CFD Simulation of Internal Flowfield of Dual-mode Scramjet

C. Butcher[1], K. Yu[1]

[1]University of Maryland, College Park, MD, USA

Abstract

The complex internal flow field of a hypersonic air-breathing propulsion engine was modeled using COMSOL Multiphysics® software. This type of flow field can be found in a dual-mode scramjet engine. After creating the geometry, a 2D CFD simulation was run using the High Mach Number Flow physics interface in the CFD Module. A stationary time study was run and the results from the CFD simulation were compared with experimental data that were gathered from a model scramjet. Preliminary results from the simulation followed the trends in the model scramjet as shown in Figures 1 and 2. The general flow features and numerical data were similar in both the experimental and computational models. After matching the baseline non-reacting case, the simulation was altered to gain a better understanding of the physical processes that occur in a chemically reacting case undergoing supersonic combustion. The simulation was changed to match the model scramjet in areas such as the heat release profile generated from a chemical combustion reaction, the shock train formed upstream of the reaction zone, and the associated pressure profile. This was done using a series of heat sources and line mass sources in their respective locations. It is hoped that a heat release profile can be generated to match the model scramjet. The simulation was used to better understand the physical processes that occur and help predict the expected behavior in a realistic situation. This proved beneficial in reducing the time and costs associated with running more detailed experiments over a wider range of conditions.

Reference

Camilo Aguilera, EFFECT OF FIN-GUIDED FUEL INJECTION ON SUPERSONIC MIXING AND COMBUSTION (Doctoral dissertation), 2014.

Figures used in the abstract

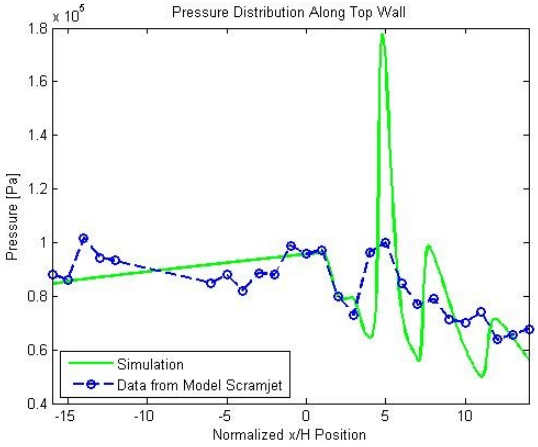

Figure 1: Pressure distribution along top wall in simulation vs. model scramjet [1].

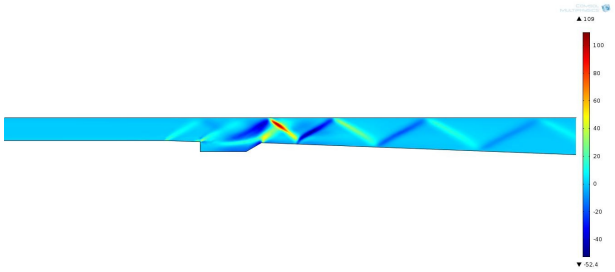

Figure 2: Density gradient plot showing series of oblique shocks that form downstream of the flame holding cavity.