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Thermal Decomposition Study of Paraffin Based Hybrid Rocket Fuel containing Aluminum and Boron additives

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HIGHLIGHTS

- Metallic additives enhanced the exothermicity of Combustion process.
- Metal additives in Paraffin-based fuel increased the peak exothermic temperature.
- Boron additive decreased the Activation Energy of the combustion process.

Abstract

Hybrid rocket fuels are considered safer compared to solid and liquid based rocket fuels due to operational and handling reasons. The thermal stability and combustion capability are important aspects determining the usability and their efficiency. In this work, thermal decomposition studies were carried out on Paraffin blended Polyethylene (P/PE)-based solid hybrid fuels incorporated with metallic additives under N_2 and O_2 environment using Differential Scanning Calorimeter (DSC). The metallic additives such as Aluminium (Al) and Boron (B) were added to increase the energy density. We observed that the combustion initiation temperature to be same for additive samples, whereas upward shift in the peak decomposition temperature for Al compared to B. The B samples exhibited higher heat release compared to Al samples. The peak decomposition temperature increased with increasing additives concentration in the Paraffin/PE matrix indicating the metal additives may be contributing to thermal stability. The kinetic parameters of thermal decomposition and combustion were evaluated and discussed for 5 % by weight loading of Al and B additives

Keywords: Solid fuels. Paraffin wax. Boron. Aluminium. Thermal decomposition. Activation Energy.

Nomenclature

β	Heating Rate (°C min^{-1})
T_p	Peak Temperature (°C)
A	Pre-exponential Factor (min^{-1})
R	Universal Gas Constant (kJ mol^{-1} K^{-1})
E_a	Activation Energy (kJ mol^{-1})
k	Rate Constant (s^{-1})
T_m	Melting Temperature (°C)
ΔH_m	Melting Enthalpy (J g^{-1})
ΔH_c	Enthalpy of Combustion (J g^{-1})
ΔH_p	Enthalpy of Pyrolysis (J g^{-1})