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DEVELOPMENT OF A NITROUS OXIDE-BASED MONOPROPELLANT PROPULSION SYSTEM FOR SMALL SATELLITES

Abstract

As the demand for highly capable microsatellite missions continues to grow, so too does the need for small yet effective satellite technologies. One area which needs to be addressed is compact propulsion systems capable of performing on-orbit maneuvers, station keeping, and de-orbit impulses with good efficiency. Another important consideration for propulsion systems is the safety and ease in handling, integrating, and testing the propulsion system. This is particularly important for small satellites in order to maintain simplicity by avoiding toxic propellants such as hydrazine. In response to this demand, the Space Flight Laboratory has developed its next generation propulsion system which builds on the experience of the Canadian Nanospace Advanced Propulsion System (CNAPS), a cold gas system that enabled the successful CanX-4/CanX-5 formation flying mission in 2014. The new propulsion system uses nitrous oxide (N2O) as the propellant. The benefits of nitrous oxide are that it is safe to handle, non toxic, cheap, and much easier to access and transport than traditional propellants. Nitrous oxide also self pressurizes to 50.5 bar (733 psi) at 20 C and thus does not require the addition of a pump or pressurant gas to move the propellant; this allows the tank and feed system design to be much simpler than for liquid propellants. Nitrous oxide can also be used as monopropellant, that is to say that it can be exothermically decomposed to provide an increase in efficiency from an input power point of view. This paper summarizes SFL's effort in the development of this system. A 100 mN resistojet was initially developed. The performance using nitrous oxide was verified with a specific impulse of 100 s and input power of ¡75 W. In the next stage of development, a monopropellant version of the thruster was developed. The 100 mN monopropellant thruster has successfully demonstrated sustainable nitrous oxide decomposition with a specific impulse of 148 s and operational endurance of greater than 50 hours. Current research focuses on evaluating different catalysts and further extending the operational lifetime of the system.