The environmental impact of composite solid rocket propellants: where do we stand now?

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Abstract

Composite propellants typically contain ammonium perchlorate as main oxidizer. This molecule releases chlorine-based products which cause acidic behavior after their release in the atmosphere. Since the Space Shuttle era, chlorine-based exhaust products have been the target of studies and analyses. In time, the knowledge of solid propellant exhaust products on environment interaction has been analyzed, although some trends have been scrutinized more than others.

The interaction of chlorine-based combustion products with the stratosphere has been the target of extensive studies and, for example, the mechanism of ozone depletion is quite understood and characterized. This important milestone has been mostly obtained by the global attention on chlorine chemical reactivity stemming from the general advancement of knowledge on ozone layer depletion from humankind activities[1]. On the other hand, a lot is inferred but few is really known about the plume effects on ground, and almost nothing is available about mesosphere. In general, propulsion-specialized literature data for the different phases of a space launcher are sparse, lacking systematic collections and interpretation.

The lecture will briefly discuss the evolution of environmental impact awareness on solid propellants and the interconnection with green propulsion research trends. Then, the discussion will explore the (un)available knowledge based on the interaction between plume and environment. Finally, preliminary results of some recent experimental activities regarding on-ground potential contamination will be disclosed to the audience.

Given the complexity and the amplitude of the subject, the lecture will address the environmental impact only from the perspective of the most relevant aspects correlated to plume/environment interaction, without exploring the wider life-cycle perspective. The author will present his vision about the gaps that prevent from for a correct comprehension of the phenomena.

References

1) Sherwood, R.F. “Stratospheric Ozone Depletion”, Philos. Trans. R. Soc. Lond. B Biol. Sci., Vol. 361, 2006, pp.769–790.