

Overview of Modeling Selective Catalytic Reduction using ANSYS Technology

Jayesh Mutyal, Padmesh Mandloi, Stefano Orsino, Laz Foley, ANSYS Inc. Jayesh Mutyal, Padmesh Mandloi, Stefano Orsino, Laz Foley

Abstract:

Selective Catalytic Reduction is one of the most important ways to meet diesel NO_x emission norms. CAE modeling is a fast, easy and rather inexpensive way of studying the detailed flow and structure related physics in aftertreatment devices, especially SCR systems. From CFD standpoint, accurately modeling flow, heat transfer and chemical kinetics in a SCR system are very critical. The two most important steps in modeling SCR system are spray, evaporation and mixing of aqueous urea solution and the decomposition of this solution into iso-cyanic acid and ammonia. Design of injector and mixer in SCR system depend upon parameters like uniformity index at the inlet to substrate, pressure drop, eccentricity etc.

A semi-automatic process is developed using ANSYS Workbench for modeling SCR system. The process defines a very easy to use workflow right from importing CAD model of a SCR system to meshing the fluid as well as solid sections of the model, setting up the CFD problem using ANSYS FLUENT & post-processing the results to derive important output parameters like flow-uniformity, gamma index etc. Decomposition of urea solution is modeled using user-defined-subroutine. The inputs to this subroutine and to other SCR specific models are specified through a customized GUI which is fairly easy to use. The simulation setup is automated and saves time as well as avoids unnecessary human errors. For a parametric CAD model, with very limited user intervention the entire simulation process can be repeated for a modified model with different parameter value. The workflow can also be re-used for an altogether new CAD model, again with some small manual intervention. This unique feature of Workbench allows easy design evaluation of mixer and injector geometry. The temperature field on the mixer, injector deck and other important regions can be used to perform static-structural analysis to examine thermal stresses. The CFD specific work-flow can simply be extended to include this uni-directional transfer of information to perform FEA analysis within Workbench. An example is used to describe the CFD and FEA analysis along with parameterization and design optimization of SCR mixer geometry using Workbench.