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Numerical investigation of shock train unsteady movement in a mixing duct

Lei Lu[1], Yi Wang[1*], Xiao-qiang Fan[1], Guo-wei Yan[1], Jing-wen Pan[2]

1 College of Aerospace Science and Engineering, National University of Defense Technology, Changsha 410073, China

2 Army Academy of Armored Forced, Beijing 100000, China

Abstract

Supersonic mixing layers and complex background waves exist in the mixing duct of the RBCC (Rocket-Based Combined Cycle) engine and supersonic-supersonic ejector. Different from the isolator with uniform incoming flow, the shock train in a mixing duct has special structures and motion characteristics. To study the characteristics of shock train forward movement in a mixing duct, a 2d unsteady numerical simulation was conducted. The results indicated that many unsteadiness factors existed in the background flow field such as the development of mixing layers, and multiple complex interactions. With backpressure linearly increasing over flow time, the shock train moved upstream in the process of which two forward movement patterns were found, namely slow pattern and jump pattern. Two patterns alternatively governed the whole forward movement, resulting in periodical changes of leading shock structures. The leading shocks were 'stretched' and 'squeezed' during the movement process, which was referred to as 'spring' characteristics in this research. Further analysis indicated that the characteristics of shock train movement were closely related to the background flow structure, or rather the surface pressure gradient. The shock train leading edges jumped forward in an adverse wall pressure gradient and crept forward in a favorable wall pressure gradient. The whole movement process consisted of 5 motion periods. In the 2nd

* Associate Professor, Corresponding author, E-mail: wange_nudt@163.com, Phone:+86 13574830605