

Release Notes

INSTED/Plate-Fin

INSTED Ver. 12.0 (Released AUGUST 10, 2020)



TTC TECHNOLOGIES, INC.

August 10, 2020

Release Features

INSTED Ver. 12.0

The latest version of INSTED (Ver. 12.0), released on 10 August 2020, contains major enhancements to the INSTED/Plate-Fin module. This update is available free-of-charge to licensed customers with an up-to-date annual maintenance program (AMP) contract with TTC.

SUMMARY of THE NEW FEATURES IN INSTED Ver. 12.0

The new features contained in the update (Version 12.0) to the Plate-Fin module of The INSTED Thermal Analysis Software package are as follows:

- ✓ **The “Fin Code” capability has been added.** This capability allows you to save your fin configurations in storage and retrieve them in future for use in other projects
- ✓ **More options for flow rate specification.** You can now specify volume flow rate, mass flow, and frontal-area-based velocity for the two streams in your HEX
- ✓ **Addition of Standard United States atmosphere properties to INSTED Database.** Since heat exchangers are often used at altitudes where fluid properties can be significantly different from their values at STP, INSTED now supports the use of air properties at elevated heights, using the US Standard Atmosphere data. Elevations corresponding to the troposphere and part of the stratosphere (about 10 km below the stratopause), are now supported. You may access this database item for the pressure and temperature and/or the thermophysical properties of absolute viscosity, specific heat at constant pressure, thermal conductivity, or the density.
- ✓ **Addition of ethylene glycol/water mixture data to INSTED Database.** The built-in database has been modified to add the properties of ethylene glycol/water mixtures for volume percentage between 0 and 100% ethylene glycol. Percentage in terms of the mass of ethylene glycol is also supported. The effects of temperature are supported.
- ✓ **Addition of more solid/fluid items to INSTED Database.** The properties of Aluminum Alloy 3003 have been added to the built-in INSTED solid properties database under the “Metallic Solid” category. Also, the properties of Dowfrost (with 30%, 40%, and 50% propylene glycol by volume) have been added; as have those of Dowtherm 4000 (with 30%, 40%, and 50% ethylene glycol by volume).
- ✓ **Addition of sample custom/variable fluid data to INSTED Database.** In the new version of INSTED, a collection of custom (variable thermophysical properties) data of certain fluid mixtures has been added to the built-in INSTED database, which you can copy into your project. The added fluid mixtures are: Ethylene Glycol/Water (30/70 by volume), Ethylene Glycol/Water (40/60 by volume), Ethylene Glycol/Water (50/50 by volume), Ethylene Glycol/Water (60/40 by volume), Ethylene Glycol/Water (70/30 by volume), DOWFROST (Propylene Glycol 30% by volume), DOWFROST (Propylene Glycol 40% by volume), DOWFROST (Propylene Glycol 50% by volume), DOWTHERM 4000 (Ethylene Glycol 30%

by volume), DOWTHERM 4000 (Ethylene Glycol 40% by volume), and DOWTHERM 4000 (Ethylene Glycol 50% by volume)

- ✓ **Improvements to the Graphics User Interface (GUI) Design.** The improvements below have been made on the GUI for INSTED:
 - ❖ Quick access buttons have been added to allow you to enter fin data for flow B directly from the tab for Fin-A, and vice versa.
 - ❖ Quick access menu buttons have been added to allow you to directly save projects in sub-tabs.
 - ❖ The fin geometry illustration figure for offset strip fin has been updated
 - ❖ The fin geometry illustration figure for herringbone fin has been updated

- ✓ **Addition of on-screen Help/Tips.** The enhancements below have been made in order to enhance your understanding of certain terminologies and input items:
 - ❖ Quick access buttons have been added to allow you to enter fin data for flow B straight from the tab for Fin-A, and vice versa.
 - ❖ Tips have been added to clarify the term “Viscosity”
 - ❖ Tips have been added to clarify the term “Offset Pitch” for the offset-strip fin
 - ❖ Tips have been added to clarify the term “Wavelength” for the herringbone fin

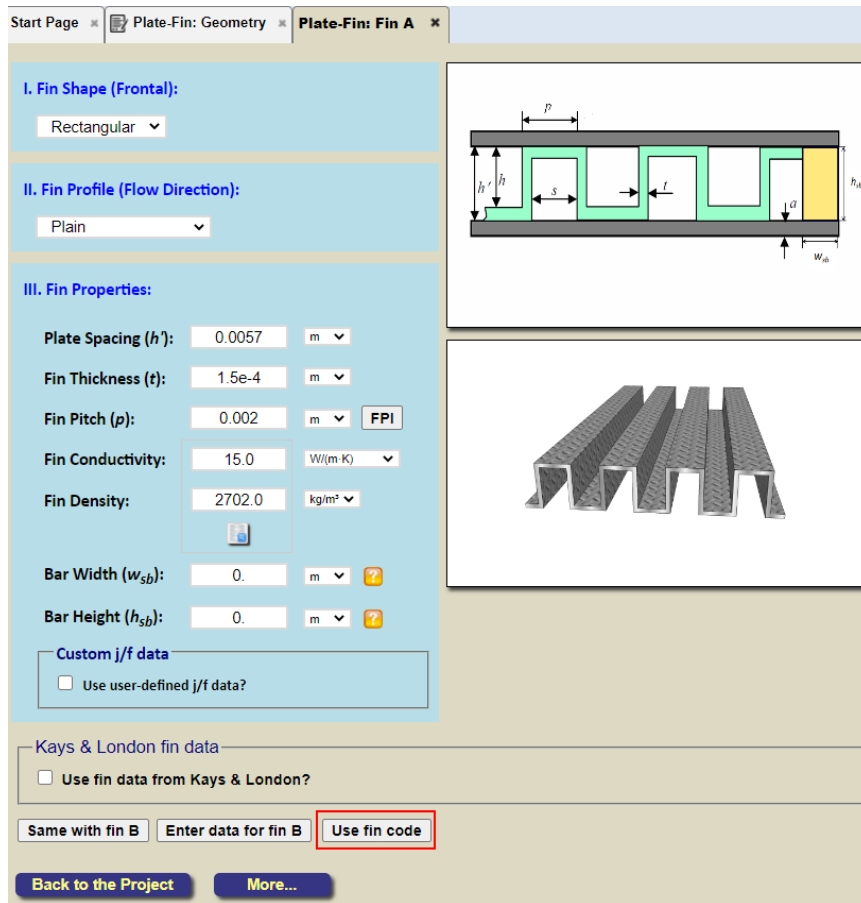
- ✓ **More Unit Items have been added**
 - ❖ The unit “cP” (centipoise) has been added to the drop-down unit list for dynamic viscosity
 - ❖ The unit “Btu/m” (Btu per minute) has been added to the drop-down unit list for power
 - ❖ The unit “mm” (millimeter) has been added to the drop-down unit list for length

DETAILS OF THE NEW FEATURES IN INSTED Ver. 12.0

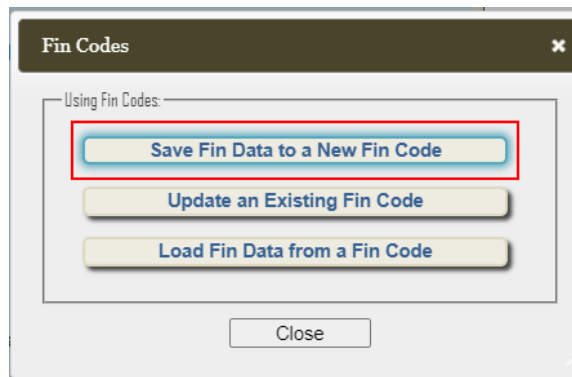
Addition of “Fin Code”

- 1) The concept of “**Fin Code**” refers to a way to store fin geometry parameters into a standalone data entity so that the fin parameters stored in a fin code can be retrieved and loaded into any heat exchanger **geometry** projects.

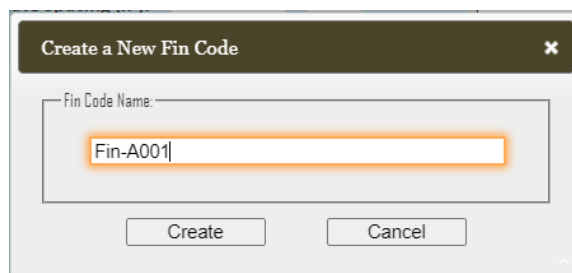
- 2) To create a fin code, simply click the “**Use fin code**” button when entering fin **geometry** data.



A pop-up dialog box will be shown. Click the “**Save Fin Data to a New Fin Code**” button.

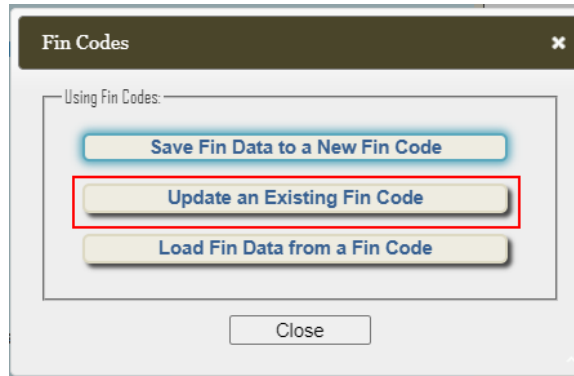


A pop-up dialog box will be shown to let you enter the name to use for the fin code.

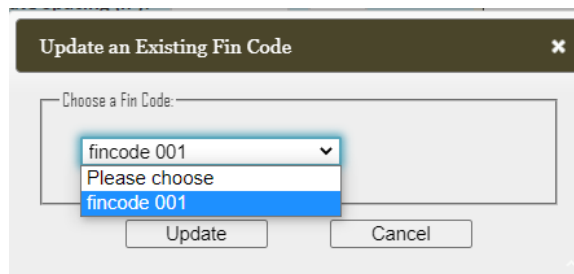


Input the name for the fin code and click the **“Create”** button. The fin code will be created.

- 3) Instead of creating a new fin code, if you want to overwrite the fin geometry data in an existing fin code, use the second option in the dialog box: **“Update an Existing Fin Code:”**

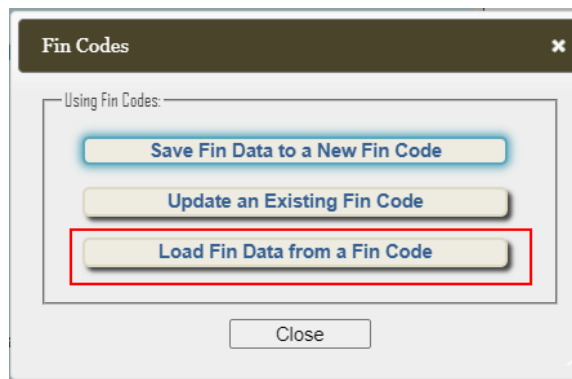
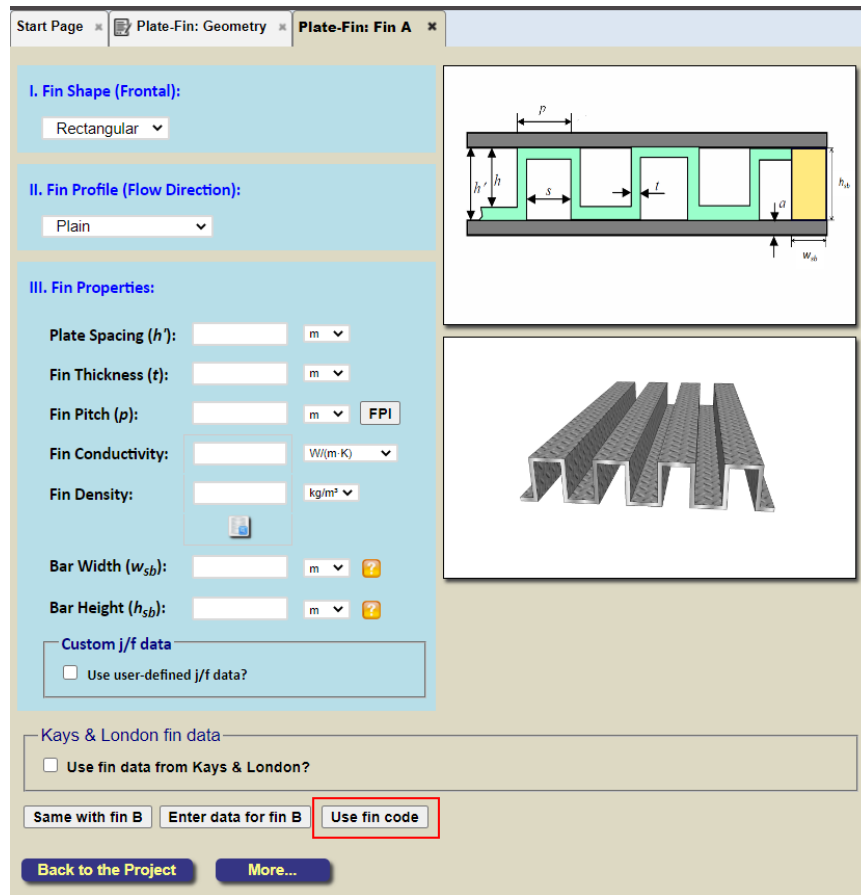


A pop-up dialog box will be shown to let you choose the previously generated fin code that you want to overwrite:

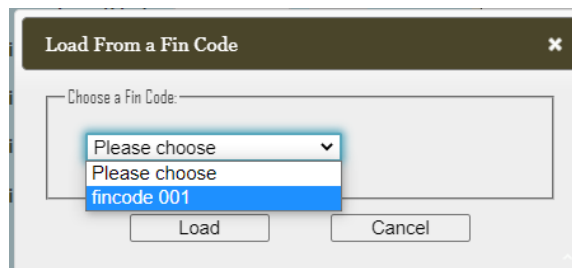


Choose a fin code to overwrite and click the **“Update”** button. The selected fin code will be updated with the new fin geometry data.

- 4) To load a fin code data into a project, click **“Use fin code”** when entering the fin geometry data. In the pop-up dialog box, click **“Load Fin Data from a Fin Code”**



A pop-up dialog box will appear to let you select the previously generated fin code to load:



Choose a fin code to load and click the “**Load**” button. The previously generated fin geometry data will be loaded.

I. Fin Shape (Frontal):
 Rectangular

II. Fin Profile (Flow Direction):
 Plain

III. Fin Properties:

Plate Spacing (h'): 0.0057 m

Fin Thickness (t): 1.5e-4 m

Fin Pitch (p): 0.002 m **FPI**

Fin Conductivity: 15.0 W/(m-K)

Fin Density: 2702.0 kg/m³

Bar Width (w_{sb}): 0. m

Bar Height (h_{sb}): 0. m

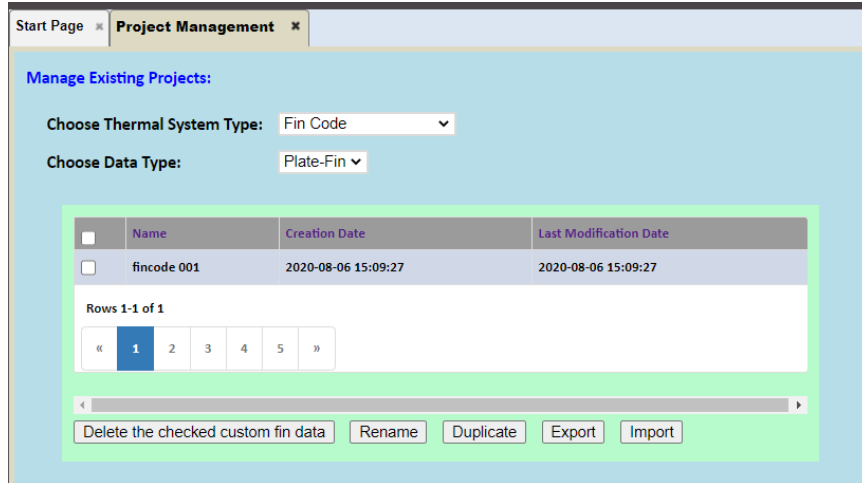
Custom j/f data
 Use user-defined j/f data?

Kays & London fin data
 Use fin data from Kays & London?

Same with fin B Enter data for fin B Use fin code

Back to the Project More...

- 5) Note that the “Custom j/f data” and “Kays & London fin data” are also saved into the fin code if they are used. Basically, all the input in the fin data specification interface above (including custom j/f data and Kays and London fin geometry and j/f data, if they are used) will be saved into the fin code.
- 6) The saved fin code data can be viewed and managed in the “**Project Management**” menu, where you can delete/rename/duplicate/export/import a fin code



More Options for Specifying Inlet Flow Rate

- 1) In previous versions of INSTED, you could only input “**Mass Flow Rate**” for the inlet flow. In the current version, two new options have been added: “**Volume Flow Rate at Inlet**” and “**Core Mean Flow Velocity at Inlet.**”
- 2) To specify an option to use to specify inlet flow rate, simply click the “**options**” button when specifying the “**Flow Conditions**”

Start Page * **Plate-Fin: Rating** *

I. Project Name:
(Sample) Hewitt Rating (5)

II. Choose Heat Exchanger Geometry to Rate:
(Sample) Hewitt HX (5) [View Details](#)

III. Flow Assignment:
 Fluid A is hot Fluid B is hot

IV. Flow Direction:
 Co-Current Counter-Current

V. Two Phase Flow?
No Phase Change

VI. Flow Conditions:

	Hot	Cold	
Inlet Mass Flow Rate:	25.4	25.0	kg/s options
Inlet Temperature:	733	573	K
Inlet Pressure:	0.	0.	Pa
Fouling Resistance:	0.	0.	m ² K/W
K-Factor In	0.4	0.4	
K-Factor Out	0.4	0.3	

VII. Fluid Properties:

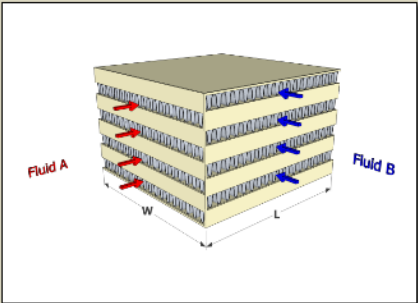
★ Hot Fluid Properties:
 Fixed Variable/Custom REFPROP

★ Cold Fluid Properties:
 Fixed Variable/Custom REFPROP

	Hot	Cold	
Density:	0.54	4.86	kg/m ³
Specific Heat:	1060.0	1060.0	J/(kg·K)
Viscosity:	3.2e-5	3.2e-5	kg/(m·s)
Conductivity:	0.05	0.05	W/(m·K)

VIII. Calculation Method (Optional)
[Set Calculation Method](#)

[New](#) [Save](#) [Save As](#) [Load](#) [Close](#) [Compute](#)



A pop-up dialog box will be displayed to allow you to enter the flow rate in one of three options:

- Mass Flow Rate
- Volume Flow Rate at Inlet
- Core Mean Flow Velocity at Inlet

Choose Flow Rate Type ✕

Choose flow rate type:

Hot Side:

Cold Side:

[Confirm](#) [Cancel](#)

After selecting the flow rate type for each stream, the corresponding input textboxes will be displayed to allow you to enter the values of the chosen type of flow rate.

Start Page * **Plate-Fin: Rating** *

I. Project Name:
(Sample) Hewitt Rating (4)

II. Choose Heat Exchanger Geometry to Rate:
(Sample) Hewitt HX (4) [View Details](#)

III. Flow Assignment:
 Fluid A is hot Fluid B is hot

IV. Flow Direction:
 Co-Current Counter-Current

V. Two Phase Flow?
No Phase Change

VI. Flow Conditions:

	Hot	Cold	
Inlet Volume Flow Rate:	47.1		m ³ /s
Inlet Flow Velocity:	7.42		m/s
Inlet Temperature:	733	573	K
Inlet Pressure:	0	0	Pa
Fouling Resistance:	9.e	1.7E	m ² /KW
K-Factor In	0.4	0.4	
K-Factor Out	0.4	0.3	

VII. Fluid Properties:

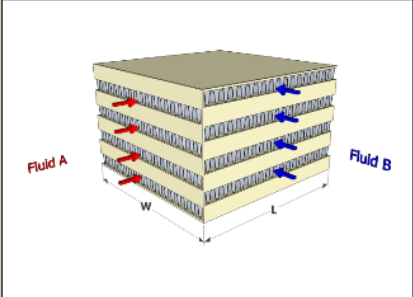
★ Hot Fluid Properties:
 Fixed Variable/Custom REFPROP

★ Cold Fluid Properties:
 Fixed Variable/Custom REFPROP

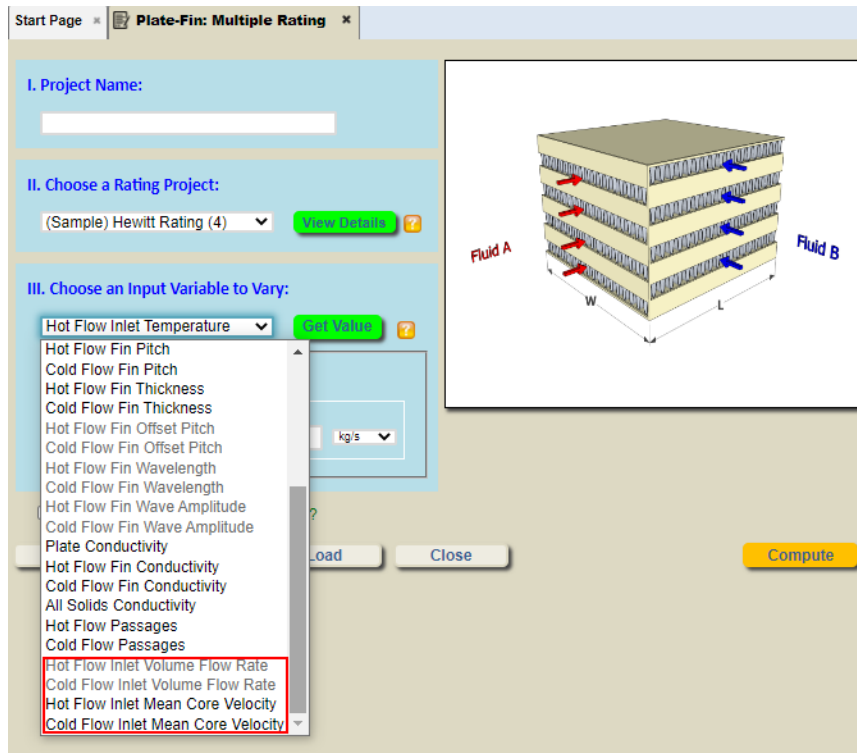
	Hot	Cold	
Density:	0.54	4.86	kg/m ³
Specific Heat:	1060.0	1060.0	J/(kg·K)
Viscosity:	3.2e-5	3.2e-5	kg/(m·s)
Conductivity:	0.05	0.05	W/(m·K)

VIII. Calculation Method (Optional)
[Set Calculation Method](#)

[New](#) [Save](#) [Save As](#) [Load](#) [Close](#) [Compute](#)




- 3) The “Hot/Cold Flow Volume Flow Rate” and “Hot/Cold Core Mean Velocity” options have also been added to the **Multiple Rating** task to allow the range of flow rate to be used in the chosen input type during the calculation.




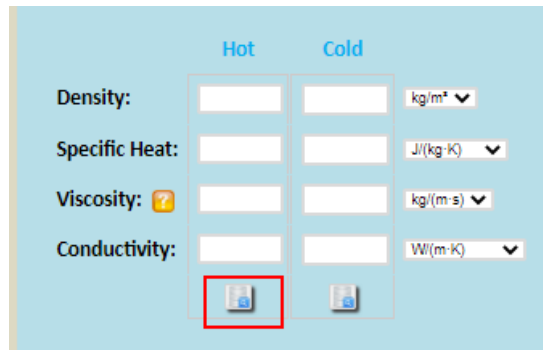
Note that only the flow rate type chosen in the reference rating project can be activated in Multiple Rating, and the options for other types of flow rate specification will be greyed out.

Similarly, the “Hot/Cold Flow Volume Flow Rate” and “Hot/Cold Core Mean Velocity” options have also been added to the Excel/XML template files for “User-Defined Multiple Rating Data.”

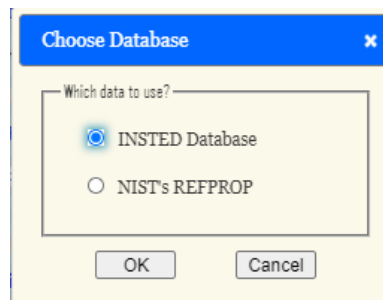
Addition of Standard United States Atmosphere Properties Data

- 1) "Standard US Atmosphere" data has been added to the built-in fluid properties database in INSTED
- 2) Note that the fluid database can be accessed in two ways: (a) through the built-in fluid properties inquiry which is initiated by clicking the "Find from Database" button, which has the icon (); (b) from the standalone database by clicking the "INSTED Database" menu.

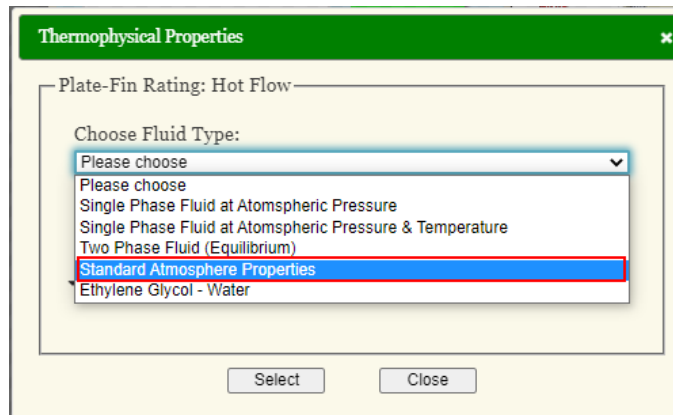
Here, we use the first option to illustrate the procedure. So, click the  button to query the fixed fluid properties from INSTED's built-in database:



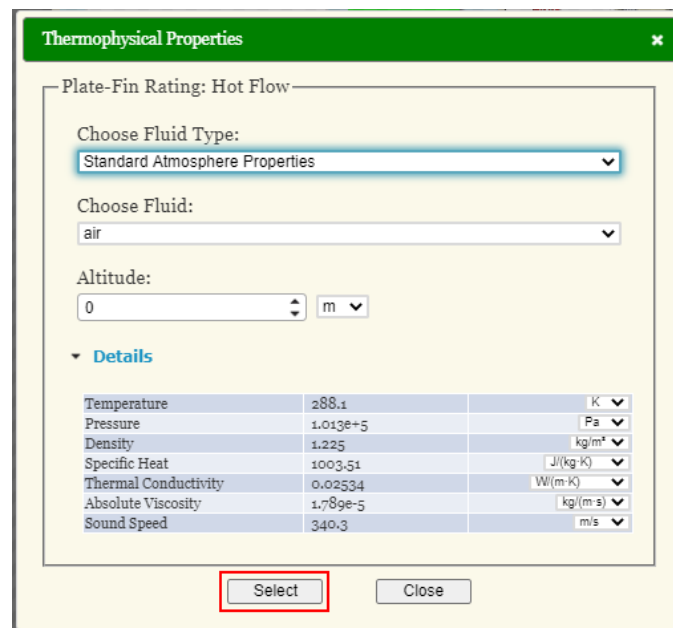
A pop-up dialog box will be displayed (below). Select "**INSTED Database**" and click on the "**OK**" button.



After the fluid properties category has been displayed, select "**Standard Atmosphere Properties**" under the "**Choose Fluid Type**" drop-down list.

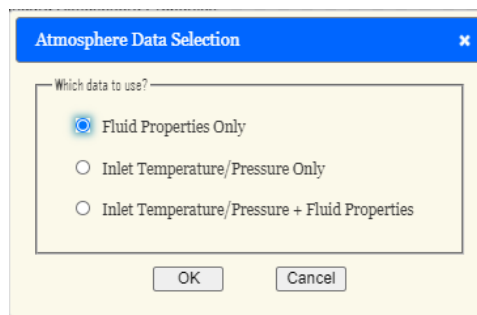


The “**Standard Atmosphere Properties**” data will be displayed. The properties of atmospheric air at the specified altitude will be calculated after you have specified a value for the altitude.

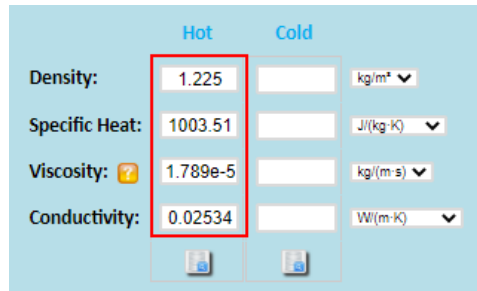


The data for the **fixed fluid properties** can be obtained directly for atmospheric air in the database by clicking on the “**Select**” button. When you do this, you are presented with three options:

- Fluid Properties Only
- Inlet Temperature/Pressure Only
- Inlet Temperature/Pressure + Fluid Properties

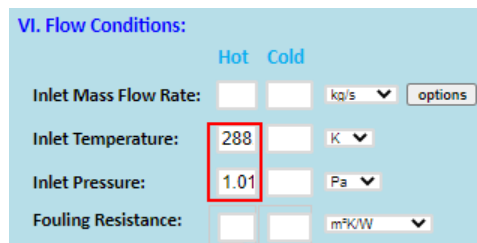


If you select the “**Fluid Properties Only**” option, after clicking the “**OK**” button, only the fluid thermophysical properties (dynamic viscosity, specific heat at constant pressure, thermal conductivity, and density) will be loaded into your project.



	Hot	Cold	
Density:	1.225		kg/m ³ ▼
Specific Heat:	1003.51		J/(kg·K) ▼
Viscosity: ⓘ	1.789e-5		kg/(m·s) ▼
Conductivity:	0.02534		W/(m·K) ▼

If the “**Inlet Temperature/Pressure Only**” option is selected, after clicking the “**OK**” button, only the fluid inlet temperature/operating pressure will be loaded into your project.

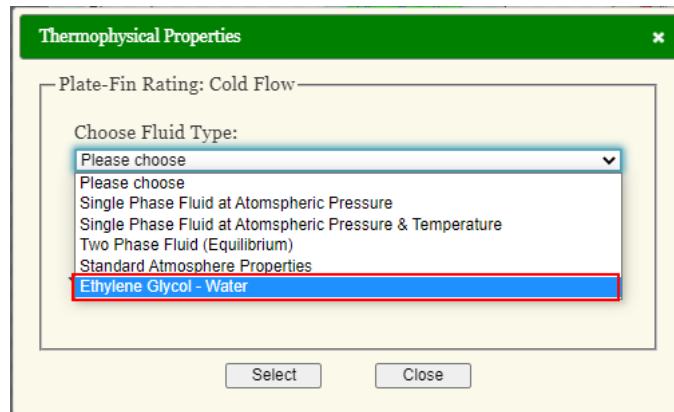


	Hot	Cold	
Inlet Mass Flow Rate:			kg/s ▼ options
Inlet Temperature:	288		K ▼
Inlet Pressure:	1.01		Pa ▼
Fouling Resistance:			m ² K/W ▼

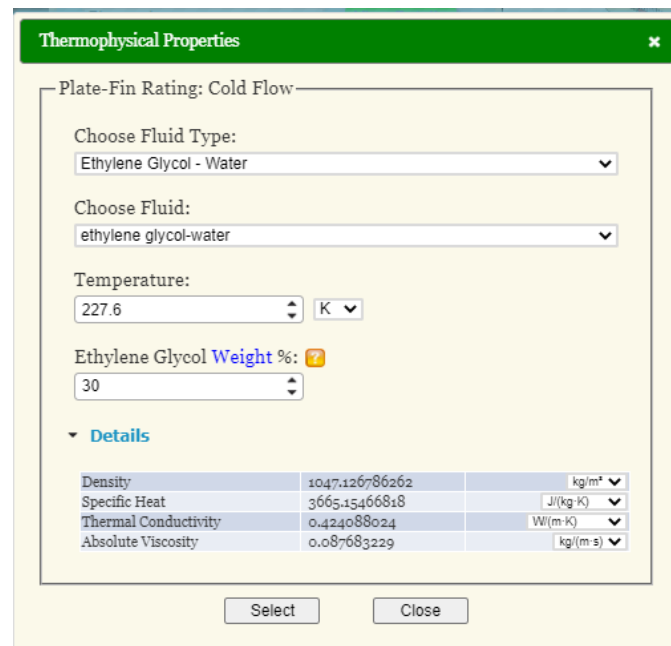
If the “**Inlet Temperature/Pressure + Fluid Properties**” option is selected, after clicking the “**OK**” button, both the fluid thermophysical properties (dynamic viscosity, specific heat at constant pressure, thermal conductivity, and density) and the fluid inlet static temperature/operating static pressure will be loaded into your project.

Addition of Ethylene Glycol/Water Mixture Properties Data (0 to 100%)

- 1) "Ethylene Glycol/Water" data has been added to the INSTED's built-in fluid properties database.
- 2) To access the **Ethylene Glycol/Water** data, simply select "Ethylene Glycol/Water" under the "Choose Fluid Type" drop-down list.



The **Ethylene Glycol/Water** data will be displayed. The ethylene glycol/water mixture properties will be calculated when you specify the values of the temperature and percentage weight (or volume) of ethylene glycol.



Note that you can click "**Weight**" or "**Volume**" (in blue text) to switch between percent weight and percent volume.

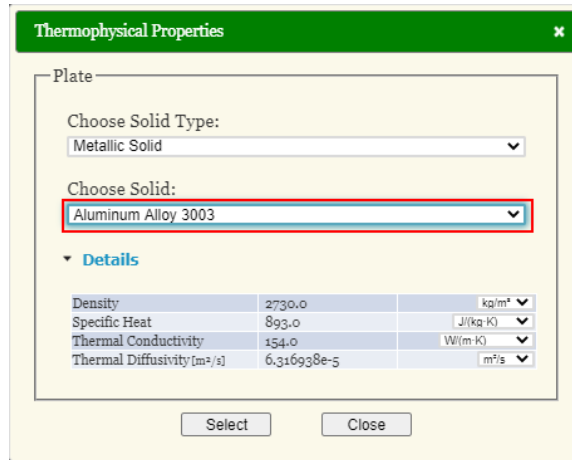
Ethylene Glycol **Weight** %: ?

click "**Weight**"
→
←
click "**Volume**"

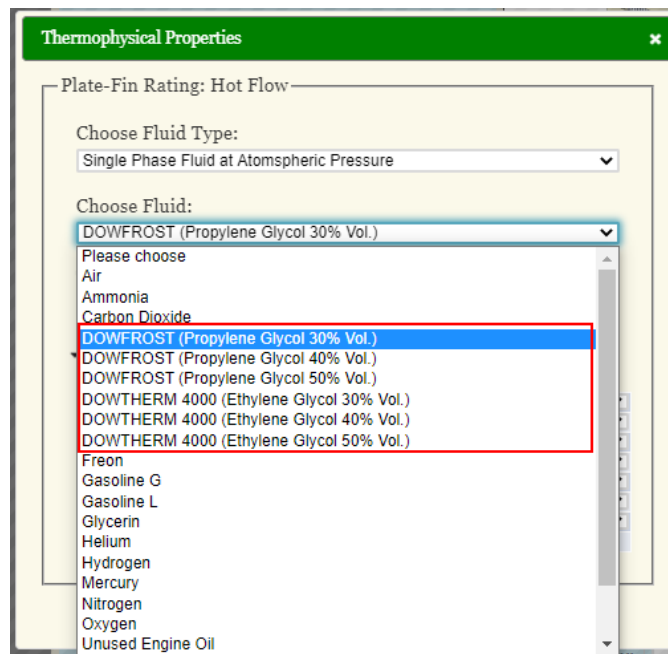
Ethylene Glycol **Volume** %: ?

More Solid/Fluid Items Added to Built-In INSTED Database

- 1) “Aluminum Alloy 3003” has been added to the built-in **solid properties database** in INSTED under the “**Metallic Solid**” category.



- 2) The following fluids have been added to the built-in **fluid properties database** in INSTED under the “**Single Phase Fluid at Atmosphere Pressure**” category:
 - DOWFROST (Propylene Glycol 30% Vol.)
 - DOWFROST (Propylene Glycol 40% Vol.)
 - DOWFROST (Propylene Glycol 50% Vol.)
 - DOWTHERM 4000 (Ethylene Glycol 30% Vol.)
 - DOWTHERM 4000 (Ethylene Glycol 40% Vol.)
 - DOWTHERM 4000 (Ethylene Glycol 50% Vol.)



Addition of Sample Custom/Variable Fluids Data

- 1) In the current version of INSTED, a collection of **sample custom/variable fluid** data has been added, so you can copy them into your account to use in your project.
- 2) The “**sample custom/variable fluid**” data can be accessed by clicking on the “**Custom Fluid Properties**” on the menu panel.

Start Page x Custom Fluid Properties x

Custom Fluid Properties:

Existing custom fluid data:

Choose a data for details: -- Please Select --

Details (Excel) Details (XML) Delete

Upload a new custom fluid data:

Choose File Format: Excel

Choose a File to Upload: Choose File No file chosen

Upload Excel File ?

Download template file: [single phase, two phase](#) ?

Copy sample custom fluid data:

Choose a Sample Data: Ethylene Glycol / Water (30/70 Vol.)

Copy Sample Data

- 3) To copy a sample custom fluid data into your account, choose a fluid in the “**Choose a Sample Data**” drop-down list and then click the “**Copy Sample Data**” button. After the data has been successfully copied, the sample custom fluid properties will become available to use in the **Rating** task.

VII. Fluid Properties: ?

★ Hot Fluid Properties:

Fixed Variable/Custom REFPROP

Choose Hot Fluid: Select

★ Cold Fluid Properties:

Fixed Variable/Custom REFPROP

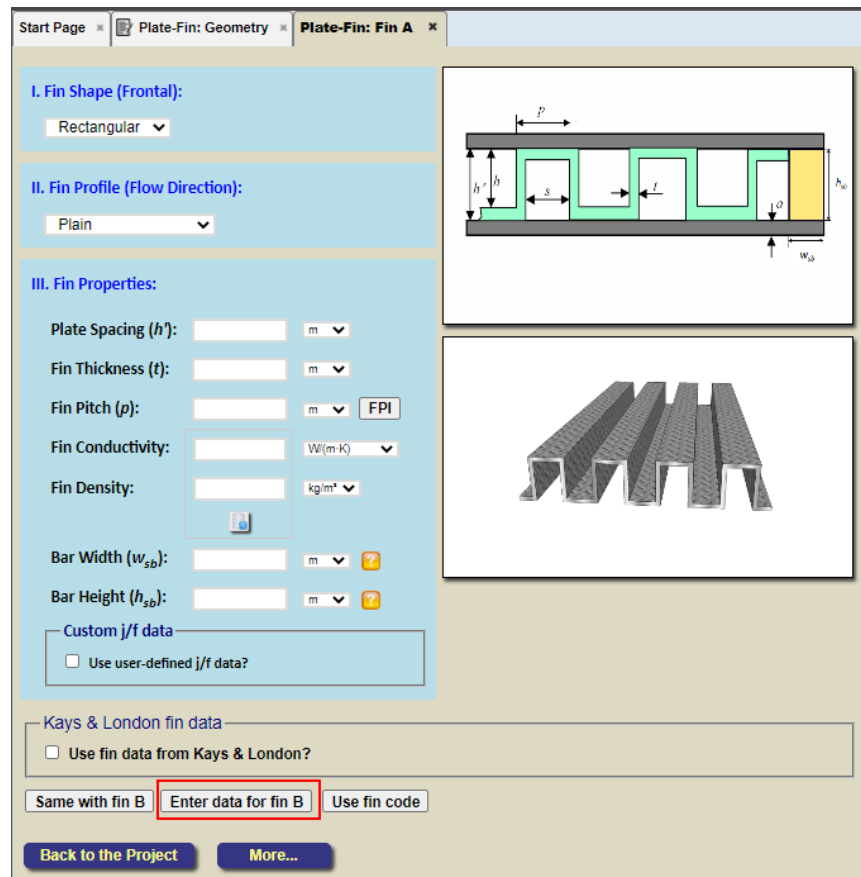
(Sample) Air 288-378K

Ethylene Glycol / Water (30/70 Vol.)

- 4) The following sample custom fluids have been added:
 - Ethylene Glycol/Water (30/70 Vol.)
 - Ethylene Glycol/Water (40/60 Vol.)
 - Ethylene Glycol/Water (50/50 Vol.)
 - Ethylene Glycol/Water (60/40 Vol.)
 - Ethylene Glycol/Water (70/30 Vol.)
 - DOWFROST (Propylene Glycol 30% Vol.)
 - DOWFROST (Propylene Glycol 40% Vol.)
 - DOWFROST (Propylene Glycol 50% Vol.)
 - DOWTHERM 4000 (Ethylene Glycol 30% Vol.)
 - DOWTHERM 4000 (Ethylene Glycol 40% Vol.)
 - DOWTHERM 4000 (Ethylene Glycol 50% Vol.)

Improvements to the Graphics User Interface (GUI) Design

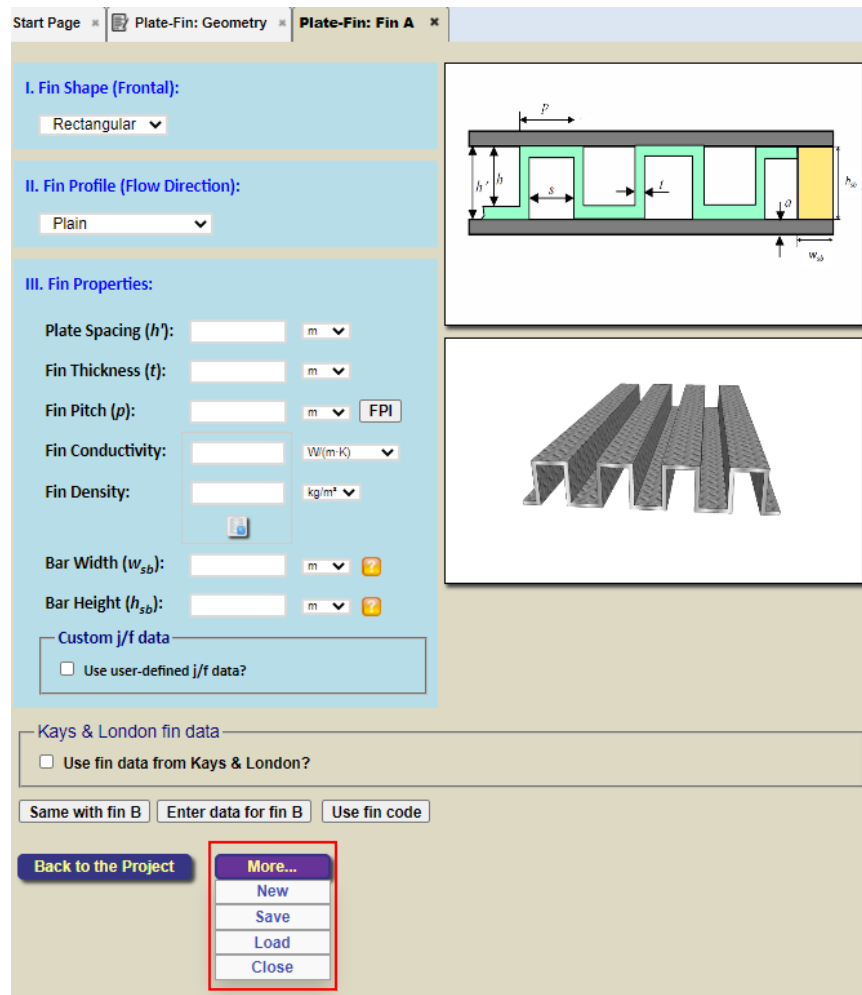
- 1) Quick access buttons have been added to allow you to enter fin data for flow B directly from the tab for Fin-A.
 - In previous versions of INSTED, when you complete the entering of the data for Fin-A and want to proceed to enter the data for Fin-B, you have to return to the main heat exchanger geometry project tab and click on the “Enter Fin Data for Flow B” button. In the current version of INSTED, the “Enter data for fin B” button has been added to the tab for Fin-A. You can be directed to the tab for Fin-B by clicking the button.



- Similarly, the “Enter data for fin A” button has also been added to the tab for Fin-B, which directly takes you to the tab for Fin-A.

2) Quick access menu buttons have been added to allow you to directly save your project in sub-tabs.

- In previous versions of INSTED, when you complete the input of the data for Fin-A or Fin-B, and want to save the project, you have to return to the tab for the main heat exchanger geometry project and then click the “Save” button. In the current version of INSTED, the “More ...” button has been added to all sub-tabs (such as the tabs for Fin-A and Fin-B in the heat exchanger geometry task). If you hover the mouse over the More... button, a drop-down menu will be displayed to allow you to directly manage (New or Save As, Save, Load, and Close) the project.



- Note that the menu buttons “New/Save/Load/Close” have the same functions as those in the main heat exchanger geometry tab.



3) The fin geometry illustration figure for offset-strip fin has been updated

The updated figure can be found below inside the box with edges shown in red ink

The screenshot displays the 'Plate-Fin: Fin A' configuration window. It is divided into three main sections:

- I. Fin Shape (Frontal):** A dropdown menu is set to 'Rectangular'.
- II. Fin Profile (Flow Direction):** A dropdown menu is set to 'Offset-Strip'.
- III. Fin Properties:** This section contains several input fields:
 - Plate Spacing (h): [] m
 - Fin Thickness (t): [] m
 - Fin Pitch (p): [] m FPI
 - Fin Offset Pitch: 0.0 m
 - Fin Conductivity: [] W(m·K)
 - Fin Density: [] kg/m³
 - Bar Width (w_{sb}): [] m
 - Bar Height (h_{sb}): [] m

Below these sections are checkboxes for 'Custom j/f data' (with 'Use user-defined j/f data?' unchecked) and 'Kays & London fin data' (with 'Use fin data from Kays & London?' unchecked). At the bottom, there are buttons for 'Same with fin B', 'Enter data for fin B', 'Use fin code', 'Back to the Project', and 'More...'. On the right side, two diagrams illustrate the fin geometry. The top diagram is a 2D cross-section showing dimensions p , h , s , t , h_c , and w_{sb} . The bottom diagram, highlighted with a red border, is a 3D perspective view showing 'Lance Offset', 'Cut Off Length', 'Flow Length (EASY WAY)', 'Lance Length', 'Fin Height', 'Fin Thickness', and 'Fin Pitch', with the formula $FPI = 1 / FIN PITCH$.

4) The fin geometry illustration figure for herringbone fin has been updated

The updated figure can be found below inside the box with edges shown in red ink

The screenshot displays the 'Plate-Fin: Geometry' software interface. On the left, there are three sections for configuration:

- I. Fin Shape (Frontal):** Set to 'Rectangular'.
- II. Fin Profile (Flow Direction):** Set to 'Herringbone/Wavy'.
- III. Fin Properties:** Includes input fields for Plate Spacing (h'), Fin Thickness (t), Fin Pitch (p), Wavelength (λ), Wave Amplitude (A), Fin Conductivity, and Fin Density. It also has dropdown menus for units (m, kg/m³, W/(m·K)) and a checkbox for 'Use user-defined j/f data?'. Below this are sections for 'Kays & London fin data' and 'Same with fin B'.

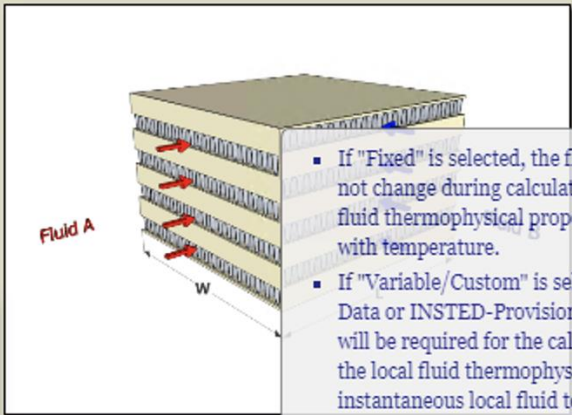
On the right, there are two diagrams:

- The top diagram shows a cross-section of a rectangular fin with parameters h' , h , s , l , h_s , and w_{sb} .
- The bottom diagram, highlighted with a red border, shows a herringbone fin profile with parameters: Radius, Wave Amplitude, Cold Flow Length (Side Width), Wave Pitch, Fin Height, One Fin = $1/p$, Fin Pitch, Cut-Off Length (Cold Flow Length), and Fin Thickness. The flow direction is also indicated.

At the bottom of the interface are buttons for 'Back to the Project' and 'More...'.

Addition of More On-Screen Help/Tips

- 1) Tips have been added to explain the three options you have when specifying fluid properties in INSTED/Plate-Fin: Fixed, Custom/Variable, and REFPROP.



Fluid A

w

VII. Fluid Properties: ?

★ **Hot Fluid Properties:**

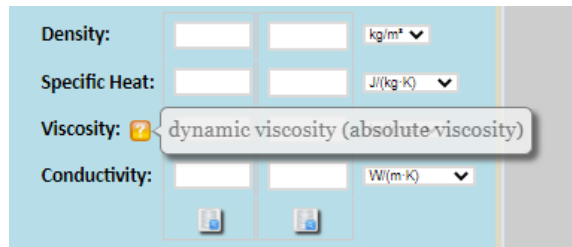
Fixed Variable/Custom/REFPROP

★ **Cold Fluid Properties:**

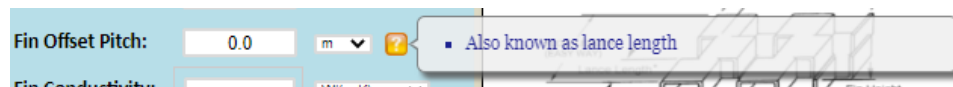
Fixed Variable/Custom/REFPROP

- If "Fixed" is selected, the fluid thermophysical properties will not change during calculation. Use this option only if the fluid thermophysical properties do not vary significantly with temperature.
- If "Variable/Custom" is selected, User-Defined Custom Fluid Data or INSTED-Provisioned Sample Variable Property Data will be required for the calculations. INSTED will determine the local fluid thermophysical properties based on the instantaneous local fluid temperature. Use this option if the thermophysical properties in a stream vary significantly with temperature, and you can provide the correct property data.
- If "REFPROP" is chosen, the NIST REFPROP database will be used to obtain local, temperature-dependent thermophysical properties during calculation.
- If the "Two-Phase" calculation option is enabled, the option of "Fixed" fluid properties becomes invalid. Use the "Variable/Custom" option for two-phase custom fluids or simply use REFPROP if the fluid is available in this database.
- Avoid using "REFPROP" fluid for the Sizing or Optimization tasks, since REFPROP leads to high computational expense for these tasks.

2) Tips have been added to clarify the term “Viscosity”



3) Tips have been added to clarify the term “Offset Pitch” for the offset-strip fin

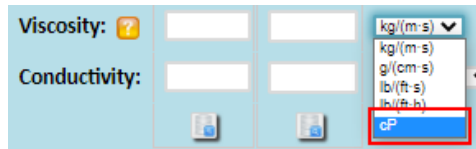


4) Tips have been added to clarify the term “Wavelength” for the herringbone fin

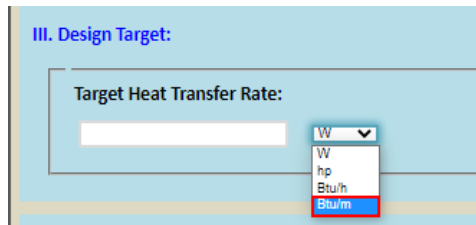


Additions of More Unit Items

- 1) The unit “cP” (centipoise) has been added to the drop-down list of units for dynamic viscosity



- 2) The unit “Btu/m” (Btu per minute) has been added to the drop-down list of units for power



- 3) The unit “mm” (millimeter) has been added to the drop-down list of units for length

