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Preliminary Performance of a Liquid Oxygen-Liquid Methane Pintle Injector for Thrust Variations

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Abstract : Due to the non-toxic nature and high performance in terms of vacuum specific impulse and density specific impulse, the combination of liquid oxygen and liquid methane have been identified as a promising option for future space vehicle systems. Applications requiring throttling capability include specific missions such as rendezvous, planetary landing and de-orbit as well as weapon systems. One key challenge in throttling liquid rocket engines is maintaining an adequate pressure drop across the injection elements, which is necessary to provide good propellant atomization and mixing as well as system stability. The potential scalability of pintle injectors, their great suitability to throttling and inherent combustion stability characteristics led to investigations using a variety of propellant combinations, including liquid oxygen and hydrogen and fluorine-oxygen and methane. Presented here are the preliminary performance and heat transfer information obtained during hot-fire testing of a pintle injector running on liquid oxygen and liquid methane propellants. The specific injector design selected for this purpose is a multi-configuration building block version with replaceable injection elements, providing flexibility to accommodate hardware modifications with minimum difficulty. On the basis of single point runs and the use of a copper/nickel segmented calorimetric combustion chamber and associated transient temperature measurement, the characteristic velocity efficiency, injector footprint and heat fluxes could be established for the first proposed pintle configuration as a function of injection velocity- and momentum-ratios. A description of the test-bench is presented as well as a discussion of irregularities encountered during testing, such as excessive heat flux into the pintle tip resulting from certain operating conditions.

Keywords : green propellants, hot-fire performance, rocket engine throttling, pintle injector
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