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Title

Development of a dual-position oxidizer main valve

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Abstract

The flow of cryogenic liquid oxygen to the combustor in liquid rocket engines is controlled by a main oxidizer valve of which a faulty part could be catastrophic for any engine. Among the three valve types – poppet, butterfly, and ball – which are the most widely used as a shut-off valve, the poppet valve has proved to be the most reliable and versatile unit for rocket engine fluid control [1]. The poppet valve is connected to an actuator which converts the energy of high-pressure pilot gas to mechanical translation of the valve. This operation is accomplished by pressuring cavities and moving pistons, in this way, the valve is pushed and closed.

For extending the engine startup flexibility, a dual-position pneumatic poppet valve has been developed. An intermediately opened position is included in addition to the fully opened and closed positions. The dual-position valve is of help to reduce the abrupt impulse to the vehicle and engine by decreasing oxidizer flow rate during the engine startup. The engine startup using relatively small amount of propellants at sufficient high pressure insures stable engine ignition against hard start and prevents pump stall caused by a sudden supply of large mass flow rate [2]. Partially opened position is required for controlling and optimizing the engine start transient. A ball valve had been developed for providing a partially opened position with the adjustable stop system for the Vinci engine [3]. Two independent pilot gas supplies are needed for the three-positions actuator of the ball valve. However, the poppet valve in the present study can provide an intermediate position with one pilot gas supply. The function of a dual-position with one pilot gas supply is attractive as the simplification of the system configuration can lessen the risk of the engine failure by reducing its components.

The operating mechanism of the dual-position and the numerical analysis are presented to understand the effects of design parameters on the operating characteristics of the valve.

References

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