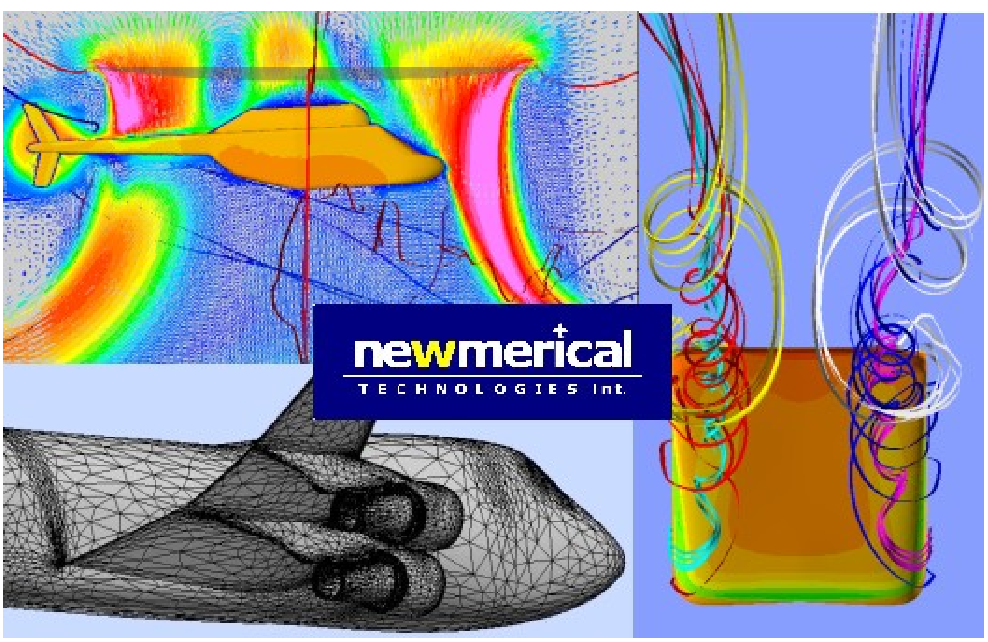
RELEASE NOTES

FENSAP-ICE
(FENSAP, DROP3D, ICE3D, CHT3D/C3D)

VERSION 2011 RELEASE 1.1



ANTIice

NEWMERICAL TECHNOLOGIES INTERNATIONAL (NTI)

680 Sherbrooke Street West, Suite 723
Montreal, QC, Canada H3A 2M7

Tel. +1 (514) 398-7314
Fax +1 (514) 398-8454

www.newmerical.com

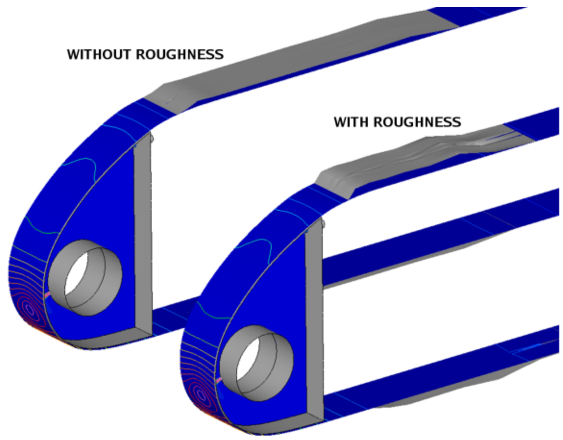
SUPPORT

Tel. +1 (514) 398-7314
(9 am to 5 pm EDT, Monday to Friday)
Email: support@newmerical.com

About the current release of FENSAP-ICE

NEW: CHT3D WITH ROUGHNESS

This release introduces: ***CHT3D with roughness for the external flow domain*** for an even more realistic simulation of ice accretion after CHT3D.

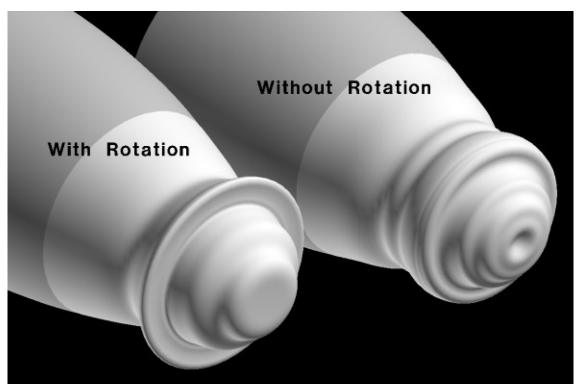


This new feature is activated by selecting the full Navier-Stokes option for the external flow domain in CHT3D. Roughness is imposed only in regions where the anti-icing heat fluxes are not sufficient to keep the surface ice-free. Other regions remain smooth.

The ice growth for the required time is computed with ICE3D after the CHT3D solution has been obtained. The shear stresses and heat fluxes can be transferred automatically from the CHT3D solution to ICE3D with a single drag & drop operation and all the input that is required is the length of time for the ice accretion simulation.

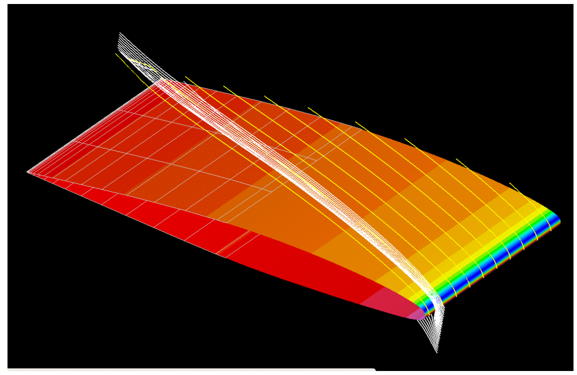
NEW: ICE ACCRETION ON ROTATING SPINNERS AND ENGINE CENTER CONES

This release features a new capability: ***Ice accretion on rotating spinners and engine center cones.***



A rotational velocity can be imposed on surfaces of revolutions, such as spinners and center cones. The GUI automatically determines the centerline of the rotating surface, which may be aligned in any arbitrary direction with respect to the coordinate axes, as well as the incoming airflow. The tangential velocities on the spinner surface are imposed automatically. The shear stresses, heat fluxes and impingement coefficients are then averaged circumferentially on the rotating surface by ICE3D to provide correct simulations when the incoming airflow/droplet stream is not aligned with the axis of rotation.

NEW: 3D LINEAR PERIODICITY FOR THE SIMULATION OF INFINITE SWPT WINGS



This release features a new capability: ***3D linear periodicity for the simulation of infinite swept wings.***

All codes, including CHT3D, now support 3D linear periodicity. This is a more general way of imposing periodicity on a fully 3D wing stub to simulate an infinite swept wing. This feature has been introduced to alleviate the cost of CHT analysis during the initial wing design process by eliminating the need for the full external 3D aircraft solution and a piccolo tube section with many rows of holes, greatly reducing the mesh generation and solution cost. The piccolo tube section only requires one set of the repeating hole pattern. The periodicity is detected automatically; only the flow angle, corrected for induced angle of attack, is required.

FENSAP-ICE remains *"the only truly 3D" in-flight icing simulation system*, trailed by other 2 1/2-D and 2-D codes.

In addition to covering ***Appendix C***, FENSAP-ICE also addresses the upcoming ***Appendix D*** and ***Appendix O*** of the FAA certification guidelines through its ***Ice Crystals*** and ***SLD capabilities***.

Release notes for FENSAP:

1. Steady-state simulation of rotating surfaces of revolution, such as propeller spinners and engine center cones, is now supported to permit ice growth and CHT3D simulations on these components. The GUI automatically determines the centerline of the rotating surface, which may be aligned in any arbitrary direction with respect to the coordinate axes, as well as the incoming airflow. The tangential velocity at each point of the surface grid of the rotating component is automatically computed by FENSAP using the distance from the centerline. There are no limits on the number of rotating surfaces.

Release notes for DROP3D:

1. DROP3D now also supports rotating surfaces of revolution, such as propeller spinners and engine center cones for ice growth and CHT simulations. There are no limits on the number of rotating surfaces.

2. In SLD mode with break-up enabled, the droplet diameter can be specified at inlets with user-defined spatial algebraic expressions. In the case of a Langmuir-type distribution of droplet sizes, this distribution is scaled for each of the DROP3D runs in accordance with the diameter ratios of the droplet distribution. This feature also allows restarts from previous solutions, but with a different inlet diameter distribution.

3. DROP3D fully supports linear periodicity for the simulation of ice accretion on 3D infinite swept wings.

Release notes for ICE3D:

1. ICE3D is now capable of simulating ice accretion on rotating surfaces of revolution, such as spinners and engine center cones. Shear stresses, heat fluxes and impingement coefficients are averaged circumferentially on the rotating surface to provide correct simulations when the incoming airflow/droplet stream is not aligned with the axis of rotation. Furthermore, body forces are taken into account in the water film transport equation. There are no limits on the number of rotating surfaces.

Release notes for CHT3D/C3D:

1. CHT3D for anti-icing applications now allows the inclusion of ice roughness for more accurate simulation of ice growth in regions where the anti-icing heat fluxes are too weak to prevent ice from forming. Other regions will remain smooth. This feature requires the selection of the full Navier-Stokes option for the external flow calculation, since both the heat fluxes and shear stresses will be affected. The ice shape produced when running ICE3D after CHT3D are generally thicker than for uniformly smooth surfaces, as expected.

2. CHT3D-FLUENT with the k-ε turbulence model also supports the imposition of ice roughness for more accurate calculation of ice shapes with ICE3D after CHT3D.

3. CHT3D fully supports 3D linear periodicity to simulate anti-icing on infinite swept wings for the preliminary analysis of hot-air and electro-thermal IPS performance for swept-wing applications. This feature greatly reduces the complexity of the problem and the calculation time with a small loss of accuracy and is appropriate for the initial stages of IPS design.

4. C3D now supports full restarts from previous solutions.

Release notes for the FENSAP-ICE GUI:

1. Introduction of the framework required for the specification of roughness in CHT3D with the full Navier-Stokes option.

2. Introduction of the framework required to specify a rotational velocity for surfaces of revolution, such as propeller spinners and engine center cones. Multiple spinners are supported. The GUI automatically determines the location of the centerline of the rotating component.

Release notes for the FENSAP-ICE converters:

1. **nti2tecplot**:
    a. Support for larger grids in ASCII format.
    b. Support for the latest DROP3D file formats.
    c. Introduction of the "-bound" command line flag to export boundaries only (no volume data) and speed up visualization of surface data for large grids.
    d. Introduction of the "-mini" command line flag, in SOLN mode, to export only the density, velocity components, pressure and temperature.

2. **convertgrid**:
    a. grid transformation options (rotation/translation/scaling).
    b. periodic rotational auto-detection.

3. **soln2soln**:
    a. speed-up using multi-threads (LINUX only).