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ACTIVE CONTROL DEVICES FOR ADVANCED SOLID PROPULSION

Abstract

In order to provide more flexibility and versatility to Solid Rocket Motors, Snecma Propulsion Solide has developed innovative CMC hot gas valve systems applicable to space propulsion, using the following enabling technologies :

- pintle throttling to modulate the combustion gases flow rate through the SRM nozzle(s)
- carbon / silicone carbide and carbon / carbon thermostructural thrusters compatible with very high temperature operations and long durations
- proportional electromechanical actuators with low response time
- metal free solid propellants with high energetic impulse and modulation capabilities
- electronic controls integrating the motor's pressure regulation and thrust vector management

These active control devices aim to adjust on demand the motor's pressure and thrust according to the system operational requirements, thus optimizing the use of the on-board propulsive energy (or SRM total impulse). They also provide lightweight and reactive thrust vector control with extended capabilities in comparison with conventional flexseal nozzles.

After a brief overview on Snecma Propulsion Solide background in the field of hot gas valves, this paper will address the following main topics :

- operational advantages of SRM regulation and energy management
- key technologies of the associated active control devices
- aerothermal and thermostructural analysis tools which have been consolidated thanks to a consistent data base of materials and parts behavior in real operating conditions
- real-time simulation tools and hardware to set-up the pressure control loop and thrust delivery strategies. The paper will include an overview of control and command design methodology and specific electronic platforms recently developed, which enable robust control performances and rapid prototyping.
- technology maturation conducted in the frame of RD programs funded by the French Defense Agency (DGA) and Snecma Propulsion Solide for tactical missile applications
- examples of feasible applications to space propulsion such as thrust modulated SRM or attitude control systems