Towards a less dissipative computation of detonation problems based on reduced chemical kinetics models

***Yi-Jhen Wu[1], †Yang-Yao Niu[1]**

[1]Department of Aerospace Engineering, Tamkang University, No.151, Yingzhuan Rd., Tamsui Dist., New Taipei City 25137, ROC.

*Presenting author: 811370013@o365.tku.edu.tw
†Corresponding author: yyniu@mail.tku.edu.tw

Abstract

In the field of oblique detonation wave engines (ODWEs), accurately predicting oblique detonation waves (ODWs) is crucial to their design. This study presents a successful development of reduced chemical kinetics models and an accurate hybrid flux splitting scheme to simulate flow discontinuities induced by oblique detonation. The proposed time-operator splitting method and AUSM+ numerical flux combined with the ATM (Average of THINC-EM and MUSCL) scheme aim to reduce the numerical stiffness commonly found in chemical reaction calculations. A grid-independent study was also conducted. The numerical results demonstrate clear capture of left-running transverse waves (LRTWs), smooth LRTWs, and abrupt left-running transverse waves (RRTWs) that construct the cells and triple points. The study also reveals that the wedge angle should fall within a specific range to avoid generating unstable ODWs and maintain the stability and performance of the ODWE. Furthermore, the proposed ATM reconstruction shows accurate simulation of discontinuous phenomena.

Keywords: Oblique detonation, flux splitting, shock wave, reduced chemical kinetics models