Paper ID: 44008
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IAF SPACE PROPULSION SYMPOSIUM (C4)
Propulsion System (2) (2)

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# EFFECT OF PRESSURE LOSS DEVICES ON THE PERFORMANCE OF HYBRID ROCKET SYSTEMS

**Abstract**

Internal ballistic devices that are used to trip the gas flow such as blades, steps, diaphragms or screens are commonly implemented in hybrid rocket motors in order to improve the mixing in the system. Enhanced mixing typically leads to an improvement in the regression rates and combustion efficiencies. The major issues with the use of these elements are 1) the pressure drop associated with the gas flow over these obstacles, 2) additional weight and 3) additional system complexity and cost. Despite the fact that a total pressure drop leads to a reduction in the thrust specific fuel consumption for air breathing propulsion systems, rockets do not suffer a direct hit on their specific impulse. The objective of this paper is to outline a theoretical proof that any pressure drop encountered along the motor axis does not lead to a reduction in the thrust or specific impulse performance of the rocket system. The primary adverse effect of the pressure loss is on the structural mass fraction of the rocket system. Assuming that the pressure at the nozzle entrance does not change, pressure drop requires higher head end pressures leading to increased injector manifold and feed system pressures. Using some example cases, we have estimated the combustion efficiency improvement required to balance the structural mass fraction increase caused by the flow trip devices. Such analysis needs to be conducted to justify the use of pressure drop elements for each design. Even though these arguments were developed for hybrid rockets, the analysis and conclusions are valid for all other chemical rocket types as well (i.e. solids and liquids).