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Modeling of Conjugate Heat Transfer including Radiation in a Kerosene/Air Certification Burner

Authors : Lancelot Boulet, Pierre Benard, Ghislain Lartigue, Vincent Moureau, Nicolas Chauvet, Sheddia Didorally

Abstract : International aeronautic standards demand a fire certification for engines that demonstrate their resistance. This demonstration relies on tests performed with prototype engines in the late stages of the development. Hardest tests require to place a kerosene standardized flame in front of the engine casing during a given time with imposed temperature and heat flux. The purpose of this work is to provide a better characterization of a kerosene/air certification burner in order to minimize the risks of test failure. A first Large-Eddy Simulation (LES) study of the certification burner permitted to model and simulate this burner, including both adiabatic and Conjugate Heat Transfer (CHT) computations. Carried out on unstructured grids with 40 million tetrahedral cells, using the finite-volume YALES2 code, spray combustion, forced convection on walls and conduction in the solid parts of the burner were coupled to achieve a detailed description of heat transfer. It highlighted the fact that conduction inside the solid has a real impact on the flame topology and the combustion regime. However, in the absence of radiative heat transfer, unrealistic temperature of the equipment was obtained. The aim of the present study is to include the radiative heat transfer in order to reach the same temperature given by experimental measurements. First, various test-cases are conducted to validate the coupling between the different heat solvers. Then, adiabatic case, CHT case, as well as CHT including radiative transfer are studied and compared. The LES model is finally applied to investigate the heat transfer in a flame impaction configuration. The aim is to progress on fire test modeling so as to reach a good confidence level as far as success of the certification test is concerned.

Keywords : conjugate heat transfer, fire resistance test, large-eddy simulation, radiative transfer, turbulent combustion
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