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A STUDY ON THE OPTIMUM DESIGN OF SOLID PROPELLANT GRAIN USING MACHINE LEARNING.

Abstract

The conventional solid propellant design process involves assuming an arbitrary shape, performing burn-back analysis to determine whether the requirements are met, and repeatedly modifying the design until the requirements are satisfied. This design method has the drawbacks of high design fatigue and varying design completeness depending on the designer's capabilities. To solve the problems of the conventional design method, this study proposes a method for optimally designing the propellant shape by introducing machine learning into burn-back analysis. The propellant shape was selected as the FINOCYL shape with a Cylinder-Taper-Slot section, which is frequently used for propellant shapes. Since machine learning requires a large amount of computation, the FINOCYL analytical burn-back code was developed to reduce the time and computation required for burn-back analysis. To program the FINOCYL analytical burn-back code, the FINOCYL shape was analyzed to classify the different combustion shape cases that occur during combustion, and a function was written to calculate the combustion area for each case. The FINOCYL analytical burn-back code was validated by comparing the results with the drafting burn-back analysis results and confirming that they are identical within the significant digits. Machine learning was performed using the burn-back analysis results of the FINOCYL analytical burn-back code, which quickly calculates the combustion area, to enable the designer to obtain the desired propellant shape profile. To verify the optimal design performance, the neutral combustion area profile and the dual thrust combustion area profile were optimally designed, and the errors between the optimal design results and the profiles were confirmed.