SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (1) (3)

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DEVELOPMENT OF HIGH PERFORMANCE LIQUID APOGEE MOTOR FOR GEOSTATIONARY SPACECRAFT

Abstract

The 440N bipropellant Liquid Apogee Motor (LAM) is used for orbit raising of satellites from Geostationary Transfer Orbit to Geostationary Orbit. Liquid Propulsion Systems Centre(LPSC) of Indian Space Research Organisation(ISRO) has developed and qualified LAM and it was successfully used in thirty four spacecraft missions including Chandrayaan-1, the mission to moon and in Mangalyaan, the mission to Mars. The propellant combination employed is MON-3 MMH at a mixture ratio of 1.6. The engine with an area ratio(AR) of 160 delivers a thrust of 440 N with a specific impulse(ISP) of 315 s(nominal) which is the maximum reported in the international scenario for this class of engines having identical AR. LAM uses a single element coaxial swirl injector made of Titanium alloy. The thrust chamber is made of columbium alloy, silicide coated and radiation cooled and it is electron beam welded to the injector. Flow control valves used are of solenoid type with sliding plunger. The valves are assembled to the engine mechanically using two seals. ISRO is venturing to launch heavier satellites in near future and LPSC has undertaken a programme to develop an engine with improved performance. Towards this, a modified version of LAM with enhanced AR is designed. AR is enhanced from 160 to 250 to improve the ISP by over 1% which will result in a propellant saving thus extending the satellite life. The injector configuration remains the same as that of the existing LAM and the nozzle is redesigned for enhanced AR to achieve a higher thrust amplification factor. Two engines were realised and subjected to qualification level vibration and thermo vacuum tests. After this, the engines were subjected to qualification hot tests in high altitude facility. Both the engines showed a gain in ISP of over 1% with respect to nozzle with AR 160 thus validating the design modification. The engines were subjected to off nominal tests also and this version engine will be inducted to Geostationary Spacecrafts soon. This paper presents the details of the qualification tests carried out.