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EXPERIMENTAL INVESTIGATION OF A CONTINUOUSLY CONTROLLED PRESSURIZATION SYSTEM FOR REUSABLE LAUNCH VEHICLES

Abstract

At present, the aerospace transportation system is transforming from single-use to multiple use, in which a reusable and variable-thrust propulsion system is often essential. Usually, the pressure in propellant tanks is maintained within a narrow range required by rocket motors. This is achieved by continual supply of pressuring gas, which is controlled by solenoid valves and orifice plates. However, frequent on-off motion of solenoid valves often leads to wastage of sealing surface and fluctuation of pressure in the tank. Recently, a pressurization system based on variable area cavitating venturis is proposed to solve the limited reusability of existing pressuring systems. The venturi is equipped with a hyperbolic pintle which is actuated by a stepping motor. The mass flow rate of pressuring gas through the venturi is controlled linearly by the stepping motor. Simulation results indicate that the tank pressure can be continuously controlled in the system. In this paper, an experimental setup is established to investigate the performance of the continuously controlled system. Typically, 28 MPa helium gas from two 40 L cylinders flows through the venturi to pressurize a 2.1 m3 water tank. At the exit of the tank, a manual valve is used to simulate the load of variable-thrust rocket motors by changing the opening area of the valve. Tank pressure signals are detected by sensors to control the stepping motor in the venturi. In the tests, the pressure in the tank is kept within 0.402 0.406 MPa while the nearly 1.8 m3 water is discharged with a throttling ratio of 10:1. Experimental results show that the system can keep the tank pressure steadily and precisely around the target value in variable propellant mass flow rate cases. It is believed that the limited reusability of existing pressurization systems can hopefully be solved with this system. The requirement of large-range thrust regulation can also be fulfilled.