

Release Notes

Cold Plate Version

INSTED Ver. 11.2



TTC TECHNOLOGIES, INC.

November 13, 2019

Release Features

INSTED Ver. 11.2

The latest version of INSTED (Ver. 11.2) includes the following enhancements, changes, and bug fixes to the Cold Plate module.

Resolved Issues in the Cold-Plate Module

- Fin Efficiency Output Error** In the previous version of the Cold Plate module, there was a bug in which the fin efficiency was incorrectly reported for fin efficiency in the Rating calculation results. As the screen below shows, a very small number was incorrectly reported **when custom j/f data is used**. This was an I/O (display) error that did not affect the accuracy of the calculations. This issue has been fixed in the current version of INSTED.

| | | |
|--------------------------|---------------|-----|
| Fin Shape: | rectangular | |
| Fin Profile: | herringbone | |
| Fin Efficiency (Top): | 2.288706e-179 | |
| Fin Efficiency (Bottom): | 2.288706e-179 | |
| Plate Spacing: | 0.00381 | m ▼ |
| Fin Pitch: | 0.00254 | m ▼ |

- Error in Wall Inner-Surface Temperature** In the previous version of the Cold Plate module, there was a bug which is related to the inner/outer plate temperatures reported in the Rating calculation results. The bug causes the temperature on the solid surface in contact with the coolant to have values which were too close to the temperature of the coolant (for the prevailing heat transfer coefficient), **when a constant heat flux boundary condition** is specified on the outer surface of the plate. In some cases, this inner plate-surface temperature was lower than the coolant temperature, which is not physical. This issue has been resolved in the current version of INSTED. Note that the bug only existed when a constant heat flux boundary condition is specified. The plots shown below illustrate the changes in the plate temperature after the issue has been resolved. The calculations shown are based on the experiments conducted by Boeing; the INSTED results are compared with both experimental data and the results of hand calculation. The INSTED results are reported for the two cases of bulk and discrete models.

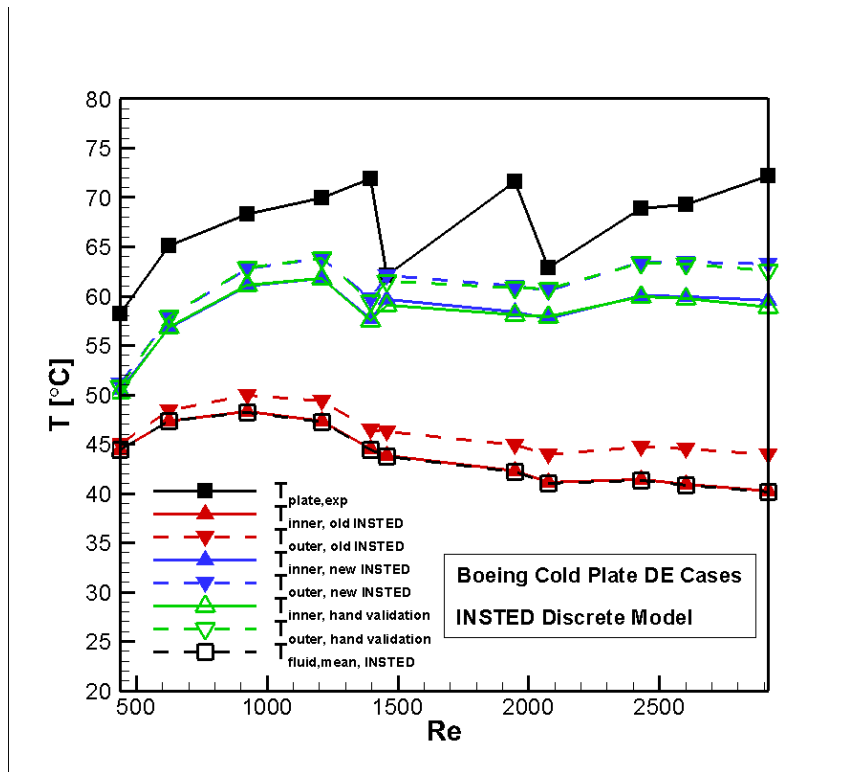


Figure 1 Comparison of Cold Plate Results (Discrete Calculation Model in INSTED)

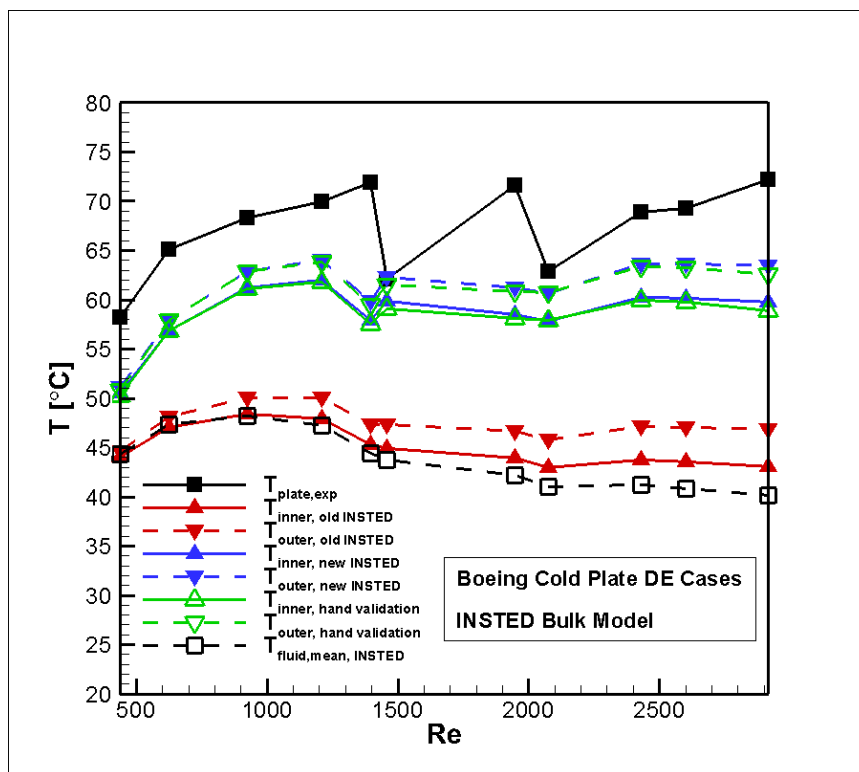


Figure 2 Comparison of Cold Plate Results (Bulk Calculation Model in INSTED)

Enhancements to the Cold-Plate Module

The following enhancements have been made to the Cold Plate module of INSTED.

- More Rating data have been added to the downloadable Excel spreadsheet from INSTED/Cold Plate. These include the following:
 - “column AM” - unfinned heat transfer surface area on the top plate
 - “column AN” - unfinned heat transfer surface area on the bottom plate
 - “column AO” - total heat transfer surface area
 - “column AP” - total effective heat transfer surface area on the top plate
 - “column AW” - mean internal flow temperature
 - “column BB” - internal flow mass flux
 - “column BC” - internal flow mean velocity
 - “column BG” - internal flow heat transfer coefficient
 - “column BH” - fin efficiency regarding to the top plate
 - “column BI” - fin efficiency regarding to the bottom plate
 - “column BJ” - Colburn j factor
 - “column BK” - fanning friction f factor

| AK | AL | AM | AN | AO | AP | AQ | AR | AS | AT | AU | AV |
|-------------------------|-------------------|-------------------|--------------------|-------------------|-------------------|-------------------------|----------------------|-----------|-----------|------------|-----------|
| Fin Design Input | | | | | | | | | | | |
| A_c | A_{fin} | $A_{unfin,top}$ | $A_{unfin,bottom}$ | A_t | $A_{c,eff}$ | k_{fin} | ρ_{fin} | T_{out} | T_{avg} | Δp | x_{out} |
| [m ²] | [m ²] | [m ²] | [m ²] | [m ²] | [m ²] | [W/(m ² *K)] | [kg/m ³] | [K] | [K] | [Pa] | [-] |
| 1E-04 | 0.02944 | 0.01426 | 0.01426 | 0.05796 | 0.0286 | 14.9 | 8000 | 351.4 | 324.8 | 2763 | |

| BA | BB | BC | BD | BE | BF | BG | BH | BI | BJ | BK | BL |
|--|--------------------------|-----------|------|------|-------|-------------------------|------------------|---------------------|-------|-------|-------|
| Cold Plate Rating Performance Outputs | | | | | | | | | | | |
| Internal Flow | | | | | | | | | | | |
| k_{mean} | G | V_{avg} | Re | Pr | Nu | h | $\eta_{fin,top}$ | $\eta_{fin,bottom}$ | f | j | Pow |
| [W/(m ² *K)] | [kg/(s*m ²)] | [m/s] | [-] | [-] | [-] | [W/(m ² *K)] | [%] | [%] | [-] | [-] | [W] |
| 0.648 | 565.587 | 0.574 | 1365 | 3.26 | 21.71 | 11542.6 | 0.305 | 0.305 | 0.011 | 0.035 | 1586 |