STAR-CD ENHANCEMENTS

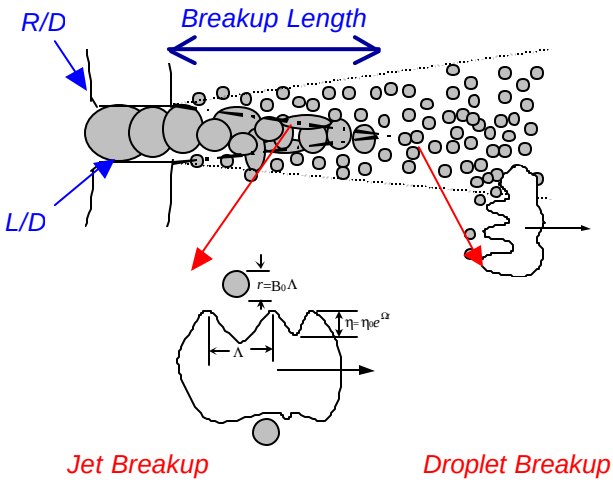
adapco modeling partnerships

University of Wisconsin - Engine Research Center KIVA Models

The University of Wisconsin's Engine Research Center (ERC) is widely recognized for its suite of physical models developed for in-cylinder simulations using the KIVA CFD program. Many of these models have now been adapted by the ERC for use with **STAR-CD** and are available as an add-on enhancement to the standard **STAR-CD** software.

At present, five Diesel models are available:

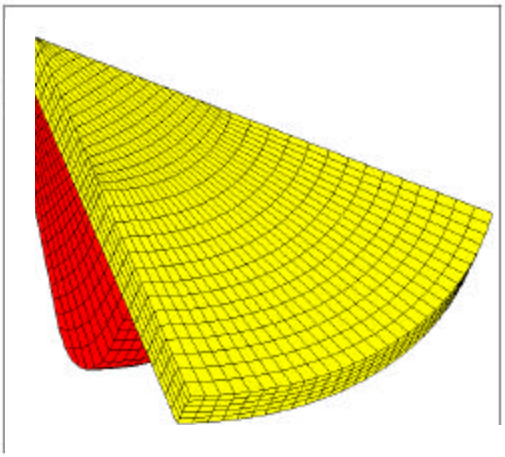
- A spray atomization model that combines a Kelvin-Helmholtz wave instability process for initial jet breakup with a Rayleigh-Taylor model for droplet aerodynamic breakup.



Schematic of ERC Atomization Model

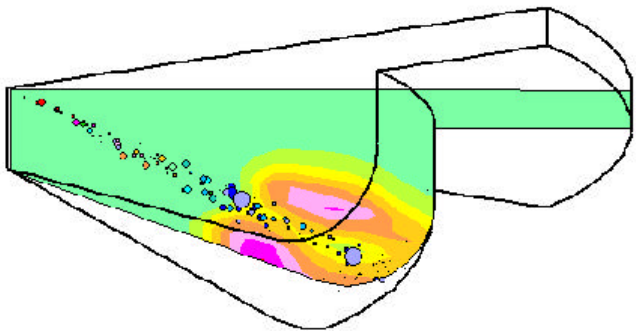
- The eight-step Shell model to describe the auto-ignition process, including low temperature chemistry.
- A laminar and turbulent characteristic timescale model for post-ignition combustion that considers seven species (fuel, O_2 , N_2 , CO, CO_2 , H_2 , and H_2O).
- A soot model that includes competition between soot formation and oxidation to obtain a net formation rate.
- A thermal NO_X formation model based on the extended Zel'dovich mechanism.

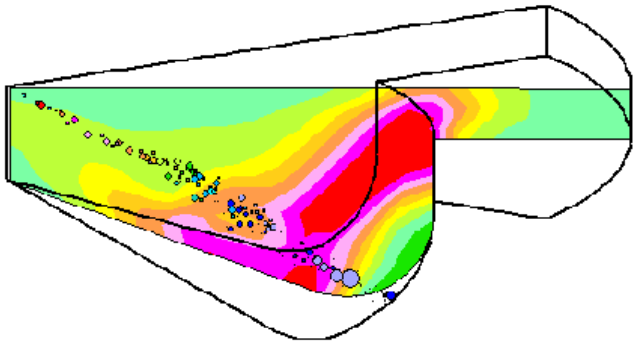
Validation studies are currently underway, with some preliminary calculations performed with a 60° sector analysis of the Caterpillar 3400 engine.



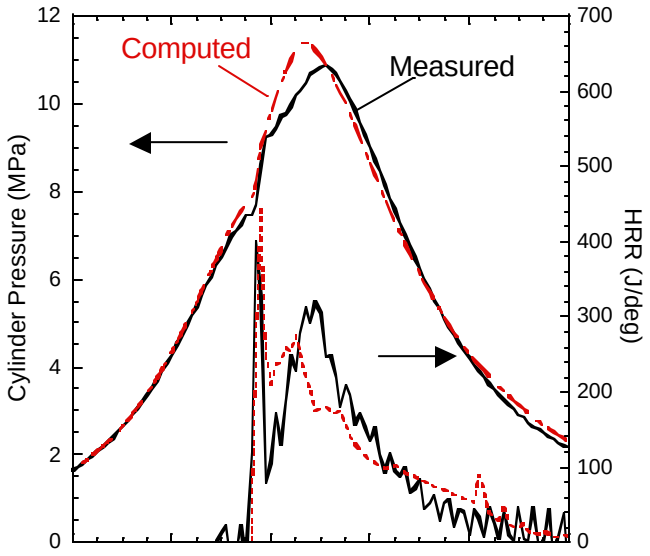
Sector Mesh for Caterpillar 3400 Simulations

A high load (75%), single injection (SOI = -9° ATDC) case was used to calibrate the ERC models implemented in **STAR-CD** with available experimental data.

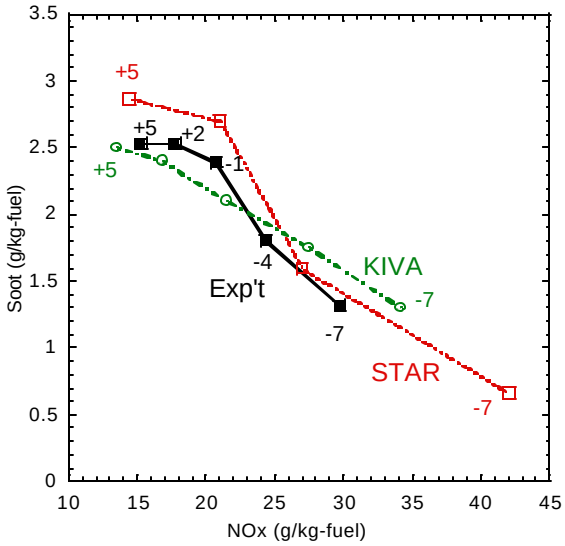




Spray distribution and temperature contours at ignition (top) and at peak pressure (center) for the baseline case. The plot below compares both cylinder pressure and heat release rate.



Once the models were calibrated, a series of calculations were performed at various combinations of loads, injection timings, etc. As the accompanying plot below demonstrates, the combination of **STAR-CD** with the ERC models correctly shows trends and provides semi-quantitatively accurate results.



Soot versus NO_X at high load for various injection timings (SOI relative to ATDC).

Additional comparisons for other conditions can be obtained from adapco and the Engine Research Center.

Work continues to make more of the ERC models available in **STAR-CD**, including: multi-component fuel vaporization, spray/wall interaction, liquid film, unsteady wall heat transfer,

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