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Small Motor Testing for Determining the Burning Rate of Solid Propellant

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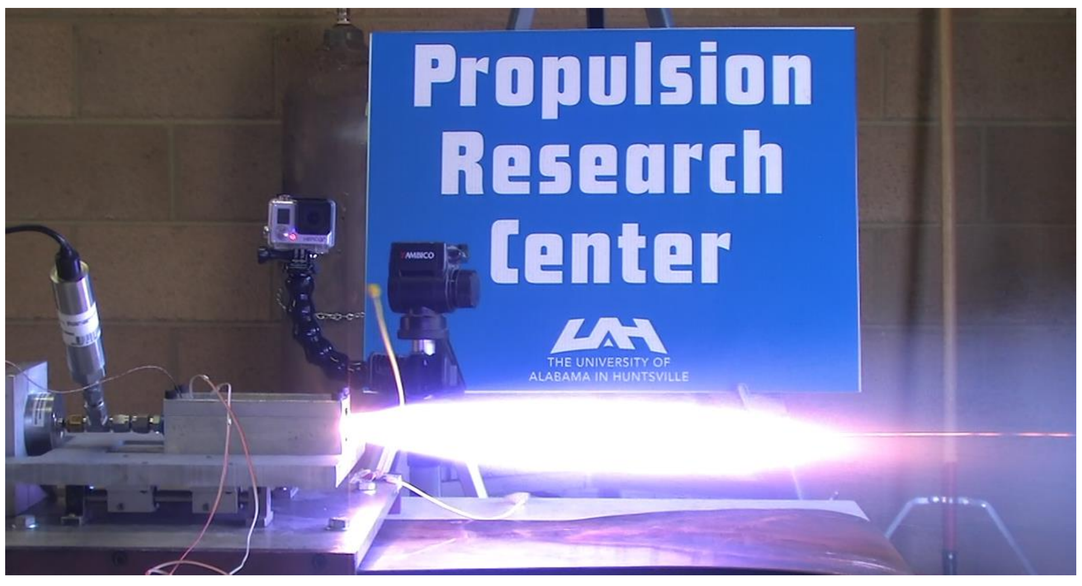
Overview

• This research investigation demonstrates an experimental approach for approximating burning rate as a function of pressure for an Aerotech G138T-14A solid rocket motor.

• In this experiment, the burning rate was determined using thrust and chamber pressure values acquired during hot-fire tests.

• Two types of nozzles, phenolic and copper, were tested for the same HTPB/AP composite solid rocket motor.

• The empirical equation for burning rate is $r = ap_1^n$, where r is the burning rate, a is the temperature coefficient, p_1 is the chamber pressure and n is the pressure exponent.

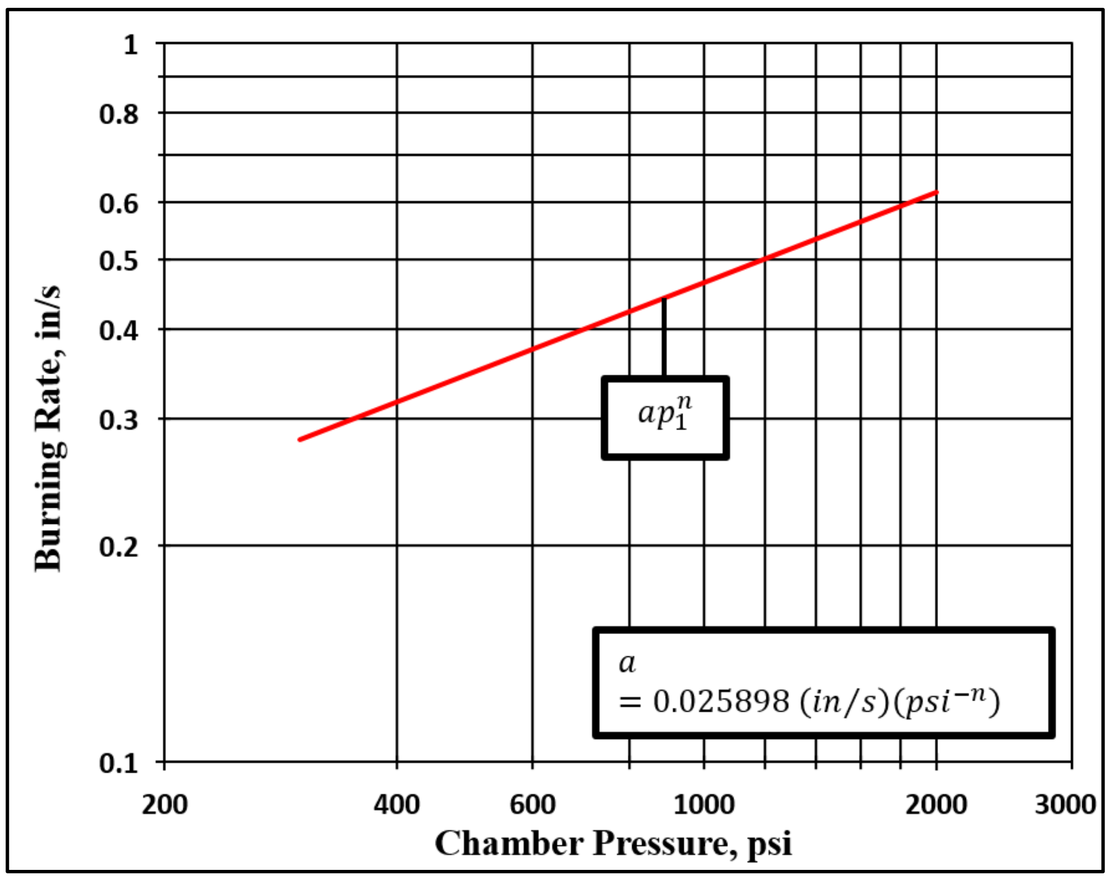


Impact

• This work illustrates an efficient approach for characterizing the burning rate for an unknown propellant formulation after a single hot-fire test.

• Developing this small motor analysis technique should assist in understanding the phenomena related to burning rate behavior.

Key Findings



• The pressure exponent and the temperature coefficient were found using burning rate relations, grain dimensions, nozzle throat area and thrust and chamber pressure data.

• Calculation of the pressure exponent was highly sensitive to small variations in thrust, chamber pressure and throat diameter measurements, but the findings were consistent with published values for similar propellants.

Explanation

• Success in solid rocket motor design and development depends significantly on knowledge of burning rate behavior of the solid propellant under all motor operating conditions.

• Analytical methods exist for preliminary estimates of the burning rate, but have not yet developed enough to predict the burning rate of a new propellant formulation, therefore new experimental techniques are of interest to the solid propellant community.

• The test data from this project were included in both the appendix of a advanced solid rocket propulsion textbook draft and in the Propulsion Research Center digital database.

Acknowledgements

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