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ON THE STABILITY OF COMBUSTION INSTABILITY IN SPACE PROPULSION.

Abstract

One of most absolved issue in space propulsion is combustion instability. In a combustion dependent operation resulting in propulsion, it is imperative to detail comprehensive understanding of the combustion instability phenomenon for propulsive operations under varying conditions. The combustion instability is primarily studied in three categories, of which the most important is system instability. It is very difficult to draw any patterns from the applications leading to the intermittent or sudden lapse, crashes, failure. Present work represents an effort made to enhance understanding by considering the spray burner example to draw useful insight for upper stages. Systematic numerical simulations were carried on Fire Dynamics Simulator (FDS)–Smoke view (SMV) which is a Large eddy simulation (LES) computational fluid dynamics (CFD) model of low-speed fire driven fluid flow. The simulations emphasize on boundary condition oriented Navier Stokes equations for heat transfer from concerned fire systems. For selected open or confined fires, the governing equations are discretized in spatial and temporal domain. The spatial iterations are performed on a structured grid, with second order, central differencing or upwind schemes depending on the parameter. The temporal iterations are guided with second order, predictor-corrector method. The predictions are well supported by depiction of tracer particle flow, gas phase contours, temperature and flow vectors highlighting flow direction and magnitude in each plane computed from soot densities. Parametric variation of GHRR (Gross Heat release rate), flow rate, particle velocity, heat rate losses in the form of radiation, convection and conduction are thoroughly investigated to extract good physical insight. The numerical predictions are verified and validated with the conventional fire and heat transfer theory. The results are expected to be very useful for testing, validation and designing of futuristic space propulsion systems and in understanding the nature of sudden changes.