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Title:

“Review of Combustion Stability Characteristics of Swirl Coaxial Element Injectors”

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Abstract:

Liquid propellant rocket engine injectors using coaxial elements where the center liquid is swirled have become more common in the United States over the past several decades, although primarily for technology or advanced development programs. Currently, only one flight engine operates with this element type in the United States (the RL10 engine), while the element type is very common in Russian (and ex-Soviet) liquid propellant rocket engines. In the United States, the understanding of combustion stability characteristics of swirl coaxial element injectors is still very limited, despite the influx of experimental and theoretical information from Russia. The empirical and theoretical understanding is much less advanced than for the other prevalent liquid propellant rocket injector element types, the shear coaxial and like-on-like paired doublet. This paper compiles, compares and explores the combustion stability characteristics of swirl coaxial element injectors tested in the United States, dating back to J-2 and RL-10 development, and extending to very recent programs at the NASA MSFC using liquid oxygen and liquid methane and kerosene propellants. Included in this study are several other relatively recent design and test programs, including the Space Transportation Main Engine (STME), COBRA, J-2X, and the Common Extensible Cryogenic Engine (CECE). A presentation of the basic data characteristics is included, followed by an evaluation by several analysis techniques, including those included in Rocket Combustor Interactive Design and Analysis Computer Program (ROCCID), and methodologies described by Hewitt and Bazarov.