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UNDERSTANDING FIRE SAFETY FOR LIQUID PROPELLANT ROCKET ENGINES WITH VARIABLE LEAN INJECTION SYSTEMS

Abstract

Fire safety have been an integral aspect of a successful space mission. Liquid propellant engines are one of the key component of upper stage rocket propulsion system and have contributed significantly in the development of space flights and advanced space operations. The operation of liquid propulsion system depends heavily on the injection systems utilized. The combustion characteristics and thus the performance depends heavily on the effectiveness of injection systems. In the last five decades one of the key controlling issue, yet to be comprehensively addressed is the fire safety in rocket propulsion. The magnitude of the issue can be understood from the type of crashes, loss of systems, resources, facilities and every year huge amount of money being spent on research activities. Through appreciable and sufficient technological advancements have been made however, a closed form solution to the fire extinction is yet to be achieved owing to heterogeneous fire behavior.

Present work, intends to understand the fire phenomenon in liquid propellant engines with injection systems comprising of varying number of controlled injectors. The key controlling parameters viz., flame types, flame shape,flame structure, flame interactions, are investigated for varying orientations, flow rates, number of burners, type of configurations, type of fuel and inter-space distance. Systematic experimental study will be carried out with experimental setup(s) for the particular cases of spatial (linear and non-linearly placed injectors) and temporal (constant, intermittent and adaptive availability of injectors) configurations.

The work is expected to provide useful physical insight into the combustion phenomenon and for selected cases, the fire propagation in liquid propellant rocket engines. The data will be useful in validation, testing and design of futuristic missiles and liquid rocket engines for enhanced safety, performance, and spontaneity.