 / 28
		Material	Carbon steel

Fan Geometry

Fan Geometry		Fin Geometry	
Norbay	3	Type	Circular
Fan ring type	Straight	Fins/length (fin/meter)	393.7
Diameter (mm)	1219	Fin root (mm)	25.400
Ratio, Fan/bundle face area	0.4181	Height (mm)	15.875
Driver power (kW)	0.92	Base thickness (mm)	0.457
Tip clearance (mm)	9.525	Over fin (mm)	57.150
Efficiency (%)	65.000	Efficiency (%)	85.6
		Area ratio (fin/bare)	21.5
		Material	Aluminum 1100-annealed

Airside Velocities

Actual		Standard	
Face (m/s)	2.20	2.08	
Maximum (m/s)	4.84	4.57	
Flow (100 m3/min)	11.071	10.463	
Velocity pressure (mmH2O)	1.610		
Bundle pressure drop (mmH2O)	6.969		
Bundle flow fraction	1.000		

Thermal Resistance, %

Thermal Resistance, %	
Air	36.82
Tube	44.86
Fouling	15.79
Metal	2.53
Bond	0.00
Lowerers	0.00
Hail screen	0.00
Steam coil	0.00

The software interface also shows a sidebar with various tools and a bottom status bar indicating 'Run Completed'.

STEP #5: Analyze the results

Material streams

(SXTMO)

Name: Xace

Desc:

Identification Parameters Reports Scripts Report Streams Notes Advanced parameters

Add Delete Copy

Property	No 1	No 2
Temperature (K)	533.16	322.05
Pressure (atm)	33.0024	32.7354
Molar flowrate (kmol/h)	356.241	356.241
Mass flowrate (kg/h)	5715	5715
Volume flowrate (m3/h)	475.002	276.595
Enthalpy flux (kcal/h)	822148	32858.1
Solid fraction (mol)	0	0
Liquid fraction (mol)	0	0
Vapor fraction (mol)	1	1
Partial molar flowrates (kmol/h)		
METHANE	356.241	356.241
Partial mass flowrates (kg/h)		
METHANE	5715	5715
Mole fractions		
METHANE	1	1
Mass fractions		
METHANE	1	1

OK Cancel



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Software & Services In Process Simulation

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