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An Experimental Study on the Coupled Heat Source and Heat Sink Effects on Solid Rockets

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Abstract : Enhancing the rocket efficiency by controlling the external factors in solid rockets motors has been an active area of research for most of the terrestrial and extra-terrestrial system operations. Appreciable work has been done, but the complexity of the problem has prevented thorough understanding due to heterogenous heat and mass transfer. On record, severe issues have surfaced amounting to irreplaceable loss of mankind, instruments, facilities, and huge amount of money being invested every year. The coupled effect of an external heat source and external heat sink is an aspect yet to be articulated in combustion. Better understanding of this coupled phenomenon will induce higher safety standards, efficient missions, reduced hazard risks, with better designing, validation, and testing. The experiment will help in understanding the coupled effect of an external heat sink and heat source on the burning process, contributing in better combustion and fire safety, which are very important for efficient and safer rocket flights and space missions. Safety is the most prevalent issue in rockets, which assisted by poor combustion efficiency, emphasizes research efforts to evolve superior rockets. This signifies real, engineering, scientific, practical, systems and applications. One potential application is Solid Rocket Motors (S.R.M). The study may help in: (i) Understanding the effect on efficiency of core engines due to the primary boosters if considered as source, (ii) Choosing suitable heat sink materials for space missions so as to vary the efficiency of the solid rocket depending on the mission, (iii) Giving an idea about how the preheating of the successive stage due to previous stage acting as a source may affect the mission. The present work governs the temperature (resultant) and thus the heat transfer which is expected to be non-linear because of heterogeneous heat and mass transfer. The study will deepen the understanding of controlled inter-energy conversions and the coupled effect of external source/sink(s) surrounding the burning fuel eventually leading to better combustion thus, better propulsion. The work is motivated by the need to have enhanced fire safety and better rocket efficiency. The specific objective of the work is to understand the coupled effect of external heat source and sink on propellant burning and to investigate the role of key controlling parameters. Results as of now indicate that there exists a singularity in the coupled effect. The dominance of the external heat sink and heat source decides the relative rocket flight in Solid Rocket Motors (S.R.M).

Keywords : coupled effect, heat transfer, sink, solid rocket motors, source
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