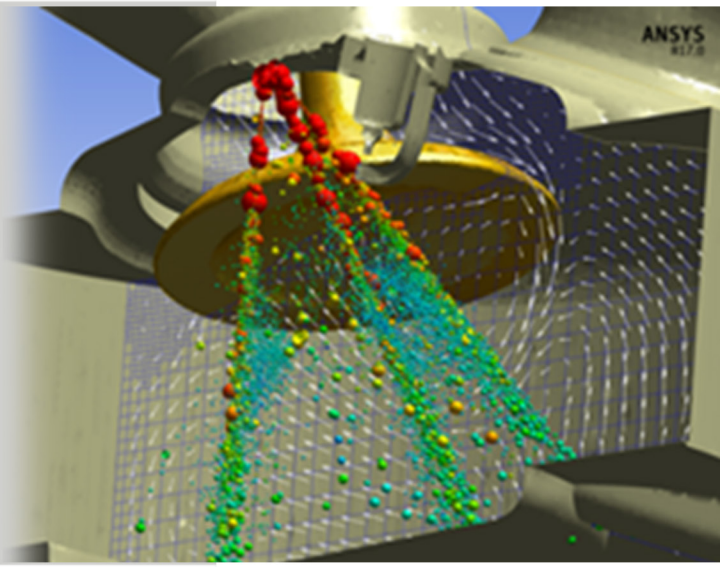
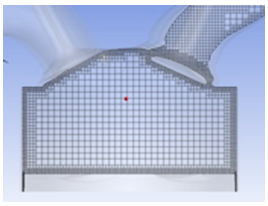
ANSYS®



Forte

ACCELERATE YOUR ENGINE COMBUSTION CFD WITH ANSYS FORTE

Accelerate your engine combustion CFD with ANSYS Forte



ANSYS Forte automatically generates the moving volume mesh on-the-fly, during the simulation

ANSYS Forte is the only CFD simulation package for internal combustion engines that incorporates proven ANSYS Chemkin-Pro solver technology – the gold standard for modeling and simulating gas phase and surface chemistry. Forte includes state-of-the-art Automatic Mesh Generation (AMG), including Solution Adaptive Mesh Refinement (SAM) and geometry-based adaptive mesh refinement (AMR). While legacy engine-combustion CFD simulations utilize chemistry solvers that are too slow to handle the chemistry details required for accurate predictions of ignition and emissions, Forte enables the use of multicomponent fuel models to combine with comprehensive spray dynamics – without sacrificing simulation time-to-solution. Forte robustly and accurately simulates IC engine combustion performance with nearly any fuel, helping engineers rapidly design cleaner burning, high-efficiency, fuel-flexible engines. Coupling Forte's robust, accurate combustion modeling capabilities with automated mesh generation enables engine designers to quickly analyze designs without the mesh generation headache.

Supported Engine Simulation applications include:

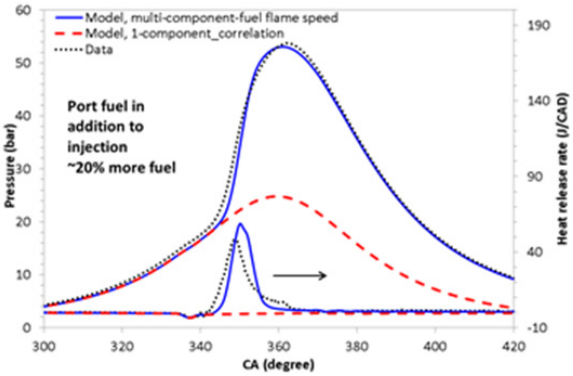
- Spark Ignition – Natural Gas, Gasoline Direct Injection & Port Injection
- Diesel – Heavy Duty, Passenger, Power Generation and Marine
- Dual Fuel (any fuel combination, multiple injections)
- Four-Stroke and Two-Stroke
- Homogeneous Charge Compression Ignition (HCCI, PCCI))

Key benefits of the FORTÉ CFD Package include:

- Automatic mesh generation that eliminates weeks of effort typically spent on manual mesh preparation
- Embedded Chemkin-Pro solver technology that provides the computational speed required for predictive engine simulations
- True multicomponent fuel-vaporization models that enable a self-consistent representation of the physical spray and the kinetics for accurate prediction of fuel effects
- Advanced spray models that dramatically reduce grid and time-step dependency when compared to existing approaches
- The ability to track soot particle formation, growth, agglomeration and oxidation without a compute-time penalty to predict particle size and number

Simulate combustion more quickly, easily and accurately

To efficiently create novel, fuel-flexible engines with improved fuel economy and lower pollutant emissions, while simultaneously reducing development costs and schedules, effective combustion simulation is a must. Other combustion CFD packages cannot model realistic fuels needed for timely and realistic predictions of combustion performance. To meet development schedules, vital chemistry information, including the fuel surrogate, is often sacrificed and replaced with empirical or severely reduced models. This approach requires the constant "calibration" of models, reliance on hardware experimentation, and the expertise of users to achieve acceptable results. Forte eliminates



ANSYS Forte results using Modern Fuel Library (blue line) closely approximate actual measurements. Compare to conventional, single-component fuel model (red line).

the "accuracy versus compute time" compromise and enables more innovation and wider exploration of new designs.

Real fuel chemistry, without the wait

Forte's embedded Chemkin-Pro solver technology gets the right answer, right on time. Now you can incorporate larger, more accurate fuel models into your simulation and achieve compute times similar to those with severely reduced, less accurate models. The Chemkin-Pro solver technology is the gold standard for use in chemical kinetic simulation and it employs a number of innovative and proprietary techniques to achieve unprecedented calculation speeds:

Dynamic Cell Clustering leverages an advanced algorithm to group those cells that have similar kinetic conditions at each time-step, eliminating duplicate calculations.

Dynamic Adaptive Chemistry automatically reduces the kinetics on the fly at every time-step; using only the necessary chemistry at a given time leads to huge savings in solution time, with no loss in accuracy.

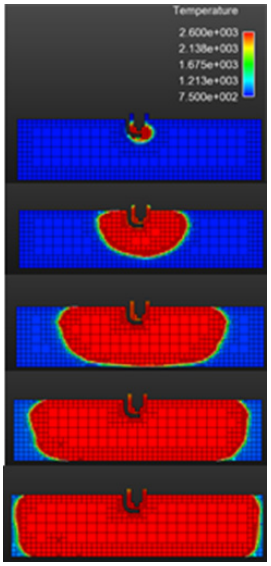
The world's best spray models

Industry-leading spray modeling options in Forte maintain consistency between the physical properties of the spray and the chemical model of the fuel. Spray model components include a nozzle flow model with cavitation effects; droplet breakup models; a gas-jet model; a droplet collision model; and a multicomponent fuel-vaporization model. These models capture both primary and secondary atomization effects for diesel and gasoline direct injections. Forte's simulation models provide more accurate spray representation without the need for drastic mesh refinement. Increased model accuracy reduces the time and effort you spend calibrating.

Modeling soot emissions and engine knock

Advanced chemistry models are proven to predict the effects of operating conditions and fuel variations on engine knock, soot emissions and particulate matter (PM) size, yet they are too complex to run in conventional CFD software.

Forte uses Chemkin-Pro solver technology to enable the use of accurate soot chemical models that track the formation, growth and agglomeration of soot particles. The particle-tracking model built into the Forte CFD Package provides local, dynamic predictions of mean particle size and number density to support intelligent virtual prototyping. Forte software's exceptional ability to handle complex chemical models without a time-to-solution penalty allows the calculation of knock intensity with variations in conditions such as engine boost, spark timing, EGR and fuel. Virtual pressure sensors can capture pressure fluctuations from auto-ignition that lead to engine knock



Adaptive meshing balances mesh size, resolution and accuracy

ANSYS

ANSYS, Inc.
Southpointe
2600 ANSYS Drive
Canonsburg, PA 15317
U.S.A.
724.746.3304
ansysinfo@ansys.com

If you've ever seen a rocket launch, flown on an airplane, driven a car, used a computer, touched a mobile device, crossed a bridge or put on wearable technology, chances are you've used a product where ANSYS software played a critical role in its creation. ANSYS is the global leader in engineering simulation. We help the world's most innovative companies deliver radically better products to their customers. By offering the best and broadest portfolio of engineering simulation software, we help them solve the most complex design challenges and engineer products limited only by imagination.
Visit www.ansys.com for more information.