Paper ID: 5470
student

38th STUDENT CONFERENCE (E2)
Student Conference II (2)

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CFD SIMULATION OF HYDROGEN-OXYGEN AND METHANEOXYGEN SYSTEM FOR SPACE SHUTTLE MAIN COMBUSTION CHAMBER INCLUDING RADIATIVE EFFECTS

Abstract

This work investigates the influence of radiation on the total wall heat flux in a turbulent, chemical reacting flow through a rocket combustion chamber. The geometry of the combustion chamber is modelled as the Space Shuttle Main Engine (SSME) Main Combustion Chamber (MCC). Within a first study, the typical SSME combustion process involving liquid hydrogen (LH2) and liquid oxygen (LOX) is considered. The aim of this first study is to approximate the amount of total wall heat flux caused by radiation in hydrogen systems as well as getting an insight into capabilities of two state of the art commercial solvers, ANSYS CFX and FLUENT. To judge their capabilities, comparison to a benchmark is realised. A second study investigates the combustion of methane (CH4) and LOX, again focusing on the radiative wall heat flux and its influence on the total wall heat flux. Comparability to the LH2/LOX study is achieved by simulating methane combustion with the same thrust (first case) and with the same mass flow rate (second case) as in the hydrogen combustion. In both studies, turbulence is modelled using a modified k-epsilon model. Chemical reactions are simulated with the Eddy Dissipation Model (EDM) whereas radiation is employed with two different models, the moment based P1 model and the Discrete Transfer Model (DTM) that bases on the discrete ordinate method. A Weighted Sum of Grey Gases Model (WSGGM) is used to model the spectral properties of the participating media.