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Hypersonic Air-breathing and Combined Cycle Propulsion, and Hypersonic Vehicle (7)

Author: Mr. Dong-xing HUO
Academy of Aerospace Solid Propulsion Technology, China Aerospace Science and Technology Corporation (CASC), China, 13572031651@163.com

INVESTIGATION ON THE REGULARITIES OF VFDR WORKING ENVELOPES

Abstract

In order to operate stably,several restrictions must be satisfied in a ramjet such as inlet stability,combustion stability,thrust-drag banlance,and so on.As for variable flow ducted rocket(VFDR),in addition to the missile attitude,the crucial restriction would be fuel gas generator pressure rather than fuel gas mass flow rate.In this paper,the performances of a VFDR with aft mounted dual intakes were calculated.All parameters of the engine in the full working envelope with altitude of 0km to 20km,velocity of 2Ma to 4Ma,incidence angle of 5° to 10°,side slip angle of 0° to 5° and excess air coefficient(EAC) of 0.1 to 5.0 were obtained.By using PERFORMANCE SHOW software, the 3D embodiments of working envelopes under intricate restrictions were figured in altitude - velocity - EAC coordinate system.Then,the regularities of working envelopes at 0° incidence angle and 0° side slip angle were quantitatively investigated.The results show that the working envelopes increase with the improving of the total pressure ratio,which is defined as Pt_2/Pt_{2cr}.When the total pressure ratio is 1,the stable working envelope volume ratio of the engine in the non-buzz state is 0.895.The working envelopes of the engine increase with the decreasing of the minimum fuel rich gas mass flow rate.Because the generator pressure can not be lower than the total pressure of the afterburner,the working envelope volume ratio is 0.826 under the minimum limit fuel rich gas mass flow rate.Increasing the maximum fuel rich gas flow rate can enlarge the working envelopes of the engine, but it will suffer from the weight of engine structure.The drag coefficient has a significant effect on the working envelopes of the engine. The larger the drag coefficient,the smaller the working envelopes available will be.Finally,the working envelopes and performance maps of the engine under two typical restrictions were presented.It is shown that working envelope volume ratio of 0.638 through 0.682 can be available for the VFDR studied in this paper.