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Investigation on Regression Rate Behavior of Polylactic Acid Manufactured by Fused Deposition Modelling for Hybrid Rocket Motor

(2024) *Journal of Aeronautics, Astronautics and Aviation*, 56 (1), pp. 157-165.

DOI: 10.6125/JoAAA.202403_56(1S).08

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Abstract
This investigation focuses on the regression rate behavior of polylactic acid (PLA) manufactured by fused deposition modeling (FDM) for the hybrid rocket motor (HRM). HRMs generally have many advantages but they suffer from a low regression rate. In view of this, PLA produced by FDM potentially can offer a more environmental-friendly alternative. The primary objective of this study is to determine the regression rate of PLA in HRMs by exploring different geometrical configurations and porosities. Analytical analyses are conducted to evaluate the performance of PLA HRMs in terms of regression rate, thrust and specific impulse. PLA motors with varying configurations and porosities are designed and developed. Static firings are done to demonstrate the motor performance and the collected data is used to establish empirical correlations between regression rate, thrust and specific impulse. The results obtained from this study indicate a minimal percentage of deviation between analytical and experimental regression rates for the PLA use in HRM, ranging between 0.53% at a mass flux of 79 kg/m2s to 1.69% at 112 kg/m2s. For PLA motor configurations, employing a star port at a mass flux of 50 kg/m2s yields maximum specific impulse of 674.52 s. On the other hand, using a cylindrical port or a wagon wheel port at a mass flux of 150 kg/m2s results in minimum specific impulse of 80.34 s.

Author Keywords
Hybrid rocket motor; PLA; Polylactic acid; Regression rate

Index Keywords
Polyesters, Porosity, Regression analysis, Rocket engines; Environmental-friendly, Geometrical configurations, Hybrid rocket motors, Polylactic acid, Primary objective, Rate behavior, Regression rate, Specific impulse, Thrust impulse; Deposition

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Publisher: The Aeronautical and Astronautical Society of the Republic of China

ISSN: 19907710
Language of Original Document: English
Abbreviated Source Title: J. Aero. Astron. Aviat.
2-s2.0-85187551936
Document Type: Article
Publication Stage: Final
Source: Scopus