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PRELIMINARY DESIGN OF HIGH SPEED TEST FACILITY FOR COUNTERFLOW JET EXPERIMENTS REDUCING HEAT AND DRAG

Abstract

Counterflow-jet is the method that injects high-pressure gas to the front of the supersonic vehicle to control the drag. Depending on the conditions of the counterflow-jet, the drag may increase or decrease, NASA have studied it also to the reentry vehicle to increase drag. Since the application of the counterflow-jet can also reduce the thermal load of the reentry vehicle, the counterflow-jet is one of the technologies that must be studied. Therefore, in this study, a free-jet type supersonic wind tunnel to experiment counterflow-jet is analyzed and studied. The free-jet type supersonic wind tunnel is supersonic wind tunnel with larger area in the test region than the nozzle exit area, and it has the advantage of having a greater blockage ratio than the closed-jet type supersonic wind tunnel. However, since the Mach number changes when the area changes in the supersonic flow, the Free-jet type supersonic wind tunnel has a disadvantage that it is hard to maintain a constant Mach number in the test region. Therefore, a study of supersonic diffuser conditions is conducted to find the condition that the Mach number of the test region is kept constant while maintaining the advantage of having a high blockage ratio. A supersonic diffuser is a device that changes the supersonic flow to a high pressure and a low velocity, thereby lowering the operating pressure ratio of the supersonic wind tunnel and controlling the pressure in the test region. In this study, a supersonic diffuser with a constant diameter is studied. To analyze the characteristics of supersonic diffuser, one-dimensional modeling is carried out. The supersonic wind tunnel is modeled by dividing the wind tunnel into three parts: the free-jet region from the supersonic nozzle to the diffuser inlet, the recapturing region from the diffuser inlet to the constant area, and the Fanno flow region which is constant area of supersonic diffuser. One-dimensional modeling analysis shows that the nozzle exit area and the diffuser exit area ratio, the distance from the nozzle exit to the diffuser and the diffuser diameter are variables that greatly influence the test region Mach number of the free-jet type supersonic wind tunnel. Although there is a limitation of one-dimensional analysis, this one-dimensional modeling is expected to help design free-jet-type supersonic wind tunnel. And the results of this study can be applied to manufacture the free-jet type supersonic wind tunnel.