SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (2) (5)

Author: Dr. Ganesh Paramasivan
ISRO Propulsion Complex, Mahendragiri, India, India

PERFORMANCE EVALUATION OF WATER - HOT GAS EJECTOR SYSTEM USED IN LIQUID ROCKET ENGINES

Abstract

A liquid-gas ejector system commonly known as thermal regulator is used in a pump-fed liquid rocket engine to supply hot-gas under regulated temperature for a prime mover in the electro-hydraulic engine gimbal control (EGC) system. Hot gas requirement for the prime mover is having inlet temperature of about 230-250 deg C and pressure of 36 bar. The temperature and pressure requirements of hot-gas is achieved using thermal regulator in which hot gas from gas generator (GG) at 600 deg C is a active gas and subsequently water is sucked into the system through the ejector mechanism. The ejector used here is a venturi type with an injection hole at the throat through which the hot gas sucks the water against the static pressure depression caused by the venturi effect. The inlet pressure for hot gas and water inlet conditions are maintained at the same pressure of 36 bar which implies that the water flow rate is governed by the hot gas flow rate conditions. It is observed while evaluating the engine performance that the hot gas temperature at the prime mover inlet is raised to 300 deg C and more which is the failure mode of the prime mover. This kind of temperature variation warranted the experimental characterization of the thermal regulator for better understanding of the phenomenon/parameters contributing the same.

In order to carry out the experimental evaluation of a thermal regulator system, high temperature (600 C) and high pressure (36 bar) hot gas i.e., 85 % super-heated steam is required. Hot gas source is designed by a novel way of diluting the combustion products of GH2 and GO2 operating at MR of 6 with water injection. The percentage of super heated steam is maintained similar as in the engine GG. The experiments were carried out by varying the operating conditions such as mass flow rate of hot gas, inlet pressure temperature to study the performance of a thermal regulator. The operating region of the thermal regulator for a nominal outlet temperature i.e. 230-250 C is mapped through the experimental results. The ground level observations through these experiments are having good agreement with the phenomena observed in the engine level. It is concluded from the experimental characterization that the phenomena of the outlet temperature variation was greatly influenced by the hot gas flow rate and threshold value of a hot gas flow rate for nominal operation was established.