Mechanical Engineering Thesis Defense

Investigation of the Electrical Resistivity of a Perchlorate Oxidizer Based Electric Propellant Formulation

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abstract

In recent years, a new type of ionic salt based solid propellant, considered inert until the application of an electric current induces an electro-chemical reaction, has been under investigation due to its broad range of possible uses. However, while many electric propellant formulations and applications have been explored over the years, a fundamental understanding of the operational mechanisms of this propellant is necessary in order to move forward with development and implementation of this technology. It has been suggested that the metallic additive included in the formulation studied during this investigation may be playing an additional, currently unknown role in the operation and performance of the propellant. This study was designed to examine variations of an electric propellant formulation with the purpose of investigating propellant bulk volume electrical resistivity in order to attempt to determine information regarding the fundamental science behind the operation of this material. Within a set of fraction factorial experiments, variations of the propellant material made with tungsten, copper, carbon black, and no additive were manufactured using three different particle size ranges and three different volume percentage particle loadings. Each of these formulations (a total of 21 samples and 189 specimens) were tested for quantitative electrical resistivity values at three different pulse generator input voltage values. The data gathered from these experiments suggests that this electric propellant formulation's resistivity value does change based upon the included additive. The resulting data has also revealed a parabolic response behavior noticeable in the 2D and 3D additive loading percentage versus additive particle size visualizations, the lowest point of which, occurring at an approximately 2.3% additive loading percentage value, could be indicative of the effects of the percolation phenomena on this material. Finally, the investigation results have been loosely correlated to power consumption testing results from previous work that may indicate that it is possible to relate propellant electrical resistivity and operating requirements. Throughout this study, however, it is obvious based on the data gathered that more information is required to be certain of these conclusions and in order to fully understand how this technology can be controlled for future use.

November 29, 2018; 8:00 AM; ECG 335