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V2 – What's New in PHOENICS 2025

Introduction

The latest version of PHOENICS is here: PHOENICS 2025 version 1.0. It brings with it additions and improvements to the VR-Editor, VR-Viewer, the Earth Solver and also to USP. These updates provide expanded physical modelling capabilities, improved usability, and bring USP closer to leaving beta-status, as well as corrections and fixes across PHOENICS. Some features are highlighted below, for the full list please see TR006 – What's New in PHOENICS.

Earth Solver

PHOENICS now provides access to the Spalart-Allmaras one-equation turbulence model. Designed for aerodynamic and wall-bounded flow simulations, the model is offered in both high- and low-Reynolds-number forms. It is compatible with Cartesian, polar, and body-fitted coordinate meshes and works with both SPARSOL and PARSOL. Although originally developed for external aerodynamic flows, the SA model offers a good balance of accuracy and computational efficiency across a wide range of applications. Example cases are included in the PHOENICS Input Library, and a complete technical description is available in POLIS.

The Volume of Fluid method now supports a two-phase evaporation, boiling, and condensation mechanism. The implementation distinguishes between film and bulk boiling through separate evaporation rate formulations. The model uses a non-conservative form of the VOF equation, assumes incompressible fluids, and includes a revised energy equation formulation to account for latent heat effects.

The VOF method also receives an additional surface tension model, "second-order-in-temperature", to addresses cases where a linear relationship between temperature and surface tension is insufficient. VOF may benefit from this in simulations involving thermo-capillary or Marangoni forces.

PHOENICS' Non-Newtonian fluid modelling capabilities have been extended with a modified power-law viscosity, which was used to model for turbulent pipe flow of a pseudo-plastic fluid.

VR-Editor & VR-Viewer

The VR-Editor now has two new options for specifying turbulence boundary conditions at inlets: In addition to the two existing modes, 'Intensity + Auto Length Scale' and 'User Set', two new types are now available: 'Intensity + Viscosity Ratio' and 'Intensity + Length Scale'. The new 'Viscosity Ratio' approach calculates inlet conditions based on turbulence intensity and the ratio of turbulent to laminar viscosity, and the new 'Length Scale' option allows the user to specify the Prandtl's mixing length directly in conjunction with turbulence intensity.

To facilitate before and after comparisons and scenario testing, a new toggle switch has been added to the Object Specification dialog. This feature allows users to deactivate objects without removing

them or altering their type, preventing any unwanted impact on the computational grid and simplifying workflow during testing and setup.

Amongst others, conveniences added include line plotting at cell centres along constant I, J, or K directions, access to storage of quantities such as the dynamic turbulent viscosity, or additional output from body force integration.

Unstructured PHOENICS (USP) (beta)

Work on USP has continued and it receives several expansions to it capabilities.

USP takes the standard PHOENICS Cartesian grid and adds levels of grid refinement close to items of interest. Users can now view the USP grid in the VR-Editor, with a new toggle option added under the Mesh menu to switch between the USP and original Cartesian grids. This addition should facilitate grid set up.

USP's grid is generated by a special utility called USPGRID, which has been reworked significantly: from changes to data structures, over updates to algorithms, to data output to support new features. Additionally, to improve geometric flexibility support for Angled-Ins and Angled-Outs has been added to USP.

Lastly, but not least, USP can now run Hydrodynamics simulations in parallel thanks to an expansion of the code as well as the new PAR_USP tool, which partitions the USP mesh for parallel execution.

USP is under development and is still in "beta" status i.e. it still contains some bugs and issues.

Fixes

In addition to the above highlighted features, PHOENICS has also received numerous improvements and corrections. These range from extended multi-byte character support, over upgrades to FLAIR e.g. the option to include humidity in the calculation of mixture density, upgrades to plotting cut-cells and double-cut cells, to improvements to robustness thanks to updated solver settings and boundary treatments for IMMERSOL or the turbulence generation tern, to name a few.

For the full list of additions and corrections please see TR006 – What's New in PHOENICS.