INSTED Plate-Fin Tutorial

TTC INSTED Ver. 9.2



TTC TECHNOLOGIES, INC.

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1. QuickStart: Running a Plate-Fin Sample Problem

This tutorial will teach you how to quickly run a Plate-Fin sample problem that has been previously generated and archived in INSTED. Please follow the steps below.

(1) Click "Sample Problem" from the menu panel shown on the left-side of the screen shot



(2) After the "Sample Problems" tab has been loaded, ensure that "Plate-Fin HEX" is displayed for "Choose Problem Type." As a sample problem, locate "Hewitt.315" from the list of available Plate-Fin sample problems, and then click the "Copy to Your Account" button.

Create HEX Geometry Rate HEX Multiple Rating Sizing Optimization	e Problems:
Multiple Rating Sizing Optimization	ose Problem Type: Plate Fin HEX •
Shell & Tubes Heat Exchanger • Create HEX Geometry • Rate HEX • Multiple Rating • Preliminary Design Concentric Tubes Heat Exchanger • Create HEX Geometry	Hewitt.315 This test problem illustrates the use of INSTED/Plate-Fin program to compute single-phase heat transfer with thermophysical properties obtained at a single, representative temperature.

(3) A popup window will show up to confirm the sample problem has been copied to your account. Note that two projects are created: "(Sample) Hewitt HX" for the heat exchanger Geometry module and "(Sample) Hewitt Rating" for the heat exchanger Rating module. Click "OK" to view the rating project.

Conf	irmation Required	×
Th	e following data have been copied t	o your account:
ſ	(Plate-Fin Geometry) (Sample) Hewitt HX (Plate-Fin Rating) (Sample) Hewitt Rating	
Do	you want to open the copied Sample Ra	ting problem?
		Yes No

(4) The interface for the Plate-Fin rating module will be displayed. Note that the "Rate HEX" menu is highlighted in the menu panel to indicate the working project is for the Plate-Fin Rating module. Also note that "(Sample) Hewitt HX" is selected for "Choose Heat Exchanger Geometry to Rate", which is the heat exchanger geometry project that was copied in Step (3) above. Click the "Compute" button to start the Rating calculation.



(5) Wait until the calculation has finished, after which the calculation results will be displayed. Click "Hot Flow / Cold Flow / Overall" to view the results for the hot stream, cold stream, or the overall results. You can choose a different variable to plot using "Choose Plot Variable." Click the "Download ALPEMA Sheet" button to display the calculation results in ALPEMA sheet format or click the "Download Rating Data" button to download the calculation results in a Microsoft Excel file format.

alculation Result:			
Hot Flow Cold Fl	ow Overall		į.
No. of Passages:	150	-	
nlet Temperature:	733.16	К	•
Outlet Temperature:	617.181245538	к	•
Pressure Loss:	6862.218586185	Pa	
Mass Flow Rate:	25.4	kg/s	•
Mass Flux:	18.324630937	kg/(s·m [#])	
Flow Velocity:	33.934501736	m/s	
Fouling Resistance:	0.	m*K/W	
Equivalent Diameter	0.002775	m	
Revnolds Number	1589.089089089		
Heat Coefficient:	127.769725797	W/(m=K)	•
Effective hA:	1.910064e+5	WK	
Effective Heat Area:	1494.926573861	mª	•
Colburn Factor J:	0.005078535		-
Friction Factor F:	0.016396232		
Fin Shape:	rectangular		
Fin Profile:	plain		
in Efficiency:	0.775128148		
Plate Spacing:	0.0057	m	•
Fin Pitch:	0.002	m	•
Fin Thickness:	1.5∈-4	m	•
Flow Length:	0.9	m	•
Flow Width:	1.8	m	•
Power:	3.227784e+5	W	•
Mean Temperature:	675.170622768	К	•
Mean Density:	0.54	ka/mª	
Mean Specific Heat:	1060.0	J/(kg·K)	•
Mean Viscosity:	3.2e-5	kg/(m·s)	•
Mean Conductivity:	0.05	W/(m-K)	•
Mean Heat Capacity:	26924.0	WK	
Mean Prandtl Number:	0.6784		
Vean Nusselt Number:	7.091219782		
Free Flow Area:	1.3861125	mª	

2. QuickStart: Creating a Plate-Fin Geometry

This tutorial will teach you how to manually create a Plate-Fin heat exchanger geometry.

(1) Click the "Create Hex Geometry" button under "Plate-Fin Heat Exchanger" from the menu panel



- (2) After "Plate-Fin: Geometry" tab has been loaded, input the following data as a sample heat exchanger geometry:
 - a. Input "Hewitt HX" in "Heat Exchanger Geometry Name:"
 - b. Select "Cross" for "Flow Arrangement:"
 - c. Choose "150" for "No. of Passages" for both "Fluid A" and "Fluid B".
 - d. Choose "1" for "No. of Flow Passes" for both fluids.
 - e. Choose "1" for "No. of Partitions" for both fluids.
 - f. Select "Single" for "Banking Type"
 - g. Input "0.9 [m]" for "L" (heat exchanger length)
 - h. Input "1.8 [m]" for "W" (heat exchanger width)
 - i. Input "0.0003 [m]" for "Plate Thickness"
 - j. Input "0.0003 [m]" for "End Plate Thickness"
 - k. Input "15.0 [W/m.K]" for "Plate Conductivity"
 - I. Input "2700 [kg/m³]" for "Plate Density"

. Heat Exchanger Geome	try Name:					
Hewitt HX			Atzunnun	TANKAMAN	THE REAL PROPERTY OF	
I. Flow Arrangement: Parallel	• Cross		Fluid A			Fluid B
II. Plates Arrangement:			W			
	Flow A.	Flow B		_		_
No. of Passages:	150 💌	150 🔻	VI. Plate Properties:			
No. of Flow Passes:	1	1 💌	Plate Thickness:	0.0003	m 🔻	
No. of Partitions:	1 •	1. •	End Plate Thickness:	0.0003	m 🔻	
			Plate Conductivity:	15.0	W/(m-K)	•
V. Banking Type:			Plate Density:	2700.0	kg/m² ▼	
• Single	Double					
/. Heat Exchanger Plate S	ize:		VII. Fin Properties:			
L = 0.9		m 🔻	Enter Fin Data for I	A wor		
W = 1.8		m 🔻	Enter Fin Data for I	low B		

- (3) Click "Enter Fin Data for Flow A" button. The "Plate-Fin: Fin A" tab will be displayed.
 - a. Choose "Rectangular" for "Fin Shape (Frontal)"
 - b. Choose "Plain" for "Fin Profile (Flow Direction)"
 - c. Input "0.0057 [m]" for "Plate Spacing"
 - d. Input "0.00015 [m]" for "Fin Thickness"
 - e. Input "0.002 [m]" for "Fin Pitch"
 - f. Input "15.0 [W/m.K]" for "Fin Conductivity"
 - g. Input "2702.0 [kg/m³]" for "Fin Density"
 - h. Input "0.0" for both "Bar Width" and "Bar Height' (See the sketch below for the definition of these parameters. The bar is shown in yellow color.)
 - i. Confirm "Use user-defined j/f data?" is unchecked
 - j. Confirm "Use fin data from Kays & London?" is unchecked

Rectangular 🔻			
II. Fin Profile (Flow Direction):			h^{s} h s \rightarrow t
Plain	•		
. Fin Properties:			T w _{ey}
Plate Spacing (h'):	0.0057	m v	
Fin Thickness (t):	0.00015	m. 🔻	
Fin Pitch (p):	0.002	m 🔻	
Fin Conductivity:	15.0	W/(m K) 🔻	
Fin Density:	2702.0	kg/m² ▼	
Bar Width (w _{sb}):	0.	(m.) 🖬	
Bar Height (h _{sb}):	0.	m 🔻 🔂	-
Custom j/f data —	1 j/f data?		
Kays & London fin	data		

- (4) Click "Back to the Project" button at the bottom of "Plate-Fin: Fin A" tab to return to the "Plate-Fin: Geometry" tab. Click "Enter Fin Data for Flow B" button. The "Plate-Fin: Fin B" tab will be displayed.
 - a. For this illustration problem, the same fins are used for both streams. Click the "Same with Fin A" button so that all previously inputted data for "Fin A" will automatically be used for "Fin B."

I. Fin Shape (Frontal): Rectangular 🔹			
II. Fin Profile (Flow Dire	ection):		
Plain	•		*
III. Fin Properties:			, w _{at}
Plate Spacing (h'):	0.0057	m 🔻	
Fin Thickness (t):	0.00015	m. T	
Fin Pitch (p):	0.002	m 🔻	
Fin Conductivity:	15.0	W/(m·K) ▼	
Fin Density:	2702.0	kg/m² ▼	
	<u>1</u>		
Bar Width (W _{sb}):	0.0	m 🔻 🔁	
Bar Height (h _{sb}):	0.0	m 🔻 🔁	
Custom j/f data			
Use user-defined	j/f data?		
Kous & Landas fin	data		
Use fin data from	Kavs & Lond	on?	
	nays a cona		

(5) Click the "Back to the Project" button at the bottom of the "Plate-Fin: Fin B" tab to return to the "Plate-Fin: Geometry" tab. Click "Save" button to save current project.

V. Heat Exchan	ger Plate Size:	VII. Fin Properties:
L =	0.9	m 🔻
W =	1.8	m T
New	Save	Load Close

(6) A notification "Your data has been successfully saved!" will be displayed to confirm that the project has been saved.

Art Page Plate-Fin: C Heat Exchanger Geometry Hewitt HX I. Flow Arrangement: Parallel	eometry × F	Plate-Fin: Fin A	Plate-Fin: Fin B	LADUADA	TER DEPOSITE
. Heat Exchanger Geometry Hewitt HX I. Flow Arrangement: Parallel	/ Name:		Yanning Analon in	CANULADA	THATTAN
I. Flow Arrangement:			The second se	in Manager	- ANTICINU
	Cross		Fluid A Martine Contraction		
II. Plates Arrangement:	Flow A	Flow B			
No. of Passages:	150 •	150 •	VI. Plate Properties:		
No. of Partitions:	1 •	1	Plate Thickness: End Plate Thickness:	0.0003 0.0003	m ¥
V. Banking Type:			Plate Conductivity: Plate Density:	15.0 2700.0	W/(m·K) kg/m² ▼
Single	Double			4	
V. Heat Exchanger Plate Size	81		VII. Fin Properties:		
L = 0.9 W = 1.8	m	•	Enter Fin Bata for Enter Fin Bata for	Flow A	
	II. Plates Arrangement: No. of Passages: No. of Flow Passes: No. of Partitions: V. Banking Type: Single /. Heat Exchanger Plate Size L = 0.9 W = 1.8	II. Plates Arrangement: Flow A No. of Passages: 150 • No. of Flow Passes: 1 • No. of Partitions: 1 • V. Banking Type: Single Double A Heat Exchanger Plate Size: L = 0.9 m W = 1.8 m	II. Plates Arrangement: Flow A Flow B No. of Passages: 150 • 150 • No. of Flow Passes: 1 • 1 • No. of Partitions: 1 • 1 • V. Banking Type: • Single Double A Heat Exchanger Plate Size: L = 0.9 m • W = 1.8 m •	II. Plates Arrangement: Flow A No. of Passages: 150 • No. of Plow Passes: 1 • No. of Flow Passes: 1 • No. of Partitions: 1 • 1 • Plate Thickness: Plate Thickness: Plate Thickness: Plate Thickness: Plate Thickness: Plate Thickness: Plate Conductivity: Plate Density: VI. Fin Properties: VI. Fin Properties: W = 1.8	II. Plates Arrangement: Flow A No. of Passages: 150 • No. of Plow Passes: 1 • 1 • 1 • 1 • Plate Properties: Plate Thickness: 0.0003 End Plate Thickness: 0.0003 Plate Conductivity: 1 • • Single Double VI. Fin Properties: 2. Heat Exchanger Plate Size: L = 0.9 w = 1.8 VII. Fin Properties: 2. There Fine Dates For Place For Pl

(7) Note that the saved project can be loaded back by clicking the "Load" button. The geometry name is used to distinguish different saved Plate-Fin geometry projects.

. Plates A	Load Plate-Fin Geometry Data	0.000	
No. of Pa	Which data to load?		
No. of Pa	Last modified at: 7/2/2018, 1:11:04 PM	0.0003	m 🔻
NO. OF PE	OK Cancel	0.0003	m ¥
		15.0	W/(m K) ▼
Banking Ty	pe: Plate Density:	2700.0	kg/mª 🔻

(8) Continue to the next tutorial to learn how to rate this newly created heat exchanger geometry.

3. QuickStart: Rating a Plate-Fin Geometry

This tutorial will teach you how to manually create a Plate-Fin rating project to rate the heat exchanger geometry created in the previous tutorial.

(3) Click "Rate HEX" under "Plate-Fin Heat Exchanger" from the menu panel

Plate-Fin Heat Exchanger	Me
 Create HEX Geometry 	2
Rate HEX	
 Multiple Rating 	
Sizing	
Optimization	

- (4) After the "Plate-Fin: Rating" tab has been loaded, follow the steps below:
 - a. Input "Hewitt Rating" for "Project Name"
 - b. Choose the name of the Plate-Fin heat exchanger geometry created in the previous tutorial ("Hewitt HX") in "Choose Heat Exchanger Geometry to Rate"
 - c. Choose "Fluid A is hot" in "Flow Assignment"
 - d. Choose "Co-Current" in "Flow Direction"
 - e. Choose "No Phase Change" in "Two Phase Flow?"
 - f. Input "25.4", "25.0" for hot and cold stream "Inlet Flow Rate" and choose "kg/s" as the flow rate unit
 - g. Input "733.16", "573.16" for hot and cold stream "Inlet Temperature" and choose "K" as the temperature unit
 - h. Input "0", "0" for hot and cold stream "Inlet Pressure"
 - i. Input "0.4", "0.4" for hot and cold stream "K-Factor In"
 - j. Input "0.4", "0.4" for hot and cold stream "K-Factor Out"
 - k. For "Fluid Properties", choose "Fixed" for both hot and cold stream
 - I. Input "0.54", "4.86" for hot and cold stream fluid "Density" and choose "kg/m³" as the density unit
 - m. Input "1060.0", "1060.0" for hot and cold stream "Specific Heat" and choose "J/(kg·K)" as the specific heat unit
 - n. Input "3.2e-5", "3.2e-5" for hot and cold stream "Viscosity" and choose "kg/(m·s)" as the viscosity unit
 - o. Input "0.05", "0.05" for hot and cold stream "Conductivity" and choose "W/(m·K)" as the conductivity unit

Project Name.								
Hewitt Rating					Theorem	-		ACTIVITY
Chapter Heat Fuchan	ant Coor	antra to D	ator		Junior State		ALL DURING THE	MADEMAN
Howitt HY	Bei deon	• ON	ate.		The second second		TALLAND TO A	Fluid Fluid
The wat the			IN CALOUR	2	Fluio		REDEUDING	-
. Flow Assignment:						w	1	
• Fluid A is hot	- Flui	id B is hot				ý		
. Flow Direction:					VII. Fluid Properti	es:		
Co-Current	Cou	unter-Curi	rent		 Hot Fluid Pr 	operties:		
Two Dhase Flow?					🤨 Fixed	Variable,	/Custom	REFPROP
No Phase Change								
No Fliase Change					- Cold Fluid P	roperties:		
					· Fixed	Variable	/Custom	REFPROP
I. Flow Conditions:								
	Hot	Cold				Hat	Cold	
Inlet Flow Rate:	25.4	25.0	kg/s 🔻		Donsitu	0.54	4.06	
Inlet Temperature:	733.16	573.16	K 🔻		Density.	0.54	4.00	Ngrini Y
Inlet Pressure:	0	0	Pa 🔻		Specific Heat:	1060.0	1060.0	J/(kg·K) ▼
Fouling Resistance:	0	0	m*K/W	•	Viscosity:	3.2e-5	3.2e-5	kg/(m·s) ▼
K Eactor In	-	1			Conductivity:	0.05	0.05	W/(m·K)
N-ractor III	0.4	0.4				4	1	
K-Factor Out	0.4	0.4						
Constant a set	0.4	0.4			VIII. Calculation N	lethod (Op	tional)	
		-				1.4		

(5) Click the "Save" button to save the project.

New	Save	Load	Close	Compute

(6) Click the "Compute" button to begin the rating calculations.

New	Save	Save As	Load	Close	Compute

(7) Wait until the calculation has finished and some calculation results shown. Click "Hot Flow / Cold Flow / Overall" to view the "overall" results. Select any variables you might want to plot by clicking on the "Choose Plot Variable" button. Click on "Download ALPEMA Sheet" if you want to view the calculation results in ALPEMA format or click "Download Rating Data" to view them in a Microsoft Excel file.

alculation Result:			Choose Plo	t Variable		: Te	: Tempe
Hot Flow Cold Fl	ow Overall		show disc	orete data?		8	2
No. of Passages.	150						
Inlet Temperature.	733.16	K ¥					
Outlet Temperature	617.181245536	к. 💌		f -			
Pressure Loss:	6862.218586185	Pa 🔻		1			
Mass Flow Rate:	25.4	kg/s 🔻	⊊ ⁷⁰⁴	-		1	~
Mass Flux	18.324630937	kg/(s·m²) ▼	2 672	-			
Flaw Velocity:	33.934501736	mis 🔻	te 640	2			
Fouring Resistance:	0	m²K/W	du				/
Equivalent Diameter	0.002775	m •	₽ 600			/	/
Reunalde Number	1589 089089089		576	- /			
Heat Coefficient:	127.769725797	W/m²-K)					i - i
Effective hA	1 910064445	W/R T		0 0	ò	2	2 04
Fearting Heat Area	1404 008573881			Dist. Alor)	ng F	ng Pass
College Faster 1	0.005070505						
Enction Factor E	0.016396232						_
Fin Shape:	rectangular		Downto	ed ALPEN	1	IA 3	A Shee
Fin Ptofile:	plain					_	
Fin Efficiency.	0.775128146		Down	load Ratin		g D	g Data
Plate Spacing.	0.0057	m 🔻				_	
Fin Pitch:	0.002	m. 💌					
Fin Thickness:	1.5e-4	m 🔻					
Flaw Length.	0.9	m 🔻					
Flaw Width:	1.8	m . 🔻					
Power	3.227784e+5	W					
Mean Temperature:	675.170622768	K.F.					
Mean Density	0.54	kaim' r					
Muner Sensifie Heat	1080.0	When the second					
wean specific rieat	1000.0	nded et a					
Mean Viscosity.	3.2e-5	kg/(m/s) 🔻					
Mean Conductivity:	0.05	WV(m-K) 🔹					
Mean Heat Capacity:	26924.0	W/K T					
Mean Pranett Number:	0.6784		+				
Mean Noosell Norther	7 091919789						

4. QuickStart: Creating & Running a Multiple Rating Project

In the Multiple Rating module, INSTED allows you to successively run multiple Plate-Fin rating calculations by changing the values of one or more geometry or flow parameters based on an existing regular Plate-Fin rating project. This is basically a parameter sweep analysis.

This tutorial will teach you how to create a Plate-Fin Multiple Rating project so that the hot stream inlet mass flow rate is varied over a given range. The rating project created in the previous tutorial will be used for the illustration.

Note that this tutorial only demonstrates how to change one geometry/flow parameter in Multiple Rating project. To change more than one geometry/flow parameters simultaneously, please refer to the Tutorial *"23. Advanced Topics: Custom Multiple Rating"*.

(1) Click "Rate HEX" under "Plate-Fin Heat Exchanger" in the main menu panel



- (2) After the "Plate-Fin: Multiple Rating" tab has been loaded, following the steps below:
 - a. Input "Hewitt Multi-Rate" for "Project Name"
 - b. Choose the name of the Plate-Fin Rating Project created in previous tutorial "Hewitt Rating" in "Choose a Rating Project." Note that the details of the selected Rating Project can be viewed by clicking on the "View Details" button.
 - c. Choose "Hot Flow Flowrate" in the "Choose an Input Variable to Vary" dropdown list. Note that a couple of geometry/flow parameters are allowed to vary, but we will only vary the hot stream flow rate in this example.



Hewitt Multi-Rate	
Hewitt Rating View Retails	Fluid A Hold Hold Hold Hold Hold Hold Hold Hold
No. of Levels: 2 V Min. Max.	

(3) Change "No. of Levels" to 10, which indicates 10 rating calculations will be carried out.

Project Name:	
Hewitt Multi-Rate	With the second s
Choose a Rating Project: Hewitt Rating	
	Fluid A Hold Read and A Hold R
Hot Flow Flowrate	W WILling L
No. of Levels: 2	4
Min. Max.	
Flow Poto	

(4) Click the "Get Value" button so that the value of the original hot stream mass flowrate will be shown in the "Min./Max. Flow Rate" textboxes.



(5) Change the "Min." value to 15.0 and the "Max." value to "22.0." This indicates that 10 rating calculations will be carried out for hot stream flowrate between 15.0 kg/s and 22.0 kg/s.

Hewitt Multi-Rate				
. Choose a Rating Hewitt Rating I. Choose an Input	Project: Variable to Vary:	View Vietanie 💽 📻	Fluid A	Harden and Andrew Andre
Hot Flow Flowrate	•	Gei Velue 📔 📔		1

(6) Click the "Save" button to save the project.

		_			
New	Save	Load	Close	J	Compute
				·	

(7) Click the "Compute" button to begin the Multiple Rating calculations.

New	Save	Save As	Load	Close	Compute

- (8) Wait until the calculation has been completed, and the calculation results displayed:
 - a. Under "Choose One Rating Point" dropdown list, you can choose a specific rating point to view its results
 - b. Click the "Save Selected Rating Data to a Regular Rating Project" button to save the selected rating point into a regular Plate-Fin Rating Project
 - c. Click on "Choose Plot Variable" to select a variable to plot. Note that the "X-axis" represents the variable that is being varied (the hot stream flowrate in this case)
 - d. Additional options are available for plot settings.
 - e. Click on "Download Multiple Rating Data" to view calculation results in a Microsoft Excel file.



5. QuickStart: Creating & Running a Sizing Project

In the Sizing module, INSTED tries to find a Plate-Fin heat exchanger geometry that satisfies a design target (target heat transfer rate). This is done by changing several heat exchanger geometry parameters in an existing rating project (reference rating project).

This tutorial will teach you how to create a Plate-Fin sizing project. The Rating Project created in the previous tutorial will be used.

(1) Click "Sizing" under "Plate-Fin Heat Exchanger" from the menu panel



(2) After the "Plate-Fin: Sizing" tab has loaded, follow the steps below:

- a. Input "Hewitt Sizing" for "Project Name"
- b. Select the name of the Plate-Fin rating project created in the previous tutorial ("Hewitt Rating") in "Choose a Rating Project." Note that the details of the selected Rating Project can be viewed by clicking the "View Details" button.
- c. Note that the total heat transfer rate of the original "Hewitt Rating" project is "3.122612 E+6 W." In this sizing calculation, specify "3.5E+6 W" for "Target Heat Transfer Rate."
- d. The "Sizing Criteria" controls the parameters that are allowed to change in the referenced Rating Project during the Sizing calculations. In this case, only allow plate length and width to change.

Hewitt Sizing Choose a Reference Rating Project: Hewitt Rating Ingle phase calculation only Design Target:	Fluid A		nananananan nananananan nanananan nanananan nanananan nanananan n
Target Heat Transfer Rate: 3.5e+6 W T	V. Min/Max	Bounds on Design I Act Doumls	Parameters:
Sizing Criteria: 📴	Difference b	etween sizing and r	ating:
Sizing Criteria: 👩 Fix Plate Length?	Difference b	etween sizing and r	ating:
Sizing Criteria: Fix Plate Length? Fix Plate Width?	Difference be	etween sizing and r Rating Plate Length Plate Weth	ating: Sizing Target Head Transfer Rate
Sizing Criteria: Fix Plate Length? Fix Plate Width? Fix Hot Flow Rate?	Difference by	Plate Longth Plate Width No. of Plates No. of Plates	ating: <u>Sizing</u> Target Heat Transfer Rate
Sizing Criteria: Fix Plate Length? Fix Plate Width? Fix Hot Flow Rate? Fix Cold Flow Rate?	Difference be	Etween sizing and r Rating Plate Length Plate Width No. of Plates No. of Plates No. of Plates (Hot) No. of Plate Plates (Hot) Mass Flow Plate (Hot)	ating: Sizing Target Heat Transfer Rate
Sizing Criteria: Fix Plate Length? Fix Plate Width? Fix Hot Flow Rate? Fix Cold Flow Rate? Fix No. of Flow Passes? Fix No. of Flow Passes?	Difference by	Plate Longth Plate Longth Plate Width No. of Plates No. of Flow Plates (Cold) Meas Flow Plates (Flot) Meas Flow Plates (Flot) Meas Flow Rate (Flot) Res Shape/Profile (Hot)	ating: Sizing Daget Heat Transfer Rate
Sizing Criteria: Fix Plate Length? Fix Plate Width? Fix Hot Flow Rate? Fix Cold Flow Rate? Fix Cold Flow Rate? Fix No. of Flow Passes? Fix No. of Plates? Fix No. of Plates?	Difference be	Plate Length Plate Length Plate Length Plate Width No. of Plates No. of Plates No. of Plates No. of Plave Plates (Hot) No. of Plave Plates (Hot) Mass Flow Rate (Hot) Mass Flow Rate (Cold) Fin Shape/Profile (Hot) Fin Shape/Profile (Cold) Fin Shape/Profile (Cold)	ating: Sizing Target Heat Transfer Rate
Sizing Criteria: Fix Plate Length? Fix Plate Width? Fix Hot Flow Rate? Fix Cold Flow Rate? Fix No. of Flow Passes? Fix No. of Flow Passes? Fix No. of Plates? Fix No. of Plates? Fix Entire Hot Fin Selection? Fix Hot Fin Height & Pitch?	Difference be	Plate Longth Plate Longth Plate Width No. of Plates No. of Plates No. of Plates No. of Plave Pass (Pot) Mass Flow Pass (Cold) Mass Flow Rate (Cold) Mass Flow Rate (Cold) En Shape/Profile (Cold) Fin Shape/Profile (Cold) Fin Height/Plitch (Lold)	ating: Sizing Darget Head Transfer Rate
Sizing Criteria:	Difference be Imputs Dutputs	Plate Length Plate Length Plate Length Plate Width No. of Plates No. of Plates No. of Plates No. of Plates No. of Plates (Plates No. of Plates No. of Plates No. of Plates No. of Plates No. of Plates No. of Plates No. of Plates (Plate) No. of Plates No. of Plates No. of Plates (Plate) No. of Plates No. of Plates	Arring: Sizing Target Head Transfer Rate Plate Length (Plate Width)
Sizing Criteria: Fix Plate Length? Fix Plate Width? Fix Hot Flow Rate? Fix Hot Flow Rate? Fix Cold Flow Rate? Fix No. of Flow Passes? Fix No. of Plates? Fix No. of Plates? Fix Hot of Flow Passes? Fix Hot Fin Height & Pitch? Fix Hot Fin Height & Pitch? Fix Hot Fin Shape (Frontal)? Fix Hot Fin Profile (Flow Dir.)? Fix Entire Cold Fin Selection?	Difference be Impute Outpute	Plate Length Plate Length Plate Width No. of Plates No. of Plates No. of Plates No. of Plates No. of Plate Plates No. of Plate Plates (Cold) Mass Flow Rate (Hot) Mass Flow Rate (Lold) Mass Flow Rate (Cold) Ris Shape/Profile (Cold) Ris Shape/Profile (Cold) Ris Height/Plitch (Lold) Ris Height/Plitch (Cold) Heat Transfer Rate	Target Head Transfer Rate Plate Length (Plate Width (No. of Plates (No. of Flates (
Sizing Criteria:	Difference by Impute Durpute	Etween sizing and r Enting Plate Length Plate Width No. of Plates No. of Flow Plates (Poot) Mass Flow Rate (Poot) Mass Flow Rate (Poot) Head Shape/ProtNe (Cold) Rin Height/Pitch (Cold) Head Transfer Rate	Plate Length (Plate Length (Plate Width) No. of Plates (Hot) (No. of Plates (Hot) (No. of Plates (Hot) (No. of Plates (Hot) (Mass Flow Plats (Hot))
Sizing Criteria:	Difference be Inputs Durputs	Plate Length Plate Length Plate Midth No. of Plates No. of Plates No. of Plates (Hot) No. of Plates (Hot) Nass Flow Rate (Hot) Mass Flow Rate (Hot) Mass Flow Rate (Hot) Sin Shape/Profile (Cold) Rin Shape/Profile (Cold) Rin Shape/Profile (Cold) Rin Height/Plitch (Cold) Rin Height/Plitch (Cold) Hear Transfer Rate	Plate Length (Plate Length (Plate Width (No. of Flates) No. of Flates (No. of Flates (No
Sizing Criteria:	Difference be Inggester Outputer	Plate Longth Plate Longth Plate Width No. of Plates No. of	Target Head Transfer Rate Darget Head Transfer Rate Plate Length (Plate Width) No. of Flow Pass (Not) No. of Flow Pass (Not) No. of Flow Rate (Het) (Mass Flow Rate (Cold) (Bin Shapa/Profile (Het) (Bin Shapa/Profile (Cold) (Bin Shapa/Profile (Cold) (
Sizing Criteria:	Difference by Impute Dumute	etween sizing and r Enting Plate Length Plate Width No. of Plates No. of Flow Plates (Poot) No. of Flow Plates (Poot) Mass Flow Rate (Poot) Mass Flow Rate (Poot) Mass Flow Rate (Poot) Rin Shape/Profile (Pool) Rin Shape/Profile (Cold) Rin Height/Pitch (Cold) Heart Transfer Rate	Plate Length (Plate Length (Plate Wedth (No. of Plates (Heat) (Mass Flow Plates (Heat) (Mass Flow Rate (Heat) (Bin Shapa/Profile (Heat) (Bin Shapa/Profile (Heat) (Bin Height/Plitch (Heat) (Bin Height/Plitch (Heat) (Bin Height/Plitch (Heat) (Bin Height/Plitch (Heat) (

(3) Click the "Set Bounds" button; the "Plate-Fin: Design Constraints" tab will be displayed. The range of the design parameters that are allowed to change can be set here. For this illustration, leave the default values unchanged. Click the "Back" button to go back to the "Plate-Fin: Sizing" tab.

Win. Hot Flow Rate=0.006kq/sWax. Cold Flow Rate=80.0kg/sWin. Cold Flow Rate=0.006kg/sWax Plate Length=12.0mWin Plate Length=0.004mWax Plate Width=8.0mWax Material Temperature=1000.0KWax Hot Pressure Drop=10.e+5PaWax Number of Plates=1000KWin Number of Plates=4Max Hot Plate Spacing=5.e-4mMax Cold Plate Spacing=0.05mMax Cold Plate Spacing=0.05mMax Cold Plate Spacing=5.e-4mMax Cold Plate Spacing=5.e-4m<	Max. Hot Flow Rate	= 80.0	kg/s ▼
Max. Cold Flow Rate=80.0kg/sWin. Cold Flow Rate=0.006kq/sMax Plate Length=12.0mWin Plate Length=0.004mMax Plate Width=8.0mMax Plate Width=0.001mMax Material Temperature=1000.0KMax Material Temperature=1000.0KMax Hot Pressure Drop=10.e+5PaMax Number of Plates=1000Min Number of Plates=4Max Hot Plate Spacing=5.e-4mAax Cold Plate Spacing=0.05mAax Cold Plate Spacing=5.e-4mAax Cold Plate Spacing=5.e-4m <th>Min. Hot Flow Rate</th> <th>= 0.006</th> <th>kq/s ▼</th>	Min. Hot Flow Rate	= 0.006	kq/s ▼
Win. Cold Flow Rate=0.006kq/s×Wax Plate Length=12.0m×Win Plate Length=0.004m×Wax Plate Width=8.0m×Wax Plate Width=0.001m×Wax Material Temperature=1000.0K×Wax Material Temperature=200.0K×Wax Hot Pressure Drop=10.e+5Pa×Wax Cold Pressure Drop=10.e+5Pa×Wax Number of Plates=1000m×Wax Hot Plate Spacing=0.05m×Aax Cold Plate Spacing=0.05m×Max Cold Plate Spacing=0.05 <td< th=""><th>Max. Cold Flow Rate</th><th>= 80.0</th><th>kg/s ▼</th></td<>	Max. Cold Flow Rate	= 80.0	kg/s ▼
Max Plate Length=12.0mmVin Plate Length=0.004mmVin Plate Width=8.0mmVin Plate Width=0.001mmVin Plate Width=1000.0KMVin Material Temperature=1000.0KMVin Material Temperature=200.0KMVin Material Temperature=10.e+5PaMVin Material Temperature=10.e+5PaMVin Material Temperature=10.e+5PaMVin Max Cold Pressure Drop=10.e+5PaMVin Number of Plates=1000MMVin Number of Plates=4MMVin Hot Plate Spacing=5.e-4mMVin Hot Plate Spacing=0.05mMVin Cold Plate Spacing=0.05mMAax Cold Plate Spacing=0.05 </th <th>Vin. Cold Flow Rate</th> <th>= 0.006</th> <th>kq/s ▼</th>	Vin. Cold Flow Rate	= 0.006	kq/s ▼
Min Plate Length = 0.004 m ▼ Max Plate Width = 8.0 m ▼ Min Plate Width = 0.001 m ▼ Max Material Temperature = 1000.0 K ▼ Max Material Temperature = 200.0 K ▼ Max Hot Pressure Drop = 10.e+5 Pa ▼ Max Cold Pressure Drop = 10.e+5 Pa ▼ Max Number of Plates = 1000 Max Number of Plates Anax Hot Plate Spacing = 0.05 m ▼ Ain Hot Plate Spacing = 5.e-4 m ▼ Max Cold Plate Spacing = 0.05 m ▼ Max Cold Plate Spacing = 5.e-4 m ▼ Max Cold Plate Spacing = 5.e-4 m ▼ Max Cold Plate Spacing = 5.e-4 m ▼	Max Plate Length	= 12.0	m 🔻
Max Plate Width = 8.0 m Min Plate Width = 0.001 m Max Material Temperature = 1000.0 K Max Material Temperature = 200.0 K Max Hot Pressure Drop = 10.e+5 Pa Max Cold Pressure Drop = 10.e+5 Pa Max Number of Plates = 1000 Min Number of Plates = 4 Max Hot Plate Spacing = 0.05 m Max Cold Plate Spacing = 0.05 m	Vin Plate Length	= 0.004	m 🔻
Win Plate Width = 0.001 m ▼ Max Material Temperature = 1000.0 K ▼ Win Material Temperature = 200.0 K ▼ Max Hot Pressure Drop = 10.e+5 Pa ▼ Max Cold Pressure Drop = 10.e+5 Pa ▼ Max Cold Pressure Drop = 10.e+5 Pa ▼ Max Number of Plates = 1000 m ▼ Max Hot Plate Spacing = 0.05 m ▼ Max Cold Plate Spacing = 0.05 m ▼	Max Plate Width	= 8.0	m 🔻
Max Material Temperature = 1000.0 K Min Material Temperature = 200.0 K Max Hot Pressure Drop = 10.e+5 Pa Max Cold Pressure Drop = 10.e+5 Pa Max Number of Plates = 1000 Image: Second Se	/lin Plate Width	= 0.001	m 🔻
Min Material Temperature = 200.0 K Max Hot Pressure Drop = 10.e+5 Pa Max Cold Pressure Drop = 10.e+5 Pa Max Number of Plates = 1000 Min Number of Plates = 4 Max Hot Plate Spacing = 0.05 m Max Cold Plate Spacing = 0.05 m Max Cold Plate Spacing = 0.05 m	Nax Material Temperature	= 1000.0	К▼
Max Hot Pressure Drop = 10.e+5 Pa ▼ Max Cold Pressure Drop = 10.e+5 Pa ▼ Max Number of Plates = 1000 Image: Second Sec	Ain Material Temperature	= 200.0	K 🔻
Max Cold Pressure Drop = 10.e+5 Pa ▼ Max Number of Plates = 1000 Min Number of Plates = 4 Max Hot Plate Spacing = 0.05 m ▼ Min Hot Plate Spacing = 5.e-4 m ▼ Max Cold Plate Spacing = 0.05 m ▼	Max Hot Pressure Drop	= 10.e+5	Pa ▼
Max Number of Plates = 1000 Min Number of Plates = 4 Max Hot Plate Spacing = 0.05 m ▼ Ain Hot Plate Spacing = 5.e-4 m ▼ Aax Cold Plate Spacing = 0.05 m ▼ Ain Cold Plate Spacing = 0.05 m ▼ Ain Cold Plate Spacing = 5.e-4 m ▼ Ain Cold Plate Spacing = 5.e-4 m ▼ Ain Cold Plate Spacing = 5.e-4 m ▼	Max Cold Pressure Drop	= 10.e+5	Pa 🔻
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Max Hot Plate Spacing = 0.05 m ▼ Min Hot Plate Spacing = 5.e-4 m ▼ Max Cold Plate Spacing = 0.05 m ▼ Air Cold Plate Spacing = 0.05 m ▼ Air Cold Plate Spacing = 5.e.4 m ▼ Air Cold Plate Spacing = 5.e.4 m ▼ Air Cold Plate Spacing = 5.e.4 m ▼	Ain Number of Plates	= 4	
Vin Hot Plate Spacing = 5.e-4 m ▼ Vax Cold Plate Spacing = 0.05 m ▼ dia Cold Plate Spacing = 5.e.4 m ▼ dia Cold Plate Spacing = 5.e.4 m ▼	Max Hot Plate Spacing	= 0.05	m 🔻
Max Cold Plate Spacing = 0.05 m ▼ dia Cold Plate Spacing = 5.0.4 m ▼ tic Algorithm Parameters:	Min Hot Plate Spacing	= 5.e-4	m 🔻
tic Algorithm Parameters:	Max Cold Plate Spacing	= 0.05	m 🔻
	tic Algorithm Parameters:	E o 4	•

(4) Click the "Save" button to save the project.

New	Save	Load	Close	J	Comput

(5) Click the "Compute" button to begin the sizing calculations. Depending on the settings, the calculation may take several minutes.

New	Save	Save As	Load	Close	Compute

(6) Wait until the sizing calculation has finished; a list of possible design realizations will be displayed. You may select a particular realization from the table and then click the "Rate Selected Realization" button to view the details of the realization.

	No.	Plates	N _{p,hot}	N _{p,cold}	L m V	w	M _{hot} kg/s ▼	M _{cold} kg/s ▼	∆P _{hot} Pa ▼	∆P _{cold} ▲ Pa ▼
۲	1	301	1	1	10.403768882	0.369849002	25,4	25.0	9.08471e+5	31.0729542(
0	2	301	1	1	10.387434311	0.380619943	25.4	25.0	8.672595e+5	32.00881362
0	з	301	1	1	10.766442111	0.369854008	25.4	25.0	9.399149e+5	30.00381620
0	4	301	1	1	0.519148438	7.737687956	25.4	25.0	537.605909849	43153.514074
0	5	301	1	1	0.563097782	7.198798683	25.4	25.0	626.627198955	35376.446226
0	6	301	1	1	0.6038	6.80015	25.4	25.0	711.087024094	29975.633122
0	7	301	1	1	7.949819434	0.519617168	25.4	25.0	4.087772e+5	57.04307588
0	8	301	1	1	8.873980748	0.467099792	25.4	25.0	5.385687e+5	45.9342507£
0	9	301	1	1	8.074486994	0.516470391	25.4	25.0	4.191014e+5	55.81113619
0	10	301	1	1	6.84070888	0.611902469	25.4	25.0	2.727287e+5	78.04366917
0	11	301	1	1	6.669032506	0.629962505	25.4	25.0	2.541144e+5	82,40913866
0	12	301	1	1	11.4077533	0.369034308	25.4	25.0	9.990083e+5	28.22095664
0	13	301	1	1	7.264560421	0.58158335	25.4	25.0	3.134307e+5	69.83540624
0	14	301	1	1	0.689066182	6.151180133	25.4	25.0	896.432124795	22072-139795
0	15	301	1	1	8.957832974	0.474226485	25.4	25.0	5.309081e+5	46.17503730
0	16	301	1	1	5.969440614	0.713470809	25.4	25.0	1.873977e+5	104.2423148
0	17	301	1	1	0.659439752	6.487405571	25.4	25.0	813-249396971	24924.480146
0	18	301	1	1	0.784614795	5.472597898	25.4	25.0	1146.95118222	16043.388484
										•

(7) The details of the selected realization will be shown in the "Plate-Fin: Sizing Realization" tab

- a. The results of the sizing calculation are shown under "Sizing Result"
- b. The rating results for the selected realization will be shown under "Detailed Results"
- c. Clicking the "Save to a Regular Rating Project" button allows you to save the realization into a regular Plate-Fin rating project
- d. Click "Download Realization Data" to view the realization results in a Microsoft Excel file.

Sizing Result: Plate Length: Plate Width: Hot Flow Rate: Cold Flow Rate: Total No. of Plates:	10.403768882 0.369849002 25.4	m V m V	Detailed Results: Hot Flow Cold Flow	v Overall	
Plate Length: Plate Width: Hot Flow Rate: Cold Flow Rate: Total No. of Plates:	10.403768882 0.369849002 25.4	m V	Hot Flow Cold Flow	/ Overall	
Plate Width: Hot Flow Rate: Cold Flow Rate: Total No. of Plates:	0.369849002 25.4	m 🔻			
Hot Flow Rate: Cold Flow Rate: Total No. of Plates:	25.4		No. of Passages:	150	
Cold Flow Rate: Total No. of Plates:		ka/s 🔻	Inlet Temperature:	733.16	К
Total No. of Plates:	75.0		Outlet Temperature:	605.682536649	К
Total No. of Plates:	25.0	kg/s ▼	Pressure Loss:	9.08471e+5	Pa
	301		Mass Flow Rate:	25.4	kg/s
No. of Hot Passes:	1		Mass Flux:	89.183249235	kg/(s·m²)
No. of Cold Passes:	1		Flow Velocity:	165.15416525	m/s
Hot Fin Shape:	rectangular		Fouling Resistance:	0.	m²K/W
			Equivalent Diameter:	0.002775	m
Hot Fin Profile:	plain		Reynolds Number:	7733.859894575	
Hot Fin Efficiency:	0.550786069		Heat Coefficient:	399.251504308	W/(m²·K)
Hot Plate Spacing:	0.0057	m 🔻	Effective hA:	1.130725e+8	W/K
Hot Fin Pitch:	0.002	m V	Effective Heat Area:	2832.111255557	m²
			Colburn Factor J:	0.003260686	
Hot Fin Thickness:	1.5e-4	m V	Friction Factor F:	0.0081725	
Cold Fin Shape:	rectangular		Fin Shape:	rectangular	
Cold Fin Profile:	plain		Fin Profile:	plain	
Cold Fin Efficiency:	0.833180432		Fin Efficiency:	0.550788069	
			Plate Spacing:	0.0057	m
Cold Plate Spacing:	0.0057	. m. T .	Fin Pitch:	0.002	m
Cold Fin Pitch:	0.002	m 🔻	Fin Thickness:	1.5e-4	m
Cold Fin Thickness:	1.5e-4	m 🔻	Flow Length:	10.403768882	m
Heat Transfer Rate:	3.432203e+6	w v	Flow Width:	0.369849002	m
			Power:	4.273179e+7	W
Heat Transfer Area:	1154.347060104	m ³	Mean Temperature:	669.421268324	K
Hot Pressure Loss:	9.08471e+5	Pa 🔻	Mean Density:	0.54	kg/m
Cold Pressure Loss:	31.072954205	Pa 🔻	Mean Specific Heat:	1080.0	J/(kg⋅K)
Operating Weight:	2720,298064202	kg 🔻	Mean Viscosity:	3.2e-5	kg/(m-s
			Mean Conductivity:	0.05	W/(m·K)
Effectiveness:	0.809481892		Mean Heat Capacity:	26924.0	W/K
COP:	0.080319376		4		
Save to a Regular	Rating Project		Download Realiza	ation Data	

6. QuickStart: Creating & Running an Optimization Project

In the Optimization module, INSTED attempts to find the best Plate-Fin heat exchanger geometry that satisfies stipulated objective functions and constraints. The constraints could include a specified value of the heat transfer rate in an existing Rating project (or Reference rating project).

This tutorial will teach you how to create a Plate-Fin optimization project. The rating project created in the previous tutorial will be used.

(1) Click the "Optimization" button under "Plate-Fin Heat Exchanger" from the menu panel



- (2) After "Plate-Fin: Optimization" tab has been loaded, follow the steps below:
 - a. Write "Hewitt Optimization" for "Project Name"
 - b. Choose the name of the Plate-Fin Rating Project created in the previous tutorial ("Hewitt Rating") in "Choose a Rating Project." Note that the details of the selected Rating Project can be viewed by clicking on the "View Details" button.
 - c. The "Optimization Objective Functions" tab controls the optimization objectives. In the present illustration problem, we want to determine the heat exchanger geometry that uses the minimum number of plates and provides the highest overall effectiveness. To specify these objectives, check "Minimize No. of Plates" and "Maximize Effectiveness" in "Optimization Objective Functions"
 - d. "Optimization Criteria" controls the parameters that are allowed to change in the reference Rating project during the optimization calculation. For this problem we allow only the plate length and width to change.

Optimization Objective Functions:		www.unitedantedantedantedantedantedantedantedan	Fluid e
Minimize Pressure Loss? Minimize Heat Transfer Area? Minimize Overall Weight? Minimize No. of Plates? Minimize Power? Maximize Effectiveness? Maximize COP? Maximize COP?	neters:	IV. Optimization Criteria:	
Office: Plate Longth/Weth No. of Plates No. of Flow Plate (Hot Plate How Plate (Hot Fin Shape/Profile (Ho Fin Shape/Profile (Ho	t & Cold) & Cold) xt & Cold] & S. Cold]	Fix Entire Cold Fin Selection? Fix Cold Fin Height & Pitch? Fix Cold Fin Shape (Frontal)? Fix Cold Fin Profile (Flow Dir.)? Fix Effectiveness? Fix COP?	

(3) Click the "Set Bounds" button; the "Plate-Fin: Design Constraints" tab will be displayed. The range of the design variables that are allowed to change can be specified here. For the sample problem, use the default values. Click the "Back" button to return to the "Plate-Fin: Optimization" tab.

kq/s ▼ kg/s ▼ kq/s ▼ m ▼ m ▼ m ▼ K ▼ K ▼
kg/s ▼ kq/s ▼ m ▼ m ▼ m ▼ K ▼ K ▼
kq/s ▼ m ▼ m ▼ m ▼ K ▼ K ▼
m ▼ m ▼ m ▼ m ▼ K ▼ K ▼
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(4) Click the "Save" button to save the project.

New	Save	Load	Close	1	Comp

(5) Click the "Compute" button to begin the Optimization calculations. Depending on the problem settings, the calculations may take several minutes.

New Sa	ve Save As	Load	Close	Compute

(6) Wait until the optimization calculations have been completed; a list of possible design realizations will be displayed. You can select one of the realizations and click the "Rate Selected Realization" button to view the details of the selected realization. Note that the list of the realizations is ordered in decreasing order of the best result based on the objective function.

tart Page × Plate-Fin: Optimization × Plate-Fin: Opt. Result ×												
	ioose	e One	Plotes	N _{p,hot}	or Katır N _{p,cold}	L m T	W m ▼	M _{hat} kg/s ▼	M _{cold} kg/s ▼	ΔP _{hot} Pa ▼	<i>∆P_{cold}</i> Pa ▼	r V
	۲	1 best	11	1	1	2.307543946	6.308295977	25.4	25.0	5.012954e+5	4.814717e+5	3.1
	0	2	11	1	1	2.328801197	5.039547183	25.4	25.0	7.205869e+5	3.808545e+5	3.1
	\bigcirc	з	11	1	1	2.357334297	4.751868059	25.4	25.0	7.998979e+5	3.52001e+5	3.0
	\circ	4	11	1	1	2.12352326	5.042454196	25.4	25.0	6.589861e+5	4.501988e+5	3.0
	0	5	13	1	1	2.143394042	5.584661355	25.4	25.0	4.244563e+5	3.515869e+5	3,1
	\bigcirc	6	13	1	1	2.213445781	4.973949847	25.4	25.0	5.255017e+5	2.9653e+5	3,1
	0	7	13	1	1	2.050185329	5.267258173	25.4	25.0	4.460333e+5	3.599689e+5	3,1
	\odot	8	13	1	1	2.246206445	4.671144154	25.4	25.0	5.884749e+5	2.717561e+5	3.1
	\bigcirc	9	13	1	1	2.190249138	4.749648808	25.4	25.0	5.59484e+5	2.890446e+5	3.1
	\bigcirc	10	13	1	1	2.24798223	4.55284746	25.4	25.0	6.132387e+5	2.647337e+5	3.0
	A	11	13	1	1	2 122104001	4 837618008	25.4	25.0	5 781306615	3 111047645	30
							Sort Fi	lter <u>Clear</u>				
Rate Selected Realization Back to the Project												

- (7) The details of the selected realization will be shown when you select the "Plate-Fin: Optimization Realization" tab:
 - a. The values of the optimization parameters will be shown under "Optimization Result"
 - b. The Rating Results of the selected realization will be shown under "Detailed Results"
 - c. Clicking on "Save to a Regular Rating Project" allows you to save a selected realization into a regular (single-point)Plate-Fin Rating project
 - d. Click on "Download Realization Data" to view the realization results in a Microsoft Excel file.

Start Page 🛪 📄 Plate-F	in: Optimization 🛛 🛪	Plate-Fin: Opt. F	lesult ×	Plate-	Fin: Opt. R	lealization ×	
	1		-				
Optimization Results:			De	tailed Re	esults:		
Plate Length:	2.307543946	m 🔻	н	ot Flow	Cold Flow	Overall	· · · · · · · · · · · · · · · · · · ·
Plate Width:	6.308295977	m	N	o. of Pass	ages:	5	
			In	let Tempe	rature:	733.16	К
Hot Flow Rate:	25.4	kg/s 🔻	0	utlet Temp	erature:	615.269780103	К
Cold Flow Rate:	25.0	kg/s ▼	Pr	ressure Lo)55:	5.012954e+5	Pa
Total No. of Plates:	11		м	ass Flow I	Rate:	25.4	kg/s 1
No. of Hot Passes:	1		м	Mass Flux:		156.861706262	kg/(s·m²)
	-		FI	Flow Velocity:		290.484841225	m/s 1
No. of Cold Passes:	1		Fo	Fouling Resistance:		0.	m²K/W
Hot Fin Shape:	rectangular		E	Equivalent Diameter:		0.002775	
Hot Fin Profile:	plain		R	eynolds N	umber:	13602.851089876	W/(m².K)
Hot Plate Spacing:	0.0057		E	factive hA		1 03558+5	W/K
not hate spacing.	0.0057		Ef	fective He	• •at Area:	322.843302785	m² 1
Hot Fin Pitch:	0.002	m 🔻	6	Colburn Factor J:		0.002783836	
Hot Fin Thickness:	1.5e-4	m V	Fr	iction Fac	tor F:	0.006374588	
Cold Fin Shape:	rectangular		Fi	n Shape:		rectangular	
Cold Fin Brofile:	alain		Fi	n Profile:		plain	
cold Fill Profile.	piain		Fi	n Efficienc	ey:	0.465887418	
Cold Plate Spacing:	0.0057	m 🔻	PI	ate Spacir	ng:	0.0057	m 1
Cold Fin Pitch:	0.002	m 🔻	Fi	n Pitch:		0.002	m
Cold Fin Thickness:	1.5e-4	m V	Fi	n Thickne	55:	1.5e-4	m
			FI	ow Length	1:	2.307543946	m
Heat Transfer Rate:	3.174076e+6	w v	FI	ow Width:		6.308295977	
Heat Transfer Area:	145.566701942	m² 🔻	Po	ower:		2.357945e+7	W
Hot Pressure Loss:	5.012954e+5	Pa 🔻	M	ean Temp	erature:	0/4.214890052	K 1
Cold Pressure Loss:	4.814717e+5	Pa 🔻	M	ean Densi	ity: fic Heat	1080.0	- Wkn-K)
			M	ean Visco	sity:	3.28-5	kg/(m-s)
Operating Weight:	354.435795403	kg 🔻	M	ean Cond	uctivity:	0.05	W/(m-K)
Effectiveness:	0.748602896		M	ean Heat	Capacity:	26924.0	W/K
COP:	0.121816746						
Course to a Description	Dating Project		1	Davert	and the state	Han Data	
save to a Regular	Rating Project			Downo	ad realiza		
Back to the Project							

7. Tips: Accessing Integrated Database

In INSTED, the database is integrated into the GUI and can be accessed by clicking the **J** buttons. More details of the database in INSTED are provided below.

(1) Solid Properties database

In the Plate-Fin Geometry module, the plate and fin solid material conductivity and density can be obtained directly from the built-in solid thermophysical properties database in INSTED:

Plate Conductivity: Win K		
Plate Density: sqm ² ¥		
(1)		
	A	
	Thermophysical Properties x	
	-Plate	
	Choose Solid Type:	
	Character Bullia	
	Aluminum Alioy 195	
	- Details	
	Density 2795.0 cam? •	
	Specific Heat 832.0 Jun H	
	Select Close	
	2	
		•
		Plate Conductivity: 168.0 Winney T
		Plate Density: 2790.0 we V

(2) Fluid Properties database

In the Plate-Fin Rating module, the fluid density, heat capacity, viscosity, and thermal conductivity can be obtained directly from the built-in fluid thermophysical properties database in INSTED. INSTED includes two kinds of Fluid Properties database:

- INSTED Fluid database
- NIST'S REFPROP database

Note that the fluid properties you obtain from clicking the **J** button is single-point only. To obtain variable properties please refer to Sections "14. Fluid Properties: Using NIST's REFPROP Database" and "15. Fluid Properties: User Defined Fluid Properties."

INSTED Fluid Database



NIST's REFPROP Database



activity: 0.02638

(8) -

Con

Note that REFPROP will be opened in a new web page in the browser. If the "popup blocker" is enabled you may see the error message in the screen shot below. In this case, you should enable the page to popup, and then retry to access the REFPROP database.



8. Tips: Using Integrated Unit Conversion

The Unit Conversion capability is integrated with INSTED GUI. When changing the unit of a variable, the value of the variable will be automatically changed consistent with the new unit selected.



Note that the "automatic input unit conversion" can be disabled in "Preferences -> Automatic input unit conversion" from the main menu panel.

INSTED Database				
×				
	Units:			
	Choose default unit system:	SI	۳	
	Automatic input unit conversion:	On	•	2
				-

9. Fins: Natively Supported Fins

The INSTED Plate-Fin module natively supports the following fin types for the frontal shape and the profile in the flow direction:

- Frontal shape
 - o rectangular
 - o trapezoidal
 - o triangular
 - o wavy
- Flow Direction profiles
 - \circ plain
 - o offset-strip
 - o herringbone


10. Fins: Using Kays & London Fins

Fifty six (56) Kays & London fins are integrated into the INSTED Plate-Fin program. They can be accessed from the main menu panel: Create HEX Geometry > Enter Fin Data for Flow A/B > Use find data from Kays & London? as shown below:

 Create HEX Decret Rate HEX Multiple Rating Sining Optimization 					
	VII, Fin Properties:	2			
	3	- Kays & London fin data Use fin data from Kays & Lo	ndon7	4	
	3	- Kays & London fin data V Use fin data from Kays & Lo Choose a Kays & London Fi	ndon7 n ship-fin plate-fin	313.12.22 •	lo en
	3	- Kays & London fin data - Use fin data from Kays & Lo Choose a Kays & London Fi - Kawa - Kays & London Fin -	ndon7 ship-fin plate-fin 2/32-12.22 con-fin anda fin	4 3/33-12 22 • For Area / Total Area Taxas Mittal at Tax = 1	0.85
	3	- Kays & London fin data	ndon7 strip-fin plate-fin (3:32-12:22) uno fin paie fin personal st	9/33.12.22 •	10 atz
	3	Kays & London fin data Use fin data from Kays & Lo Choose a Kays & London Fin Heat Extrange Type Fin Shape Honter: Ph Shape Honter:	in Strip-fin plate-fin 3/32-12.22 strip-fin plate-fin restangular series	3/32-12-22 • 1 Fin Ansa / Total Ansa Base Weth of Fin [- •] Top Weth of Fin [- •] Fin Spectrum coupled in the direction[]	0.882
	3	Kays & London fin data Use fin data from Kays & Lo Choose a Kays & London Fi Kame Heat Exchange Type Fin Stapp (Tontar: Fin Stapp	endion 7 sthip-fin plate-try 3 32-12 22 strop fin paste fin recomputer strip store	3/33-12 22 • Pin Area - Total Area Basea Watth of Fin [- •] Top Watth of Fin [- •] Fin Length (paceful to flow direction) [Fin Length (paceful to flow direction) [0.882 0. 0. 0.0024
	3	Kays & London fin data Juse fin data from Kays & Lo Choose a Kays & London Fi Aams: Heat Extrange Type Fin Drops (Fronter: Fin Special Instant) Fin Drops (Fronter: Fin Special (Fronter: Fin Drops (Fronter	ndon 7 strip-fin plate-fin 3:30-12:22 strip-fin pase-fin motorry_let strip gaar- dd5:0	A An Area / Total Area Beas Width of Fin [- • 1] Top Width of Fin [- • 1] Top Width of Fin [- • 3] Fin Length (parallel to flow direction)] - • 1 Gas States (perpendicular to flow	0.882 0. 0. 0.0024
	3	Kays & London fin data Jise fin data from Kays & Lo Choose a Kays & London Fi Aame Heat Exchange Type Fin Siget Invite: Fin	ndon7 ship-fin plate-fin 3:32-12:22 unp-fin pale fin netarogular whip plasm 480,0 0.0123	9/33.12 22 Fin Area / Total Area Base Wridty of Fin [- •] Top Works of Fin [- •] Top Works of Fin [- •] Top Langth (parallel is flaw direction) [- •] - •] Day Space (perpendicular to flow omegoin) [- •]	0.852 0, 0.0024 0,
	3	Kays & London fin data Use fin data from Kays & Lo Choose a Kays & London Fi Reme Heat Euclonge Type Fin Stating (file directory Fin Stating (file directory Fin Stating (file directory) Fin Photo (files directory)	indian 7 is strip-fin plate-fin- (3:32-12:22) ump-fin pase-fin- netrargulat whip dian- 450,0 0:0123 0:02241	A 3/32-12-22 • Prin Area *Total Area Base Width of Fin [- •] Top Width of Fin [- •] Prin Langth (panella to flow direction) [- •] Des Tables (persendicular to flow direction) [- •] Prevende Placement.	0.882 0. 0.0024 0. 0.
	3	Kays & London fin data Vise fin data from Kays & Lo Choose a Kays & London Fi Kans Heat Endange Type Fin Space (Ton dividenty Fin S	edion 7 strip-fin plate-fin 332/12 22 strop-fin paste fin recomputer Mrip platen 450.0 0.0122 0.00541 1.02541	A 3/32-12-22 • Pen Area / Total Area Base Width of Fin [= •] Top Width of Fin [= •] Fin Length cascelle to flow direction) [= •] dap Space (perpendicular to flow creation) [= •] Perces Placement. Yumber of Spiniski.	0.882 0. 0. 0. 0. 0. 0.
	3	Kays & London fin data Use fin data from Kays & Lo Choose a Kays & London Fi Aame Heal Extrange Type Fin Droop Innter: Fin	mion 7 at strip-fin plate-fin 3:30-12:22 atop-fin pate-fin metangulet atrip gisen- 450.0 0:0122 0:02241 V.238-4	A And Area (Total Area Base Width of Fin [- • 1] Top Width of Fin [- • 1] Top Width of Fin [- • 2] Fin Langth (parallel is flow direction)] - • 1 Past States (perpendicular to flow direction) [- • 1] Reveals Plasement: Number of Spitters. Spitter Rate:	0.882 0. 0. 0.0024 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

11. Fins: Custom J/F Data – Discrete Mode

You can provide your own J/F data to override the built-in J/F correlations contained in INSTED Plate-Fin. You can do this in two ways: Discrete approach and Analytic approach. In the discrete approach, the J/F data can only be entered as a function of the Reynolds number, and can be entered in a discrete lookup table form. Follow the steps in the screen shots below.



- Existing custom J/F data can be modified by clicking the "Edit" button
- The discrete J/F data points must be entered in the table in increasing order of the Reynolds number

12. Fins: Custom J/F Data – Analytic Mode

In the Analytic Approach for specifying your custom J/F data, you can provide the data by simply typing the analytical expressions for J and F directly on the keyboard. INSTED will interpret (parse) the typed expressions and evaluate the J and F values at runtime. More details about how the parser works can be found in "INSTED J/F Equation Interpreter Syntax Reference Manual."



13. Fluid Properties: Fixed (Single-Point) Thermo-Physical Fluid Properties

In the Plate-Fin Rating Module, several options are available for obtaining single-point thermal physical properties of the (hot and cold) fluids:

- Fixed
- Variable/Custom
- REFPROP

When "Fixed" is chosen, you need to provide the (single) values of density, heat capacity, viscosity, and thermal conductivity for the fluids.

VII. Fluid Properti	es:		
• Hot Fluid Pr	operties:		
Fixed	Variable	/Custom	REFPROP
(1) Cold Fluid P	roperties:		
* Fixed	Variable	/Custom	REFPROP
	Her (2) cold	
Density:	1.09484	999.3	4D-M2 .
Specific Heat	1007.8	4226.0	199 K) - 1
Viscosity:	1.9404e	0.001794	kgimili 🔻
Conductivity	0.02778	0.558	Witten Ko
1	4	1	

14. Fluid Properties: Using NIST's REFPROP Database

When "REFPROP" is chosen, you need to select the name of the fluid from a dropdown list.

. Fluid Properti	esc		
- Hot Fluid Pr	operties:		
* Fixed	Variable	e/Custom	REFPROP
 Cold Fluid P 	roperties:		1
Fixed	Variabl	e/Custam	REFPROP
Choose Col	d Fluid:	water	•
-	ties	2	
Density:	1 09484		kgiet T
Specific Heat:	1007.8		J(kg/K) 🕈
Viscosity:	1.9404e		Aptimat #
Conductivity:	0.02778		W(m K)
	14		

15. Fluid Properties: User Defined Fluid Properties

When the "Variable/Custom" button is selected, you need to select the fluid from the list of previouslygenerated custom fluid properties.

 Hot Fluid Pro 	operties:	
* Fixed	Variable/Cust	tom REFPROP
	~	
Cold Fluid P	roperties	_
Fixed	Variable/Cus	tom REFPROP
Choose Col	d Fluid: (Sam	ple) Air 288-3 🔹
	Hal	(2)
Density:	1.09484	sgimt *
Specific Heat:	1007.8	J(Rg K) T
	1.9404e	kgrimis) *
Viscosity:		
Viscosity: Conductivity:	0.02778	পালে মা

The "Variable/Custom fluid data" capability has been provided for the following purposes:

- To allow you to use your own thermophysical fluid data
- To allow you to provide variable thermophysical fluid data, i.e. the fluid thermophysical properties can be a function of the local temperature and pressure.

To use this capability, you need to first create the "Variable/Custom fluid data." This is done by uploading a Microsoft Excel file with the "correct" format. This can easily be done by downloading the sample Excel template file in INSTED and modifying them directly.

Two template files are available:

- Single-phase fluid Excel template
- Two-phase fluid Excel template

The capability to create a "Variable/Custom fluid data" can be accessed from "Custom Fluid Properties" menu in the main menu panel.

Sample Problems	
Custom Fluid Properties	
Project Management	
INSTED Database	
Preferences	
Custom Fluid Properti Existing custom fl Choose a data fo	es: uid data: r details: Please Select • Details Delete
Choose a File to l	Upload: Choose File No file chosen Upload File Download template file: single phase, two phase
	(2)

- You can view details of an existing custom fluid data by clicking the "Details" button
- You can delete an existing custom fluid data by clicking the "Delete" button

	121	▼ Jx							
1	A	В	C	D	E	F	G	H	1
				INSTED CLOUD SI	NGLE PHASE CUSTOM	FLUID DATA			
		Type:	1	0					
		Name:	Air (288-378)	3)					
		No. of Points:	10	9					
1		Temperature(K)	Density(kg/m3)	Spec. Heat(J.kgK)	Viscosity(kg/ms)	Conductivity(W/mK)	Enthalpy(J/kg)	Surf. Tens(N/m)	
		288.1600037	1.216599941	1006.700012	1.7868E-05	0.025353	228600	0	
)		298.1600037	1.169999957	1007	1.8368E-05	0.026153	228900	0	
1		308.1600037	1.134199977	1007.099976	1.8845E-05	0.026534	229300	0	
2		318.1600037	1.100999951	1007.700012	1.9317E-05	0.026904	229600	0	
3		328.1600037	1.067700028	1008.099976	1.9789E-05	0.027643999	229900	0	
1		338.1600037	1.03489995	1008.5	2.02536E-05	0.028384	230200	0	
5		348.1600037	1.001700044	1008.900024	2.07256E-05	0.029112	230500	0	
5		358.1600037	0.97517997	1009.799988	2.11704E-05	0.030608	230800	0	
7		368.1600037	0.950339973	1010.799988	2.16084E-05	0.031367999	0	(1) 0	
3		378.1600037	0.925599992	1011.799988	2.20464E-05	0.032127999	0	(4) 0	
9		·						\sim	
3									
1	-								
4 1	fluid .	instruction 🚬 😋							

Single-Phase template:

Two-Phase template:

	_													
		0				ISTED CLOUD TWO PH	ASE CUSTOM	FLUID DATA						
	Tunat	(2)		Molecular Mr.	101									
	Name	5 1124		Boiling Pt ///	263 600037									
	No of Points	8		Crit Termo (K):	45									
	no, or roma.	u u		Crit Prace /Ral	4000000									
				ent messiling.	4000000									
					VAPOR					LICUL	0		-	
	Temperature(K)	Sat Pres (N/m2)	Density(kg/m3)	pec. Heat(), kgK)	Viscosity(kg/ms) Cor	ductivity(W/mK) Ent	halov(J/kg) D	ensity(kg/m3) Spe	Heat()/kgK)	cosityike/ms) Co	nductivity/W/mKi	COLONION	(J/kg) bu	rf. Tens(N/m
	243.1600037	84280	4.388999939	744.0999756	9.62401E-06	0.009044	215700	1326	1289	0.0003243	0.098920003	E	20500	0.01885000
	263.6600037	204100	10.10000038	798,7999878	1.05102E-05	0.01098	228900	1324	1291	0.0003222	0.09866	3)	21100	0.011
	264,1600037	208200	10.28999996	800.2999878	1.05298E-05	0.01103	229300	1323	1292	0.0003201	0.098399997		21800	0.011
	264.6600037	212300	10,48999977	801.7000122	1.05499E-05	0.01108	229500	1321	1294	0.0003181	0.098140001		22400	0.011
	265.1600037	216500	10.68000031	803.2000122	1.05801E-05	0.01112	229900	1320	1295	0.000316	0.097879998		23100	0.011
	265.6600037	220700	10.88000011	804.7000122	1.06002E-05	0.01117	230200	1318	1297	0.000314	0.097620003		23701	0.011
	266.1600037	225000	11.07999992	806.2000122	1.06198E-05	0.01121	230500	1316	1298	0.000312	0.09736		24401	0.011
	313.1600037	1018000	49.09000015	1009	1.314E-05	0.01554	256600	1315	1300	0.00031	0.097130001		24999	0.0016
H fl	id instruction	2				14				01				-

- Click the "Instruction" worksheet in Excel to view instructions
- Need to enable "Macros" to use template
- All fluid data must be in "Fluid" worksheet, do not rename the sheet
- All thermophysical properties must be entered in SI units.

16. Tips: Accessing Standalone Database Interface

The following components are available in the Standalone database in INSTED, which can be accessed by clicking on the "INSTED Database" menu in the menu panel:

- Thermophysical properties of fluids and solids
- Pipe schedules
- Suggested velocities for the flow of various fluids
- Minor loss k-factors
- Fouling factors
- Absolute roughness
- Sample film coefficients
- Tube counts in Shell-and-Tubes
- Moody charts (friction factor calculation)
- Radiation properties
- NIST's REFPROP

Sample Problems Custom Fluid Properties Project Management

INSTED Database Preferences

1



Choose Material Type:					
Two Phase Fluid (Equilibrium)					
		_			
Choose Material:		The	rmal-physical Properties		
Acetic Acid (Two-Phase)		1	inar physical i roperties		
Choose Temperature:		-	honon Material Trme		
391.15		5	Single Phase Fluid at Atomspheric	Pressure	V
			anger the contract the mapping the		
 Details 		C	hoose Material:		_
General Vapor Data Liquid Da	ata	Ľ	Air		~
Chemical Formular	CH3CO2H	C	hoose Temperature:		
Molecular Weight	60.05	- 6	100 \$		
Melting Point(k)	289.85				
Critical Temperature (K)	594.75		Details		
Critical Pressure (Ps) Critical Density (page)	5790 350 6	T	Jensity (kg/m²]	3.5562	
Saturation Temperature (k)	560	E	xpansion Coefficient [1/K]	n/a	
Saturation Pressure (Pat	3590000	S	pecific Heat [J/(kg-K)]	1.0320+3	
rmal-physical Properties		I	hermal Diffusivity [m²/s]	2.5458-6	
		A	bsolute Viscosity [N+s/m¥]	7.11e-6	
		B	inetic Viscosity [m²/s]	1.99938-6	
noose Material Type:		-		enteller!	
retailic Solid		~			
hoose Material:		1	ube Counts		
luminum Alloy 195		~			
			Choose Group:		
Details					
			3/4 in: OD (TUBE), 1 in: SQUA	ARE PITCH	
the second s	1.0.0000		3/4 in. OD (TUBE), 1 in. SQUA	ARE PITCH	
ensity[kg/m²] becific Heat (1/(ke.83)	2.798+3		3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame	ARE PITCH	
ensity[kg/m³] becific Heat [J/(kg-K)] hermal Conductivity[W/(m-K)]	2.79e+3 0.883 168.0		3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in.	RE PITCH	
ensity [kg/m²] pecific Heat [J/(kg·K)] hermal Conductivity [W/(m·K)] hermal Diffusivity [m²/s]	2.79e+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in. Choose Number of Tube I	ARE PITCH ter: Passes:	
ensity [kg/m²] Defic Heat [J/(kg/k]] nermal Conductivity [W/(m/k]] nermal Diffusivity [m²/s]	2.798+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in. Choose Number of Tube I	ARE PITCH ter: Passes:	
ensity [kg/m³] becific Heat [J/(kg·K)] bermal Conductivity [W/(m-K)] bermal Diffusivity [m²/s] Moody Chart	2.79e+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in. Choose Number of Tube I	RE PITCH ter: Passes:	
ensity [kg/m²] Destific Heat [J/(kg-%)] Dermal Conductivity [W/(m-%)] Dermal Diffusivity [m²/s] Moody Chart	2.79e+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in. Choose Number of Tube I Choose Number of Tube I Details	RE PITCH ter: Passes:	
ensity [kg/m³] becific Heat [J/(kg:%)] hermal Conductivity [w/(m-%)] hermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0	2.79e+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in. Choose Number of Tube I Choose Number of Tube I Details ube Arrange Type	RE PITCH ter: Passes: square	
ensity [kg/m³] becific Heat [J/(kg:K)] hermal Conductivity [w/(m-K)] hermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2	2.79e+3 0.883 168.0 6.8194e-5	m 💌 🔒	3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in. Choose Number of Tube I Choose Number of Tube I Details ube Arrange Type ube Pitch [in]	RE PITCH ter: Passes: square 1.0	
ensity [kg/m³] becific Heat [J/(kg:%)] hermal Coductivity [w/(m-%)] hermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01	2.79e+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in. Choose Number of Tube I Choose Number of Tube I Details ube Arrange Type ube Pitch (in) tensions	RE PITCH ter: Passes: Square 1.0	
ensity [kg/m³] becific Heat [J/(kg:K)] hermal Conductivity [w/(m-K)] hermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness:	2.79e+3 0.883 168.0 6.8194e-5	m • 4	3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in. Choose Number of Tube I Choose Number of Tube I Details Ube Arrange Type Ube Fitch (in) iensions	RE PITCH ter: Passes: Square 1.0	
ensity [kg/m³] becific Heat [J/(kg:K)] hermal Conductivity [w/(m-K)] hermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness:	2.79e+3 0.883 168.0 6.8194e-5	m v s	3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in. Choose Number of Tube I Details Ube Arrange Type ube Pitch (in) iensions	RE PITCH ter: Passes: Square 1.0	
ensity (kg/m³] becific Heat [J/(kg:K)] nermal Conductivity (w/(m-K)) nermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness: Calculate	2.79e+3 0.883 168.0 6.8194e-5	m v s	3/4 in. OD (TUBE), 1 in. SQUA Choose Shell Inner Diame 10 in. Choose Number of Tube I Details Ube Arrange Type ube Pitch (in) iensions ct Pipe Material:	RE PITCH ter: Passes: Square 1.0	
ensity (kg/m²] escific Heat [J/(kg:K)] nermal Conductivity (w/(m-K)) nermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness: Calculate	2.79e+3 0.883 168.0 6.8194e-5 Close	m v s	3/4 in. OD (TUBE), 1 in. SQU/ Choose Shell Inner Diame 10 in. Choose Number of Tube I Details Ube Arrange Type ube Pitch (m) iensions ct Pipe Material: ught Steel / Wrought Iron	RE PITCH ter: Passes: square 1.0	
ensity [kg/m³] becific Heat [J/(kg:K)] nermal Coductivity [w/(m:K)] nermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness: Calculate	2.79e+3 0.883 168.0 6.8194e-5 Close	m v a	3/4 in. OD (TUBE), 1 in. SQU/ Choose Shell Inner Diame 10 in. Choose Number of Tube I Details ube Arrange Type ube Pitch (m) iensions ct Pipe Material: ught Steel / Wrought Iron Choose Pipe Size:	RE PITCH ter: Passes: square 1.0	
ensity [kg/m³] becific Heat [J/(kg:K)] nermal Conductivity [w/(m:K)] nermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness: Calculate	2.79e+3 0.883 168.0 6.8194e-5	m v a	3/4 in. OD (TUBE), 1 in. SQU/ Choose Shell Inner Diame 10 in. Choose Number of Tube I Details ube Arrange Type ube Pitch (m) iensions ct Pipe Material: ught Steel / Wrought Iron Choose Pipe Size: Nominal Diameter (in.) 1	RE PITCH ter: Passes: square 1.0	
ensity [kg/m³] becific Heat [J/(kg:K)] nermal Conductivity [w/(m:K)] nermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness: Calculate	2.79e+3 0.883 168.0 6.8194e-5	m •	3/4 in. OD (TUBE), 1 in. SQU/ Choose Shell Inner Diame 10 in. Choose Number of Tube I Details ube Arrange Type ube Pitch (m) iensions ct Pipe Material: ught Steel / Wrought Iron Choose Pipe Size: Nominal Diameter (in.) 1	RE PITCH ter: Passes: square 1.0	
ensity [kg/m³] becific Heat [J/(kg:K)] nermal Conductivity [w/(m:K)] nermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness: Calculate	2.79e+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQU/ Choose Shell Inner Diame 10 in. Choose Number of Tube I Details ube Arrange Type ube Pitch (m) iensions :t Pipe Material: ught Steel / Wrought Iron Choose Pipe Size: Nominal Diameter (in.) 1	RE PITCH ter: Passes: square 1.0	
ensity (kg/m³] pecific Heat [J/(kg:K)] nermal Conductivity [w/(m:K)] nermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness: Calculate	2.79e+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQU/ Choose Shell Inner Diame 10 in. Choose Number of Tube I Details ube Arrange Type ube Pitch (m) iensions :t Pipe Material: ught Steel / Wrought Iron Choose Pipe Size: Nominal Diameter (in.) 1 Choose Type: Schedule 40 Standard	RE PITCH ter: Passes: square 1.0	
ensity (kg/m³] becific Heat [J/(kg*X)] nermal Conductivity (w/(m-X)) nermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness: Calculate	2.79e+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQU/ Choose Shell Inner Diame 10 in. Choose Number of Tube I Details Ube Arrange Type Ube Pitch [in] iensions :t Pipe Material: ught Steel / Wrought Iron Choose Pipe Size: Nominal Diameter (in.) 1 Choose Type: Schedule 40 Standard	RE PITCH ter: Passes: square L0	
ensity (kg/m³] becific Heat [J/(kg*X)] hermal Coductivity (w/(m-X)) hermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness: Calculate	2.79e+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQU/ Choose Shell Inner Diame 10 in. Choose Number of Tube I Details Ube Arrange Type Ube Pitch [in] iensions :t Pipe Material: ught Steel / Wrought Iron Choose Pipe Size: Nominal Diameter (in.) 1 Choose Type: Schedule 40 Standard	RE PITCH ter: Passes: square L0	
ensity (kg/m³] becific Heat [J/(kg*X)] hermal Coductivity (w/(m-X)) hermal Diffusivity [m²/s] Moody Chart Reynolds Number: 500.0 Pipe Diameter: 0.2 Absolute 0.01 Roughness: Calculate	2.79e+3 0.883 168.0 6.8194e-5		3/4 in. OD (TUBE), 1 in. SQU/ Choose Shell Inner Diame [10 in. Choose Number of Tube I Choose Number of Tube I Details ube Arrange Type ube Pitch [in] iensions :t Pipe Material: ught Steel / Wrought Iron Choose Pipe Size: Nominal Diameter (in.) 1 Choose Type: Schedule 40 Standard Details Outer Diameter [in] Inner Diameter [in]	I.315 1.04904	

17. Tips: Modifying Heat Exchanger Geometry Data Directly in the Rating Interface

In the Plate-Fin Rating module, if you want to change the HEX geometry parameters, you do not need to close the current Rating project and switch to the geometry module in order to make the modification. There is a "shortcut" in the Rating module which allows you to directly modify the HEX geometry parameters. This is done by clicking the "View Details" button on the right of HEX geometry selection dropdown list and then clicking the "Edit" button in the "Plate-Fin: HEX Details" tab:

Start Pag	e · Plate-File: Rating ·	Plate-Fint HEX	Dotaits #		
Plate	Fin Heat Eachanger Geometry	Summary:			
100	14.56				1284
De	Tent Tent			2	and the second second
70	Anargement	Cross .	1	. 5	
24	tag Type	Single +			
110	of Passages 14;	150 •			-
110	s/Famapes &	150 +			
100	at Picci Fasses (A)	1 .			I CARA
16	of Face Passie (E)		6		Cabcat
10	of Passage Paditure (A)	2	4) (4)
200	of Passage Partners (B)	1 .			
Rat	sleigh (= +)	0.9			
Plat	a vism (- +)	1.0			
910	a Thistoweri (- •)	0 0003			
End	Plate Tholizone] + +	0003			
714	Considerity (====) • [15			
Pe	e Densky (+g==1 +)	2700			
		0			
		୍ତ			

- The geometry parameters become editable after clicking "Edit" button
- Click the "Save" button to save changes
- All changes will be discarded if the "Cancel" button is clicked

18. Tips: Modifying Heat Exchanger Rating Data Directly in the Interface for Multiple-Rating, Sizing, and Optimization

Similar to the support provided for the editing of Geometry Parameters in the Rating module, there is also a shortcut in Multiple Rating, Sizing, and Optimization modules that allows you to directly change Rating project input data.

*	Start Page * 🕞 Plate-Fin: Sizing * Plate	Fin: Rate Details ×	
	Plate-Fin Rating Project Summary: Hewitt Rating Overall Hot Flow Cold Flow HEX Geometry to Rate. Flow Assignment. Fluid A is	Puld A	Printer and
	Flow Direction: Co-Curren Two-Phase Type: No Phase Calculation Method: Default User-Specified J/F Scaling? No	t · Change · · Edit	Save Cancel

- The Rating parameters become editable after clicking the "Edit" button
- Click the "Save" button to save changes
- All changes will be discarded if the "Cancel" button is clicked
- The geometry data can also be shown and modified by clicking "View Details" button under the "HEX Geometry to Rate" dropdown list

19. Advanced Topics: Two-Phase Analysis

In the Plate-Fin Rating module, for two-phase analysis, the following models can be selected by clicking the "Select Two Phase Models" button under the "Two Phase Flow?" dropdown list. The following options are available:

- Twenty (20) condensation models for the hot fluid
- Seventeen (17) boiling models for the cold fluid
- Four (4) frictional pressure loss models for the hot stream
- Four (4) frictional pressure loss models for the cold stream



Note that the technical details of the boiling and condensation models supported can be found in section *"37. Technical Details: Two-Phase Models."*

20. Advanced Topics: Discrete vs. Bulk Methods

INSTED Plate-Fin supports two calculation methods:

- Bulk method, which uses the traditional ε-NTU model
- Discrete method, which uses a low-order, one-dimensional, finite-volume-type numerical integration of the flow and heat transfer equations

You can select the model to use by clicking the "Set Calculation Method" button and selecting the desired "Calculation Method"

VIII. Calculation Method (Optional)	
*	I. Calculation Method: 📔
	Methods Default Bulk Discrete

- Problems involving variable fluid thermophysical properties can only be analyzed with the Discrete calculation method
- The Bulk calculation method is currently not available for phase-change problems
- The Bulk calculation method is currently not available for problems involving multi-passes and multi-partitions
- When the "Default" Calculation Method is chosen, INSTED will automatically choose the calculation method based on the setup of the Rating problem:
 - $\circ~$ If the problem involves a single-phase fluid with fixed thermophysical properties and there are no multiple passes or multiple partitions, INSTED will choose the Bulk method
 - \circ $\;$ Otherwise, the "Discrete" Calculation Method will be used.

21. Advanced Topics: User-Defined Fins

In Section "9. Fins: Natively Supported Fins," the natively-supported fin types in INSTED Plate-Fin are listed. If you want to use a fin type that is not currently natively-supported, INSTED provides a feature called "User-Defined Fins" that allows you to use your own fin type, if you can provide the values of the following parameters:

- Plate Spacing
- Equivalent Diameter of the flow passage
- Free Flow Area per Passage
- Finned (Enhanced) Heat Transfer Area per Unit Plate Area
- Base (Un-finned) Heat Transfer Area per Unit Plate Area
- Fin Efficiency
- Fin Weight per Unit Plate Area
- Custom j/f Data

This interesting feature of INSTED can be accessed from the Rating module by clicking on the "Set Calculation Method" button and checking the checkboxes under "User Defined Fin Geometry"

VIII. Calculation Method (Optional)				
\$				
46,1	User Defined Fin Geometry: 🧧 🌀	Y		
E	Use user-defined fin geometry in the hot stream	/		
	Plate Sparing	0		
	Equivalent Diameter:			
	Tree Now Area per Passage:		-	
	Fin (Enhanced) Heat Transfer Area per Unit Plate Area:		0	
	Base (Unfinned) Heat Transfer Area per Unit Plate Area:		9	
	Fin Efficiency:		56	
	Fin Weight per tivit Plate Areas		ADMENT.	
	Custom j/f Data:	Please choose .		
				-
4	Use user defined fin accoretry in the cold stream			

Note that currently the "User-Defined Fin" settings are located inside the Rating module and that the User-Defined fin data will override the fin geometry data that might have been previously defined in "HEX Geometry."

22. Advanced Topics: J/F Data Scaling

Under the "Plate-Fin: Cal. Parameters," there is a feature that allows you to specify scaling factors that can be applied to the default or user-specified J/F data. The feature can be accessed from the Rating module by clicking the "Set Calculation Method" button and checking the checkboxes under "J/F Data Scaling"

VIII. Calculation Method (Optional)		
	J/F Data Scaling:	
	Scaling factor for hot-side J data: 1 Scaling factor for hot-side F data: 1 Scaling factor for cold-side J data: 1 Scaling factor for cold-side F data: 1 Default	

- A factor of unity implies no-scaling
- The J/F scaling factors are currently available only for single-phase analysis

23. Advanced Topics: Custom Multiple Rating

Section "4. QuickStart: Create & Run a Multiple Rating Project" shows you how to create a Multiple Rating project by allowing one flow or geometry parameter of a reference Rating project to be varied within a specified range. In this section, we will tell you how to allow more than one flow or geometry parameters to be varied simultaneously in a Multiple Rating project. This feature is called "Custom Multiple Rating."

To use this capability, you need to first create the "Custom Multiple Rating data." This is done by uploading a Microsoft Excel file with the "correct" format. This can be done by downloading Excel sample template files in INSTED and modifying them directly.

The capability can be accessed by checking "Use user-defined multiple rating data?" in the Multiple Rating module.



Custom Multiple Rating Templates:

C4	+ (*)	fx 3								
A	В	C	E	F	G	Н	1	1	К	L
			INST		TE-EIN MU	TLRATING SH	FFT (Ver. 1.1	1	_	
-			11131		TE-TIT IND	err-to-strine of	cer (ven 1.	-1		
	No. of Ratings	:	3 - (3)							
	4	# Parameter	1	2	3					
		1 Hot Flow Flowrate [kg/s]	25.4	26.4	27.4					
		2 Cold Flow Flowrate [kg/s]	25.4	26.4	27.4	(5)				
		Hot Flow Fin Height [m]	0.012	0.024	0.03	9				
	4	4 Cold Flow Fin Pitch [m]	0.002	0.005	0.005					
	Add a Nev	w Parameter								
		4								
() H mu	ti-rate instruction	U .		14		ШÜ				

Note:

- Click the "Instruction" worksheet in Excel to view the instructions
- You need to enable "Macros" to use the template
- All fluid data must be in "multi-rate" worksheet, which must not be renamed
- Click the dropdown list on the right of "No. of Ratings:" to change the number of rating calculations to run.
- Click the "Add a new Parameter" button to add a new variable. The variable can be selected from a dropdown list (Column C in the Excel Table)

After the Excel file has been edited and uploaded in INSTED, if there are no errors in the Excel file, INSTED will show the basic information on the uploaded custom Multiple Rating data, as shown in the screen shot below:

•	Use user-defined n Custom multiple r	nultiple rating data? ating data is defined:	
	Uploaded data:	There are 3 proposed rating calculations; 4 parameters are defined.	
		Reset View Details	

- Clicking the "Reset" button will remove the current custom Multiple Rating data
- Clicking the "View Details" button will download a new Excel file that contains the custom Multiple Rating data that allows you to view the details.

24. Post-Processing: Line Plots

INSTED provides many tools for customizing the line plots of the results from the Rating and Multiple Rating calculations. Here we use the line plot interface for the results from the Rating calculations to illustrate the various plotting capabilities.

Choose Plot Variable: Temperature	Plot Settings
	Set Units of Plotting Variables Unit for Temperature:
1	- Choose Plotting Curves-
704	Plot Lines for : hot & cold 🔻
Y 672	Choose Plotting Direction
hot	Reverse plotting direction? (7)
576 -	Close
0 0.2 0.4 0.6 0.8 1 Dist. Along Passage / Passage Length	
Hot Flow Cold Flow	
No. Dist. Along Passage / Passage Length Temperature [K]	
1 0. 733.16	

Note:

•

- Clicking the "Choose Plot Variable" dropdown list will change the variable on the y-axis
- Checking the "show discrete data?" checkbox will display the discrete data points used in a line plot in a table below the plot. You can copy these data and use other plotting tools to regenerate the plot, say for publication quality purposes.
 - More Plot settings are available by clicking the "Plot Settings" button:
 - The unit for the y-axis variable can be changed
 - You can plot the distribution of a variable for both the hot and the cold streams or for just one of them
 - You can reverse the plot direction for the hot and/or cold stream. Note that, by default, the curves are plotted along the respective flow directions. "Reversing" the plotting direction is especially useful for parallel counter-flow HEX. By reversing the plotting direction of one stream, you can compare the data for the two streams point-by-point.

25. Post-Processing: ALPEMA Sheets

You can download the Plate-Fin rating results into a file format that follows the ALPEMA sheet standard. The ALPEMA sheet can be downloaded into either Excel format or PDF format. You can also specify the unit system desired for the data contained in the sheet.

	Download File	×
1 Download ALPENA Show	Which format to download? Excel (.xlsx) PDF (.pdf) Preferred Units 3 Which format to download? Default (User Preferred) • 4 OK Cancel	

Sample ALPEMA Sheet

		BF	RAZED ALU	MINIUM P	LA	TE-FIN H	IEAT EXC	H/	NGER S	PECIFIC	ATI	ON						
Customer		Project						-		Location	-						-	
Item numb		Service			_					Date		8/2/2018		_	Revision			-
Stream I.d. / fluid name	Unit	Warm		Cold			C/			D/			E/	_		F/		_
Flow rate Total	kg/s	25.4		25					_						-			
Item nomb] Stream I.d. / fluid name Unit. Flow rate Vap/Zlq. In kg/s Vap/Zlq. In kg/s Molecular vAap. In/Out Clq. In/Out Clq. In/Out Clq. In/Out Clq. In/Out Kg/m* Viscosity Vap. In/Out Kg/m* Viscosity Vap. In/Out Kg/m* Specific he Vap. In/Out Kg/m* Liq. In/Out Kg/m* Clq. In/Out Kg/m* Clg. In/Out Kg/		1	1	1	1		1			1			1			1		
Vap./Liq. Out	BRAZED ALUMINIUM PLATE-FIN HEAT EXCHANGER SPECIFICATION Project Date Date d name Unit Warm Cold C/ D/ E/ Total kg/s 25.4 25 D/ E/ D/ E/ Juq. In kg/s 25.4 25 D/ I/ I/		1			1												
Molecular vVap. In/Out	+		1		1			1			1			1			1	
Liq. In/Out	-		1		1			1			1			1		_	1	
Density Vap. In/Out	kg/m ^a	0.54	1	4.86	1			1			1			1			1	
Líg. In/Out	kg/mª	0.54	1	4.86	1			1		-	1	_		1			1	
Viscosity Vap. In/Out	kg/(m*s)	0.000032	1	0.000032	1			1			1			1			/	
Liq. In/Out	kg/(m*s)	0.000032	1	0.000032	1			1			1	-		1			1	_
Specific he Vap. In/Out	J/(kg*K)	1060	1	1060	1			1			1			1			/	
Liq. In/Out	J/(kg*K)	1060	1	1060	1			1		-	1	-		1			1	_
Thermal co Vap. In/Out	W/(m*K)	0.05	/	0.05	1			1			1	-	-	1			1	
Liq. In/Out	W/(m*K)	0.05	/	0.05	1			1		-	1	-	-	1			1	_
Temperatu In/Out	ĸ	733.16	/ 617.1812	573.16	1	690,9944	-	1		-	1		-	1		_	1	
Operating pressure In	Pa	0		0	_			_			_		-	_		-	_	
Allowable Inctional pressure drop	Pa	2400044.0	OF.	0400044	005		-	_	_				-					
Preat load	VV	3122011.9	65	3122011.5	000			_	-				-	_				
Corrected MTD	n.	21.51/5/0	00	27.51/5/0	000		-	-	_		_	_	-	_		_	_	
Fouling resistance	m**K/W	0	1001	0	1		1		-				-	-		-	1	
Design pressure / test pressure	Pa		7		1	-		1			1	-		1	-		1	_
Design temperatures max / min.	Pa		/		1			1	12	12 1	1			1			1	-
Number of cores and assemblies	-	In parallel		In series	-		Number of	CO	es/assemb	ly	-		Number o	fas	semblies			-
Core size	m	Width	1.8	Height	_	1.8003	Length		0.9			-						
Flow pattern	-	Counter			_	Cross-cou	inter			Cross	_		X		Parallei		_	
Number of layers (including dummy laye	m	Parting shi	eet thickness:	-		0.0003	Cap sheet	thic	kness:			0	Side bar w	ridth	li.			a
Approx. weights	kg	Core empt	у	1138.5558	845	Core open	ating		1145.292	Assembly	emp	ty		As	sembly oper	ating		-
Number of layers	-	150		150	_		-			-			-	_			_	
Fin code: Heat transfer fin	-	rectangula	r	rectangula	Ir	_		_		-			-	_		_		
Distributor fin	-	plain		plain	_			_					-	_		_		
Effective width	m	1.0		1.0	_		-	_		-	_		-	_				
Effective thermal length	m	0.9		0.9			-							_				
Heat transfer surface/core	m.	486	Le L	486	Le.	-	-		_		L		-	Tr	-	_	1. 1	_
Lore opening size In/Out	m	-	1	-	1	-	-	1			1	-	-	1		_	1	
Nozzie number × size In/Out	m	-	/	-	1	-	-	/	-		1	-	-	1			1	
mamoru pipe size invout	10		1/	100.000	1			/			11		-	1		_	1	-
Calculated frictional pressure drop	Pa	6862.2185	86	4321.0787	.a			_	_	1.00	_	_		_			-	
Stacking arrangement:					_													_
Code and/or regulation:																		
Notes																		
and the second second					_			_			_							
User supplied data												and a	Data shee	t sur	pplied by ALF	PEMA		

26. Post-Processing: Downloadable Calculation Results

Instead of the ALPEMA sheet, INSTED also allows you to view the Rating and Multiple Rating calculation results in an Excel file which can be more easily analyzed and modified. The feature is useful for Multiple Rating since it allows you to download all the results into a single file. You can also select a desired unit system for the data contained in the spreadsheet.

Which format to download? Excel (.xlsx)	
Preferred Units 2 Which format to download? Default (User Preferred) (3)	
	Which format to download? Excel (.xlsx) Preferred Units 2 Which format to download? Default (User Preferred) 3

Sample Multiple Rating Downloadable Excel File

	A	В	С	D	E	F	G	Н	1	J	K	L	М
1	INSTED Output for HX Sizing and Rating Simulations- La	st Rev. [08/29/2016]											
2													
3									HX	(Problem S	Statemen	t	
4			Performan	ce Requiren	nent	Ope	rating Con	litions -H	ot	Oper	rating Con	ditions -Col	d
	Design #	Description (for example, flow arrangement,	Q	∆p-hot	∆p-cold	Fluid Type	Flow Rate	Tin	Pin	Fluid Type	Flow Rate	Tin	Pin
		multipassing, single/two phase flow etc.)											
5			fload	[kpa]	[kpa]	0	[kg/c]	[1/]	[Dol		[kg/c]	[17]	[Dol
0	H1. H - A	Correct flows of a data baselite a	[KVV]	[KPd]	[KPd]	1-1	[Kg/S]	700.40	[Pa]	1-1	[Kg/S]	[N]	[Pd]
7	#1: Hot flow mass flow rate = 15 [kg/s]	Cross-flow, single banking					15	/33.10	0		25	575.16	U
8	#2: Hot flow mass flow rate = 15.777777777778 [kg/s]	Cross-flow, single banking					15.7778	733.16	0		25	573.16	0
9	#3: Hot flow mass flow rate = 16.555555555556 [kg/s]	Cross-flow, single banking					16.5556	733.16	0		25	573.16	0
10	#4: Hot flow mass flow rate = 17.33333333333333333 [kg/s]	Cross-flow, single banking					17.3333	733.16	0		25	573.16	0
11	#5: Hot flow mass flow rate = 18.1111111111111 [kg/s]	Cross-flow, single banking					18.1111	733.16	0		25	573.16	0
12	#6: Hot flow mass flow rate = 18.8888888888888888888888888888888888	Cross-flow, single banking					18.8889	733.16	0		25	573.16	0
13	#7: Hot flow mass flow rate = 19.666666666666666 [kg/s]	Cross-flow, single banking					19.6667	733.16	0		25	573.16	0
14	#8: Hot flow mass flow rate = 20.4444444444444 [kg/s]	Cross-flow, single banking					20.4444	733.16	0		25	573.16	0
15	#9: Hot flow mass flow rate = 21.2222222222222 [kg/s]	Cross-flow, single banking					21.2222	733.16	0		25	573.16	0
16	#10: Hot flow mass flow rate = 22 [kg/s]	Cross-flow, single banking					22	733.16	0		25	573.16	0

_																								
3																								
4		1	IX Core D	esign Inp	out				HX C	ore Dime	nsions							He	ot Side					
	t-sp	t-ep	w-sb-hot	h-sb-hot	w-sb-colo	th-sb-cold	P-L	P-W	L-NF/S	Np-h	Np-с	w	k _{plate}	Туре	N-Fin or	Н	t-fin	l or λ	2a	d _h	A,	A _b	A _{eff}	k _{fin}
5															Channel	(Plate Spacing								
6	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[-]	[-]	[kg]	[W/(m*K)]	[-]	[1/m]	[m]	[m]	[m]	[m]	[m]	[m²]	[m²]	[m²]	[W/(m*K)]
7	0.0003	0.0003	0	0.0057	0	0.0057	0.9	1.8	1.8	150	150	1139	15	rectangular/p	500	0.0057	0.0002			0.0028	1.3861	243	1574.7	15
8	0.0003	0.0003	0	0.0057	0	0.0057	0.9	1.8	1.8	150	150	1139	15	rectangular/pl	500	0.0057	0.0002			0.0028	1.3861	243	1570.3	15
9	0.0003	0.0003	0	0.0057	0	0.0057	0.9	1.8	1.8	150	150	1139	15	rectangular/pl	500	0.0057	0.0002			0.0028	1.3861	243	1558.3	15
10	0.0003	0.0003	0	0.0057	0	0.0057	0.9	1.8	1.8	150	150	1139	15	rectangular/pl	500	0.0057	0.0002			0.0028	1.3861	243	1552	15
11	0.0003	0.0003	0	0.0057	0	0.0057	0.9	1.8	1.8	150	150	1139	15	rectangular/p	500	0.0057	0.0002			0.0028	1.3861	243	1545.9	15
12	0.0003	0.0003	0	0.0057	0	0.0057	0.9	1.8	1.8	150	150	1139	15	rectangular/pl	500	0.0057	0.0002			0.0028	1.3861	243	1539.9	15
13	0.0003	0.0003	0	0.0057	0	0.0057	0.9	1.8	1.8	150	150	1139	15	rectangular/p	500	0.0057	0.0002			0.0028	1.3861	243	1534	15
14	0.0003	0.0003	0	0.0057	0	0.0057	0.9	1.8	1.8	150	150	1139	15	rectangular/p	500	0.0057	0.0002			0.0028	1.3861	243	1528.3	15
15	0.0003	0.0003	0	0.0057	0	0.0057	0.9	1.8	1.8	150	150	1139	15	rectangular/p	500	0.0057	0.0002			0.0028	1.3861	243	1522.8	15
16	0.0003	0.0003	0	0.0057	1 0	0.0057	0.9	1.8	1.8	150	150	1139	15	rectangular/n	500	0.0057	0.0002			0.0028	1.3861	243	1517.3	15

AL AM AN AO AP AQ AR AS AT AU AV AW AX AY AZ BA BB BC BD BE BF BG BH BI

3										нх	Size, W	eight an	d Perfo	rmance-	Output	t i								
4					Colo	Side												Hot Side						
	Туре	N-Fin or	н	t	l or λ	2a	dh	A,	Ab	Aeff	k _{fin}	Tout	Tmean	Δр	σΔΡ	Pmean	μ _{mean}	Cp-mean	k.mean	Re	Pr	Nu	hAem	Pow
		Channel	(Plate																					
5			Spacing																					
6	[-]	[1/m]	[m]	[m]	[m]	[m]	[m]	[m²]	[m²]	[m²]	W/(m*K	[K]	[K]	[Pa]	[kPa]	[kg/m ³]	kg/(m*s)	J/(kg*K)	W/(m*K)	[-]	[-]	[-]	[W/K]	[W]
7	rectangular/pla	500	0.0057	0.0002			0.0028	0.6931	243	1375.3	15	590.68	661.92	2278.6		0.54	3E-05	1060	0.05	938.44	0.6784	4.7661	135232	63294
8	rectangular/pla	500	0.0057	0.0002			0.0028	0.6931	243	1375.3	15	592.79	662.98	2319.6		0.54	3E-05	1060	0.05	987.1	0.6784	4.8841	138191	67773
9	rectangular/pla	500	0.0057	0.0002			0.0028	0.6931	243	1375.3	15	594.52	663.84	3497.6		0.54	3E-05	1060	0.05	1035.8	0.6784	5.2105	146299	107230
10	rectangular/pla	500	0.0057	0.0002			0.0028	0.6931	243	1375.3	15	596.56	664.86	3759.6		0.54	3E-05	1060	0.05	1084.4	0.6784	5.3856	150604	120677
11	rectangular/pla	500	0.0057	0.0002			0.0028	0.6931	243	1375.3	15	598.61	665.89	4028.4		0.54	3E-05	1060	0.05	1133.1	0.6784	5.5585	154825	135110
12	rectangular/pla	500	0.0057	0.0002			0.0028	0.6931	243	1375.3	15	600.66	666.91	4304.1		0.54	3E-05	1060	0.05	1181.7	0.6784	5.7294	158966	150554
13	rectangular/pla	500	0.0057	0.0002			0.0028	0.6931	243	1375.3	15	602.71	667.93	4586.3		0.54	3E-05	1060	0.05	1230.4	0.6784	5.8983	163032	167033
14	rectangular/pla	500	0.0057	0.0002			0.0028	0.6931	243	1375.3	15	604.74	668.95	4875.1		0.54	3E-05	1060	0.05	1279.1	0.6784	6.0653	167026	184572
15	rectangular/pla	500	0.0057	0.0002			0.0028	0.6931	243	1375.3	15	606.76	669.96	5170.3		0.54	3E-05	1060	0.05	1327.7	0.6784	6.2306	170952	203197
16	rectangular/pla	500	0.0057	0.0002			0.0028	0.6931	243	1375.3	15	608.75	670.96	5471.9		0.54	3E-05	1060	0.05	1376.4	0.6784	6.3942	174814	222929

	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC
1																				
2																				
3																				
4						(old Side									Overall HX	Core Pe	formanc	e	
	Tout	Tmean	Δр	σΔΡ	ρ _{mean}	μ _{mean}	C _{p-mean}	k. _{mean}	Re	Pr	Nu	hA _{eff}	Pow	EB	C*	3	Q	NTU	UA	COP
5	[1]	[17]	[Dol	[kDo]	[kg/m3]	ka (Imite)	1/////	Al /Im*K	0	11	11	[]4///]	[14/]	[0/]	0	- 11	[14/]	0	[14/1/]	0
•	[N]	[N]	[Pd]	[KPd]	[Kg/III]	Kg/(III.S)	J/(Kg K)	w/(m·k)	11	11	11	[WV/K]		[70]		11	[VV]	11	[WV/K]	11
7	658.65	598.02	4321.1		4.86	3E-05	1060	0.05	3128.1	0.6784	11.548	286154	22228	0.6		0.8905	2E+06	5.7323	91144	26.49
8	661.75	598.54	4321.1		4.86	3E-05	1060	0.05	3128.1	0.6784	11.548	286154	22228	0.6311		0.8773	2E+06	5.5296	92479	26.084
9	664.97	598.49	4321.1		4.86	3E-05	1060	0.05	3128.1	0.6784	11.548	286154	22228	0.6622		0.8665	2E+06	5.4728	96041	18.793
10	667.87	598.8	4321.1		4.86	3E-05	1060	0.05	3128.1	0.6784	11.548	286154	22228	0.6933		0.8537	3E+06	5.3271	97877	17.562
11	670.63	599.08	4321.1		4.86	3E-05	1060	0.05	3128.1	0.6784	11.548	286154	22228	0.7244		0.8409	3E+06	5.1903	99643	16.417
12	673.27	599.34	4321.1		4.86	3E-05	1060	0.05	3128.1	0.6784	11.548	286154	22228	0.7556		0.8281	3E+06	5.0615	1E+05	15.354
13	675.78	599.57	4321.1		4.86	3E-05	1060	0.05	3128.1	0.6784	11.548	286154	22228	0.7867		0.8153	3E+06	4.9398	1E+05	14.369
14	678.18	599.78	4321.1		4.86	3E-05	1060	0.05	3128.1	0.6784	11.548	286154	22228	0.8178		0.8026	3E+06	4.8248	1E+05	13.457
15	680.46	599.96	4321.1		4.86	3E-05	1060	0.05	3128.1	0.6784	11.548	286154	22228	0.8489		0.79	3E+06	4.7158	1E+05	12.614
16	682.64	600.13	4321.1		4.86	3E-05	1060	0.05	3128.1	0.6784	11.548	286154	22228	0.88		0.7776	3E+06	4.6123	1E+05	11.834

27. Miscellaneous: Saving Selected Multiple Rating Result into a Regular Rating Project

In the Plate-Fin Multiple Rating module, the selected rating data point can be saved into a regular rating project.

			16
5: Hot flow mass flow	rate = 18.11111111	1 [kg/s] 🔻	
Hot Flow Cold Flow	Overall		-
No. of Passages:	150		
Inlet Temperature:	733.16	К	•
Outlet Temperature:	598 613799547	к	
Pressure Loss:	4028.432828906	Pa	
Mass Flow Rate:	18.11111111	kg/s	
Mass Flux:	13.066119172	kg/(sim*)	
Flow Velocity:	24 196516986	m/s	
Fouling Resistance:	0.	m*K/W	
Equivalent Diameter:	0.002775	m	
Reynolds Number:	1133.077521966		6
Heat Coefficient	100.153966862	W/(m*-K)	
Effective hA:	1.548248e+5	WK	
Effective Heat Area:	1545.86748174	im²	
Colburn Factor J:	0.005582996		
Friction Factor F:	0.019027207		
Fin Shape:	rectangular		
Fin Profile:	plain		
Fin Efficiency:	0.812899923		
Plate Spacing:	0.0057	m	•
Fin Pitch:	0.002	m	7
Fin Thickness:	1.5e-4	m	۲
Flow Length:	0.9	m	٠
Flow Width:	1.8	m	
Power:	1.3511e+5	W	•
Mean Temperature:	665 886899774	K	,
Mean Density:	0.54	kg/m*	
Mean Specific Heat:	1060.0	J/(kg-K)	
Mann Vinconity:	3.2e-5	kg/(m-s)	
wedn viscosity.			

- The names for the HEX Geometry and Rating projects to be saved need to be specified after the "Save Selected Rating Data to a Regular Rating Project" button has been clicked
- The saved Rating project can be loaded in the Rating module.

28. Miscellaneous: Saving Selected Sizing/Optimization Realization into a Regular Rating Project

In the Plate-Fin Sizing and Optimization modules, a selected realization can be saved into a regular Rating project.

Optimization Resul	tsi		
Plate Length:	2.171432254	m T .	
Plate Width:	5.019610805	(m 🔻	
Hot Flow Rate:	25.4	kg/s 🔻	
Cold Flow Rate:	25.0	kq/s 🔻	
Total No. of Plates:	11		
No. of Hot Passes:	1		
No. of Cold Passes:	1		
Hot Fin Shape:	rectangular		
Hot Fin Profile:	plain		
Hot Plate Spacing:	0.0057	m 🔻	
Hot Fin Pitch:	0.002	m. V.	
Hot Fin Thickness:	1.5e-4	m 🔻	
Cold Fin Shape:	rectangular		
Cold Fin Profile:	plain		
Cold Plate Spacing:	0.0057	(m 🔻	
Cold Fin Pitch:	0.002	m. 🔻 1	
Cold Fin Thickness:	1.5e-4	m 💌	
Heat Transfer Rate:	3.074693e+6	w V	
Heat Transfer Area:	108.997448043	m² 🔻	
Hot Pressure Loss:	6.780528e+5	Pa 🔻	Save to a Regular Rating Project
Cold Pressure Loss:	4.305195e+5	Pa 🔻	Project to Save:
Operating Weight:	265.394466445	ka 🔻	Geometry Project
Effectiveness:	0.725163538		Hewitt Optimize Realization #10 (Geometry) Rating Project
COP:	0.090145283		Hewitt Optimize Realization #10 (Rating)

- The names of the HEX Geometry and Rating projects to be saved need to be specified after the "Save Selected Rating Data to a Regular Rating Project" button has been clicked
- The saved Rating project can be loaded in the Rating module.

29. Miscellaneous: Sorting and Filtering Sizing/Optimization Realizations

The realizations from Sizing and Optimization analysis are presented in a tabular form. INSTED provides a tool for sorting and filtering these realizations, which can be accessed by clicking the "Sort/Filter/Clear" buttons located at the bottom of the dialog box containing the realization table.

	¥				L	w	Mhot	M _{cold}	ΔPhot	AP _{cold}
	NO.	Plates	Np,hot	Np,cold	m 🔻	m 🔻	kg/s ▼	kg/s 🔻	Pa 🔻	Pa 🔻
	1	271	1	1	0.810716063	1.627204355	25.4	25.0	7769.054259725	8073.558580912
	2	275	1	1	0.831019148	1.627414017	25.4	25.0	8980.368613342	6516.628607936
	3	275	1	1	0.8377224	1.629241479	25.4	25.0	5715.403070749	6765.811497398
	4	273	1	1	0.849855405	1.627362593	25.4	25.0	7399.321479179	3595.451453051
	5	275	1	1	0.826049483	1.668432227	25.4	25.0	9183.231062277	6699.423765596
	6	275	1	1	0.842522228	1.639376957	25.4	25.0	7390.896992727	7649.420846864
	7	271	1	1	0.858490777	1.636017837	25.4	25.0	5942.438821604	4918.878714137
	8	273	1	1	0.819399042	1.704039666	25.4	25.0	10959.064818659	2760.578532784
	9	271	1	1	0.85714847	1.644094679	25.4	25.0	8399.381842718	3371.925595689
	10	275	1	1	0.84683824	1.642371479	25.4	25.0	8359.790903085	5393.92938496
	11	275	1	1	0.844184156	1.648087846	25.4	25.0	6946.380313612	7766.307490467
6	12	277	1	1	0.838265766	1.650604638	25.4	25.0	7973.656748255	4693.096482238
	13	273	1	1	0.836128593	1.681342261	25.4	25.0	11124.257096047	6038.23621241
	14	275	1	1	0.853577277	1.636748507	25.4	25.0	8922.257428536	5195.687308224
	15	273	1	1	0.86698437	1.624924571	25.4	25.0	7102.302770626	3514.943479542
	16	271	1	1	0.833757914	1.703947036	25.4	25.0	6334.6467951	3564.761869416
	17	279	1	1	0.837381332	1.649131668	25.4	25.0	10399.827637772	5853.992772764
	18	271	1	1	0.827024447	1.720227338	25.4	25.0	19536.640473939	2606.770994972

If you click the "Sort" button, a new dialog box will appear that enables you to select the variable on which the sorting should be based. For example, the following setting will order the list of realizations in ascending order of the hot stream pressure drop:

Sort Realizations:	
Sort by:	
Pressure Loss (hot)	•
In order:	
Ascend	•

No.	Plates	N _{p,hot}	N _{p,cold}	L m V	w m v	M _{hot} kg/s ▼	M _{cold} kg/s ▼	ΔP _{hot} Pa ▼	ΔP _{cold} Pa ▼
3	275	1	1	0.8377224	1.629241479	25.4	25.0	5715.403070749	6765.811497398
7	271	1	1	0.858490777	1.636017837	25.4	25.0	5942.438821604	4918.878714137
27	271	1	1	0.859279963	1.666356581	25.4	25.0	6162.996553583	4681.977484485
25	271	1	1	0.832534785	1.717483063	25.4	25.0	6309.722165268	3438.135032869
16	271	1	1	0.833757914	1.703947036	25.4	25.0	6334.6467951	3564.761869416
11	275	1	1	0.844184156	1.648087846	25.4	25.0	6946.380313612	7766.307490467
15	273	1	1	0.86698437	1.624924571	25.4	25.0	7102.302770626	3514.943479542
6	275	1	1	0.842522228	1.639376957	25.4	25.0	7390.896992727	7649.420846864
4	273	1	1	0.849855405	1.627362593	25.4	25.0	7399.321479179	3595.451453051
30	271	1	1	0.859830913	1.668139042	25.4	25.0	7598.398144587	5415.810918932
21	271	1	1	0.867283203	1.645169037	25.4	25.0	7727.496655303	3798.572333389
1	271	1	1	0.810716063	1.627204355	25.4	25.0	7769.054259725	8073.558580912
12	277	1	1	0.838265766	1.650604638	25.4	25.0	7973.656748255	4693.096482238
22	275	1	1	0.856791838	1.641991539	25.4	25.0	8152.60041813	6868.838909232
10	275	1	1	0.84683824	1.642371479	25.4	25.0	8359.790903085	5393.92938496
9	271	1	1	0.85714847	1.644094679	25.4	25.0	8399.381842718	3371.925595689
29	273	1	1	0.866172901	1.642353637	25.4	25.0	8548.547812272	4999.735058987
23	273	1	1	0.852980764	1.662478217	25.4	25.0	8681.859237757	7240.373090178

If you click the "Filter" button, a new dialog box will appear to enable you to set filter conditions. Only the realizations for which the filter conditions are satisfied will be displayed. For example, the following setting will cause the GUI to display only the realizations for which the hot stream pressure drop is smaller than 7500 Pa.

			Filter							×	
			Filt Filt	er Crite er with er ranş	ria #1: 1: Pre ge: <	essure Loss	s (hot) 7500.0		·		
			Filt	er Crite er with	ria #2: n: No	ne			÷	8	
						Filter	Car	ncel			
	No.	Plates	Nashat	Npanid	L m •	W m T	M _{hot} kg/s T	M _{cold}	ΔP _{bol} Pa ▼	∆P _{culd} Pa ▼	W
	3	275	1	1	0.8377224	1.629241479	25,4	25.0	5715.403070749	6765.811497398	3.15
	7	271	1	1	0.858490777	1.636017837	25,4	25.0	5942.438821604	4918.878714137	3.14
	27	271	1	1	0.859279963	1.666356581	25,4	25.0	6162.996553583	4681.977484485	3.16
1.1	25	271	1	1	0.832534785	1.717483063	25.4	25.0	6309.722165268	3438.135032869	3.15
	16	271	1	1	0.833757914	1.703947036	25.4	25.0	6334.6467951	3564.761869416	3.13
0	11	275	1	1	0.844184156	1.648087846	25.4	25.0	6946.380313612	7766.307490467	3.13
	15	273	1	1	0.86698437	1.624924571	25.4	25.0	7102.302770626	3514,943479542	3.14
U.	6	275	1	1	0.842522228	1.639376957	25.4	25.0	7390.896992727	7649.420846864	3.1
	4	273	1	1	0.849855405	1.627362593	25.4	25.0	7399.321479179	3595.451453051	3.14

Note that in the current version of INSTED, a maximum 2 filter conditions are allowed. You can choose the logical operation (AND or OR) between the two filter conditions. For example, the following settings will show only the realizations for which the hot stream pressure drop is smaller than 7500 Pa and the cold stream pressure drop is smaller than 6000 Pa.

Filter with:	Pressure Loss (hot)	¥
Filter range:	< • 7500.0	
Operatory	AND -	
operator:	AND	
Filtar Critaria #2		
Filter Criteria #2	Pressure Loss (cold)	

	No.	Plates	N _{p,hot}	N _{p,cold}	L m V	w m v	M _{hot} kg/s ▼	M _{cold} kg/s ▼	<i>∆P_{hot}</i> Pa ▼	ΔP _{cold} Pa ▼	W
Q.	7	271	1	1	0.858490777	1.636017837	25.4	25.0	5942.438821604	4918.878714137	3.14
	27	271	1	1	0.859279963	1.666356581	25.4	25.0	6162.996553583	4681.977484485	3.16
	25	271	1	1	0.832534785	1.717483063	25.4	25.0	6309.722165268	3438.135032869	3.15
	16	271	1	1	0.833757914	1.703947036	25.4	25.0	6334.6467951	3564.761869416	3.13
	15	273	1	1	0.86698437	1.624924571	25.4	25.0	7102.302770626	3514.943479542	3.14
	4	273	1	1	0.849855405	1.627362593	25.4	25.0	7399.321479179	3595.451453051	3.14

By clicking the "Clear" button, the filter settings will be removed and the list of realizations will appear in the default order.

30. Miscellaneous: Changing the Default Unit System

You can change the default unit system that you want to use for your analysis by selecting "Preferences" in the main menu panel.



You can select either "SI," "British," or "Customized" unit systems as your default unit system in INSTED. If "Customized" is chosen, you will need to specify the default unit for each variable type. You do this by clicking on the "Customize Preferred Units" button.

Preferences:		Please set preferred units:	
Units:		Area:	m² •
Choose default unit system:	Customiz • Customize Preferred Units	Density	kg/mª •
		Dynamic Viscosity:	kg/(m·s) •
utomatic input unit conversion:	(3)	Effective hA, Heat Capacity	W/K ·
		Energy:	J • (4
		Energy Flux:	W/m² •
		Enthalpy Specific Energy, Heat of Vaporization	J/kg 🔻
		Fouling Factor:	m²K/W
		Heat Transfer (Film) Coefficient	W/(m² K) •
		Length:	m •
		Mass Flowrate.	kg/s •
		Mass Flux:	kg/(s·m²) ▼
		Power	w •
		Pressure.	Pa 🔹
		Specific Heat. Entropy. Gas Constant:	J/(kg·K) •
		Surface Tension:	N/m 🔻
		Temperature:	к •
		Thermal Conductivity	W/(m-K) •
		Thermal Expansion Coefficient	1/K. •
		Thermal Diffusivity, Kinetic Viscosity.	m²/s
		Thermal Resistance:	KW .
		Velocity:	m/s •
		Volume Flow Rate:	m²/s. •
		Fin Density. Wave Number	1/m •
		Weight (Mass)	kg 🔹
		Mass per Area	ka/m² •

31. Miscellaneous: Changing the Precisions of Output Floating Number

You can change the default floating number output precision and format in "User Preferences."

Custom Fluid Properties				
Project Management				
INSTED Database				
Preferences				
	Format Numbers:			
	The exponent value, beneath which scientific notation occurs:	3		\bigcirc
	The exponent value, above which scientific notation occurs:	5		2
	Maximum number of digits for scientific notation:	7	•	
	Maximum number of digits for non-scientific notation:	9		
	Between Formerting			

32. Miscellaneous: Renaming/Deleting/Duplicating Existing Projects

In INSTED, existing project data can be managed using the "Project Management" tool, which can be accessed by clicking the "Project Management" button in the menu panel.

Project Management			
Preferences			
and makes			
	Start Page × Project Managemen	t ×	
	Manage Existing Projects:		
	Choose Thermal System Type:	Plate Fin HEX , (2)	
	Choose Data Type:	Geometry	
		3	
	Heat Exchanger Name	Creation Date	Last Modification Date
	Hewitt HX	2018-07-02 13:10:04	2018-07-02 13:11:04
	(Sample) Hewitt HX	2018-07-02 09:19:31	2018-07-02 09:19:31
	Rows 1-2 of 2		
	« 1 2 3 4	5 »	

- Make sure the correct data type ("Geometry," "Rating," "Multiple Ratings," "Sizing," or "Optimization") is selected.
- To rename or duplicate a project, select a project by checking the checkbox and then clicking the "Rename/Duplicate" buttons. A new dialog will be displayed to enable you to specify the new project name.
- For deletion, multiple projects can be selected at once.
- When deleting a Rating project, the Delete operation will fail if the Rating project is also used by a Multiple Rating, Sizing, or Optimization project. You need to delete the Multiple Rating, Sizing, and Optimization projects first before deleting the Rating project.
- When deleting a HEX Geometry project, the Delete operation will fail if the Geometry project is also used by a Rating project. You need to delete the corresponding Rating project first before deleting the Geometry project.

33. Miscellaneous: Exporting an Existing Project into an XML File

In INSTED, a project data can be exported into an XML text file, which can be imported back later. The feature serves two purposes:

- Backing up of project data
- Sharing of project between INSTED users

Under "Project Management" in the menu panel choose "Thermal System Type" and "Data Type"

Plate-Fin Heat Exchanger 😤	Start Page a Project Management ×
Cresle HEX Geometry	Manage Existing Projects:
Rale HEX Multiple Rating Sizing Optimization	Choose Thermal System Type: Plate Fin HEX Choose Data Type: Rating Choose Data Type:
Sholl & Tubos Hoat Exchanger - Create HEX Geometry - Rate HEX - Preliminary Design	Reting Date Name Multiple Ratings Sizing Opt Test (Rating) 88 Optimization Optimiza
Concentric Tubes Heat Exchanger + Create HEX Geometry	(Sample) Hewitt Rating (4) (Sample) Hewitt HK (4) 2016-01-23 22:28:46 2016-03-03 00:30:28 One Test / Review I
Rate HEX Longth Calculation	(Sample) Chapman Rating (Sample) Chapman HX 2016-02-24 14:39:11 2016-02-24 14:39:11
Plate-Frame Heat Exchanger	multirate test 2 (Rating) 3 multirate test 2 (Geometry) 3 2016-02-10 13:07:48 2016-02-19 12:33:35
Create HEX Geometry Rate HEX	multirate test 2 (Rating) 2 multirate test 2 (Geometry) 2 2016-02-10 13:03:01 2016-02-10 13:03:01
Multiple Rating Sizing Optimization	multirate test 2 (Rating) multirate test 2 (Geometry) 2016-02-10 13:01:44 2016-02-10 13:01:44 (Sample) CHE Rating (Custom I/F) 2 (Sample) CHE HX (Custom I/F) 2 2016-01-16 17:11:50 2016-02-10 13:01:21
Piping System	(Sample) CHE Rating (Custom I/F) (1) (Sample) CHE HX (Custom I/F) (1) 2016-02-10 12:59:43 2016-02-10 13:00:08
Design & Rate K Fin & Fin Array	Sample) CHE Rating (Sample) CHE HX 2016-02-10 12:59:26 2016-02-10 12:59:38
Thermal Analysis <u>Heat Conduction</u> Thermal Analysis & Design	x x 2 3 4 5 x
Tubo Banks • Thermal & Hydraulic Analysis	Delete the checked rating projects Rename Duplicate Export Import
Sample Problems	
Custom Fluid Properties	
Project Management	
INSTED Dolabnse	
Unit Conversion	
Math Calculator	

Check the "checkbox" corresponding to the project (file) you want to export and click the "Export" button.

Plate Fin Heat Exchanger	Start Page	Project Management *			
Create HEX Geometry Rate HEX Multiple Rating Sizing Optimization	Manage E) Choose Choose	xisting Projects: • Thermal System Type: Plate Fir • Data Type: Rating	n HEX •		
Sheit & Lubes Heat Exchanger • Create HEX Geometry • Rate HEX • Preliminary Design		Rating Data Name 1 Opt Test (Rating) 33	Huat Exchanger Name Dpt Test (Geometry) 33	Creation Date 2016-03-03 01:05:22	Last Modification Date
Concentric Tubes Heat Exchanger - Create HEX Geometry - Rate HEX - Length Calculation	0.01.0	(Sample) Hewitt Rating (4) (Opt Test (Rating) Imported ((Sample) Chapman Rating (Sample) Hewitt HX (4) Opt Test (Geometry) Imported (Sample) Chapman HX	2016-01-23 22:28:46 2016-03-02 11:43:44 2016-02-24 14:89:11	2016-03-03 00:30:28 2016-03-02 11:43:44 2016-02-24 14:39:11
Plate-Frame Heat Exchanger • Create HEX Geometry • Rate HEX • Multiple Rating • Sizing • Optimization Piping System • Design & Rate		multirate test 2 (Rating) 3 multirate test 2 (Rating) 2 multirate test 2 (Rating) 2 multirate test 2 (Rating) 4 multirate test 2 (Rating (Custom i/F) 2 (Sample) CHE Rating (Custom i/F) 1 (Sample) CHE Rating (Custom i/F) (Sample) (CHE Rating (Custom i/F) (Sample) CHE Rating (Custom i/F) (Sample) (CHE Rating (CUstom i/F) (C	nultirate test 2 (Geometry) 3 nultirate test 2 (Geometry) 2 nultirate test 2 (Geometry) Sample) CHE HX (Custom J/F) 2 Sample) CHE HX (Custom J/F) (1) Sample) CHE HX	2016-02-10 13:07:48 2016-02-10 13:03:01 2016-02-10 13:03:01 2016-02-10 13:01:44 2016-01-16 17:11:50 2016-02-10 12:59:45 2016-02-10 12:59:26	2016-02-19 12:33:35 2016-02-19 13:03:01 2016-02-10 13:01:44 2016-02-10 13:01:21 2016-02-10 13:00:08 2016-02-10 12:59:38
Fin & Fin Array • Thermal Analysis <u>Heat Conduction</u> • Thermal Analysis & Design	Ro	elete the checked rating projects	Rename Duplicate	Export Import	1
Idde bailies • Thermal & Hydraulic Analysis Sample Problems Custom Fluid Properties Project Management INSTED Database Unit Conversion Math Calculator Preferences					

A dialog box will be displayed to show the name of the Rating project to be exported and its associated "Geometry." To give the project and/or its geometry a different name, simply write over the current name of the project and/or its geometry, as shown below.

- Project to Export:	
Plate-Fin Rating: Opt Test (Rating) 33	
—Auxiliary Projects to Export: —	Can change the name of the exporte projects
Plate-Fin Geometry: Opt Test (Geometry) 33	

Clicking the "Export" will cause a project file to be generated and downloaded into the default Download folder of your browser. This means that you need to know the location of the Download folder in your computer. Your system administrator should be able to help you obtain this bit of information.



34. Miscellaneous: Importing a Project from an XML File

The following instruction contains the procedures for importing a project from an XML text file.

Under "Projects Management" in the menu panel, choose the type of task for which you want to import a project and click the "Import" button.

Plate-Fin Heat Exchanger Start Pa	ge · Project Management ×				
Create HEX Geometry Manage Existing Projects:					
Rate HEX Multiple Rating Sizing Optimization Ch	oose Thermal System Type: Plate F oose Data Type: Rating	Fin HEX •			
Shell & Tubes Heat Exchanger					
Rate HEX	Rating Data Name	Heat Exchanger Name	Creation Date	Last Modification Date	
Preliminary Design <u>Concentric Tubes Heat Exchanger</u> Create HEX Geometry Rate HEX Length Calculation <u>Plate-Frame Heat Exchanger</u> Create HEX Geometry Rate HEX Multiple Rating Sizing Optimization <u>Priping System</u> Design & Pate	Opt Test (Rating) 33	Opt Test (Geometry) 33	2016-03-03 01:05:22	2016-03-03 01:05:22	
	(Sample) Hewitt Rating (4)	(Sample) Hewitt HX (4)	2016-01-23 22:28:46	2016-03-03 00:30:28	
	Opt Test (Rating) Imported	Opt Test (Geometry) Imported	2016-03-02 11:43:44	2016-03-02 11:43:44	
	(Sample) Chapman Rating	(Sample) Chapman HX	2016-02-24 14:39:11	2016-02-24 14:39:11	
	multirate test 2 (Rating) 3	multirate test 2 (Geometry) 3	2016-02-10 13:07:48	2016-02-19 12:33:35	
	multirate test 2 (Rating) 2	multirate test 2 (Geometry) 2	2016-02-10 13:03:01	2016-02-10 13:03:01	
	multirate test 2 (Rating)	multirate test 2 (Geometry)	2016-02-10 13:01:44	2016-02-10 13:01:44	
	(Sample) CHE Rating (Custom J/F) 2	(Sample) CHE HX (Custom J/F) 2	2016-01-16 17:11:50	2016-02-10 13:01:21	
	(Sample) CHE Rating (Custom J/F) (1)	(Sample) CHE HX (Custom J/F) (1)	2016-02-10 12:59:45	2016-02-10 13:00:08	
	(Sample) CHE Rating	(Sample) CHE HX	2016-02-10 12:59:26	2016-02-10 12:59:33	
Fin & Fin Array	Rout 1.10 of 23				
Thermal Analysis					
Heat Conduction	× 1 2 3 4 3 %				
Thermal Analysis & Design	B.L. B. L. B. B. B. B. B. B. B.			7	
Tube Banks	Delete the checked rating projects	Rename Duplicate	Export	<u> </u>	
Samole Problems					
Custom Fluid Properties					
Project Management					
INSTED Database					
Unit Conversion					
Math Calculator					
Preferences					
And a second					

A dialog box will be displayed.
-Upl	oad Project File to Import: -				-
	Plate-Fin Rating:				
	Choose File 880	430e8-0126	9cf19 (2).xm	il	
	1.0	blood	Canaal		
_		bload	Cancel		_

Choose the file you want to upload and click the "Upload" button.

A dialog box containing the details of the imported project will be displayed. You also have the option of changing the name (descriptions) of the imported project.

Important Information: Please note that your project files are downloaded into your browser default download folder. This is where to look when you want to export the file to other INSTED users.

roject to Import-		
Plate-Fin Rating:		
Opt Test (Rating) Import	ed	
		Can change the name of the imported
uxiliary Projects to Export:		projects
Plate-Fin Geometry:	Opt Test (Geometry) Imported	

Click the "Confirm" button to import the project.

35. Flow Configurations: Parallel Flow vs. Cross Flow, Multiple Passes vs. Multiple Partitions, Counter-Current vs. Co-Current

The following table contains the flow configurations supported in the INSTED Plate-Fin module:

Flow Assignment	Flow Passes (hot-cold)	Flow Partitions (hot-cold)	Flow Direction	Illustration
Parallel	1-1	1-1	Counter- current	Fuid B Fuid A
Parallel	1-1	1-1	Co- current	Fuid B Huid A W

Parallel	2-1	1-1	counter- current	Fuid B Fuid A W
Parallel	2-1	1-1	co-current	Fluid B Fluid A W
parallel	1-2	1-1	counter- current	Fluid B C W L









Cross	2-1	1-1	counter- current	Fuid A
Cross	2-1	1-1	co-current	Fuld A
Cross	1-2	1-1	counter- current	Fuid A Fuid a

Cross	1-2	1-1	co-current	Fuid A W
Cross	2-2	1-1	counter- current	Fluid A
Cross	2-2	1-1	co-current	Fuid A Fuid a



Cross	1-1	2-2	co-current	Fluid A
Cross	2-1	1-2	n/a	Fluid Water and a state of the
Cross	1-2	2-1	n/a	Puid A

36. Technical Details: Built-in J/F Correlations for Various Fins

In INSTED Plate-Fin, the following built-in J/F correlations are used for the different types of fins:

Plain Fins

TTC's internal proprietary J/F correlations are used for plain fins. The correlations have been obtained from joint work with TTC customers and from the literature, such as the Kays and London correlations [1].

Offset-Strip Fins

For the offset-strip type of fins, Bergles and Manglik's model [2] is used.

Herringbone Fins

For herringbone/wavy fins (flow direction), Award's model [3] is used.

Note that you can always use your own customized J/F correlations in place of the built-in correlations. Please refer to Section "12. Fins: Custom J/F Data – Analytic Mode" for instructions on how to specify your own j/f data.

Reference:

- [1] Kays, William Morrow, and Alexander Louis London. "Compact heat exchangers." (1984).
- [2] Bergles, R. M., and A. E. Manglik. "The thermal-hydraulic design of the rectangular offset-strip-fin compact heat exchanger." Compact Heat Exchangers: A Festschrift for AL London 123 (1990).
- [3] Awad, M., and Yuri S. Muzychka. "Models for pressure drop and heat transfer in air cooled compact wavy fin heat exchangers." Journal of Enhanced Heat Transfer 18, no. 3 (2011).

37. Technical Details: Two-Phase Models

The various boiling and condensation models supported in INSTED Plate-Fin were obtained from the literature where they have mostly been developed for flow in circular pipes or ducts. A list of the two-phase models is shown in the table below. TTC has modified these models to make them applicable to extended fin surfaces. The details of the procedure to do this can be found in a paper from TTC's [1]. Note that this paper can be downloaded from TTC's website under "Publications.".

Reference:

[1] Li, W., Alabi, K. and Ladeinde, F., "Comparison of 30 Boiling and Condensation Correlations for Two-Phase Flows in Compact Plate-Fin Heat Exchangers," ASME Paper HT2017-4907, July 2017. Note that each of the two-phase models listed in the table below is valid for only a certain flow regime and conditions. Some information on the validity of the various models are contained in the table.

Boiling Models:

No.	Correlation	Channel Geometry	Boiling Mechanism	Fluids
1	Chen (1966)	Horizontal tubes	Nucleate boiling and forced convective boiling	Water, Methanol, Pentane, Heptane, Benzene, etc.
2	Shah (1982)	Horizontal and vertical tubes $D_h=5.0-15.8 \text{ mm}$	Nucleate boiling and forced convective boiling	R11, R12, R22, R502, etc.
3	Gungor and Winterton (1986)	Horizontal and vertical tubes $D_h=2.95-32 \text{ mm}$	Nucleate boiling and forced convective boiling	Water, R11, R12, R113, etc.
4	Gungor and Winterton (1987)	Horizontal and vertical tubes $D_h=2.95-32 \text{ mm}$	Nucleate boiling and forced convective boiling	Water, R11, R12, R113, etc.
5	Kandlikar (1990)	Horizontal and vertical tubes $D_h=4.6-32 \text{ mm}$	Nucleate boiling and forced convective boiling	Water, R11, R12, R22, R113, Nitrogen, etc.
6	Liu and Winterton (1991)	Horizontal and vertical tubes $D_h=2.95-32 \text{ mm}$	Nucleate boiling and forced convective boiling	Water and refrigerants
7	Steiner and Taborek (1992)	Horizontal tubes D _h =1-32 mm	Nucleate boiling and forced convective boiling	Water, refrigerants, cryogenics
8	Kattan (1998)	Microfin tube	Nucleate boiling and forced convective boiling	R134a, R123, R402a, R404a, R502
9	Rohsenow (1951)	Horizontal tubes	Nucleate boiling	Water, CCl4, Benzene, n-Pentane, Ethyl alcohol, etc.
10	Cooper (1984)	Pool boiling	Nucleate boiling	Water, refrigerants, organic fluids, cryogens
11	Koyama (1995)	Microfin tube	Nucleate boiling	Refrigerants
12	Tran (1996)	Horizontal tubes $D_h=2.4-2.92 \text{ mm}$	Nucleate boiling	R12, R113
13	Kew and Cornwell (1997)	Horizontal tubes $D_h=1.39-3.69 \text{ mm}$	Nucleate boiling	R141b
14	Warrier (2002)	Horizontal tubes D _h =0.75 mm	Nucleate boiling	FC-84
15	Yu (2002)	Horizontal tubes D _h =2.98 mm	Nucleate boiling (moderate convective boiling maybe included)	Water

Condensation Models:

No.	Correlation	Channel Geometry	Condensation Regime	Fluids
1	Carpenter and Colburn (1951)	Horizontal tubes	Annular flow	Steam
2	Kosky and Staub (1971)	Horizontal tubes	Annular flow	Steam
3	Cavallini and Zechin (1974)	Horizontal tubes	Annular flow	Steam
4	Jaster and Kosky (1976)	Horizontal tubes	Stratified flow	Steam
		D _h =12.5 mm		
5	Shah (1979)	Horizontal tubes	Annular flow	Water, R11, R12, R22, R113, methanol, ethanol,
		D _h =7-40 mm		benzene, etc.
6	Haraguchi (1994)	Horizontal tubes	Annular flow	R22, R134a, R123
		D _h =8.4 mm		
7	Fujii (1995)	Horizontal tubes	Gravity and shear flows	R22, R134a, R123
		D _h =8.4 mm		
8	Yu and Koyama (1998)	Microfin tubes	Gravity and shear flows	R22, R134a, R123
9	Moser (1998)	Horizontal tubes	Annular flow	Steam
		D _h =3.14-20 mm		
10	Dobson and Chato (1998)	Horizontal tubes	Annular and stratified-wavy flows	R12, R22, R134a, etc.
		D _h =3.14-7.04 mm		
11	Webb (1998)	Horizontal tubes	Annular flow	R12
		D _h =1-7 mm		
12	Cavallini (2002)	Horizontal tubes	Annular, annular-stratified, and	R22, R134a, R125, R236ea, R32, R410A
		D _h =8 mm	stratified-slug flows	
13	Thome (2003)	Horizontal tubes	Annular, stratified-wavy, and wavy flows	R22, R134a, R125, R236ea, R32, R410A
		D _h =8 mm		
14	Cavallini (2006)	Horizontal tubes	Δ T-dependent and Δ T-independent flows	R22, R134a, R125, R236ea, R32, R410A
		D _h =8 mm		
15	Shah (2009)	Horizontal/vertical tubes	Laminar, transitional, and turbulent flows	Water, halocarbon refrigerants, hydrocarbon
				refrigerants, and organics