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PARAMETRIC OPTIMIZATION OF A BISTABLE ELECTROMECHANICAL VALVE ACTUATOR FOR TANK PRESSURIZATION

Abstract

Space propulsion components are required to fulfil high reliability while working under harsh thermal and mechanical environments. On the basis of a design that takes advantage of over 40 years of development and production of high performance valves, a parametric study is performed to examine possible new design approaches for a more robust and lighter final product.

The aim of this investigation is the parametric optimization of an electromagnetic tank pressurization valve actuator for the future European Ariane 6 launcher. It is a bistable design, in which a permanent magnet is used to hold a ball-poppet in closed or open position. The actuation from closed to open position and vice versa is achieved by electric command of a solenoid that surrounds the actuator. For the purpose of enhancing the current actuator design, optimization algorithms fed by two-dimensional finite element electromagnetic simulations are applied. A large number of input parameters and several objective functions are handled, such that mass, electric current, mechanical robustness and reliability requirements can be met.

The automatization of the simulation and optimization workflow offers the capability to shorten development cost and lead time, since the traditional arduous exchange between design and analysis departments can be minimized. At the same time, further insight and performance of the component is achieved at reduced cost throughout the optimization process.