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Hypersonic Air-breathing and Combined Cycle Propulsion (9)

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NUMERICAL STUDY OF THE IMPROVEMENT OF THE EJECTOR-JET PERFORMANCE IN THE RBCC ENGINE COMBUSTOR MODEL

Abstract

An air-breathing or rocket-based, combined cycle engine extracts oxygen from the atmosphere, so it can reduce the amount of oxygen for combustion on board. At launch, the engine produces the power by specially designed rockets placed in a combustor and gains even more power with secondary combustion with induced air flow. This cycle is called an ejector-jet and the ejector efficiency in the RBCC engine depends on the entrainment rate of the secondary flow (air). Ejectors are devices, which uses high velocity flow as an accelerator to the low speed induced air and the accelerations are achieved by the transfer of momentum and energy which will be shown as the dependence on the rocket nozzle configurations in this study. RBCC engines are being studied in Kakuda Space Center, a division of Japan Aerospace Exploration Agency (JAXA). Series of small scale tests of the RBCC engine are currently conducted as well as the large scale engine combustion tests. As for the ejector-jet mode of RBCC, the model with the rocket exhaust simulation devices were constructed and tested in various Mach regions. In addition to the plain rocket exit, by slicing off the rocket exit plane obliquely, two rocket nozzles called convex and concave were introduced and studied experimentally by Tani et al. Tani et al. found the remarkable difference of the pressure distributions for the concave configurations such as topwall pressure falls,i.e., the acceleration of the flow, in the high rocket pressure regions compared with other two cases. Since the model size was rather small, the data which can be obtained by experiments are limited and not enough to understand phenomena inside the RBCC engine in detail. One of the authors, Hasegawa, conducted numerical calculations in order to clarify flow fields inside the RBCC engine. Comparisons were provided between the experiments and calculations in regard with pressure distribution on the top wall. Numerical simulations were qualitatively good agreements with experimental results obtained by Tani and the phenomena of the inside the combustor model were discussed. After the verification of the numerical methodology, parametric study of the configurations was performed to get higher ejector-jet performance. The detail of the contents of my study is to be presented in the conference.