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STRUCTURAL ANALYSIS AND MANUFACTURING OPTIMIZATION OF A 35 KN COMPOSITE ROCKET ENGINE USING CARBON FIBER FILAMENT WINDING

Abstract

This paper presents a study on the structural analysis and manufacturing optimization of a 35 kN composite rocket engine that is designed using carbon fiber reinforced plastics (CFRP) filament winding. The objective of this study is to optimize the structural design and manufacturing process of the rocket engine to improve its performance, reliability, and cost-effectiveness. Carbon fiber filament winding offers several advantages over other composite manufacturing techniques, such as high strength-to-weight ratio.

The structural analysis of the rocket engine is performed using finite element analysis (FEA) software to determine the stress, strain, and deformation characteristics of the engine components under internal pressure loading condition. The results of the FEA are used to identify critical areas of the engine that require reinforcement or redesign to ensure structural integrity and safety.

The manufacturing optimization of the rocket engine is carried out using advanced manufacturing techniques, such as carbon fiber filament winding and additive manufacturing, to improve the quality, consistency, and efficiency of the manufacturing process. The optimization process includes the optimization of filament winding parameters, such as the winding angle, fiber tension, and fiber orientation, to minimize defects.

The optimization of the filament winding parameters is carried out using simulation tools that predict the fiber placement and compaction during the winding process. The simulation results are then used to adjust the winding parameters to achieve coverage while minimizing wrinkles, gaps, and overlaps. The fiber orientation is obtained from the winding parameters as well, although the orientation is mainly limited by the number of axes of the filament winder.

The results of the structural analysis and manufacturing optimization show that the composite rocket engine made using carbon fiber filament winding can be designed and manufactured to meet the required performance and safety factor with improved efficiency and reduced costs. The optimized design and manufacturing process could make rocket engines more accessible to researchers and industry professionals, leading to further innovation and advancement in the field of space exploration and rocket technology.