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LITERATURE STUDIES AND EXPERIMENTAL CHARACTERIZATION OF MULTIPLE SOLID PROPELLANT REGRESSION RATES USING CRAWFORD BOMB METHOD AND ROCKET DESIGN ANALYSIS

Abstract

The relatively recent inclusion of the private sector into the space field has opened a wider range of opportunities to study the unknowns of the universe. Specially, an important effort is being devoted to enhance the propulsion systems currently available. By developing cheaper and safer rockets manufactured in a short amount of time, more experiments could be brought out to space, providing a priceless research to science.

One of the factors to achieve that success in solid propellant rocketry is by making an optimized nozzle and rocket design. However, this is not an easy task, as it requires knowing properties from the fuel being used that sometimes can only be got experimentally. This is the case for the *fuel average regression rate*, the parameter that drives the pressure in the combustion chamber for solid propellant rockets. This rate is calculated using the regression rate coefficient (a_o) and the regression rate exponent (n). Although some effort has been done to build models which can predict that quantity, there is still no comprehensive theory that can be used. Moreover, those values are generally held secretly, and they are unavailable for many propellant combinations. However, once this rate is known, it is possible to accurately design a solid propulsion rocket with the required performance.

As a result, due to the paramount importance of that parameter and those related coefficients, an extensive literature research on those values is done for different available solid propulsion propellants under different conditions. Therefore, all the experimental research is combined obtaining a straight table with the value of those coefficients. This research will serve as a very useful guideline for solid rockets' design. Moreover, different experimental tests are carried out to crosscheck the validity of those values. A modified version of the Crawford bomb method is used to accurate measure those values.

Other different fuel compositions are also analyzed, tested and reported using that strategy, with the goal of enhancing the knowledge about the current state of art in solid propellant rocket' fuels. Different additives are included to reach exotic propellant combinations for futuristic space missions. Experimental set-up and an overview of the prototypes and fuel composition is fully addressed. Finally, the paper

finalizes by using those values to design, test and analyze different nozzles adapted to the most suitable environmental pressure using the already tested propellants' types.