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AN EFFECTIVE PISTON PRESSURIZATION SYSTEM FOR SPACECRAFT BIPROPELLANT TANKS

Abstract

In this paper we present a new form of propellant tank pressurization systems for bipropellant engine configurations and demonstrate its effectiveness in design simplicity, mass reduction, and cost savings on the system. This tank configuration is intended for liquid bipropellant launch vehicles with additional applications to spacecrafts, where precision and predictability of fluid mass flow are critical.

Currently, propellants are typically stored in separate tanks each with their own independent inert gas pressurant system. Such a system requires at least an additional tank to store the pressurant gas, additional plumbing, and a complex control system.

In this new design, both propellants are stored inside the same tank, separated by a piston head device, in a stacked configuration. The upper fluid is contained by another piston head, which is driven by an actuator. The actuator presses down on the fluids which in turn keeps them pressurized to the desired level. Doing so keeps both propellants at the same pressure and expels them with a proportional mass flow rate equal to the oxidizer-fuel ratio. This system offers advantages in its simple approach and reduced mass since both tanks are combined to one without the need for a separate pressurant system. While this paper demonstrates the design's cost savings, future research will more closely investigate the effect of propellant sloshing, and the control of the modal behaviors of the tank by adjusting the actuator's force pushing on the fluid.