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ANALYSIS OF SOLID PROPELLANT COMBUSTION USING IMAGE PROCESSING TECHNIQUES

Abstract

Solid propellants are of immense importance in space technology as they offer the simplest design of rocket motors and serve as the first stage propulsion system in many launch vehicles. The performance of solid propellants is affected by chamber pressure, initial temperature, composition, and also by dynamic processes like combustion instabilities. A complete analysis of the burn characteristics of solid propellants generally necessitates multiple experiments, which may involve risks and errors. This research was aimed at a comprehensive study of solid propellant combustion with the application of multiple image processing techniques to analyze high-speed images from experiments in a Crawford bomb. The burn rates for different compositions at various pressures were evaluated solely from the images, by converting the images into digital data matrices, mapping the position of reference points and evaluating the average rate of change of the position. The dynamic behavior associated with the flame edge curvatures and with the integrated heat release rate were analyzed by treating the image sets as non-stationary time series and applying statistical tools and spectral methods. The results of this method were found to be in agreement with experimental and theoretical results. This method of analysis can potentially act as an accurate way of studying solid propellants with much-reduced risks.

Keywords: Solid propellant combustion, image processing techniques, time series analysis, spectral methods, statistical tools.