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Performance comparison of aero-ramp and transverse injector based on gas-pilot flame

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中文摘要:

A direct performance comparison between the four-hole aero-ramp injector and single transverse injector in a dual-mode scramjet combustor was conducted. The mixing characteristics of two injectors were calculated by solving the three-dimensional (3-D) compressible Reynolds-averaged Navier-Stokes equations (RANS), with the help of the shear-stress-transport (SST) k-ω turbulence model. The numerical results show that the far field mixing efficiency of the aero-ramp injector is higher than that of the single transverse injector. High enthalpy vitiated air was heated to a total temperature of 1200K by hydrogen-oxygen combustion, entering the isolator entrance at a Mach number of 2.0. Non-reacting experimental conditions involved sonic injection of nitrogen to safely simulate ethylene injected into the combustor at a jet-to-free stream momentum flux ratio of 2.6. Schlieren photographs were obtained to analyze the shock structure around the injectors. Reacting test conditions involved sonic injection of ethylene at the jet-to-free stream momentum flux ratios ranging from 0.5 to 2.7. High speed camera was used to capture the flame structures in the near-field combustion. The experimental results show that the aero-ramp injector produce sustained combustion over a wider range of fuel-air ratios than the single transverse injector. At the identical jet-to-free stream momentum flux ratio, the aero-ramp has a larger isolator margin than the single transverse injector, demonstrating a better ability for avoiding overflows. However, the air specific impulse and total temperature recovery of two injectors, which are calculated by the one-dimensional (1-D) performance analysis code, are almost identical.

英文摘要:

A direct performance comparison between the four-hole aero-ramp injector and single transverse injector in a dual-mode scramjet combustor was conducted. The mixing characteristics of two injectors were calculated by solving the three-dimensional (3-D) compressible Reynolds-averaged Navier-Stokes equations (RANS), with the help of the shear-stress-transport (SST) k-ω turbulence model. The numerical results show that the far field mixing efficiency of the aero-ramp injector is higher than that of the single transverse injector. High enthalpy vitiated air was heated to a total temperature of 1200K by hydrogen-oxygen combustion, entering the isolator entrance at a Mach number of 2.0. Non-reacting experimental conditions involved sonic injection of nitrogen to safely simulate ethylene injected into the combustor at a jet-to-free stream momentum flux ratio of 2.6. Schlieren photographs were obtained to analyze the shock structure around the injectors. Reacting test conditions involved sonic injection of ethylene at the jet-to-free stream momentum flux ratios ranging from 0.5 to 2.7. High speed camera was used to capture the flame structures in the near-field combustion. The experimental results show that the aero-ramp injector produce sustained combustion over a wider range of fuel-air ratios than the single transverse injector. At the identical jet-to-free stream momentum flux ratio, the aero-ramp has a larger isolator margin than the single transverse injector, demonstrating a better ability for avoiding overflows. However, the air specific impulse and total temperature recovery of two