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# PARAFFIN-BASED FUELS FOR HYBRID PROPULSION: CHARACTERIZATION OF WAXES AND ITS BLENDS.

**Abstract**

Hybrid-propulsion systems are expected to be utilized in many applications, such as upper-stage orbital control purposes, and tactical and strategic missile systems. In the development of future high-performance hybrid rockets still exist a lot of challenges one of which is the continuation in the development of energetic fuels and oxidizers while acquiring more in-depth understanding of their ignition and combustion behavior. Paraffin waxes represent an important class of solid fuels because of high regression rate which is possible to obtain compared with traditional fuels. A rheological, thermal, mechanical and ballistic investigation on different compositions of paraffin-based solid fuels for hybrid propulsion is presented. Formulations containing different mass fraction of a styrene-based thermoplastic elastomer (Polystyrene-block-poly(ethylene-ran-butylene)-block-polystyrene grafted with maleic anhydride, named SEBS-MA) used for the strengthening of paraffin waxes have been investigated. Two different waxes named SASOL and GW and its formulations with polymer were characterized. A deep knowledge of the thermal, rheological and mechanical behavior of these blends is important in order to get a good solution between mechanical and ballistic properties. For better understanding an important parameter of entrainment phenomena it is needed to obtain a visco-elastic properties. The parameters such as viscosity, surface tension, elastic modulus were obtained and compared for investigated formulations. Rheological properties were investigated using a parallel plate rheometer. Thermal properties were studied using a differential scanning calorimeter (DSC) setup in order to obtain data about the transitions: solid/solid and solid/liquid transition. From mechanical characterization of blends the correlation between the most important parameters (Young's modulus, elongation at break, maximum load) and different waxes, mass fraction of polymer and elongation speeds was obtained. A physical interpretation of the behavior of paraffin waxes blended with the selected thermoplastic elastomer is discussed. Ballistic properties were investigated performing firing tests in a lab-scale hybrid motor using gaseous oxygen.