IAF SPACE PROPULSION SYMPOSIUM (C4)
Propulsion System (1) (1)

Author: Ms. SHARMISTHA CHOUBEY
Indian Space Research Organization (ISRO), Liquid Propulsion Systems Centre (LPSC), India, sharmistha.choubey@gmail.com

Mr. Deepak K. Agarwal
Indian Space Research Organization (ISRO), India, dagarwal_iitk@yahoo.com
Mrs. Jayashree A.
Indian Space Research Organization (ISRO), India, a_jayashree@lpsc.gov.in
Dr. John T Tharakan
Indian Space Research Organization (ISRO), Liquid Propulsion Systems Centre (LPSC), India, tharakan12@gmail.com
Dr. Sunil Kumar S.
Indian Space Research Organization (ISRO), India, ted.prsg@gmail.com

# TESTING OF LOX METHANE ENGINE IN HIGH ALTITUDE TEST FACILITY

**Abstract**

Cryogenic engines employing liquid methane (LCH4) as fuel have advantage of higher density compared to liquid hydrogen (LH2), resulting in the former having lower stage mass and speed of hydrogen pump. Use of methane has added advantage due to its presence in Martian atmosphere, thereby making it an attractive fuel for interplanetary mission. This has led to worldwide development of LOX-LCH4 engines. ISRO is also developing a LOX-LCH4engine to be used in upper stage of its launch vehicle. Large area ratio rocket engines used in upper stages are tested on ground using a high altitude test (HAT) facility, which maintains low pressure at the exit of the engine by employing a diffuser-ejector system. Every HAT facility is uniquely designed for a particular engine based on its overall size, thrust and mass flow rate. The diffuser uses the momentum of the engine exhaust to form a positive isolation between the nozzle exit and the downstream through a series of complex oblique shock train.ISRO has established a high altitude test facility for the testing of its cryogenic engine, which uses a propellant combination of liquid oxygen (LOX) and liquid hydrogen (LH2). Numerical simulations are carried out in order to assess the possibility of testing LOX-LCH4 engine in this HAT facility. The performance of ejector is evaluated in terms of location of terminal shock in diffuser. The facility is protected from high temperature engine exhaust gases by means of cooling water flow through double walled diffuser section. Water in sprayed inside the HAT facility, downstream of the diffuser in order to cool the hot gases before reaching the ejector. The adequacy of water flow rates for both these systems during testing of LOX-LCH4 engine is also evaluated. Multiphase numerical simulations are carried out by solving Reynolds Averages Navier Stokes (RANS) equations, with water injection and evaporation modelled using Discrete Particle Model (DPM). Ejector recovery pressure and cooling water outlet temperatures are compared for LOX-LCH4 and LOX-LH2 engine testing to assess performance of HAT facility. The flow rates of ejector nozzle, jacket cooling and water injection are adjusted for LOX-LCH4 engine testing to achieve similar performance of the HAT facility.