COMPARING BALLISTICS OF AP- vs. ADN-BASED COMPOSITE SOLID ROCKET PROPELLANTS

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For many decades composite solid rocket propellants aimed at space propulsion missions mainly used ammonium perchlorate (AP) as inorganic oxidizer, a common rubber (such as hydroxyl terminated polybutadiene, HTPB) as polymeric matrix and some high-energy metal (such as aluminum powder) as fuel. Although easily available and a well-known ingredient, AP suffers several drawbacks ranging from modest performance to appreciable toxicity, including a substantial production of hydrochloric acid.

In order to overcome these limitations, during last years several innovative oxidizers, such as ammonium dinitramide (ADN), CL-20, and hydrazinium nitroformate (HNF), were proposed as possible replacements of AP [1] [2] [3]. While the USA originated CL-20 revealed very expensive and the Dutch originated HNF proved too hazardous, the Russian originated ADN (first synthesized in 1971 at the Zelinsky Institute of Organic Chemistry in Moscow) attracted much attention for its good combination of valuable performance and great environmental respect. Detailed ballistic studies pointed out that ADN features the highest burning rate (up to 80 bar) as well as the lowest ballistic exponent among the above oxidizers tested as monopropellants [1]. When used in HTPB bound composite solid propellants as partial substitution of AP, ADN proved to be very effective for burning rate increment even in small quantities [2]. However, total replacement of AP with ADN leads to a good increase of not only burning rate, but also of the ballistic exponent approaching the critical value of unity [3].

In this work substitution of AP with ADN is experimentally assessed, by comparing a standard AP/HTPB/Al formulation to the corresponding ADN/HTPB/Al formulation in terms of burning rate and ballistic exponent. Thermochemical calculations are carried out to quantify the performance gain obtainable with ADN as well as the reduction of environmental impact. A preliminary characterization is performed of the ADN needles “as manufactured” and prilled ADN, with a typical size in the range 300 to 400 μm.

References

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