reaction DESIGN

FORTÉ
Modeling Emissions from SI Engines

Spark-Ignition (SI) internal combustion engine designers are increasing their use of combustion simulation as they strive to meet new environmental regulations. Approaches such as stratified charge, controlled fuel injection, variable valve timing and Exhaust Gas Recirculation (EGR) are being used to improve engine performance and reduce emissions. This Solution Brief describes how FORTÉ can be used to simulate SI engine emissions of pollutants such as NO_x, CO and Unburned Hydrocarbon (UHC). This example is a port-injected gasoline engine with 4 valves and is modeled using FORTÉ's automatic mesh feature.

Setting Up in FORTÉ

Port fuel injection is approximated by a premixed, prevaporized blend of fuel and air in the intake port (see Figure 1). There are two exhaust and intake valves and the simulation domain includes the intake and exhaust manifolds. In other words, the initialization of the gas composition is used to specify the fuel-air mixture in the intake port region and perfect mixing within the port is assumed. The case is reacting flow, with a single-component 59-species fuel that is appropriate for engine simulations that are not concerned with knock.

The geometry is input into FORTÉ through an .stl file that is produced from a CAD system. The automatic mesh is defined with a global mesh size and some refinements near specific geometry features during portions of the cycle, such as near valves during opening and closing.

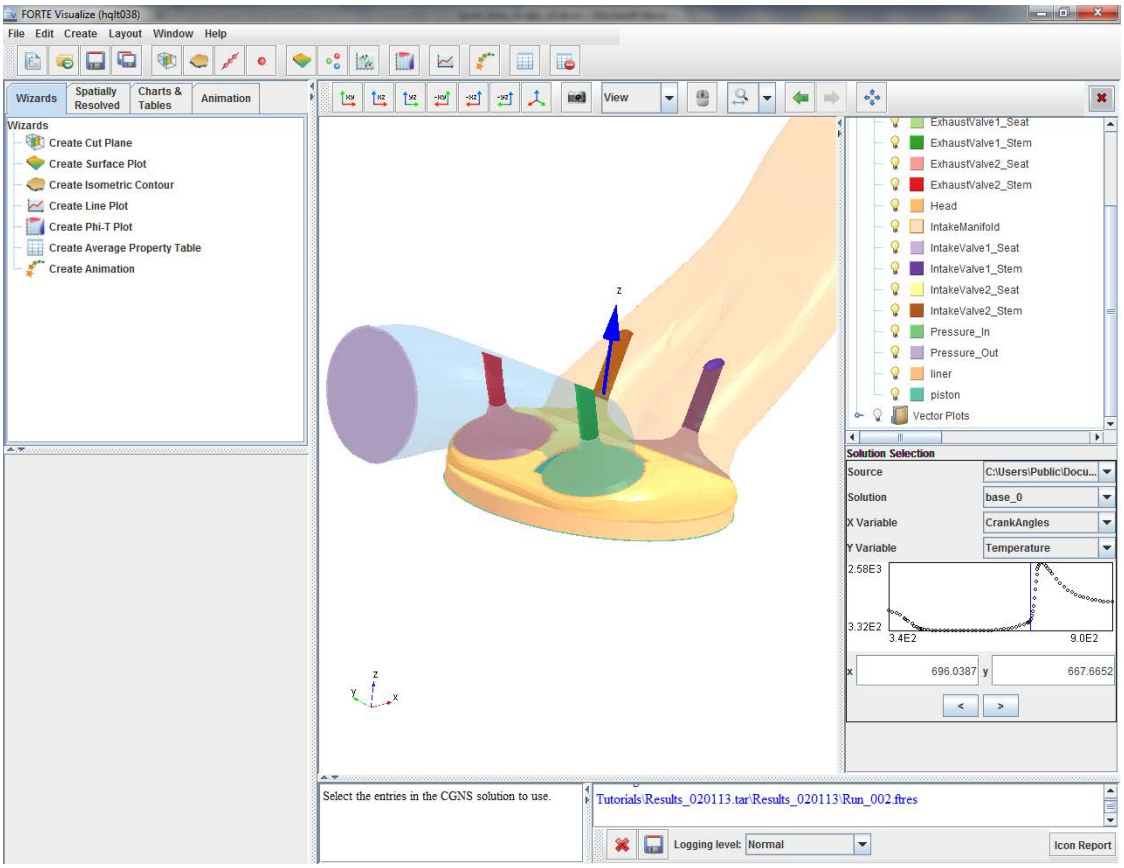

Figure 1. SI engine geometry in FORTÉ.

Results

It is easy to view the results of the SI engine simulation in FORTÉ's Visualizer, where wizards guide the creation of cut planes, line plots, contour plots and animations for reports or presentations. The pressure and heat release curves in Figure 2 show the impact of the spark at 688 CA and the subsequent flame propagation and heat release. The emissions of NO_x and CO are shown as Figure 3.

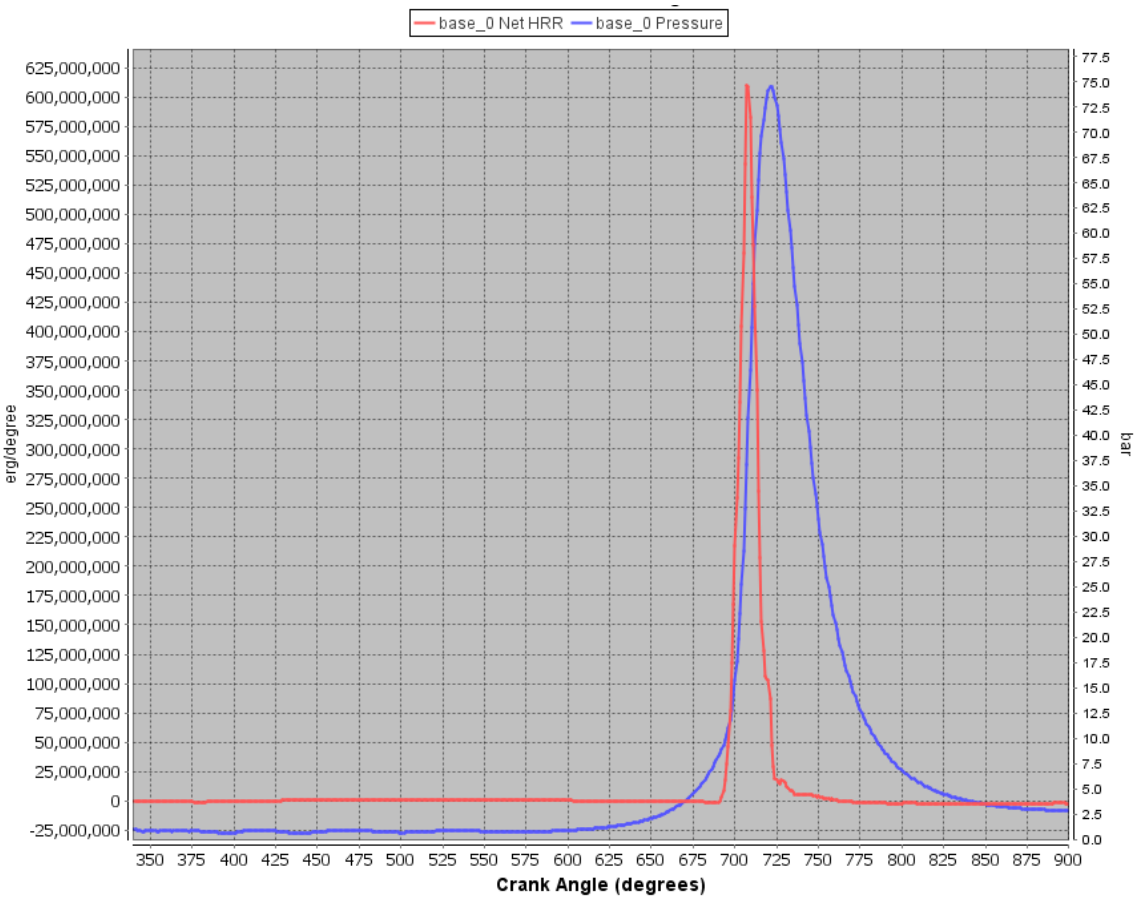

Figure 2. Pressure and heat release for SI engine simulation.

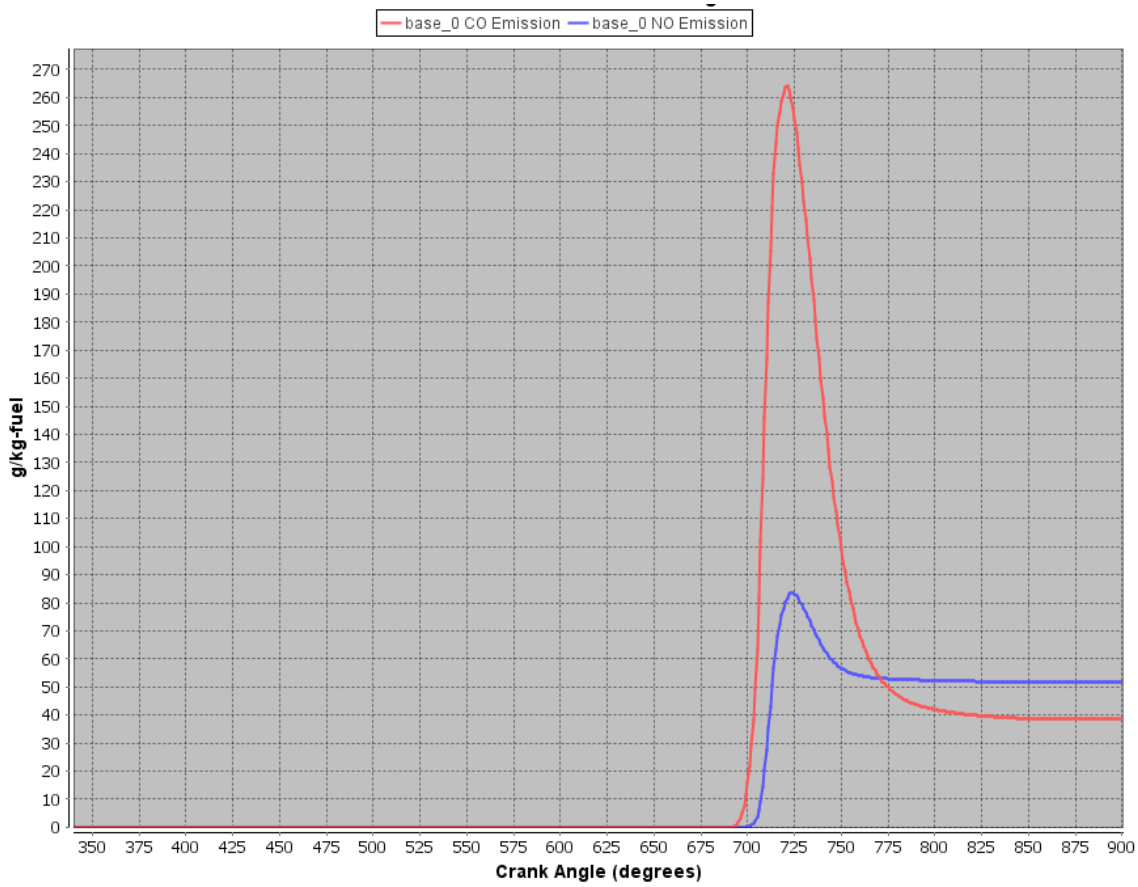

Figure 3. NO_x and CO emissions during the cycle.

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