IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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DESIGN, DEVELOPMENT AND QUALIFICATION TESTING OF A HIGH PRESSURE GAS BOTTLE FOR A CRYOGENIC ROCKET STAGE.

Abstract

The pressure inside propellant tanks of the cryogenic stage of a launch vehicle is maintained by using high pressure cold Helium gas, stored inside high pressure gas bottles. These gas bottles are kept inside a liquid propellant tank to increase the storage capacity of the gas bottles. The material of construction of cryogenic gas bottles is Ti-6Al-4V-ELI grade Titanium alloy. These gas bottles are spherical in shape and have an inner volume of 60 liters. The gas bottles underwent an extensive qualification program, as part of developmental tests. Proof pressure tests, pressure hold tests and pressure cycling tests at various environments were carried out, in addition to environmental compatibility tests. One of the tests carried out as part of the qualification program was hydraulic burst test at room temperature. This test was carried out to find the structural capability of the gas bottle under internal pressure at room temperature. The burst pressure estimation and the prediction of strain values were carried out using elasto plastic finite element analysis and with tested material properties. Gas bottle burst at a pressure slightly higher than the predicted burst pressure. The test data and its analyses gave considerable insights into the behavior of a spherical pressure vessel made of relatively brittle material like Ti6Al4V. The margin on actual burst pressure over design ultimate pressure was 10 % at room temperature. Using fracture analysis tools, the real capability of the gas bottle at actual working environment was also estimated.