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NUMERICAL SIMULATION STUDY ON THE SCALAR MIXING CHARACTERISTICS IN SUPERSONIC MIXING LAYERS

Abstract

A turbulent supersonic mixing layer plays a very important role on combustion performance of a dual-combustor ramjet (DCR). There exist huge difficulties for the characteristics study on the turbulent supersonic mixing layer, because the turbulent supersonic mixing layer has the high compressibility, complex turbulent structure and little shock wave structure. There are many literatures on momentum mixing characteristics of mixing layer. Considering that the scalar mixing efficiency will control the combustion efficiency of engine and the research work on the scalar mixing characteristics of the turbulent supersonic mixing layer with high Reynolds number is seldom, so the turbulent supersonic mixing layer with high Reynolds number is simulated numerically by the large eddy simulation method, and the influences of characteristic Reynolds number and compressibility on the scalar mixing characteristics of the turbulent supersonic mixing layer are studied and some conclusions are given as follows. Firstly, the influence of different flow parameters (e.g. Reynolds number, convective Mach number) is studied on momentum and scalar characteristics of supersonic mixing layer. The study of momentum characteristics proves that Reynolds number mainly makes contribution to completely mixed section, while the increase of convective Mach number will influence the whole flow field. Secondly, in terms of scalar characteristics, self-similarity is found. Different from unimodal distribution of momentum, scalar fluctuation and longitudinal pulse output show in the form of bimodal distribution. Furthermore, bimodal distribution will gradually turn into unimodal mode with the change of flow parameters. These findings on the supersonic mixing layer can provide more insight into the scalar mixing mechanism.