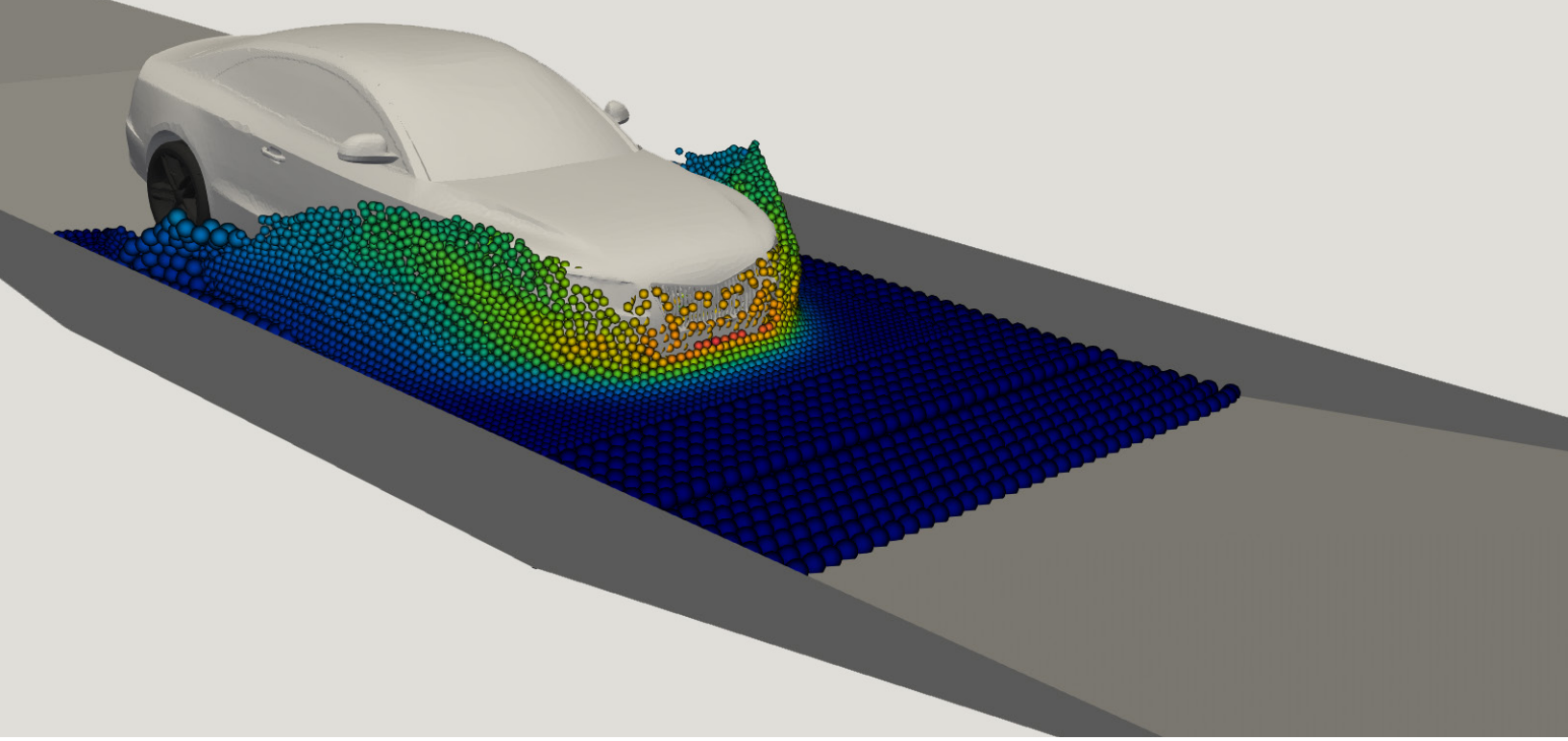


SIEMENS DIGITAL INDUSTRIES SOFTWARE

Simcenter SPH Flow

Smoothed-particle hydrodynamics solver for complex CFD simulation

Benefits

- Eliminates meshing-related constraints of traditional approaches
- Solves dynamic flows with complex interfaces
- Eliminates complex meshing and boundary conditions

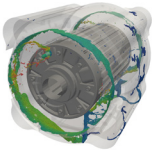
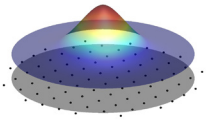
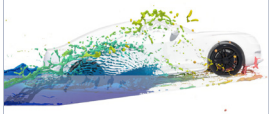
Summary

Simcenter™ SPH Flow software is one of the most advanced smoothed-particle hydrodynamics (SPH) solvers dedicated to complex computational fluid dynamics (CFD) simulation.

The SPH method is part of a new generation of numerical methods, developed to overcome meshing-related constraints with traditional approaches while still being based on the Navier-Stokes equations. Classical methods like finite volume that require volume meshing can be challenging for applications such as dynamic flows with complex interfaces, which SPH can address.

With its Lagrangian characteristic and its particle-based approach, Simcenter SPH Flow is particularly well suited for high-dynamics flows, deformable and complex boundaries and interfaces with fragmentations/reconnections, such as solid impacts, shocks, breaking waves, jets and splashes, moving parts, deformations and more.

SPH method characteristics

			
Navier-Stokes	**No meshing**	**Lagrangian**	**Free surface**
Solves the exact Navier–Stokes equations	Fluid is described by a set of interacting particles	Particles are straight-forwardly advected with the fluid flow	Fluid/fluid interfaces are inherently defined, thus naturally followed
Like the finite volumes method (but unlike the Lattice-Boltzmann method) Can be as accurate as FV and much faster	Allows very complex geometries and complex motions, including deformable bodies	Only the fluid is discretized	Represented with no diffusive interface and with no additional CPU cost

Features

Simcenter SPH Flow can solve complex applications such as complex topologies and geometries, complex free surface problems and complex physics involving fluid-structure interactions.

State-of-the-art accuracy	Advanced scheme	Riemann solver, gradient renormalization, monotonic upstream-centered scheme for conservation laws (MUSCL) reconstruction, particles shifting, arbitrary Lagrangian Eulerian (ALE), local particle refinement, implicit incompressible SPH, etc.
	Advanced boundary treatment	Ghost method, normal flux method
Extensive modeling capabilities	Various physics	Viscosity, heat transfer, surface tension, wettability, aerodynamic forcing, thermal capabilities, non-Newtonian, etc.
	Boundary conditions	Wall, inlet, outlet, periodicity, wave, porous media, etc.
	Solid body	Imposed motion, 6-DOF
	Fluid-structure interaction (FSI)	Open application programming interface (API) for coupling with any finite element analysis (FEA) code; couplers developed with various FEA solvers
Industry-relevant	Easy particle initialization	Setup in less than one hour
	Complex surface mesh capability	Tri-, quad-dominant based on IGES, STEP or STL geometry formats
	Well adapted for high-performance computing (HPC) clusters	Message passing interface (MPI) and open multi processing (OpenMP) scalable parallelization
	Convenient postprocessing	Sensor probes, chart live monitoring capabilities

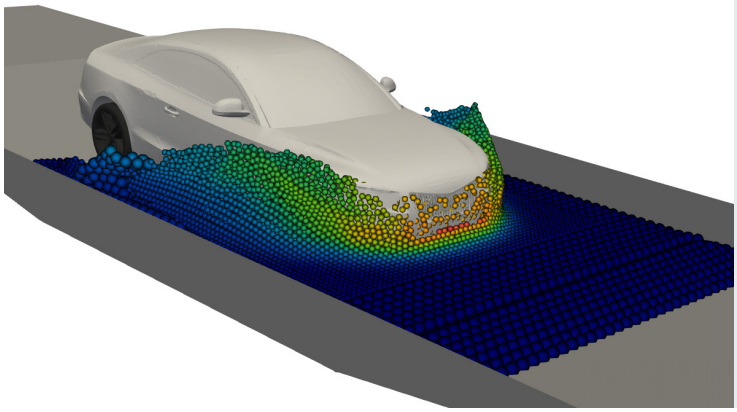
Applications

Simcenter SPH Flow can address various applications in many industrial fields and domains.

Below are some iconic example application cases.

Vehicle water wading simulation

Protect the underneath structure of the vehicle from damages due to water wading



Challenge

- High-speed fording generates high-pressure splashes that may impact the underneath structure of the vehicle. Electronics, air intake, and other areas may be sensitive to water.

Solution

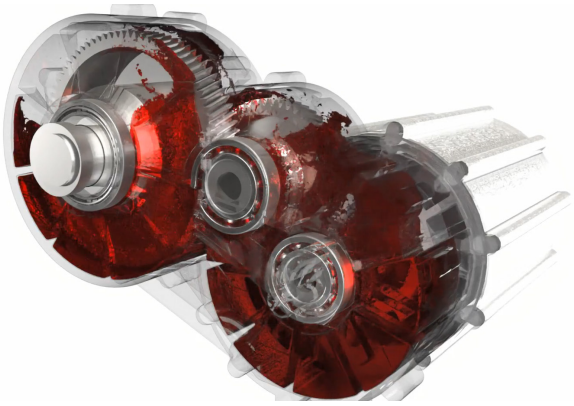
- Use Simcenter SPH Flow meshless method with Adapted Particle Refinement to correctly capture the free-surface flow, multiple splashes and water run-off and be able to trace back the water source.

Benefits

- Protect the underneath structure of the vehicle from damages.
- Identify the water sources and optimize the safety cover to protect critical parts of the car.

Gearbox simulation

Ensure optimal operation and extend life of industrial gearboxes



Challenge

- Designers want to reduce oil inside gearboxes to reduce churning losses, while ensuring oil gets to critical location.

Solution

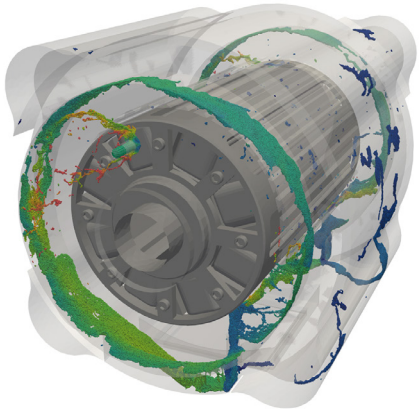
- Use Simcenter SPH Flow meshless method to easily model the high rotation and flow in-between the gears and accurately capture oil jets and splashes with no diffusive interface.

Benefits

- Fewer physical tests result in reduced cost and faster time to market.
- Reduce energy usage and extend drive range while improving reliability.

Electric motor cooling simulation

Minimize heat losses of an industrial electric motor



Challenge

- Thermal constraints result in significant limitations in how electric motors perform and affect their reliability and safe operation.

Solution

- Use Simcenter SPH Flow meshless method to accurately simulate the free surface of cooling oil jets and atomization and help optimize the cooling efficiency.

Benefits

- Reduce heat dissipated power to ensure higher efficiency and an extended life of the machine.
- Optimize the quantity of oil lubrication and reduce churning losses.

Supported platforms

Operating systems:

- Microsoft Windows 10
- Red Hat Enterprise Linux 7 and 8
- CentOS 7 and 8

Simcenter SPH Flow is fully optimized for HPC on parallel computation clusters based on MPI technology.

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