swift

AVL SWIFT Virtual De-Icing Test Bed

Vehicle de-icing performance must meet standards applied in the countries where the vehicle is commercialized. The main standards are published respectively by the European Union and the USA.

For a typical test the vehicle is put into a cold, originally isothermal (around -18°C). Test-bed chamber and a homogeneous ice film is formed on the windscreen. The engine is started and the warming air is blown to the passenger compartment via the de-icing air ducts. Proper de-icing occurs if the standard windscreen reference views are defrosted within a certain amount of time.

AVL SWIFT v3.1 now offers a fully integrated virtual de-icing test bed platform. Not only are the unsteady physical processes taking place during a de-icing experiment simulated, but also the European and US Standard constraints are parameterized and their requirements checked during the calculation. This results in a streamlined user environment producing repeatable and accurate predictions.

Physical Modeling
Simulation of the cabin air flow profits from SWIFT's turbulence modeling features - such as the Hybrid Turbulence Model and the Reynolds Stress Model. The Thin Walls module enables modeling of the solid thermal inertia of regions such as the windscreen, the side windows and the roof. Each wall may be modeled as a multi-layer composite wall where the transient 1D normal heat conduction takes place.
These walls exchange heat with the internal air by way of convection and with the test bed chamber – considered as the external environment - by way of convection and/or radiation.

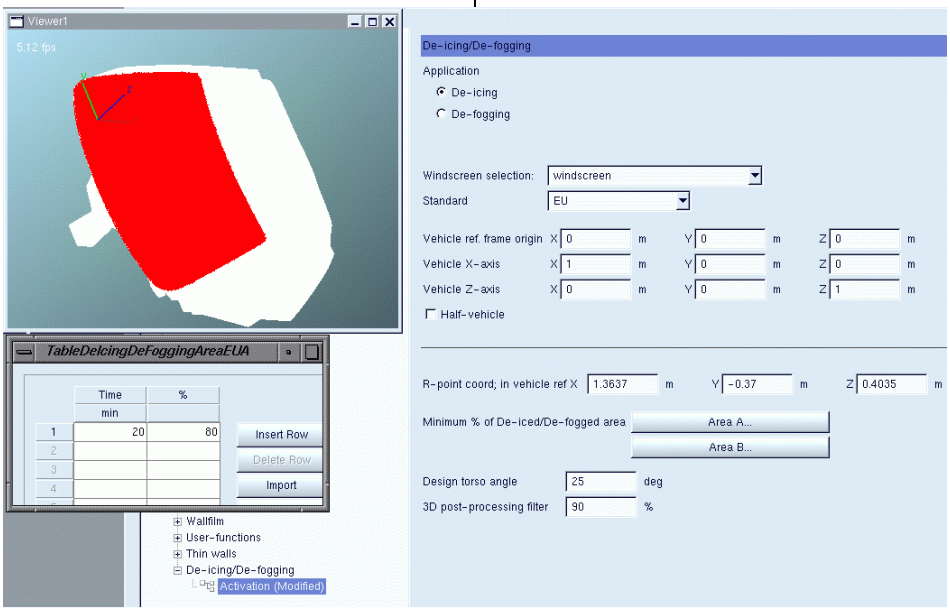

Figure 1: Easy specification of de-icing standards in the CFD Workflow Manager.

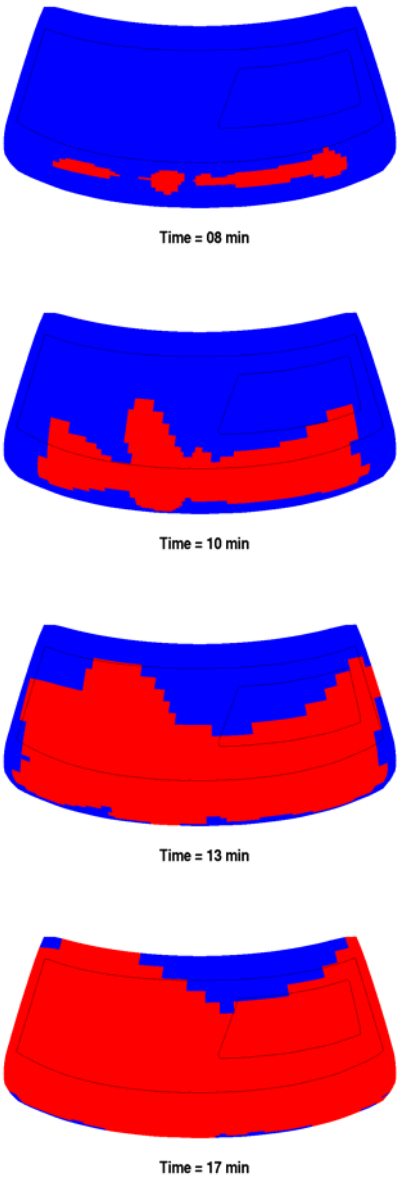

Figure 2: Evolution in time of the windscreen de-iced regions (in red). In black: limits of European reference views A and B.

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This solid heat conduction model does not require any mesh generation and demands only low CPU and memory consumption.
The ice film is modeled on the outer side of the windscreen and melts as heat is transferred through the windscreen.

the solver to compute windscreen reference views. The specification of the Standard qualification constraints - for example the European driver reference view A should be defrosted at 80% below 20min - allows to check whether de-icing performance is suitable or not. Of course the de-icing process of other passenger compartment parts, such as the side windows, can be simulated.

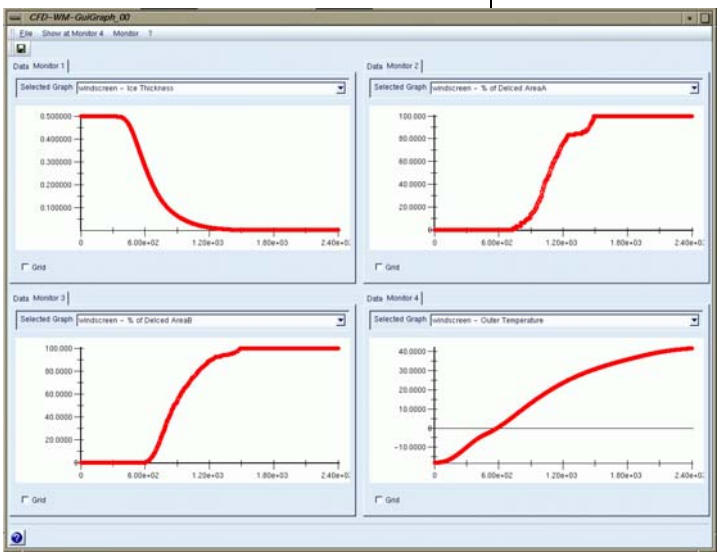

Figure 3: Time history of windscreen mean ice thickness [mm], percentage of de-iced European reference views A and B, mean external side windscreen temperature [°C]

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************************************************************
*                  DE-ICING SUMMARY                        *
*                  EU STANDARD                             *
************************************************************

  Current Time: 25 min, 0.0 sec

  Area A: 100.0 % De-Iced
  Area B: 100.0 % De-Iced

*----------------------------------------------------------*
* VALIDATION PROCESS                                       *
*----------------------------------------------------------*

----   AREA A:  -----
CRITERION 1 (80.0%) Reached in 13.2 min (20.0 min Required) :: SUCCESSFUL

----   AREA B:  -----
CRITERION 1 (95.0%) Reached in 17.2 min (40.0 min Required) :: SUCCESSFUL
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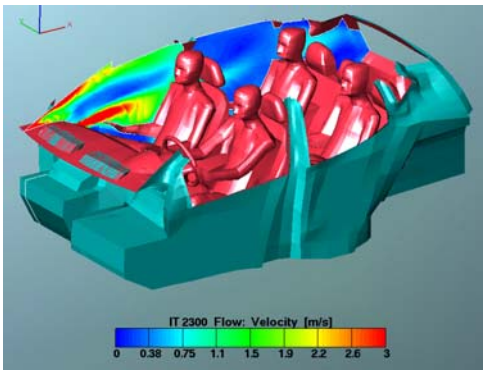
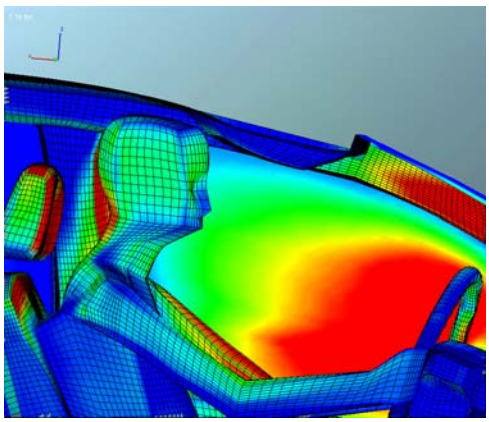
Figure 4: Example of de-icing summary output file.

Post-processing
The AVL IMPRESS post-processor enables engineers to accurately analyze specific results of the de-icing experiment, such as spatial distribution of heat transfer, ice thickness or de-iced regions (Fig. 2); the 2D Results tool can monitor the time history of the percentage of de-iced reference views (Fig. 3).
Furthermore, the status of the satisfaction criteria is made available (Fig. 4).

De-icing simulations can be run on serial or parallel computers, the latter using MPI technology.





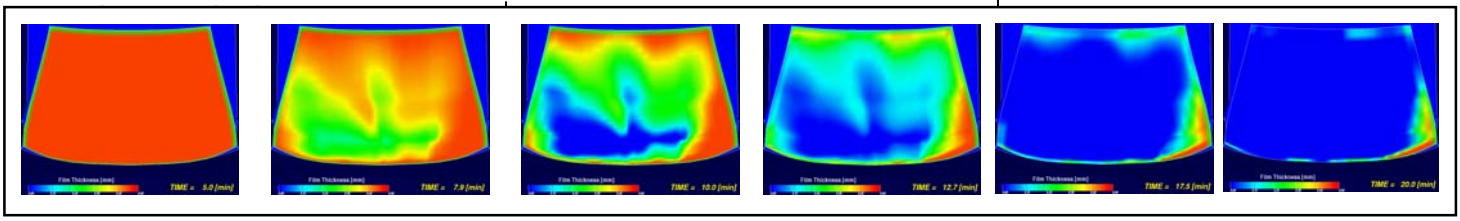


Figure 5: Sequence of reduction of ice-thickness

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