Water flow prediction

OEMs can now better anticipate tank sloshing effects and prevent water leakages in vehicles with new water flow simulation capabilities

Thanks to its new water flow module, ESI Virtual Performance Solution (VPS) enables predictive crash simulation by accounting for fluid mass and momentum influence during a crash event. This breakthrough technology, which is driving innovation forward, can also be used for testing hybrid and electric vehicles.

Since ESI conducted the very first car crash simulation via computer for Volkswagen Group in 1986, ESI's flagship VPS simulation software has evolved to meet the demanding challenges that car manufacturers face. In the development of new materials, processes and innovative technologies for lightweight and green vehicles, efficient and accurate software is required, which enables engineers to test multiple ideas on virtual prototypes in very short loops.

Eisei Higuchi, chief engineer, Honda R&D, explains, "Honda R&D has been using ESI's VPS for more than 20 years. Today we are leveraging the capacities of VPS's single-core model on a full car for our latest vehicle platform development. The consistent chaining of virtual manufacturing results and virtual performance – not only for crash and safety domains but also for NVH and durability – is a definite technological breakthrough. VPS enables us to ensure the right levels of product performance for lightweight design, and to face challenges related to evolving regulations."

The water flow module can be used to predict tank sloshing in crash scenarios

Recently, ESI's VPS introduced a breakthrough innovation in its latest version – a water flow simulation module. This new module enables engineers to predict fluid structure interaction (FSI) accurately and with minimal effort. In other words, this module is designed to represent extreme situations involving fluids such as water leakage, water jet pressure or tank sloshing. This is especially critical in a crash situation where the mass coupling and incompressible behavior of the fuel can significantly change the accuracy of the crash simulation result.

Just last month, newly established startup company

EP Tender's range-extending device for EVs. The company used ESI's software to validate the safety performance of the new trailer-mounted battery system

"The water filter on the driver window can be predicted to optimize the geometry of the car body and mirrors to ensure the driver's visibility through the side windows in heavy rain situations"

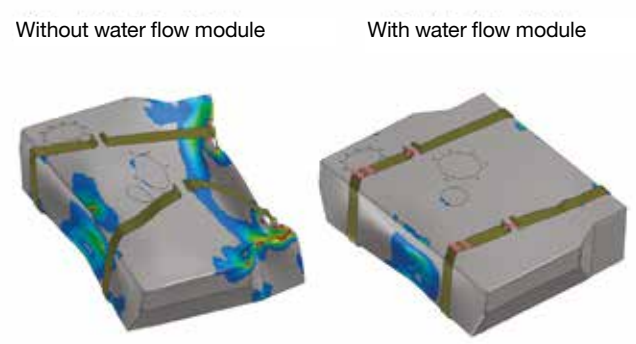
EP Tender communicated on how the new water flow simulation module was instrumental in helping it guarantee the safety of its trail-mounted electrical battery units for EVs.

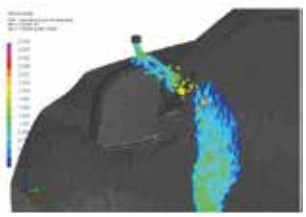
"Using VPS has enabled us to virtually validate our crash scenario for the generator's fuel tank and to demonstrate that our trailer brings more energy-absorption capacity. Integrating ESI's latest water flow module for tank sloshing in our model has been particularly efficient to accurately model the content of the tank and get more realistic results," says Jean-Baptiste Segard, founder and CEO of EP Tender.

The engineering team demonstrated the ability of the trailer to resist even the most severe rear crash configuration listed in the FMVSS 301 US regulation. As this regulation requires fuel tanks to remain sealed after a crash, the team created a specific design that included a patented structure that would preserve the generator's fuel tank by shifting it downward during an impact.

Simulation results quickly and efficiently allowed EP Tender to validate the crash scenario; the amount of energy absorbed confirmed that the newly developed trailer contributes to 30% of the energy absorption compared with a standalone vehicle.

To test the water-tightness of the tank, the team first modeled the fuel tank as an empty structure, with added mass equivalent for the fuel that it would contain – a quite common simplification for tank modeling. However, virtual simulation results demonstrated an abnormally high plastic deformation, reaching rupture limits in some areas. Therefore, ESI proposed an investigation using its new water flow module for tank sloshing based on the incompressible finite pointset method (FPM). An important advantage of FPM is that it does not require cumbersome and time-consuming meshing. The software generates and updates the point cloud used for solving CFD automatically. The user only needs to specify fluid properties and fluid level.





TOP: Analysis of tank deformation with and without ESI's water flow module. Results are much more sophisticated and detailed using the new module

ABOVE: Engineers can also use the tool to predict flow patterns of rain, which could hamper the driver's visibility when travelling in severe conditions

Simulation showed that using the water flow module in VPS provided a more realistic modeling of the fuel and considerably decreased the deformation of the tank, due to the contained incompressible fluid. Thanks to the adjustments they were able to make, with the help of VPS, they no longer reached the tank rupture limit and the team validated the tank design. EP Tender's concept successfully fulfilled the FMVSS 301 regulation. This clearly demonstrates that the accurate modeling of fluids is essential for this kind of simulation.

This new capability of water flow prediction is also used to improve seal systems' designs and prevent water leakage. VPS accounts for the complete seal system, including seal positioning, pre-stresses of the rubber, and fluid structure interaction. Engineers can now choose the best rubber material for the entire temperature range early in the development process and determine the acceptable geometrical tolerances to avoid hazardous water leakage inside the cabin.

Similarly, the water filter on the driver window can be predicted to optimize the geometry of the car body and mirrors to ensure the driver's visibility through the side windows in heavy rain situations. The droplet trajectory simulation in ESI's software also enables engineers to improve trunk designs so that no water leaks inside when opening them.

Water flow simulation is revolutionizing crash and safety testing. It is becoming essential to support new car developments, to comply with new battery safety standards, or to perform total immersion and water-covered road tests. ❮