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Intermittent Effect of Coupled Thermal and Acoustic Sources on Combustion: A Spatial Perspective

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Abstract : Rockets have been known to have played a predominant role in spacecraft propulsion. The quintessential aspect of combustion-related requirements of a rocket engine is the minimization of the surrounding risks/hazards. Over time, it has become imperative to understand the combustion rate variation in presence of external energy source(s). Rocket propulsion represents a special domain of chemical propulsion assisted by high speed flows in presence of acoustics and thermal source(s). Jet noise leads to a significant loss of resources and every year a huge amount of financial aid is spent to prevent it. External heat source(s) induce high possibility of fire risk/hazards which can sufficiently endanger the operation of a space vehicle. Appreciable work had been done with justifiable simplification and emphasis on the linear variation of external energy source(s), which yields good physical insight but does not cater to accurate predictions. Present work experimentally attempts to understand the correlation between inter-energy conversions with the non-linear placement of external energy source(s). The work is motivated by the need to have better fire safety and enhanced combustion. The specific objectives of the work are a) To interpret the related energy transfer for combustion in presence of alternate external energy source(s) viz., thermal and acoustic, b) To fundamentally understand the role of key controlling parameters viz., separation distance, the number of the source(s), selected configurations and their non-linear variation to resemble real-life cases. An experimental setup was prepared using incense sticks as potential fuel and paraffin wax candles as the external energy source(s). The acoustics was generated using frequency generator, and source(s) were placed at selected locations. Non-equidistant parametric experimentation was carried out, and the effects were noted on regression rate changes. The results are expected to be very helpful in offering a new perspective into futuristic rocket designs and safety.

Keywords : combustion, acoustic energy, external energy sources, regression rate
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