Suborbital Flight Preparation of the Pistonless Pump Technology Demonstrator

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Abstract

The Pistonless Pump Technology Demonstrator is a NASA funded project that aims to demonstrate pistonless pump technology for both launch vehicle and in-space applications. Pistonless pumps are a desirable alternative for these vehicles because they feature a simpler design that induces higher reliability. Through cooperation between academia, industry, and NASA, the team is developing a test bed for the pumping and transfer of a rocket propellant simulant in a relevant operational environment utilizing pistonless pump technology. The project has already begun hardware and design configuration testing. Pending NASA approval, this experiment will be manifested on Virgin Galactic's SpaceShipTwo reusable sub-orbital launch vehicle for space environment testing future testing.

Pistonless Pump System

Operating on pneumatic principles, a pistonless pump system features two or more small pumping chambers that draw fluid from a reservoir tank utilizing a pressurant gas. The fluid is then pressurized to a desired outlet pressure and ejected at a steady rate by cycling between pumping chambers. This results in a light-weight fluid pump that does not use any rotating machinery or physical pistons. It offers advantage over liquid rocket pump designs currently in use, which feature fast rotating impellers that, despite the high cost of development and manufacturing, are extremely sensitive to high vibration environments and two-phase fluid flow. While ground tests have been completed on this technology, comprehensive space environment testing is scheduled to increase the technology readiness level of this innovative design.

Experimental Demonstrator Design

The flight ready payload will feature a small pistonless pump system, with saturated water at ambient temperature and approximately 25 Torr as the working fluid (cryogenic simulant). Critical measurements for this experiment are fluid pressures entering and exiting the pump, fluid temperature, and a comprehensive video of the pistonless pump in startup, steady state, and power down conditions to observe fluid behavior and any off-gassing of the liquid.

Conclusions

Pistonless pump technology potentially offers an innovative solution to liquid rocket propellant pressurization, microgravity fluid transfer, and other in-space fluid pumping applications. The project team is aiming to test this technology in a relevant environment, and has already begun initial hardware testing. Virgin Galactic SpaceShipTwo vehicle flight preparations will be commenced shortly, and the team aims to be in a "flight-ready" state by mid-summer 2013.

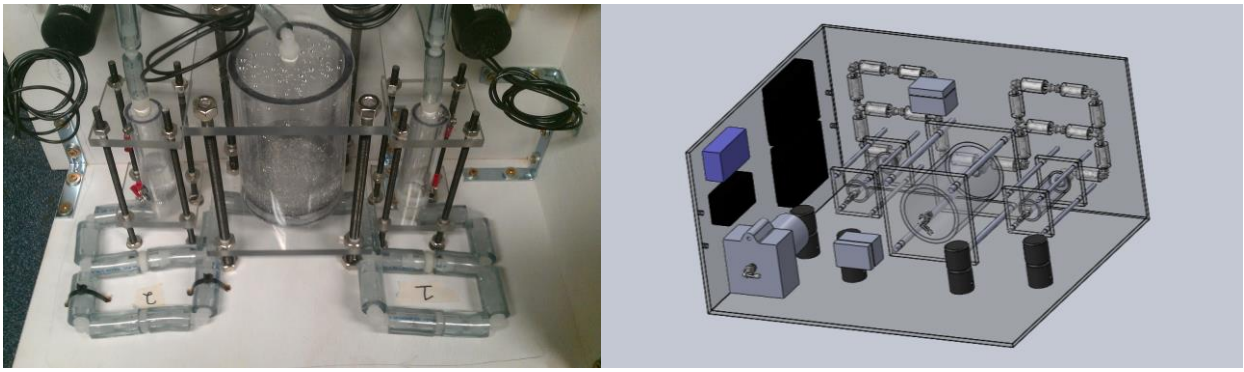

Fig 1: (left) Pistonless Pump Technology Demonstrator Mock-up Prototype **(right)** Current flight-ready design of the Pistonless Pump Technology Demonstrator Payload