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Abstract

Propellant gels are used in some rocket engines to increase safety and increase system insensitivity to external threats. The viscoelastic properties of these gels allow the propellants to be stored in tanks as if they were solids and yet to flow like liquids under pressure into the engine. However, these viscoelastic properties can also affect their atomization and consequent hypergolic ignition and combustion. Gelled propellants sometimes exhibit longer ignition delays that can lead to hard starts and catastrophic engine damage. For gelled propellants to be viable in modern engine systems, the effect of the gel phase on the ignition must be understood. This work focused on the effect of the gel phase on fuel atomization. Spray experiments and detailed rheology measurements investigated the effect of the viscoelastic properties on the formation of impinging jet sprays. A series of sprays were imaged to compare among sprays of Newtonian oil and oil gels. The injector was an impinging type typical of those in rocket engines. Varying stream velocity and gel strength enabled comparison over ranges of momentum and viscoelastic properties. The spray images show marked differences in sheet formation, rim behavior, instability propagation, and drop formation. These differences can be attributed primarily to the increased elasticity of the gels. The elastic gels require substantially more momentum to form sprays. This spray formation behavior can be classified into regimes defined by ranges of elasticity number (El) and velocity.

Key words:
Gelled propellants, viscoelastic properties, impinging jet sprays