Paper ID: 3393
student

SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

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THE PROPELLANT MANAGEMENT OF THE PRECOOLED TURBOJET ENGINE

Abstract

We report an unsteady analysis with a fundamental experiment of the propellant management on the small precooled turbojet engine (S-engine) developed by JAXA (Japan Aerospace eXploration Agency). The S-engine has an air precooler using liquid hydrogen fuel which protects the compressor from the aerodynamic heating under the hypersonic flight and improves the engine performance (thrust and Isp). The precooler can expand the flight envelope of the turbojet to Mach 5 - 6.

The S-engine feeds liquid hydrogen fuel to two combustors; the main combustor and the after burner. As for the main combustor system, the liquid hydrogen fuel controlled by a regulation valve is first evaporated in the evaporator located after the turbine and supplied to the main combustor. The fuel is mainly used to drive the turbine. Meanwhile, most of the liquid hydrogen fuel is supplied to the afterburner through the precooler and regenerative cooling wall of the nozzle. The fuel is mainly used to cool the air and the high-temperature structures as well as the enhancement of the thrust.

The fuel management of the S-engine, especially during the engine startup is difficult because the S-engine needs the short duration start-up (20 sec) with keeping the temperature limit (950) of the non-cooling turbine. Additionally, the cryogenic fuel changes its phase such as gaseous phase, two phase, liquid phase by the heat capacity of the tubes and valves. The flow density passed through the flow regulation valve changes drastically and the control of the fuel rate is difficult.

In this research, we build an unsteady simulator to analyze the liquid hydrogen fuel management of the S-engine including the engine start-up. The simulator has the thermal fluid property model taking account of the phase change. We also show the fundamental experiment of the phase change of the cryogenic fluid to build the thermal property model.