Rotating Detonation Rocket Engine Progress from the Air Force Research Laboratory

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Abstract:

Rotating detonation rocket engines (RDRE's) have the potential to improve rocket combustion systems through increased global performance and decreased total system cost. In the pursuit of realizing these benefits, the Air Force Research Laboratory is investigating the operability and performance of a 300 lbf thrust class RDRE through a joint experimental and modeling effort. For the experimental work, over 1000 successful hot-fire tests have been performed using gaseous methane (GCH_4) and oxygen (GO_2), encompassing a wide array of flow conditions with equivalence ratio ϕ ranging from $0.2 < \phi < 2.5$ and total propellant mass flow rate spanning $0.2\ \mathrm{lbm/s} < \dot{m}_{\mathrm{tot}} < 1.5\ \mathrm{lbm/s}$. Engine operability and engine performance (i.e., thrust and specific impulse) were quantified across this flow regime and it was found that the RDRE successfully operates in a detonative mode for each condition. Various hardware configurations have been tested including injection area variation, as well as multiple exit area constrictions. Automated image processing algorithms are used to resolve the average and instantaneous detonation propagation properties of the active operating mode. Complementary high-fidelity simulations have used the same annular RDRE geometry, modeling non-premixed discrete injectors and consequently yielding a realistic and non-idealized detonation. These computations show reasonable agreement with experimental pressures and wave speeds as well as the qualitative flowfield.

Speaker Biography:

Blaine received a Bachelor's degree in mechanical engineering from California State University Long Beach in 2016, and is currently pursuing an online Master's degree in aerospace engineering through the Georgia Institute of Technology. He has worked at the Air Force Research Laboratory for over 3 years, where he has most recently been working for ERC, Inc. as a research engineer, performing experimental work on rotating detonation rocket engines.