PURE PARAFFIN WAXES ANALYSIS FOR HYBRID ROCKET SOLID FUELS: RHEOLOGICAL, THERMAL AND MECHANICAL CHARACTERIZATION

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Abstract

Numerous fundamental studies have proved that by using paraffinic-based materials it can be possible to obtain higher regression rate values that can be achieved with conventional polymeric fuels. The melts of a paraffinic material led to obtain a low viscosity liquid layer due the hydrodynamic instability (entrainment effect) [1] from the liquid-phase interface and, basically to high regression rate values. Different paraffins were investigated, both macro-crystalline and micro-crystalline. The thermal, viscosimetric, rheological and mechanical properties were investigated. For thermal properties a Differential Scanner Calorimetry (DSC) was used and tests reveal that one part of the studied samples are containing, at least, two different fraction characterized by two well-defined melting peaks in the range of 30 – 36 °C and 52 – 54°C. Another sample reveal two melting peaks in the range of 42 - 46 °C and 62 - 64 °C, another in the range of 64 - 67 °C and 83 - 94 °C where the second one occurs at lower heat flow in respect to the other, and for another sample it is identifiable only one dominant melting peak in the range of 65 - 68 °C. Viscosimetric investigation was carried out using a rotational Couette viscosimeter. Some results reveal that from 50 s^{-1} to 630 s^{-1} the viscosity decreases from 0.14 to 0.009 Pa*s with a quasi-logarithmic behavior; in the range between 630 s^{-1} to 1259 s^{-1} the viscosity value was stable in the range 0.02 – 0.009 Pa*s. For rheological investigation a parallel plate rheometer [2] set-up was used and tests were performed with respect to shear rate and temperature. Then in order to analyze the mechanical behavior of these different pure waxes, tensile tests using a uniaxial elongational test machine were carried out at different load velocities. Some results reveal that, as expected, there is a direct proportionality between the applied tensile velocity and ultimate strenght values. A chemical characterization (gas-chromatography) of these paraffins was also carried out for a better comprehension of the thermo-physical behavior of these kind of waxy materials. In almost all macro-crystalline wax samples studied, two main different paraffinic fractions were detected: between C_{16} – C_{18} and C_{30} – C_{33}.

References

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