COMPARING AP- AND AN-BASED PROPELLANTS WITH LOW ALUMINUM CONTENT

M. Fassina[1], S. Dossi[1], L.T. De Luca[2] and L. Galfetti[2]
Politecnico di Milano, Milan, MI, I-20156, Italy

The increasing interest for environmental conditions during last years has prompted efforts from several research groups to identify alternative and less polluting rocket propellant formulations. In particular, solid rocket propulsion is a well-known and developed technology, very employed for both civil and military applications, because it guarantees high performance and mission reliability. On the other hand, every motor flight, especially of big commercial transportation systems such as space launchers, has a considerable impact on the environment nearby the launch site and the surrounding atmosphere. In the very common case of Ammonium Perchlorate (AP)-based propellants, sensible pollution is due to the presence in the exhausts of Cl and HCl causing acid rains and ozone depletion. Ammonium Nitrate (AN) is considered a natural substitute of AP because of the absence of Cl and because of its low cost, which could greatly lower operative costs [1-2]. A full thermochemical analysis was carried out in terms of performance and pollution to examine the effects of introducing AN in place of AP.
Typical commercial solid rocket propellant formulations contain around 16-19% of micron-size Al (μAl) and thus produce a great amount of smoke (suspension of condensed-phase particles) that contains important levels of Aluminum Oxide Al_2O_3. This is detrimental to the delivered specific impulse because of the associated 2P flow losses, to the atmosphere quality because of the alumina particles that are deposited into the lower and upper regions of Earth atmosphere, and also to remote radar guidance because Al is a major contributor to free electrons in the plume of tactical rockets thus hindering electrical communications. In this work the exhaust smoke level was reduced by charging the propellant with only 4% nAl (to help stability). Also, to assess feasibility and compare pros/cons of AN vs. AP and nAl vs. μAl, the ballistic performance of 3 different propellant formulations was experimentally investigated: 1) AP-based, 2) AN-based, and 3) dual oxidizer (AP+AN)-based propellant, each loaded with 4% nAl [3].

References

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[1] PhD Candidate, Aerospace Engineering Dept., 34 via La Masa.
[2] Professor, Aerospace Engineering Dept., 34 via La Masa.