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MODELING AND SIMULATING DISTRIBUTED COMBUSTION IN SRM

Abstract

The aim of this work is to develop and implement a model for Al combustion in solid rocket motors. Investigation of distributed combustion in solid-propellant rockets is mandatory for an in deep understanding of aeroacoustic phenomena, ballistic/performance predictions, predictions of thermal loads and/or erosion, etc. In fact, aluminium droplets or agglomerates, constituting the principal component of the condensed phase evolving through combustion chamber and nozzle, burn generating micrometric particles of lower diameters and smoke of alumina. These particles, which density (number of particles for volume unit) is strongly affected by the flow field, undergo mechanical and chemical interactions with walls and the flow itself, affecting amplitude and frequency of the aeroacoustic phenomena. The ability to simulate these phenomena opens the door to the possibility of predicting the behaviour of nanometric particle distributions as well, which evolve and burn in the combustion chamber with different characteristic times and modes compared to particle distributions with a diameter in the order of tens or hundreds of microns. Based on lagrangian tracking of the particles, the proposed model represents an improvement of existing numerical models, "tuned" by using experimental data of Aluminium combustion available in literature. Particular attention has been focused on multiphase behaviour of the flow, including mutual particle-flow interaction and alumina particles break-up for both micro and nanometric Al distributions. Several simulations have been performed, comparing results in terms of temperature, pressure, vorticity field and residual mass fraction of un-burnt aluminium with available data. Based on the above results the presented model will be proposed for numerical simulations of multi-phase Aluminium combustion in large scale in SRM.