

IAF SPACE PROPULSION SYMPOSIUM (C4)
Liquid Propulsion (2) (2)

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DESIGN AND DEVELOPMENT OF A LARGE STROKE AND HIGH CYCLIC LIFE SOLENOID
VALVE FOR BI-PROPELLANT SPACECRAFT THRUSTERS**Abstract**

Indian Space program has developed bi-propellant thrusters of 10N to 1000N class for various spacecraft applications. As part of a recent development, a solenoid flow control valve (FCV) has been designed and tested for a 100N RCS engine. Typically, a pair of solenoid valves are installed in fuel and oxidiser lines which operate in tandem for pulse mode operation to admit/ cut-off propellant to the thruster. This paper discusses the design and development of a large stroke and high cyclic life FCV with a unique design feature in which an armature assembly is precisely guided in a flexure pack. This feature enables sliding free actuation and improved response characteristics (≤ 10 ms), consequently aiding in pulse mode operation. Requirements of stringent leak tightness (max. 1×10^{-5} sccs of He gas) and absence of self-generated contamination are also fulfilled. Flexure has been designed for a larger stroke while limiting the operating stress within endurance limit to achieve higher cyclic life (one million cycles). This arrangement also prevents the possibility of cold welding/ stiction between the sliding parts under space environment. Design of flow passage is made to meet a wide range of flow rate requirements. Magneto-static analysis has been carried out using Ansys Maxwell and the electromagnetic circuit has been optimized. Development tests were carried out and the design is validated. Performance of the valve was found to be satisfactory under all operating conditions (-7 deg C to +150 deg C) and one million cycles of operation has been demonstrated. Health of FCV was consistent throughout the life cycle test. Pressure drop through the valve has been characterized for various flow rates. These valves have undergone hot test with the thruster for 600 seconds satisfactorily. Keywords: Solenoid valve, RCS, flexure, pulse-mode operation, high cyclic life, magneto-static.