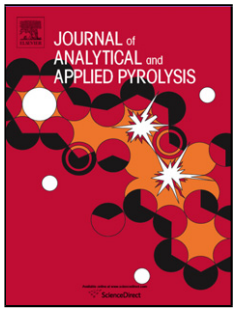

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Thermo-analytical study of 2,2,2-trinitroethyl-formate as a new oxidizer and its propellant based on a GAP matrix in comparison with ammonium dinitramide

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Highlights

- A new TNEF/GAP propellant was studied in comparison with ADN/GAP propellant.
- Thermo-analytical study of the samples were investigated by DSC and TG/DTG.
- Different methods were used to determine the decomposition kinetics of the samples.
- TNEF is a promising oxidizer which might be used in propellant formulation.

Abstract

A new high energy dense oxidizer (HEDO) 2,2,2-trinitroethyl-formate (TNEF) was prepared and characterized by nuclear magnetic resonance (NMR). A new propellant based on glycidyl azide polymer (GAP) and TNEF was prepared. Thermo-analytical study of TNEF in comparison with ammonium dinitramide (ADN) and their propellant formulations based on GAP were investigated. The decomposition gaseous products and the combustion characteristics of the propellants were determined by using thermodynamic code (EXPLO5_V6.03). Scanning electron microscope (SEM) technique was applied to clarify the crystal morphology of the oxidizers in addition to the homogeneity of the propellants ingredients. Impact and friction sensitivities of the oxidizers and the GAP binder were measured. Differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA) techniques were used to study the pyrolysis of the oxidizers as well as the prepared propellants. The decomposition kinetics were determined by Kissinger and Kissinger–Akahira–Sunose (KAS) methods. The thermal degradation of ADN is faster than TNEF oxidizer. ADN and TNEF have melting temperatures at 95.5 and 127.1 °C and maximum decomposition temperature at 183.5 and 210.1 °C respectively. In addition, TNEF has activation energy in the range of 131-146 kJ mol^{-1}, while ADN has activation energy in the range of 114-117 kJ mol^{-1}. TNEF has specific impulse (250.1 s) higher than ADN (202.4 s). TNEF is a promising oxidizer to be used in composite solid rocket propellants.

Keywords: TNEF; ADN; GAP; Thermal degradation; decomposition kinetics