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SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic Air-breathing and Combined Cycle Propulsion (9)

Author: Mr. Jimmy-John Hoste
University of Strathclyde, United Kingdom, jimmyjohn.hoste@strath.ac.uk

Dr. Marco Fossati
University of Strathclyde, United Kingdom, marco.fossati@strath.ac.uk
Dr. Ian Taylor
University of Glasgow, United Kingdom, Ian.Taylor@glasgow.ac.uk
Dr. Rowan Gollan
University of Queensland, Australia, r.gollan@uq.edu.au

MODELING SCRAMJET SUPERSONIC COMBUSTION VIA EDDY DISSIPATION MODEL

Abstract

Scramjet technology has gained considerable interest in multi-stage to orbit design concepts due to its reusability and high specific impulse at high-Mach regimes. When optimizing trajectories for these multi-stage design concepts, low-fidelity approaches are typically used to characterize the scramjet engine performance. There is a desire to increase the fidelity of the engine performance assessment by use of Reynolds Averaged Navier-Stokes (RANS) CFD calculations. The aim of the work presented here is to validate a RANS-based approach for scramjet engine performance.

As an accelerator for multi-stage vehicles, high Mach number ($\sim$ 7 - 12) scramjet engines are an attractive choice. In these high Mach number engines, the combustion process is limited by the rate of fuel-air mixing. Therefore, when simulating the performance of these engines, we seek a model for turbulence-chemistry interaction that can capture the turbulent mixing effect. A good candidate model appears to be the Eddy Dissipation Model (EDM) introduced by Magnussen and Mjertager, which assumes that turbulent motions and not chemistry is the main driver in the rate of combustion.

In this paper, we will investigate the suitability of the EDM for simulating the performance of high-Mach number scramjet engines. We intend to assess the suitability by comparison of numerical simulations to experimental scramjet engine results obtained in the University of Queensland's T4 shock tunnel.