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Investigation on the Regression Rate of Additively Manufactured Polylactic Acid Nested Skeleton for Hybrid Rocket Motor

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Abstract
The low regression rate of conventional hybrid rocket motors (HRM) poses a significant challenge in the field. Due to its high regression rate, Paraffin wax has emerged as a promising hybrid rocket fuel. In this study, a 3D-printed skeleton is embedded within the paraffin grain to act as a secondary fuel while enhancing the mechanical properties of the fuel. Different types of skeletons utilising various infill designs available in 3D-printed slicer software employing PLA material were examined. The objective of the research is to evaluate the performance of armored grain with honeycomb, gyroid, and concentric designs PLA skeleton analytically using the internal ballistic model and static firings for the determination of thrust, regression rate, and specific impulse while comparing the ballistic response of the armored grains to that of pure paraffin-based fuels. The result shows the embedded skeletons significantly improved the regression rate of the paraffin fuel. The concentric PLA skeleton increased the regression rate by approximately 48.28%, achieving 1.29 mm/s, while the gyroid and honeycomb designs resulted in increases of 40.23% and 20.69%, respectively. Additionally, all PLA skeletons improved performance parameters compared to pure paraffin wax, with the concentric design showing a 28% increase in thrust (67.27 N vs. 60.3 N).

Author Keywords
Armored Grain; Hybrid Rocket; PLA; Regression Rate

Index Keywords
Armor, Ballistics, Honeycomb structures, Rocket engines, Rockets; Armored grain, Gyroids, Hybrid rocket motors, Hybrid rockets, Mechanical, PLA, Property, Regression rate, Rocket fuels, Secondary fuels; Musculoskeletal system

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